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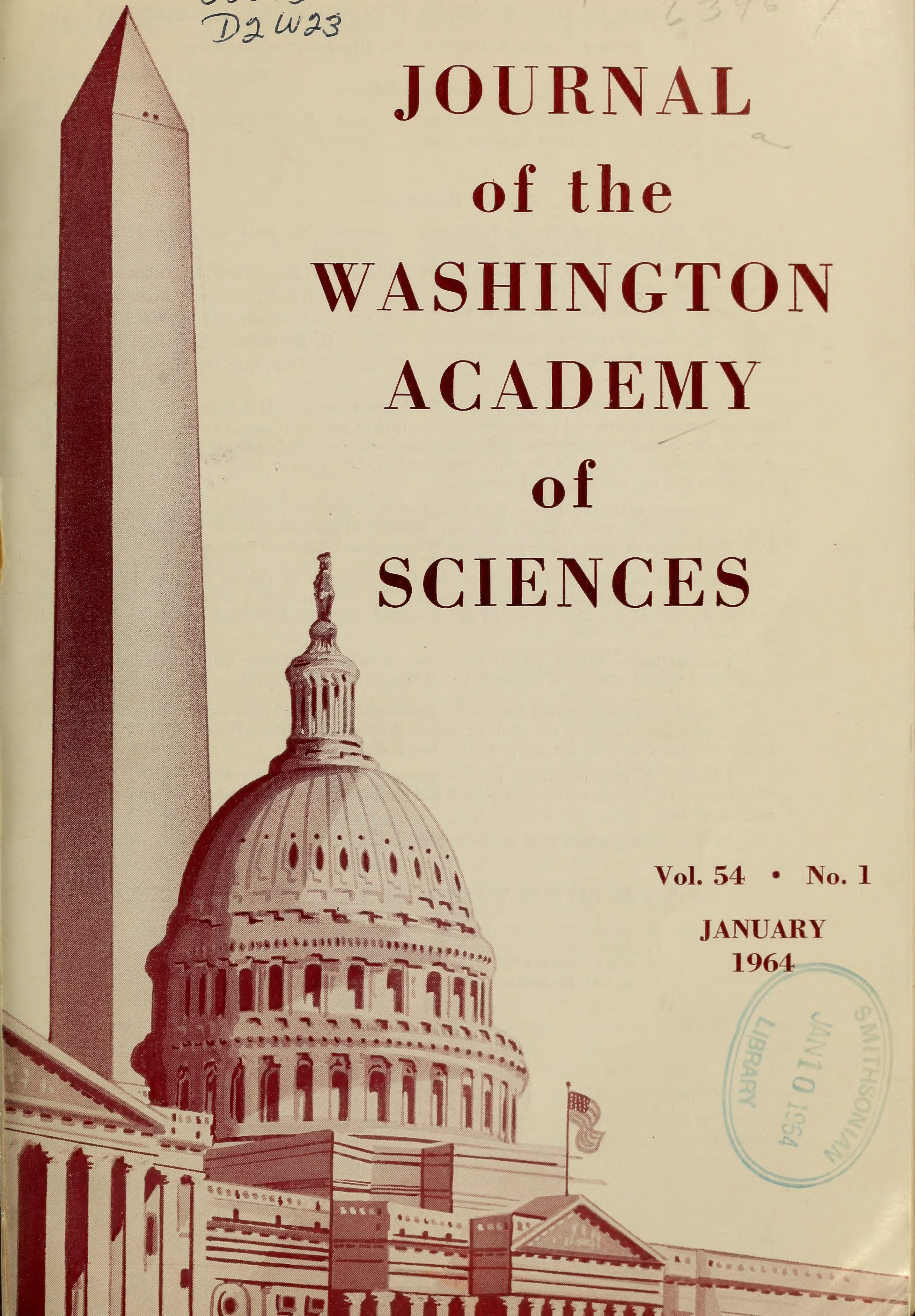

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Science Education for Tomorrow*

Raymond J. Seeger

National Science Foundation

Today's education is for tomorrow! Today's students are tomorrow's citizens! Today's lessons are for use 25 years from now! What is our outlook today for 1985?

What was our outlook for 1960 25 years ago, in 1935? Did we thrill our students with the unbelievable story of electromagnetic radiation that ranges from penetrating X-rays and colorful lights to radio-frequencies, low ones for sound and high ones for TV sights; radiation that would shortly include superhigh radio-frequency for radar defense and for radio-astronomy exploration? Or did we disregard science as being out of place in a world worried about social problems? Did we amaze our students with the new alchemy of nuclear transformations, soon to supply atomic energy for war and for peace? Or did we insist that physics even in a technical high school should be included in only one of 15 curricula, and then merely as an elective —just prior to the war sometimes called the physicists' war? Did we allow our students to play with ever fascinating numbers, about to flash in high-speed computing machines that would solve abandoned problems in physics, answer undreamed questions in sociology, guide flying messengers out into uncharted space? Or did we scoff at mathematics as a curious fossil belonging to an archaic education? Whatever our outlook in 1935, certainly it was too shortsighted for World War II and the post-war world.

What is our outlook in 1960 for 25 years hence, in 1985? Are we thrilling our students now with glimpses of the strange frontier of a new world of biology and medicine, seen from the wonderland of biophysics and biochemistry? Or are we relegating chemistry and physics to technical training, improper for the cultural heritage of a liberal education? Are we opening our students' eyes to the international vista of global sciences encompassing the trembling rocks beneath our feet, the restless seas on either hand, the glorious atmosphere above our head? Or are we focusing their attention upon technological gadgetry and national competition? Are we stimulating our students to probe logical techniques subtly involved in language, in mathematics, in science; to invent new thought patterns for our increasingly complex knowledge? Or are we dulling their thinking with the lethargic security of superficial surveys? Whatever our outlook in 1960, undoubtedly it will be too rigid for the new discoveries and exciting developments of our radically changing science.

Regardless of "what" and the "how" of current curriculum tactics, we need to be ever watchful for the "why" of new educational strategies. Let us watch out for science education for tomorrow!

In the first place, let us watch out for the unity of nature! The broad complexity of nature has forced man to approach it from narrow viewpoints. It is quite common nowadays to deplore the abandonment of comprehensive generalization for inadequate specialization. For example, take the familiar case of a falling body. In physics we are little concerned whether an elephant or a mouse slides down a smooth inclined

* Address at the dedication of the Science Building at Montgomery Junior College, October 20, 1960.

plane (the physicist's hill). The downward motion of either body is similarly described. As physicists, we have no occasion to be particularly interested in biological aspects. One day a lawyer visited me at the university. He began cautiously, "Are you a physicist?" In view of the sign on my office door I could not deny this vocation. By way of introduction he said, "Can you help me solve a case involving a falling body?" As a teacher of physics, I could not ignore this elementary problem. "A man leaned out of a third-story window and fell to the ground. Was it suicide?" he asked simply. Obviously a falling body, but far more complicated than the kind we are wont to study in physics. Perhaps as physicists, we become so engrossed in examining the fall that we actually forget the body. This tendency to abstraction has resulted in more serious consequences for larger intellectual areas. One of the best books dealing with mathematical hydrodynamics (published about 1932) refers casually to the basic law of the now common shockwaves of supersonic flow with a footnote: "no physical evidence is adduced in support of the proposed law." Likewise much of our modern mathematics may become too far removed from nature to be of immediate help in science—or even in mathematics. Certainly the danger of over-specialization may loom up at any moment.

On the other hand, specialization if pursued sufficiently close to one's goal leads inevitably to generalization. When I first joined the Foundation's staff, I was assigned the problem of outlining research programs, together with their budgetary requirements, for two years ahead in astronomy, in chemistry, in earth sciences, in engineering sciences, in mathematical sciences, and in physics. As an inquiring scholar I was overcome with the prospect; as a government servant I learned to overcome my scruples. In a short while I was proudly reviewing my budget justification. It dealt with fluid dynamics in astronomy, fluid dynamics in chemistry, fluid dynamics in earth sciences, fluid dynamics in engineering sciences, fluid dynamics in mathematical sciences, and fluid dynamics in physics. No wonder! I saw fluid dynamics everywhere—not just because I am a fluid dynamicist, but because fluid dynamics is all about us. It is not without reason, therefore, that the public has become increasingly familiar in recent times with aerophysics and atmospheric physics, with astrophysics and geophysics, with biophysics and chemical physics, with engineering physics and mathematical physics, etc. Physics, too, is everywhere.

The history of physics reveals striking instances where the answer to a particular problem has been obtained only by considering related problems. For example, in the eighteenth century many people showed considerable interest in the glamorous conduction of electricity in solids. The observational evidence, however, did not permit one to differentiate sharply between two possible theories: whether electricity is a single fluid or really two fluids—what might be called the electrical dilemma of the eighteenth century. In the nineteenth century some individuals investigated the less popular conduction of electricity in liquids. Here, too, a dilemma was soon apparent: whether electricity occurs as an continuous fluid or in discrete units. By this time, however, even research physicists were no longer challenged by the conduction of electricity in solids or in liquids—or in anything else. Nevertheless, the clue to both these electrical dilemmas was latent in the conduction of electricity in gases, a neglected field of physics until the end of the nineteenth century. The answer was the electron, a negatively charged particle, which alone moves in solids. About the same time as this discovery, X-rays were encountered. How! Although they afford a solution to a medical problem and the answer to a biological question, as to how to get inside an organism without surgery, I doubt if they would ever have been produced by any direct frontal attack—regardless of the availability of funds, private or public. The discovery of X-rays, indeed, was a byproduct of the curiosity of a physicist who was investigating an entirely different matter.

Complementary to the dead-end danger of overspecialization is the precipitous hazard of undergeneralization. Specialization is inadequate to solve any complex problem nowadays. For example, an engineer who desires to build an electric motor cannot be merely an electrical expert. He must know also about the properties of materials, the mechanics of structures, and the flow of heat, as well as about the behavior of electricity.

No matter where or when man goes in the universe, he finds always uniformity—nature is apparently the same everywhere. There is evidently an inter-relatedness, which suggests a coherent unity. Nature, indeed, is like a room. It can be entered by different doors, but regardless of the mode of entrance the room is still the same.

Nature is like a wheel. You may easily grab it on one outside spoke and I on another one, but as we move along the spokes nearer the center, we come also closer together. Do you recall the facetious remark that scientists are people who aim to learn more and more about less and less, whereas philosophers are those who strive to know less and less about more and more? The fact is that if we know all about anything, at the same time we know something about all. For something is a part of everything! Nature is whole; therefore, we must look at it whole. Watch out for the unity of nature! Do not be content with a partial view of the universe. Or, to translate this general principle into a specific rule: do not study any special science, like physics, except as a part of the general science of nature.

Let us watch out also for the simplicity of man! In all our experiences we soon realize that we are dealing with incomplete information. Note the line (a circular arc) that I have drawn upon the blackboard. What picture immediately comes to your mind? A whole circle? Your inference is quite incorrect. It is only that broken line which I wished to draw—nothing more. Man is always prone to extrapolate his partial data and to fill out the whole picture as he sees it (cf. the observed Great Dipper as the imagined Ursa Major).

Some years ago, when I was teaching college physics, I proudly told my class how the story of nature could be written with elementary words like atoms and molecules; how these, in turn, could be expressed with a universal PEN of three fundamental letters, namely Proton, Electron, Neutron. Perhaps it is fortunate that I am not teaching general physics nowadays, inasmuch as the number of elementary particles is approximately 30—as of this date.

Let us look for a moment at the elusive electron! What is it, really? "A particle!" immediately claim some. The ionization along the straight path of an electron in a cloud chamber indicates clearly a course like that of a moving particle. "No! An electron is a wave," insist others. The pattern formed by electrons passing through a thin sheet of metal is similar to the wave formation on a rippling surface of water. Well, what is an electron? Is it a particle, or is it a wave? This problem turned out to be one not so much of physical analysis, as of logical inference. What, indeed, are the definitive criteria for a particle? A linear path? But this requires precise knowledge of the position and velocity of the particle at every moment. For the determination of a propagated wave, in turn, one must measure precisely at any instant the energy of the disturbance. To our dismay we have learned from quantum mechanics that we cannot measure simultaneously with exact precision either the position and the velocity of an elementary particle, or the energy and the time of a wave. In other words, we have never been completely justified in stating that an electron is definitely a particle, or truly a wave. In view of our inexact data, we must humbly admit that under certain physical conditions an electron apparently behaves like a particle, whereas under others like a wave.

A child is engaged in solving a jig-saw puzzle. A visitor asks him, "What are those pieces?" "Oh," says the child proudly, "Those are the white caps of a blue sea." Later when the picture is completed, the visitor returns and exclaims, "Where are the white caps in the blue sea?" Disdainfully the child explains, "Those pieces were white clouds in a blue sky!" The same pieces fit together exactly as before, but the overall view has changed. As we form our pictures of nature out of our necessarily fragmentary information, consciously or unconsciously, we are inclined to make them simple. This is one of man's prejudices. In his provocative book, "Nature and the Greeks," Erwin Schrödinger, a Nobel prize winner in physics, recommends that nuclear physicists study Greek ideas. Why? Because the Greeks were experts in atomic theory? Of course not! On the contrary, we should become familiar with Greek thinking because they were prejudiced. What can ancient biases have to do with modern science? The fact is that we, too, are prejudiced! Unfortunately, at times we become sensitive to our own ingrained, orthodox opinions only by being shocked by the exposed, heretical attitudes of others.

Let us examine a few such examples of Greek prejudice. Three famous mathematical problems perplexed the Greeks, who tried unsuccessfully to solve them with only a straight edge and a compass: the duplication of a cube, the squaring of a circle, the trisection of an angle. It developed later that these problems are all unsolvable: the first because it involves an irrational number; and the second, a transcendental number. The trisection of an angle, it is true, can be solved, but not under the Greek stipulation. This limitation, therefore, evidently restricts the possible solutions. The narrower problem, which later yielded hidden treasures of modern mathematics, stunted the growth of Greek mathematics.

All of us, I suppose, are thrilled with the simple perfection of a circle. The Greeks thought that heavenly bodies would naturally move in perfect circles. Accordingly, they investigated only circular motions for planets despite their knowledge of the more descriptive ellipse. The progress of theoretical celestial mechanics was thus retarded for 1800 years.

One other incident! Are you familiar with the Greek number system? If so, you recall that each letter of the alphabet represented a different number: alpha for one, beta for two, gamma for three, etc. If you have ever tried to add or subtract such Greek numbers, you realize why the Greeks never made much progress in arithmetic. What arithmetical success they did have was acheieved solely through ingenious, but often cumbersome geometric techniques. If only they had eradicated the deep-rooted prejudice favoring their own system of numbers and had cultivated the fruitful seeds of other civilizations, they might have contributed as much to arithmetic as to geometry. As we look at Greek mathematics from the prespective of history, we become increasingly aware of the importance of Greek presuppositions.

Man's mind is able to play so significant a role in intellectual history because of the very comprehensibility of nature. Einstein once remarked that the one thing about the universe incomprehensible to him is its comprehensibility. Not only is nature seemingly reasonable, but it is understandable in man's own language. You may recall the story of Winnie-the-Pooh's search for a Woozle. As he was going around a spinney of larch trees, he espied the tracks of a strange animal. He invited his friend Piglet to help him trace the owner of these unknown tracks. Each time they went around the spinney, they noticed additional sets of similar tracks—their own. In one of his books, Eddington tells of a strange footprint that man has found impressed upon the intellectual sediments of natural phenomena—it is man's. To a large degree nature is simple because man regards it as simple. What we see is often merely a reflection of what we wish to see.

Watch out, therefore, for the simplicity of man! Do not be content with a childish view of the universe. Or, to translate this general principle into a specific rule: do not study any science without understanding the limitations of its data and of its method.

Finally, let us watch out for the humanism of science. About a hundred years ago we rejoiced in the birth of the science of sociology. Only in the last 25 years, however, have we begun to appreciate the growth of the sociology of science. We have learned that no single criterion is sufficient for the social acceptability of the truth of a scientific theory—not even the necessary condition that it be true to observations. Take, for example, the Copernican theory. Both the heliocentric and geocentric hypotheses of the sixteenth century satisfied equally well the astronomical observations of that day. The distinctive advantage of the Copernican theory was its mathematical convenience. The Ptolemaic theory, on the other hand, was akin to common sense, and seemed to fit in better with the popular philosophy. No wonder that the geocentric view was generally more acceptable to the intellectual class. Not only does the development of science determine to some degree the future of history, but the history of the past also influences in some measure the development of science. The very inter-relations of the several sciences find expression in a unity of science—what might be called the philosophy of science.

Even the physical sciences can and do make evident contributions to the meaning of the social sciences. For example, consider a person's ethics (in essence, applied sociology). Regardless of what a scientist may do as a man, as a scientist he is irrevocably bound by an absolute truthfulness to the observed data and to their reasonable interpretation. Lying is out of place in a physics laboratory! One wonders if the social sciences will ultimately have to subscribe to this same principle, which has been so successful in the physical sciences.

What about social problems? for example, the critical improvement of international relations. How are we to achieve mutual understanding? First of all, we must have common interests in order to have a common ground even for the meeting of people—not to say, of minds. Politics and religion are hardly attractive subjects to draw all men together. The only common denominator apparently in sight is science. Regardless of creed or color or country, peoples from all over the earth discuss with one another, freely and joyously, natural phenomena and man's understanding of them. Science may well become a stepping stone, rather than a supposed stumbling block, to the achievement of world peace.

Let us consider spiritual values! In the vastness of the universe, in its comprehensibility through reason, in the carefulness of its details, all of us are inspired with a mystical feeling of empathetic wholeness. The nature of God, I believe, can be inferred to some extent from His imprint upon nature. The heavens do declare the glory of God to His children.

Thus we see that man's everyday relations, his problems of personal ethics, his social problems like international relations, his spiritual values of supernatural religion, all are imbedded in science to varying depths. We cannot study science without being involved in all-significant values; we dare not consider such values without including all-important science. Science is not to be cultivated in an academic vacuum. Behold, the glory that was Greece! What were its glowing peaks? Most people would immediately cite the literature, the philosophy, the politics of Athens. Do not gaze solely upon Athens! Look also toward the eastern horizon of colonial Asia Minor, where science was born. The Greek world comprised both Athens and Asia Minor; Greek culture produced both humanism and science. It was their very combination that contributed to the Greek miracle. The genius of the Greek people enabled them to envisage the whole of life. So, too, humanistic science today can truly be a natural bridge between the humanities and the sciences. Watch out, therefore, for the humanism of science! Do not be content with an inhuman view of the universe. Or, to translate this general principle into a specific rule: do not study any science without emphasizing its history, its philosophy, its sociology.

In conclusion, let us keep watch in the universe! Let us watch out for the unity of nature! Do not study any special science except as a coherent part of the general science of nature. Let us watch out for the simplicity of man! Do not study any science without noting definitely the limitations of its data and of its method. Let us watch out for the humanism of science! Do not study any science except in the matrix of history, philosophy, and sociology. Science is not an isolated corner of education separated from the rest of culture; rather, "the stone which the builders refused is become the headstone of the corner." Mind you, I am not claiming that science is a sufficient educational way for all—or even for a few. I am insisting, however, that science is a necessary educational way for everyone today and tomorrow. Let us keep watch in the universe today! Let us watch out for science education for tomorrow!

The Engineer in Today's Society*

Robert M. Page

Director of Research, Naval Research Laboratory

In May 1962, the Institute of Radio Engineers published in the 50th Anniversary Issue of its Proceedings a monograph on "Man-Machine Coupling—2012 A.D." In this somewhat imaginative bit of writing it was predicted that within the next 50 years the communication between men and machine would be perfected to a degree that would permit coupling between the human mind and a mechanical brain, much closer than is now possible between two human minds. The article went on to speculate that once the secrets of tight coupling to the human mind were mastered, the machine might be eliminated, and the coupling be effected directly between two human minds. At this point the subject was dropped, and it was left to the reader to visualize a group of people tightly coupled together and highly organized to concentrate all minds on a single purpose. Could we perhaps call such an organization of people an "all-human machine"?

The construction and operation of such an all-human machine could pose some nice engineering challenges. For example, the engineering exercise of matching impedances at the interfaces might seem formidable, but they could well be dwarfed by the problems of stabilizing human transfer characteristics in desirable modes. We might say that these would be truly problems in human engineering.

* Address at installation banquet of the District of Columbia Gamma chapter of Tau Beta Pi, national engineering honor society, at George Washington University on February 16, 1963. First published in THE BENT of Tau Beta Pi for April 1963. Reprinted by permission.

But the tight coupling of mind to mind does not *produce* the problems of matching impedances and stabilizing transfer characteristics. It only intensifies these problems, bringing them into focus where we can see and understand them better, and thus, perchance, do something about them. The problems exist in everyday personal relationships in any society of people. We recognize them as human problems, and wonder what engineering as we know it has to do with them. It might interest us to consider engineering "as we know it," and then explore its possibilities.

To exemplify a product of engineering, we think of a system, in which a number of components function harmoniously together to accomplish a desired operation. The coupling of one component to another is a means of communication by which one component receives information from the other. Matching impedances means designing the coupling so that both components comprehend the same language at the same intelligence level. Thus each understands the other perfectly.

Each component is identified for engineering purposes by its transfer characteristic. In simple language, the transfer characteristic describes what the component does in response to information it receives from other components. Technically speaking, it is the relationship between the output and the input. As with each component, so also the system as a whole may be identified by the over-all transfer characteristic. It is determined by the summation of the transfer characteristics of all the components. If the transfer characteristic of one component has undesirable features, these undesirable features can be balanced out by adding another component with a compensating transfer characteristic. In some cases the over-all performance may be improved by actually degrading the transfer characteristic of a particular component. Take, for example, the preacher who increased his Sunday collection by using a butterfly net for a collection plate! Then all will be well as long as the transfer characteristics remain stable. If any component is unstable in its transfer characteristic, there is no way to compensate for it. From this we can see that for any component, the stability of its transfer characteristic is more important than its basic features, since undesirable features can be compensated for, but instability can not. If one must use a component whose transfer characteristic varies unpredictably, the whole system must be designed in such a way that the influence of the unstable component on the over-all transfer characteristic is reduced to a minimum.

It has been customary for engineers to think of their systems as being composed entirely of mechanical components. Many systems, however, include one or more human beings as components, and engineers have been forced to cope with the transfer characteristics of human beings. Now, the transfer characteristics of human beings have some very interesting peculiarities. They are non-linear, discontinuous, have a rather narrow frequency band pass, and, worst of all, they are highly variable. Needless to say, engineers have had quite a time trying to fit that component into a system whose performance could be predicted with some degree of confidence. When a system includes only one human being among its components, it is possible to add compensating components which satisfactorily reduce the influence of human unpredictability on the over-all transfer characteristic of the system. This is a tribute to the relatively new field of Engineering Psychology. The problem becomes vastly more complicated when the system includes two or more human beings, especially when they react on each other in the functioning of the system. May we now repeat a statement made a few moments ago? "The construction and operation of an all-human machine could pose some nice engineering challenges." I think we can recognize here some of the marks of an understatement.

Having looked briefly at one phase of engineering "as we know it," can what we know be of any use to us in understanding the human problems of man in a society of people? Let us think of the society of people as an engineering system, with human beings only as components. Each component is coupled more or less tightly to many other components, by various means of communication. Perfect mutual understanding depends on perfectly matched impedances in all channels of communication. This involves not only speaking the same language at the same intelligence level, through any and all sensory media, but correctly interpreting gestures of the body, expression in the eyes, involuntary muscular movements, and signs of agitation and calm, such as breathing rate, skin color change, and all other tell-tale indices of emotion.

It requires a good matching of impedances for concepts and ideas to flow freely from one person to another. Captain Horn, a good friend of mine, in the U. S. Navy, identified a poor impedance match when he said, "I gave him the pitch, but he failed to hoist it aboard." But a good impedance match is no guarantee of how a person will react when he does "hoist it aboard." It is said that ideas, like fleas, jump from person to person, but they don't bite everyone. I think we all realize that the impedance match between two people is in some cases pretty wonderfully good, in others pretty sadly poor, with the average fully adequate for preservation of the race, if not always of the individual.

Now what can we say about transfer characteristics? Just what is the transfer characteristic of a human being in a society of people? We have defined it broadly as what the component does in response to information it receives from other components. Might it now be more succinctly stated as the sum total of all one's reactions to other people that one passes on to other people? Many volumes have been written on this broad and elusive subject, but I venture the opinion that nowhere has it been considered as a transfer characteristic in an engineering sense. And I further venture to suggest that if it were so considered, much needed enlightenment could be injected into the solving of human problems. May we just take a moment to glance briefly at some of the possibilities?

As a component in a man-machine system, man's transfer characteristic was found to be non-linear, discontinuous, with narrow frequency band pass, and variable. These are basic features and all carry over into his transfer characteristic as a component in a society of people. Different persons differ widely in each of these basic features. For example, some people rise to great heights of diplomacy in the arena of oratory, while others open their mouths only to change feet.

In machine systems we found the most critical factor in a transfer characteristic to be its stability. This could well be true also in a society of people. Here we must be careful to distinguish between input and transfer characteristic. For example, a mere tap on the shoulder can evoke widely different reactions in the same man with no change in transfer characteristic. Suppose he is dancing to sweet music under soft lights with the girl of his dreams, his spirit soaring far into his dream world. A light tap on the shoulder, and the soft spoken words, "Pardon me, Buddy, it's my turn now," and he goes meekly off looking for another man to tap on the shoulder. But suppose he has been trying vainly to climb out of a freshly dug grave into which he had fallen when taking a short-cut through a cemetery at night, and from another man who had preceded him in a similar accident comes a light tap on the shoulder and the soft-spoken words, "It's no use, Buddy, you can't make it." He generally does. But this very different reaction is not from a difference in transfer characteristic. It can be traced to certain subtle differences in the input.

Undesirable traits in one person can be recognized, and appropriate allowances made by others to protect or to compensate. But variability in transfer characteristic appears as unpredictability of personal reactions, and unreliability of performance. There is no way of compensating for this, and a successful society manages to adjust itself so as to reduce to a minimum the influence exerted by its most unstable members.

Now permit me to draw the line a little finer in exploring the bases of instability in human transfer characteristics. We will pass over such superficial or transient phenomena as the wonderful play of the night before, the flu virus you just caught, the cold coffee for breakfast, or when two men across the street look like three when there is only one. Stabilizing the transfer characteristic against that type of "noise" is merely a matter of "growing up" and acquiring the natural stability that characterizes emotional maturity. We look for a more basic foundation, a stable element, if you please, to which the transfer characteristic might be served, and we find such a stable element in the person's character. As long as one's transfer characteristic, one's reactions to other people which are passed on to other people, is a true expression of what one really is, it will be as stable as human character is stable. But when one tries to be some one or some thing other than what he really is, then his transfer characteristic will vary with the mood and the weather. It was a good engineer who said, "First to thine own self be true, and it follows as day follows the night, thou canst not then be false to any man."

Academy Proceedings

January Meeting

(66th Annual Dinner Meeting)

DATE:	**THURSDAY, JANUARY 16, 1964**
PLACE:	**John Wesley Powell Auditorium, Cosmos Club, 2170 Florida Avenue, N.W.**
SCHEDULE:	**Cocktails at 6:30, Dinner at 7:00, Meeting at 8:15**
PROGRAM:	Reports of Officers and Committees Installation of Delegates of Affiliated Societies Presentation of Awards for Scientific Achievement, Conducted by Robert W. Berliner, Chairman of Awards Committee

AWARD WINNERS

Biological Sciences

Brian J. McCarthy, Department of Terrestrial Magnetism, Carnegie Institution of Washington, "for his role in deciphering the biosynthetic relationships among nucleic acids." Introduced by Richard B. Roberts, Staff Scientist, Department of Terrestrial Magnetism.

Physical Sciences

George A. Snow, Department of Physics, University of Maryland, "for outstanding research on the fundamental properties of elementary particles." Introduced by Wilson H. Elkins, President, University of Maryland.

Engineering Sciences

Gordon L. Dugger, Applied Physics Laboratory, Johns Hopkins University, "for major investigations and leadership in the field of hypersonic propulsion." Introduced by Ralph E. Gibson, Director of the Applied Physics Laboratory.

Mathematics

James H. Bramble, Institute of Fluid Dynamics and Applied Mathematics, University of Maryland, "for his contributions to the numerical treatment of partial differential equations." Introduced by Wilson H. Elkins, President, University of Maryland.

Teaching of Science

Frank T. Davenport, Frank W. Ballou High School, "for performance as an inspiring teacher of high school biology." Introduced by Carl F. Hansen, Superintendent of Schools, District of Columbia.

George M. Koehl, Physics Department, George Washington University, "for sustained excellence in teaching the beauty and order of physics." Introduced by Thomas H. Carroll, President, George Washington University.

Leo Schubert, Chemistry Department, American University, "for contributions to science education at the high school and college levels." Introduced by Hurst R. Anderson, President, American University.

BOARD OF MANAGERS MEETING NOTES

The Board of Managers held its 559th meeting on November 21, 1963 at the Cosmos Club, with President Van Evera presiding.

The minutes of the 558th meeting were approved as previously distributed.

Announcements. Dr. Van Evera made the following announcements:

(1) Messrs. T. W. Lashof of NBS, R. W. Krauss of the University of Maryland, and K. B. Morris of Howard University had been appointed to represent the Academy on a "Joint Committee on Recognition of Engineering, Science, and Architecture" of the Academy and the D. C. Council of Engineering Societies.

(2) Russell B. Stevens had been asked to consider appointment as Academy archivist; his decision was pending.

(3) He expected soon to name a chairman of the Ways and Means Committee, which would consider, among other things, the establishment of a permanent secretariat for the Academy.

(4) The slate of officers for 1964 had been established as follows: F. N. Frenkiel, president; Leo Schubert, president-elect; G. W. Irving, Jr., secretary; and M. C. Henderson, treasurer. Four candidates had been named for two Board positions, namely, Allen Alexander, Michael Goldberg, Marion Parker, and Francis Reichelderfer.

Executive Committee. Dr. Van Evera reported that the Committee had met on November 13 to discuss such matters as duplication of membership application forms and plans for future Academy directories.

Meetings. Chairman Robbins announced that the Academy's December 19 meeting would be held at the Naval Observatory, and would consist of a lecture, "From Harrison No. 4 to the Atomic Clock—200 Years of Timekeeping," preceded by an exhibition of Harrison's Timekeeper No. 4 and modern timekeepers.

Membership. In the absence of Chairman Hobbs, the Secretary presented the names of two candidates for fellowship, for First Reading.

Grants-in-Aid. Chairman McPherson announced that one application for a grant was being prepared, but was not yet ready for Board action.

Treasurer. Treasurer Henderson reported the following balances: Academy, \$5,125.61 as of November 15; Junior Academy, \$999.89 in checking account and \$1,539.92 in savings account; market value of assets as of November 18, \$78,436.50.

Editor. Editor Detwiler reported that the October Journal was in the mail; that galley proofs were at hand for the November issue; and that copy was being prepared for the December issue.

Mr. Detwiler presented the following comparison of costs of the September (directory) issues for 1962 and 1963:

	1962	1963
Master card list of members	$ 9.87	$ 9.12
Directory questionnaire	79.96	138.53
IBM services	359.07	387.04
Printing	543.00	832.75
Mailing	18.73	17.90
Postage	63.82	18.96
Miscellaneous	0.00	8.24
Total	$1074.45	$1412.54

Mr. Detwiler indicated that the four Affiliates, whose complete rosters were included in the 1963 directory, would be asked to make the following nominal contributions to its cost (at 25 cents per copy): Code F (entomologists), $40.00; Code K (botanists), $47.00; Code W (dental researchers), $16.75; Code 4 (IFT), $35.50.

In the ensuing discussion, it was emphasized that the Academy would appreciate reactions from the four affiliated societies whose complete membership rosters were published in the 1963 directory, to guide the Academy in development of its 1964 directory.

New business. The Board agreed that the Institute of Electrical and Electronics Engineers, recently formed by merger of the American Institute of Electrical Engineers and the Institute of Radio Engineers, should be recognized as an affiliate of the Academy, seniority to be determined by the elder of the two merged societies (American Institute of Electrical Engineers), and that the Board certify this action pending necessary amendment of the Bylaws. Since the change in name will require revision of the Bylaws, it was suggested by Dr. Van Evera that the Policy and Planning Committee be asked to develop language for action by the membership, which would revise the Bylaws suitably so that future changes of this type would not require Bylaws revision. This could be effected by listing Society affiliates in the Standing Rules rather than in the Bylaws. The Institute of Electrical and Electronics Engineers will be asked to name a single delegate representing the merged organization.

Inasmuch as the Institute of Aerospace Sciences recently absorbed the American Rocket Society and assumed the new name, American Institute of Aeronautics and Astronautics (AIAA), the Board agreed that the AIAA be considered the affiliate of the Academy, and that the Academy certify such affiliation pending revision of the Bylaws. Dr. Frenkiel indicated that the AIAA had designated Maj.-gen. A. W. Betts as its delegate to the Academy.

Dr. Van Evera indicated that President-elect Frenkiel would attend the AAAS meeting in Cleveland in December, and would represent the Academy on the AAAS Academy Council. Since the Academy can have two delegates, Dr. Van Evera expected to name a second representative.

The secretary read a letter from Raymond J. Seeger, president of the American Association of Physics Teachers, suggesting that some liaison between the Academy and his organization be established so that common objectives could be better achieved. The Board directed the secretary to reply to Dr. Seeger, indicating that the Academy was considering a mechanism for liaison or affiliation.

Science in Washington

CALENDAR OF EVENTS

January 13—American Society for Metals

Thomas F. Kearns, Bureau of Naval Weapons, "The Metalworking Processes and Equipment Program."

AAUW Building, 2401 Virginia Ave., N.W., 8:00 p.m. Dinner at 6:30 p.m. at same address.

January 13—Computer Science Colloquium

Regular meeting. "Information Processing on the IMP Satellite."

Rm. 26, Computer Science Center, University of Maryland, 4:00 p.m.

January 14—James Curley Lectures in Science

C. C. Kiess, professor of astronomy, Georgetown University, "Interpretation of Martian Phenomena."

Gaston Hall, Georgetown University, 8:30 p.m.

January 14—American Institute of Industrial Engineers

Professor Tullier, Naval Academy, "Practical Uses of Operations Research."

Perpetual Building Association Auditorium, 11th & E Sts., N.W., 8:00 p.m. Dinner before the meeting at O'Donnell's Restaurant, 1221 E St., N.W.

January 15—Society of American Foresters

Luncheon meeting. Rep. Compton I. White, Jr., member of House Committee on Interior and Insular Affairs, "The Public Land Problem in the Western States."

Occidental Restaurant, 1411 Pennsylvania Ave., N.W., noon.

January 15—Paleontological Society of Washington

Norman K. Sachs, Geological Survey, "An Oceanographic Cruise to the Equatorial Atlantic."

Rm. 43, National Museum, 10th St. and Constitution Ave., N.W., 8:00 p.m.

January 20—American Society for Microbiology

Charles W. Shilling, director, Biological Sciences Communication Center, "A Mission Oriented Information Center."

Officers Club, Walter Reed Army Medical Center, 6:30 p.m.

January 20—American University Lecture Series

Maurice Ewing, director of Lamont Geological Observatory, Columbia University, "Oceanology."

Glover Hall, American University, 8:00 p.m. The lecture is sponsored by Operations Research, Vitro Corporation of America, and Harris Research Laboratories.

January 21—Anthropological Society of Washington

Michael Moermann and Jasper C. Ingersoll, American University, "Village Roles in North and Central Thailand: Controlled Comparisons in a Single Culture."

Rm. 43, National Museum, 10th St. and Constitution Ave., N.W., 8:15 p.m.

February 13—Chemical Society of Washington

Joint meeting with Washington Junior Academy of Sciences. Ralph K. Iler, E. I. duPont de Nemours and Company, "Inorganic Colloids—Some Interesting Properties."

National Naval Medical Center, Bethesda, 8:15 p.m.

SCIENTISTS IN THE NEWS

Contributions to this column may be addressed to Harold T. Cook, Associate Editor, c/o U. S. Department of Agriculture, Agricultural Marketing Service, Federal Center Building, Hyattsville, Md.

AGRICULTURE DEPARTMENT

R. E. Hardenburg, Agricultural Marketing Service, received the distinguished service award of the Produce Packaging Association at its 13th Annual Convention in Chicago, November 11.

A. M. Pommer attended a meeting of the Association of Military Surgeons of the United States, held in Washington on November 8, and a Symposium on Relation of Geology and Trace Elements to Nutritional Problems, held by the Geochemical Society in New York on November 17.

Chester R. Benjamin was recently appointed chairman of the Fungus Nomenclature Committee of the Mycological Society of America. This is in addition to Dr. Benjamin's assignment as representative of the Society on the National Research Council.

C. H. Hoffmann, assistant director of the Entomology Research Division, was guest speaker at the annual dinner meeting of the William Penn Chapter, Soil Conservation Society of America, on November 26 at Newtown Square, Pa. Dr. Hoffmann's address was on "Benefits and Hazards of Modern Insecticides and New Approaches to Insect Control."

In October, **Harold H. Shepard** visited several research facilities of the pesticide industry in England and Switzerland, as well as the Pest Infestation Laboratory at Slough (England), the Organization for Economic Cooperation and Development in Paris, and the World Health Organization at Geneva. Dr. Shepard noted that criticism of pesticide usage is now widespread in the European press, similar to what was at its peak in American journals some months ago. Rachel Carson's "Silent Spring" can now be obtained in French and German translations.

Justus C. Ward, during a recent trip to San Francisco and Hawaii, gave talks before the National Pest Control Association at San Francisco, the Hawaiian and National Associations at Honolulu, a conference of State of Hawaii agriculturists, health workers and University faculty members in Honolulu, and a small gathering of similar specialists at Lihue, Kauai. All these talks were on the general subject of pesticides, the existing laws dealing with their labeling, and the importance of proper use.

F. W. Poos was presented a meritorious award and citation for distinguished service to agriculture and entomology by the Eastern Branch of the Entomological Society of America at its annual meeting in New York, October 24-25. Dr. Poos recently retired as editor of the Journal of Economic Entomology, a position he had occupied since his retirement as senior entomologist in the Agricultural Research Service.

CATHOLIC UNIVERSITY

Frank A. Biberstein, head of the Department of Civil Engineering, is a member of the Building Research Institute Planning Committee on Masonry in Building. The Committee met on November 19 at the Mayflower Hotel.

COAST AND GEODETIC SURVEY

Joseph L. Stearn, research mathematician, gave a 40-minute talk before a group of graduate students and faculty members in the Department of Geodetic Sciences, Ohio State University, on November 15. First, the results of a research study of tests of departure from normality for theodolite errors of observation were outlined, followed by brief topics for research on the subjects of minimum deviation as an adjunct to least squares, pseudo-inverse solution of singular systems, and ill-conditioned matrices.

Aaron L. Shalowitz, who retired from C & GS after 46 years of continuous service, has been recalled to active duty to complete Volume Two of his treatise, "Shore and Sea Boundaries."

Leonard M. Murphy, chief of the Division of Seismology, attended the Defense Research Board—ARPA meeting in Ottawa, Canada, on October 28-30, where joint cooperation in seismological research between the United States and Canada was discussed.

HARRIS RESEARCH LABORATORIES

Harvey Alter was moderator of a Symposium on Plastics in the Building Industry at a meeting of the Baltimore-Washington Section, Society of Plastics Engineers, in Washington on December 3.

Alfred E. Brown attended the semiannual meeting of the Scientific Manpower Commission in Washington on December 2.

HOWARD UNIVERSITY

L. N. Ferguson spoke on "Physicochemical Studies on the Sense of Taste" before the Central Pennsylvania Section, American Chemical Society, held at Pennsylvania State University October 25.

M. D. Taylor recently discussed his research before a gathering of the research staff of the Dow Chemical Company at Midland, Mich. Recently he was appointed to the Advisory Board of the new publication, *Chemistry*, of the American Chemical Society.

J. B. Morris has been appointed to serve as one of the representatives of the Washington Academy of Sciences on a committee with representatives of the D. C. Council of Engineering and Architectural Societies, to promote recognition of engineers, scientists, and architects in the Washington area. He attended the Eastern Analytical Symposium on Analytical Chemistry at New York on October 13-15.

The following have been recent guest speakers at the Physical Chemistry Seminar: October 8, R. R. Stromberg, NBS, "Ellipsometry and Some Applications"; October 22, F. Saalfield, NRL, "Mass Spectrometry of Volatile Hydrides"; November 11, E. Horowitz, NBS, "Preparation and Properties of Coordination Polymers"; November 19, F. A. Khoury, "Aspects of the Solid State Structure and Morphology of Synthetic Organic Polymers."

NATIONAL BUREAU OF STANDARDS

Gordon M. Kline retired in December as chief of the Polymers Division after more than 37 years of Government service. A specialist in plastics, he is internationally known for his research on the chemistry and properties of polymers and the development of standards for plastics. In 1953, the Commerce Department awarded him its Exceptional Service Gold Medal for "major contributions to science and technology through pioneering work and accomplishments in the field of organic plastics and for distinguished authorship." He also holds the Honor Award of the Washington Section of the American Institute of Chemists.

Harry C. Allen, formerly chief of the Analytical and Inorganic Chemistry Division, has been named chief of the Inorganic Solids Division. In his new post Dr. Allen will direct Bureau research on properties of nonmetallic inorganic solids, including such industrially important materials as ceramics, glass, and refractory oxides.

On December 5, **Allen V. Astin** received a 1963 Rockefeller Public Service Award, the highest private honor for Government career service. Dr. Astin is one of five Government senior career employees chosen for the 1963 Award because of outstanding contributions they have made to the nation through their work.

Abner Brenner, chief of the Electrolysis and Metal Deposition Section, Metallurgy Division, has recently published (Academic Press) a massive two-volume treatise entitled, "Electrodeposition of Alloys," which represents the most comprehensive treatment of this subject in the field.

Floyd Buckley, former assistant chief of the Physical Chemistry Division, retired on September 11 after 15 years of service with NBS. Mr. Buckley first came to the Physical Chemistry Division in 1943.

Irvin L. Cooter has returned from a year's training assignment at Oxford University. During this period he visited several magnetic laboratories in England and on the Continent.

Earle K. Plyler, internationally recognized expert in infrared spectrometry, retired from the Bureau on October 8. Dr. Plyler has been an NBS staff member since 1945, and chief of the Infrared Spectroscopy Section in the Bureau's Atomic Physics Division since 1952. In 1962 he was awarded the Commerce Department's Gold Medal for Exceptional Service on the basis of his "pioneering advances in the physics of infrared radiation and for major advances in instrumentation for infrared spectroscopy."

Hideo Okabe, a member of the Physical Chemistry Division, left on October 3 to begin a one-year tenure as visiting professor at the Institut für Physikalische Chemie at the University of Bonn, Germany, which is under the direction of Professor W. E. Groth. Dr. Okabe will work on field ion mass spectrometry; he is expected to return to the Bureau in October 1964.

Recent talks by Washington staff members:

H. C. Allen, Jr.: "The John-Teller Effect in Some Copper Chelates"—North Carolina State University, Department of Physics, Raleigh.

R. K. Cook: "Very Low Frequency Atmospheric Sounds Caused by Geophysical Phenomena"—Rice University, Houston; and "Radiation from Subsonic Surface Waves"—Acoustical Society of America, University of Michigan, Ann Arbor.

W. J. Hamer: "Standard Cells and Zener Diodes"—Chicago Section of the Electrochemical Society, Chicago; Pacific Northwestern Section Electrochemical Society, Spokane, Wash.; San Francisco Chapter, Electrochemical Society, Berkeley; and Southern California-Nevada Electrochemical Society, Los Angeles.

G. C. Paffenbarger: "Present Day Plastics for Use as Denture Base Materials"—Greater New York Dental Meeting, New York; "Some Highlights of the Current Research Program of the Dental Research Section at the National Bureau of Standards"—New York Academy of Dentistry, Columbia University Club; "Gallium Alloys" and "The Use of the Specifications of the American Dental Association as Teaching Aids in the Science of Dental Materials"—Conference for Teachers of Dental Materials, Northwestern University, Chicago.

A. H. Scott: "Techniques for Using the Airgap Method for the Precise Determination of the Dielectic Constant and Loss Angle of Solid Disk Specimens."

G. Shapiro and **O. B. Laug:** "Project FIST—Fault Isolation by Semi-Automatic Techniques"—NASA-Battelle Seminar on Automatic Checkout Equipment and Techniques, Columbus.

C. M. Sitterly: "What is the Sun Made of?"—Visiting Scientists and Engineers Program—Joint Board on Science Education, North Bethesda Junior High School.

J. K. Taylor: "An Evaluation of Coulometric Titrations" and "Crisis in Analytical Chemistry"—Eastern Analytical Symposium, New York.

C. M. Tchen: "Plasma Oscillations with Collective Correlation"—Case Institute of Technology, Cleveland.

R. Zwanzig: "Current Status of Irreversible Thermodynamics" — Chemical Engineering Seminar, Johns Hopkins University, Baltimore.

NATIONAL INSTITUTES OF HEALTH

Margaret Pittman, chief of the Division of Biologics Standards Laboratory of Bacterial Products, directed a 3-day symposium on pertussis vaccine. Eighty-one scientists from the United States and four foreign countries participated.

Bernhard Witkop and Fritz Marki of the National Institute of Arthritis and Metabolic Diseases have isolated the toxic principles of the lethal venom secreted by the skin of the kokoi frog. Poison from this frog is used by the Cholo Indians of Colombia.

Norman B. McCullough, chief of the Laboratory of Bacterial Diseases, National Institute of Allergy and Infectious Diseases, discussed his work on brucellosis at the NIAID Grand Rounds on October 9.

UNCLASSIFIED

Roy C. Dawson represented the Food and Agriculture Organization at the Dairy Society International Meeting in Dallas, November 3-5. He also spoke to the College Park (Md.) Rotary International on "Freedom from Hunger," on November 6.

Eugene W. Weber, deputy director of civil works for policy, Corps of Engineers, was one of five to receive the 1963 Rockefeller Public Service Award at a luncheon on December 5. The award was given for accomplishments in the field of administration.

DEATHS

William E. Wrather, director emeritus of the Geological Survey, died November 28 at his home in Washington. Born in Brandenburg, Ky., in 1883, Dr. Wrather became one of the world's foremost petroleum geologists. After graduation from the University of Chicago, he joined the J. M. Guffey Petroleum Company (now Gulf Oil Company) to become one of the first to apply geological knowledge to the exploration for oil. As a consulting geologist in Dallas from 1918 to 1942, Dr. Wrather achieved outstanding recognition by the oil industry. Among his accomplishments was his location and supervision of drilling operations that resulted in the discovery well at Desdemona, Comanche County, Tex. His many explorations in foreign countries during the 1920's and 1930's led to important oil discoveries abroad.

Dr. Wrather became director of the Geological Survey in 1943 and served until his retirement in 1956.

Dr. Wrather was a past president of the American Institute of Mining and Metallurgical Engineers, the American Association of Petroleum Geologists, the Society of Economic Geologists, and the Texas Geological Society, and an officer or member of many other professional groups. He received honorary degrees from Southern Methodist University, Colorado School of Mines, University of Kentucky, and Montana School of Mines, as well as numerous other awards for distinguished accomplishment.

SCIENCE AND DEVELOPMENT

A new technique using **carbon ^{14} for pinpointing sources of saline waters** which contaminate many coastal areas of the United States was reported at the 75th anniversary meeting of the Geological Society of America on November 18 by Bruce Hanshaw, William Back, and Meyer Rubin of the Geological Survey. Dr. Rubin is a member of the Washington Academy of Sciences. With the new technique in a test area near Brunswick, Ga., the authors found that the salt water contaminating the drinking water came from ancient limestone formations and not from the ocean, which was eliminated as a source because of its relatively high carbon ^{14} content. The new technique may be useful in solving existing or threatening salt water contamination problems in such areas as Long Island, Philadelphia, and the Florida coast.

Accurate long-range weather forecasts can be based on "the certainty that the family of regular harmonics of 273 months, in solar radiation and terrestrial weather, is a controlling geophysical fact." This assertion is made by Charles G. Abbot, formerly secretary of the Smithsonian Institution and director of the Smithsonian Astrophysical Observatory. A harmonic is defined as a recurring fraction of a larger number, such as 3/273, 9/273, 27/273, etc. If the 273-month family of regular harmonic periods exists in weather with such amplitudes that by their summation a controlling influence is exerted, then the weather should tend strongly to repeat its features at intervals of 22 years and 9 months. Dr. Abbot's conclusions are the result of a detailed study of the measurements of the solar radiation constant since 1876. His paper, "Solar Variation and Weather," was recently published by the Smithsonian Institution.

A survey of doctorate-degree production in the nation's universities, issued by NAS-NRC, reports that (1) the United States will double its 1962 annual output of 12,000 Ph.D. graduates by 1969 if present trends continue; (2) two geographic regions—East North Central and Middle Atlantic—produce nearly half the annual total of doctorates, but employ only one third; (3) graduate education is systematically spreading wider, with less concentration in the leading schools; (4) the proportion of doctorates in the physical sciences—about 30 percent of the total—has not increased over a 40-year period; (5) women account for only 5 percent of the doctorates awarded in the natural sciences now, compared to 11 percent in 1920. The 215-page report presents data on more than 183,000 persons who earned third-level research degrees in the period 1920-1962. The total includes the Ph.D., Sc.D., Eng.D., and Ed.D. degrees, but not such degrees as M.D., D.D.S., and D.V.M.

A Symposium on Statistical Association Methods for Mechanized Documentation will be held March 17-19 at the National Bureau of Standards. Sponsored by NBS, the American Documentation Institute, and the Research Information Center and Advisory Service on Information Processing, the symposium will review the state of the art of the application of statistical association methods to mechanized documentation systems. The following topics will be covered: (1) pioneering applications of statistical association techniques in documentation, (2) information retrieval and search renegotiation; (3) statistical association methods and citation indexing; (4) automatic assignment indexing; (5) automatic classification and categorization; and (6) future prospects. Original papers and critical reviews are being considered for presentation. Further information can be obtained from Mary E. Stevens at NBS.

Hurricane Beulah was seeded with silver iodide crystals on August 23-24 to determine if the energy patterns in a hurricane could be changed. Known as "Project Stormfury," the enterprise was conducted by the Navy Department and Weather Bureau with NSF support, as a continuation of experiments begun in 1961. A Navy A3B Skywarrior dropped newly-designed silver iodide canisters into the hurricane clouds from a height of 35,000 feet; a vertical "sheet" of silver iodide more than 20,000 feet in depth was swept around by the strong hurricane winds in a path from 15 to 35 miles from the storm center. As the silver iodide was injected, "flying laboratories" penetrated and traversed the clouds at various levels to observe and record the results. While a complete analysis of the experiment is not yet available, project scientists observed that winds following the seeding on August 23 continued to increase, but did decrease on the days after the seeding on August 24.

The Earth Science Curriculum Project, an interdisciplinary science program for secondary schools that is conducted by the American Geological Institute with NSF support, has begun publication of an "ESCP Newsletter" to keep interested persons informed of progress. Volume 1, Number 1, issued in October 1963, surveys the project's organization, objectives, philosophy, and future. Subsequent issues can be obtained free upon request to Earth Science Curriculum Project, P.O. Box 1559, Boulder, Colo.

Use of stereophotogrammetric measurements to detect underground nuclear explosions is being investigated by the Army Engineers' Geodesy, Intelligence, and Mapping Research and Development Agency at Fort Belvoir. The system under study essentially involves stereoscopic observation and measurement of photographs taken at a test site before and after an explosion. Ground surface changes that might occur above an underground nuclear explosion would be shown by these stereophotogrammetric measurements. The heart of the method is GIMRADA's Halcon Plotter System, now under development. Designed for high altitude mapping, the interim system consists of two 12-inch focal length convergent cameras and a specially built, highly precise, projection-type plotter with 12-inch projectors to match the cameras.

A systematic two-stage approach for fitting families of curves to data dependent on two variables has been developed at the National Bureau of Standards. In the first stage, the method takes advantage of the relations that usually exist among the curves so that the curves can be fitted simultaneously, often as a family of straight lines. In the second stage, the functional form of the relation is determined.

National Bureau of Standards scientists have designed **multistaged electron guns** that will pass the maximum possible number of low-voltage electrons through a given space. These guns give a current at low voltages at least an order of magnitude higher than previously attainable, and therefore can be used in performing experiments heretofore considered impossible. Two such guns have been built and evaluated.

The October 1963 American Documentation Institute meeting was the occasion for an NSF-supported **experiment in conference programming** to promote more effective speaker-participant communication and rapid exchange of information on a personal basis. An opportunity was provided also to demonstrate that certain forms of scientific publication can be accomplished in significantly shorter time than they have in the past. Papers presented at the annual gathering, held this year in Chicago, were not read during the meeting, but were printed and distributed to the registrants in advance. Along with the papers was enclosed a checklist of authors, to be used by the registrant to indicate his desire to discuss work with particular authors. All responses were processed and schedules established to bring authors and participants together for small-group discussions on particular subjects. The rapid publication of the papers was accomplished by putting them on punched tape for automatic typesetting, indexing, and word analysis. An edited, line-adjusted version of the tape was then prepared by computer for operating phototypesetting equipment. This master tape was also used to compile and print an index and a glossary of all key words used in the papers. The final volume was printed and distributed to registrants prior to the ADI meeting.

Research scientists, as well as librarians, abstractors, and bibliographers, now have a new tool available with publication of a "Subject Heading List" by the National Agricultural Library, in cooperation with the Rockefeller Foundation. The breadth and complexity of agriculture are shown in the compilation of 93,000 subject headings and cross-references used by the library in its card catalog. This is the most comprehensive international list of agricultural subjects ever published, according to library officials. Based on the National Agricultural Library's subject file, which has been developed over the past 100 years, the list is a tool for providing access to the world's agricultural literature through abstracting and indexing services and library catalogs.

Delegates to the Washington Academy of Sciences, Representing the Local Affiliated Societies*

Philosophical Society of Washington	R. D. Myers
Anthropological Society of Washington	Regina Flannery Herzfeld
Biological Society of Washington	John L. Paradiso
Chemical Society of Washington	Leo Schubert
Entomological Society of Washington	Frank L. Campbell
National Geographic Society	Alexander Wetmore
Geological Society of Washington	G. Arthur Cooper
Medical Society of the District of Columbia	Frederick O. Coe
Columbia Historical Society	U. S. Grant, III
Botanical Society of Washington	Wilbur D. McClellan
Society of American Foresters	Harry A. Fowells
Washington Society of Engineers	Martin A. Mason
Institute of Electrical and Electronics Engineers	Delegate not appointed
American Society of Mechanical Engineers	William G. Allen
Helminthological Society of Washington	Doys A. Shorb
American Society for Microbiology	Howard Reynolds
Society of American Military Engineers	Delegate not appointed
American Society of Civil Engineers	Thorndike Saville, Jr.
Society for Experimental Biology and Medicine	Falconer Smith
American Society for Metals	Hugh L. Logan
International Association for Dental Research	George Dickson
American Institute of Aeronautics and Astronautics	A. W. Betts
American Meteorological Society	J. Murray Mitchell, Jr.
Insecticide Society of Washington	Robert A. Fulton
Acoustical Society of America	Malcolm C. Henderson
American Nuclear Society	George L. Weil
Institute of Food Technologists	Richard P. Farrow
American Ceramic Society	J. J. Diamond
Electrochemical Society	Delegate not appointed

*Delegates continue in office until new selections are made by the respective affiliated societies.

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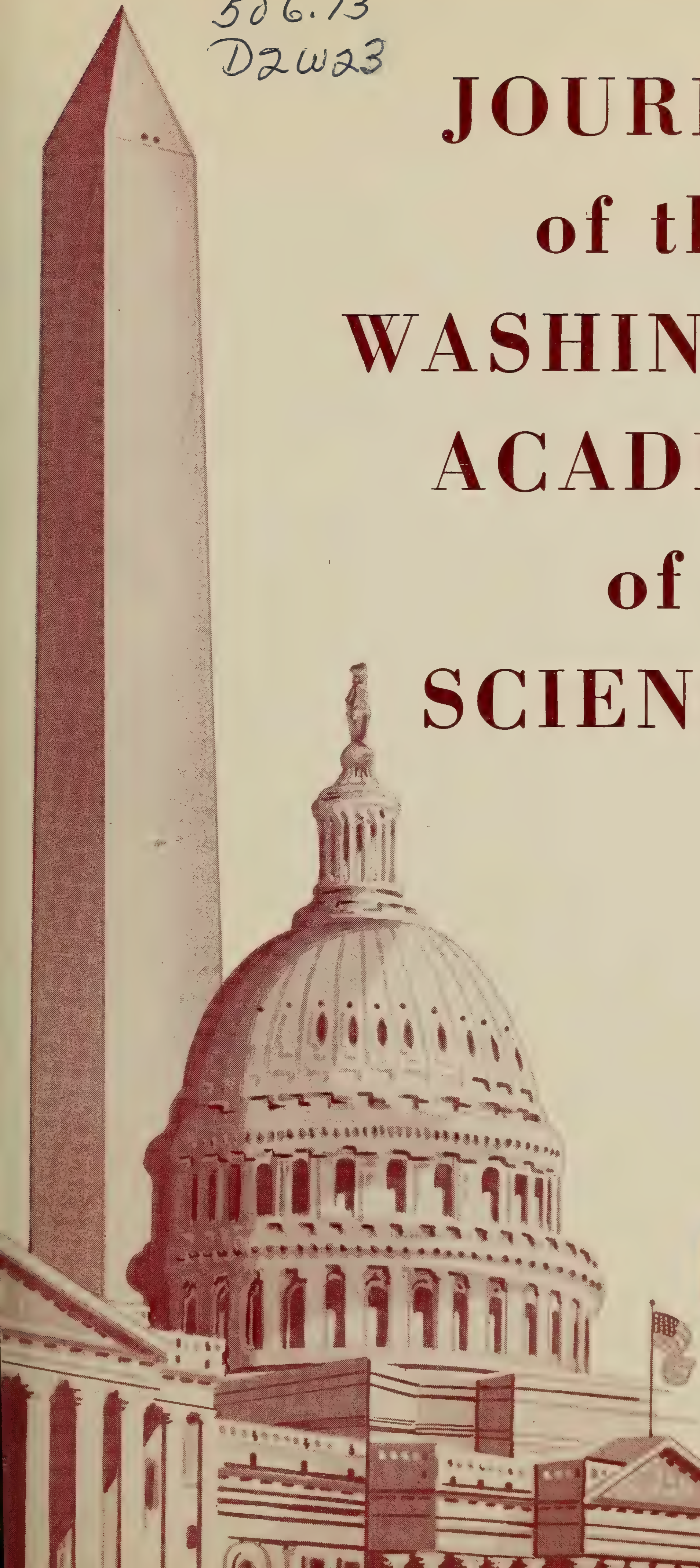

Vol. 54 • No. 2

FEBRUARY
1964

JOURNAL OF THE WASHINGTON ACADEMY OF SCIENCES

Editor: Samuel B. Detwiler, Jr., Department of Agriculture

This Journal, the official organ of the Washington Academy of Sciences, publishes historical articles, critical reviews, and scholarly scientific articles; notices of meetings and abstract proceedings of meetings of the Academy and its affiliated societies; and regional news items, including personal news, of interest to the entire membership. The Journal appears nine times a year, in January to May and September to December.

Subscription rate: $7.50 per year (U.S.) or $1.00 per copy; foreign postage extra. Subscription orders should be sent to the Washington Academy of Sciences, 1530 P St., N.W., Washington, D.C. Remittances should be made payable to "Washington Academy of Sciences."

Back issues, volumes, and sets of the Journal (prior to Volume 51) can be purchased direct from the Johnson Reprint Corporation, 111 5th Avenue, New York 3, N.Y. This firm also handles the sale of the Proceedings of the Academy (Volumes 1-13, 1898-1910), the Index, and the Monograph.

Current issues of the Journal (past two calendar years) may still be obtained directly from the Academy office at 1530 P Street, N.W., Washington 5, D.C.

Claims for missing numbers will not be allowed if received more than 60 days after date of mailing plus time normally required for postal delivery and claim. No claims will be allowed because of failure to notify the Academy of a change of address.

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ACADEMY OFFICERS FOR 1964

Seven Scientists Receive Academy's Annual Awards

Awards for outstanding scientific accomplishment were conferred upon four young research scientists and three science teachers at the Washington Academy's 66th Annual Dinner Meeting on January 16 at the Cosmos Club.

The young investigators honored were Brian J. McCarthy of the Carnegie Institution of Washington, in the biological sciences; George A. Snow of the University of Maryland, in the physical sciences; Gordon L. Dugger of the Applied Physics Laboratory, Johns Hopkins University, in the engineering sciences; and James H. Bramble of the University of Maryland, in mathematics. The science teachers were Frank T. Davenport of Frank W. Ballou High School, George M. Koehl of George Washington University, and Leo Schubert of American University.

Award winners were introduced by Richard B. Roberts, staff scientist of the Department of Terrestrial Magnetism, Carnegie Institution; R. Lee Hornbake, vice president for academic affairs, University of Maryland; Ralph E. Gibson, director of the Applied Physics Laboratory; Thomas H. Carroll, president of George Washington University; Carl F. Hansen, superintendent of District of Columbia schools; and Keith C. Johnson, science supervisor of District of Columbia schools.

The Academy's awards program was initiated in 1939 to recognize young scientists of the local area for "noteworthy discovery, accomplishment, or publication" in the physical, biological, and engineering sciences. An award for outstanding teaching was added in 1955 and another for mathematics in 1959.

Unusual this year was the fact that for the first time three awards for the teaching of science were made. The multiple awards were made in recognition of the large number of excellent candidates nominated and as a reflection of the intent to recognize excellence in teaching at the school level as well as at the university level.

Biological Sciences

Cited "for his role in deciphering the biosynthetic relationships among nucleic acids" was Brian J. McCarthy, of the Department of Terrestrial Magnetism, Carnegie Institution of Washington. The work of Dr. McCarthy and his associates has contributed to knowledge of the mechanisms whereby the genetic information stored in the DNA of the cell nucleus is translated into the structural proteins and enzymes of living organisms. Dr. McCarthy's work has helped to clarify the processes involved in the synthesis of ribosomes, and, with his associates, he has developed a technique which makes it possible to obtain highly purified strains of DNA and RNA for further study and analysis. The technique can also be used to show genetic relationships between organisms by establishing that they share the same or closely similar strains of DNA or RNA.

Born in London on March 7, 1934, Dr. McCarthy received the B.S., M.A., and Ph.D. degrees from Oxford University. In 1958 he came to this country as a Carnegie Institution fellow, and he has stayed on as a staff member in its Department of Terrestrial Magnetism. He now resides with his wife and two children in Kensington, Md.

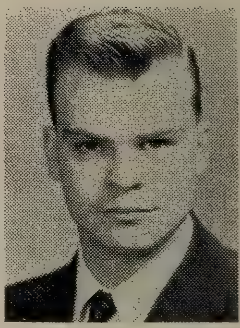
Physical Sciences

George A. Snow, professor of physics at the University of Maryland, was cited "for outstanding research on the fundamental properties of elementary particles." Among his contributions to modern physics have

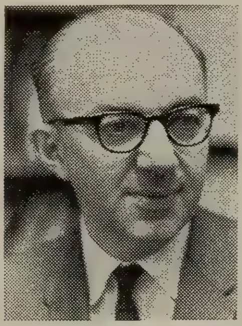
Brian J. McCarthy

George A. Snow

Gordon L. Dugger



James H. Bramble



Leo Schubert

George M. Koehl

F. T. Davenport

been his studies demonstrating the equal parity of sigma and lambda hyperons, and studies clarifying the mechanism of meson capture by nuclei.

Born August 24, 1926 in New York City, Dr. Snow received the A.B. degree from C.C.N.Y. in 1945, and the M.A. and Ph.D. degrees from Princeton. He joined the faculty of the University of Maryland in 1957.

Engineering Sciences

An authority on propulsion systems for hypersonic flight (*i.e.* above 3000 miles per hour), Gordon L. Dugger is a member of the principal professional staff at the Applied Physics Laboratory. He was cited "for major investigations and leadership in the field of hypersonic propulsion." His experimental work has proved the feasibility of the combustion in supersonic flow needed to achieve orbital speeds in airplanes equipped with ramjet engines.

Born in Winter Haven, Fla., in 1923, Dr. Dugger is married and has three children. He received the B.Ch.E. degree (with honors) from the University of Florida in 1944 and his M.S.E. from the same university in 1947. In 1953 he received the Ph.D. from Case Institute of Technology.

Mathematics

Cited "for his contributions to the numerical treatment of partial differential equations," James H. Bramble is a research associate professor in the Institute for Fluid Dynamics and Applied Mathematics, University of Maryland.

Born in 1930 in Annapolis, Md., Dr. Bramble received the A.B. degree from Brown University in 1953. In 1955 he received an M.A. from the University of Maryland where he was also awarded the Ph.D. degree in 1958.

Dr. Bramble served on the University of Maryland staff from 1953 until 1957 when he became manager of the Mathematics Group, General Electric Company. After serving in this position until 1959, he was a mathematician at the Naval Ordnance Laboratory for one year. In 1960 he became a consultant to the National Bureau of Standards and rejoined the University of Maryland staff.

Teaching of Science

The teachings of Leo Schubert, chairman of the Department of Chemistry, American University, have not only influenced his own students but also students and teachers from all over the country. For eight years he has directed a summer institute for high school teachers of chemistry and physics. During this time over 400 teachers from all over the country and from several foreign countries came under the influence of his teaching. Many concepts presented during this time anticipated the work of such chemistry programs as the CHEM study and the CBA study for high school students.

Professor Schubert was cited "for contributions to science education at the high school and college levels."

A teacher of undergraduate physics for the past 26 years at George Washington University, George M. Koehl is singled out by President Carroll as "that excellent combination—all too rare in University circles today—of a first-rate teacher and administrator." Professor Koehl has consistently shown creativity and originality in developing new methods of instruction for use in elementary physics laboratories, and in designing new laboratory equipment for teaching physics. Over the years he has become noted for his meticulous preparation of lectures and laboratory materials. He has also demonstrated a warm, human interest in his students, which extends to their general programs of studies as well as to their work in physics. His approach to teaching places emphasis on individual instruction.

Professor Koehl was cited "for sustained excellence in teaching the beauty and order of physics."

Frank T. Davenport organized the course of study and taught the advanced biology course offered to secondary school students in the District of Columbia for the first time in 1961. A biology teacher at Frank W. Ballou Senior High School in Washington, Mr. Davenport received the Outstanding Biology Teacher Award for the District of Columbia, presented by the National Biology Teachers' Association in 1962. He was later chosen by the Association as the Outstanding Biology Teacher for Region V (comprising eight states and the District of Columbia).

Mr. Davenport was born in 1926 and now resides in Arlington, Va. He received the B.S. degree in 1950 from Edinboro State Teachers' College, and the M.Ed. degree in 1957 from the College of William and Mary.

He was cited "for performance as an inspiring teacher of high school biology."

The Meaning of "Least" In Least Squares*

Churchill Eisenhart

National Bureau of Standards

I. Introduction

The present status of the Method of Least Squares is this: Everyone uses it, but not in exactly the same way, nor for the same reasons. There is thus some similarity to the present status of Probability, with respect to which Bertrand Russell has remarked (1): "While interpretation in this field is controversial, the mathematical calculus itself commands the same measure of agreement as any other branch of mathematics." But the situation with respect to the Method of Least Squares is not exactly parallel: In the case of the Method of Least Squares there is complete agreement on the procedure for forming the 'normal equations' from the fundamental 'observational equations,' and everyone comes up with the very same numbers for the solutions of the normal equations; but their reasons for employing the Method of Least Squares, their understanding of its objectives and the conditions under which these are achieved, and their interpretations of end results of its application, may be quite different. Furthermore, in contrast to the situation in Probability, individuals who utilize the 'Method of Least Squares' as a tool in their own line of work are usually not aware of the existence of alternative formulations of this technique.

This somewhat extraordinary situation results from the fact that the Method of Least Squares was developed originally from three distinctly different points of view: (1) *Least Sum of Squared Residuals* (Legendre, 1805), (2) *Maximum Probability of Zero Error of Estimation* (Gauss, 1809), and (3) *Least Mean Squared Error of Estimation* (Gauss, 1821). These differ not only in their aims and in their initial assumptions, but also in the meanings that they attach to the numbers that all three yield as a common answer to any given problem. Unfortunately, the existence of these three different formulations and consequent different interpretations of the end results of applying 'Least Squares' are rarely mentioned in books on the practical application of the Method of Least Squares. The only exception in English of which I am aware is Whittaker and Robinson's *The Calculus of Observations* (2), first published in 1924: chapter IX contains a discussion of Legendre's original formulation, in which no probability considerations are involved; a full treatment of Gauss's first "proof," in which what we now term the 'normal distribution' plays a central and indispensable role; and a brief summary of Gauss's second development, which he showed to be independent of the functional form of the law of error involved whenever the 'best values' implied by the techniques of *Least Sum of Squared Residuals* are linear functions of the basic observations. Gauss himself decidedly preferred his second formulation, the existence of which seems to be virtually unknown to almost all American users of "Least Squares," except students of advanced mathematical statistics.

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* Extracts from a paper in preparation on "The Background and Evolution of the Method of Least Squares."

II. Minimization of Residuals and Legendre's "Methode des Moindres Quarres"

The Method of Least Squares evolved early in the 19th century in response to a recognized need for a 'best' general procedure for the combination of observations in astronomy and geodetic surveying.

When two or more related quantities are measured individually, the resulting measured values usually fail to satisfy the constraints on their magnitudes implied by the given interrelations among the quantities concerned. In such cases these 'raw' measured values are mutually contradictory and require 'adjustment' in order to be usable for the purpose intended.

Inasmuch as the actual *errors* of individual observations are usually unknown and forever unknowable, the early attempts to achieve a good adjustment seem to have concentrated on minimizing the apparent inconsistency of a set of observations as evidenced by some simple function of their *residuals*.* The practical requirements of unique solutions and computational simplicity then led, in due course, to the technique of *Least Sum of Squared Residuals*. This was the essence of Legendre's "Méthode des Moindres Quarrés," proclaimed in 1805 (3). No probability considerations were involved.

The successive stages of this evolution of the Method of Least Squares were:

1. When several 'equally good' measurements of a single quantity were available, the Principle of the Arithmetic Mean stated that the 'best' value to take was their arithmetic mean. The arithmetic mean a of a set of measurements $Y_1, Y_2, \ldots, Y_n$ is the solution of the equation

$$\sum_{1}^{n}(Y_i - a) = 0, \qquad (1)$$

that is, the value determined by the *condition of zero sum of residuals.*

This principle seems to have originated in western Europe sometime in the latter half of the 16th century A.D. and appears to have evolved from the technique of taking measurements in pairs such that the two members of a pair are affected by systematic errors of (approximately) equal magnitude but of opposite signs, in which case the arithmetic mean of a pair is (at least, more nearly) free from the effects of these errors.

2. Roger Cotes (1682-1716), in his *Aestimatio errorum* (4), suggested that, when several determinations of a single quantity were available that were subject to unequal uncertainties, then the 'best' value to take for the quantity in question is the weighted arithmetic mean of the individual determinations weighted "inversely proportional to the lengths of the Deviations over which one can spread [their] Errors."

3. Application of Cotes's suggestion to determining the slope β of a line through the origin, $y = \beta x$, from observational points $(Y_1, x_1), (Y_2, x_2), \ldots, (Y_n, x_n)$ affected by errors in the y-direction only, leads to taking the value B determined by the equation

$$\sum_{i=1}^{n}(Y_i - Bx_i) = 0 \qquad (2)$$

as the 'best' value for β, when the uncertainties of the respective Y_i are essentially constant over the range of value of x involved. If the Y_i are regarded as observed values of the respective quantities βx_i, for which the corresponding adjusted values are Bx_i, $(i = 1, 2, \ldots, n)$, then (2) clearly expresses *the condition of zero sum of residuals;* and, when written in the form

$$\bar{Y} - B\bar{x} = 0, \qquad (3)$$

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* If $Y_1, Y_2, \ldots, Y_n$ are observed values of a magnitude α, then $Y_1-\alpha=E_1$, $Y_2 - \alpha = E_2, \ldots$, $Y_n-\alpha=E_n$ are the *errors* of the respective observations. If, the value of α being unknown, one adopts some particular value for it, say a, then $Y_1-a=R_1$, $Y_2-a=R_2$, $\ldots$, $Y_n-a=R_n$ are the *residuals* of the observations corresponding to the *adjusted value* a.

where Y and x are the arithmetic means of the Y- and x-values respectively, shows that "the Cotes line," $y = Bx = (\overline{Y}/\overline{x})x$, passes through the two-dimensional center-of-gravity of the data, $(\overline{x}, \overline{Y})$.

4. In 1748, Leonard Euler (1707-1783) and Tobias Mayer (1723-1762) independently devised and applied (5, 6) an extension of the condition of zero sum of residuals to multi-parameter problems that is today called the Method of Averages: this consists of subdividing the observational points into as many subsets as there are coefficients to be determined, the subdivision being in terms of the values of (one of) the independent variable(s), and then applying the condition of zero sum of residuals to the points of each subset, in the manner of equation (2) above. Provided that one is thus able to form as many distinct observational subsets as there are unknown parameters to be determined, the Method of Averages will always come up with a value for each parameter. But there is usually some arbitrariness and room for subjective choice in the formation of the subsets, with consequent variation in the answers obtained.

5. As a means of overcoming such arbitrariness and subjectivity, Roger Joseph Boscovich (1711-1787) proposed that, given more than two pairs of observed values of variables x and y connected by a linear functional relationship of the form $y = \alpha + \beta x$, then the values (a and b) that one should adopt for α and β in order to obtain the line ($y = a + bx$) that is most nearly in accord with all of the observations should be those determined jointly by the two conditions:—

I. *The sums of the positive and negative residuals (in the y-direction) shall be equal.*

II. *The sum of the absolute values of all of the residuals shall be as small as possible.*

Condition I implies that the best fitting line $y = a + bx$ shall pass through the centroid $(\overline{x}, \overline{y})$ of the observational points. Condition II *in conjunction with Condition I* requires that the slope b shall satisfy the equation

$$\sum_{i=1}^{n} |(y_i - \overline{y}) - b(x_i - \overline{x})| = \text{minimum.} \quad (4)$$

Consequently, determination of a "Boscovich line" reduces to determining its slope b from equation (3) and then evaluating a from the relation $a = \overline{y} - b\overline{x}$.

Boscovich stated and applied his two conditions for a line of best fit for the first time in his 1757 summary and reevaluation (7) of the measurement of a meridian arc near Rome by Christopher Maire and himself, first published in 1755. In this first pronouncement and application of his method he does not give any indication of how he solved equation (4) to obtain the 'best' value of the slope b. Three years later (8), Boscovich restated his two conditions and then gave a very useful algorithm for solving equation (4), together with a geometric proof of its validity, followed by a step-by-step illustration of its application. His algorithm and his proof, in outline, may be found in my chapter in the Boscovich Memorial Volume edited by L. L. Whyte (9).

6. Pierre Simon, Marquis de Laplace (1749-1827), in his first memoir on the Figure of the Earth (10), proposed, as a test of the adequacy of a linear relation $y = a + bx$ to describe a given set of data, that the values of a and b be chosen so as to *minimize the absolute value of the largest deviation* and then a subjective judgment made whether the resulting largest residual is, or is not, explainable in terms of the recognized uncertainties of the data involved. He also outlined a procedure for determining the required values of a and b. In his second memoir on the Figure of the Earth (11), Laplace adopted Boscovich's two criteria for a line of best fit and gave an algebraic formulation and derivation of Boscovich's algorithm for solving equation (4) above. In Book III, Chapter 5, of his Mécanique Celeste (12),

Laplace described again (pp. 417-424) the method that he had used in 1783 to determine the line that minimizes the absolute value of the maximum residual and then gave (pp. 424-434) an alternative procedure for achieving the same end "when the number of observations is considerable." He also extended (pp. 438-442) his 1789 algebraic formulation of Boscovich's technique to the case of observational points of unequal weight.

7. In 1795, at the age of eighteen, Carl Friedrich Gauss (1777-1855), mathematical peer of Archimedes (287-212 B.C.) and Sir Isaac Newton (1642-1727) and unequaled in mathematical precocity, discovered the algebraic and arithmetical advantages of the technique of *Least Sum of Squared Residuals* for adjustment of observations in geodesy.

> "Originally Gauss did not attach great importance to the method of least squares; he felt it was so natural that it must have been used by many who were engaged in numerical calculations. Frequently he said that he would be willing to bet that elder Tobias Mayer (1723-1762) had used it in his calculations. Later he discovered by examining Mayer's papers that he would have lost the bet." (13. p.113).

This may serve to explain in part why Gauss did not publish anything on the Method of Least Squares for over a decade, although he employed the Method almost daily from 1801 onwards in a great variety of astronomical calculations. (14, p. 98).

8. Adrien Marie Legendre (1752-1833) introduced the world to the technique of *Least Sum of Squared Residuals* in his book on "New Methods for Determining the Orbits of Comets" (3) published in 1805. In an Appendix "On the Method of Least Squares," occupying pages 72-80, he wrote:

> "Of all the principles which can be proposed for [the combination of observations] I think there is none more general, more exact, and more easy of application, than that of which we have made use in the preceding researches, and which consists of rendering the sum of the squares of the errors as a *minimum*. By this means there is established among the errors a sort of equilibrium which, preventing the extremes from exerting an undue influence, is very well fitted to reveal that state of the system which most nearly approaches the truth."

Legendre then proceeded to deduce his now well-known rules for forming the so-called 'normal equations.' He then shows that the Principle of the Arithmetic Mean is a special case of his Principle of *Least Sum of Squared Residuals.*

Unfortunately, throughout Legendre's exposition of his "Méthode des moindres quarrés," and his illustrations of its application, he used the term "errors" for what are more accurately termed *residuals*. This has served to confuse the unwary and to conceal the distinction between what he merely asserted in 1805 and what Gauss showed in 1821 to be a statistical property of the procedure. The essence of what Legendre said is this: If in the interest of achieving an objective adjustment one seeks to minimize the mutual inconsistencies of the observations as measured by some simple function of their *residuals*, then the practical requirements of general applicability, unique arithmetical solutions, and ease of computation lead to the adoption of the technique of *Least Sum of Squared Residuals.* No probability considerations were involved. And his "discovery" simply marked the culmination of the attempts by Euler, Mayer, Boscovich, Laplace, and others to develop a practicable objective method of adjustment based solely on consideration of residuals.

III. 'Laws of Error' and Gauss's First 'Proof' of the Method of Least Squares

The *error* of a measurement Y is, by definition, the difference $Y - \tau$ between the measurement and the *true value* τ of the quantity measured. The error of a particular measurement, y, is, therefore, a fixed number, $y - \tau$. The numerical magnitude and sign of this number are ordinarily unknown and unknowable, because τ, the true value of the quantity concerned, is usually unknown and unknowable. A mathematical *theory of errors* is not possible so long as individual measurements are regarded as unique entities, that is, as *fixed numbers* $y_1, y_2, \ldots$. A mathematical theory of errors is possible only when particular measurements $y_1, y_2, \ldots$ are regarded as instances characteristic of the measurements $Y_1, Y_2, \ldots$ that might have been, or might be, yielded by the same measurement process under the same circumstances. This fundamental step was taken on March 4, 1755, by Thomas Simpson (1710-1761), Professor of Mathematics at the Woolwich Military Academy, in "A Letter to the Right Honourable George Earl of Macclesfield, President of the Royal Society, on the advantage of taking the mean of a number of observations, in practical astronomy" (15). This remarkable letter began as follows:

"My lord, it is well known to your lordship, that the method practiced by astronomers, in order to diminish the errors arising from the imperfections of instruments, and of the organs of sense, by taking the Mean of several observations, has not been so generally received, but that some persons, of considerable note, have been of opinion, and even publicly maintained, that one single observation, taken with due care, was as much to be relied on as the Mean of a great number.

"As this appeared to be a matter of much importance, I had a strong inclination to try whether, by the application of mathematical principles, it might not receive some new light; from whence the utility and advantage of the method in practice might appear with a greater degree of evidence. In the prosecution of this design (the result of which I have now the honour to transmit to your Lordship) I have, indeed, been obliged to make use of an hypothesis, or to assume a series of numbers, to express the respective chances for the different errors to which any single observation is subject . . .

"Should not the assumption, which I have made use of, appear to your Lordship so well chosen as some others might be, it will, however, be sufficient to answer the intended purpose: and your Lordship will find, on calculation that, whatever series is assumed for the chances of the happening of the different errors, the result will turn out greatly in favour of the method now practised, by taking a mean value."

Simpson's first "hypothesis" was that the *errors* of measurements of a single quantity by a particular measurement process be regarded as taking the values $-v, -v+1, \ldots, 2, 1, 0, 1, 2, \ldots, v-1, v$, with equal probabilities, *i.e.*, a *discrete uniform distribution.* Next, he assumed that the errors be regarded as taking on the above values with probabilities proportional to $1, 2, \ldots, v-1, v, v+1, v, \ldots, 2, 1$, respectively, *i.e.*, a *discrete isosceles triangle distribution.* Utilizing the generating function techniques that had been employed by Abraham DeMoivre (1667-1754) for the solution of problems relating to tosses of dice and other games of chance (16), Simpson derived, for each of these distributions, the probability distribution of the *sum* of *n independent errors* from such a distribution, and then from these the corresponding distributions of the *arithmetic mean* of *n independent errors.* He summed up his findings as follows:

"Upon the whole of which it appears, that the taking of the Mean of a number of observations, greatly diminishes the chances for all the smaller errors, and cuts off almost all possibility of any great ones: which last consideration, alone, seems sufficient to recommend the use of the method, not only to astronomers, but to all others concerned in making of experiments of any kind (to which the above reasoning is equally applicable). And the more observations or experiments there are made, the less will the conclusion be liable to err, provided they admit of being repeated under the same circumstances."

In a second paper on "the advantage arising by taking the mean" (17), Simpson found the distribution of the mean of *n* independent errors from a *continuous isosceles triangle distribution,* by proceeding to the limit as the spacing between the error values in the fixed interval $(-a, +a)$ tends to zero.

It should be noted that Simpson did *not* prove that "taking of the arithmetic mean" was the best thing to do, but merely that it *is* advantageous. However, in accomplishing this goal he did something much more important: he took the bold step of regarding errors, not as individual unrelated happenings, but as properties of the measurement process itself and the observer involved. He thus opened the way to a mathematical theory of measurement based on the mathematical theory of probability.

Simpson's idea of probability distributions of error was taken up quickly on the Continent. Joseph Louis, Comte de Lagrange (1736-1813), an Italian by birth, a German by adoption, a Frenchman by choice, and one of the greatest mathematicians of all time, reproduced and elaborated on Simpson's results—without mention of Simpson—in a long memoir "on the utility of taking the mean" (18). By a similar passage to the limit he deduced the (subsequently oft rediscovered) distribution of the arithmetic mean of n independent errors from a *continuous uniform distribution.*

Daniel Bernoulli (1700-1782), nephew of James Bernoulli (1654-1705) whose *Ars Conjectandi* (1713) is one of the great landmarks in the history of probability, published in 1778 a highly original paper on "The most probable choice between several discrepant observations and the formation therefrom of the most likely induction" (19) that apparently existed in manuscript as early as 1774 (20, p. 634). In this paper Bernoulli proposed (1) a *semi-circular law of error,*

$$f(x) = \frac{2}{\pi a^2} \sqrt{a^2 - x^2}, \quad -a \lesseqgtr x \lesseqgtr +a,$$

where $x = y - \tau$ is the error of y as an observed value of the *true value* τ, and $\pm a$ are limits which an error will never exceed; and (2) advocated maximization of the product $f(x_1)f(x_2) \ldots f(x_n) = \left(\frac{2}{\pi a^2}\right)^n \prod_{i=1}^{n} [a^2 - (y - \tau)^2]^{1/2}$ with respect to τ to obtain the "most likely value" of τ indicated by the observations $y_1, y_2, \ldots, y_n$. Today we would call this "most likely value", $T = T(y_1, y_2, \ldots, y_n)$, the *maximum likelihood estimate* of τ corresponding to the law of error $f(x)$. For $n = 3$, evaluation of T requires the solution of an equation of the fifth degree consisting of twenty terms; and for $n > 3$, the algebra and arithmetic become unmanageable. However, for $y_1 \lesseqgtr y_2 \lesseqgtr y_3$, Bernoulli showed that his "most likely value" T is greater than, equal to, or less than the arithmetic mean of the three values according as the middle value (y_2) is less than, equal to, or greater than the midpoint $\frac{1}{2}(y_1 + y_3)$ between the extremes, respectively. His T thus assigns greater weight to the more distant of the two extreme observations. The actual magnitude of the difference $T - \bar{x}$ depends, however, on the choice of a, the limit an error will never exceed in absolute value, but tends to zero rapidly as $a \to \infty$, leading Bernoulli to remark: "Those who are most shocked by our principles will have nothing further to contradict if only they make the field of possible deviations as large as possible."

In 1774, Laplace, in his first discussion of the problem of the 'best mean' (20), proposed (1) *a double-exponential law of error,*

$$f(x) = \frac{m}{2} e^{-m|x|}, \quad -\infty < x < +\infty;$$

and (2) adoption as the 'best mean' that function $T(Y_1, Y_2, Y_3)$ of three observations for which the average value of $|T - \tau|$ is a minimum. Today we would call his T the *minimum mean absolute error estimator of* τ. *For* $n = 3$ *and* $y_1 \lesseqgtr y_2 \lesseqgtr y_3$, Laplace's 'best mean' T is greater than, equal to, or less than y_2, the middle value (*i.e.*, the *median*), according as y_2 is less than, equal to, or greater than $\frac{1}{2}(y_1 + y_3)$, the midpoint between the extremes, respectively. T is thus a 'corrected median', the correction being in the direction of the more distant of the two extreme observations. Furthermore, $T \to y_2$ as $m \to \infty$ (*i.e.*, very high *precision*); and $T \to \bar{y}$, the mean of the three values, as $m \to 0$ (*i.e.*, very poor precision).

Thus, while Simpson's and Lagrange's work had shown the arithmetic mean to be increasingly 'good' as $n \to \infty$, Bernoulli's and Laplace's work implied that the arithmetic mean was 'best' only in the limiting case of infinitely poor precision.

As noted above, Gauss discovered the great algebraic and arithmetical advantages of the technique of *Least Sum of Squared Residuals* in 1795. In 1797 he attempted to justify this procedure via the calculus of probabilities, concluding that determination of "most probable values" of unknown quantities is impossible unless the law of error is known explicitly. "When this is not the case, nothing remains but to assume such a function as an hypothesis. It seemed to him most natural to proceed first the other way around and to look for that function on which the whole theory should be based if for the simplest case there is to result the rule generally accepted as good, namely, that the arithmetic mean of several values obtained for the same unknown through observations of equal reliability is to be considered as the most probable value" (14, p. 98). By June 1798 (13, p. 113) he had completed his now famous 'proof' of the Method of Least Squares, in which he (a) adopted as a postulate the Principle of the Arithmetic Mean, (b) utilized the concept that repetition of a measurement process generates a *probability distribution of errors*, and (c) applied Bayes's *method of inverse probability*—without reference to Thomas Bayes (1702-1761). Starting from these premises he showed that if the arithmetic mean of n independent measurements of a single magnitude is to be the most probable value of this magnitude *a posteriori*, then the *errors* $X_i = Y_i - \tau$ of the individual measurements Y_i must be distributed in accordance with the law of error

$$f(x) = \frac{h}{\sqrt{\pi}} e^{-h^2x^2} \qquad -\infty < x < +\infty.$$

(5) Then he showed that, *if* errors are normally distributed, and *if* the unknown values of the essential parameters have *uniform a priori distributions*, then the most probable values of the unknown implied by a given set of observational data are given identically by the application of the technique of Least Sum of Squared Residuals. He did not publish these results, however, until 1809, in Book II, Section 3, of his *Theory of the Motion of Heavenly Bodies Moving about the Sun in Sections* (21).

Gauss was well aware that this derivation of his now famous law of error and consequent justification of the technique of *Least Sum of Squared Residuals* was merely an extension of the Principles of the Arithmetic Mean and stood or fell with this Principle. Thus, he remarked that the principle that "the most probable system of values of the unknown quantities [is that for which] the sum of the squares of the differences between the observed and computed values of the functions [observed] is a minimum . . . must, everywhere be considered an axiom with the same propriety as the arithmetical mean of several observed values of the same quantity is adopted as the most probable value" (21, art. 179). But his analysis of the Method of Least Squares remains notable because he recognized that "the constant h can be considered as a measure of the precision [*praecisionis*] of the observations" and then went on to give (1) the formula for the precision of a linear function independent observations of equal or unequal precisions, and (2) the rule for weighting results of unequal precision so as to obtain the combined result of maximum attainable precision. These are everlasting accomplishments of his first 'proof'.

Laplace greatly strengthened Gauss's first 'proof' almost immediately after its publication, by his discovery (22 pp. 383-389) that, under certain very general conditions (not considered in full generality by Laplace) the distributions of linear functions, and hence of the arithmetic means, of n independent errors can be approximated (when properly scaled) by

Gauss's law of error (5), with the error of the approximation tending to zero as $n \rightarrow \infty$. From this it follows directly that the Method of Least Squares as developed by Gauss leads to 'most probable values' (under "very general conditions") when the number of independent observations involved is large. The Method of Least Squares was, therefore, regarded as firmly established, not merely on grounds of algebraic and arithmetical convenience, but also via the calculus of probabilities—at least when the number of independent observations is large!

IV. Minimum Errors of Estimation and Gauss's Second 'Proof'

As noted above, Laplace suggested in 1774 (20) that the 'best mean' to take in practical astronomy is that function of the observations which has an equal probability of over- and under-estimating the true value, showed that this is equivalent to adopting the principle of *Least Mean Absolute Error of Estimation,* and gave an algorithm for finding this particular function of three observations in a one-parameter case. By this algorithm his 'best mean' is given by the abscissa $T(y_1, y_2, y_3)$ that divides the area under the curve $f(y_1—\tau)f(y_2—\tau)f(y_3—\tau)$, considered as a function of τ, into two equal halves, $f(x)$ being the law of error involved. In 1778 (23), Laplace extended this agreement to the case of n independent observations and termed this procedure "the most advantageous method" of estimation. This approach was invented anew and fully explored by E. J. G. Pitman in 1939 (24). Unfortunately, it usually leads to intractable equations for the "most advantageous" estimates, except for very special choices of the law of error. Thus, in 1811 (25), Laplace found that, among all laws of error of the form $f(x) = Ke^{—\psi(x^2)}$, where $\psi(x^2)$ is an arbitrary continuous function of $x^2 = (y—\tau)^2$, the Gaussian law (5) is the only one for which the arithmetic mean $\overline{Y}$ of n independent observations is the "most advantageous" estimator of τ.

By adopting instead the principle of *Least Mean Squared Error of Estimation* and the requirement that the resulting "best mean" should yield the true values of the quantities concerned if it should happen that all of the observations were entirely free from error, Gauss showed in 1821-23 (26, 27) that, when the resulting 'best values' are linear functions of the observations, then they are identically the same as those given by the technique of *Least Sum of Squared Residuals* (which provides the practical *modus operandi* for obtaining them), and that in this important case the *Least Mean Squared Error* property is completely independent of the law of error involved. This fact, which mathematical statisticians today express by saying that the Method of Least Squares yields *minimum variance linear unbiased estimators* of the unknown magnitudes concerned under "very general conditions", is considered by many mathematical statisticians today to be the *real* theoretical basis of the Method of Least Squares. Henri Poincaré (1854-1912) remarked in 1893-94 (28, p. 168), "This approach justifies the [Method of Least Squares] *independently of the law of errors . . . .* is, thus, a refutation of Gauss's [earlier] reasoning [and] it is rather strange that this refutation is due to Gauss himself". And it is equally surprising that this best-linear-unbiased-estimator property of Least Squares seems to be unknown to many users of the Method of Least Squares today.

V. Concluding Remarks

The robust survival of the Method of Least Squares as a valuable tool of applied science no doubt stems in part from the algebraic and arithmetical advantages of *Least Sum of Squared Residuals* and in part from the fact this procedure also yields estimates of *Least Mean Squared Error* in the important case when the end results are linear functions of the basic observations. This one-to-one correspondence between minimizing some function of the *residuals* and minimizing *the same function* of *Errors of Estimation* appears to be a unique property of *Least Squares.* And although the Method of Least Squares does not lead to the best available estimates of unknown parameters when the law of error is other than the Gaussian, if the number of independent observations available is much larger than the number of parameters to be determined the Method of Least Squares can be usually counted on to yield nearly-best estimates.

References

(1) Russell, Bertrand. *Human Knowledge: Its Scope and Limits.* Simon and Schuster, New York, 1948, p. 344.

(2) Whittaker, E. T. and Robinson, G. *The Calculus of Observations.* Blackie & Son, Ltd., London, 1924. 2nd edition, 1932; 3rd edition, 1940.

(3) Legendre, Adrien Marie. *Nouvelles méthodes pour la détermination des orbites des comètes.* Paris, 1805. Appendix, 'Sur laMéthode des moindres quarrés', pp. 72-80. (English translation of pp. 72-75, by Henry A. Ruger and Helen M. Walker, in David Eugene Smith, *A Source Book in Mathematics,* McGraw-Hill Co., Inc., New York, 1929, pp. 576-579. Reprinted in 2 vols., Dover Publications, Inc., New York, 1959.)

(4) Cotes, Roger. Aestimatio errorum in mixta mathesi, per variationes partium trianguli plani et sphaerici, *Opera Miscellania* (appended to his *Harmonia Mensurarum,* Cantabrigiae, 1722), pp. 1-22.

(5) Euler, Leonhard. Pièce qui a remporté le prix de l'Academie royale des sciences en 1748, sur les inégalités du mouvement de Saturne et de Jupiter. Paris, 1749.

(6) Mayer, Johann Tobias. Abhandlung über die Umwälzung des Mondes um seine Axe, *Kosmographische Nachrichten und Sammlungen,* Vol. I (1748), pp. 52-183 (published 1750).

(7) Boscovich, Roger Joseph. De Litteraria Expeditione per Pontificiam ditionem, et Synopsis amplioris Operis, ac habentur plura ejus ex exemplaria etiam sensorum impressa, *Bononiensi Scientiarum et Artum Instituto Atque Academia Commentarii,* Tomus IV, pp. 353-96, 1757.

(8) Stay, Benedict. *Philosophiae Recentioris, a Benedicto Stay in Romano Archigynasis Publico Eloquentare Professore, versibus traditae, Libri X, cum adnotationibus et Supplementis P. Rogerii Josephi Boscovich* S.J., Tomus II, Romae, 1760.

(9) Eisenhart, Churchill. Boscovich and the Combination of Observations. Chapter 7 in R. J. Boscovich, F.R.S.: *Studies of His Life and Work,* edited by Lancelot Law Whyte, Allen and Unwin, Ltd., London, 1961.

(10) Simon, Pierre, Marquis de Laplace. Mémoire sur la Figure de la Terre. *Mémoires de l' Académie royale des Sciences de Paris, pour l'année 1783,* pp. 17-46, Paris, 1786. Reprinted in *Oeuvres de Laplace,* National Edition, Vol. 11, Gauthier-Villars, Paris, 1895.

(11) Laplace. Sur les degrés mesurés des méridiens, et sur les longueurs observées sur pendule, *Histoire de l'Académie royale des inscriptions et belles lettres, avec les Mémoires de littérature tirées des registres de cette académie, Année* 1789, 18-43 of the Memoires. Paris, 1792.

(12) Laplace. Traité de Mécanique Céleste, Vol. II. Paris, 1799. Reprinted as Vol. II of *Oeuvres de Laplace,* Paris, 1843; National Edition, Gauthier-Villars, Paris, 1878; English translation, with notes and commentary, by Nathaniel Bowditch, Boston, 1832.

(13) Dunnington, Guy Waldo. *Carl Friedrich Gauss: Titan of Science.* Hafner Publishing Co., New York, 1955.

(14) Gauss, Carl Friedrich. Summary of his paper "Theoria combinationis observationum erroribus minimis obnoxiae, pars prior." *Göttingische gelehrte Anzeigen,* February 26, 1821; Gauss *Werke,* vol. IV, p. 96-100.

(15) Simpson, Thomas. A letter to the Right Honourable George Earl of Macclesfield, President of the Royal Society, on the advantage of taking the mean of a number of observations, in practical astronomy, *Phil. Trans. Roy. Soc. London,* Vol. 49, Part I, pp. 82-93, 1755.

(16) Demoivre, Abraham. *The Doctrine of Chances: or a Method of Calculating the Probability of Events in Play.* London, 1718 (2nd ed., 1738; 3rd ed., 1756).

(17) Simpson. An attempt to show the advantage arising by taking the mean of a number of observations in practical astronomy. In his *Miscellaneous Tracts on Some Curious and Very Interesting Subjects in Mechanics, Physical-Astronomy, and Speculative Mathematics,* pp. 64-75. J. Nourse, London, 1757.

(18) Joseph-Louis, Comte de Lagrange. Mémoire sur l'utilité de la méthode de prendre le milieu entre les résultats de plusieurs observations; dans lequel on examine les avantages de cette méthode par le calcul des probabilités; et où l'on résoud différents problèmes relatifs à cette matière. *Miscellanea Taurinensia,* Vol. 5 (1770-1773), pp. 167-232 of Mathematics portion. Reprinted in *Oeuvres de Lagrange,* Vol. 2, pp. 173-234. Gauthier-Villars, Paris, 1868.

(19) Bernoulli, Daniel. Dijudicatio maxime probabilis plurium observationum discrepantium atque verisimillima inductio inde formanda. *Acta Academiae Scientiorum Petropolitanae,* Vol. I (1777), Pt. I, pp. 3-23 of the Memoirs. St.

Petersburg, 1778; English translation by C. G. Allen, *Biometrika,* Vol. 48, Pts. 1 and 2 (June 1961), pp. 3-13.

(20) Laplace. Problème III: Déterminer le milieu que l'on doit prendre entre trois observations données d'un même phénomène. Pp. 634-644 of his "Mémoire sur la probabilité des causes par les événements", *Mémoires de Mathématique et de Physique,* Vol. 6, pp. 621-657, Paris, 1774.

(21) Gauss. *Theoria Motus Corporum Coelestium in Sectionibus Conicis Solem Ambientium.* Frid. Perthes et I. H. Besser, Hamburg, 1809; Reprinted in *Carl Friedrich Gauss Werke,* Band VII. Gotha, 1871. English translation by Charles Henry Davis, Boston, 1857; reprinted by Dover Publications, Inc., New York, 1963.

(22) Laplace. Mémoire sur les approximations des formules qui sont fonctions de trèsgrands nombres, et sur leur application aux probabilités, *Mémoires de la classe des Sciences Mathématiques et Physiques, de l'Institut de France Année 1809,* pp. 353-415; Supplement pp. 559-565. Paris, 1810.

(23) Laplace. Mémoire sur les Probabilités, *Histoire de l'Académie royale des Sciences de Paris,* Annee 1778, pp. 227-332. Paris, 1781.

(24) Pitman, E. J. G. The estimation of the location and scale parameters of a continuous population of any given form, *Biometrika,* Vol. XXX, Parts 3 and 4 (Jan. 1939), pp. 391-421.

(25) Laplace. Mémoire sur les intégrales définies et leur application aux probabilités, et spécialement à la recherche du milieu qu'il faut choisir entre les résultats des observations, *Mémoires de la Classe des Sciences Mathématiques et Physiques de l'Institut Impérial de France, Année 1810,* pp. 279-347. Paris, 1811.

(26) Gauss. Theoria combinationis observationum erroribus minimis obnoxiae. Pars prior. [presented 15 Feb. 1821.] *Commentationes societas regiae scientiarum Göttingensis recentiores,* Vol. V, pp. 33-62, 1823. Reprinted in *Carl Friedrich Gauss Werke,* Vol. IV, pp. 1-26. Göttingen, 1873.

(27) Gauss. Theoria combinationis . . . Pars posterior. [Presented 2 Feb. 1823.] *Commentationes . . .,* Vol. V, pp. 63-90, 1823. Reprinted in *Werke,* Vol. IV, pp. 29-53. Göttingen, 1873.

(28) Henri Poincaré. *Calcul des probabilités. Leçons professées pendant le deuxième semestre 1893-1894.* Georges Carré, Paris, 1896.

Academy Proceedings

February Meeting

(478th Meeting of the Washington Academy of Sciences)

SPEAKER: **BENJAMIN D. VAN EVERA**
Dean for Sponsored Research, George Washington University

SUBJECT: **ADDRESS OF THE RETIRING PRESIDENT**

TIME: **THURSDAY, FEBRUARY 20, 1964—**
8:15 P.M.

PLACE: **JOHN WESLEY POWELL AUDITORIUM, COSMOS CLUB**
2170 Florida Ave., N.W.

Abstract of Address—At a time when the country needs excellent teaching more than it ever has before, society is imposing on teachers, both active and potential, pressures which lead them not to teach or to neglect their teaching. Some of these pressures are enumerated and discussed and suggestions are made for improving the situation.

Election Results Announced

Returns from the annual mail ballot of the membership, sent out in mid-December, were tallied by a Committee of Tellers on January 3 and reported at the Academy's annual meeting on January 16.

This year's balloting covered only the election of officers and managers; no By-laws changes were involved. About 340 valid ballots were cast, as compared with 278 returns in January 1963 and 468 returns in January 1962.

Leo Schubert of American University was elected president-elect, without opposition.

George W. Irving, Jr., of the Department of Agriculture, and Malcolm C. Henderson of Catholic University were re-elected secretary and treasurer, respectively, without opposition.

Allen L. Alexander and Francis Reichelderfer were elected managers-at-large for the period 1964-66, defeating Michael Goldberg and Marion Parker.

The successful candidates took office at the close of the annual meeting on January 16. At the same time, Francois N. Frenkiel, last year's president-elect, automatically assumed the presidency.

A complete roster of officers, managers, and committee chairmen will be published in an early issue of the Journal.

Summary Annual Report of Secretary for 1963

The Secretary's annual report of Academy activities in 1963 is intended to supplement, and in some instances summarize, detailed reports of other officers and committee chairmen.

Membership. This year, as a result of amendments to the Bylaws approved by the necessary two-thirds majority of the membership, the Academy had two classes of membership—fellows and members. The term "fellow" identifies all who qualified for membership prior to the Bylaws amendments, and to future candidates of equivalent scientific status who are approved by the Board of Managers. The term "member" identifies persons who are interested in supporting science, but who do not have all of the qualifications necessary to become "fellows." Membership is approved by the Membership Committee of the Board of Managers.

Donald H. Williams of the Dairy Industries Supply Association had the distinction of being the first official member of the Academy under the new membership rules.

As of the end of 1963, there were 12 qualified members. However, the Membership Committee has recently furnished the Secretary with approved applications of 30 new members as a start for 1964. During 1963, 19 applicants qualified as fellows.

The following deaths, with the dates indicated where known, were reported in 1963: Sara E. Branham, November 16, 1962; William W. Coblentz, September 15, 1962; Robert C. Duncan, May 8, 1963; Virginia F. Griffing, September 5, 1963; E. F. Mueller, July 1963; Kenneth L. Sherman, November 5, 1962; B. T. Simms, September 26, 1963; Lloyd W. Stephenson, October 13, 1962; William E. Wrather, November 28, 1963; H. A. Allard; Earle S. Belote; and Michael X. Sullivan.

Meetings. The March, April, May and November meetings of the Academy were held in the John Wesley Powell Auditorium of the Cosmos Club. The October meeting was held at Carnegie Institution, and the December meeting at the Naval Observatory.

The 65th annual dinner meeting of the Academy was held in February 1963 instead of January, and was recorded by the Secretary in his report for 1962, published in the March 1963 issue of the Journal.

Raymond J. Seeger, special assistant to the director, National Science Foundation, addressed the 472nd meeting of the Academy on March 21, 1963, "On the Sociology of Science."

On Thursday, April 18, Ragnar Rollefson, director of the Office of International Scientific Affairs, established in the Department of State in 1962, addressed the 473rd Meeting of the Academy. His subject was, "Science in the Department of State."

"Conformation of Proteins in Solution: Optical Rotatory Dispersion Studies" was the subject of the address by Sherman Beychok, assistant professor of biochemistry in the College of Physicians and Surgeons, Columbia University, at the 474th meeting of the Academy, on May 16.

The 475th meeting on October 17 consisted of a debate on "The Nature of the Lunar Maria" between Ralph B. Baldwin and John A. O'Keefe.

"The International Indian Ocean Expedition," the subject of the 476th meeting of the Academy, came about as the result of a meeting of a Special Committee for Oceanic Research of the International Council of Scientific Unions in 1958. Irvin E. Wallen, assistant director for oceanography at the National Museum, the speaker, talked primarily about the biological program of the Expedition.

At the 477th meeting of the Academy, William Markowitz, director of the Time Service Division, Naval Observatory, discussed "200 years of Timekeeping: From Harrison Number 4 to the Atomic Clock."

following an open house at the Observatory where Harrison No. 4, constructed in 1759, and modern timepieces were on exhibition.

The 66th annual dinner meeting was held on January 16, 1964, in the John Wesley Powell Auditorium of the Cosmos Club. The winners of awards for scientific achievement for 1963 are Brian J. McCarthy, Department of Terrestrial Magnetism, Carnegie Institution of Washington—biological sciences; George A. Snow, Department of Physics, University of Maryland—physical sciences; James H. Bramble, Institute of Fluid Dynamics and Applied Mathematics, University of Maryland—mathematics; Frank T. Davenport, Frank W. Ballou High School; George M. Koehl, Physics Department, George Washington University; and Leo Schubert, Chemistry Department, American University—teaching of science.

Miscellany. The annual student awards dinner meeting of the Academy was held May 1, 1963 in the faculty dining room at Georgetown University. Father Francis J. Heyden, S.J., chairman of the WAS Committee on Encouragement of Science Talent, was in charge of the arrangements. Forty outstanding science students were presented with certificates of merit at the dinner. The speaker for the occasion was Robert Page of the Naval Research Laboratory. His topic was, "Man and Machines in the World Today."

Five grants-in-aid to young scientists of the area were approved by the Board of Managers upon recommendation of the committee headed by A. T. McPherson, and the American Association for the Advancement of Science was authorized to disperse $520.20 for approved projects such as polishing a crystal for a ruby laser, utilization of acoustic vibrations to destroy boundary layers in electrodialysis, distribution of small mammals in the Middle Peninsula of Virginia, effects of pesticides on fish, and further investigations on salamanders.

Volume 53 of the Academy's Journal appeared during the year in nine issues having a total of 232 pages. Eight of the issues, as in 1962, contained a variety of articles by leading area scientists, reviewing the status of research in a number of important fields; special reports of science education and other major Academy program; and news concerning the Academy's organization, plans, and accomplishments. The ninth issue, appearing in September, contained a directory of the membership, classified alphabetically, by place of employment, and by membership in affiliated societies. It included, also, as a trial for feasibility, the complete membership rosters of four of the Academy's affiliated societies—Entomological Society of Washington, Botanical Society of Washington, International Association for Dental Research, and the Institute of Food Technologists.

George W. Irving, Jr., Secretary, 1963

Delight Hall Rothe

Mrs. Delight Hall Rothe, who served as assistant treasurer for the Washington Academy of Sciences in 1962 and up to March 1963, died on January 16 as a result of a riding accident she had suffered the previous Saturday. Her horse apparently stumbled after completing a jump; Mrs. Rothe was thrown on her head, and although she was wearing a riding hat, her head and spine were injured and she never recovered consciousness.

Mrs. Rothe's prior experience as office manager for the Chicago Daily News Bureau was most valuable in her work for the Academy, and your treasurer has had many reasons to be grateful for her assistance. Aside from her part-time work at the Academy, she was an active author and book reviewer, particularly of modern French fiction and art history. She also operated a private research office and undertook research assignments for the Smithsonian Institution. Her funeral was held in the Bethlehem Chapel of the Washington National Cathedral on January 20, with Dean Sayre reading the service.

—*Malcolm C. Henderson*

Annual Report of the Treasurer for 1963

Washington Academy of Sciences

Receipts

Dues	$ 9,846.00
Subscriptions to *Journal*	2,403.69
Sales—Reprints	489.05
Single Issues	61.25
Committee Receipts—Regular	381.65
Special	364.21
Dividends—Regular	2,103.57
Capital Gain	30.73
Interest	74.85
J. B. Taxes and Salary Refunded	2,793.49
Miscellaneous Refunds	462.85
Grants Reimbursed	570.20
Services to Joint Board	400.00
Miscellaneous (Science Calendar, etc.)	160.00
Total Receipts	$20,141.54

Disbursements

Secretary (office expenses)	$ 713.59
Treasurer (printing, postage, etc.)	155.25
Reprints	258.00
Science Calendar	150.00
Committee Expenses	2,805.90
Headquarters Expenses	
Supplies, Etc.	961.20
Salaries	2,602.62
Furniture Purchased	58.81
Refunds and Debit Memos	55.00
Taxes (Including J.B.) Paid	2,698.81
Reimbursab'e Grants	615.20
Outright Grants	300.00
Awards Expense	8.75
Journal Expense (7 issues)	6,256.38
Miscellaneous (incl. J.B. salary)	2,245.73
Total Disbursements	$19,886.24

Cash Account Reconciled With Bank

Balance 1 Jan. 1963	$4,926.82	31 Dec. 1963	$5,181.12
Excess R/D in year	255.30	Petty Cash	1.00
	$5,182.12		$5,182.12

Income Account

Receipts	$20,141.84	Expenditures	$19,886.24
Accounts Receivable:		Accounts Payable	
Services to J.B.	200.00	1/5 J.B. Sal.	1,000.01
Taxes Reimbursab!e	274.11	Nov. Journal	495.62
Deficit for 1963	1,355.36	Dec. Journal	589.44
	$21,971.31		$21,971.31

Assets

(Market values as of Dec. 16, 1963)

2893 sh. Mass. Investor's Trust @ 15.46	$ 44,725.78
(64 sh. Capital Gain Dividend + $12.99)	
1149 sh. Investment Co. of America @ 10.87	12,489.63
(25 sh. Cap. Gain Div. + $9.92)	
64 sh. State St. Investment Co. @ 40.50	2,592.00
(3 sh. Cap. Gain Div. + $0.42)	
1745 sh. Washington Mutual Inv. Co. @ 10.78	18,811.10
(50 sh. Cap. Gain Div. + $7.40)	
Capital Cash (Balance from 1962 + Cap. Gain Divs.)	783.66
Income Cash ($5,182.12 less 783.66)	4,398.46
Grand Total (Not including Petty Cash)	$ 83,800.63

Income from Investments

Dividends: Massachusetts Investors Trust	$1,179.09
Investment Company of America	284.78
State Street Investment Company	54.40
Washington Mutual Investment Company	585.30
Interest on Treasury Notes	74.85
Total	$2,178.42

Comparison	*1/1/63*	*12/31/63*
WAS stocks at market value	$67,651.07	$78,618.51
Cash	4,926.82	5,182.12
Totals	$72,577.89	$83,800.63

Membership

New Members in 1963	12
New Fellows in 1963	19
Life Members	4
Active Fellows	
Paid Dues for 1963	947
Paid Dues for 1964	2
Delinquent for 1963 only	40
Delinquent for 1962 & 1963	23
Delinquent for 1961-1963	3
Emeritus Status, receiving Notices, Bulletin and *Journal*	
Paid Subscription to *Journal*	7
Gift of WAS	3
Owing for 1963	7
"Retired", no payment	43
Emeritus Status, Receiving Notices & Bulletins	69
Total Membership	1,179
Resigned in 1963	9
Deceased	10
Dropped	5

Joint Board on Science Education

Balance January 1, 1963	$ 8,931.68
Total Receipts	8,700.00
	$17,631.68
Expenditures (paid through WAS)	$14,111.71
Balance carried forward to 1964	3,519.97

Washington Junior Academy of Sciences

Checking Account

Balance Jan. 1, 1963	$ 349.59	Expended in 1963	$3,482.64
Receipts in 1963	3,884.25	Balance Dec. 30, 1963	751.20
	$4,233.84		$4,233.84

Savings Account

Balance Jan. 1, 1963	$1,439.92	Withdrawn 1963	$1,900.00
Deposited 1963	2,000.00	Balance Dec. 30, 1963	1,539.92
	$3,439.92		$3,439.92

Forward to 1964:	
Savings Account	$1,539.92
Earned Interest	53.60
Checking Account	751.20
Total Assets:	$2,344.72

Malcolm C. Henderson, Treasurer, 1963

Report of Committee on Grants-in-Aid of Research, 1963

The Committee presents the following report for the period from January 14, 1963, to January 16, 1964.

Grant Funds. The amount available for grants according to letter of January 29, 1963, from Hans Nussbaum, Business Manager, AAAS, to Dr. Van Evera, was $920.88. The following grants were approved by the Board during the Academy year 1963:

June 12. *Daniel Peacock* (Sponsor: Charles O. Handley, Jr., Smithsonian Institution. Project: Study of the Distribution of Small Mammals on Middle Peninsula of Virginia) $100.00

June 12. *Hunter Woodward.* (Sponsor: C. R. Naeser, George Washington University. Project: Utilization of Acoustic Vibrations To Destroy Boundary Layers in Electrodialysis) $250.00

Oct. 15. *James Steakley* (Sponsor: R. Yamamoto, NIH. Project: Continuation of Research on Salamanders) .... $ 38.30

Oct. 15. *Howard Ozer.* (Sponsor: Anthony Inglise, Fish & Wildlife Center. Project: Investigation of Pesticides on Fish) $131.90

Total grants awarded $520.20

Balance (Available for obligation in 1964) $400.68

Aproximate amount expected to be alloted by AAAS in 1964 .... $460.00

Approximate Total Available for Grants-in-Aid, 1964 .... $860.68

Grants Not Recommended. One application was not processed because a preliminary experiment that was suggested showed that the basic idea was not feasible. Several inquiries and discussions with students led to the withdrawal of applications because scientists to whom the students were referred recommended improvising equipment instead of buying the items sought.

Publicity Regarding Grants. The attached policy regarding Grants-in-Aid of Research, which was approved by the Policy and Planning Committee on December 28, 1962, has been circulated informally among Board members and science supervisors. To give it wider publicity, it is recommended that this policy statement be published in the *Journal of the Washington Academy of Sciences.*

—*A. T. McPherson, Chairman*

Policy Statement on Grants-in-Aid of Research

The Washington Academy of Sciences makes grants-in-aid of research from funds provided for the purpose by the American Association for the Advancement of Science and such other funds as may become available. The grants are made to assist in meritorious original work and are awarded by the Board of Managers of the Academy on the basis of recommendations by the Committee on Grants-in-Aid.

1. *Who is eligible for a grant?* Grants may be made to any person, group, or organization in the Washington metropolitan area. (In recent years most of the recipients have been high school students.)

2. *Amount of grants.* Grants are usually made in amounts of less than $100, although larger grants have been made when warranted by the nature and requirements of the project. (The total amount currently available is about $500 per year.)

3. *Basis of awarding grants.* Proposed projects are judged on the basis of (1) the merit of the project as a subject of scientific investigation; (2) the qualifications of the applicant as shown by his analysis and presentation of the project, his previous accomplishments, and his school record.

4. *Permissible Uses of Grant Funds.* Grants are usually made for special materials, supplies, and equipment that cannot be obtained through the schools or through laboratories that cooperate in school science programs. Grants have been made, however, for travel expenses for necessary field work and for lunches and bus fares for students who engage without compensation in summer work in research laboratories.

5. *Applications for grants.* Applications for grants may be made at any time. No special form is required for the application. The application should describe the proposed project and itemize the objects for which funds are requested. If the applicant has done previous work on the project, this should be summarized in the application. If the work is to be done with the use of school facilities, the application should be endorsed by a teacher or science supervisor either in a letter or by a note written at the bottom of the application.

6. *Review by a research scientist.* If the applicant for a grant has not already been in touch with a scientist in the field in which he proposes to work, the Committee on Grants-in-Aid will put him in touch with such a person. This discussion with someone working actively in the field may lead to changes in the project which will save time and effort and, in some cases, may result in special facilities and equipment being made available to the applicant.

7. *Processing of grants.* When the applicant and the sponsoring scientist have agreed on the proposed project, the Committee undertakes to act on the application promptly and report its recommendation at the next meeting of the Board. If the Board takes favorable action, the Secretary will send a request to the AAAS for the amount of the grant and when this is received by the Treasurer of the Academy, he will send a check for the amount of the grant to the successful applicant. The whole transaction from the initial filing of the application to the payment of the grant seldom takes more than two months.

8. *Reporting on grants.* In the past, most persons awarded grants have voluntarily reported significant accomplishments such as the publication of papers and the receipt of honors or prizes. Henceforth, a summary report will be expected from all awardees. This report should tell what was done and what results were obtained, and should give an accounting of the expenditure of funds.

Grants are not made primarily for the purpose of preparing exhibits for science fairs, but recipients of grants are encouraged to present their work in fairs whenever it is possible to do so.

BOARD OF MANAGERS MEETING NOTES

December Meeting

The Board of Managers held its 560th meeting on December 19, 1963 at the Old Europe Restaurant, 2434 Wisconsin Avenue, with President Van Evera presiding.

The minutes of the 559th meeting were approved as previously distributed, with a minor correction.

Announcements. Dr. Van Evera made the following announcements:

(1) Russell Stevens had declined to accept appointment as archivist.

(2) Bourdon F. Scribner had accepted appointment as chairman of the Ways and Means Committee.

(3) President-elect Frenkiel expected to represent the Washington Academy at the Academy Council meeting, to be held in conjunction with the AAAS sessions in Cleveland, the last week in December.

(4) The American Board of Microbiology had approved of certification in public health and medical laboratory virology for Mary Louise Robbins; also, she was now a diplomate of the American Board of Microbiology, and was one of two to receive recognition in 1963 in this particular field.

Meetings. Chairman Robbins announced that the Academy's annual dinner meeting would be held January 16 in the Cosmos

Club auditorium. Reporting for Alphonse Forziati, chairman of the Banquet Committee, she indicated that the social hour would begin at 6:30 p.m., followed by dinner at 7 o'clock and the meeting at 8:30. The Board of Managers would meet at 5:30. On motion of Dr. Robbins, the Board agreed to subsidize the dinner to the extent of one dollar per ticket.

Awards for Scientific Achievement. In the absence of Chairman Berliner, Dr. Van Evera announced the following selections for awards to be made at the January banquet: Engineering sciences, Gordon L. Dugger of the Applied Physics Laboratory, Johns Hopkins University; biological sciences, Brian J. McCarthy, Department of Terrestrial Magnetism, Carnegie Institution of Washington; physical sciences, George A. Snow, Department of Physics, University of Maryland; mathematics, James H. Bramble, Institute of Fluid Dynamics and Applied Mathematics, University of Maryland. Additionally, there were three selections for the teaching-of-science award—Frank T. Davenport of Ballou High School; George M. Koehl of the Physics Department, George Washington University; and Leo Schubert of the Chemistry Department, American University. The Board approved all seven of these selections.

Grants-in-Aid. Chairman McPherson indicated that one application for a grant was being processed, but was not yet ready for Board action.

Election of Fellows. Following the Second Reading of their names by the secretary in the absence of Membership Chairman Hobbs, two nominees were elected to fellowship in the Academy, as follows: Edward J. Baldes and Jacob J. Diamond.

Treasurer. Treasurer Henderson presented the following statistics on the membership: New fellows qualified, 19; new members qualified, 12; active fellows (resident and nonresident), dues-paid for 1963, 947; dues-excused past presidents, 12; dues paid for 1964, 2; delinquents for 1963, 40; delinquents for 1962 and 1963, 23; delinquents for 1961, 1962, and 1963, 3; emeriti (receiving notices, ballots, and Journals), with $3.75 paid for Journals for 1963, 7; emeriti owing $3.75 for 1963 Journals, 7; free Journals to past presidents of WAS, 4; "retired," no payments (reason unknown), 43; emeriti (receiving meetings notices and ballots), 69; resignations in 1963, 9; 1963 deaths reported in 1963, 5; deaths prior to 1963 and reported in 1963, 5; dropped for nonpayment of dues or unable to locate, 5.

Editor. Editor Detwiler asked for the assistance of Board members in securing material for publication in the Journal.

New Business. The Board began consideration of a revision of its standing rules. Further consideration was expected to be given at the next Board meeting on January 16.

Science in Washington

CALENDAR OF EVENTS

February 10—American Society for Metals

Howard Cross, Battelle Memorial Institute, "Superalloys."

AAUW Building, 2401 Virginia Ave., N.W. Dinner at 6:30 p.m., meeting at 8 o'clock.

February 10—Institute of Electrical and Electronics Engineers

Panel discussion on "Global Communications—Cable or Satellite?" Moderator, Ralph L. Clark, special assistant to director, Telecommunications Management, OEP. Discussion leaders, Leonard Jaffee, director, Communications Systems, NASA, and Herbert H. Schenck, executive vice-president, U. S. Undersea Cable Corp.

National Museum, auditorium, 8:00 p.m.

February 18—Anthropological Society of Washington

John Adair, NIMH, NIH, "The Role of Anthropology in the Navaho-Cornell Medical Project."

Rm. 43, National Museum, 8:15 p.m.

February 18—James Curley Lectures in Science

Gen. James McCormack, USAF (Ret.) and vice-president for sponsored research, MIT, "The Socialization of Science."

Gaston Hall, Georgetown University, 8:30 p.m.

February 19—Engineers, Scientists, and Architects Day

Sponsors: D. C. Council of Engineering and Architectural Societies, and Washington Academy of Sciences.

Presidential Arms. Program and awards, 9:30-11:30 a.m. Luncheon, 12:15 p.m.

February 19—Georgetown University Distinguished Lecture Series

Rev. Francis J. Heyden, director, Georgetown Observatory, "Space Astronomy, the New Frontier."

Gaston Hall, Georgetown University, 8:00 p.m.

February 25 — Washington Colloquium on Science and Society

Panel discussion on "Societal Implications of Modern Biological Researches." Panelists: Thomas Kennedy, Office of Director, NIH; Daniel S. Greenberg, Editorial Office of *Science* magazine; Joseph Cooper, adjunct professor, American University.

Lounge of School of International Service, American University, 8:00 p.m.

SCIENTISTS IN THE NEWS

Contributions to this column may be addressed to Harold T. Cook, Associate Editor, c/o U. S. Department of Agriculture, Agricultural Marketing Service, Federal Center Building, Hyattsville, Md.

AGRICULTURE DEPARTMENT

C. H. Hoffmann, assistant director of the Entomology Research Division, served as expert and chairman of the 3rd session of the FAO Committee on Pesticides, held December 9-14 in Rome.

M. B. Matlack retired on December 30. He had been with USDA since 1930 as nutritionist, food technologist, grain technologist, and biochemist. Previously, Dr. Matlack had held positions with the National Bureau of Standards, Georgia Tech, and General Foods Corporation.

GEOLOGICAL SURVEY

At the annual meeting of the Mineralogical Society of America in New York City, November 17-20, **George T. Faust** was elected vice president for the coming year, and **Marjorie Hooker** was re-elected treasurer. Miss Hooker returned in early November from Europe, where she met with mineralogists in various countries and did library research in Naples and Lisbon.

HARRIS RESEARCH LABORATORIES

Anthony M. Schwartz gave a talk on "Cosmetic Practices in Cleansing Hair" before the Chicago meeting of the American Academy of Dermatology on December 4.

John Menkart attended the Research Advisory Committee meeting of the Textile Research Institute in Princeton, N.J., on December 6.

NATIONAL BUREAU OF STANDARDS

The 52nd meeting of the International Committee of Weights and Measures was held in Paris in October. **A. V. Astin** was the U. S. member of the committee. Major decisions affecting international cooperation in science were reached at the meeting.

Gordon M. Kline retired in January as chief of the Polymers Division after 37½ years of Government service. A specialist in plastics, Dr. Kline is internationally known for his research on the chemistry and properties of polymers and for the development of standards for plastics. He is a recipient of the Commerce Department's Exceptional Service Gold Medal. He also holds the Honor Award of the Washington Section of the American Institute of Chemists. Dr. Kline will continue as technical editor of *Modern Plastics,* and will serve as a part-time consultant on standards at NBS. He also expects to assist in developing a polymers program at a Florida university. He and Mrs. Kline will reside in their new home in Lake Worth, Fla.

Ladislaus L. Marton, chief of International Relations, has returned from the University of Paris, Faculty of Sciences, where he spent the academic year 1962-63 as a visiting professor. Dr. Marton held seminars in electron physics at the University, and lectured in Belgium, Denmark, England, Germany, Holland, Italy, Poland, Portugal, Spain, Sweden, and Switzerland. The University of Brussels conferred a medal upon him as an expression of appreciation.

On December 11 at Wesley College in Dover, Del., **Charlotte M. Sitterly,** astronomer and NBS staff member since 1945, was one of seven women—each representing a specific field of endeaver—to be awarded the Annie Jump Cannon Centennial Medal. The medals were awarded at a centennial celebration, honoring Dr. Cannon (1863-1941), who has been called the world's most famous woman astronomer. Dr. Sitterly was one of the speakers at the ceremony.

Recent talks by staff members have included the following:

G. C. Paffenbarger: "Research and Saving of Teeth" and "The Current Program of the Dental Research Section at the National Bureau of Standards" — Alpha Omega Fraternity, Miami Beach.

C. M. Tchen: "Plasma Oscillations with Collective Correlations"—Ford Motor Scientific Laboratories, Dearborn, Mich., December 31, and "Kinetic Theories of Plasma"—National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

D. Rosenblatt: "On Some Recursive Models of Large-Scale Information Systems" — AAAS meetings, Symposium, Joint Program of Sections on Organization, Search, and Retrieval of Scientific Information, co-sponsored by the Institute of Management Sciences, Cleveland, Ohio.

R. Stair: "Recent Investigations Relative to the Use of Thermal Detectors and Quartz-Iodine Lamps in Radiometric Measurements"—Colloquium of G. E. Lamp Research and Development Laboratory, General Electric Company, Nela Park, Cleveland, Ohio.

NATIONAL INSTITUTES OF HEALTH

Marshall W. Nirenberg, chief of the Section on Biochemical Genetics, National Heart Institute, presented the 24th National Institutes of Health Lecture at the Clinical Center auditorium on December 4. The title of Dr. Nirenberg's lecture was, "On the Nature of the RNA Code."

George A. Hottle, chief of the Laboratory of Viral Immunology, Division of Biologics Standards, retired from the Public Health Service on November 30 after more than 17 years as a Public Health Service officer. Dr. Hottle served as a delegate to the Washington Academy of Sciences. He will continue his work on bacterial toxins and viral vaccines at the University of California, where he has been appointed head of the Division of Bacteriology, Naval Biological Laboratory, School of Public Health.

NAVAL RESEARCH LABORATORY

At the AGARD 17th S&M Panel Meeting in London last September, **G. R. Irwin,** superintendent of the Mechanics Division, presented a pilot lecture entitled "Structural Aspects of Brittle Fracture." The text of Dr. Irwin's lecture was scheduled to appear in the January 1964 issue of *Applied Materials Research.*

L. S. Birks of the Optics Division visited Japan in November at the invitation of Japanese scientific societies. He presented papers on election probe microanalysis and fluorescent X-ray spectroscopy at the Universities of Tohoku, Nagoya, and Osaka, and also at the Tokyo National Conference on X-Ray Analysis, sponsored by the Society for Analytical Chemistry. His other visits in Japan included many government and industrial laboratories engaged in X-ray research as well as manufacturers of X-ray and electron probe instruments.

On December 16, **Richard Tousey,** head of the Rocket Spectroscopy Branch, received the Navy Award for Distinguished Achievement in Science. The award, the highest offered by the Navy to its scientists, was accompanied by a check for $5,000. The presentation was made to Dr. Tousey by the Hon. James H. Wakelin, Jr., Assistant Secretary of the Navy for Research and Development.

SMITHSONIAN INSTITUTION

The following scientists recently joined the staff of the Museum of Natural History: **Dan H. Nicolson,** a recent graduate of Cornell University's Department of Botany, as associate curator, Division of Phanerogams; **Clayton E. Ray,** formerly assistant curator at Florida State Museum and assistant professor at the University of Florida, as associate curator, Division of Vertebrate Paleontology; and **Richard B. Woodbury,** formerly associate professor of anthropology at the University of Arizona, as associate curator, Division of Archeology.

DEATHS

James I. Hoffman, 71, who retired two years ago as consultant to the director of the National Bureau of Standards, died January 16 at his home in Halifax, Pa.

An analytical chemist, Dr. Hoffman spent 43 years with the Bureau. He was instrumental in developing a method for purifying uranium during World War II when the Manhattan Project was working on the atomic bomb.

A native of Pennsylvania, Dr. Hoffman held degrees from Franklin and Marshall College, George Washington University, and American University. At NBS, he was chief of the Surface Chemistry Section, assistant chief of the Chemistry Division, and chief of the Metallurgy Division before becoming consultant to the director.

He held the Hillbrand Prize of the Chemical Society of Washington, the Commerce Department's Meritorious Service Silver Medal, the Department's Exceptional Service Gold Medal, and the 1959 Fisher Award in Analytical Chemistry.

In addition to his membership in the Washington Academy, Dr. Hoffman was a member of the Cosmos Club, a councilor of the American Chemical Society, and a past president of the Chemical Society of Washington.

Delegates to the Washington Academy of Sciences, Representing the Local Affiliated Societies*

Philosophical Society of Washington	R. D. Myers
Anthropological Society of Washington	Regina Flannery Herzfeld
Biological Society of Washington	John L. Paradiso
Chemical Society of Washington	William A. Zisman
Entomological Society of Washington	Frank L. Campbell
National Geographic Society	Alexander Wetmore
Geological Society of Washington	G. Arthur Cooper
Medical Society of the District of Columbia	Frederick O. Coe
Columbia Historical Society	U. S. Grant, III
Botanical Society of Washington	Wilbur D. McClellan
Society of American Foresters	Harry A. Fowells
Washington Society of Engineers	Martin A. Mason
Institute of Electrical and Electronics Engineers	Delegate not appointed
American Society of Mechanical Engineers	William G. Allen
Helminthological Society of Washington	Doys A. Shorb
American Society for Microbiology	Howard Reynolds
Society of American Military Engineers	Delegate not appointed
American Society of Civil Engineers	Thorndike Saville, Jr.
Society for Experimental Biology and Medicine	Falconer Smith
American Society for Metals	Hugh L. Logan
International Association for Dental Research	George Dickson
American Institute of Aeronautics and Astronautics	A. W. Betts
American Meteorological Society	J. Murray Mitchell, Jr.
Insecticide Society of Washington	Robert A. Fulton
Acoustical Society of America	Malcolm C. Henderson
American Nuclear Society	George L. Weil
Institute of Food Technologists	Richard P. Farrow
American Ceramic Society	J. J. Diamond
Electrochemical Society	Delegate not appointed

*Delegates continue in office until new selections are made by the respective affiliated societies.

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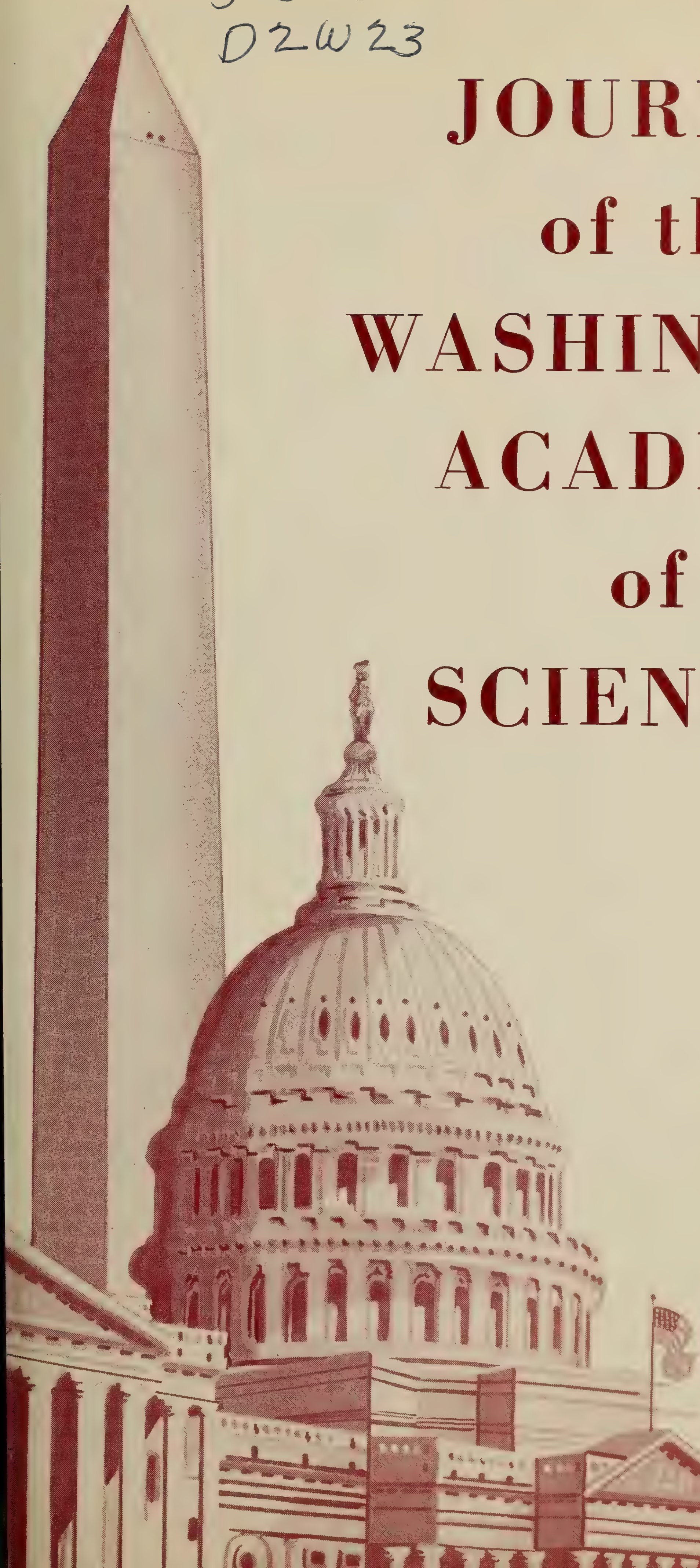

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JOURNAL OF THE WASHINGTON ACADEMY OF SCIENCES

This Journal, the official organ of the Washington Academy of Sciences, publishes historical articles, critical reviews, and scholarly scientific articles; notices of meetings and abstract proceedings of meetings of the Academy and its affiliated societies; and regional news items, including personal news, of interest to the entire membership. The Journal appears nine times a year, in January to May and September to December. It is included in the dues of all active members and fellows.

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ACADEMY OFFICERS FOR 1964

The International Indian Ocean Expedition: A Status Report*

Irvin E. Wallen

Assistant Director for Oceanography, Museum of Natural History, Smithsonian Institution

The Planning Period

One measure of the success of the International Geophysical Year (IGY) has been the large number of international cooperative projects that have followed in its wake. Inspired by the monumental collection of comparable data on a broad scale during the IGY, new committees were formed by the International Council of Scientific Unions to consider the initiation of international cooperative projects in the future. Out of one of these committees, the Special Committee on Oceanic Research (SCOR), grew the International Indian Ocean Expedition (IIOE). Dr. Georg Wüst, a member of the committee from Germany, proposed that over an appropriate period of time many ships should visit the area, making standard observations and collecting data for a detailed description of the physical, chemical, biological, and geological characteristics of the Indian Ocean.

Since this ocean exhibits unique phenomena, the desirability of such an expedition was easy to demonstrate. Unlike the Atlantic and Pacific, the Indian Ocean is located entirely within tropical and southern zones, enclosed by a land mass at its northern limit. Nowhere else is there a similar seasonal reversal of the prevailing wind, for in that part of the Ocean lying above the equator two monsoons occur annually, one blowing from the northeast for approximately six months and the other blowing from the southwest during the rest of the year.

Closely related to the mass air movements are such basic oceanographic questions as how much time is necessary for winds to produce ocean currents, and how rapidly such currents deepen with time. Also, in contrast to the extensive areas along the west coasts of North and South America and of Africa, where deep water comes to the surface by upwelling, it appears that near the coast of northwest Australia there is only spasmodic upwelling. An opportunity to study this phenomenon promises to bring a closer understanding of the presently inexplicable factors in the phenomenon of upwelling, wherever it occurs.

The Indian Ocean includes 28 million square miles of water, which is about 14 percent of the earth's surface, an area greater than that of the continents of Asia and Africa combined. However, primarily because of its isolation from the research impetus of the Northern Hemisphere, less than two dozen vessels had carried out oceanographic investigations in the Indian Ocean prior to 1957, when the IGY began.

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* Address presented at a meeting of the Washington Academy of Sciences on November 21, 1963.

Figure 1. Outline map showing locations of IIOE shore stations at Bombay, Nossi Bé, and two in South India.

Except for data collected during the IGY, the structure of the earth's crust and the topography of the floor of the Indian Ocean are barely known. Trenches, undersea mountain ranges, fracture zones, and other bathymetric features remain to be discovered and described.

From a practical standpoint, the goals of the IIOE are to seek data related to new sources of proteins, better long-range weather forecasting, and better navigational charts. In addition, it is hoped that the Expedition will provide intensive training and experience in oceanographic research to scientists in the area. It is expected to serve as a device to attract students to careers in oceanography, thus helping to relieve a shortage of specialists in the field.

Biologists have been enthusiastic about the IIOE plan, in part because of their recognition that the IGY had included little biology and their determination not to be excluded from the IIOE, and in part because of reported biological conditions in that Ocean.

As an example, spectacular flowering of the phytoplankton and subsequent growth of zooplankton have occurred following the onset of the southwest monsoon. It is desirable to understand the mechanism that permits this increase in production. Also, in June, 1957, a Russian merchant ship enroute between Colombo, Ceylon, and the Gulf of Aden reported millions of tons of dead fishes floating in an area about 600 miles long and 125 miles wide, extending across the middle of the Ocean. Similar reports came from British ships in the region. It is not known how these fishes were killed, but this served as an indication of extensive productivity in the area.

From a biological standpoint, the objectives developed for the IIOE are (1) to assess the magnitude of the living resources through studies of primary and plankton production and of demersal and pelagic fisheries populations, including the effects of seasonal changes; (2) to explore the distribution of plants and animals in relation to the physical and the biological characteristics of the Ocean; (3) to obtain information regarding the potentiality for commercial fisheries, through assessment of the pelagic fish populations, including the distribution of their eggs and larvae; (4) to investigate the effects of island complexes on productivity; and (5) to study the productivity of coral reefs.

Biological observations include such things as (1) the occurrence and size of schools of fishes; (2) instances of large-scale fish mortality; (3) census of fishes in dip net catches under lights at night; (4) numbers and species of sea birds, seals, cetaceans, flying fishes, surface jelly fishes, squid, sea snakes, etc.; and (5) occurrence and sampling of discolored water.

In the United States the National Academy of Sciences Committee on Oceanography (NASCO) developed plans for the IIOE. After receipt and consideration of such plans, the National Science Foundation (NSF) agreed to budget funds for the Expedition. During Fiscal Years 1963 and 1964 a total of over $5 million will be spent by NSF on the IIOE, and almost that much more is planned for Fiscal Year 1965. In addition, the Department of the Navy has budgeted over $5 million for the three fiscal years, and smaller amounts will be spent by the Coast and Geodetic Survey, the Bureau of Commercial Fisheries, and other Government agencies.

In late 1959 an international coordinator for IIOE, Robert G. Snider, was employed by SCOR to visit the various nations having an interest in the Indian Ocean and to assist in developing and coordinating their participation. In 1962 the international aspects of the project were transferred to the offices of the new Intergovernmental Oceanographic Commission in the Paris Headquarters of UNESCO. Also in 1962, John Lyman of NSF was appointed U. S. coordinator for the Expedition.

Participation

Up to the present time 20 countries—Australia, Ceylon, East Africa, France, Germany, India, Indonesia, Israel, Japan, Malagasy Republic, Malaysia, Mauritius, Netherlands, Pakistan, Portugal, Thailand, Union of South Africa, Union of Soviet Socialist Republics, United Kingdom, and the United States—have provided or planned to provide vessels or shore facilities for the Expedition. An additional nine nations—Austria, Brazil, Burma, Canada, China, Denmark, Rumania, Sweden, and the United Arab Republic—have arranged to have their scientists participate in the expedition on ships or shore facilities of other nations. Most of these countries have established national committees to develop an IIOE program and to follow its progress.

Ships

United States participation in the Expedition includes 14 vessels, operated by Columbia University, Scripps Institution for Oceanography, Woods Hole Oceanographic Institution, the Coast and Geodetic Survey, and the Naval Oceanographic Office. Guest scientists from U. S. universities and government organizations, as well as from foreign universities, have been or will be aboard most of these vessels.

Aircraft

Five United States aircraft have been included in the IIOE for collections of weather data. A C54Q aircraft from Woods Hole Oceanographic Institution has made one series of flights and will make another in 1964. Observations will be made of dropsonde humidity and temperature, of wind, of solar and albedo radiation

Figure 2. With guidance from Mrs. Beatrice Burch (right), assistant supervisor of the Smithsonian Oceanographic Sorting Center, and Mrs. LaNelle Peterson (center), museum specialist, museum aides separate marine specimens from Indian Ocean collections. *(Photo courtesy Smithsonian Institution.)*

fluxes, and of turbulent transport of heat, water vapor, and momentum. Also, nuclei counts will be made, cloud distribution will be studied, and radar data will be obtained of precipitation areas. In addition, four U. S. Weather Bureau research aircraft spent three months in 1963 making flights in the IIOE area and will again make observations in early 1964. All have installed modern equipment for collection of varied meteorological data, much of it recorded digitally on magnetic tape for use in the International Meteorological Center, which was established in Bombay for the IIOE.

Shore Stations

Five shore stations, using existing facilities, have been established with assistance from the United States, at Nossi Bé in Madagascar, and in India at Cochin (Ernakulum), Mandapam Camp, and Bombay (two stations). Arthur G. Humes, professor of biology at Boston University, has been designated as chief scientist and liaison officer for U. S. participants planning to visit Nossi Bé. A motor vehicle, inflatable boat with outboard motor, microscopes, and laboratory equipment and supplies have been provided to supplement that which has been furnished directly to participating scientists. Under the direction of M. Angot, the Center, which is operated by the Institute of Scientific Research in Madagascar, is providing housing, food, and lodging to scientists in residence for marine research.

The Indian Ocean Biological Center at Cochin has nominal support from the United States, with principal support coming from the Intergovernmental Oceanographic Commission and substantial support from the government of India. Established in April 1963 and operated in a building belonging to the Oceanography Department of the University of South India, the assistant director in charge is an Indian national; however, Vagn Hansen, from the governmental scientific staff in Denmark, serves as curator of the Center with responsibility for its scientific program.

Each ship taking part in the IIOE is expected regularly to make a vertical plankton haul from 200 meters to the surface. This is accomplished with a standard IIOE net which was developed in England and is distributed through the Intergovernmental Oceanographic Commission. These standard samples are being sorted by the staff of the Indian Ocean Biological Center and distributed to scientists throughout the world for studies of the classification and abundance of plankton organisms, particularly as they may lead to a better understanding of fish production in the Ocean. Approximately 150 samples had been sorted by the end of December 1963.

An Indian biological station, made available to U. S. and other foreign scientists, is the Central Marine Fisheries Institute at Mandapam Camp, across from Ceylon, in South India. A major research installation of the Indian government, it has biological laboratories and a new guest house for scientists. At Mandapam Camp the emphasis is on marine biology, including primary productivity, fish farming and physiology, fishery survey and statistics, and algology. The U. S. Biology Program of NSF has supplied field and laboratory equipment to the Institute. With a good library and adequate laboratory facilities, approximately 20 Indian scientists and at least 24 scientists from the United States, Sweden, Canada, Brazil, and Pakistan have visited the Institute or plan to work there before the end of the IIOE.

In Bombay the U.S. Biology Program supports an Indian scientist, who serves as its liaison representative in making arrangements for the participation of scientists and for the preservation, storage, and shipment of specimens.

Also in Bombay is an International Meteorological Center which coordinates that aspect of the IIOE. Located on the southern tip of Bombay peninsula, this Center is operated by the Meteorological Department of the Indian government. Synoptic weather charts will be distributed through 1964 and research is being continued under the supervision of Indian and foreign scientists at the Center. Several U. S. scientists are participating in the collection and in the analysis of the data, which accumulate from an automatic weather station, special aircraft, satellites, and ships. An IBM 1620 computer has been provided by the U. N. Special Fund to check, collate, and average surface weather observations, as well as to permit modeling of weather conditions.

Data Exchange

A special working group of SCOR called attention to the necessity for effective and rapid national and international exchange of data, cruise plans, and cruise reports. Provision was made to maintain complete records of data from the Expedition at World Data Centers A and B, in Washington, D. C., and Moscow, respectively. The Inter-governmental Oceanographic Commission in Paris was given responsibility for international interchange of published data. Specialized centers, such as the Permanent Service for Mean Sea Level in England, the International Hydrographic Bureau in Monaco, and the International Council for the Exploration of the Sea in Denmark, have agreed to store and release data appropriate to their interests.

At least three special manuals were developed specifically for U. S. participation in the IIOE. An instruction manual for use by the scientific staff of the U. S. Program in Biology was developed by David W. Menzel of the Woods Hole Oceanographic Institution. In it, procedures for collecting data at ocean stations were provided in detail to insure that consistent and comparable results would be obtained over two years' operation of the research vessel *Anton Bruun.*

A preliminary guide to the birds of the Indian Ocean was prepared by George Watson, Richard Zusi, and Robert Storer and published by the Smithsonian Institution. This guide was intended to summarize existing information on Indian Ocean birds in such a way that inexperienced ornithologists could make field identifications and observations which would have value for future research on birds of the area. A planned program of observations has been undertaken by the Smithsonian Institution to supplement the guide with a substantial quantity of new data.

A third manual, written by Bruce Collette and Robert Gibbs, was published by the Smithsonian Institution with assistance from the NSF Biology Program for IIOE. Because of the importance of tunas and mackerels as human food, this preliminary guide to the scombroid fishes of the Indian Ocean was considered to be useful. A summary of existing knowledge and current research concerning these fishes should increase the rate of observations during the expedition and promote the collecting of new kinds of data.

The two field guides were distributed to each participant in the IIOE Biology Program and to specialists in the Indian Ocean area. The Smithsonian Institution also furnished equipment, taxonomic keys, pictures, and instructions for the capture and identification of seals, porpoises, and other cetaceans.

Te Vega Program

In addition to diverting vessels of American oceanographic institutions from research programs in the Atlantic or Pacific Oceans, the United States also has converted two vessels for use by oceanographic biologists during the IIOE. One of these is the *Te Vega,* a two-masted, steel-hulled schooner, 134 feet long and having a gross weight of 265 tons. Although its main propulsion is by sail, it has an auxiliary motor and is air conditioned for tropical work. Built in Germany in 1930, it was registered as an undocumented yacht before conversion under auspices of NSF for use by Stanford University as an oceanographic vessel.

The *Te Vega* accommodates a senior scientific staff of seven and a professional crew of 15. Eight graduate students are on board for courses in biological oceanography, which will be offered by Stanford University three times during the current year. Under the direction of the senior staff the students keep a biological log; operate the many kinds of gear and instruments; preserve, sort, label, catalog, and pack the biological collections; make meteorological and hydrographic observations; tabulate the data collected; and make preliminary charts and graphs of the results. Opportunities are provided to observe living organisms in aquaria on board the vessel, as well as in the field. The students work closely with members of the scientific staff on research projects on plants and animals of the Indian Ocean.

Anton Bruun

The other special U. S. biological oceanographic ship is the research vessel *Anton Bruun,* formerly the U. S. Presidential Yacht, *Williamsburg.* It was released by President Kennedy early in 1962 for conversion by NSF. Two hundred and forty-three feet long and displacing 1,700 tons, it was originally constructed in 1930 as the *Aras.* She served as a Navy escort vessel during World War II, when her name was changed to *Williamsburg.* After conversion in the Baltimore yard of the Maryland Shipbuilding and Drydock Company, the vessel was named the *Anton Bruun* after the famous marine biologist, Anton Bruun of Denmark, who had participated in cruises in the Indian Ocean and had been very active in the Special Committee on Oceanic Research. Dr.

Bruun was serving as first president of the Intergovernmental Oceanographic Commission at the time of his sudden death in 1961.

The *Anton Bruun* carries a complement of 26 scientists and 19 crew members. As organized for the International Indian Ocean Expedition, she accommodates eight staff scientists, employed from graduate schools of various universities to carry out routine scientific observations for the two years of the Expedition. In preparation for this assignment, the staff scientists received three months training under the supervision of John Ryther at the Bermuda Biological Station.

Biological Program

The principal scientific research efforts are carried out by biological oceanographers from various private and governmental laboratories, from universities in the United States, and from comparable agencies and institutions from cooperating countries.

Ten members of the permanent staff of the Smithsonian Institution either have participated or are scheduled to participate in the IIOE. In addition, one permanent staff member is participating in the expedition from the standpoint of administration to assist in the development of techniques of collection, preservation, record keeping, and storage of specimens. Another scientist has been employed temporarily by the Smithsonian Institution for the purpose of participating in the Expedition. An additional staff member represented the United States at the advisory committee meeting of the Indian Ocean Biological Center in Cochin, India.

The *Anton Bruun,* designated as the principal research vessel for biological oceanography in IIOE, performs the following basic program:

(a) Hydrographic cast to 1,000 meters for obtaining data on temperature, salinity, dissolved oxygen, phosphates, nitrates, nitrites, silicates, and ammonia compounds.

(b) Van Dorn bottle casts to depths corresponding to penetration of 100, 50, 25, 10, and 1 percent of incident light for pigment analysis as well as for 24-hour simulated *in situ,* and 4-hour incubator carbon-14 uptake experiments.

(c) Determination of submarine light penetration of all daylight stations.

(d) Vertical plankton haul from 200 meters with standard IIOE net (mesh aperture=0.300 mm.); samples for deposition in the Indian Ocean Biological Center at Cochin, India.

(e) Vertical microplankton haul from 200 meters with number 25 mesh net.

(f) Oblique plankton tow with Bé sampler (mesh aperture = 0.330 mm.) from 2000 meters or greatest depth possible in shallower water.

(g) Bathythermograph observations.

Additional work is undertaken on the vessel, varying with each cruise. Intensive sampling with Gulf shrimp trawls, Isaacs-Kidd midwater trawls, gill nets, long lines, dip nets, aqualungs, and other devices assist in an evaluation of the fishery potential in the Indian Ocean. For example, on Cruise 2 of the *Anton Bruun* by means of long-line and other methods of fishing, 185 large tunas of four species, 24 marlins of three species, 81 specimens of nine other commercial-sized species, and 87 specimens of five kinds of sharks were taken. The distributions of adult tunas, marlins, and sharks are being studied by the Bureau of Commercial Fisheries in relation to water temperature and ocean circulation during the two monsoon reasons. Serological techniques are used to identify subpopulations of tunas and other apex predators. Catches are weighed and measured; recordings are made of sex and maturation stage of gonads; collections are taken of stomach contents, ovaries, and blood samples; and certain whole specimens are retained for taxonomic study. Using bottom trawling procedures, similar studies will be made of demersal fishes.

Collections taken with plankton nets provide scientists with data to evaluate the populations of larval tuna and other fishery species and to ascertain their relationships within the food web.

Smithsonian Oceanographic Sorting Center

The specimens collected by the *Anton Bruun* and the *Te Vega* are partially sorted on board the vessels, where they are preserved, carefully packed, and sent to the Smithsonian Oceanographic Sorting Center in Washington, D. C. Here they are separated into general taxonomic categories and are made available to scientists for systematics and ecologic research. Such specimens are not considered to belong to the Smithsonian Institution but to the collector. The Sorting Center thus assists in expediting research on the specimens and maintains a central record of all specimens collected during the expedition. The sorting is provided as a service by the Smithsonian Institution as a part of its contribution to the IIOE. The samples sent to the Sorting Center do not include the standard plankton samples; in accordance with the IIOE cooperative program, these are sent to the Indian Ocean Biological Center in Cochin.

At the end of calendar year 1963, a large proportion of the nonstandard specimens from IIOE Cruise 1 of the *Anton Bruun* had been received and sorted at the Sorting Center. The total number of specimens received was over one million. Included were 17,427 fishes of 133 families, 18 sea snakes of an estimated three species of the family Hydrophiidae, 31,357 pelagic and benthic invertebrates of 94 major taxonomic groups, and over 960,000 plankton organisms of which 94,188 specimens of 45 taxonomic groups were counted. The specimens of this rich and interesting fauna are available to biologists for studies of their classification, abundance, and ecology. Advisory committees to the Sorting Center will determine the distribution of these specimens to specialists in accordance with commitments and plans of the U. S. Biology Program.

Results of the Expedition are just beginning to be realized. Published reports of research results from IIOE should be appearing for many years to come.

Bibliography

Bezrokov, P. C. Studies conducted by the *Vityaz* under the International Indian Ocean Expedition program. Rev. Acad. Sci. USSR (8), 97-104, (1963) (translated by OTS).

Brown, H., et al. Recommended program for United States participation in the International Indian Ocean Expedition, also appendices A-E. NAS Com. Oceano., Mim., 81 pages (1961).

Deacon, G. E. R. The Indian Ocean Expedition. Nature *187*, 561-562 (1960).

Gibbs, R. H., Jr., and Collette, B. B. Preliminary field guide to the mackerel- and tuna-like fishes of the Indian Ocean (Scombridae). U. S. Nat. Mus., 48 pages (1963).

Knauss, J. A. The International Indian Ocean Expedition. Science *134*, 1674-1676 (1961).

Knauss, J. A. and Bruce, A. T. Measurements of currents along the equator in the Indian Ocean. Nature *198* (4878), 366-377 (1963).

Lyman, J. Report of the United States participation in the International Indian Ocean Expedition. Mim., 56 pages (1963).

Menzel, D. W. Instruction manual for routine measurements for the U. S. program in biology, International Indian Ocean Expedition. Mim., 34 pages (1962).

Ramage, C. S. The International Indian Ocean Expedition. Special leaflet, U. S. Dept. of Commerce, Weather Bureau, folded presentation (1963).

Ramage, C. S. International Indian Ocean Expedition, meteorological research goes to sea. The Marine Observer 551.506.5 (267), 74-78 (1963).

Shor, G. G., Jr., and Pollard, D. D. Seismic investigations of Seychelles and Saya da Malha Banks, Northwest Indian Ocean. Science *142*, 48-49 (1963).

Snider, R. G. The Indian Ocean. A

preliminary prospectus. Internat. Council Sci. Unions, Special Committee on Oceanic Research, Mim. report, 7 pages (1960).

Terada, K., ed. IIOE Newsletter of Japan, Numbers 1, 2 and 3. IIOE Data Center of Japan, Mim. (1962-63).

UNESCO. International Indian Ocean Expedition. Intergovernmental Oceanographic Commission Information Papers Nos. 1-4, Mim. (1963).

Watson, G. E., Zusi, R. L., and Storer, R. L. Preliminary field guide to the birds of the Indian Ocean. U. S. Nat. Mus., 214 pages (1963).

Statistics in Its Proper Place*

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Enthusiasts sometimes drag statistics into studies when tables or graphs are in themselves completely convincing. Statistical techniques are sometimes employed to establish the statistical significance of experimental effects which are, however, so small as to be of no practical consequence. Resort is sometimes had to statistical techniques in the hope, almost always vain, that some large collection of data contains something worth publishing. Sometimes elaborate statistical operations are used to dress up an otherwise mediocre paper. The best interests of science are not served when statistics is found in places like those just enumerated.

Statistics can be found in respectable places, however. The average or arithmetic mean is a "statistic." The average is widely used to summarize data and there are other "statistics" that serve this function. The probable error and the standard deviation are used to measure one's confidence in averages. There are formulas for computing the average and the standard deviation of a set of measurements. The essence of statistics lies in knowing when and how to use these formulas.

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Suppose we plant 20 seeds with the purpose of measuring the heights of the plants one month after planting. Thirteen plants come up and one of these just barely shows through the soil. If we take the sum of the 13 heights plus 7 zeros, shall we divide by 20, 13, or 12? Our choice makes a big difference. And the choice also makes a tremendous difference in the value we would get for the standard deviation.

Our choice would be easier if we had formulated the ground rules of the game *before* we started the experiment. Picture the kind of a poker game we would have if we endeavored to formulate the rules of the game *after* the hands were dealt and examined. Yet this happens over and over again in what are intended to be scientific investigations. Statistics has no useful place trying to formulate the ground rules after the data have been taken. Statisticians can examine preliminary data and make suggestions regarding possible statistics, i.e., ground rules, for evaluating the main event.

Now there are some standard rules, just as there is a fairly standard poker game. But we must be sure that all in the game are playing by the same rules. A straight is a straight. But suppose a poker player looks at his hand and declares that a run of odd cards—3, 5, 7, 9, J makes a

Smith straight and this should beat a regular straight. There are people who go looking for just such odd relationships in a stack of data. You can always find such pseudo relationships if you are industrious. Good science and good statistics require setting forth the rules before the game starts.

What does this mean in a scientific investigation? First it means formulating at least one definite, clear-cut question that the investigation presumably will try to answer. Efficiency demands that a number of questions be thought of because they may be all included in the one study. These questions should be written out beforehand. General statements such as "I propose a study of a system made up of A, B, C" invite later trouble. Better to state: "I propose to measure the effect of temperature changes on Property Y in the system A, B, C." Even this is not enough. We should know why this property Y is of interest. We should have a fair idea of how accurately we expect to measure property Y. Preliminary data plus statistical techniques permit us to estimate the amount of work necessary for any desired accuracy.

If the amount of work, time, and money available is not enough to constitute an improvement on earlier work, perhaps we shouldn't undertake the program. This may reduce the number of programs abandoned after considerable work has been expended. What I am saying here is, that, instead of asking statistics to evaluate the data you have collected, you might ask statistics to evaluate the size of the program needed to get what you want. Of course this requires that you know what you want, or what you are willing to accept as constituting a contribution to knowledge.

In almost every case, data consist of measurements made by some specified procedure, often using specified equipment on samples or specimens prepared in a particular way. If the measurement involves the destruction of the test specimen, there is no easy way to separate the contribution that specimen variation makes to the measured result. One may prepare a special batch of specimens made to very exacting tolerances and compare the results with those obtained using routinely prepared specimens from the same stock. If the specimen is an important factor there should be a reduction in the spread exhibited by the specially prepared set. Here practical considerations are apt to be overruling. Generally speaking, the instrumentation used in the measurement need not be refined beyond the point where its contribution to the uncertainty is less than half that of the specimen. At this point, overall improvement of any consequence demands more uniform specimens, and continued improvement requires an alternation of effort between specimen and equipment.

The foregoing paragraph leads immediately to a very important point. Let us suppose that two materials are to be compared using four specimens prepared from each material. The specimen preparation and measurement follow the standard procedure. We further suppose that the materials fall well within the range of experience. We have before us four measurements relating to each material, and these repeat measurements provide an estimate of error. There is a standard statistical procedure, the *t*-test used to compare the two means.

$$t = \frac{m_1 - m_2}{s} \sqrt{\frac{4 \times 4}{4 + 4}}$$

Here s is the pooled estimate of the standard deviation, with six degrees of freedom. If t exceeds the value 2.447, we know that this would happen five percent of the time even when the two materials are identical. We say that the difference is statistically significant at the 5 percent level.

The above formula can be found in many books. But there is often a better way to appraise these data. We were talking about a method of measurement that presumably has been in regular use, and we really ought to know this measurement method thoroughly. In particular, we should know what performance we can expect with materials of this class, using this specimen-equipment combination.

This should be one of the first things to which we should devote our attention. What we want to ascertain is the measurement error that goes with this combination of materials, specimens, instrumentation, and technique. We will find this out by pooling a series of estimates of s each derived from sets of data similar to those referred to in the preceding paragraph. Examining such a series of even as few as ten such estimates of s, we arrive at a consensus which may fairly be designated by σ, the standard deviation that is a *property* of this measurement process.

A statistical glance must be taken to satisfy ourselves that the values for s are not drifting with time or are otherwise unacceptably erratic. Once we are satisfied on that point, we will use the consensus value σ in any new set of data rather than the s associated with that particular limited set of data. If we do this, the numerical value of t that gives the same five percent confidence limit is now 2.00 and with further experience can drop to 1.96. In other words, we can now detect similar differences between materials.

Naturally we will keep a sharp eye on each individual s which we will continue to calculate even though we do not use it to calculate t. The individual values for s must stay below an appropriate upper bound. Individual values for s based on six degrees of freedom will, under normal circumstances, be 50 percent larger than σ about five percent of the time. So long as there is no evidence of a deterioration in the measurement technique, it is better to use the consensus σ than the individual s. Indeed there is no correlation whatever, under normal circumstances, between the individual estimates of the standard deviation and the errors in the averages.

Admittedly an out-of-line value for s will disturb the average as well as play havoc with the estimate of s for that set of data. Indeed, this estimate for s is an extremely useful way to pick up such problem results, because we do have a solid value for σ as a criterion. Most tests for outliers use only the information in the particular set of data and are relatively conservative when it comes to the rejection of results. An unusually large value for s may justify rejection of the whole set of data. Notice that a particular danger attaches to tests that use the individual values for s. A large s makes a large difference between an average and a required specification value apparently acceptable, because the ratio t falls within the acceptable limit. Test procedures should, wherever possible, require that individual values for s stay within a specified limit in order to maintain the quality of the testing. Incidentally, this approach is exactly that of the quality control techniques widely used in industry.

Although I have chosen as an example a routine method of testing materials, the ideas presented may be carried over into basic research. Here, too, a set of apparatus and a measurement routine are almost always required. Naturally the intent is to get numerical values which will ultimately go into the tables and graphs that constitute the basis for the research paper or report. Far too often little thought is given to the calculation of the errors in the results until the writing stage is reached. Surely in the debugging of the equipment an eye is kept on the consistency of repeat measurements, but seldom is any formal evaluation of the measurement errors attempted during the course of the investigation.

Substantial advantages come from a systematic and current error calculation made as the work progresses. Among these are the detection of seemingly aberrant results while it is still possible to verify them or to disclose them as aberrant. Another possibility is that the error may depend on the magnitude of the measured result. In such a case it is easy to adjust the number of measurements taken for various materials so that the averages can be taken as of equal weight. This immensely simplifies the visual inspection of the results as well as any subsequent curve-fitting activities.

Why is it that investigators so frequently underestimate the magnitude of the errors in their work? I attempted to answer this question about three years ago (1).

It is obvious that within a laboratory every effort is made not to change experimental conditions, whereas differences exist between the procedures of different laboratories. Yet a laboratory truly interested in getting an idea of the sources of variation would deliberately introduce changes. Particularly in analytical work do we find laboratory disagreements. But what laboratory intentionally tries a new reagent supply, or different thermometers, meters, hot plates, or other pieces of equipment? There must be some cause or causes for the greater disagreement found between laboratories. These causes can only be located when one laboratory deliberately abuses the procedure. There are systematic ways of approaching this problem (2, 3).

The use of statistics in place of the scientist's common sense is not proper. At best, statistics puts in quantitative terms the qualitative judgments of the experimenter. The blind use of statistical procedures sometimes leads to ridiculous results. The experimenter, spell-bound by the statistical snake, apparently abdicates his proper role and accepts utter nonsense. As an instance I recall a recent report dealing with a study to ascertain whether tedious and lengthy reference methods could be replaced by more rapid and convenient procedures. The methods were for SiO_2, magnesium, and R_2O_3. Two alternative methods in addition to the referee method were tried for each of these determinations. Four materials were selected and four laboratories participated. All determinations were run in duplicate. We have, therefore,

Determinations	3
Methods	3
Materials	4
Laboratories	4

= 144 pairs of duplicates.

These 144 pairs were examined by an appropriate statistical test, and seven pairs were rejected at the 5 percent level because of excessive differences. The disturbing fact was that some of the rejected pairs had means that were in very good agreement with results from other laboratories while some pairs were retained even when their means were outrageously out of line with the consensus of results from other laboratories. This seems to mean that if a laboratory is very careful to repeat exactly a wrong operation and hence get good agreement of duplicates the results should be kept. Now a careful scrutiny of the analytical error as revealed by the duplicates should not be deplored. In fact, if a particular laboratory has the task of *comparing* two or more similar materials, the error as established by the duplicates is the appropriate one.

In the study just outlined the agreement of the duplicates was only part of the story. The task was to compare the referee method with shorter methods. What is more important is how well the four laboratories agree using the same method, coupled with the requirement that any substitute method should not have a large bias when compared with the referee method. After all, the conclusions drawn from the study presumably were to serve as a guide to all laboratories concerned in such work. At the very outset, before getting *any* data, we see that we are confronted with the problem of *extrapolating* from the performance of four laboratories to the whole population of laboratories doing such work. The between-laboratory error for all methods was much greater than the duplicate error and was therefore the determining error in appraising the work. The study served to reveal the relative importance of the within and between-laboratory errors, and to guide the investigators as to which of the methods merited further study.

What was missing from this study was a preliminary statement of objectives. Clearly we might anticipate that short-cut analytical procedures would show more between-laboratory scatter than would a referee method, and in addition might be subject to bias. We need this information to come to a decision. We ought to formulate, in advance, how large an increase in interlaboratory error we would accept. We have to do this eventually. Should one accept a threefold increase in the between-laboratory error? If the answer is, "Certainly not," then the program of work had better be adequate to detect such an increase in error. The data we have will look like this, using the duplicate means

	Procedure		
Laboratory	Referee	S1	S2
A	—	—	—
B	—	—	—
C	—	—	—
D	—	—	—
Ave.			

Only four results on each method are available from which to calculate the real error of interest. The sad fact is that a substitute method could have three times the error of the referee method and there would be a very poor chance of getting statistically acceptable evidence of this state of affairs. More laboratories are needed.

The above table presents the data for just one of the four materials that were circulated. Thus we have the results from three other similar sets to look at and can strengthen our comparison of the methods. It should be emphasized that while we do have 16 results of each method we do not have 16 laboratories. There are only four laboratories, no more, and it is from the performance of these four that we must predict the suitability of a substitute method for all laboratories.

It appears that this seemingly simple and straight-forward experimental inquiry has led us very quickly into some rather complicated matters. How are we to come to an evaluation? Shall we insist on including all the materials or should we be prepared to recommend a substitute method for certain classes of materials? How large an average bias are we prepared to accept? These are examples of the questions that unavoidably beset the investigator after the work is done. Surely these questions should be considered before starting the work. If a committee cannot agree on criteria beforehand how can we expect agreement later?

It is not for statistics to formulate the questions of interest to the investigator. Given the questions, statistics has a place in appraising the data to see if the answers are "yes," "no," or "inconclusive." Largely as a result of experience, statisticians may suggest questions (prior to seeing the actual data!) to ascertain whether these questions are of interest. Here care must be observed lest the statistician come close to taking over the thinking that the experimenter should do.

Statistics has only a small proper place in the scheme of things. Well planned programs often require only simple and conventional statistical action. Generally speaking, if the issue is so close that the fine edge of elaborate statistical procedures is needed for discrimination, many will want additional data. In any event, the statistical tail must never wag the scientific dog.

(1) Youden, W. J. Systematic errors in physical constants. Physics Today *14* (9), 32-34, 36, 38, 40, 43 (1961).

(2) Youden, W. J. The collaborative test. J. Assoc. Official Agr. Chemists *46* (Feb. 1963).

(3) Youden, W. J. Experimental design and ASTM committees. ASTM Materials Res. and Std. pp. 862-7 (Nov. 1961).

The Ultraviolet Realm of Spectroscopy

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The bands of color familiarly known as the visible spectrum portray but a small section of the total electromagnetic spectrum. The optical spectrum overlaps the X-ray spectrum at the short wavelength end of the extreme ultraviolet, and extends many octaves into the long-wave region where infrared detectors are used, then still further where the electromagnetic spectrum is detected by radio telescopes. The extensions of the visible spectral range in both directions are of special interest to astrophysicists because of the striking advances in space technology during the past 20 years. The present comments will be confined to the short wavelength or far ultraviolet region of the spectrum, from 3000 A to 13 A.

The question may be raised as to why this interval of the spectrum is of special interest today. The answer rests with man's inherent curiosity about the unknown, in the present case the ultraviolet spectrum of the sun, our nearest star.

Nature has provided a delicate balance of atmospheric conditions that make it possible for life to exist on this planet, the earth. The earth's atmosphere contains the constituents required to maintain both plant and animal life. Among the commonest are simple compounds such as H_2O and O_2 made up of familiar and abundant chemical elements. The ozone in the atmosphere provides a blanket of protection against the deadly ultraviolet radiation from the sun. This makes it impossible, however, to observe the ultraviolet solar spectrum from the surface of the earth.

The sun provides a powerful light source for spectroscopic study. At least four different types of spectra in the region accessible to study have contributed much to our knowledge of the physical conditions pertaining in this star. The spectrum produced by integrated light from the solar disk contains some 26,000 lines. This is the familiar Fraunhofer spectrum consisting of absorption lines produced by the solar reversing layer. The spectrum of sun spots is also very rich in lines but is of a different type than the Fraunhofer spectrum.

The solar chromosphere is rich in emission lines. It can be studied at a solar eclipse when the moon masks the main part of the disk but leaves a very thin crescent at second and third contacts. Without the disk as a background, emission lines replace the absorption lines seen in the normal solar spectrum. The light from this crescent is that of the solar atmosphere above the reversing layer. Finally, the outer solar corona reveals a still different emission spectrum.

On the basis of years of study of these spectra, the solar physicist has speculated about the wealth of information in the ultraviolet solar spectrum concealed by the ozone layer in the earth's atmosphere. At last the stage of speculation is over, and this long-cherished dream of the astronomers has been realized. In 1946, Tousey (1) and his associates at the Naval Research Laboratory first succeeded in flying a spectrograph in the fin of a V2 rocket, taking successive film exposures of the solar spectrum as the rocket rose above the ozone layer. This classical film reveals the gradual unmasking of the ultraviolet region on the last three exposures as the rocket gained altitude from 34 to 55 and, finally, to 88 km. The instrument withstood the impact of the crash when the rocket landed in the desert at White Sands, N.M.

Very strong leading lines of the familiar elements magnesium and silicon could be readily detected, as had long been anticipated. It was evident, also, that the spectrum was rich in lines. A realm of rewarding research both in space and laboratory spectroscopy was coming into being.

At present, solar spectra observed from rockets soaring to heights of some 233 km, and from an orbiting solar observatory, are accumulating photometric and spectroscopic records of the ultraviolet radiation that extend to 13 A, thus overlapping the soft X-ray region of the spectrum. An excellent account of the contributions made by workers at various institutions such as Johns Hopkins University, the University of Colorado, the Air Force Cambridge Research Laboratories, and the National Aeronautics and Space Administration, has been published by Tousey and his staff (2, 3). The solar data accumulated to date cannot be adequately interpreted because of the present serious lack of knowledge of laboratory spectra.

One of the most important and most challenging problems is to identify the solar lines as to chemical origin. This spectrum is a mixed or blended one produced by the various atoms and ions that are constituents of the solar atmosphere. The interpretation of the spectrum involves a careful sorting process. The starting point is to make a comparison of the solar spectrum with well-known atomic spectra produced in the laboratory. The solar lines must match accurately in position and in relative intensity the leading lines of a given laboratory spectrum if the element is present in the sun. By such a process Rowland (4) in 1895, from his observations of the visible spectrum, listed 39 chemical elements in the sun, all but two of which were confirmed by later work. It is obvious from such a comparison that not all elements are equally abundant. For example, almost every laboratory line of the arc spectrum of iron, Fe I, has its counterpart in wavelength and relative intensity in the solar spectrum. Silver is noticeably more rare, only the very strongest lines being present but not strong in the sun. These are simple illustrations of a far more complex problem. Before an attempt is made to interpret the short-wave solar region, the vista now opened up by space research, a few general comments on the laboratory analyses of atomic spectra may serve to clarify the astrophysical aspect.

The starting point is the periodic chart of the atoms, where the chemical elements are arranged by atomic number, Z, starting with hydrogen ($Z=1$) and extending to Lawrentium, an element artificially produced, and having the largest known atomic number, $Z=103$. Each of the chemical elements is made up of atoms characterized by special properties that distinguish them from all other atoms. One of these properties is their optical spectra which are produced by the outer or valence electrons. In general, the complexity of the spectra increases with Z; in particular, it increases according to the number of electrons that are not firmly bound in "shells," *i.e.* the number that are active in producing the optical spectra. With sufficient excitation in the laboratory source, it is possible to produce spectra of different stages of ionization of a given element, the stage of ionization being defined by the number of electrons the atom loses as the energy of excitation increases. In 1946 Meggers (5) pointed out that for the 92 chemical elements then commonly included in the periodic table, the theoretical number of possible atomic spectra added up to a total of 4278. This number is never realized with laboratory sources because it would require nuclear energies to strip the atoms of all their electrons. Today the total number of optical spectra of all elements which have been wholly or partially analyzed probably does not exceed 550. This figure embraces a wide variety of spectra ranging from those that have been well observed, some of which have thousands of lines, to those known only from a few of the strongest lines.

More important than the number of known atomic spectra is the significance of the origin of spectra. Each spectrum has its own distinctive pattern of lines having characteristic relative intensities under varying conditions of observation. From precise measurements of the position of each line, its wavelength in A (Angstrom units) is determined. From the wavelengths and the measured or estimated intensities of the lines, a detailed study of the regularities in the spectrum can be made. Each line is produced by the transition of an electron from one energy state to another. Conversely, from the observed lines a limited number of energy levels characteristic of the spectrum is derived. These are constants of nature and furnish a permanent record of the quantum properties of the atoms or ions producing the spectrum. Each spectrum is thus analyzed according to the well-known principles of the quantum theory. The "shells" occupied by electrons of different types, the binding energies of the various electrons, and the excitation and ionization potentials can thus be determined from careful laboratory observations of a given spectrum.

Hydrogen, the first and lightest of the elements, has a simple spectrum consisting of regular series of lines produced when a single electron makes transitions between different energy levels. The familiar series in H occur in widely separated spectral regions. The strongest H line, known as Lyman alpha, is the leading line of the Lyman Series and occurs in the ultraviolet at 1215 A. To judge from the great strength of other lines of H which have higher excitation potentials and lie in the accessible region of the solar spectrum, one would expect this line, which arises from the ground state, to be by far the most conspicuous of all ultraviolet solar lines. This expectation has been abundantly confirmed; it is the strongest line observed on all rocket solar spectrograms and photometric tracings of this region. In fact all of the lines of the hydrogen series are well-known features in the solar spectrum, and the observation of the Lyman series is consistent with our earlier knowledge of the great abundance of hydrogen in the sun.

The second lightest element, helium, has an interesting history. The name of this element is the Greek word for "sun." It was so named as the source of a yellow line observed in the flash spectrum at the total solar eclipse of 1868. The element was not found in the laboratory until 1895, when Ramsey discovered it as a chemical constituent of the earth's atmosphere.

Helium having atomic number $Z=2$, has two spectra, He I and He II, the first being that of the neutral atom, *i.e.* the spectrum produced by two electrons; the second, He II is that produced by the radiation of helium atoms that have lost one electron. More excitation of the atoms is required in the laboratory source to produce the second spectrum. This spectrum resembles in structure the spectrum of hydrogen because it is produced by the configurations of a single outer electron. More energy is involved, however, and consequently the series lines of He II occur further to the violet than the corresponding hydrogen lines. The great strength of the helium chromospheric lines in the visible region indicates that the strongest lines in both spectra, which lie in the far ultraviolet, will stand out in this "rocket" region. The "raies ultimes" or the principal lines of He I at 584 A and the He II pair at 303 A appear as conspicuous features in the spectrum, as expected.

Next in order of abundance come the light elements carbon, nitrogen, and oxygen, having respective atomic numbers 6, 7 and 8, with carbon and oxygen exceeding nitrogen in abundance. As the atomic number increases, so do the number of observable spectra. Similarly, as the stage of ionization increases, the spectral lines lie further toward the short-wave region. The first spectra of these elements have long been known in the solar spectrum. For the spectra of higher ionization, however, the region now observed from rockets and the like offers interesting possibilities. Among the earliest identifications were lines of O VI at 1031 A and 1037 A, *i.e.* lines produced by oxygen atoms that have lost five electrons. Others were lines of C II, C III, C IV and N V in the region from 1100 A to 1600 A. More recently, the solar observations have been extended to still shorter wave lengths. The interesting counterpart of the strong Lyman alpha line of H I He II, etc. has been observed in C VI at 33 A.

The identifications of the selected solar lines mentioned above present a most incomplete picture of the span of solar observations now opened up by space research. As yet there is no detailed compendium of the spectral lines shorter than 3000 A. From this limit to 2200 A, more than 3,000 absorption lines have been observed that are as yet unidentified. To wavelengths short of 2000 A, "the Fraunhofer lines are progressively replaced by emission lines, the radiation coming from higher and higher regions" (6). From here to shorter wave lengths, the high-ionization spectra of familiar elements appear, spectra requiring energies of excitation approaching those required to produce the spectrum of the outer solar corona. Some 300 emission lines remain, however, whose chemical origin is still unknown.

The spectra of abundant metals account for a large number of the solar lines. Magnesium, silicon, and iron are of special interest. Both Mg I and Mg II are conspicuous in the solar spectrum. Among the first detectable features in the 1946 rocket spectrogram were a pair of well-known Mg II lines near 2800 A, a Mg I line at 2852 A, and a Si I line at 2881 A. Later Mg X and Si XII emission lines were found near 600 A and 500 A, respectively. Iron is equally interesting. The first and second spectra are rich in lines and are readily identifiable among the numerous solar lines short of 3000 A. An interesting recent identification is that of two lines near 360 A attributed to Fe XVI, *i.e.* iron atoms lacking 15 electrons. This spectrum belongs to the Na I isoelectronic sequence, and the observed lines are analogues of the very strong Mg II lines mentioned above.

From the general study of the various spectra whose origin is the radiation from the sun, 62 chemical elements have been detected without question in the solar atmosphere. There is a possibility that four more may be present, but further evidence is needed for confirmation. One element, neon, has been added from the ultraviolet solar observations. Two lines at 770 A and 780 A are due to Ne VIII and furnish the first evidence of this element in the sun. One line of Ne VII has also been identified.

The "space" observations in the realm of the ultraviolet solar spectrum have provided tremendous impetus to solar research. Enough is known to present many challenging problems. The temperature gradients in the solar atmosphere, and the related study of the mechanisms whereby the high-excitation energies of the identified emission lines can be produced, are illustrative. Studies of line profiles, measurements of line intensities for work on abundances of chemical elements in the sun, theoretical work on solar models, and the like, are of great astrophysical interest. Tousey has pointed out, however, that "Solar ultraviolet and X-ray spectroscopy is still in the observational stage. A number of excellent spectra have been obtained, but many more are needed, along with more identifications, intensities, and spectroheliograms" (6).

The astrophysical interpretation of the ultraviolet solar spectrum starts basically with the correct identifications of the observed lines. The active extra-terrestrial spectroscopic programs briefly described above create an urgent need for equally active laboratory programs on the analyses of atomic spectra of abundant elements. With modern light sources and equipment, the earlier analyses can be greatly extended. High-ionization spectra should be systematically observed down to the region where optical and X-ray spectra overlap. The present work with plasma sources points the way and should be greatly expanded.

New observations are needed to extend the analyses of familiar complex spectra such as Fe II and Ni II. From such work, many solar lines between 2200 A and 3000 A could be identified. These are but a few examples of important research projects for the coming decade. With teams of well-trained laboratory spectroscopists working side by side with those who will continue to observe ultraviolet solar spectra, a golden era of astrophysics lies ahead.

References

(1) Tousey, R., Strain, C. V., Johnson, F. S., and Oberly, J. J. Astron, J. *52*, No. 1162, 158 (1947).

(2) Tousey, R. Space Science Rev. *2*, 3-69 (1963); Appl. Optics *1*, 679-694 (1962).

(3) Tousey, R., Purcell, J. D., Austin, W. E., Garrett, D. L., and Widing, K. G. COSPAR 4th Int. Space Sci. Symp. and 6th Plenary Meeting, Warsaw, Poland, June 3-12, 1963.

(4) Rowland, H. A. See Astrophys. J. *1-5* (1895-1897).

(5) Meggers, W. F. J. Opt. Soc. Am. *36*, 442 (1946).

(6) Tousey, R. The Observatory, in press (January 1964).

Nth-Order Effects of The Government's Support Of Research*

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A concrete embodiment of an old abstract argument may be taking place today with profound social consequences. The philosophical controversy involves the question whether or not quantitative changes can bring about qualitative ones. From a practical standpoint, the transition may be regarded as the point at which latent effects begin to demand attention. An important transformation of this nature is becoming visible as a result of increasing government support of research and development.

The impact of the Federal outlay upon the American scene can be appreciated from a few facts and figures.

The United States Government will spend about 200 billion dollars next year. About one out of every seven of these dollars will be expended on research, development, and testing of technological innovations. The Defense Department alone is currently spending about seven billion dollars a year in the area.

About 70 percent of the two billion dollar annual research and development budget of American universities is provided directly by the Federal Government. As high as 60 percent of the total operating costs of individual universities comes from Government sources, not counting such indirect benefits as tax credits. Sizable fractions of the total are spent in large research centers. Forty percent goes to 35 government-owned, university-operated installations such as the Argonne National Laboratory, Jet Propulsion Laboratory, and Los Alamos Scientific Laboratory. Most of the funds go to the larger schools. Sixty-eight percent is alloted to 25 universities.

A comparable influence is exerted upon industry. It is not rare nowadays to find companies with about half of their total income being derived from research and development contracts; a large proportion of this comes from the government. The current controversy surrounding the newest experimental tactical fighter plane, TFX, clearly shows the nature of competition involved in some cases.

All in all, about three-fourths of the total research and development expenditures for the whole country are provided directly or indirectly by the Federal Government.

This generous support of research and development gave rise to the major technological advances of today, impressive even to the casual observer. These represent the readily apparent first-order effects of the government's patronage of research. The results had been knowingly contracted for by the government and other sponsors. They had been openly agreed to by the scientist and engineer in the laboratory. Three examples may illustrate the genesis and nature of such first-order effects.

The first example is taken from the area of natural resources. It is expected that

* A talk presented in 1963 at a seminar sponsored by the Army Research Office staff at Duke University.

based on our present state of knowledge, the United States either has available within her own boundaries or can gain access to sufficient quantities of food, clothing material, water, energy, and space to continue to improve the standard of living with increasing populations for at least 50 years. In 1961 only 304 out of 638 million acres of high productivity have been planted. Only nine per cent of the labor force was required to produce the needed amount of food. By 1980 only 297 million acres, using only six percent of the labor force, would be needed, producing a 40 percent increase in crop yield. Beyond the year 2000, however, it may be necessary to have much faster-growing varieties of plants and animals. Research grants and contracts are therefore being awarded in plant and animal genetics and breeding. The resulting scientific information and new varieties of plants and animals represent first-order effects of the sponsorship of research by the United States Department of Agriculture.

The second example is drawn from the electronic industry. With increasing demands for international communications, new devices with much higher capacities for handling messages in undersea cables are required. A new amplifier, transmitting 128 telephonic conversations simultaneously in two directions and requiring no maintenance for 20 years, represents a first-order effect of the support of research by the Bell Telephone Laboratories.

The third example comes from basic research in biochemical genetics. Considerable progress has been made during the last two decades on the mechanism of transfer of characteristics from one generation of organisms to another. The National Science Foundation and other agencies have been supporting work along this direction. One of the latest theories to have come out of these activities is quantum genetics. According to this hypothesis, the genetic information is coded in the coils of the DNA molecule itself, as influenced by the proton position in the hydrogen-bonding between the paired DNA molecules. These protons obey quantum laws. Occasionally these wave packets spread through potential barriers to unlikely positions, thereby bringing about mutations, which are responsible for evolution. This genetic model of the quantum-mechanical tunnel effect in solid-state diodes represents a first order effect of the government grants in basic research.

With the generously increasing support of science and technology over the past several decades, higher-order effects are becoming visible. These are the changes brought about by money expended for research and development which have been covered neither in the scope of the contract or grant, nor in the expressed purposes of the technical studies involved. No one has explicitly or implicitly planned for or against their occurrence. They do not come into consideration in the formulation of overall programs for government support, in the allocation of specific grants, or in the solicitation of such assistance on the part of industry and universities. No one and no agency can be held responsible. No one and no agency is assuming the responsibility unto himself or itself.

Seven examples of such higher-order effects are described in the following paragraphs.

Change in the Character of the American University

Prior to the forties, nearly all of the research in American universities, except agricultural studies in land-grant colleges, was carried out by the academic departments. There was no dean for research, no research coordinator, no vice-president in charge of research, no research contracting officer. With the increasing involvement in research supported by outside funds, various changes occurred. Progressively larger numbers of full-time research associates were added to the academic departments. This was accompanied by more cohesive groupings of outside sponsored research activities in the form of institutes, as integral parts of the university, such as the Anthropoid Center being set up in California.

At the same time heavy capital investments were made, which require continued support, such as the Illiac high-speed digital computer at the University of Illinois.

Universities were no longer reluctant to manage government-owned, university-operated centers such as Brookhaven National Laboratory. At the same time, affiliation with non-profit research organizations, such as Armour Research Foundation and the Stanford Research Institute, became accepted practice.

The previous loose administration of research in universities could not cope with the far-flung activity. A more formal organizational structure appeared involving contract attorneys, negotiators, public relations experts, and an administrative hierarchy. Because of the presence of organized centers and project teams, personnel with managerial competence became important on the campus. These are the people who can manage complex multimillion dollar organizations, who can weld diverse talents into directional programs, and who can maintain appropriate contacts for the required funds, personnel, and awards. In many institutions these personalities have begun to replace the scholar in international prestige. The tone of the campus is reflecting this emphasis from the scholarly to the managerial.

In addition there is an emergence of a "research community" drawing its support from non-academic sources. A growing concern is in evidence regarding the fraction of the university's energies that should be apportioned for such "non-instructional" activities. A minority favors divesting the campus of all research institutes and reverting back to the earlier system of academic departments. By and large, however, faculty members argue that the best education is associated with the best research, and that a strong research effort on the campus is necessary for a strong educational program. The situation is still in a state of vigorous contention. The question, "How much research is too much?" remains unanswered.

Change in the Place of Universities in the Community

With two decades of academic experience in large-scale technical projects, and with the return to its campus of professors who have whetted their appetites in the action whirl of World War II, the university has become a reservoir of technical and executive talent for non-academic exploitation.

There is the call for technical coordinators in organizing international programs, such as the International Geophysical Year.

There is the demand for managers of affiliated research institutions, such as the Applied Physics Laboratory of Johns Hopkins University.

There are the financial lures of industrial consultancies, such as the 700 university consultants used by the American Telephone and Telegraph in 1960.

Efforts have been made to facilitate these relationships, such as the 115-acre campus of the Illinois Institute of Technology, being located adjacent to a 50-acre industrial research park.

There is, thus, a move on the part of universities to tie closer with the outside world of practical affairs. At the same time there is a move on the part of industry and government toward the direction of research of an academic type. The abundance of available funds for research has made it possible for a series of interesting experiments in the industrial support of basic research. Many companies are now maintaining central research laboratories, in which quite fundamental thinking is going on.

The government laboratories themselves have become a significant contributor to science and technology. Some of their advanced research rivals the best of academic research institutions.

It appears that, as a result of these trends, the difference in research competences and orientation between the universities and the rest of the community is no longer a qualitative affair but rather a quantitative one. One is no longer surprised nowadays to hear of a Nobel laureate from the industrial world. No longer is the university the sole preserve of the "lone wolf" pioneer. There are equally "lone wolves" outside the ivy walls—although admittedly not many as yet. No longer is the university faculty member regarded as a naive academic scholar. There are practical business minds within the ivy walls—although admittedly not too many as yet. But the qualitative separation between the two sides of the academic fence has been demolished. How far the diffusion process will go and what the equilibrium constant will turn out to be, no one can say.

Decrease in Intellectual Influence of Academic Presidents and Deans

In their sponsorship of research, federal agencies have been very careful not to "control research." Yet the very facts of federal appropriations require that judgment be exercised in the selective distribution of research funds among the large number of requests. Partly in a desire to be above suspicion, partly in response to the professional custom of being "evaluated by one's peers," and partly in an honest attempt at the best decisions in public interest, government agencies have resorted to the use of advisory panels in many cases. These panels are composed predominantly of university personnel. Although their deliberations are understood to be advisory, nevertheless their evaluations do constitute one of the most important factors in determining whether or not a given professor receives research support.

This evaluation system creates an interesting situation. The research being undertaken by a professor on Campus A is dependent for support, to a considerable extent, upon opinions of a group of professors on Campus B, C, D, etc., and vice-versa. The type of research is not as much dependent, as it once was, upon the presidents and deans of the various universities.

The question arises, as to whether there has been a significant erosion of university presidential leadership in developing the character of the educational system. Some observers liken the present dilemma to that in the story about the 1848 uprising in Paris. A person saw his friend tagging along with a mob about to storm a barricade. Knowing that the troops behind the barricade were well-armed and seasoned, he urged his friend to get back from the crowd. Whereupon his friend replied, "I can't. I'm their leader!"

Increasing Acceptance of Thinking as an Article of Commerce

The offering of one's creative talents for monetary returns has been an age-old practice. On the whole, the exchange of intellect and creativity for money during the earlier days had been relatively subdued. The transactions were conducted quite demurely.

During recent decades, however, there has been a greatly increased number and fervor of organizational representatives "selling," so to speak, their intellectual prowess to the highest bidder. The problem to which the talent is to be devoted or the sponsor for which the work is done, often appears to merit only secondary consideration.

A pertinent example of the extent of commercial traffic in thinking is a fair size industrial subsidiary set up with the expressed purpose of doing basic research at a profit on the free market. Although the concern is doing quite well at the present time, it is difficult to say whether or not this precedent will develop into a major trend.

Another concept regarding the place of basic research in the scheme of things is being explored by some people. The idea has not gained much support at the present time. Nevertheless, it is significant as an indication of the kind of change that may be taking place in the American attitude toward basic research. The funding plan divides research activities into two categories, namely:

(a) Those devoted to the fulfillment of stipulated materiel systems or social needs, which lie within the possibility of our current knowledge.

(b) These devoted to the fulfillment of stipulated materiel systems or social needs, which lie beyond the possibility of our current knowledge.

According to this scheme of management, advances in fundamental knowledge will no longer be recognized as an approved objective for explicit support. Instead they are to be achieved as a derivative fall-out of the second category. This exemplifies an extreme reaction to the art-for-the-sake-of-art thesis of the Romantic period of history.

Creation of a New Avenue of Power

Because of the sheer magnitude of the money involved and because of the important economical and international ramifications of research findings, scientific advisors have been offered an unparalleled opportunity for political power.

In some respects, this recalls the observation of Heinrich Heine on writers in 1852. He referred to the passage in Hugo's *Notre-Dame* in which Frollo held a huge book in his hands and pointing to the towers of Notre-Dame, said, "This will annihilate that!" The press will supersede the padre. Lemoinne later said the same thing about newspapers when he stated that "the Journal will supersede the Parliament." Heine commented that "if these hopes, even irrationally, are beginning to inspire men of intellect—which of them, do you think, will spend his time stringing rhymes, weaving novels and romances, when he can aspire to rule national masses of men?"

Great writers have continued to appear since 1852, despite Heine's fears. Nevertheless, a new social power—that of the political press—has become a reality. Whether or not a comparable power of political chemists, political physicists, and other political scientists (of the new technological vintage) are here to stay in today's world is not clear at the moment.

More Influential Role of the Government in Intellectual Fashions

Quite apart from the size of patronage, the selection of the intellectual problems to be pursued and the determination of areas of exploration have thrust the government into a new role.

In this connection, the legend about America's first Nobel laureate may be of worth relating. In contrast to other professors, A. A. Michelson was said to have been not too enthusiastic about graduate students. He was supposed to have expressed the feeling that the incompetent students would only bungle the fine research problems delineated for them; the more capable and successful ones, however, would inevitably fail, in their conceit, to recognize the importance of the proper problem selection on the part of the professor.

It is true that most of the research problems being undertaken under government sponsorship have originated from the university and industrial workers themselves. Nevertheless, the government is now involved in the formulation of research problems and in the definition of new investigational salients to a much higher degree than ever. This is tantamount to setting the intellectual fashions of the day—something new in the recent evolution of government leadership.

Change in Value Preferences in the American Society

The above events cannot help but exert considerable influence upon our value norms. Formerly, thinkers in the field of philosophy, ethics, and social studies set the pace on questions involving norms. *De facto,* however, today's guidelines seem to be influenced more by the market of exchange, the financial rewards, the prizes, and the psychic compensations. The skewed support of the sciences in the universities, the junior science fairs, the greater outlet for jobs in fields related to research being supported by government funds—such factors have greatly increased the attractiveness of the physical sciences as a way of life. This higher-order effect of research affluence has been discussed repeatedly in other articles and needs no repetition in this essay.

It may well be that the higher-order changes, brought about perhaps only indirectly by liberal government sponsorship and research and development, constitute an inevitable evolution in the technological phase of man's historical development. The issue may not be a matter of preference.

Nevertheless, the scholar and scientist may ask himself a crucial question regarding the preservation of his own values and attitudes. The seeker after enlightenment, who carries on in his own chambers unstrutted by the resources of the government and other public sources of revenue, may continue to preserve his traditional freedom from financial auditors, program reviewers, and other interlocutors of society. Few will begrudge him the accoutrements of the classical academicians.

The majority of the scientists, however, is faced with a more difficult choice. Their fortunes are tied to the new research affluence. They hope and strive to preserve their former prerogatives. But a moral issue has emerged onto the public plane: Should a person who has extended his influence to the social sphere retain the privileges attendant to his activities when they were more personal and private in consequence? The debate will continue long and loud. But the eventual outcome appears reasonably certain, if society at large is to have the say. It may not please many a sincere scholar and scientist.

Academy Proceedings

March Meeting

(479th Meeting of the Washington Academy of Sciences)

SUBJECT:	**CONVERSAZIONE**
DATE:	**THURSDAY, MARCH 19, 1964—** 8:15 to 10:30 p.m.
PLACE:	**JOHN WESLEY POWELL AUDITORIUM, COSMOS CLUB** 2170 Florida Ave., N.W.

Fellows and Members of the Academy are invited to an interdisciplinary social hour. Come and exchange ideas with your fellow scientists in other fields. Discuss your scientific problems with a cup or glass* in hand.

Meet the individual members of the Board of Managers of the Academy and present your gripes—but do not forget to offer a solution!

Reservations are required. Reservation cards were mailed to Academy members. Those who have not returned the cards should do so immediately or phone Miss Greta Townsend, FE 3-9000, Ext. 554. Name tags and tickets will be distributed at the door.

* Snacks, coffee, soft drinks, and one cocktail will be on the house.

WASHINGTON ACADEMY OF SCIENCES

ORGANIZATION FOR 1964

Officers

President	Francois N. Frenkiel	David Taylor Model Basin
President-Elect	Leo Schubert	American University
Secretary	George W. Irving, Jr.	Department of Agriculture
Treasurer	Malcolm C. Henderson	Catholic University of America

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1962-64	Harold H. Shepard	Department of Agriculture
1962-64	Russell B. Stevens	George Washington University
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1963-65	John K. Taylor	National Bureau of Standards
1964-66	Allen L. Alexander	Naval Research Laboratory
1964-66	Francis W. Reichelderfer	Weather Bureau

The Journal

Editor	Samuel B. Detwiler, Jr.	Department of Agriculture

Chairmen of Standing Committees

Executive Committee	Francois N. Frenkiel	David Taylor Model Basin
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Committee on Policy Planning	B. D. Van Evera	George Washington University
Committee on Ways and Means	Bourdon F. Scribner	National Bureau of Standards
Committee on Meetings	Mary Louise Robbins	George Washington University
Committee on Awards for Scientific Achievement	Margaret Pittman	National Institutes of Health
Committee on Grants-in-Aid for Research	Archibald T. McPherson	National Bureau of Standards
Committee on Encouragement of Science Talent	Rev. Francis J. Heyden, S.J.	Georgetown University
Committee on Public Information	Watson Davis	Science Service
Committee on Science Education *	John K. Taylor	National Bureau of Standards

Chairmen of Special Committees

Committee on Bylaws and Standing Rules	Lawrence A. Wood	National Bureau of Standards

* The Academy contingent of the Joint Board on Science Education, which is sponsored by the Academy and the D. C. Council of Engineering and Architectural Societies.

Summary of Journal Operations for 1963 (Volume 53)

On February 12, 1963, the Board of Managers approved a budget item of $8,000 for nine issues of the *Journal* (eight regular issues from January through May and October through December, and a directory issue in September). These nine issues contained 232 pages of text, as compared with 228 pages in 1962. The following statement contains comparable cost figures for 1962.

	Eight Regular Issues		Directory Issue		Total	
	1963	1962	1963	1962	1963	1962
Expenses [1]						
Type composition	$2,844.75	$2,793.11	$ 34.75	$ 28.00	$2,879.50	$2,821.11
Printing and binding	2,385.74	2,441.62	798.00	515.00	3,183.74	2,956.62
Engraving	165.61	346.84	0.00	0.00	165.61	346.84
Addressing and mailing	147.05	144.73	17.90	18.73	164.95	163.46
Mailing envelopes	0.00	57.75	0.00	0.00	0.00	57.75
Postage deposits	150.00	110.20	15.00	63.82	165.00	174.02
Staff expenses	24.79	41.61	0.00	0.00	24.79	41.61
IBM services	0.00	0.00	387.04	359.07	387.04	359.07
Directory questionnaire, etc.	0.00	0.00	147.65	89.83	147.65	89.83
Office equipment	138.54	0.00	0.00	0.00	138.54	0.00
Total	$5,856.48	$5,935.86	$1,400.34	$1,074.45	$7,256.82	$7,010.31

	1963	1962
Income Credits [2]		
Subscriptions	$2,403.69	$1,717.00
Sale of back issues	62.25	1,238.07
Total	$2,465.94	$2,955.07
Reprints [3]		
Reprint income received	$ 187.50	$ 246.90
Plus reprint income due	25.60	296.40
Minus reprint costs	223.60	493.20
Net reprint income	$ —10.50	$ 50.10
Summary		
Journal expenses	$7,256.82	$7,010.31
Minus income credits	2,465.94	2,955.07
Minus net reprint income	—10.50	50.10
Net cost of *Journal*	$4,801.38	$4,005.14

[1] *Obligated* in year

[2] *Received* in year.

[3] Income *earned*, expenses *obligated* in year.

Report of Committee on Science Education, 1963

The Science Education Committee is responsible for planning, organizing, and implementing a program to stimulate student interest in science, and to encourage high-quality teaching of the sciences and mathematics. Activities are carried out jointly with representatives of the D. C. Council of Engineering and Architectural Societies under an organization known as the Joint Board on Science Education.

The program is directed primarily to secondary schools located in the municipalities and counties within a 25-mile radius of the National Capital. Virtually all schools within this area—public, private, parochial—are served. Several thousand teachers and many thousands of students are contacted directly or indirectly.

Activities have been developed to stimulate interest in science among students of all levels of academic achievement. The program is financed from two sources—local contributions and National Science Foundation grants.

Local Program

During the academic year 1962-63, the Board obtained contributions amounting to $5,500 from local technical societies and science-oriented business organizations. Activities supported were as follows:

Science Fairs. Printed matter including posters, entry blanks, and related materials was supplied to the five local area fairs. The expenses of six students and three teachers were provided for their participation in the National Science Fair—International at Albuquerque, N. M., during May 1963. Four other students and two teachers from the area also attended the fair under sponsorship of a school system and a business association. The five area fairs and the school fairs which preceded them involved participation of some 20,000 students.

Teacher Awards. Sixty local teachers were given citations for excellent science teaching at the Engineers, Scientists, and Architects Day luncheon held on February 20, 1963. Of these, 12 were given awards for outstanding teaching, consisting of a two-day trip to research laboratories in the New York area.

School Contacts Program. A scientist or engineer liaison contact was provided for each of the 210 secondary schools of the Washington area. A directory of school contacts, containing information on science resources available to the schools, was published.

Women in Science. A luncheon seminar was held which emphasized present-day opportunities for women in science. Some 100 girls of the area were guests on this occasion.

Frontiers of Science Lectures. Four lectures on recent advances in science were given for high school students of the area. Held on Saturday mornings during the spring of 1963, a cumulative audience of 600 was in attendance.

Project Ideas for Young Scientists. Some 2,000 copies of this source book for science projects were sold during the past year. Orders were received from literally every state and several foreign countries.

NSF Program

The Academy received a grant of $18,600 to carry on during 1962-63 the three projects outlined below. A sum of $15,875 also was granted to provide for several activities during the 1963-64 academic year. This program was administered by the Joint Board with John K. Taylor as program director.

Visiting Scientists and Engineers Program. A roster of 600 scientists and engineers is maintained to speak to school classes, judge at science fairs, replace classroom teachers for special purposes, and for related activities. A catalog of 441 talks was distributed to the schools. Two hundred and eight of these talks were presented at 70 schools during the year.

Science Conferences. Ten conferences on various aspects of science, mathematics, and engineering were held during the school year. Involved were three closely related parts: A series of conferences on problems related to science teaching in elementary and secondary schools; a conference on stimulating the interest of girls in science education; and a regional conference of neighboring state academies on programs concerned with the encouragement of science talent. Scientific and engineering societies co-sponsored several of the conferences.

The conferences provide the opportunity for teachers, college instructors, and professional scientists to meet in all-day session to discuss current trends in science education as well as local problems concerned with the teaching of science and mathematics.

The all-day conferences were held on Saturdays in conference rooms provided by schools and universities, or in other convenient facilities. Luncheon was served to those who attended. The programs consisted of speakers of high reputation in their fields, followed by discussions, either general or in groups.

The Reporter. An eight-page newsletter was published monthly during the 1962-63 year and bimonthly during the 1963-64 year. Carrying news of interest to teachers, it is sent free to all science and mathematics teachers of local secondary schools and to scientists interested in promoting science education. The circulation is 3,000.

Conclusion

The program of the Academy through the Joint Board is considered by many to be a model undertaking. It has stimulated a more active program in two neighboring academies. Several cities are considering organizing a similar operation.

The Academy can justly claim considerable credit for the high level of interest in science on the part of students of the area and for their commendable achievements in such national competitions as the science fairs and the talent search. The Committee recognizes that its local program is the result of the efforts of many individuals, whose cooperation is acknowledged with sincere thanks.

—*John K. Taylor, Chairman*

BOARD OF MANAGERS MEETING NOTES

January Meeting

The Board of Managers held its 561st meeting on January 16, 1964 at the Cosmos Club, with President Van Evera presiding.

The minutes of the 560th meeting were distributed and approved.

Announcements. Dr. Van Evera announced appointment of Paul Oehser, Alfred E. Brown, and Paul Foote to the Ways and Means Committee. Also, he introduced Kurt H. Stern, delegate representing the Electrochemical Society, who was attending his first Board meeting.

Grants-in-Aid. Chairman McPherson submitted the annual report of his Committee and discussed the application of John H. Fournelle for a grant to pursue a research project on production of ultraviolet-induced pigment mutants in *Chlorella.* The Board approved a grant of $32.50.

Meetings. Chairman Robbins submitted the annual report of her Committee and indicated that at its February 20 meeting the Academy would be addressed by Dr. Van Evera as retiring president.

Encouragement of Science Talent. Chairman Heyden announced that the Committee roster had been completed; that proceedings of the most recent meeting of the Junior Academy, at Georgetown University, were being printed and would soon be available for distribution; that since the D. C. public schools appeared to lack interest in Junior Academy activities, means were being explored for stimulating interest; and that he would welcome suggestions on a site for this year's science fair.

Tellers. Chairman Fowells reported the results of the recent election, as follows: President-elect, Leo Schubert; secretary, George W. Irving, Jr.; treasurer, Malcolm C. Henderson; managers (1964-66), Allen L. Alexander and Francis W. Reichelderfer.

Secretary. Secretary Irving submitted his annual report and reported new delegates of affiliated societies, as follows: Frank Hettrick, University of Maryland, replacing Howard Reynolds as delegate of the American Society for Microbiology; Harold H. Shepard replacing Frank L. Campbell as delegate of the Entomological Society; and Luna Leopold replacing G. Arthur Cooper as delegate of the Geological Society.

Treasurer. In the absence of Treasurer Henderson, Dr. Van Evera distributed copies of the treasurer's annual report, which was accepted by the Board. Dr. Van Evera announced that the Auditing Committee (Lawrence A. Wood, chairman, W. G. Brombacher, and Gordon W. McBride) had found the treasurer's accounts in order, and that the treasurer's report for 1963 represented "a true and accurate statement of the transactions of the year and the current assets of the Academy."

Editor. Editor Detwiler reported that the January issue of the Journal had been mailed on January 7; repeated a previous appeal for feature material for the Journal; and indicated that additional individuals were being added to the Journal staff.

Old Business. Continuation of the Board's review of a draft of the revised Standing Rules was deferred.

New Business. Dr. Van Evera advised the Board that the Washington Section of the American Chemical Society (Chemical Society of Washington), one of the Academy's affiliates, had requested that the Bylaws of societies with which the ACS is affiliated should include a clause similar to the following: "No organization which is a member of the Washington Academy of Sciences shall be committed by any of its actions in conflict with the charter, constitution, or bylaws of said organization, or of its parent society." After brief discussion, the matter was referred to an Academy Committee on Bylaws and Standing Rules, which was established by concurrent action.

Science in Washington

CALENDAR OF EVENTS

March 18—Institute of Environmental Sciences

Walter Carlson, director of technical information, OSD, "The Sources of Information in the Field of Environmental Science."

Harry Diamond Laboratories, Building 133, Connecticut Ave. and Van Ness St., 8:00 p.m.

March 24—CU Mathematical Lecture Series

Lecture Series in Mathematical Statistics and Probability Theory, sponsored by Catholic University Statistical Laboratory. William G. Cochran, Harvard University, "Sequential Experiments for Estimating the Median Lethal Dose."

Rm. 109 Caldwell Hall, CU, 3:30 p.m.

March 25—Society of American Foresters

Meeting from 9:00 a.m. to about 2:30 p.m. on subject, "Depressed Areas—Can They Be Cured?" Principal speaker, at 9:30, Hon. Franklin D. Roosevelt, Jr., Under Secretary of Commerce, "National Problems and Federal Responsibilities." Luncheon at 12:55. Luncheon speaker, Ed Dodd, creator of *Mark Trail,* "Mark Trail Views Forestry, Conservation, and Depressed Areas."

Presidential Arms, 1320 G St., N.W.

April 1—University of Maryland Zoology Colloquium

Wesley C. Hymer, National Institutes of Health, "Studies on the Isolation and Characterization of Two Different Types of Cellular Organelles Obtained by Using New Isolation Techniques."

Rm. 405 McKeldin Library, University of Maryland, 4:00 p.m.

April 6-8—Institute of Electrical and Electronics Engineers

International Conference on Nonlinear Magnetics.

Shoreham Hotel.

April 7—James Curley Lectures in Science

Ansley J. Coale, Princeton University, "Population Trends and Population Control."

Gaston Hall, Georgetown University, 8:30 p.m.

April 9—Chemical Society of Washington

F. Albert Cotton, MIT, "*pi*-Bonding in Metal Carbonyls—a Quantitative Approach." Hans L. Falk, National Cancer Institute, NIH, "Air Pollution and Cancer."

Howard University, 8:15 p.m.

SCIENTISTS IN THE NEWS

Contributions to this column may be addressed to Harold T. Cook, Associate Editor, c/o Department of Agriculture, Agricultural Marketing Service, Federal Center Building, Hyattsville, Md.

AGRICULTURE DEPARTMENT

Justus C. Ward gave talks on pesticide regulations at the 17th Annual Cotton Insect Research and Control Conference at Memphis, Tenn., on January 8, and at the 1964 Southern Weed Conference at Jackson, Miss., on January 15.

GEOLOGICAL SURVEY

Speakers at the January 22nd meeting of the Geological Society of Washington included **Robert O. Fournier,** who talked on "The Effect of Supersaturated Silica Solutions During the Hydrothermal Alteration of Feldspars," and **Thomas P. Thayer,** who talked on "The Ophiolite Concept vs. the Alpine Magic Magma Stem."

George Phair has been appointed to a two-year assignment as Geologic Division editor for the *Annual Review*, the Geological Survey Professional Paper summarizing the economic and scientific work accomplished during each fiscal year. During the first year of the assignment Dr. Phair will be assistant editor and during the second year, editor-in-chief.

GEORGE WASHINGTON UNIVERSITY

Reuben Wood has been appointed director of GWU's spring Peace Corps Training Project. The University will conduct a 10-week special training program for about 55 Peace Corps volunteers preparing for service in Nepal.

HARRIS RESEARCH LABORATORIES

Milton Harris attended the American Management Association Planning Council meeting in New York on January 9. On January 17, Dr. Harris addressed the Oregon State University Department of Science on the subject, "University, Science, and Government"; on the same day, he spoke at the 75th anniversary celebration of the University's Home Economics Department on the subject, "Textiles in the Modern World."

Alfred E. Brown addressed the Washington Chapter of the American Institute of Chemists on January 14. His subject was, "New Efforts toward Cooperation among Scientific, Technological, and Educational Organizations in Washington, D. C."

NATIONAL BUREAU OF STANDARDS

Director **Allen V. Astin** was one of five senior Government career employees who recently received the 1963 Rockefeller Public Service Award.

William N. Harrison has retired as chief of the Metallic Building Materials Section after 41 years with NBS.

Donald Hubbard retired in January after 38 years of service at the Bureau.

NATIONAL INSTITUTES OF HEALTH

Bernard B. Brodie and **Marshall W. Nirenberg** were among 10 medical men who recently received Distinguished Achievement Awards from the editors of the international medical journal, *Modern Medicine.* Dr. Brodie, chief of the National Heart Institute's Laboratory of Chemical Pharmacology, was cited for "his creative contributions in basic research of how drugs act in the body." Dr. Nirenberg, chief of the Section on Biochemical Genetics in the Laboratory of Clinical Biochemistry, was cited as a leader in the field of molecular biology.

SCIENCE AND DEVELOPMENT

The Department of Civil Engineering at Catholic University sponsored a University Faculty Panel Discussion on **"The American City—Its People, Its Plans and Its Politics"** on December 11, in connection with the University activities for its diamond jubilee year. The moderator was Col. William A. Roberts, chairman of the Federation of Citizens' Associations of the District of Columbia. Panel members included Paul J. Claffey (transportation), Rev. Robert G. Howes (city planning), Joseph Miller (architecture), John P. McCarthy (politics) and Russell W. Leedy (social service). Despite threatening weather, nearly 200 people attended this interdisciplinary program.

Georgetown University was recently awarded a **three-year predoctoral research training grant in the space-related sciences** by the National Aeronautics and Space Administration. The University will select up to six participants in space-related predoctoral studies to enter the program in September 1964. The students may elect to work in the fields of astronomy, biology, chemistry, mathematics, or physics. Each graduate fellow will receive a stipend of $2,400 for 12 months of training, and he may be entitled to an additional allowance for dependents. He may be assured of three years of predoctoral study if he maintains a satisfactory record.

Georgetown already has three faculty members cooperating with various activities of NASA: Father Francis J. Heyden, chairman of the Astronomy Department; William J. Thaler, chairman of the Physics Department; and Father Matthew P. Thekaekara, associate professor of physics.

An "FDA Institute for Advanced Analytical Chemistry" has been established at Georgetown University. It will offer four 12-week courses each year of intensive study of advanced theory and applications of instrumental methods to analytical chemistry. The institute will enable FDA scientists to continue to keep abreast of the latest advances in analytical chemistry, and apply the most up-to-date instrumentation to their work. Instruction will be given by the faculty of the Georgetown University Chemistry Department. Enrollment will be limited, with FDA chemists having enrollment priority.

Twenty-two postdoctoral resident research associateships are being awarded for 1964-65 by USDA's Agricultural Research Service. They will enable the recipients to study and do basic research on animal genetics, biochemistry, microbiological chemistry, physical chemistry, entomology, histopathology, microbiology, mineral nutrition of plants, plant physiology and plant virology in pioneering research laboratories in Albany, Calif.; Beltsville, Md.; Lafayette, Ind.; New Orleans, La.; Peoria, Ill.; Philadelphia, Pa.; Washington, D. C.; and Plum Island, N.Y.

Delegates to the Washington Academy of Sciences, Representing the Local Affiliated Societies*

Philosophical Society of Washington	R. D. Myers
Anthropological Society of Washington	Regina Flannery Herzfeld
Biological Society of Washington	John L. Paradiso
Chemical Society of Washington	William A. Zisman
Entomological Society of Washington	Harold H. Shepard
National Geographic Society	Alexander Wetmore
Geological Society of Washington	Luna Leopold
Medical Society of the District of Columbia	Frederick O. Coe
Columbia Historical Society	U. S. Grant, III
Botanical Society of Washington	Wilbur D. McClellan
Society of American Foresters	Harry A. Fowells
Washington Society of Engineers	Martin A. Mason
Institute of Electrical and Electronics Engineers	Delegate not appointed
American Society of Mechanical Engineers	William G. Allen
Helminthological Society of Washington	Doys A. Shorb
American Society for Microbiology	Frank Hettrick
Society of American Military Engineers	Delegate not appointed
American Society of Civil Engineers	Thorndike Saville, Jr.
Society for Experimental Biology and Medicine	Falconer Smith
American Society for Metals	Hugh L. Logan
International Association for Dental Research	George Dickson
American Institute of Aeronautics and Astronautics	A. W. Betts
American Meteorological Society	J. Murray Mitchell, Jr.
Insecticide Society of Washington	Robert A. Fulton
Acoustical Society of America	Malcolm C. Henderson
American Nuclear Society	George L. Weil
Institute of Food Technologists	Richard P. Farrow
American Ceramic Society	J. J. Diamond
Electrochemical Society	Kurt H. Stern

* Delegates continue in office until new selections are made by the respective affiliated societies.

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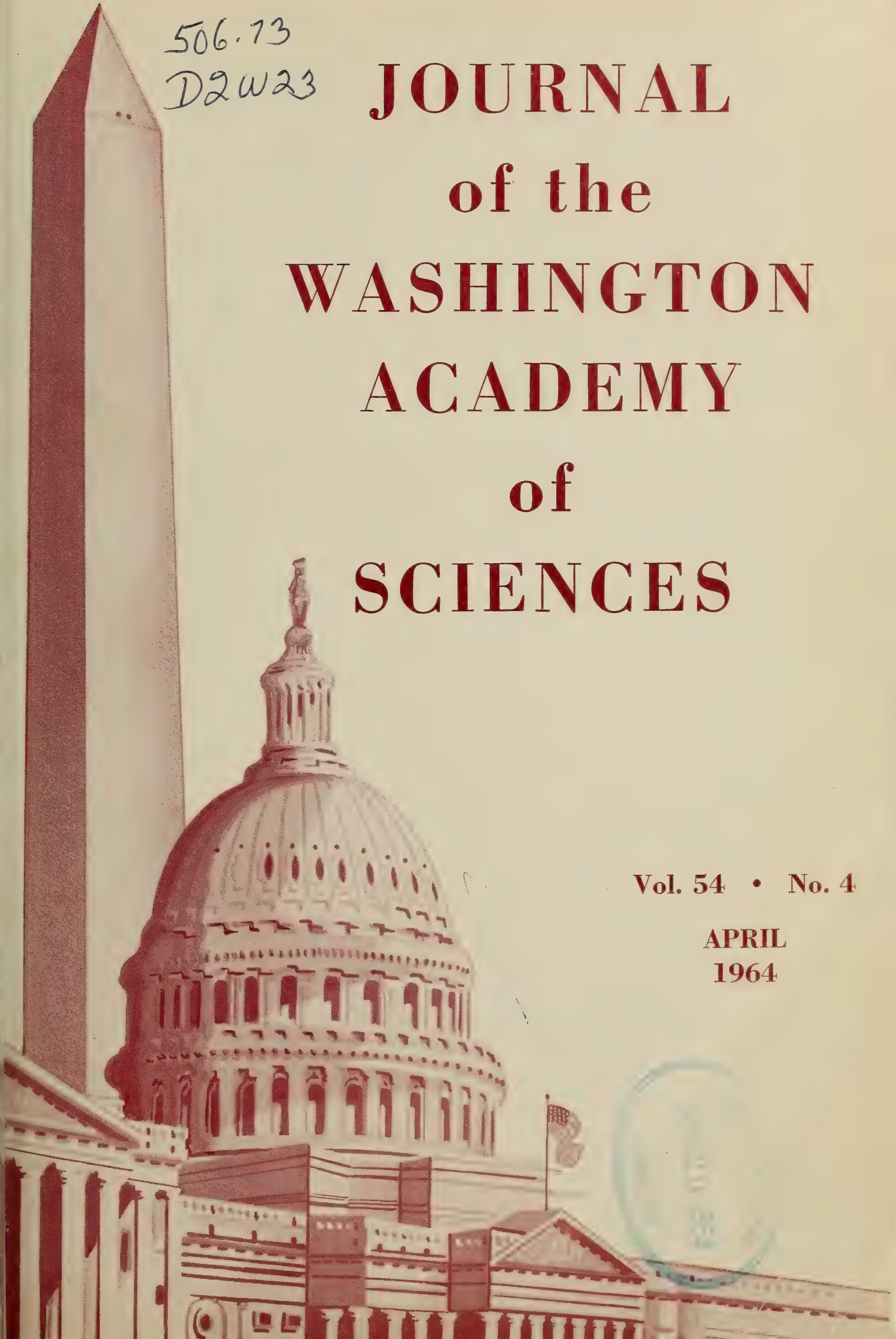

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APRIL
1964

This Journal, the official organ of the Washington Academy of Sciences, publishes historical articles, critical reviews, and scholarly scientific articles; notices of meetings and abstract proceedings of meetings of the Academy and its affiliated societies; and regional news items, including personal news, of interest to the entire membership. The Journal appears nine times a year, in January to May and September to December. It is included in the dues of all active members and fellows.

Subscription rate to non-members: $7.50 per year (U.S.) or $1.00 per copy; foreign postage extra. Subscription orders should be sent to the Washington Academy of Sciences, 1530 P St., N.W., Washington, D.C. Remittances should be made payable to "Washington Academy of Sciences."

Back issues, volumes, and sets of the Journal can be purchased direct from the Johnson Reprint Corporation, 111 5th Avenue, New York 3, N.Y. This firm also handles the sale of the Proceedings of the Academy (Volumes 1-13, 1898-1910), the Index, and the Monograph.

Current issues of the Journal (past two calendar years) may still be obtained directly from the Academy office at 1530 P Street, N.W., Washington 5, D.C.

Claims for missing numbers will not be allowed if received more than 60 days after date of mailing plus time normally required for postal delivery and claim. No claims will be allowed because of failure to notify the Academy of a change of address.

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American Society for Microbiology Holds Annual Meeting Here

The Washington Branch of the American Society for Microbiology will be host for the 64th annual meeting of the national society, to be held at the Sheraton-Park and Shoreham hotels, May 3 to 7. Expectations are that this will be the largest meeting in the history of the Society, with an estimated attendance of more than 4,000 microbiologists.

Registrants will have an opportunity to attend their choice of 10 symposia, 14 or more round tables, and 77 sessions in which a total of approximately 750 short scientific papers will be given. The "paper sessions" cover a wide range of subjects, including Metabolic Control Mechanisms, Protoplasts and L-Forms, Genetics, Industrial Fermentation, Aquatic Microbiology, Mycology, Viruses and Tumors, and Immunological Reactions. The titles and conveners of symposia and scheduled round tables are as follows:

Symposia	*Convener*
Information Retrieval and Documentation	Harold W. Batchelor, Fort Detrick
Mechanisms of DNA Replication and Recombination	Edward A. Adelberg, Yale University
History of Microbiology	R. N. Doetsch, University of Maryland
The Fine Structure and Replication of Bacteria and Their Parts	Roger M. Cole, National Institutes of Health
Papova Viruses	Karl Habel, National Institutes of Health
Current Research in Medical Mycology	Charlotte C. Campbell, Harvard School of Public Health
The Enterococci	C. F. Niven, Jr., University of Chicago
Microbial Insecticides	Harlow H. Hall, Department of Agriculture

Round Tables	*Convener*
Current Trends in Diagnostic Microbiology	A. Balows, University of Kentucky
Proposed Changes for the 12th Edition of Standard Methods for the Examination of Dairy Products	William G. Walter, Montana State College J. C. McCaffrey, Illinois Department of Health F. E. Nelson, University of Arizona
Antiseptics and Disinfectants	Paul A. Wolf, Dow Chemical Co.
The Anaerobic and Microaerophilic Microflora of the Soil	L. E. Casida, Jr., Pennsylvania State University
Culture Collections and Their Documentation	William A. Clark, American Type Culture Collection
Application of Microbiology to Developing Nations	Martin Alexander, Cornell University
Pollution of Marine Waters	John J. A. McLaughlin, Haskins Laboratories and St. Francis College
Gaseous Sterilization	Robert R. Ernst, Wilmot Castle Co.
Current Problems in Meningococcal Meningitis	Michael Pelczar, University of Maryland
A Discussion on Microbial Contamination of Surfaces	Joseph J. McDade, Communicable Disease Center, HEW
Vitamins and Amino Acids	E. B. Ferrer, Upjohn Co.
The Anaerobic Spirochetes	Thomas A. Nevin, Communicable Disease Center, HEW
Antibiotic Residues in Tissues	Robert Hans, Parke, Davis and Co.
Laboratory Experiments and Demonstrations in Microbiology	L. S. McClung, Indiana University

An important special feature of the annual meetings is the Office of Naval Research Lecture, given by a prominent foreign microbiologist under the auspices of the Office of Naval Research. The lecture is regularly a part of the opening session on Sunday evening. This year the lecturer is R. R. Porter of the Wright-Fleming Institute of Microbiology, London. His subject will be "The Chemical Structure and Biological Activities of Antibodies."

Another special feature is the address of the Eli Lilly Award winner, on Monday evening. This award of $1,000 is given annually to a young microbiologist who has performed outstanding research in microbiology or immunology. The name of the winner will not be announced until the meeting.

A special round table on Laboratory Experiments and Demonstrations in Microbiology has been arranged for science teachers and high school and college students and will be held on Thursday morning. This session will be followed by a tour of the scientific exhibits and an opportunity to attend the Science Film Theater.

The Science Film Theater will be open every afternoon to show outstanding films ranging from "*Arthrobotrys conoides*, a Nematode-trapping Fungus," to "The Microscope: Design and Function." More than 100 scientific and commercial exhibits will be on display throughout the meeting.

Lest the microbiologists become saturated with scientific papers and discussions, arrangements have been made for tours to the American Type Culture Collection, the National Naval Medical Center, the National Institutes of Health, Walter Reed Army Institute of Research, a dairy processing plant, and the New York Yankees-Washington Senators baseball game. Since the meeting will be held at the time Washington is at its loveliest, many of the male members of the Society will probably bring their wives. These ladies have not been forgotten. Their special activities include a tour of Washington, with a White House appointment; a visit to historic Georgetown; and an embassy tour and tea.

Many details of the meeting are the special responsibility of the local committee on arrangements, under the leadership of Roy C. Dawson, general chairman, and Lloyd G. Herman, vice-chairman and treasurer. Committee members, with their responsibilities, are William L. Sulzbacher and John Alford, registration; Howard Reynolds, A. P. Dunnigan, and Thomas P. O'Barr, session rooms; Gabriel A. Castellano and Louis R. Heiss, commercial exhibits; Matthew Fusillo and Elizabeth J. Oswald, public relations; Mary Louise Robbins and Ruth G. Wittler, round tables; Donald Boyd and Judd Wilkins, scientific exhibits; William A. Clark and Rudolph Hugh, tours; Robert G. Coon and Frank Bradley, special meals; E. R. Kennedy and C. C. Cutchins, hotel reservations; Mrs. Donald Boyd, Mrs. Francis B. Gordon, and Mrs. Glenn G. Slocum, hostesses; Raymond N. Doetsch, history of bacteriology; Chester W. Emmons, president's reception; Glenn Slocum and L. R. Shelton, banquet; H. R. Curran, mixer; Richard Finkelstein and Earl Richardson, information; C. W. Bohrer and C. B. Denny, "Incubator."

American Type Culture Collection Presents Dedication Symposium

In conjunction with the annual meeting of the American Society for Microbiology, the American Type Culture Collection will hold a symposium on May 1 and 2 to celebrate the dedication of the first building designed specifically for the Collection.

Most of the events will take place at the Shoreham Hotel. The scientific sessions will be devoted to one general subject, "Stability in Dynamic Microbial Systems," divided into three specific subtopics, as follows: Bacteria, Fungi, and Protozoa (C. W. Emmons, convener); Viruses (R. L. Thompson, convener); and Cell Lines (W. F. Scherer, convener).

At the dedication dinner, R. E. Buchanan of Iowa State University will discuss the history and development of the American Type Culture Collection. C. B. van Niel of the Hopkins Marine Station also will speak, on a topic to be announced.

Dedication ceremonies will be held on Saturday afternoon, May 2, at the new building in Rockville, Md. The principal address will be given by Colin M. MacLeod of the Office of Science and Technology, Executive Office of the President.

History of the Washington Branch, American Society for Microbiology

Raymond N. Doetsch *

University of Maryland

The Washington Branch of the American Society for Microbiology was founded by a small group of bacteriologists, associated mainly with national governmental agencies, on January 17, 1917. It thereby shares with the Connecticut Valley Branch (initially designated the New Haven Branch) the honor of being oldest among local branches of the society.

Since its beginning 47 years ago, many internationally-known bacteriologists have served as officers. J. J. Kinyoun was the first elected president; and such pioneers as George W. McCoy, Charles Thom, Lore A. Rogers, S. H. Ayers, A. Parker Hitchens, Alice Evans, Sara Branham, Erwin F. Smith, and James M. Sherman, among many others, have served in various capacities.

Seven members of this branch have been elected national presidents, as follows: Erwin F. Smith (1906), J. J. Kinyoun (1909), Lore A. Rogers (1922), A. Parker Hitchens (1924), Alice C. Evans (1928), James M. Sherman (1937), and Charles C. Thom (1940). Previous national meetings of the society have been held in Washington, D. C., in 1902, 1911, 1917, 1924, and 1937.

* Chairman of the Committee on History of the Washington Branch, American Society for Microbiology.

WASHINGTON BRANCH, AMERICAN SOCIETY FOR MICROBIOLOGY

Organization for 1964

President	Francis B. Gordon	Naval Medical Research Institute
Vice President	Rudolph Hugh	George Washington University
Secretary	John A. Alford	Eastern Utilization R&D Division, Department of Agriculture
Treasurer	Marvin P. Bryant	Animal Husbandry Research Division, Department of Agriculture
Members-at-Large, Executive Committee	Lewis F. Affronti	George Washington University
	Donald H. Hunter	Walter Reed Army Institute of Research
	Viola Mae Young	National Institutes of Health
Councilor to the American Society for Microbiology	P. Arne Hansen	University of Maryland
Delegate to the Washington Academy of Sciences	Frank Hetrick	University of Maryland

Meetings

Regular meetings of the Society are held six times a year, on the fourth Tuesday of January, February, March, May, October, and November. The meetings are generally held in the Sternberg Auditorium of the Walter Reed Army Institute of Research. The November meeting is the annual business meeting and is usually preceded by the annual banquet. Other meetings are usually devoted to current business and presentation of scientific papers by members of the Society or invited speakers.

During its early years the Washington Branch met four times a year in the various government buildings in the city. The first secretary-treasurer, Lore A. Rogers, recorded 40 members in 1917. (Present-day membership is approximately 300.) The first scientific paper presented before the Washington Branch was given at its second meeting (March 15, 1917) by Erwin F. Smith. This paper, "illustrated with lantern slides," was entitled, "Newer Studies on Crown Gall Bacteria with Special Reference to Tumor Formation." The relation between gall formations and cancer had always intrigued Smith, and he wrote 40 papers on it during his lifetime.

Subsequently, a practice was begun whereby members of a given institution or bureau would be responsible for the scientific program at a given meeting. Thus, the fourth meeting (December 14, 1917) was the responsibility of the Microbiology Laboratory of the Bureau of Chemistry, the fifth (February 15, 1918) of the Hygienic Laboratory, and the sixth (April 5, 1918) of the Dairy Division, Bureau of Animal Industry. This practice was continued with few variations for some years, during which sessions of high scientific caliber were held.

Article II of the constitution of the Washington Branch, adopted on January 30, 1917, stated: "The object of this society shall be the promotion of the science of bacteriology, the bringing together of Washington bacteriologists, the demonstration and discussion of bacteriological information, and the consideration of subjects of common interest." This aim still remains foremost among the present-day membership.

In 1923 the Washington Branch became the 16th affiliate of the Washington Academy of Sciences.

Currently, the Washington Branch meets six times a year in the Sternberg Auditorium of the Walter Reed Army Institute of Research, in Washington. The membership is representative of all fields of microbiology; and because of this fact, the ever-changing, ever-advancing front of this discipline is constantly a reminder to them of Leeuwenhoek's exclamation: "Lieve God, wat zijnder al wonderen in soo een kleyn schepsel!"

A History of Microbiology In the Washington Area*

American Type Culture Collection

The need for the development of a national collection of microorganisms had long been recognized by the Society of American Bacteriologists. In 1911, under the leadership of C. E. A. Winslow, a "Bacteriological Collection and Bureau for the Distribution of Bacterial Cultures" was established at the American Museum of Natural History in New York City. In 1922 the Winslow Collection was temporarily housed in the Army Medical Museum at Washington, D.C., under the care of a group of local bacteriologists. In 1924 the National Research Council obtained a grant from the Rockefeller Foundation to make the Collection self-supporting. Two representatives each from the Society of American Bacteriologists and the McCormick Institute and one each from the American Phytopathological Society, the American Association of Pathologists and Bacteriologists, and the American Zoological Society were appointed to a Committee on Maintenance. In 1925 the Committee incorporated the Collection as a nonprofit scientific institution under the name "American Type Culture Collection" and transferred it to the John McCormick Institute for Infectious Diseases in Chicago, where it remained for 12 years. Ultimately the number of strains preserved at the McCormick Institute was about 1500; another 300 to 600 strains were available from a number of special collections.

Because of financial losses during the Depression, the McCormick Institute could no longer sponsor the collection, and the Committee accepted an offer of quarters from the Georgetown University School of Medicine in 1937. As the size of the Collection increased, the facilities at Georgetown became inadequate, and in 1947 the Collection was moved to 2029 M St., N.W. In 1956 the Collection was moved again to 2112 M St., the present quarters. Because of expansion to include the national repository and distribution center for animal cell lines in 1961, administrative and business offices were located at 1025 Connecticut Avenue. A

* Condensed from a 36-page brochure prepared by the Washington Branch, American Society for Microbiology, for distribution at the 64th annual meeting of the national society, May 3-7. The brochure is the work of the Committee on History of the local Branch, headed by Raymond N. Doetsch of the University of Maryland.

building fund drive, headed by R. D. Coghill, was initiated in 1960. The National Science Foundation, the National Institutes of Health, private industry, and other organizations responded so favorably that modern, permanent facilities are now located in the Washington-Rockville Industrial Park.

The "Committee on Maintenance" of 1924 became known as the Board of Trustees when the Constitution of the ATCC was formulated in 1947. The following comprise the current nominating societies represented on the Board: American Association of Immunologists, American Association of Pathologists and Bacteriologists, American Institute of Biological Sciences, American Phytopathological Society, American Society for Microbiology, American Society of Zoologists, Genetics Society of America, Mycological Society of America, and the National Academy of Sciences-National Research Council.

Many efforts have been expended to make the Collection self-supporting since the initial grant from the Rockefeller Foundation. Aid was given by the Society of American Bacteriologists, UNESCO, private industry, and the U.S. Public Health Service. The fee for cultures was substantially increased in 1948, and a large contribution was made to the Collection by commercial firms. Recent financial assistance has been obtained from the National Science Foundation, the National Institutes of Health, private industry, and several scientific societies.

By 1960 the activities of the Collection necessitated an administrative reorganization. The following departments, all responsible to a director, were established: bacteriology, mycology, virology, tissue culture, and information. The departments are supported by a Facilities Department and a Business Office.

Initially established as a repository and distribution center for bacteria, the American Type Culture Collection now contains extensive collections of bacteria and fungi, a large collection of viruses, and small collections of algae and protozoa. The ATCC also acts as the distributing agency for the Plant Virus Registry. Recently a substantial grant was obtained from the National Institutes of Health to establish a collection of animal cell lines.

The Viral and Rickettsial Registry was established in 1949 as a cooperative undertaking by a group of scientists engaged in the study of viral and rickettsial diseases. Its purpose is to ensure the continued existence of classical or reference strains and to provide an efficient means for their distribution. Anyone who deposits an agent in the Registry is required to supply documentation for the strain.

Because of the rapid increase in the use of cell cultures in many areas of biology and medicine in the past 10 years, Jerome T. Syverton of the University of Minnesota was asked in 1959 to organize a committee to establish a national animal cell culture collection to provide well characterized and contaminant-free cell lines for reference material in long-term studies. Aided by a grant from the National Cancer Institute, the ATCC established a repository for animal cell lines.

The American Type Culture Collection is developing a necessary program of service and research to provide scientists with the specimens they require.

Department of Agriculture

Dairy Products — Bacteriology has played an active role in research at the Dairy Products Laboratory for more than 60 years. Lore A. Rogers, chief from 1906 to 1942, was active in research on the bacteriology of milk and milk products, especially cheese. In 1937, he received the first Borden Award in Dairy Manufacturing. In 1962, at the age of 87, he received the second Distinguished Service Award of the American Dairy Science Association.

This laboratory was the scene of the classic work of W. M. Clark on pH and indicators in connection with studies on the colon-aerogenes group, bacterial media, and cheese. The early classic work of Alice C. Evans on *Brucella abortus* was also done here. Long-range studies have been done by L. A. Burkey on Swiss cheese starters and the bacteriology of Swiss cheese, and on the bacteriology of bovine mastitis; H. R. Curran on effects of nutritional and environmental factors on formation and germination of bacterial spores with emphasis on their thermal resistance; W. T. Johnston on bacterial flora of milk, milk sanitation, and the microbiology of Swiss and Blue cheeses; M. Rogosa on the bacteriology of Swiss cheese and bovine mastitis (with L. A. Burkey), the taxonomy of the lactobacilli (with R. P. Tittsler), and the vitamin and mineral requirements of lactobacilli; R. P. Tittsler on effects of environmental factors on *Propionibacterium*, the taxonomy of lactobacilli, effect of temperature on growth of lactic cheese starters, and the bacteriology of Cheddar, Swiss, and Provolone cheeses; and R. E. Hargrove on effects of antibiotics on cheese starters, synthesis of vitamin B_{12} by *Propionibacterium*, composition of cheese starters, control of bacteriophage in cheese starters, cheese bacteriology, and development of a selective medium for *Leuconostoc*.

Plant and Soil Sciences—Work on plant diseases in the Department of Agriculture began in 1885 when F. Lamson-Scribner joined the Division of Botany as head and entire technical staff of the new Section of Mycology. Mycology, applied mycology, and plant pathology were then essentially synonymous; the early work was largely confined to plant diseases, all presumably due to parasitic fungi. The Section and the Division underwent various organizational changes through the years. The present Agricultural Research Service is composed of several divisions with microbiological interests. These include the Crops Research and the Soil and Water Conservation Research Divisions at the Plant Industry Station.

Early in the 1890's, Erwin F. Smith began research on bacteria as an important factor in plant pathology. His first paper dealt with the bacterial wilt of cucurbits and was followed by numerous publications on specific bacterial diseases, an exhaustive treatise in three volumes on "Bacteria in Relation to Plant Diseases," and his monumental work on crown gall (plant cancer). In 1897, a polemic developed with Alfred Fischer of Berlin University on occurrence of bacterial diseases. Smith won his case and established his world leadership in bacterial pathology.

The Bureau of Plant Industry was formed in 1901. Miss Charles, C. L. Shear, and B. O. Dodge worked out the polymorphism of a bread mold, *Monilia sitophila*, the conidial stage of *Neurospora sitophila*. The Laboratory of Soil Bacteriology and Water Purification was established in 1904, mainly to develop methods for producing legume bacteria and field inoculation of legumes. When K. F. Kellerman was made chief in 1907, work was broadened to include pioneer studies on cellulose-decomposing bacteria in soil, their identification and classification. Felix Löhnis joined this laboratory in 1914, the year Kellerman started the Journal of Agricultural Research, and became chief in 1923.

In 1904, Charles Thom was appointed mycologist at Storrs Experiment Station, Connecticut. After studies in Europe on ripening cheeses by molds, he isolated and described *Penicillium camemberti* and *P. roqueforti* from imported cheeses. Later he straightened out the confusion in the literature about the penicillia and aspergilli. In 1914 he moved to Washington and was joined by Currie, Church, and others. They conducted a long series of studies on aspergilli and penicillia, some of which led to important industrial fermentations—citric acid, oxalic acid, etc. Thom became the world's undisputed authority on *Aspergillus* and *Penicillium* and the *Aspergillus glaucus* group. He correctly identified Fleming's mold as *Penicillium notatum*. When the Bureau of Chemistry and Soils was formed in 1928, he was made chief of soil microbiology.

Francis Clark did outstanding early work on the biological control of plant diseases, especially cotton root rot, by green manures. F. E. Allison, S. R. Hoover, and D. Burk (1933) isolated a vitamin they called coenzyme R. Almost simultaneously two other laboratories independently isolated growth factors called "biotin" and "vitamin H." The three substances were later shown to be the same and are now all called biotin. Dean Burk and H. Lineweaver did pioneer research on the biochemistry of *Azotobacter* and its mechanism of nitrogen fixation. L. A. Pinck and associates showed how clay minerals in soils adsorb and inactivate organic substances. Charles Drechsler, making observations on fungi habitually parasitizing resting oospores in old isolation plate cultures, encountered numerous related clampless hyphomycetes that subsist through capture of nematodes, often intermingled with conidial phycomycetes that were destructive mainly to rhizopods. The 75 members of this new Order of Zygomycetes (the Zoopogales), the 25 species he described in the Pythiales, and the 25 new species of the Entomophorales represent a substantial portion (about 11 percent) of all the lower fungi now known.

Food and Drug Administration

In 1907, under Harvey W. Wiley, the Bureau of Chemistry of the Department of Agriculture was given the job of enforcing the first general Food and Drug Act. The earliest bacteriological investigation recorded concerned causes of spoilage and the use of preservatives in canned food products. At about the same time, the water supply of Roanoke, Va., was studied in an effort to combat an epidemic of typhoid fever.

Over 400 organisms isolated from various sources were identified and many chemicals were evaluated as germicides. Some work was also done on sterility of dressings, bandages, pads, ligatures, gauzes, etc. In 1909 extensive bacteriological investigation of shellfish and the shellfish industry was begun, and a pharmacological laboratory was set up, as well as facilities for microchemical and bacteriochemical work. In 1913 a microbiological laboratory was established, with Charles Thom as head, and extensive research and control operations in food microbiology were conducted. Work was expanded in food sanitation and food poisoning, e.g., studies of shellfish from polluted water as a source of typhoid fever and other enteric disease and studies of *Clostridium botulinum* in commercial and home-canned food. Stewart Koser explored the metabolism of coliform organisms and established the basis for distinguishing *E. coli* from other members of the group.

The Food and Drug Administration later became a new, separate bureau of USDA and still later was transferred to the Federal Security Agency, now the Department of Health, Education, and Welfare. The Bacteriological Laboratory, under A. C. Hunter, was made a branch of Division of Food. Attention was focused on food spoilage, food poisoning, and bacteriological aspects of food plant sanitation. Work was renewed on sterility control of drug products and on sutures and surgical dressings. A separate laboratory in the Insecticide Division evaluated products represented as antiseptics and disinfectants. In 1939 all bacteriological activities were consolidated in a separate Division of Bacteriology under Dr. Hunter. This division merged with the Microanalytical Division in 1945 to form the Division of Microbiology, now directed by G. G. Slocum.

Following the Food, Drug, and Cosmetic Act of 1938, a new division, directed by Henry Welch, was established to deal with regulatory control of penicillin and later of other antibiotics. This group keeps a constant check on potency, toxicity, sterility, pyrogenicity, and other requirements of all antibiotics that come under the certification program.

National Canners Association

The National Canners Association was founded in February 1907 with its first headquarters at Bel Air, Md. In 1909 a modest laboratory was set up and R. S. Page was retained to investigate the claims of food poisoning that were becoming prevalent. Dr. Page studied hundreds of cases of illness reported to be due to canned foods and showed that canned foods rarely were the cause of food poisoning.

The NCA now maintains three laboratories: one in Washington, D.C. at 1133 20th St., N.W.; one in Berkeley, Calif., which began as a Western Branch Laboratory in San Francisco in 1926; and the Northwest Laboratory established in Seattle in 1919 principally for the salmon industry. I. I. Somers is now Director of Research for all three. C. A. Greenleaf is Associate Director at Washington, C. T. Townsend is Associate Director at Berkeley, and W. V. Yonker is manager of the Northwest Laboratory.

The first major bacteriological program was concerned with isolating and identifying canned food spoilage organisms and determining the heat resistance of their spores. Food poisoning by *Clostridium botulinum* was a great threat to the canning industry between 1918 and 1924. The basic knowledge to control it was acquired in 1925. Methods developed in the NCA Research Laboratories were fundamental to the investigation and helped solve the problem faster.

Under E. J. Cameron, the Washington laboratory investigated spoilage causes and their elimination. In 1926, Cameron inaugurated the field laboratory to investigate sources of contamination within the canning plant itself. In 1945, NCA developed a program for the U.S. Army Quartermaster Corps personnel assigned to three Army mobile laboratories housed in large trailer trucks and subsequently cooperated in operating the mobile truck laboratories in several states. In 1947, a fully equipped laboratory was installed in a 24-ft. house trailer, and bacteriological studies of canning operations were conducted from Minnesota to Florida.

In 1952 the feasibility of cold sterilization of foods was investigated. Early studies indicated that *Cl. botulinum* was the most resistant to gamma radiation of all spoilage organisms, almost completely reversing the phenomenon noted in heat sterilization. The Army Quartermaster Corps contracted with NCA for a detailed study of sterilization requirements using high dosage rate sources, in collaboration with the American Can Company and the Continental Can Company. It was found that the doses required to destroy 10,000 spores per gram of product were great enough to adversely affect the quality of the product.

National Institutes of Health

The history of microbiology at NIH is made up largely of individual contributions. The following are a few of these contributions:

J. J. Kinyoun bacteriologically confirmed bubonic plague from cases during the San Francisco epidemic in 1900. G. W. McCoy isolated, identified, and cultivated the causative organism of tularemia, a plague-like disease. Edward Francis demonstrated that it is transmitted to humans from infected wild rabbits, either through vectors or by direct contact. R. E. Dyer, by recovering typhus organism from fleas on rats trapped in areas where typhus cases had been reported, demonstrated the source of typhus and its mode of transmission. With Kenneth Maxcy, Lucius Badger, Adolph Reureich, and William Workman he helped to clarify the confusion between typhus and Rocky Mountain Spotted Fever. R. R. Spencer and R. R. Parker perfected a vaccine against the latter. Ida Bengtson was first to cultivate the rickettsia of Rocky Mountain Spotted Fever and the virus of lymphocytic choriomeningitis in developing chick embryos. She also cultured the rickettsiae of endemic and epidemic typhus fever in tissue culture.

Charles Armstrong was the first successfully to transmit poliomyelitis virus to a small laboratory animal (1939). When he returned from assisting J. P. Leake to investigate the St. Louis outbreak of encephalitis in 1933, he brought back samples of brain tissue from fatal cases, from one of which he isolated a new virus. He gave the first description of the agent, which he named *Lymphocytic choriomeningitis* virus.

Alice C. Evans showed that raw milk from infected cows is a common source of human brucellosis. She served on the Committee on Infectious Abortion of the NRC from 1925 to 1930 and was president of the Society of American Bacteriologists in 1928.

M. J. Rosenau and J. F. Anderson pioneered in studies of anaphylaxis. Dr. Anderson and W. H. Frost were first to demonstrate that the serum of normal adults contains neutralizing antibodies to poliomyelitis. Karl Habel developed a test with laboratory animals to establish a workable standard for potency of rabies vaccine. He improved the method of killing the rabies virus in the vaccine by using ultraviolet irradiation instead of phenol. With J. A. Bell and associates, he confirmed that the paralytic factor in vaccine is caused by introduction of foreign brain tissue. Leon Jacobs was first to succeed in recovering the *Toxoplasma* parasite from a human eye in a collaborative study with Walter Reed Hospital. Sara Branham provided information on meningococci that made possible the development of a classification system for their identification and differentiation. Her research made it clear that meningococcal epidemics are caused by one particular serological group.

Naval Medical Research Institute

Laboratories for bacteriological and virological research at the Naval Medical Research Institute were completed in February 1943. Early investigations included treatment and control of streptococcal and diarrheal diseases. A section for study of prevention and therapy of tropical diseases gradually developed; a major study was concerned with rickettsial disease, particularly scrub typhus. After World War II, divisions of bacteriology, parasitology, and virology were formed.

Commander L. A. Barnes (now Captain) was head of the Bacteriology Division from 1946 to 1955. A field trial of the efficacy of monovalent parenteral and oral vaccines composed of *Shigella flexneri 3* was conducted during this period. Also, R. A. Nelson evaluated the treponemal immobilization test on a large scale and later reported on the immune-adherence phenomenon. Captain Barnes was succeeded by Cmdr. T. M. Floyd (now Captain). Investigation centered around the nutrition of *Shigella flexneri* and the search for a suitable laboratory animal for pathogenesis study. Recently the bacteriologic aspects of habitability tests in fall-out shelters have been studied. The Navy's Salmonella Typing Center (expanded to include other enteric pathogens) was transferred to the Institute in 1946. The collection, now under the care of Mrs. M. C. Babcock, numbers more than 10,000 strains of enteric pathogens obtained from all parts of the world.

C. G. Huff was appointed head of the parasitological laboratories in 1947. Basic programs have been developed on malaria, schistosomiasis, filariasis, and insect vectors of disease. In 1958, Dr. Huff received the Distinguished Civilian Service Awards of the Department of the Navy and Department of Defense for his significant contributions to malaria studies. Research in schistosomiasis has been concerned with factors relating to larval penetration of the skin of the host and serological reactions against it. In entomology, the emphasis has been on bionomics, breeding and feeding habits, effects of gamma radiation of mosquitoes, and physiology of digestion of blood in mosquitoes.

General investigations of the Virology Division up to 1954 included scrub typhus, typhus fever, arboviruses, influenza viruses, tobacco mosaic virus, bacteriophage, poliomyelitis, measles, Newcastle disease, and lymphocytic choriomeningitis. Captain Herbert Hurlbut studied arthropod transmission of Japanese encephalitis virus and the susceptibility of a variety of arthropods to parenteral inoculation of many representative arboviruses. Lieutenant J. E. Banta revealed the capacity of several human cell lines to support growth of representative arboviruses. Commander N. B. Wiebenga extended this work with special emphasis on dengue 1 virus. Lieutenant Commander D. L. Walker studied factors influencing host-virus relationships, using Coxsackie and influenza viruses.

Since 1954, F. B. Gordon, head of the Division, and E. Weiss have been concerned mainly with the large viruses of the psittacosis-lymphogranuloma-trachoma (PLT) group and with the rickettsiae and related microorganisms. Dr. Gordon has studied drug resistant psittacosis strains and the production of strains with dual drug resistance from mixed cultures of singly resistant strains. Dr. Weiss has investigated metabolic activities of rickettsiae and related microorganisms, including the development of strains of *Rickettsia prowazekii* with increased resistance to *p*-aminobenzoic acid, erythromycin, and chloramphenicol. V. L. Blackford investigated the influence of various metabolites on the growth of *Coxiella burnetii* in tissue culture. Weiss and Suitor, collaborating with W. F. Myers of the Department of Bacteriology of the University of Maryland Medical School and with E. M. Neptune, Jr., of the Institute, studied the metabolic activities of *Wolbachia persica* paralleling those of rickettsiae.

In July 1962, the Division of Bacteriology and the Division of Virology were combined and are now known as the Department of Microbiology, with F. B. Gordon as director.

Universities

American University has been expanding its bacteriology program rapidly in recent years. General bacteriology was first taught to nine students in 1930. The next 25 years saw little change—in 1955, Martha Sager taught the course to only seven students in a basement laboratory. Starting in 1957 she also taught an advanced course, stressing soil and industrial microbiology. General bacteriology is now taught to about 40 full-time students, with a night section for part-time students. Advanced courses in pathogenic bacteriology and immunology, bacterial genetics, and virology are now offered. The first M.S. degrees with a major in bacteriology were granted in 1963. Present research deals mainly with bacteriophage studies, particularly of staphylococci.

Catholic University has offered bacteriology as a formal course for 50 years. G. T. Brilmyer joined the Biology Department in 1914 and introduced bacteriology as an undergraduate course, with orientation toward medicine. Emphasis gradually shifted from etiological agents of disease to the biology of microorganisms after W. F. Simpson joined the staff in 1922. Simpson was interested in bacterial mutants, culture methods of *Endamoeba*, and the sterile culture of larval nematodes. Interest in research was greatly stimulated by E. G. Reinhard, an invertebrate zoologist who succeeded J. B. Parker, an entomologist, as head of the Biology Department in 1940. The first doctorate in biology was granted in 1915; the earliest bacteriological dissertation appeared in 1926. In the early 1940's, the popularity of graduate study of microbiology increased markedly, and it is now a major field of study in the Department.

At *George Washington University*, microbiology became an independent department in the fall of 1932, when the Department of Bacteriology, Hygiene, and Preventive Medicine was formed. The Department is now known simply as Microbiology since an independent Department of Preventive Medicine was established in 1962. In the early days of the University, Major Walter Reed, while curator of the Army Medical Museum and professor of bacteriology of the Army Medical School, taught pathology and bacteriology at GWU from 1901 to 1907, assisted by his associate, James Carroll. Surgeon-General of the Army G. M. Sternberg, a member of the first Yellow Fever Commission sent to Cuba, was professor of preventive medicine in the School of Medicine from 1906 to 1916. His text on bacteriology was well known. Since 1932, 43 Ph.D. degrees and 72 master's degrees have been granted in this field. Course work offered by the Department has increased from eight courses in 1932-33 to the current 13. All are graduate or medical school courses, except one course in general microbiology.

No history of microbiology at GWU would be complete without a word about the man who led the Department for 20 years. Intensely and primarily interested in medical and graduate education, L. W. Parr was a devoted teacher, a wise and friendly counselor to students and staff members, and an active participant in professional activities. For four and one-half years he was national secretary-treasurer of the Society of American Bacteriologists.

At *Georgetown University*, bacteriology was apparently taught for the first time at the School of Medicine in 1892. The course, consisting of lectures, demonstrations, and laboratory work on bacteriology, epidemiology, sanitary science, and public hygiene, was given to first and second year medical students. Second year students could also take a laboratory course on bacteriological investigation for diagnosis, given unassisted by one man, G. M. Kober. Dr. Kober received his M.D. degree from Georgetown Medical School in 1873, was appointed an acting assistant surgeon of the Army and sent to the West Coast, and remained in the Army until 1888 when he established himself in Washington. He soon became connected with Georgetown Hospital, and was pre-eminent in building up the Georgetown Medical School, of which he was dean from 1900 to 1929. In 1890, Dr. Kober suggested that pollution of the water of the Potomac was a factor in the prevalence of typhoid fever in Washington. In 1895, at the request of the health officers and the District commissioners, he investigated the causes of typhoid fever in Washington and was the first to point out the role of flies as vectors.

In 1894 the bacteriology course was renamed "Special Pathology and Bacteriology" and later "General Pathology and Bacteriology." More emphasis was given to infectious diseases, their etiology, pathology, and prophylaxis. In 1930, Bacteriology and Parasitology became a separate department called Bacteriology and Preventive Medicine, comprising bacteriology, immunology, mycology, protozoology, and parasitology. The Department is now headed by R. E. Ritts, who received his M.D. from George Washington School of Medicine. His particular interest is immunology.

Howard University began the first session of the four-year curriculum for the medical degree on October 1, 1894. Bacteriology and pathological histology were taught in the third year. W. W. Alleger was head of the department from 1894 to 1910; M. W. Lyons from 1910 to 1915; R. D. Adams, E. R. Whitmore, and

E. S. Keener, respectively, from 1916 to 1922; and A. B. Jackson from 1923 to 1931. Dr. Jackson's successor was H. A. Poindexter, who served from 1931 to 1949. During this time, he instituted many changes in the program: student group problems, student and staff research and department seminars. His interests ranged from protozoal infections to health surveys of Negroes in the rural areas of the Southern States. When Dr. Poindexter entered the Medical Corps of the U.S. Army in 1943, P. S. Cornely became head and continued until his appointment as medical director of Freedman's Hospital in 1947. Dr. Cornely's interests were primarily in public health and medical education. Ruth E. Moore was acting head of the department until 1949, when she became head. In 1958 she was succeeded by C. W. Buggs. The new basic science building was completed and occupied in 1956. The same year Preventive Medicine and Public Health became a separate department. The name was changed to Microbiology in 1957.

In the early days of the *University of Maryland*, bacteriology was under the Department of Veterinary Science. After World War I, course offerings were expanded. Graduate research was encouraged and seminars and several specialized courses were instituted. In 1922, the Department of Bacteriology and Sanitation was organized. Bacteriology was separated from veterinary science in 1930, and L. A. Black, the first faculty member with a doctorate in bacteriology, was appointed associate professor. In 1931, the first doctorate was awarded to W. G. Malcolm, now president of the American Cyanamid Company. L. H. James served as chairman of the department until 1944 and O. N. Allen until 1946. The present chairman is J. E. Faber. Since 1931, the Department of Microbiology (as it has been designated since 1959) has awarded over 100 doctoral degrees and has gained international recognition. Its primary aim is the discovery and dissemination of basic information on the biology of bacteria and related microorganisms.

Walter Reed Army Institute of Research

Surgeon-General George M. Sternberg, founder of the Army Medical School, pioneered in bacteriology. Early milestones were F. F. Russell's development of a typhoid immunizing agent and its first use on a massive scale in 1911; C. F. Craig's extensive studies on tropical diseases; J. S. Simmon's research on dengue fever, malaria, and St. Louis encephalitis; E. B. Vedder's demonstrations that emetine was the therapy for amebiasis and that including rice grain husks in the diet prevented beriberi; and R. A. Kelser's development of immunizing agents for rinderpest and rabies. Captain C. R. Darnall, a 1910 faculty member, originated the chlorine method of purifying water and developed a mechanical liquid chlorine water purifier. Health and medical problems of World War I increased the projects in preventive medicine, control of communicable diseases, and manufacture of biologic products. F. G. Blake and Russell Cecil produced and studied experimental pneumonia in monkeys.

Equine encephalomyelitis became virtually non-existent in the military after Col. Raymond Randall, a Veterinary School officer, developed a vaccine in 1939. Major F. E. Rodriguez, Army Dental School, was first to isolate strains of lactobacilli from carious teeth and to emphasize their importance in dental caries. That not a single soldier in World War II died of typhoid may be credited to the school and to Col. J. F. Siler's development of a more potent typhoid vaccine in 1939. J. E. Smadel and associates demonstrated in 1949 that both scrub typhus and typhoid fever could be rapidly and effectively treated with chloramphenicol.

In April 1957, M. R. Hilleman of

WRAIR read a *New York Times* item reporting that 250,000 people in Hong Kong had been stricken by an epidemic of influenza. Suspicious of this high infection rate, Dr. Hillman obtained throat washings from the flu victims. Five round-the-clock working days later, he and his associates had isolated and identified a new influenza virus for which no antibodies were present in the body. Samples were dispatched to six drug companies in time to prepare, test, and produce a vaccine before Asian Flu could gain a serious hold in America.

Recent special projects of the Institute include the establishment, in 1956, of a germfree laboratory, fourth in the world. Here chicks, rats, and guinea pigs are brought to life and maintained in completely germ-free environments.

Studies on the Agent of Trachoma At Naval Medical Research Institute*

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The World Health Organization has estimated that more than 500 million people are afflicted with trachoma (1). The disease is seen especially in the Middle East, the Mediterranean area, parts of Africa, southern and southeast Asia, and parts of South America. Incidence of affected persons in different populations varies but may exceed 90 percent. In spite of the value of antibacterial drugs in treatment, control of trachoma has not been entirely successful due to the prolonged course of therapy needed, the occurrence of reinfection, and other social or economic factors in affected populations.

Laboratory investigation of trachoma entered a new phase following a report from China in 1957 by T'ang and his associates on the cultivation of the trachoma agent in the yolk sac of embryonated eggs. Confirmation from various parts of the world soon appeared, and infection of human volunteers with cultivated strains soon fulfilled Koch's third postulate. The availability of numerous strains of this microorganism, cultivable in yolk sacs, provided new tools for investigation. The result has been a great increase in the study of the epidemiology of trachoma, the nature of the etiologic agent, and renewed search for better methods of diagnosis and control.

The agent of trachoma, first recognized as cytoplasmic inclusions in infected conjunctival cells by Halberstaedter and von Prowazek in 1907, and the similar agent of inclusion conjunctivitis have recently been given the interim name "TRIC" agents to avoid the cumbersome longer names. The etiologic agents of lymphogranuloma venereum, and the numerous "psittacosis-like" strains from birds and mammals are closely related to the TRIC agents. The members of this large group have long been called viruses because

* From Bureau of Medicine and Surgery, Navy Department, Research Task MR005.09-1200.05. The opinions or assertions contained herein are the private ones of the writer and are not to be construed as official or reflecting the views of the Navy Department or the naval service at large.

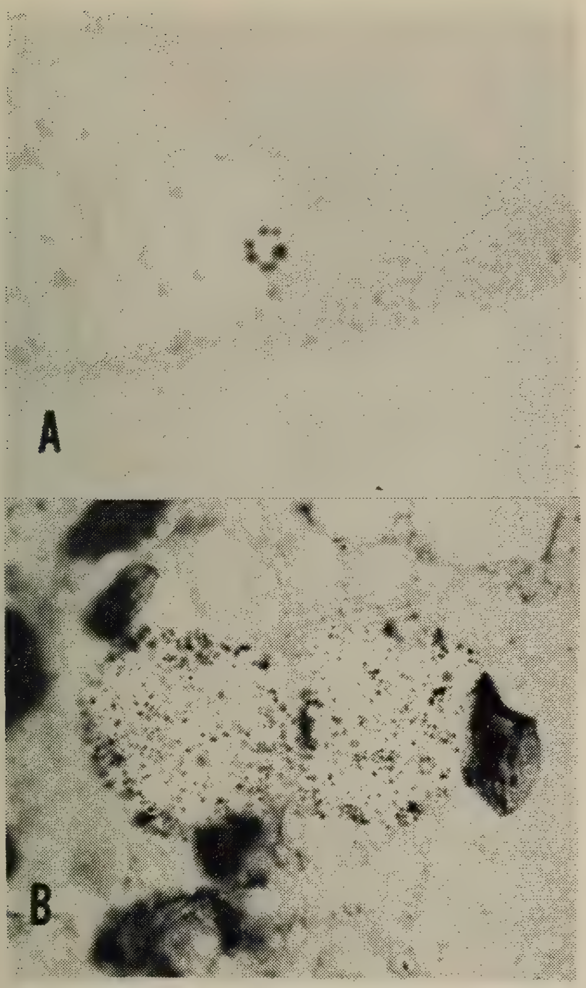

Fig.1. Strain TW-1 of trachoma agent, cultured in entodermal cells of chick embryo. May-Greenwald-Giemsa stain. A. Initial bodies 18 hours after inoculation. Approx. 1950 X. B. Two mature ovoid vesicles (inclusions) at 60 hours after inoculation. The darker bodies are host cell nuclei. Approx. 980 X.

of their small size (infectious particles being about 300 mu in diameter) and their dependence upon an intracellular environment for growth. Accumulating evidence in recent years, presented in a current review by Moulder (2), indicates that these agents possess the essential properties of bacteria and can no longer be called viruses. There is no consensus at present on suitable taxonomic terms, *Miyagawanella* and *Chlamydia* being the recommendations for generic names found in Bergey's Manual; others favor *Bedsonia* as a generic term (3) for some members of the broad psittacosis—lymphogranuloma venereum — trachoma (PLT) group.

Among the investigators who quickly went into trachomatous populations with the new laboratory tools was a group at Naval Medical Research Unit No. 2 at Taipei, Taiwan. They, and others, made available to us their early isolates. The remainder of the present communication will describe briefly the investigations performed in the past four years on trachoma and inclusion conjunctivitis (blennorrhea) strains, as well as psittacosis and related agents, at the Naval Medical Research Institute in Bethesda. What is reported here represents the contributions of a number of scientists and our supporting staff working on different aspects of the program. Individual identification with various phases of the work will be indicated principally by reference to publications (4).

Cultivation in Cell Monolayers. Our first efforts were directed toward cultivation of TRIC agents in cell cultures such as Weiss and Huang had used earlier for study of the feline pneumonitis agent. The cultures consisted of explants from the blastoderm of 4-day chick embryos, which form monolayers of large flat cells. Centrifugation of the inoculum onto monolayers was found (5) to increase the level of infection as much as two orders of magnitude, when determined by inclusion counts. By examining such preparations at intervals, the developmental cycle of the trachoma strains was observed (6) and seen to be similar in all essential characteristics to that of the previously described psittacosis cycle. Initial bodies, 500 mμ or greater in diameter, had formed small clusters by 18 hours. These increased in size by further multiplication of individual particles. Particles of smaller size began to appear and increased rapidly in number relative to the large particles, eventually forming at 48 to 72 hours a large, mature vesicle, the typical inclusion, composed mainly of elementary bodies. This sequence is illustrated in Figure 1.

All strains of TRIC agents appeared

essentially the same when studied by this technique, but a striking difference in morphology was seen when they were compared with strains of psittacosis, feline pneumonitis, and other avian and mammalian agents of this group. Figure 2 illustrates the irregular pattern made by the psittacosis inclusion and may be compared with Figure 1 where the much more rigid trachoma inclusion is illustrated. An additional difference can be seen in this and other types of infected cell cultures when the inclusions are stained with lugol's solution or with periodic acid—Schiff's reagent (PAS). The TRIC inclusions contain glycogen or a glycogen-like material which stains differentially with these reagents. This is also true of isolates of lymphogranuloma venereum, inclusion conjunctivitis, and two strains derived from rodents, but glycogen was not found in the inclusions of many other PLT strains. Glycogen first appears on the second day after cells are infected, reaches its peak at about 48 hours, and tends to fade and disappear on the third and fourth days, coincident with maturation of the inclusion body. It is demonstrable in many varieties of host cell, and in our hands its presence or absence has been governed entirely by the strain of infective agent. This suggests that its formation is the result of activity of the intracellular agent rather than the host cell and may be a valid character for a taxonomic subdivision of the PLT group.

The comparative susceptibility of a number of cell strains in comparison with chick embryo entoderm was studied. The TRIC agents are obviously not fastidious as to host cells since inclusions were obtained in many types of cells tested by us and others, including chicken, rabbit, mouse, monkey, and human. The McCoy cell line, first used for PLT agents by Morris Pollard, proved to be especially suitable and has been extensively used in our laboratory. Intracellular growth of these agents, as measured by numbers or size of inclusions, is readily influenced by

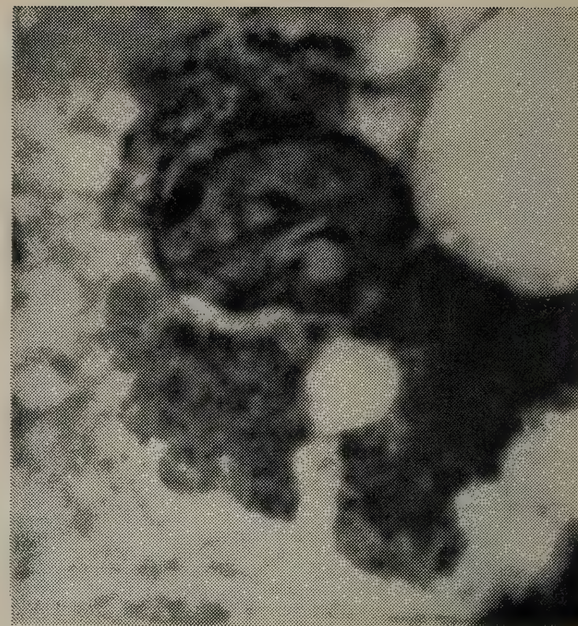

Fig. 2. Feline pneumonitis agent 48 hours after inoculation of entodermal cells of chick embryo. Irregular inclusions are seen surrounding the host cell nucleus. May-Greenwald-Giemsa stain. Approx. 1950 X.

factors in the environment. Increasing the level of glucose in the cell culture medium from the usual 5.6 mmoles (0.1 percent) by addition of 30 mmoles increased the number of inclusions produced and the infective titer of the harvest obtained (7). The temperature of incubation directly affected the size of the inclusion. An incubation temperature of 32° instead of the usual 35° produced a smaller inclusion, presumably by decreasing the rate of growth. Reduction in the concentration of horse serum in the medium to 1 percent similarly reduced the average size of the inclusions from that seen with 10 percent horse serum. Our standard culture medium is now composed of Eagle's minimal medium with vitamin and glutamine supplement, with 10 percent horse serum, and with an added 30 mmoles of glucose. McCoy cell monolayers are grown on coverslips in flat-bottomed tubes to allow centrifugation of the inoculum onto the cells.

Most strains of TRIC agents produce only a single developmental cycle in a cell culture inoculated in the usual manner with dilute emulsions of infected yolk sac tissue or with partially purified preparations. That is, few or no host cells are infected by elementary bodies spontaneously released from first cycle inclusions. Nevertheless, infection is readily detected by observing stained inclusions, and quantitation is accomplished by counting the number of inclusions in a unit area of the coverslip.

Although progressive infection of cell cultures ordinarily does not occur, as mentioned above, mechanical breaking of infected cells in a sonic oscillator, or in some cases by forceful pipetting, will release infective particles so that passage in cell culture can be effected. With two strains, TE-55 and MRC-1/G, the latter from inclusion blennorrhea, and both especially amenable to passage, we were able to maintain chronically infected flask cultures over a period of many months. Reinfection of fresh host cells was encouraged by suspending and resetting the infected cultures at frequent intervals to break up infected cells and release elementary bodies. After two or three such suspendings and resettings, almost all of the cells of the culture would be infected and the culture thereby destroyed, but we prevented this by lowering the temperature of incubation to 32°. When this occurred, the cells grew faster than the intracellular agent and shifted the equilibrium in favor of the cells. By alternating a culture between 35° and 32° and suspending and resetting at appropriate intervals, the infection could be encouraged or retarded and the culture could be carried indefinitely (8). At each suspending, a portion of the culture was removed and stored. By this means large quantities of cell culture grown agents were harvested and used in immunologic studies to be described below.

Susceptibility of TRIC Strains to Chemotherapeutic Agents. One of the early bases for suspicion that the PLT agents were not true viruses was their susceptibility to sulfonamides (some strains) and to antibiotics. Our interest in this general subject has been concerned with the possible appearance of drug-resistant strains of these agents and whether drug-resistant TRIC strains can be produced in the laboratory as has been accomplished with lymphogranuloma venereum, psittacosis, mouse pneumonitis, and feline pneumonitis strains. We have also studied antibacterial agents for suppression of contaminating bacteria in yolk sac or cell cultures of these forms. Although the feline pneumonitis agent, meningopneumonitis, and others of the PLT group are naturally resistant to sulfonamides, TRIC agents are sensitive, and there has been no report of naturally-occurring sulfonamide-resistant TRIC strains. There has been one report, as yet unconfirmed, of the development in the laboratory of a sulfadiazine-resistant trachoma strain. We have made repeated attempts to induce sulfonamide and chlorotetracycline resistance in trachoma and inclusion conjunctivitis strains without success.

The antibacterial drugs that we tested against the TRIC agents are listed in Table 1 along with the results obtained (9). Ten-fold dilutions of virus with selected concentrations of drug were mixed and allowed to stand at room temperature for 30 minutes before inoculation into 12 eggs per dilution. A titer based upon embryo mortality was thus derived for the agent cultivated in the absence and in the presence of each level of drug. We found, as have others, that streptomycin can be used in high concentrations without adverse effect on TRIC agents. This is the drug used mainly for isolation of these agents from conjunctival specimens. Ristocetin also had no adverse effect at the concentrations used. Mycostatin in doses as great as 500 units per egg, and perhaps greater, is likewise suitable. Bacitracin showed no adverse effects on trachoma isolates in the concentrations used but some reduction in titer was observed in similar and

Table 1. Effect of selected antibiotics on yolk sac titrations of TRIC agents

Antibiotics	*Strains* TW-3	TE-55	Cal-2	Har-1	MRC-1/G
Streptomycin	$\geqq$10000 *	$\geqq$1000	$\geqq$1000	$\geqq$1000	$\geqq$1000
Bacitracin, mixed with inoculum	$\geqq$1000	$\geqq$500	$\geqq$500	$\geqq$500	<250
Bacitracin, separate inoculation into egg					$\geqq$1000
Ristocetin	$\geqq$2500	$\geqq$1000	$\geqq$1000	$\geqq$1000	$\geqq$1000
Mycostatin	500?				$\geqq$3000
Polymyxin B, mixed with inoculum	0.05				
Polymyxin B, separate inoculation into egg	$\geqq$50				

* Figures indicate highest antibiotic dose, in μg, showing no reduction in infectivity titer. In most instances no end-point was reached.

repeated tests with MRC-1/G. Whether this drug can be used to differentiate between strains within this group is not yet apparent. Another surface-active antibiotic, polymyxin B, exhibited a great adverse action on TW-3 when mixed *in vitro*. When similar or greater doses of bacitracin or polymyxin B were put into the egg *after* inoculation, no reduction in infectivity was apparent, indicating that the adverse effect was entirely *in vitro* before infection was established. The conclusions derived from the results depicted in Table 1 were confirmed in infected cell cultures.

As a result of these tests, we regularly employ ristocetin and streptomycin at 100 μg and 50 μg per ml, respectively, when antibacterial drugs are needed in the cultures.

Purification of Infectious Particles. The only satisfactory method of growing the TRIC agents in large numbers is to use the yolk sac of the embryonated egg. This culture medium has decided disadvantages if one wishes to purify a suspension of infectious particles. Nevertheless, a reasonable degree of purification can be obtained without undue inactivation by various modifications of methods first used for rickettsiae, and many satisfactory preparations have been used in our laboratory for various purposes. The method is to treat suspensions of infected yolk sacs with trypsin, 0.5 percent final solution, for 30 minutes at room temperature and then to use two or more cycles of high and low speeds of centrifugation. To this can be added a treatment with Celite or exposure to an anion exchanger for removing extraneous material.

With such preparations, factors influencing the stability of these agents were studied (10). It became apparent from these studies that these agents required some osmotic protection. The concentration of sucrose needed for optimal stability in some strains was as high as 0.4 M. The addition of bovine plasma albumin further increased stability to a level comparable to that of the crude yolk sac preparations. Although the stability of intracellular microorganisms is often greater in a diluent high in potassium rather than sodium ion (rickettsiae and some malarial parasites), this was not true of strain TW-3. This phenomenon can be explained by analogy with the effect of these ions on rickettsiae and on *Wolbachia persica*, which is also more stable in an environment of Na^+. Potassium ion stimulates the respiratory activity of both agents; nevertheless, active metabolism is associated with high stability of the infectivity of rickettsiae but more rapid decline of infectivity in the case of *W. persica.*

Metabolic Activity. The presence of glycogen or a glycogen-like substance in the inclusions of trachoma agents, with circumstantial evidence that this is produced as an activity of the microorganism rather than the host cell, directed attention to the possibility of a carbohydrate metabolism of these microorganisms. While Richard A. Ormsbee of the Rocky Mountain Laboratory, Hamilton, Mont., was a guest scientist in our laboratory, he and Emilio Weiss, using purified preparations, provided conclusive evidence for glucose utilization by purified suspensions (11). This was accomplished by incubating the suspensions with C^{14} glucose. When the CO_2 was examined, high radioactive counts were obtained when carbon 1 of the glucose had been labeled, but not from labeled carbon 6. Since then Dr. Weiss has demonstrated similar activity of other strains including those of the psittacosis group (12). These results are summarized in Table 2. The amount of glucose utilized, 0.2 to 0.3 μmole, was not sufficient to produce measurable manometric changes in the Warburg respirometer, and this explains the failure of previous investigators to demonstrate this phenomenon. These results represent the strongest evidence yet obtained that these agents are bacterium-like rather than virus-like.

Analysis of Infectious Particles. Suspensions of purified particles of TRIC agents, prepared as described above, were subjected to sonication in an attempt to provide fractions for antigenic and chemical analysis. Although the particles can be ruptured by treatment in a sonic oscillator under standard conditions after 1 to 2 hours of oscillation, it was found that this time could be reduced to 15 to 30 minutes if small glass beads were introduced into the suspension. By differential centrifugation of such sonicated preparations, it was possible to prepare two fractions arbitrarily termed "cell sap" and "cell walls." The cell walls could be visualized under the electron microscope as empty sacs not unlike the similarly prepared walls of bacterial cells (Figure 3). Chemical examination of the cell walls revealed only trace amounts of nucleic acids and gave total protein and carbohydrate values which agree closely with those shown by others for PLT agents.

Table 2. Metabolism of glucose by PLT agents

	CO_2 *produced from glucose carbons in positions:*			
	1	3,4	6	All
	(Micromoles per gram of agent protein)			
Psittacosis	84	N.D.*	0.5	322
Meningo-pneumonitis	54	N.D.	N.D.	N.D.
Feline pneumonitis	27	39	0.2	71
Mouse pneumonitis	64	N.D.	0.6	192
Trachoma	36	N.D.	0.2	96
Inclusion blennorrhea	41	4.7	0.2	95
Control uninfected yolk sac (four preparations)	0.8-1.3	N.D.	0.04-0.07	1.1-1.6

* Not done.

Serologic Studies. Limited observations with the fractions described above indicated that the group antigen common to the entire PLT group was present in both the cell sap and the cell walls. One of the objectives of this line of study is to provide a stable species-specific antigen that will allow the detection of antibodies formed as a result of trachoma infection and will not be reactive to antibodies formed against psittacosis infection. Such a reagent would be of great potential value in identifying trachoma. Although such antigens have at times been reported, their reproducibility has not been regular.

Immunologic relationships within the group were studied more extensively by means of the CF test, by Alexander L. Terzin who was on our staff during 1963 as a guest scientist (13). Antisera were prepared in rabbits using McCoy cell grown strains TE-55 and MRC-1/G. Such antisera can be used without difficulty against antigenic preparations derived from infected yolk sacs because of the absence of any common antigen, i.e., yolk sac, in the immunizing and test antigens. When these antisera were absorbed with boiled antigen preparations (mouse pneumonitis strain, mopn), the group antibody was easily removed leaving specific antibodies. By using such absorbed sera, the species-specific antigens distinguishing between the TRIC agents on the one hand and psittacosis antigens on the other hand were easily demonstrated by the CF test. Purified suspensions of elementary bodies, prepared as described above, were found to possess species-specific antigenic activity when used as complement fixing antigens against the absorbed rabbit antisera. Such antigens, although retaining their species-specific property for long periods, will still react with group antibody in nonabsorbed sera. They are useful, however, for detecting a specific antibody in sera from which group antibody has been absorbed by boiled antigen. These findings are illustrated in Table 3. Dr. Terzin made two additional findings of practical interest to persons performing CF tests with this group of agents. A number of preparations of guinea pig complement were found to contain anti-PLT antibodies (14). This was ascribed to probable unrecognized infection of the guinea pigs with a PLT agent. Since this finding, such an infection, causing spontaneous inclusion conjunctivitis in guinea pigs, has been described (15). A second interesting finding was the demonstration of an antigen common to normal yolk and

Fig. 3. Electron micrograph, 9875 X. Air-dried preparation, shadowed with chromium at an angle of 23°. Cell walls of trachoma strain Cal-1 following 10 minutes of sonication with glass beads. Two or more intact particles remain.

Table 3. Antibody titers in CF tests that demonstrated presence or absence of specific antigen in various preparations

Antisera	*Preparations with group antigen only*		*Preparations with both group and specific antigens (elementary body suspensions)*		
	Mopn, boiled	Psitt, ether extracted	MRC-1/G	TE-55	Psitt
MRC-1/G	128	128	64	256	128
MRC-1/G, absorbed *	<4	<4	8	16	<8
TE-55	1024	512	512	1024	—
TE-55, absorbed *	<16	<16	16	32	—

* Absorbed with group antigen (boiled Mopn).

to PLT agents (16). Various chemical and immunological manipulations provided evidence that this observation was not the result of a nonspecific or anticomplementary activity. It was clear that a similar substance from both sources was able to fix complement in the presence of anti-PLT antisera. The recognition of these two factors will increase the accuracy of CF tests with the PLT group and will provide explanations for occasional irregularities in such tests.

Table 4. Comparison of indirect hemagglutination with complement fixation tests using solubilized antigen; antiserum titration

Antigen	*Antiserum*			
	TE-55		Psitt. 6BC	
	I.H.	C.F.	I.H.	C.F.
TE-55 (trachoma)	2560	128	<5	128
Cal-2 (trachoma)	2560	256	<5	512
6BC (psittacosis)	<5	64	10	64

Another improvement in serologic methods with these agents was sought by means of indirect hemagglutination (IH) techniques. This study was initiated by Willie Turner while in this laboratory in 1962 as a guest scientist. Antisera were prepared in rabbits, as described above, using McCoy cell grown TE-55 and MRC-1/G. When sonicated preparations of suspended elementary bodies were absorbed onto tanned sheep erythrocytes, hemagglutination was observed with homologous antisera and to a less extent with the heterologous strain (17). These observations have since been confirmed by N. A. Vedros using other PLT strains. Table 4 shows representative results of comparisons between IH and CF tests. It is clear that the antigen detected by the CF tests is the commonly known group antigen, present in all members of the PLT group. Using the same antigenic preparation and antisera, IH tests detected antigens present in the trachoma strains, but not in the psittacosis strain, and vice versa. This technique is being further investigated to determine its usefulness with this group of agents.

Problem of Laboratory Diagnosis. Two procedures have been available for detection for the causative agent of trachoma in infected eyes, i.e., microscopic examination of direct smears and the inoculation of conjunctival scrapings into the yolk sac of embryonated eggs. The first method is time-consuming and far from 100 percent positive in clinically positive cases. The latter method is usually positive only during the acute stage, and although it has been used as a valuable research tool it is not satisfactory as a routine diagnostic procedure. Blind passages in yolk sacs are often needed before a specimen can be called negative and many weeks may be required to complete the test. Recently a report has appeared from another laboratory in which encouraging results were obtained with fluorescent antibody staining (18).

Because the sensitivity of cell cultures was found to compare favorably with the sensitivity of the egg for detecting high dilution of laboratory established trachoma strains, a study was undertaken to determine the potential usefulness of cell cultures for detecting the trachoma agent in infected eyes (19). Two monkeys were inoculated with strain Cal-1, originally isolated from a case of trachoma in California. Both monkeys developed conjunctivitis within a few days accompanied by the cardinal features of acute trachoma in man. Conjunctival specimens were obtained at frequent intervals after inoculation by means of washing the conjunctival sacs and by swabbing the tarsal conjunctiva with a cotton applicator. Table 5 summarizes in shortened form the results of our attempts to recover the agent in McCoy cells and in yolk sacs. Although not quite equal to the yolk sac in these tests, it appears that the cell culture method compares favorably and has the distinct advantage of giving results in a few days rather than the weeks required with the yolk sac method.

We had the opportunity to try the cell culture technique in a human infection following a laboratory accident (20). A hypodermic needle became separated from the syringe during intravenous inoculation of mice, and some of the inoculum, which was a 20 percent suspension of infected yolk sac material, splashed onto the face of a laboratory technician. Five days later the patient noted periods of slight irritation and itching in the right eye. The following day there was redness, itching, and some pain in both eyes. An acute bilateral conjunctivitis developed and the signs of acute trachoma appeared. On days 6, 7, and 8 smears were made in which trachoma inclusions were eventually found (days 6 and 7). On day 6, a specimen was taken on a sterile cotton applicator and transferred to tubes containing the McCoy cell culture medium. Cell cultures were inoculated in the usual manner and on day 8 inclusions in these cultures were demonstrated after staining with lugol's solution. Some of the material taken on day 6 also was inoculated into embryonated eggs. One embryo died on day 11 and the yolk smear showed the elementary bodies typical of trachoma. This experience encouraged us to consider cell cultures for examination of material taken from naturally-occurring cases of trachoma. Such a study is under way at present in which cell culture is directly compared with yolk sac. Although some positive results have been obtained, the investigation has not progressed sufficiently to provide a satisfactory comparison of these two methods for detecting naturally occurring trachoma infection.

Summary. Trachoma is still a serious health problem in many parts of the world. In recent years, satisfactory methods of cultivation of the etiologic agent have appeared, providing new approaches to long-standing problems. A brief review of investigations on the trachoma agent and related microorganisms, conducted at the Naval Medical Research Institute, has been presented. This has included cursory résumés of studies on growth in cell cultures, morphology, susceptibility to chemotherapeutic agents, purification, stability, metabolic activity, analysis of infectious particles, immunologic relations, and the problem of laboratory diagnosis.

Table 5. Comparison of cell culture (CC) and yolk sac of embryonated egg (YS) for detection of trachoma infection in experimentally infected monkeys

	No. of tests	*Both tests positive*	*CC positive, YS negative*
Monkey H	7	1	0
Monkey M	24	15	1
Totals	31	16	1

	CC negative, YS positive	*Both tests negative*
Monkey H	2	4
Monkey M	3	5
Totals	5	9

References and Notes

(1) Franceschetti, A. Eyes in danger at every age of life. World Health, March-April, 1962.

(2) Moulder, J. W. The psittacosis group as bacteria. John Wiley and Sons, Inc., New York, 1964.

(3) Meyer, K. F. Psittacosis group. Ann. N. Y Acad. Sci. *56*, 545 (1953).

(4) For sources of broader information, including background and recent investigations on trachoma, the following references are cited: Gordon, F. B., Ed. The biology of the trachoma agent. Ann. N. Y. Acad. Sci. *98*, 1 (1962); Bernkopf. H. Trachoma virus—recent developments. Prog. Med. Virol. *4*, 119 (1962).

(5) Weiss, E., and Dressler, H. R. Centrifugation of rickettsiae and viruses onto cells and its effect on infection. Proc. Soc. Exp. Biol. & Med. *103*, 691 (1960).

(6) Gordon, F. B., and Quan, A. L. Morphologic observations on trachoma virus in cell cultures. Science *131*, 733 (1960).

(7) Vedros, N. A., and Gordon, F. B. The influence of glucose concentration on growth of PLT viruses in McCoy cells. (abstr.) Bacteriol. Proc. (1963).

(8) Gordon, F. B., Quan, A. L., and Dressler, H. R. Observations on growth of trachoma strains in cell cultures. (abstr.) Bacteriol. Proc. (1963).

(9) Gordon, F. B., and Quan, A. L. Drug susceptibilities of the psittacosis and trachoma agents. Ann. N. Y. Acad. Sci. *98*, 261 (1962).

(10) Weiss, E., and Dressler, H. R. Investigation of the stability of the trachoma agent. Ann. N. Y. Acad. Sci. *98*, 250 (1962).

(11) Ormsbee, R. A., and Weiss, E. Trachoma agent: glucose utilization by purified suspensions. Science *142*, 1077 (1963).

(12) Weiss, E. Glucose metabolism by agents of the psittacosis-trachoma group. Virology (1964). *In press.*

(13) Terzin, A. L. Serological studies on group and species specific antigens of trachoma and inclusion conjunctivitis (TRIC) agents. J. Hyg. (1964). *In press.*

(14) Terzin, A. L. "False positive" complement fixation with psittacosis-trachoma antigens due to antibodies in complement preparations. J. Hyg. (1964). *In press.*

(15) Murray, E. S. Guinea pig inclusion conjunctivitis virus. I. Isolation and identification as a member of the psittacosis-lymphogranuloma trachoma group. J. Inf. Dis. *114*, 1 (1964).

(16) Terzin, A. L. Studies on a common bedsonia-group antigen (CBA) found in the yolk of hens' eggs. J. Immunol. (1964). *In press.*

(17) Turner, W., and Gordon, F. B. Indirect hemagglutination with the trachoma agent and related microorganisms. J. Bact. (1964). *In press.*

(18) Nichols, R. L., McComb, D. E., Haddad, N., and Murray, E. S. Studies on trachoma. II. Comparison of fluorescent antibody, Giemsa, and egg isolation methods for detection of trachoma virus in human conjunctival scrapings. Am. J. Trop. Med. & Hyg. *12*, 223 (1963).

(19) Gordon, F. B., Magruder, G. B., Quan, A. L., and Arm, H. G. Cell cultures for detection of trachoma virus from experimental simian infections. Proc. Soc. Exp. Biol. & Med. *112*, 236 (1963).

(20) Magruder, G. B., Gordon, F. B., Quan, A. L., and Dressler, H. R. Accidental human trachoma with rapid diagnosis by a cell culture technique. Arch. Ophthalmol. *69*, 300 (1963).

Potential Analytical Applications Of *Tetrahymena Pyriformis**

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Tetrahymena pyriformis was the first of the protozoa to be cultivated in completely defined media. The exhaustive investigations by the Amherst group, Kidder and Dewey and co-workers (1, 2), defined its absolute amino acid, vitamin and other growth factor requirements, and their observations were instrumental in revealing *a*-lipoic acid as a new member of the family of B-vitamins (3) and the final ingredient permitting assembly of a defined medium for its culture.

* Presented at a Panel on Vitamins and Amino Acids of the Analytical Microbiology Group, at the 63rd annual meeting of the American Society for Microbiology, held May 5-9, 1963 in Cleveland.

The observed nutritional requirements proved to be remarkably similar to those for mammals and birds; the similarity was especially striking in the requirement, by *T. pyriformis*, for the 10 amino acids essential for normal growth of the rat. In addition, serine, not an essential for mammals, is synthesized too slowly by most strains to permit normal growth without an exogenous supply. Among the B-vitamins, folic acid, nicotinamide, pantothenic acid, riboflavin, thiamine, B_6, and *a*-lipoic acid, the latter not a mammalian requirement, are essential. It differs from mammals and birds in requirements for exogenous supplies of guanine and pyrimidines and the absence of demonstrable requirements for biotin, choline, B_{12}, the fat-soluble vitamins, or lipid factors.

These biochemical characteristics presaged a useful future for *Tetrahymena* in the assay of nutrients and metabolites important in mammalian nutrition. Its refinement into an analytical tool for the assay of amino acids, purines, vitamins, and other growth factors was a primary objective of the early work of the Amherst group (4). This early promise has not come to fruition, and little effort has been directed toward the systematic exploitation of *Tetrahymena* as an analytical tool. Major obstacles to its routine use have been summarized by Hutner and coworkers (5) as: (a) the necessity for more rigorous control of microbiological techniques to maintain purity of cultures than is required in bacteriological assays, (b) carbohydrate sterilization, (c) requirements for aerobic growth conditions, and (d) low growth temperature maximum.

Assays with the usual, hardy, lactic acid bacteria are relatively immune to contamination because of their rapid, essentially anaerobic growth and the high rate of acid production which quickly drops the pH to levels inhibitory to ordinary airborne contaminants. In contrast, three or more days of incubation are usually required to provide for adequate development of *Tetrahymena* cultures, and the optimum pH for its media is near neutrality. With aerobic conditions essential for normal growth, the medium is not acidified, hence provides excellent conditions for growth of a variety of fortuitous contaminants. The possibility for practical alleviation of this difficulty by the judicious selection and use of antibiotics would appear to be worth further investigation.

Glucose, the only simple sugar metabolized by *Tetrahymena*, has usually been used as a source of carbon and energy, and it is generally inadvisable to autoclave it in the near neutral media required by this organism. The necessity for sep-

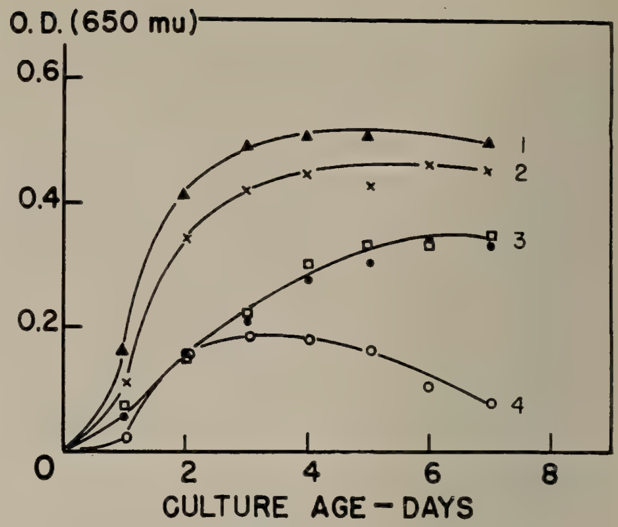

Fig. 1. Growth curves of *Tetrahymena pyriformis* W in a defined medium with: 1, 2% dextrin; 2, 1% dextrin, 3 (open squares), 2% glucose; 3 (closed circles), 1% glucose; 4, no carbohydrate. (From Reynolds and Wragg, Reference (7).)

arate sterilization and aseptic addition of glucose to other ingredients complicates the routine of assay procedure and introduces further contamination hazard. This difficulty, however, can be obviated by the use of soluble starch or dextrin which is heat-sterilizable with other media ingredients. Dextrin has been demonstrated in this laboratory (6, 7) to be a better growth stimulator than glucose. In addition, it does not exhibit the critical inhibitory levels characteristic of glucose and shown by Kidder and Dewey (3) to be determined by the amino acid/carbohydrate ratio of the medium. Relative growth stimulation by glucose and dextrin in defined media containing the 10 essential amino acids plus serine is illustrated in Figure 1. In the absence of carbohydrate, early decline followed a limited maximum achieved after three days of incubation. Growth stimulation by 1 or 2 percent glucose was equivalent and considerably less than that by 1 or 2 percent dextrin. Other data, obtained under the same conditions but not presented here, showed a pronounced growth lag with 3 percent glucose and essentially complete growth inhibition at 4 and 5 percent levels while 3, 4, and 5 percent levels of dextrin were equally stimulatory and somewhat better than 2 percent dextrin.

Under conditions of limited aeration, *Tetrahymena* cultures develop growth-limiting acidity resulting in death and lysis of cells. Various devices, including the slanting of tubes during incubation and the use of small, 35-ml micro-Fernbach flasks, have been used to obtain suitably aerobic conditions during incubation. We have obtained satisfactory growth, unaccompanied by acidification, with 4-ml quantities of media in 25 x 50 mm aluminum-capped shell vials incubated upright. This provides a surface to volume ratio of approximately 1, and growth is only moderately reduced over that attained when the surface to volume ratio is increased to 2 (Fig. 2). It will be seen that as the surface/volume ratio (i.e., aeration) was increased there were approximately parallel increases in O.D., cell count, and pH, and sharp reductions in cell volume and carbohydrate utilization.

Hutner and Hamilton and co-workers (5, 8, 9, 10) have discussed the present applications of microbiological assays with *Tetrahymena* and other protozoa and combined this with some imaginative introspection as to the potential future uses of these organisms as tools to assist in the unravelling of some of the many complex biochemical problems that remain to baffle and intrigue the investigator of nutrient function and relation. It would be useless redundancy to retrace here the expositions of those scholarly theses. I will, therefore, consider here a few of the more mundane aspects of the analytical applications of *Tetrahymena* and particularly those where the work of our laboratory may be of some pertinence.

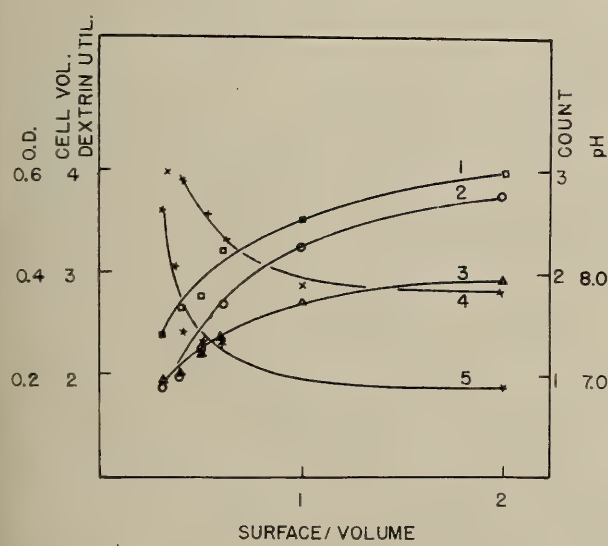

Fig. 2. Effect of surface/volume ratio of medium on O.D., cell count, pH, cell volume, and carbohydrate utilization in *Tetrahymena pyriformis* cultures growing in a defined medium. 1, O.D.; 2, cells/ml x 10^{-5}; 3, pH; 4, average cell volume, μ^3 x 10^{-4}; 5, dextrin utilization, mg/ml.

Briefly with respect to some of the B-vitamins: Kidder (1) has reported that pyridoxal and pyridoxamine are 500 times as active for *Tetrahymena* as is pyridoxine and that pyridoxal phosphate is only 75 percent as active as pyridoxal. The relatively low activity of pyridoxine is puzzling in view of the apparently equal activity for mammals of the three B_6 moieties (11). This might reflect a deficiency in *Tetrahymena* of an enzyme comparable to that from rabbit liver described by Wada and Snell (12) which oxidizes pyridoxine phosphate to pyridoxal phosphate. Nevertheless, Hutner et al. (8), noting that in common with mammals the B_6 requirement of *Tetrahymena* has not been bypassed, take this as evidence that when serving as an assay organism it is responding mainly to this nutrient and not to products of its catalytic activity. For this reason they consider further study of the practicability of such assays as worthy of continued effort.

Investigations by Kidder and Dewey (13) showed *Tetrahymena* to be more animal-like in its folic acid requirements than any other organism studied and demonstrated its ability to respond equally to free pteroyl glutamic acid and to its di-, tri-, and penta-glutamates. On the basis of these investigations, Jukes (14) described a *Tetrahymena* assay for folic acid, noting its advantage in comparison with bacterial assays which require primary liberation of folic acid thru the use of conjugase preparations.

Stockstad et al. (15) describe a *Tetrahymena* assay for *a*-lipoic acid, recommended by the specific response of the organism to both *a*-lipoic acid and its conjugates, the latter being unavailable to other microorganisms. For the other vitamins which it requires, *Tetrahymena* does not appear to possess qualifications which make it a likely candidate at this time to replace the hardy, lactic-acid bacteria as assay organisms.

The area where most interest has been shown in the analytical application of *Tetrahymena* is its development as an analytical tool to replace the slow and costly animal-feeding tests for assessing the biological value of proteins. Its successful application for this purpose would be of real economic value in such areas as the rapid evaluation of large numbers of protein samples, the control of oil seed processing operations, and in the formulation of mixed feeds.

Efforts to apply *Tetrahymena* to evaluating proteins derive from the observation of Kidder (16) that it utilizes intact proteins readily. Attempts to apply *Tetrahymena* to protein quality evaluation were begun by Rockland and Dunn in 1949 (17) and subjected to further study by Williams and students in 1951 (18) and 1954 (19), by Rosen and Fernell (20, 21), and by Viswantha and Liener in 1956 (22); some modifications were proposed by Rosen in 1960 (23). Teunisson in 1961 (24) applied the modified method to a survey of protein concentrates and later to tests on a number of protein meals as part of a collaborative study reported by Boyne et al. (25), while Stott, Smith, and Rosen in 1963 (26) described a simplified assay procedure.

A major problem attending protein quality evaluations with *Tetrahymena* has been the lack of an unequivocal method for estimating growth, or more specifically the amount of cellular protein synthesized in media containing intact proteins in solution or in suspension. Turbidimetric methods are not applicable because of changes in optical density associated with protein utilization.

Rockland and Dunn (17), applying techniques used in bacteriological assay procedures, based growth estimates on the amount of acid produced during incubation for 41 days. As shown here earlier, and noted by others, acid production in *Tetrahymena* cultures is more a measure of oxygen deprivation than of cell growth. Williams and students (18, 19) proposed an enzymatic test for measuring growth of *Tetrahymena* in media containing proteins. They were able to demonstrate a linear relationship between numbers of cells and enzymatic reduction of 2,3,5-triphenyltetrazolium chloride. Fernell and

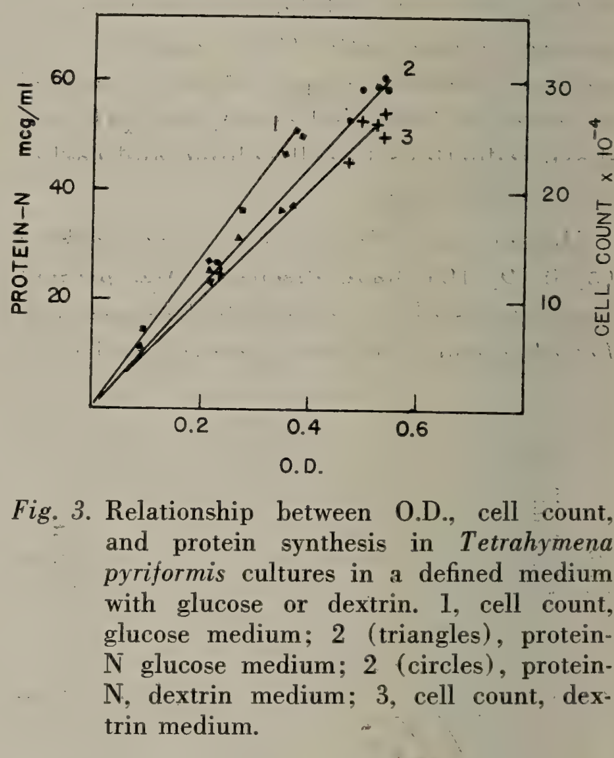

Fig. 3. Relationship between O.D., cell count, and protein synthesis in *Tetrahymena pyriformis* cultures in a defined medium with glucose or dextrin. 1, cell count, glucose medium; 2 (triangles), protein-N glucose medium; 2 (circles), protein-N, dextrin medium; 3, cell count, dextrin medium.

Rosen (21), examining growth measurement methods previously used, demonstrated that the intensity of color produced in the Anderson-Williams (18) tetrazolium reduction method varied with the nature of the protein present. Equal levels of different proteins could cause up to 100 per cent variation in color intensity. Assessment of growth by microscopic counting of organisms after culturing in media with different proteins resulted in some cross-over of response with increasing levels of media protein, a difficulty previously observed by Rockland and Dunn and by Anderson and Williams. Observing that ammonia production should reflect protein catabolism and that a low quality protein should therefore lead to greater production of ammonia, they examined and concluded that the cell count/ammonia-N ratio provided a better measure of the efficiency with which *Tetrahymena* made use of different proteins.

Subsequently, Rosen (23) observed that the cell count/NH_3-N ratio as a criterion for evaluating response of *Tetrahymena* to proteins was subject to influence by the ionic strength of the medium and that anomalies attended its application to cereals and some heat-damaged proteins. He therefore returned to the use of the direct microscopic cell count as a measure of growth response, a measure which, with Fernell (20), he had previously reported as changing the relative values of some proteins as protein level of the medium was increased, as well as failing to show a direct relationship between growth of *Tetrahymena* and accepted values of protein quality evaluated by animal feeding tests.

Results obtained in our laboratory raise questions as to the usefulness of either cell count or cell count/NH_3-N ratio as a measure of the response of *Tetrahymena* to media nitrogen. Its rate of growth, as shown earlier, can be altered by changing the type of carbohydrate in otherwise identical media. We have observed also that, in both defined and crude media, average volume of individual cells when carbohydrate is supplied as a polysaccharide, is 1.5 to 2 times that in the presence of glucose (7). The effect of this differential response on the relation between growth as measured by optical density and growth as measured by cell count or by protein synthesis is illustrated in Figure 3. It will be seen that optical density provided a satisfactory estimate of protein synthesized, independent of the type of carbohydrate, while the relation between optical density and cell count was quite different for cultures from media with dextrin or glucose. The problem of relating protein synthesis to cell count is better illustrated by presenting some of these data as in Figure 4. Here, a cell count of 200,000/ml would represent approximately 30 mcg/ml of *Tetrahymena* protein nitrogen in media with glucose as compared with approximately 45 mcg/ml in the dextrin media.

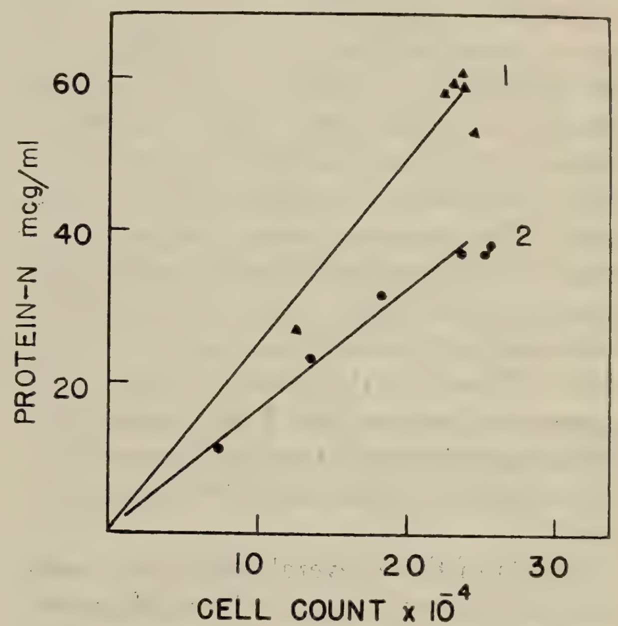

Fig. 4. Relationship between cell count and protein synthesized by *Tetrahymena pyriformis* in a defined medium with: 1, dextrin; 2, glucose.

Type of carbohydrate can also have a marked effect on the NH_3-N/protein-N ratio as is demonstrated by the data illustrated in Figure 5. With glucose in the medium, there was a sharp increase in this ratio as media nitrogen levels were increased from 0.15 to 0.60 mg/ml. In the presence of dextrin, change in this ratio was relatively moderate and, at the highest nitrogen level, the apparent efficiency in conversion of media nitrogen to protein nitrogen was much greater in media with dextrin than with glucose.

In contrast to the above noted problems of assessing growth response in *Tetrahymena* in media containing complete proteins, the number of reports of good correlations between *Tetrahymena* and animal assays of protein quality imply a solid basis of similarity in the availability to mammals and to this protozoan of amino acids from different proteins. The largest body of reported data comparing such values is that of the collaborative study reported by Boyne et al. (25). A summary of these data is presented in Table 1. Data for three of the four groups—13 to 18 samples each—of protein meals showed statistically significant correlations between gross protein values (chicks) and the *Tetrahymena* values. Of the three groups in which net protein utilization values (rat) were available, only those for whale meat meals correlated with the observed *Tetrahymena* values. At the same time, the net protein utilization values and gross protein values were not significantly correlated with one of three groups of samples. Thus, on the overall record, the agreement between the *Tetrahymena* and animal protein evaluations compares favorably with that of the two different animal assays.

Results of these several attempts to evaluate protein quality on the basis of growth response by *Tetrahymena* present the anomalous aspects of reports, by most investigators, of good to excellent correlation between the *Tetrahymena* assays and biological values as assessed by animal feeding tests, even though all methods used in estimating growth response of the protozoan were equivocal in varying degrees. However, development of a reliable method for measurement of growth response of *Tetrahymena* in protein media is essential for any useful determination of its value for assessing protein quality. Ideally this would be separation of cells from the protein-containing medium and determination, by conventional methods, of the amounts of cellular protein synthesized. Fernell and Rosen (21), however, were unsuccessful in attempts to separate *Tetrahymena* cells from the protein media by differential centrifugation in sucrose solutions or by electro-migration techniques. At present it would appear that measurement of enzyme activity offers the greatest promise. It is probably not being overly optimistic to suppose that a systematic investigation might be expected to reveal a satisfactory dye reduction test or other appropriate measure of enzyme activity, unaffected by the nature of media protein, but directly correlated with protein in the form of active *Tetrahymena* cells.

Currently, protein evaluation methods using microorganisms are subject to the same criticism applied by Almquist (27) to the determination of biological values with higher animals. The situation is analogous to attempting to determine the adequacy of a food with respect to all different vitamins by means of a single growth experiment. It is also true that, excepting those proteins with some rather extreme imbalance in their amino acid pat-

Table 1—Correlations between gross protein values (GPV), net protein utilization (NPU) and Tetrahymena evaluations (Tp) of quality of a series of protein meals [Adapted from Boyne, et al. (25)]

Protein	Correlation coefficients (r)		
	GPV T_p	NPU T_p	GPV NPU
Whale meat meals	0.894** (15)	0.821** (14)	0.904** (14)
Meat meals	.633* (13)	.303 (13)	.417 (13)
Fish meals	.070 (18)	.102 (6)	.922** (6)
Cottonseed meals	.660** (17)	——	——

Significant correlation: ** 1% level; * 5% level
( ) Number of pairs of samples.

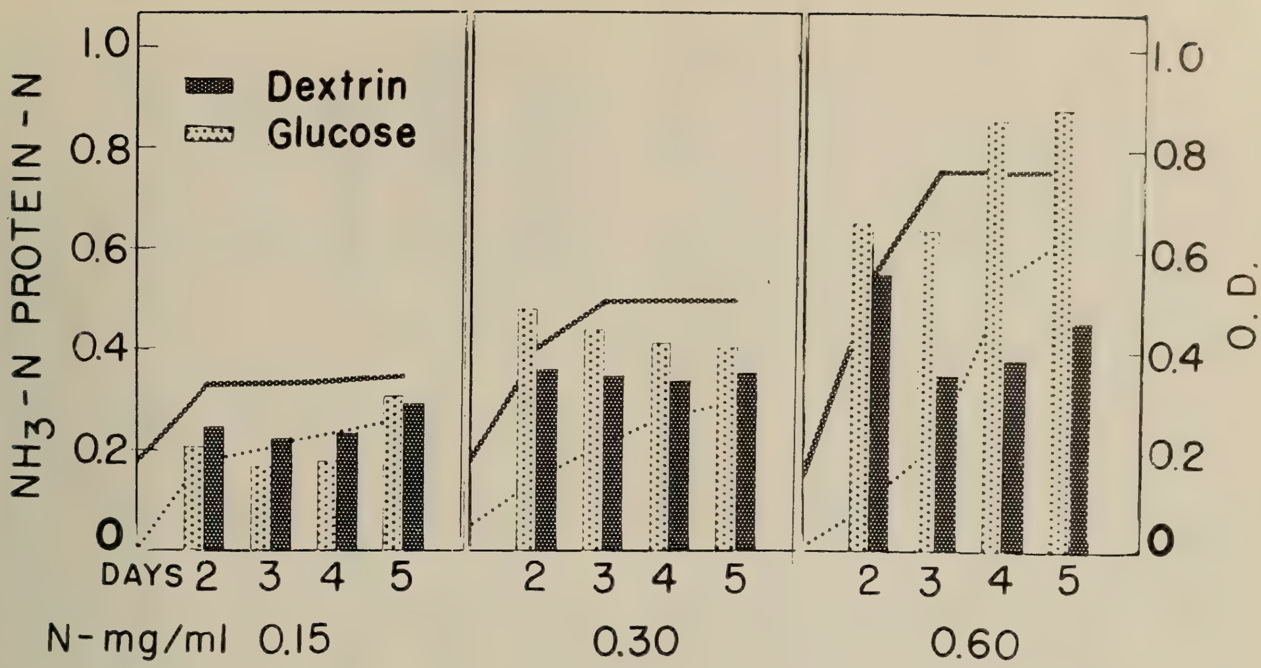

Fig. 5. Growth of *Tetrahymena pyriformis* and relation of NH_3-N to protein-N in defined media with glucose or dextrin and three media levels of amino acid nitrogen. Superimposed curves, growth as measured by O.D.; upper curve, dextrin medium; lower curve, glucose medium.

terns, the results of such tests are primarily determined by the limiting amino acid. This aspect complicates the interpretation of results based on attempts to evaluate proteins with those bacteria requiring several amino acids not essential for mammals or not requiring some which are essential. Of these tests Carroll (28) has observed that results will be influenced by such factors as the quantitative requirements of the test organisms for amino acids, the relative amounts of these actually present in the protein source, and the susceptibility of the proteins of the source to enzyme digestion under the conditions chosen for testing. These objections apply also, in some measure, to protein evaluations with *Tetrahymena*, but the mammalian-like amino acid requirements of this organism and its ability to digest proteins with proteolytic enzymes exhibiting several similarities to those of mammals (29) significantly lessen these difficulties of interpretation. Futhermore, Bender (30), reviewing biological methods of evaluating protein quality, characterized attempts to use bacteria such as *Streptococcus faecalis* (31) and *Leuconostoc mesenteroides* (32) for this purpose as less successful approaches than evaluations with *Tetrahymena.*

Grau and Carroll (28), reviewing problems inherent in evaluating the nutritional values of protein, conclude that, while measures such as "biological value," "net protein utilization," etc., will be convenient to use for some years, the value of a protein source will eventually be expressed in terms of at least 10 different amino acids—one for each in which the nutritionist is interested. *Tetrahymena* assays may well contribute to the realization of this prediction. Rockland and Dunn in 1946 (33) assayed tryptophan in unhydrolyzed casein using *Tetrahymena* and obtained values within the range of 1.2 to 1.4 percent by improved colorimetric procedures. Here again, much additional information is needed before this organism can be used as a reliable tool for estimating availability of amino acids from intact proteins. While the qualitative amino acid requirements of *Tetrahymena* are well documented, the optimum pattern and quantitative requirements are far from definition, a problem equally current in animal nutrition (34, 35). Dewey and Kidder (36) have shown that all of the essential, and at least five of the non-essential, amino acids can cause measurable inhibition of growth by *Tetrahymena* when not in proper balance.

On the basis of investigations by Williams et al. (37) reporting good correlations between carcass assay and amino acid requirements of rats, chicks, and pigs, Whalen (38) in Williams' laboratory used an amino acid pattern for *Tetrahymena* medium based on the carcass analysis pattern of its cells. Use of the carcass analysis pattern as a criterion of an organism's amino acid requirements involves the assumption of equal utilization of all amino acids for purposes other than cellular protein synthesis. Wu and Hogg (39) have reported, however, that with the exception of histidine total utilization of individual amino acids by *Tetrahymena* greatly exceeded cellular incorporation, while excess of utilization over cellular incorporation varied widely among the different amino acids. In this connection, also, Cuthbertson, quoted by Dean (40), reported that mice did better on a stock diet than on one in which the protein source consisted of completely homogenized mice.

Media adaptation presents another potential problem in the application of *Tetrahymena* to protein evaluation or the estimation of availability of amino acids from intact proteins. Adaptation could alter the organism's demands on its medium for specific amino acids and thus affect its response to a given protein. Elliot et al. (41) have observed adaptive changes in *Tetrahymena* following transfer from crude to snythetic media, while Wu and Hogg (42) reported significant changes in both the distribution of cellular nitrogen and incorporation of individual amino acids in cells from crude and synthetic media. Results in our laboratory have shown that carbohydrate can affect the composition of the free amino-acid pool of *Tetrahymena* cells (Figure 6). Here it can be seen that

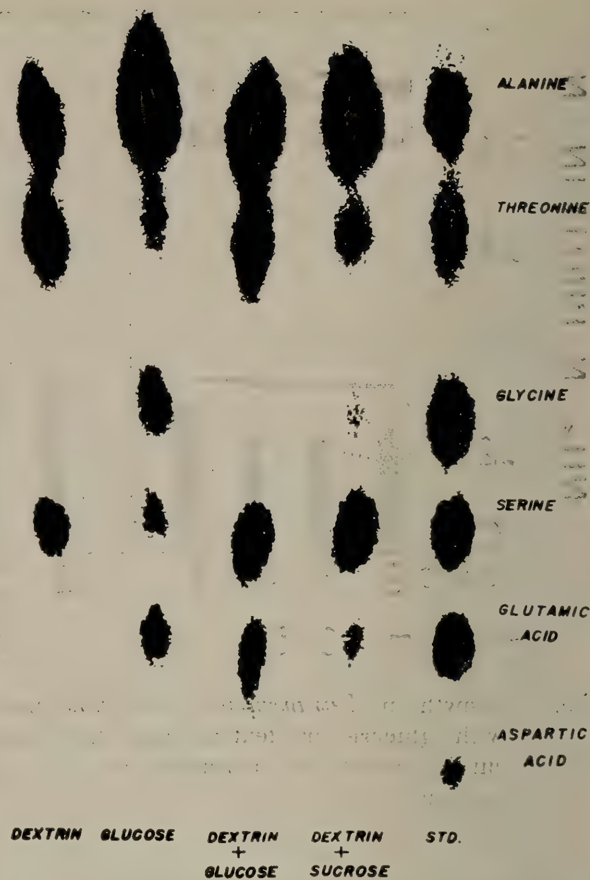

Fig. 6. Distribution of six amino acids in cell pools from *Tetrahymena pyriformis* grown in a defined medium with different carbohydrates.

the amino-acid pool of cells produced in dextrin media was higher in serine and threonine than was that of cells from glucose media, while the latter was higher in glutamic acid, glycine, and especially alanine. When cells were produced in media containing 2 percent dextrin plus sufficient glucose or the non-utilizable sugar sucrose to make them isotonic with 2 percent glucose medium, the cell pools were like those of dextrin cells in being high in serine and threonine and low in glycine and like cells from glucose medium with respect to glutamic acid and alanine content. Whether amino acid composition of cell proteins is similarly affected is yet to be investigated. In this relation, Wu and Hogg (42) observed no correlation between amino acid distribution in cell pools and in protein in *Tetrahymena*, and most investigators have agreed that composition of tissue proteins in mammals is independent of amino acid composition or balance of the diet. Dean (40), however, concludes that nothing is known with certainty about the relations between dietary protein and body protein. It is, therefore, possible that difficulties of this nature that may attend the use of *Tetrahymena* may be no more than another parallelism with mammals.

In summary, it seems evident that *Tetrahymena pyriformis* has characteristics recommending it specifically for the assay of folic and *a*-lipoic acids and possibly for vitamin B_6. At present, the most valuable potential application appears to be its development as an analytical tool for assessing the biological value of proteins or for determining the availability of individual amino acids in intact proteins. Successful routine application of *Tetrahymena* for these purposes will require the development of much additional basic data with respect to media nutrient patterns providing for optimum growth and, at the same time, not subject to imbalances arising from additional nutrients introduced with assay samples.

Acknowledgment

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References

(1) Kidder, G. W., and Dewey, V. C. *In* Biochemistry and Physiology of Protozoa, p. 323. A. Lwoff, ed. Academic Press, Inc., New York (1951).

(2) Kidder, G. W. VI Intern. Congr. Microbiol., Rome, 44 (1953).

(3) Kidder, G. W., and Dewey, V. C. Arch. Biochem. *20,* 433 (1949).

(4) Dewey, V. C., Parks, R. C., and Kidder, G. W. Arch. Biochem. *29,* 281 (1950).

(5) Hutner, S. H., Cury, A., and Baker, H. Anal. Chem. *30,* 849 (1958).

(6) Reynolds, H., and Wragg, J. B. Bacteriol. Proc., 40 (1960).

(7) Reynolds, H., and Wragg, J. B. J. Protozool. *9,* 214 (1962).

(8) Hutner, S. H., Nathan, H. A., Baker, H., Sobotka, H., and Aaronson, S. Am. J. Clin. Nutr. *7,* 407 (1959).

(9) Hamilton, L. D., Hutner, S. H., and Provasoli, L. Analyst *77,* 618 (1952).

(10) Hutner, S. H., Provasoli, L., and Baker, H. Microchem. J. Symp., Ser. 1, 95 (1961).

(11) Sherman, H. *In* The Vitamins, Vol. III, p. 251. W. H. Sebrell, Jr., and R. S. Harris, eds. Academic Press, Inc., New York (1954).

(12) Wada, H., and Snell, E. E. J. Biol. Chem. *236,* 2089 (1961).

(13) Kidder, G. W., and Dewey, V. C. Proc. Nat. Acad. Sci. U. S. *33,* 95 (1947).

(14) Jukes, T. H. Methods of Biochem. Analy. *2,* 121 (1955).

(15) Stokstad, E. L. R., Seaman, G. R., Davis, R. J., and Hutner, S. H. Methods of Biochem. Analy. *3,* 23 (1956).

(16) Kidder, G. W. Biol. Bull. *80,* 50 (1941).

(17) Rockland, L. B., and Dunn, M. S. Food Technol. *3,* 289 (1949).

(18) Anderson, M. E., and Williams, H. H. J. Nutr. *44,* 335 (1951).

(19) Pilcher, H. L., and Williams, H. H. J. Nutr. *53,* 589 (1954).

(20) Rosen, G. D., and Fernell, W. R. Brit. J. Nutr. *10,* 156 (1956).

(21) Fernell, W. R., and Rosen, G. D. Brit. J. Nutr. *10,* 143 (1956).

(22) Viswanatha, T., and Liener I. E. Arch. Biochem. Biophys. *56,* 222 (1956).

(23) Rosen, G. D. Proc. Intern. Symp. Microchem., Birmingham University, p. 212. Pergamon Press, London (1960).

(24) Teunisson, D. J. Anal. Biochem. *2,* 405 (1961).

(25) Boyne, A. W., Carpenter, K. J., and Woodham, A. A. J. Sci. Food Agr. *12,* 832 (1961).

(26) Stott, J. A., Smith, H., and Rosen, G. D. Brit. J. Nutr. *17,* 227 (1963).

(27) Almquist, H. J. *In* Amino Acids and Proteins, p. 586. D. M. Greenberg, ed. C. C. Thomas, Springfield, Ill. (1951).

(28) Grau, C. R., and Carroll, R. W. *In* Processed Plant Protein Foodstuffs, p. 153. A. M. Altschul, ed. Academic Press, Inc., New York (1958).

(29) Viswanatha, T., and Liener, I. E. Arch. Biochem. Biophys. *61,* 410 (1956).

(30) Bender, A. E. Proc. Nutr. Soc. (Engl., Scot.) *17,* 85 (1958).

(31) Halevy, S., and Grossowicz, N. Proc. Soc. Exp. Biol. Med. *82,* 567 (1953).

(32) Horn, M. J., Blum, A. E., Womack, M., and Gersdorff, C. E. F. J. Nutr. *48,* 231 (1952).

(33) Rockland, L. B., and Dunn, M. S. Arch. Biochem. *11,* 541 (1946).

(34) Williams, R. J. *In* Protein and Amino Acid Nutrition, p. 45. A. A. Albanese, ed. Academic Press, New York (1959).

(35) Leverton, R. M. *In* Protein and Amino Acid Nutrition, p. 477. A. A. Albanese, ed. Academic Press, New York (1959).

(36) Dewey, V. C., and Kidder, G. W. Arch. Biochem. Biophys. *73*, 29 (1958).

(37) Williams, H. H., Curtin, L. V., Abraham, J., Loosli, J. K., and Maynard, L. A. J. Biol. Chem. *208*, 277 (1954).

(38) Whalen, A. A. M. S. thesis, 1961, Cornell Univ.

(39) Wu, C., and Hogg, J. F. Arch. Biochem. Biophys. *62*, 70 (1956).

(40) Dean, R. F. A. *In* Processed Plant Protein Foodstuffs. A. M. Altschul, ed. Academic Press, Inc., New York (1958).

(41) Elliott, A. M., and Hogg, J. F. Physiol. Zool. *25*, 318 (1952).

(42) Wu, C., and Hogg, J. F. J. Biol. Chem. *198*, 753 (1952).

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Some Preliminaries On the Soul Complex In Eskimo Shamanistic Belief

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It has not been known before that the Eskimo universal deity was metamorphic and clearly anchored in the myth about the Sun and the Moon, who are respectively associated with sister and brother. It has been known that *silap inua* (literally: of air, its person) was some sort of an Eskimo supreme deity, without, however, a knowledge and understanding of what this deity actually was, its role and its function. The descriptions have been rather confused and distorted, not alone because of many observers' lack of understanding of the Eskimo language (which to be sure has often proved a serious impediment) but also because its counterpart and metamorphic character were not at all sensed. The many recordings I have in Eskimo from my field research in Canada, Alaska, and Greenland, leave no doubt about this question. However, descriptions which we have as early as the sixteenth and seventeenth centuries strongly indicate that the Eskimos felt themselves allied with the cosmic elements (see V. C. Frederiksen: Om det gamle Eskimoraab til de förste Söfarende efter Nordbotiden, Meddelelser om Grönland LIX, Köbenhavn 1924 [About the Old Eskimo Shout to the first Seafarers after the Norse Era]).

The Sun and the Moon are regarded as a hole, or window, in the universe. At this hole, in day appears the sister, who at the time of sunset becomes the brother and at dawn becomes again the sister. We could so far also call the universal deity the universal soul, as it is the identical counterpart to each and everyone of the life souls. The life soul is the corporeal soul which is physically present within, and bound to, the body. Every person's life soul is the counterpart of the metamorphic deity or the metamorphic universal soul.

The night side of the deity, the "moon"-brother in the sky, is an embryo creature, which at the turning point from night to day takes its seat in the adult woman, who becomes pregnant. All child-bearing women are thus the mothers of the metamorphic deity, but of its night side only. We have here something in the nature of a parallel to Jung's Animus-Anima statement. The day side, the sister, has the form of a bird, which is in itself the symbol of resurrection, and to the Eskimos a religious reality.

A metamorphic event takes place at the initiation of the male Shaman novice when he receives his Shaman name and has his night side life soul turned into a day side life soul of a bird shape. This is exactly what we see in the world-famous Lascaux caves in France, which have been determined by radiocarbon dating to be about 16,000 years old. There we have a prostrate man, shown with the face and beak of a bird, and next to him a bird sitting on a pole, the *axis mundi*—sitting on the top of the world. The concepts of the bird-soul and of the *axis mundi*—the world tree or tree of life—are found in many religions in different parts of the world.

The Eskimo soul complex is, however, dualistic beyond the relationship of the corporeally bound (life) soul, with its counterpart in the deity. The individual soul, which also could be termed the free soul, the image soul, or the name soul, is a non-physical counterpart soul, which like the universal, physical, life soul, splits off in an amoeba-like manner.

This has not been recognized in the scholastic literature, although it has been known that individual soul and name are identical. It is on the basis of the individual soul that misconceived and confused ideas of so-called Eskimo multiple souls have been described. The name represents the image of the person. The mirroring image as seen in the water would represent the individual soul of the person there reflected. Thus any picture taken of the person represents his individual soul. Naturally Eskimos, as other aboriginals, were frightened, years ago, when pictures were taken of them. I have myself experienced such an incident, which however is now an extreme rarity.

The Eskimo name system—and we cannot describe the individual soul without relevance to it and without realizing the purpose of the personal name in Eskimo belief—has not been recognized in all its essential facets in the scholastic literature, nor has its far-reaching significance in Eskimo culture, language, and religion been sensed. This is not only because of unfamiliarity with the Eskimos' language and thought processes, but also because concepts from our modern world have been projected as extraneous elements into the old Eskimo culture. This is one of the reasons why the concept of counterpart souls, their structure and function, has not been understood.

Each given name is related to successive cycles of human life as: (1) embryo, (2) birth, (3) puberty (and its opposite, the menopause in women), and, in addition, (4) illness (temporary name). At each of these stages a new name is given, each being a soul name. When a person dies, his name soul splits into two parts, one of which remains in the realm of the dead while the other is transferred to another person, for example a newborn baby, a boy or girl at puberty, or a Shaman at his initiation or during illness. In the case of an infant, the name given must be that of a person who has died recently. When the novice Shaman receives his new name, it must be that of a long-dead ancestor. Nicknames also occur, but they are not regarded as real names; they are not soul names.

It follows logically that when a soul name is discontinued, is in the process of being shifted, the Eskimo conceives of himself as "dead" for a period. Often the expression: "In some way I died," is used. The most crucial impact of the name shift on a person's consciousness would be where he is first able to visualize the consequences of the name shift; this usually happens at puberty, where the person must undergo the Shamanistic novitiate. All the horrors of death and the great novelty of resurrection are here experienced.

It may also be realized as a logical consequence that the entire Eskimo community is educated and geared for Shamandom. In the name system, the name given at birth is the name which leads to Shamandom. The fact that Eskimos often may travel long distances and live far apart in small groups also underlines the necessity of this Shamanistic extension. However, not every adult may be regarded as a full and actual Shaman. To be called a Shaman, it is necessary that the person be able to perform in public. A Shaman is one who can face the realm of death and easily enter into and out of it. We must note that to die means for the Eskimo only a transition. Death is not conceived as extinction. The realm of death is just another transcendence. All the dead ones are alive, and their individual souls have their namesakes among the actual living.

It must be emphasized that the counterpart souls are coexisting souls. The old soul continues to exist in the realm of living "dead ones." This is not the same as incarnation or reincarnation, phenomena of some of the so-called higher religions. What happens is that two soul units, both of them formed in amoeba-like fashion, are brought together and that both are subject to constant mutation.

When a person dies, his name must not be mentioned until he has been renamed. This is quite understandable because of the great mobility of the individual soul (which even in dreams is supposed to leave the body). If the counterpart of the name soul of the dead is not properly transferred to the living, danger and disorder will result. If the deceased is called by his own name, it would mean that the person mentioning that name would be possessed by the name soul of the dead one, and that he himself would die. The entire soul system must have a chance to regroup and to be brought in order again. Nothing is so dangerous as a disordered soul system. The Shaman has this order-bringing task.

But we realize then that the fact of a name which cannot be used for a certain period gives rise to the necessity for a parallel language, the Shaman language. A name that cannot be mentioned could be one that was very useful or essential in daily life. Thus, it would be inconvenient not to have another name or metaphor for Polar Bear than *nanoq*, if a person by that name had died. After renaming, the word *nanoq* could be used again.

Let me use here a concrete example, a late Eskimo friend of mine, a Shaman from Chesterfield Inlet. His name leading to Shamandom, the name he received at birth, was *nanoq*, meaning Polar Bear. We will see how at his Shaman novice initiation he literally experiences the coming to life of the Shaman language.

A relative of his was a female namesake, *nanoq*, who lived very far away. (Whether it was a female or male namesake would make no difference; sex has no role in connection with counterpart name souls). According to this Shaman's autobiography, which I recorded in Eskimo, he postulated that he was telepathically informed that his relative had died. As her namesake identity he had to die too, and he felt that he did. His individual (name) soul left his body entirely as it was. But it did not go out of existence. It mutated, it went over to another transcendence during his initiation as Shaman novice. It transmuted, and as a polar bear it became a member of his faculty of helping spirits, even becoming the leader of them. But since he could not conceive of himself any longer as *nanoq* until his dead relative had been renamed, he could only think of the concept of Polar Bear under the metaphorical expression *pisuktse*, "the land animal," "the one you have as walker." After his dead namesake had been renamed, it was safe to use the word *nanoq* again in conversation, but it would never again be his name.

One may here sense that Shamanism is a dive into the unconscious, which happens at every trance and seance as a regression of mind, where the Shaman language is used in communication with the helping spirits. In this regression he seeks the origin of the ancestry (in the name soul complex) and of the deity (in the life soul complex).

At my friend's initiation to the Shaman novitiate, the officiating Shaman "dreamt" a visitation to the mythical ancestress of the Eskimos, the woman who lives at the bottom of the sea, who once was married to a dog. From her husband *kanajoq*, Sea Scorpion, the officiating Shaman learned that my friend, who formerly had the name *nanoq* now had to answer to the new name *qimukserâq*.

In his initiation as a Shaman novice, my friend "dreamt" about the male night side embryo metamorphic deity, which up to now had been his counterpart universal (life) soul but which now at his "awakening" was transmuted to the female bird-like day side counterpart soul. He thus experienced unity with the female day side bird-like metamorphic deity. This was his resurrection, and this happened on the fifth day of his initiation, when he received his new name from the officiating name-giving Shaman. He now was a regenerated individual with a new universal counterpart soul and a new individual counterpart soul. But in spite of the new life, the new being he had become, the transmutations preserved a link with his past, with his previous existence, his origin in ancestry, and his origin in deity.

As to the metaphoric Shaman language, the point is that it is used in the unconscious state, when the Shaman is in a trance, etc., as well as in the conscious state, in the entire oral traditional literature of the old Eskimo culture.

Until now very little has been recorded of the Shaman language, and its significance and meaning have not been understood. The Shaman metaphoric words have been translated as ordinary words, when they are something entirely different. They are expressions of his soul, a part of himself, expressions too of the soul of his fellow Eskimos—a part of themselves. The myths, the legends, the entire "literature" of the aboriginal Eskimo are interwoven with Shaman words. This has definitely not been known before. There is much, much more to be recorded. We must study this "literature" in an entirely new light, and it must be done now, while some of the older Eskimos who possess this unique knowledge are still alive. In a few more years it will be too late. The only effective way of doing this is to have an Institute of Eskimology, which for a number of years I have been trying to organize. Such an Institute, which could be established at a modest cost, could accomplish this urgent task while there is still time.

Photocontrol of Anthocyanin Synthesis

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We have no way of knowing when man began to appreciate the beauty of the autumn coloration that appears in the deciduous forests of the temperate and subarctic zones. Nor do we know when he began to use and cultivate flowers for ornamental purposes. We are not even certain when man began to correlate fruit ripeness with color. As they became aware of the plants around them people must have noticed the predominance of reds and blues and attempts must have been made to use these colors as dyes for religious costumes, face and body painting, etc. Thus, the fact that the substances responsible for the blue and red colors of many plant parts are water-soluble probably was apparent at an early time. Because they were soluble in water the colored materials were easily separated from the plant tissue and, of course, had to be given a name. Undoubtedly many names were given to these water-soluble, colored substances from plants, but the one we use today is anthocyanin, from the Greek *anthos*, a flower, plus *kyanos*, dark blue.

We know that man began inquiring into the nature of anthocyanin over 300 years ago. In 1664, for example, Robert Boyle (1) noted that an extract from blue-violet petals turned red when an acid such as vinegar was added to the solution. By 1800 (2) it was known that light was generally required for anthocyanin synthesis, and by 1900 (3) the evidence clearly showed that the accumulation of soluble carbohydrates was essential.

The chemical identity of anthocyanin

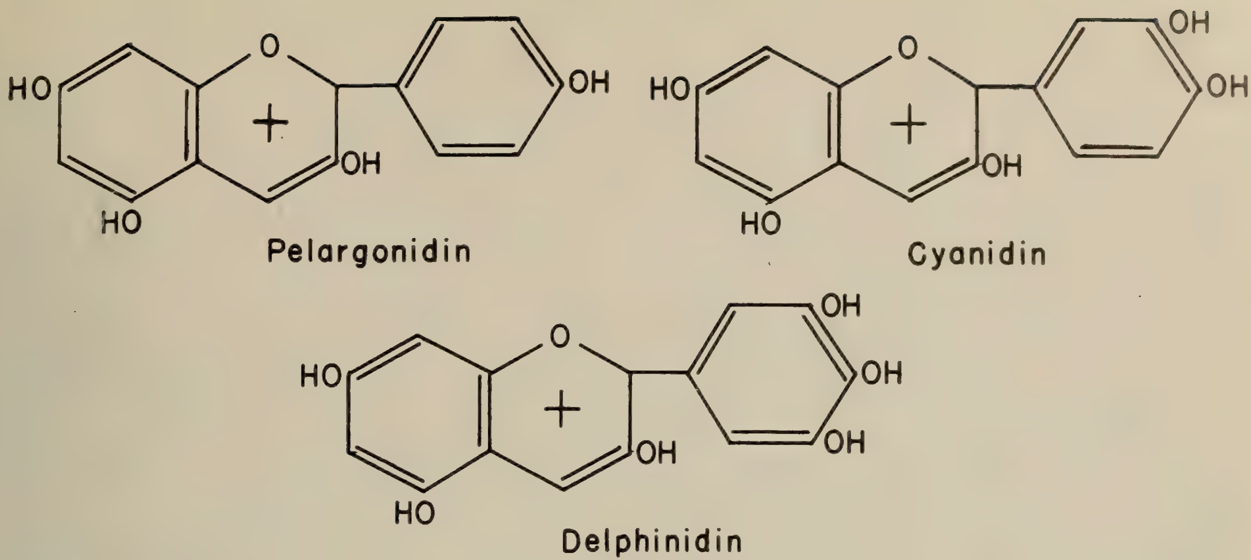

Fig.1. The three most common anthocyanidins.

was established in 1913 by Richard Willstätter (4). A number of other investigators added details that have resulted in a rather complete picture of the chemical structure. Anthocyanins are glycosides that are hydrolyzed on heating with acid into sugars and an anthocyanidin. The anthocyanin glycoside is frequently formed by replacing the hydroxyl group of the middle ring by sugars. Sugars can also be attached to places other than the central ring but normally only in the 3 position or in the 3 and 5 positions. Identification of an unknown anthocyanin thus depends on identifying the anthocyanidin and determining the number and kind of sugars present and where they are attached. Since anthocyanins are sometimes formed as acylated glycosides, the presence of an acyl component must be determined and the associated organic acid identified.

As might be expected, a large number of anthocyanins can be formed from only a few anthocyanidins. For many years the major anthocyanidins were pelargonidin, cyanidin, and delphinidin, and most of the anthocyanins were placed in one of these three categories (Fig. 1). By 1958 (5), 10 anthocyanidins could be listed, and what were once considered as single anthocyanins now proved to be several, and in some cases not anthocyanins at all. For example, what had been considered to be a cyanidin glycoside in *Spirodela oligorrhiza* was reinvestigated by chromatographic means and shown not to be directly related to any known anthocyanin (6).

The distribution of the anthocyanins in flower parts is often complex, and this complexity has yielded results of taxonomic interest. In Papaver species, for example, the species can be determined by the distribution of the six anthocyanins in the flowers (7).

A number of factors influence the formation of anthocyanin. Genetics is, of course, of prime consideration. Texas milo seedlings, for example, produce twice as much anthocyanin under a given set of conditions as do seedlings of Texas Dwarf white milo. An accumulation of soluble carbohydrates is a definite requirement for anthocyanin synthesis and any condition that affects this accumulation also affects the amount of anthocyanin produced. Thus, in nature cool temperatures would operate to reduce respiration, thereby allowing an accumulation of sugars and a corresponding production of anthocyanin.

Light exerts a most emphatic control over anthocyanin synthesis, and it is the photocontrol of anthocyanin that we wish to consider here. When all other conditions are optimum, anthocyanin will usually not be formed in the absence of light. In the few instances where some an-

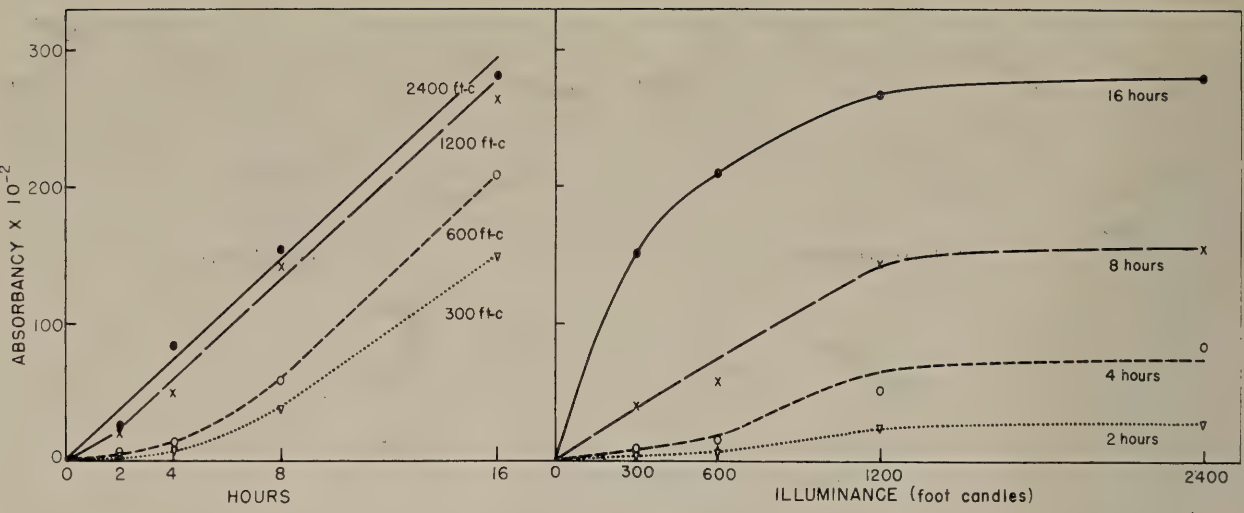

Fig. 2. Amount of anthocyanin formed in response to various durations of light from fluorescent lamps at several illumination levels. Measurement was made after a 24-hour dark incubation period (left). Amount of anthocyanin formed in response to various illumination levels after several durations of exposure to light from fluorescent lamps. Measurements were made after a 24-hour dark incubation period (right).

thocyanin is produced in darkness, the amount is increased many fold when the plant material is illuminated. Since light can be introduced into a biological system with a minimum of disturbance to the cellular processes, it provides a unique tool for studies of the overall system of synthesis. Conversely, anthocyanin production provides an excellent physiological system with which to study the photoreactions involved.

Although anthocyanin appears in a large number of plants, its production has been investigated in detail (8, 9, 10, 11, 12) in only a few. We will confine our discussion to milo (11), turnip, and red cabbage seedlings (8), and to the skin of apple fruits (10).

Table 1. Formation of anthocyanin after exposures to 1,600 ft-c fluorescent light in several varieties of Sorghum vulgare *(milo, kaffir, and sorghum)*

Variety	*Duration of exposure (hrs)*	*A x 10^{-2}*
Wheatland	16	280
Sumac	16	256
Hegari	16	140
Leoti	16	34
Sapling	16	17
Planter	23	235
Chinese Amber	23	196
Dwarf Ashburn	23	175
Texas milo	23	134
Texas DW milo	23	77
Red Kaffir	23	32
Feterita	23	10

Milo seedlings grown in the dark do not produce any anthocyanin. If dark-grown seedlings three and one-half to four days old are placed in the light, they become a faint pink in about six hours. If the seedlings are placed in darkness for 20 to 24 hours after the light period, the elongate first internode becomes an intense red. An examination of the seedlings shows that the root, the coleoptile, and the rudimentary leaves are not necessary for the formation of anthocyanin in the first internode. However, the seed should remain attached to the shoot if an appreciable amount of anthocyanin is to be formed. If the shoot is removed and the seed left attached to the root, the root will form anthocyanin in the presence of light.

A large number of varieties of *Sorghum vulgare* form anthocyanin when the dark-grown seedling is exposed to light (Table 1). This discussion of milo will deal only with the responses of the variety Wheatland. The amount of anthocyanin formed by Wheatland milo seedlings is dependent upon the light intensity and the duration

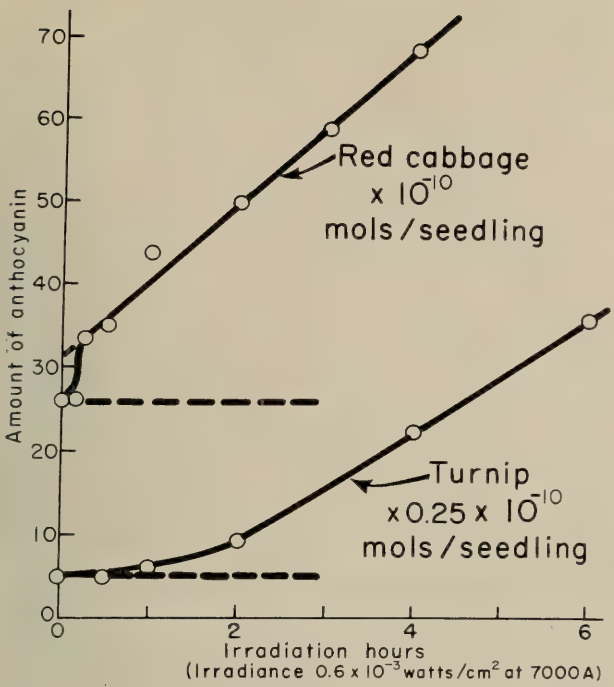

Fig. 3. Variation in anthocyanin synthesis in red cabbage and turnip seedlings with time of irradiation at a constant irradiance euqivalent in photochemical effectiveness to 0.6 x 10^{-3} watts/cm^2 at 7000 A. The seedlings were extracted for analysis 24 hours after the beginning of irradiation. Dashed lines indicate synthesis in unirradiated seedlings (8).

of exposure. However, double the intensity and half the time does not induce the same result as unit intensity and time. For example, doubling the illuminance from 1,200 to 2,400 ft-c does not increase the amount of anthocyanin appreciably, but doubling the time of exposure at 1,200 ft-c from 8 to 16 hours approximately doubles the amount of anthocyanin (Fig. 2).

At moderately high light intensities milo seedlings accumulate anthocyanin at a constant rate for at least the first 16 hours of irradiation. At lower intensities, however, a lag period of four to six hours occurs before the linear phase of anthocyanin synthesis begins. Light given continuously over a certain period is not utilized as efficiently as is light given in cycles. Light in cycles of 2 minutes light, 18 minutes dark over a four-hour period, for example, was used much more efficiently than it was in four hours of continuous light (Table 2).

The amount of anthocyanin formed by turnip and red cabbage seedlings is linearly dependent upon the duration of exposure to light (Fig. 3). Anthocyanin synthesis also depends on the intensity of the light, but intensity is not so important as time. As in milo, the reciprocity law fails in turnip and red cabbage. The time course for anthocyanin synthesis in turnip seedlings shows a time lag prior to the linear phase, whereas in red cabbage and milo it does not. Perhaps the time lag would disappear at higher energies, but they were not available at the time the experiments were conducted. Red cabbage differs from milo and turnip seedlings in that it makes an appreciable amount of anthocyanin in complete darkness.

The red color in apples requires light for its formation and the color variation of different kinds of apples indicates different abilities to synthesize anthocyanin (Fig. 4). Apple skin peeled from the apple fruit forms anthocyanin as well as it does on the fruit, providing the pieces of skin are floated on a sugar solution. Since the apple skin does not grow, it is a simpler total system than seedlings and therefore merits attention. Apples picked green were peeled and the green peel cut into 1-cm^2 sections. The sections were floated on 0.3 *M* sucrose and exposed to various

Table 2. Relative accumulation of anthocyanin per unit of light (11)*

Light per cycle (min)	*Relative accumulation per minute of light* (A x 10^{-2})
2	11.0
4	8.0
6	6.7
8	5.4
10	4.0
12	3.8
14	3.4
16	3.1
18	3.0
20	3.2

* One minute in each 20-minute cycle at an illuminance of 2,400 ft-c from fluorescent lamps. Total time was 4 hours; total light was 12 minutes.

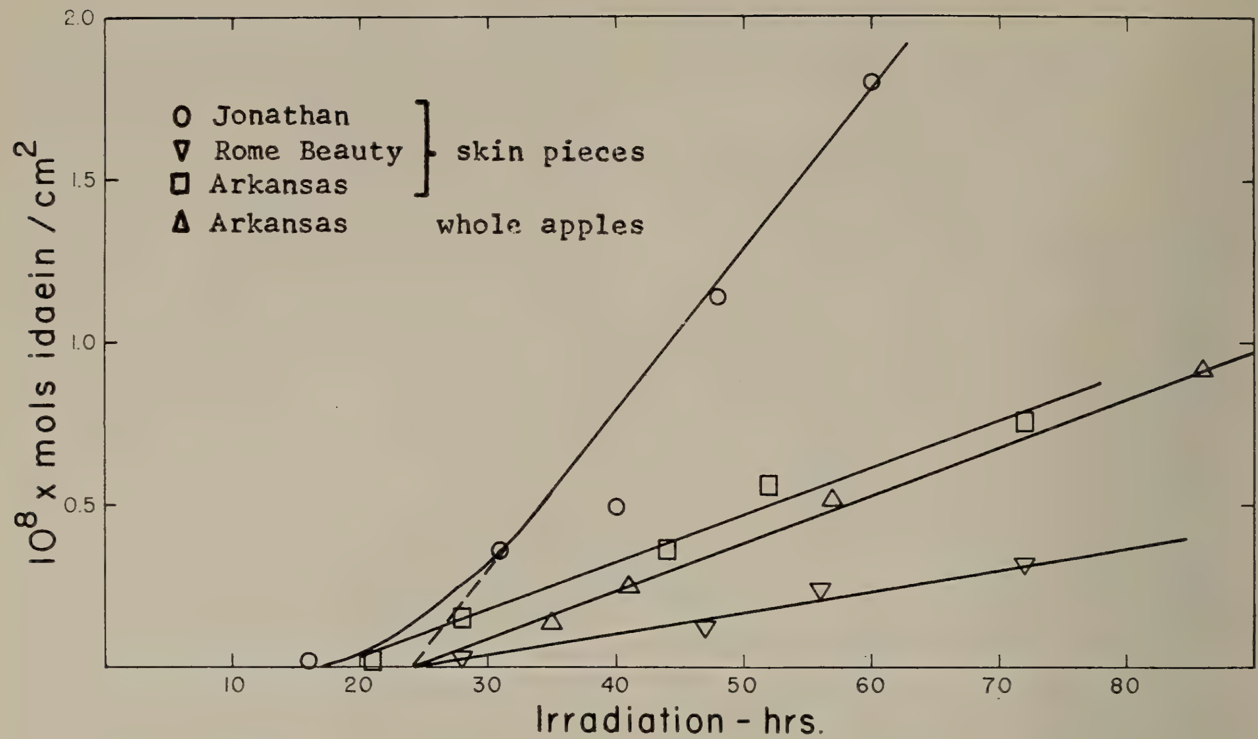

Fig. 4. The dependence of anthocyanin formation in apple skin on the time of exposure under constant irradiance with a fluorescent light source equivalent in photochemical effectiveness to 0.6 milliwatt/cm^2 at 7000 A. Results are shown for skin pieces of Jonathan, Rome Beauty, and Arkansas varieties floating on 0.3 *M* sucrose and for whole Arkansas apples (10).

light conditions. Following the exposure to light, the pieces of apple skin were allowed to incubate 24 hours in darkness. After the dark incubation, five sections of peeling were placed in 5 ml of extracting solution (1 percent HCl in methanol). The solutions were placed at 5° C for 24 hours, then the absorbancy at 530 mμ was measured in a spectrophotometer. Optical density was converted to moles idaein/cm^2 by using a molecular extinction coefficient of 3.43 x 10^4.

The time course of anthocyanin synthesis in apple skin (Fig. 4) shows a nonreciprocal time and intensity relation similar to that found in milo, turnip, and cabbage seedlings. Apples, however, require a greater period of illumination, and the time lag is so great that it may be regarded as a light-requiring preinduction period. During the preinduction period almost no anthocyanin is formed, but the duration of the preinduction period depends on the intensity of the light, the temperature, and the time for equilibration to occur between the appleskin tissue and the sucrose medium. The induction phase of anthocyanin synthesis in apple skin is linear with the duration of the exposure to light as was the case in milo, turnip, and red cabbage seedlings. During the preinduction period for apple and turnip some substrate rises to a level that permits formation of anthocyanin at a rate proportional to the intensity (10). No preinduction period is required in milo and red cabbage, which indicates an adequate level of substrate.

In order for light to produce a physiological response it must be absorbed by some substance within the plant. Photoreceptors generally absorb in specific regions of the spectrum; therefore they can be characterized by their absorption spectra. However, photoreceptors cannot always be isolated for direct absorption measurements, so the absorption characteristics are determined indirectly by the wavelength dependency of the response, that is by an action spectrum. An action spectrum is determined by placing the biological material in various wavelength regions of the spectrum and discovering how much energy is required at each narrow waveband to produce the physiological response being investigated. It follows that the narrower the waveband the more precise the action spectrum.

Action spectra not only characterize the spectral absorbance of the photoreceptor but they also equate different physiological responses to the same photomechanism. The effective use of action-spectra studies is found in the study of phytochrome. Action spectra showed that such diverse light-controlled responses as germination (13), internode elongation (14), leaf expansion (14), initiation of flowers (15), and pigmentation of the tomato-fruit epidermis (16) were controlled by the same photoreceptor. The absorption peculiarities of phytochrome revealed by the action spectra provided the assay by which phytochrome was subsequently extracted and purified (17).

Since phytochrome controls so many diverse plant responses to light, it seems natural to inquire as to whether phytochrome is also the photoreceptor controlling synthesis of anthocyanin. In order to make such an inquiry we must first understand the characteristics and *modus operandi* of the phytochrome system. Phytochrome exists in two forms; a red-absorbing, inactive P_r form that has a maximum absorption near 660 mμ; and a far red-absorbing, physiologically active P_{fr} form that absorbs near 730 mμ. When irradiated with red, P_r is transformed to P_{fr}, and when P_{fr} is irradiated with far red, it is converted to P_r. P_{fr} also slowly reverts to P_r in darkness. Generally, phytochrome-controlled plant responses require relatively low energies for brief periods of time. When the time required for a phytochrome reaction seems unduly long, it could be a result of a restricted supply of the substrate upon which P_{fr} acts. In that case we find that pulses of red radiant energy as well as continuous light keeps enough P_{fr} present long enough to induce the plant response. The frequency of the pulses must be great enough that excessive dark reversion of P_{fr} to P_r does not occur during the intervening dark periods.

Detailed action spectra for anthocyanin synthesis of milo, red cabbage, and turnip seedlings, and for apple-skin sections were determined with a large prism-type spectrograph (18). All material studied showed that irradiation in the blue region of the spectrum resulted in anthocyanin synthesis. Activity at longer wavelengths, however, varied from none in milo seedlings to maximal activity at 650 mμ in apple skins, at 690 mμ in red cabbage, and at 725 mμ in turnip seedlings. Because of the long-wavelength response, the possible control of anthocyanin synthesis by phytochrome was examined. Red cabbage seedlings, which form some anthocyanin in darkness, were irradiated briefly with red or red imemdiately followed by far red. The red radiant energy induced an increase in anthocyanin content as compared with synthesis in darkness, and the effect of the red was reversed by a subsequent far-red irradiation (Table 3). However, phytochrome was not clearly resolved as the principal photoreceptor or as a secondary control mechanism. Turnip

Table 3. Anthocyanin formation in turnip and red cabbage seedlings irradiated with an energy of about 0.1 joule/cm^2 of red (580-690 mμ) and/or far red (690-800 mμ) (8)*

Type of irradiation	Anthocyanin content per seedling: Red cabbage	Turnip
	10^{-10} moles	10^{-10} moles
None	25	2.97
Red	38	2.94
Far red	26	2.97
Far red, red	37	—
Red, far red	29	—

* Turnip seedlings were irradiated after induction of anthocyanin synthesis by exposure for 4 hours to a fluorescent source.

seedlings were irradiated for 4 hours to induce anthocyanin formation then irradiated with red or far red, but anthocyanin synthesis was unresponsive to the state of phytochrome.

In milo seedlings anthocyanin is clearly controlled by two photoreactions. The first photoreaction requires high intensities of light and exposures of several hours, and it has a maximum sensitivity near 470 mμ. The second reaction controls the effects of the first one and is a typical phytochrome response. Intensities are low, exposure times are a matter of minutes, and a maximum inhibitory effect is obtained between 710 and 750 mμ. The effects of the far-red irradiation are reversed by a subsequent irradiation in the red region of the spectrum between 630 and 670 mμ (Table 4).

Apple anthocyanin seemed to be unresponsive to the state of phytochrome. However, these early tests were made at the close of the total light period of about 40 hours. More recent investigations have shown a definite phytochrome control of anthocyanin synthesis in apple-skin sections. An inquiry was made into the stability of the products of the preinduction period which seemed to be required for successful operation of the linear induction phase. When various durations of darkness were placed between the preinduction and the induction phases, about 40 percent of the effect of the preinduction period was lost in about 24 hours (Table 5). If the dark period was preceded by a brief irradiation with far red, the loss of preinduction effect was greater. The effect of the far red was reversed when the far red was followed by an exposure to red (Table 6).

The details of the photocontrol of anthocyanin synthesis are confounded by the presence and operation of two photoreceptors; one is unknown and the other is the ubiquitous phytochrome. Siegelman and Hendricks (8) called the first photoreaction the high-energy reaction (HER) because it required more energy than did

Table 4. Reversibility of anthocyanin formation by far-red and red radiant energy (11)*

*Exposures *** Far red (number)	Red (number)	Anthocyanin ($A \times 10^{-2}$)
0	0	106
1	0	48
1	1	106
27	26	45
27	27	109
38	37	48
38	38	97
42	41	49
42	42	103

* After 3-hour exposure to an illuminance of 2,000 ft-c from fluorescent lamps.

** Three minutes of far red; 1 minute of red.

Table 5. Idaein formation in pieces of Arkansas apple skin as affected by a dark interval between the 16-hour preinduction and the 24-hour induction periods

Dark interval (hours)	*Idaein* (10^{-6} *moles/cm*^{2})
0	6.92
24	4.27
32	4.06
48	1.76
56	1.45

Table 6. Idaein formation in pieces of Arkansas apple skin as affected by the condition of phytochrome at the beginning of a 24-hour dark interval separating the 16-hour preinduction and the 24-hour induction periods

Treatment	*Idaein* (10^{-6} *moles/cm*^{2})
No dark interval	5.72
24-hr dark interval	3.45
10 min far red, 24-hr dark interval	2.88
10 min far red, 5 min red, 24-hr dark interval	3.58

phytochrome. The name has been perpetuated by Mohr and is involved in other plant responses to light than anthocyanin synthesis (9, 12).

What is the HER and what is the photoreceptor? Photosynthesis is a possibility because it is a high-energy system and is

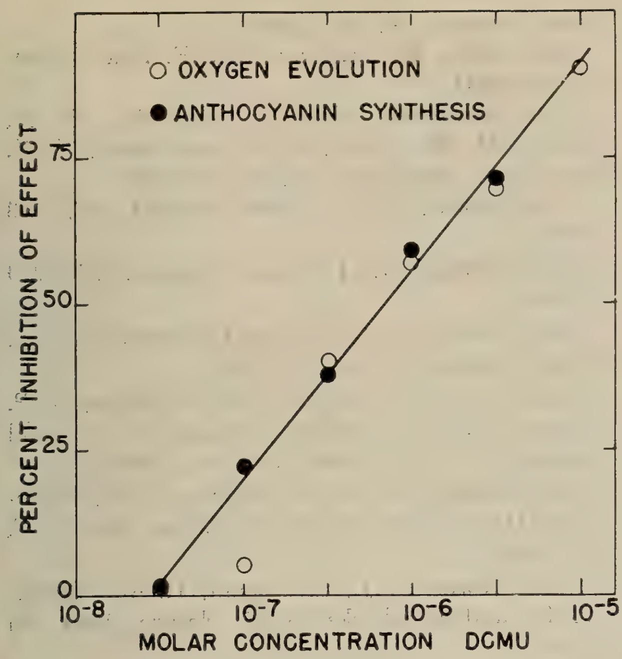

Fig. 5. Inhibition of photosynthesis (oxygen evolution) and anthocyanin synthesis in apple skin by 3(3,4-dichlorophenyl)-1,1-dimethylurea (DCMU).

active in the red and blue regions. Moreover, chlorophyll is present in the apple skin and photosynthesis does take place (19). However, the production of soluble carbohydrate by photosynthesis has been ruled out because the young seedlings used for anthocyanin studies are still self-sufficient from cotyledons (12) and endosperm, and sucrose must be added to the medium for apple-skin sections if an appreciable amount of anthocyanin is to be produced. However, the processes of photosynthesis might be required to supply some substrate other than soluble carbohydrate.

Emerson et al. (20) showed that the poor yield of photosynthesis produced by far red was enhanced by supplemental radiation of shorter wavelengths. From this enhancement effect and the subsequent work of Duysens (21) and others, it is generally agreed that electrons are transferred from water to pyridine nucleotide by two chlorophyll systems. Wavelengths in the region of 680 to 730 $m\mu$ are generally more effective in system 1, and action spectra for photosynthesis responses which are closely related to system 1 have maxima in the region. System 2 contains most of the chlorophyll b, and photosynthetic responses which depend on system 2 generally show an action maximum at 650 $m\mu$.

One manifestation of the dual pigment system is the change in fluorescence of chlorophyll that accompanies supplemental radiation in the red and far red. Apple-skin sections show a 30 percent greater fluorescence yield following supplemental red as compared to far-red radiation. Thus, the dual pigment system functions in the apple skin (19).

DCMU (3(3, 4-dichlorophenyl)-1, 1-dimethylurea) inhibits photosynthetic electron transport without interfering with other metabolic reactions. The fluorescence enhancement in the apple skin was inhibited 75 percent by 2×10^{-6} M DCMU and a concentration of 1×10^{-6} M inhibited oxygen evolution and anthocyanin synthesis by 50 percent (19). The inhibition of oxygen evolution and that of anthocyanin synthesis in the apple skin were the same for a number of DCMU concentrations (Fig. 5).

The action spectrum for anthocyanin formation in the apple skin suggests that chlorophyll system 2 might be contributing to anthocyanin synthesis. Since the carbon substrate for the HER must be supplied by exogenous sucrose, the photosynthetic system is apparently contributing a supply of an oxidant or reductant, or an energy source such as ATP.

The subsequent control by phytochrome indicates that P_{fr} action occurs on some product of the HER and is, therefore, a separate and different photoreaction than the HER.

The HER maximum in the far red that induces anthocyanin formation in other plant tissues (8, 9, 12) resembles the action of photosynthetic pigment system 1. Although data are not available to support the hypothesis that pigment system 1 is the HER for anthocyanin synthesis in these plants, the idea is not incompatible with the facts, and investigations of this type are currently in progress.

References

(1) Arthur, J. M. Biological effects of radiation, ed. by Duggar, B. M., Vol. 2, pp. 1109-1118, McGraw-Hill Book Co., 1963.

(2) Senebier, J. Physiologie vegetale, Geneva, 1799.

(3) Onslow, M. W. The anthocyanin pigment of plants, 2nd ed., Univ. Press, Cambridge, 1925.

(4) Willstätter, R. Ann. Chem. (Liebig) *401*, 189-232 (1913).

(5) Harborne, J. B. J. Chromatography *1*, 473-488 (1958).

(6) Geissman, T. A., and Jurd, L. Arch. Biochem. Biophysics *56*, 259 (1955).

(7) Acheson, R. M., Harper, J. L., and McNaughton, I. H. Nature *178*, 1283 (1956).

(8) Siegelman, H. W. and Hendricks, S. B. Plant Physiol. *32*, 393 (1957).

(9) Mohr, H. Planta *49*, 389 (1957).

(10) Siegelman, H. W., and Hendricks, S. B. Plant Physiol. *33*, 185 (1958).

(11) Downs, R. J., and Siegelman, H. W. Plant Physiol. *38*, 25 (1963).

(12) Mohr, H., and van Nes, E. Zeit. f. Bot. *51*, 1 (1963).

(13) Borthwick, H. A., Hendricks, S. B., Parker, M. W., Toole, E. H. and Toole, V. K. Proc. Nat. Acad. Sci. *38*, 662 (1952).

(14) Downs, R. J. Plant Physiol. *30*, 468 (1955).

(15) Downs, R. J. Plant Physiol. *31*, 279 (1956).

(16) Piringer, A. A., and Heinze, P. H. Plant Physiol. *29*, 467 (1954).

(17) Borthwick, H. A., and Hendricks, S. B. Science *132*, 1223 (1960); Butler, W. L., and Downs, R. J. Sci. Amer. *203*, 56 (1960).

(18) Parker, M. W., Hendricks, S. B., Borthwick, H. A., and Scully, N. J. Bot. Gaz. *108*, 1 (1946).

(19) Downs R. J., Siegelman, H. W., Butler, W. L., and Hendricks, S. B. Nature, 1964 (in press).

(20) Emerson, R., Chalmers, R., Cedarstrand, C., and Brody, M. Science *123*, 673 (1956).

(21) Duysens, L. N. M. Proc. Roy. Soc. *B 157*, 301 (1963).

The Teaching Crisis*

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Forty-one years ago this month, Professor Ben Peterson gave me the first teaching assignment in which I had complete charge of the course. This was a class of student nurses who were taking chemistry at night after spending 12 hours mopping floors, emptying bed pans, and doing all the thousand and one chores that were expected of student nurses in those days. How much the nurses learned cannot now be determined, but I learned some chemistry and I learned to love teaching. From that day to this, I have been associated with universities, always either as an active teacher or in administrative work closely allied to teaching. I am now becoming increasingly concerned with the pressures that are continually being put on professors to devote portions of their time, often large portions, to activities other than teaching. These pressures at times cause the professor to neglect his teaching and at other times drive him completely from teaching. Both are events that even rich America cannot afford. It is to this problem that I wish to address myself tonight, and my excuse for taking your time is that the past 41 years have given me some background in this area.

* Address of the retiring president before the Washington Academy of Sciences on February 20, 1964. The opinions expressed in this paper are those of Dean Van Evera alone, and are not necessarily those of either George Washington University or the Washington Academy of Sciences.

I am not the only person who is concerned about this matter. John Kemeny, professor of mathematics and chairman of the Department of Mathematics at Dartmouth College, wrote an article in the *New York Times Magazine* for June 2, 1963, entitled "Once the Professor was a Teacher . . . ," the subtitle of which is "Now all too often he is a researcher or a consultant, and his students seldom see him." Paul Gross, writing in *Science* for November 8, 1963, on the general subject "R&D and the Relations of Science and Government," states on page 648, ". . . there is now an over-emphasis on research at the expense of teaching . . ." In a letter to the editor of *Science* on November 10, 1961, Paul J. Kramer of the National Science Foundation writes, "The effects on undergraduate teaching of an excessive preoccupation with research on university campuses is seen in the fact that most of our graduate students come from colleges where little research is done, and relatively few come from universities where research occupies much of the time and energy of the staff." And again he says, "It seems possible that a well-taught freshman course and a few good students inspired to go into graduate school may be a greater accomplishment for most of us than our research." The problem as I see it is that everything possible is done to discourage excellence in teaching, with few exceptions.

Teaching itself is looked down on. The old saying, "Those that can, do. Those that can't, teach," has a large place in the back of too many people's minds. Research and consulting have been glamorized until they are considered to be the chief end of man.

The teacher is often tempted away from his classroom for longer or shorter periods of time either for money, which his low salary makes very attractive, for more glamorous and publicity-producing service on national boards or committees, or for work which he feels a social or patriotic duty to undertake.

Teaching salaries are so low that most college professors and high school teachers are not able to live on their salaries and must seek ways to supplement them. Teachers are hired for only nine or ten months a year and so must hunt for extra work in the summer if they are to have incomes during the summer. If they are known for their research, they can usually get something to do. But if they are merely excellent teachers, they are likely to have great difficulty.

Now some things are being done for teaching. The National Science Foundation supports both in-service institutes and summer institutes. But these are aimed largely at improving the technical knowledge of high school teachers, and in that respect they have helped high school teaching greatly. The conferences for college teachers similarly serve to help them. And some awards are made for excellence in teaching. But these attempts to ameliorate the situation either are completely inadequate or else do not strike at the root of the problem.

Perhaps now is the time to put our teaching into perspective. In America our secondary schools do only teaching—no research. I wonder what would happen if our high school teachers of science were encouraged to do some research. After all, Pasteur was teaching in a French secondary school when he started on his series of scientific triumphs. But our American pattern is teaching only.

The job of the university is different. A university must teach, and it must do research. Originally, teaching took precedence, between the two world wars teaching and research approached equality of emphasis, but now the research is so heavily emphasized that teaching tends to be given a minor role. This is the situation that I wish to discuss tonight, and my discussion is primarily a plea for the development of rules, rates of pay, and government policies that will restore a normal balance of effort between teaching and other activities, including research.

The late Graham DuShane said it all in

a few words in an editorial in *Science* in the issue of July 21, 1961: ". . . few university faculty members believe that time devoted to teaching will receive either recognition or reward. It is a more usual, and probably a more realistic, view that time taken for teaching is time stolen from research, and that the road to academic heaven is paved with publications." The bitter part of the pill is that usually the quality of the publications is never taken into account. In the mad race for numbers of publications, research results are published in as many pieces as possible, each giving a separate publication, and the result has been a flood of publications that is so great that no one can keep up with his field.

The size of this flood is indicated by the following quotation from *Modern Documentation and Information Practices*, edited by O. Frank: "It has been estimated that if a chemist, fluent in 30 languages, started on January first to read all the papers in his particular field for 40 hours a week at a rate of four articles an hour, then by December 31st he would have read not more than 1/10 of all the material published during that year, from which the benefit would be nil, as he would have no time left to do anything with the knowledge thereby gained." How unworthy of reading is much of this material is shown by the fact that even without reading it the forward pace of science approaches the supersonic.

One of the myths of the teaching profession is that, if one is to be a good teacher and an inspiring one, he must have some research going on. This was stated to me very authoritatively in September of 1942 when, at the meeting of the American Chemical Society in Buffalo, N. Y., I appeared before the Society's committee on professional training in an attempt to get the chemistry department at George Washington University on the approved list.

Parenthetically, here is as nice a piece of weasel-wording as anyone could desire. The ACS does not accredit chemistry departments, it puts them on an approved list. What the difference between being on an approved list and being accredited is I have never been able to understand. One thing I do know—if you are not on the list, you are discredited!

But to get back to Buffalo. After I had been questioned about the research activities of our department, the chairman of the committee pontificated that in his opinion no teacher could do a good job of teaching if he were not interested also in research. Since I was the supplicant before the all-powerful, I was scarcely in a position to point out the reasons why I thought he was—and is—wrong. Now I am no longer under the scrutiny of this awesome group, so here are those long-suppressed reasons.

1. No one has ever reported a study that proved that researchers in general make better teachers than those who devote their time to teaching alone.

2. No one has ever reported a case of a professor's teaching being improved just because he started a research project. If he is teaching on a graduate level, the literature review that we hope he made before starting the research and the intensive follow-up that he must pursue might give added depth to a course in that specialty. But if it is a general course such as general advanced organic chemistry, for example, the balance of the course may be upset if he is so enamored of the small area in which he does research that the rest of the field is neglected. This happens.

3. The biggest source of inspired, young, graduate students was then, and still is, the small liberal arts college, as Kramer says in the quotation referred to earlier and as studies made by the National Research Council also show. If research inspires so much good teaching, why aren't most of the good graduate students the product of our great university departments that do so much research? This situation is the more damning because the great research universities have the

glamor to attract the better high school graduates.

No, I have been presented with nothing more solid than opinions to support the claim that research is essential to top-quality teaching, and I believe that the record of the small colleges in producing graduates who do well in graduate school and in industrial chemistry is solid evidence to the contrary. One of our folk sayings is that the proof of the pudding is in the eating, and this is a very tasty dish. That is why I call this statement a myth.

Research, however, is easy to measure, for published papers result, and the counting of these is not arduous work for the administrator who evaluates the professor, but who is unable in most cases to evaluate the papers he counts. Neither is it arduous to add up the number of dollars brought to the university as research support for the professor, and these may both be used in evaluating him. But to evaluate his teaching is another matter.

How does one evaluate teaching? It isn't easy, for there is little that is quantitative, and much of what can be measured must be evaluated in the light of other immeasurables. For example, a professor may have a very low failure rate in his classes. But this may mean that he has taught well or that he is an easy grader or that he is a superficial examiner, and any evaluation must include consideration of the quality of students that he had. If these students take one of the national examinations, such as the cooperative examiinations in chemistry, and if they score well, then he probably taught well. If his students, taking a successive course in a series, demonstrate in the succeeding courses that they know well the material of the course taught by our professor, then one knows that he taught well. If the students' grades on the graduate record examinations now required for admission to many graduate schools are high, then the department as a whole has taught well. And finally, if a department's students are able to enter graduate schools and hold their own with their classmates, then the department has taught at least as well as the other departments. In other words, the product resulting from the professor's teaching must be evaluated. That is the only real test of any operation and, for the teaching operation, it isn't easy.

One can inquire of students as to their opinion of the professor as a teacher, but here one must be careful. Many students are not discriminating and think a shallow but entertaining teacher is a good one. A poor student always says that the teacher is no good, a defensive reaction that is understandable but which too few deans, in interviewing students who are doing poorly, take into account. The opinions of selected good students are much more reliable, for that is the type of student who likes a challenge and appreciates it.

As an example, I will cite one case about which I know. This teacher was rated highly by the department and by the better students who were in her classes. She fired a number of her freshman students with a love of chemistry which they never lost. But because she had high standards, a number of her students didn't do well and were interviewed by the dean because they had poor grades. According to them, their academic failures were all her fault. So the dean decided she was not a good teacher. I personally begged him to talk to some of the better students and get their opinion of her, but he couldn't be bothered. As a result, this excellent teacher has left teaching, and is now pursuing an outstanding career in government service. But our society is the loser, for her caliber of teacher is very rare.

The evaluation of teaching is at best a difficult and time-consuming job, and it is little wonder that it is usually poorly done. The sad thing about it is that poor teaching is difficult to catch up with, and when it shows up in the students' work years later it is too late to do anything about it. The student may have been handicapped for life or discouraged because of later failure caused by the poor teaching in that one course. He may then be deflected into some line of activity for which he has much less basic ability and for which society has much less need.

The feeling of the teacher that time spent on teaching will bring him neither recognition nor reward is real and it is justified. Take the matter of recognition. This Academy, on the record, gives five awards each year—four for excellence in research and one for excellence in teaching. Twice the awards committee has rebelled—two years ago when two teaching awards were made, and this past month when three teaching awards were made. But for the record, there is one award for each of four areas of research—in each of which teaching is done—but only one for teaching. The Chemical Society of Washington gives one award—the Hillebrand prize—which is for research. There is no award for teaching. The American Chemical Society gives one award for contributions to chemical education, in the description of which teaching is implied but not specifically listed (it is listed as "training of professional chemists"); one for contributions to inorganic chemistry which may include teaching; two for distinguished service to chemistry, not further detailed; one for public communication in the field of chemistry; one for outstanding public service; and 20 for excellence in research. Certainly very little recognition of teaching there.

One bright spot in the picture is the Manufacturing Chemists Association, which offers six awards annually to college teachers and no other awards at all. The Association makes quite an affair of the presentation, and these awards have achieved a very high stature. There may be similar awards in other areas of science, but I am not aware of them.

High school teachers get somewhat better treatment, at least in this area. One of the three awards in teaching given by this Academy last month was to a high school teacher; and yesterday at Engineers, Scientists and Architects Day 12 high school teachers were recognized for their teaching. On the college level, there is relatively little recognition for good teaching.

Now let's look at the rewards. There just isn't any real comparison between teaching salaries and industrial or research salaries or even government salaries. During my years of active teaching at George Washington University, there was never a year when I did not have students in my classes whose salaries were higher than my own. Ah yes, you say, but in teaching you have your summers off and you can do consulting. What this really means is that the professor is hired for nine or ten months and, if he wants an income during the summer, he had better find a job to bring it in; his employer assumes no responsibility for it. And when you say that he can do consulting, you are saying that you pay him a low salary so he has to moonlight, much as one pays a waiter a small salary and expects him to make it up in tips—only there aren't any tips, just extra jobs.

I have no objection to a professor's consulting in order to broaden his background or because his knowledge and talents are needed by our government, but I do object to salary scales set so low that he *has* to do consulting. I do not fear contradiction when I say that a majority, and it may be a huge majority, of the professors in these rich United States of America cannot live in a style suited to their positions in society on the salaries they are paid and that the majority have either a second job, a working wife, or a private income. The purpose of this is not high living but to be able to send Butch and Peggy, and in some cases Bill, Mary, and Elaine, to colleges of their choice, to take his wife to the theatre occasionally and to the symphony, and to enjoy the other amenities of life we like to think of as typically American.

One puzzling thing is that many members of the teaching profession itself are helping to denigrate teaching when they boast of their small teaching loads. Indeed, the small teaching load has now become a status symbol, as has attending endless conferences, or being a visiting professor whether for a few lectures or one or more school terms, or being called to Washington as an expert. All these keep the professor out of his classroom for long periods or provide an interruption to his classes. In either case, the student suffers. For too few professors nowadays do the students come first. Kemeny in his article refers to the professor who gets an offer from another institution and whose own institution, rather than increase his salary, cuts his teaching load in half. This means that the cost of teaching at his institution is doubled, where a 10 percent raise would have been cheaper but would have put our professor out of line salary-wise. Now the university cannot afford to have its teaching costs go so high, so rather than get another professor of equal rank and salary to teach the other half of our professor's teaching load, the university will have a graduate student or other cheap "help" meet these classes. The students will suffer from the poorer teaching, and the university and the professor apparently do not care. Possibly neither realizes it, which implies unforgivable stupidity. Later when these students appear as graduate students, the professor is likely to wonder why they are so poorly prepared.

This drive for the professor to do things other than teach, then, results either in less than conscientious teaching or in no teaching at all. Both are bad, but the latter is the more honest. And now what are the forces causing this calamitous situation?

One is stupid university administration —the evaluation of professors on the basis of research or consulting activity rather than on the basis of their teaching. It is one thing to want your staff to publish, but as soon as one adopts the policy of publish or perish, the purpose of the publication is to get a promotion, not to transmit one's findings to one's fellow scientists. Further, the need to get out a publication in order to get the promotion often causes the professor to devote to his research and writing much of the time he should spend on preparing for his classes.

A second reason is akin to the first. This is the overemphasis on research by society. Young men get together at meetings and compare numbers of papers published, or numbers of research grants, or numbers of dollars in research grants, so that research grants and papers published become status symbols; there are few comparable status symbols for teaching. Oh, yes, the National Science Foundation gives hundreds of postdoctoral fellowships and faculty fellowships, but the recipient usually spends his time doing research in someone else's laboratory, which will at best have only an oblique effect on his teaching. Perhaps here is where the low teaching load status symbol develops.

A third reason is economic. Teaching salaries are far too low. I have already mentioned how the average professor has to hunt for income during the summer, whereas if he has a research grant he may be paid from that during the summer. But to get the grant, he has to have a research program going, not a good teaching program.

The way our teachers are paid in this country is a social crime, and in this I include teachers at all levels in all but a few institutions. I refer to the practice of paying teachers only during the school year and letting them scavenge for scraps in the summers. To add to the insult, teachers in the grades and high schools are required to go to summer school at their own expense. Industry not only pays better salaries the year round, but often will pay all or part of the cost of any additional courses the employee takes, frequently on company time.

It is little wonder, in a society that puts so much emphasis on big cars and big houses and expensive ways of life, that teachers are looked down on as being somewhat below normal. The average person reasons that if the teacher really were smart, he'd be in the money. So from him teachers receive only an outward show of respect.

A fourth pressure is social. Our government requires the advice of scientists in great amounts. It has become almost a social requirement certainly, and is also a professional requirement, that one serve on the many boards and committees set up by more and more government agencies. If one has never been asked to serve on one of these, one just hasn't arrived. And, of course, if one is to be asked he has to be known, and he gets known by publishing the results of his research rather than by the quality of his teaching. This adds to the financial pressure, too, for the work of many of these committees is time-consuming and unpaid. Apparently, someone has decided that the decisions of these committees are more pure, more free from bias and prejudice, and more sound if made by men who are given no honoraria. The federal government can give millions annually to dictators around the globe who slap Uncle Sam's face as a matter of routine, but it can't give these committeemen an honorarium.

As a matter of fact, this service on committees is really a contribution from the university which pays the scientists' salaries. I am under the impression, which may be wrong, that most of these committeemen are university professors. If this is not true, then give industry, as well, credit for a substantial contribution. Industry can forbid its men to serve on these committees. Universities cannot for two reasons. One is that one does not forbid professors to do what the professor wishes to do professionally unless he seriously neglects his assigned duties, and second, a university is a public service institution and so is bound to allow its staff to do public service jobs of this type. But the universities are understaffed and can ill afford a great deal of this. One can say, as some do, that this is just a drop in the bucket, and that is true, but of what is a bucket filled? Drops. President Johnson has just announced that he has cut the White House light bill from $5,000 to $3,000 per month by turning off individual lights.

All this absence from the campus doesn't help a man's teaching one bit. Let me quote from the article by Kemeny to which I referred earlier:

> "A great deal of scientific manpower is spent advising the Government. To assure that Federal funds are spent wisely, panels are called to Washington. For example, to award various summer institutes, 50 scientists take a week off from their universities. Has anyone evaluated the harm done by disrupting 100 classes for a week?"

Stop and think about it. A course is not just a series of lectures; it is, or should be, an organized discussion of a subject divided into finite pieces by the demands of the clock and the physical and mental limitations of both teacher and student. Any piece of this that one misses weakens the whole. One can get a colleague to stand in front of the class and discuss the same subject, but he has a different view of the subject than the professor has and there is at least an even chance that his bit of the course will not fit properly into the mosaic that the professor is creating.

In colonial times, the prime requisite of the teacher was that he be able to lick the biggest boy in the school. Anyone who could do that could maintain order and was, therefore, able to teach. After all, he had been to school and had seen how teaching was done. From this has grown an American idea that a teacher is the person who stands in front of the class and talks, that anyone who can stand in front of the class can teach, and that teachers are completely interchangeable. If professor X can't meet his class, graduate student Y can do it for him. Y can use some teaching experience, and who worries about the students?

The point is that some government policies and actions are contributing to the deterioration of teaching at the same time that they are trying to improve teaching. Taking professors out of the classroom for even short periods of time is not good. It is the shame of the profession that they let themselves be taken out.

Another government policy that is not helping teachers is the insistence of those government agencies that give pre- and postdoctoral fellowships that the primary activity of the holder be research, and that only a bare minimum of teaching be allowed. The result is that the young scientist is shown that research pays and teaching doesn't, for it's obvious that if teaching were considered important he would be expected to do some.

Let's face it. Good teachers do not grow out of research activity. They grow because they serve as teaching assistants under great teachers—as Professor Charles Naeser did under B. S. Hopkins of Illinois, and as Dean George Koehl did under the late, great Thomas B. Brown. Not all who served these apprenticeships became great teachers, of course, but many did, and the good graduate schools were the training ground for good teachers as well as good researchers. It was men like those I have mentioned who set high standards of teaching and conduct. Unfortunately, today's holder of a fellowship—and very nearly all graduate students nowadays are bought and paid for with fellowships of one kind or another—is frequently forbidden to assist in teaching at all or is so limited in amount that he never gets any real training in teaching. He is fed on research; he is shown the path to glory; and by implication, by action, and often by the terms of his fellowship he gathers that that path is the research path. If this young man accepts a post in a university, he is likely not to know much about how to teach in the first place, and moreover he is likely to consider it an activity of secondary importance. It is from this that a low teaching load has come to be a status symbol.

But there is another unfortunate aspect of our national policies on fellowships. The fellowships are given to the very best students, a worthy aim of course. But this means that the holders of teaching assistantships are frequently those men and women who cannot qualify for the more remunerative and more prestige-bearing research fellowships. In other words, in too many cases our present teaching fellows tend to be second-rate students.

These are the students who are inspired to go into teaching because they are teaching under good men. But the students they teach may suffer because these second raters are not first raters. One may say that frequently the man who is not superior in research actually makes a better teacher, and this may be so. But it is far different to conclude that this justifies conditions which discourage our more brilliant young people from going into teaching. We need replacements for the likes of Pauling and Hildebrand and Brown, top-flight scientists who loved teaching and who, while doing solid pioneering research, were proud of their work in the classroom, preparing for their classes with the same care that they prepared for their research. The present system is, in my opinion, not set up to get men of this caliber into teaching except, perhaps, as the teaching is affiliated with their research.

In summary, then, my story is that the future of American science is in jeopardy because we are not encouraging our best young scientists to go into teaching, and that the factors which tend to discourage them are:

(a) We are not training them to be teachers, not giving them a chance to teach in their formative years.

(b) We glorify research from the time the student gets his first fellowship and, in later life, his rewards are likely to depend upon his research much more than on his teaching.

(c) If he goes into teaching, he can look forward to a very thin pocketbook.

And now what can be done about this?

With regard to our failure to train them to be teachers: The givers of the fellowships should require that all fellowship holders do some teaching unless excused by the chairman of the department. This might help in lessening the glorification of research. Professional societies can help by rewarding teaching as thoroughly as they do research, and university administrators must study the teaching of their staffs more thoroughly, so that teaching is properly rewarded in its own home. The public attitude toward teachers will change when this is done, and when teachers' salaries become more adequate.

The economic problem of the professor can be solved very simply. Just give him a pay raise with employee benefits and the operating support he needs to make his position competitive with industry.

The problem is money. Universities and colleges with few exceptions just do not have the funds required for modernization of buildings, expansion of campuses, and increasing salaries. There was a time when an enterprising college president could raise millions, sometimes from a single individual, as Harper got millions for the University of Chicago from Rockefeller. But those days passed with the coming of the confiscatory income tax. Today, some of the better known schools are able to raise substantial amounts of money, largely from wealthy alumni, but in general this is not the case. Some of the state-supported universities are able to maintain proper budgets, but again this is not the rule. What is required is a new way of funding these universities, and there is lots of talk of federal government support.

Now of course, all this federal money comes from the people, you and me. These signs one sees on road construction sites, to the effect that the cost of this project is met 90 percent by federal funds and only 10 percent by local funds, are an attempt by the bureaucrats in charge to pull the wool over the average citizen's eyes, and it is little credit to that citizen's intelligence that the propaganda is successful. The truth of the matter is that all of this money is local money, but 90 percent detours en route via the federal government, with some not negligible dissipation on the way as overhead. So let's face it: When funds to support education come from federal sources, they originally came out of our pockets, not out of Santa Claus' pack.

But federal funding means eventual federal control, and all the protest in the world cannot disprove that statement. Already the federal government sets down conditions for getting federal funds. One has to swear that he will not discriminate against anyone because of race, religion, or color—a control to achieve an object now deemed desirable by the federal government. So the principle of federal government control has been established. Tomorrow it may be deemed desirable that everyone who enters college should take some particular program of study, and all colleges may be forced to require it if they are to get federal funds. Far-fetched? It is not.

Last year the American Council on Education held a conference at the Mayflower Hotel in order to acquaint personnel from the colleges and universities with governmental programs of support. One of the programs is a National Science Foundation program which provides funds for the purchase of equipment for the teaching of science. The young man describing the program made this statement: "The poorest reason for giving funds for this equipment is that the institution needs it." I was astounded and asked whether I had heard correctly. I was assured that I had, and the speaker proceeded to explain that they were anxious to support forward-looking programs. Determined as forward-looking by whom? The people who run the college, who know its problems, its clientele and environment? Not at all. The programs that are worthy of support are decided by a committee of busy individuals who in the nature of things cannot spend more than a few minutes studying each proposal.

This is the kind of government control now being exercised. The result is that many deserving and needy schools do not get the aid they need. How much this will magnify if the federal government expands its support of education is obvious.

What is needed is a plan that will support schools and colleges quite impartially. This cannot be done by bureaucratic distribution as is now done. What is needed is a formula by which funds may be made available directly. We use formulas for lots of things. Our income taxes are computed by formula. This isn't equitable, but it's a lot better than each of us having to have our income tax set by petition. And the federal government does support the land grant colleges according to a formula. So formulas do work, and the following plan is proposed as a way to aid education substantially, without federal control, without increasing the federal establishment, and with negligible overhead costs.

This plan involves the development of a formula by means of which any college or university could compute the sum which it might collect for the current year. The formula should be developed by representatives of the colleges, perhaps the American Council on Eduction. Let me be the first to state that no formula will be ideal—it will just be better than bureaucratic disbursement after supplication.

Now, Congress will have to do three things—decide how much money that otherwise would go into income tax should go to education, authorize the colleges to develop the formula referred to above, and authorize the issuance of special receipts by the colleges for these special gifts.

After Congress had passed the enabling legislation referred to above, the colleges would compute the funds that they might collect and send their estimates to some supervisory government agency, perhaps the Office of Education. This office would determine the total, compare it to the sum Congress decided it would like to see go to education, and prorate to each college its share of the total authorized.

It is then up to the college to collect donations. For each donation, the college issues a receipt, similar to the W-2 form with which we are all currently familiar. The taxpayer, in making up his tax return for the year, submits this receipt as evidence of tax paid.

The income tax people take all the special receipts, which are coded for colleges as well as taxpayer, determine the amount each college has received, and compare this total with the college's own report. This is the simplest kind of machine computation and can be done by existing personnel by missing one coffee break. After all, there are only 2,100-odd institutions of higher education in the United States.

Now, if Siwash College accepts more money under this plan than its allotted sum, that amount is deducted from next year's sum. If Siwash accepts too much the second year in a row, then twice the excess is deducted the third year. Since that amounts to 50 percent interest on a loan, it will happen only by accident and then only once for any institution.

This plan should be applied to all increases in college support, and should reach back to include some support now given. It might, for example, include a large amount of the funds now doled out on a job basis for basic research. It would not affect the collection of funds from private givers as now obtained.

The principle of the plan is simple. Congress decides how much tax money it wants to go to higher education. Higher education has to collect it. Controls on the amounts are built in by the penalty on the second year's overtake, yet a college can get extra funds in one year for extra large projects at no total penalty. The control of the expenditure of the funds is left right where it belongs—in the college or university—and there is no government control, influence, or audit. This is in a sense a proposed return to the days when the government got things done by leaving the doing in the hands of those who knew what they were doing and setting up incentives to make people do it. The railroads were built because the builders were subsidized with land. Our present airlines are given airmail subsidies, and our merchant marine would not exist without subsidy. The kind of motivation suggested here will cost the taxpayer no more than Congress is already talking about, it will increase the overhead not at all, and it will insure against federal control of our education.

If this sounds drastic, it is not. It simply applies to education the principle, long established in America, of getting people to do things by setting up conditions that will make them want to do them.

Throughout this talk I have been discussing teaching, and at times I have indicated that I think there is too much emphasis on research. Yet my title is Dean for Sponsored Research. How do I reconcile this apparent conflict? There is no conflict, for the operation of a university is a team operation, and both teaching and research are essential. A football team with an all-America backfield and a weak line is a sorry spectacle. In many ways, teaching is the forward wall—the line—of the university, for if the teaching is not strong, the university cannot be strong. We are doing much to develop a research capability but precious little, really, to develop and set up conditions that will encourage good teaching and a devotion to it. Until a proper balance of the two is restored, we are weakening our entire future.

Roots of Modern Climatology*

H. E. Landsberg

U. S. Weather Bureau

Just 50 years ago an eminent climatologist (1) wrote:

"So impossible is it to keep our heads above the rising tide of the new meteorological literature that we are neglecting, to our loss, the rich stores which lie buried in the books of a generation ago."

If the new literature was a tide then it has become a storm surge now, and less than ever do we have the leisure to look into the history of our science. Yet we can measure progress best by taking an occasional look back. We might even derive a bit of comfort by noting that vicissitudes beset our predecessors as much as us. If we are particularly astute, we might learn a good deal about the problems of planning in science.

All environmental sciences inherit a share of their knowledge from other, more fundamental fields. Climatology is no exception. Even in its earliest stages it partook of two very diverse fields, astronomy and medicine. A crude attempt is made here to depict various stages of development of this science, with special emphasis on its evolution during the 19th century. A table showing the early leaders in the field may serve as a convenient illustration (Fig. 1). This lists the personages who have made notable contributions, under headings of their main field of endeavor or early training. The date or dates of important publications of these individuals also are shown; these publications are listed in the bibliography. Monographic studies or books have been given preference over individual papers, and in the selection of the authors as well as the publications there is, of course, always an element of personal bias. Although it would be nice

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PEDIGREE OF CLIMATOLOGY

	MATHEMATICS	ASTRONOMY	PHYSICS	EARTH SCIENCES	BOTANY	MEDICINE
ANTIQUITY		ERATOSTHENES [-276 TO -194]				HIPPOCRATES [-460 TO -376]
EARLY SCIENCE ERA		(1755) J. T. MAYER [1723–1762]		(1774, 1788) L. COTTE [1740-1815]		
ERA OF EMERGENCE	(1832) L. F. KÄMTZ [1801-1867]	(1834, 1836) ??? P. MURPHY [1782-1847]		(1817, 1831) A. V. HUMBOLDT [1769-1859]	(1827) J. F. SCHOUW [1789-1852]	(1827) J. LOVELL [1788-1836]
FOUNDATION ERA	(1843) L. A. J. QUETELET [1796-1874] (1852, 1875) J. H. COFFIN [1806-1873]	(1853) J. C. HOUZEAU [1820-1888]	(1847, 1857, 1869) H. W. DOVE [1803-1879] (1853) A. C. BECQUEREL [1788-1878] H. WILD [1833-1902]	(1841) W. MAHLMANN [1812-1848] (1846, 1852) M. F. MAURY [1806-1873] A. H. GUYOT [1807-1884]	(1840) J. L. KLAUPRECHT [ ] (1852) A. E. DE GASPARIN [1783-1862] (1857) H. HOFFMANN [1819-1891]	(1842) S. FORRY [1811-1844] (1862) A. A. MÜHRY [1810-1888] (1873) ARMAND [ ]
CLASSICAL PERIOD			(1883) J. HANN [1839-1921]	(1868, 1869) A. BUCHAN [1829-1907] (1884) A. SUPAN [1847-1920] (1875, 1884) A. I. VOEIKOV [1842-1916] (1900) W. KÖPPEN [1846-1940]		

if one could trace each thought, principle, or method to its very origin, this is quite a difficult task and often requires access to unpublished or very obscure sources. I have rather used as a principal guide the appraisal of the contemporaries. Frequently quoted material, even if it is not the first source of an idea, has shown by the fact of many citations its impact on the development of the science. This logic includes textbooks which then often contained much original material and which reflect the state of the art of their period. They often also served as the point of departure and stimulus for a succeeding generation. A guide to some of this literature is contained in Hellmann's compilations (2).

Climatology as a separately recognized discipline started just about with the end of the 18th century. Standardized instruments had been developed and the first attempts at organization of a network had been made (3). A few decades of data were available. Travelers and explorers had been in nearly all parts of the globe and a fair appreciation of the wide variety of climates and their impact on plant, animal, and human population had become clear.

The crucial step from an accumulation of facts to a science is systematization and development of causal relations. A basic contribution to this transition was made by Alexander von Humboldt (4), the great explorer and earth scientist. He was the first to give a definition of climate (5) and to map a climatological element and draw isolines, a technique which he had adapted from another earth science, geomagnetism. His isothermal map of the northern hemisphere was based on observations from 58 stations. It also contained a diagram of vertical temperature lapse rate for reduction of mountain observations to sea level. In his analysis he emphasized the departure of the isotherms from latitudinal circles to which they had been supposed to conform by traditional hypothesis. He also offered an explanation of the distortion of the isotherms as caused by the contrasts of continents and oceans and by oceanic currents. This paper, originally written in French, appeared, in extract, in four journals in three languages within two years of its presentation. A full translation into English appeared in 1820. None of these carried the chart. The first full German translation did not appear until 1853 in a collection of his casual papers.

The climatic chart with isolines has since become the standard medium of presentation and has been extended to the representation of most elements. In the 19th century the most notable contributions were:

(1) The revised annual isotherms for the northern hemisphere by Kämtz[1], using

[1] Ludwig Friedrich Kämtz (1801-1867) was not primarily interested in climatology but in physical meteorology. Born in Treptow, Prussia, he got his doctorate in Halle in 1822 in mathematics. He stayed there as docent and professor

145 stations. The same author also showed a circumpolar isotherm chart for the northern latitudes about 50°, indicating two continentally located centers of lowest temperatures. He finally contributed a partial world chart of barometric variability, covering primarily the North Atlantic and the continents of Europe, Asia, Africa, and Australia. It clearly showed the high barometric unrest in the Icelandic and Greenland region and the relative steadiness near the equator.

(2) The first world chart of annual isotherms devised by Mahlmann [2] (7), which shows in the plotting model not only the mean temperatures of summer and winter (a system already used by Humboldt) but also the mean temperatures of the warmest and the coldest month. Mahlmann used data from 305 stations and in a later revision (1844), 422 stations.

(3) The first series of monthly isotherms for the earth constructed by H. W. Dove, based on data from about 700 stations. Dove, working independently of Mahlmann, whom he apparently regarded as a rival, published his first results in the Transactions of the Berlin Academy of Sciences in 1847, and made an announcement to the British Association for the Advancement of Science in the same year. The general secretary of that Society, Col. Edward Sabine, was instrumental in having Dove's charts distributed and bringing them to the attention of a world-wide audience (8).

(4) The first isobaric charts for the earth for January, July, and the year by A. Buchan (9). These were presented to the Royal Society of Edinburgh in two memorable papers read on March 16, 1868 and April 19, 1869. The notable lag between the appearance of isothermal and isobaric charts was due to the fact that many of the early barometer records were not reduced to sea level and hence not comparable.

The middle of the last century also saw the charting of other elements. Particularly noteworthy was the effort of J. H. Coffin [3], who collected wind data for 579 stations in the late 1840's. From these he constructed first a series of northern hemisphere wind charts (11), tediously calculating resultants from the wind frequencies. Thus he was able to deduce that the single cell hypothesis of circulation between equator and pole was inadequate, and correctly demonstrated the existence of three latitudinal wind belts at the surface. As a collaborator of the Smithsonian Institution, he continued his analysis of wind records for another quarter century and calculated wind resultants for 3,223 stations. His global wind study was finished by his son and the Russian climatologist A. Voeikof, and finally published as a massive memoir by the Smithsonian Institution (12).

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until 1841. He got interested in meteorology in 1824 and won early fame by his three-volume textbook of meteorology (6). He accepted a chair at Dorpat (Tartu, Estonia), then part of the Russian Empire. In 1865 he was elected to the Imperial Academy of Sciences in St. Petersburg (Leningrad) and succeeded A. T. Kupffer as director of the Physical Observatory, then the meteorological central of Russia, at an age when others seek retirement. His tenure was only two years, when he died after a short illness.

[2] Wilhelm Mahlmann (1812-1848) was a protégé of A.v.Humboldt. Little is known of his early life and education, but he struggled as a school teacher and acted later as editor for the well-known Berlin Geographical Society. He translated, revised and extended Humboldt's famous treatise on Asia (1844). In 1846 he started the Prussian Meteorological Service within the Statistical Office, but soon succumbed because of ill health which had plagued him for years (10).

[3] James Henry Coffin (1806-1873) was an 1828 graduate of Amherst College; became a teacher and principal of the Ogdensburg, N. Y., Academy and an instructor at Williams College (1840-1843). In the latter capacity he maintained a wind recorder on Massachusetts' highest peak, Mt. Greylock. He became professor of mathematics and astronomy at Lafayette College in Easton, Pa., in 1844, where he stayed until his death.

Independently, M. F. Maury (1806-1873) had begun to lay the groundwork for his world fame by gathering wind, current, and sea temperature data over the oceans from ships' logs. His data collections and the charts based on their analysis created a phenomenal impact not only in the maritime but also in the scientific world. His theoretical explanations were weaker. In his comments on the general circulation in the third edition of his wind and current charts (13), although recognizing the existence of several belts of winds, separated by zones of calms, he still indicates two cells of essentially meridional circulations in each hemisphere as the fundamental system. While he recognizes the deflecting force of the earth's rotation, a grave misconception of the upper atmospheric currents is maintained. This continues into his most famous work, "Physical Geography of the Sea" (14), which went through six editions in less than five years—a technical best-seller by all tokens. Here Maury presents isotherms for the Atlantic for the months of March and September. He also very correctly describes the seasonal fluctuations of the equatorial zone of calms and of the subtropical belts, and quotes a lucid description of land- and sea-breeze which was furnished to him by his friend, the Dutch lieutenant M. Jansen. He also correctly stamps the oceans as the major sources of moisture through evaporation for later precipitation in continental areas. Yet he still ascribes to terrestrial magnetism the peculiarities of the general atmospheric circulation in a rather weird explanation.

Of course, we should not overlook the fact that some very popular books of the era espoused the most fantastic conglomerates of technical jumble. They had the meteorological and climatological puzzles all "solved"—or so they made the public believe. Such a pseudoscientific effort—not too unlike some still existing nonsense—can be ascribed to P. Murphy (15, 16). He had all the answers to the problems of weather and climate and grandiosely dedicated his work to the King. He bitterly complained that the Royal Society ignored him, but hoped that "Englishmen of a future day, may, possibly, turn to these discoveries with feelings of pride and exultation." The so-called discoveries were some mystic hypotheses of solar and planetary effects on weather via "the primary forces of gravity, magnetism, and electricity." In his "Anatomy of the Seasons" he proposes a perpetual almanac, and elaborates the occurrence of "storm crises" according to solar, lunar, and planetary positions. In his second book we find under the heading of "Climate, as connected with locality" (16) such unintelligible gobbledygook as:

"Locality, in its most comprehensive sense, as connected with the temperature and weather of the seasons, owing to the unity of the solar and planetary actions on which they depend,—embrace at once or within the same view,—the opposite hemispheres of the earth. And between these opposite hemispheres, owing to their being traversed throughout their extent by the axis of magnetic action, equally as that of the earth's rotation, combined with the law in reference to the relative direction of electric action, in its connexion with magnetic—a contrast, in reference to the opposite actions of the sum—electric and magnetic—always exists."

The problem of retardation of science by quackery would make an interesting theme by itself; but let us return now to the main stream of developments.

Perhaps the most powerful influence for the scientific development of climatology came from the field of botany. Of course, it had been known since the age of the great geographical discoveries that the plant cover of the earth also deviated from a simple latitudinal scheme. With the systematization of plants into genera and species had also arisen a recognition of ecological factors. The principal of these was the climate. It is therefore a logical step from plant geography to climatology. Humboldt's voyages had given him a broad insight, but his observations were not woven into a scheme.

A notable attempt in this direction was undertaken by the Dane, Joakim Frederik

Schouw (1789-1852), professor of botany at the University of Copenhagen (17). He became so enthusiastic about climatology that he devoted part of his time to analysis of data and the first attempt at comparative climatology (18). He hoped that climatology "would rise from a chaotic mass of observations to a true science." His zeal is shown by studies of wind frequencies at Copenhagen. In this process he reduced 56,050 observations to 8-point frequencies. One of his fundamental discoveries was the fact that observations of different years were quite divergent and that, for comparisons of various stations, *simultaneous intervals* would have to be used. Although he recognized the prevalence of west winds in northwest Europe, he still thought these were a part of the trade wind system. However, he noted the existence of a European monsoon from the higher summer frequency of winds from the Atlantic quadrant. He related the ratios of wind frequencies, westerlies to easterlies, to the mean temperatures of various seasons and thus arrived at a concept that we would in modern parlance call the "source regions of air masses." Schouw also noted the influence of wind on currents and sea level fluctuations in the Baltic. He proved conclusively that sea level changes were primarily caused by wind piling up waters in shallow seas rather than by pressure changes.

In following the botanic stem of our science, we have to cast a look into the meteorological effort that had been started at the University of Tübingen under Gustav Schübler, M.D. (1787-1834), professor of natural history. He had written a book on meteorology (19), a good bit of which was devoted to the influence of the moon on precipitation. Two rather interesting dissertations, both for the medical doctorate, were written under his tutelage. The first, by Wilhelm Neuffer (20), dealt with effects of temperature on trees. Neuffer measured, among other things, the temperature of the tree trunk at 4-inch depth in relation to air temperature, and speculated about the thickness of tree ring formation as a function of temperature. He also raised the question of cooling of the tree by evaporation with low environmental humidity. His colleague, Hermann Werner (21), presents us with a phenological study of various plants in different localities near Tübingen, including data on arrival and leaving of birds, and the length of stay of the storks in various years.

This line of investigation is followed up in one of the earliest textbooks on climatology by the superintendent of the Karlsruhe Forestry School, J. L. Klauprecht (22). He defines climate as the combined state of the weather and specifically refers to "organic climatology"—a term for which we have now substituted bioclimatology—as the effect of climatic conditions on organic life. He gives a very lucid discussion of the problem of temperature sums and of the different influence of freezing temperatures on various types of plants. He recognizes the different benefits that plants derive from rainfall of varying duration and intensity. Then he gives an excellent discussion on wind protection for sensitive plants. He is quite aware of the difference of evaporation from open water surfaces and vegetated soil. He wonders about the moisture from dew and its influence under marginal rainfall conditions. Interestingly enough, he discussed the effect of various CO_2 concentrations on plants at a time when low-level fluctuations were not even well established. Finally, he refutes the belief that weather changes are influenced by lunar phases—and, contrary to widespread superstitions. that these have any influence on the growth of plants. In discussing hail frequency he lambastes "hail arresters and dissipators," whether they were in form of straw or wood fires or the French practice of firing cannons into clouds. We also find in his book a proposition for a climatic classification on the basis of latitude and annual temperature, with marine, continental, and mountain influences as modifiers.

Klauprecht's book was shortly followed by an even more systematic text on agricultural meteorology by the Count A. E. de Gasparin (1783-1862). The second part of this treatise is labelled "Climatologie" (23). The presentation is by climatic elements: temperature, radiation, atmospheric electricity, wind, rainfall, snow, evaporation. These are succeeded by chapters on climates for various crop plants and limitations for cultivation of olives, grapes, grains, pasture, and forests. Here again we find an attempt at classification of climate for a practical purpose. The text is made notable by the fact that it is based on, and illustrated by, actual observational series from diverse environments. De Gasparin became frequently cited in other books and papers in the middle of the last century. Here we find even a beginning of the aerodynamics of obstacles and the effects of walls.

Chronologically, as well as regards subject matter, there follows a contribution by a French physicist, Antoine César Becquerel (1788-1878). Professor and member of the French Academy of Sciences, foreign member of the Royal Society and the Prussian Academy, he shows the tendency of the French academicians of his age: to know something about everything. He throws the weight of his authority (24) into a controversial question of the era: Does deforestation lead to a change in climate? Two other famous members of the French Academy had already voiced some opinion about the case. The celebrated D. F. J. Arago (1786-1853) had pointed to the increases in surface wind speeds on denuded soils, and the astute J. L. Gay-Lussac (1778-1850) thought that positive proof of any climatic influence on deforestation would be difficult, if not impossible, just on the basis of available climatic data.

Becquerel, in the best tradition of the "immortals" of the Institut de France, set about to survey the question comprehensively. Thus he devotes about 175 pages of his treatise to a general discussion of climate and the climates of France in particular. He draws heavily on the works of Humboldt and Gasparin. Schübler also is quoted. From Humboldt he borrows the latitudinal variations of temperatures and their different distribution in western Europe and eastern North America. The purpose of this survey is to arrive at a scheme of causes for the climate of different localities. He comes up with eleven basic ingredients of climate. (We now know that many of those enumerated are interdependent.) Only the last, and presumably least important, is the vegetation cover of the soil.

It is interesting to see his list of reasons for deforestation: (1) effects of war, (2) progress of civilization, (3) grazing animals, (4) industrial use of wood, (5) inadequate legislation to stop abuses. His discussion of forests on the hydrological cycle is very close to modern views. He certainly had a good feeling of the competition of forests with springs by using water for evapotranspiration, that otherwise might have percolated by infiltration into acquifers. He also raises the question of increase or decrease of precipitation by forested areas but does not answer it. He finally goes into all historical evidence of climatic changes. He attributes the major variations of climate to geological influences, but finds no evidence of any major changes in climate during historical times in the Mediterranean, western Europe, and North America. Minor fluctuations are readily admitted as possible. In support of the latter he lists a long series (1689-1850) of viticultural observations on the beginning of the grape harvest in Burgundy. It shows, interestingly enough, the period of cooler conditions in the first half of the 19th century. The grouped listing of dates is a very early use of such statistics.

Becquerel's discussion of the influence of forests on climate is also well ahead of any direct observations. Many of his statements were not observationally verified until 50 to 60 years later. He is quite well aware of the change in the heat balance produced by the forest. He also cites the use of shelter belts as a specific microclimatic modification of climatic conditions in the Rhone Valley. These offered protection against the Mistral. He quotes the fact that a 2-meter-high hedge will offer protection 22 meters downwind. At that time the protection was used for growing peas.

The masterpiece among the studies by botanists of the influence of climate on plants was without doubt a book by Hermann Hoffmann (1819-1891), M.D. and Ph.D., professor of botany at the University of Giessen. This contribution (25), almost entirely based on original observations, marks a milestone. It contains very detailed meteorological observations, including regular readings of soil temperature at one-foot depth and detailed simultaneous measurements of growth of leaves and heights of plants. While the analysis clearly showed the effect of singular events, such as freezes, it also established the collective influence of the meteorological factors on plant development. It proved the plant to be an integrator of the total environment. Hoffmann drops the effort to find a simple formula for climatic influence on growth, such as growing degree summations. This had been the favorite system since R. A. F. de Réaumur's work over a century earlier. In spite of Hoffmann's demonstration, the appeal of the Réaumur scheme has persisted into our times. We seem to have quite a few such hardy "perennials" in our science.

In this portion of climatological lineage, it only remains to relate that Wladimir Koeppen (1846-1940), whose main fame in the field came much later (27), also started his scientific career with a botanical dissertation (26) dealing with temperature and germination. In his student years he was tutored in meteorology by Kämtz.

The other branch of biometeorology, dealing with human beings, of course, had a respectably long history, dating back to Hippocrates. In his tradition, physicians had faithfully described the atmospheric and balneological characteristics of individual places. Also, the geographical distribution of diseases and their epidemiology seemed to be closely related to climate. Even nutritional deficiencies were suspected to be climate-related. In the early 19th century, the existence of etiological agents and vectors as well as vitamins was yet unknown; but the hope existed that by systematic surveillance of the environmental factors, the so-called medical topography, new knowledge on diseases and their prophylaxis could be obtained. It was this faith that led James Tilton (1745-1822) to order in 1814 the post surgeons of the U. S. Army "to keep a diary of the weather," an act which inaugurated the first official climatic network of observations in this country.

It is true that physicians became close observers of climate even though the connections to disease and therapy stayed elusive. Many of the data they presented either stayed localized or were restricted to specific regions. In the latter category were the important compilations and analyses of Lovell (1788-1836) (28), Lawson (29), and Forry (30) in the United States.

A few physicians accumulated so much material on the climate of a variety of locales that they felt impelled to share the wealth of information with their colleagues and the scientific world at large. Perhaps they had in mind that such collections could lead to proper prescriptions for climatic change for patients who were otherwise doomed. Among the diseases for which a change in locale was the only palliative in the middle of the 19th century were phthisis and malaria, as well as other tropical ailments. The most comprehensive of these surveys was one by Adolf Mühry, M. D. (1810-1888). This, with its supplement, amounted to over 1,000 pages (31, 32). Although covering the globe in a geographical fashion, continent by continent, it was essentially an encyclopedic rather than an analytical work.

In the same tradition, but even more medically oriented, was a somewhat later volume by a French colonial physician, Dr. Armand, who had much firsthand knowledge of the so-called "climatic diseases." With his extensive climatic descriptions of various parts of the world, he also cites coresponding statistics on the causes of morbidity and mortality. He also gives a climatic classification [4] based on annual mean values of temperature, one of the earliest of many numerical attempts (33).

Even before the middle of the last century, the observational data from all parts of the world became a veritable flood. Dove, an appreciation of whose work we will give below, lamented (34): "Lack of material is not so much an obstacle to progress as the inadequate utilization of the data already at hand." He also pleaded for simultaneous series of records, as Schouw had done earlier, and usage of calibrated instruments according to a common plan. Obviously the large masses of data called for a treatment that had not been usual in science before. Here the Belgian astronomer Lambert Adolphe Jacques Quetelet (1796-1874) appeared as a rescuer on the scene. To him we can ascribe the first use of statistical tools in climatology. He wrote a series of letters to an interested patron of science, the Duke of Saxe-Coburg-Gotha, on the theory of probability which later appeared in book form (1845). In letter 13 he concerns himself with means and frequencies, and uses for an illustration the mean daily temperatures of July in Brussels for the decade 1833 to 1842. These he gives both in tabular form and also as a histogram. In discussing the mean and the range of the distribution he remarks on the approximate symmetry of the values. In contrast, he noted in letter 16 the assymmetry of a series of daily ranges of temperature in January, also covering the years 1833-1842. He compares this with data from other months and concludes that, while one might attribute symmetrical distribution to chance, a physical reason underlies these skewed distributions.

Quetelet, in letter 33, also tackles the phenological observations on lilac at Brussels from 1839 to 1844, compared with those at 20 other European stations and one U. S. station (Rochester, N. Y.). In explaining the variability, he too tries a scheme different from that of Réaumur in correlating the flowering date with various temperature parameters. A first inkling of regression analysis rings through this analysis.

Quetelet's compatriot and fellow-astronomer, Jean Charles Houzeau (1820-1888), won merit for instructions to observers and standardization of methods. He also wrote the first popular treatise on climatology (1853). In it he uses the Brussels observations to illustrate climatological principles. He clearly conveys the concept that climate is a consequence of the daily weather events, the sum total of which represents the climate. He gives the contemporary view of global wind systems, but adds a fairly good description of land and sea breezes and of mountain and valley breezes. Among other interesting points he gives a very vivid description of the sequence of weather with passage of a cyclone. He also clearly established the persistence principle: "We must therefore conclude with a certain probability: The weather persists."

At the same time we meet a Swiss emigré in the United States, who also acquired great merit for the standardization and reduction of meteorological observations, Arnold Henry Guyot (1807-1884) [5]. He

[4] Climatic classification of Armand:

Annual mean temperature	*Climatic character*
−18°C to + 0°C	glacial
0°C to 5°C	cold
5°C to 15°C	temperate
15°C to 22°C	warm
22°C to 27°C	very warm
27°C to 32°C	torrid

[5] Guyot was born in Boudevilliers, Switzerland. He got his university education in Germany, where he acquired the Ph.D. degree with

wrote the instructions for the observers of the Smithsonian Institution, helped in the selection of new stations, and issued the first edition of the famous Meteorological Tables.

Another Swiss-born physicist, Heinrich Wild [6] (1833-1902) gained fame as developer and standardizer of instruments. He, together with C. Jelinek (1822-1876), became the driving spirit of international standardization and cooperation in meteroology. They called the first Congress of Directors of Meteorological Institutes in Vienna (1873). (Aside from the principals who attended were W. Koeppen and J. Hann as junior aides and observers.) Here the groundwork was laid for uniform systems of observations, a development that was of inestimable value to world-wide climatology. Wild became later (1879) president of the International Meteorological Committee, which is the first antecedent of the present World Meteorological Organization.

The name of Heinrich Wilhelm Dove (1803-1879) [7] has already been woven through these historical notes. His influence on his contemporaries can hardly be overestimated. He was a central figure in meteorology and climatology for almost four decades. Stimulated by Heinrich Brandes (1777-1834), the celebrated inventor of the synoptic method, Dove acquired his Ph.D. in Berlin with a dissertation on barometric variability (36). Although he devoted much of his time to the theory of winds in storms and to other problems of dynamic and physical meteorology, his contributions to climatology were very substantial. The influence of Humboldt is still quite notable in his two major climatological contributions (39, 40), but with his tireless collection of data from all over the world he gained a much broader outlook on the problems of climates. He clearly states the principle of interdependence of atmospheric condi-

a dissertation on classification of lakes. There he had attended Dove's lectures on physics and meteorology and became strongly influenced by Humboldt. He became professor in Neuchâtel, where he taught from 1839-1847. Then he lost his job in the political turmoils and emigrated to the United States. After a few years as lecturer at Harvard he became in 1854 professor at Princeton. From 1849-1881 he was advisor in meteorology to Joseph Henry, secretary of the Smithsonian Institution. He was an American correspondent and supplier of data for Dove (Dana, (35)).

[6] Wild was born in Uster near Zürich, studied at the University of Zürich and got his Ph.D. in physics at Königsberg. He worked under Bunsen and Kirchhof in Heidelberg, became docent in Zürich in 1858, and later was professor and director of the Observatory. There he added meteorological observations with self-recording instruments and developed a plan for a Swiss observing network. In 1861 he inaugurated the Swiss Office of Standards of Weights and Measures. In 1868 he was made a member of the Imperial Russian Academy of Sciences and director of the Central Physical Observatory in St. Petersburg, as successor to Kämtz. In this capacity he completely reorganized and expanded the Russian network of stations.

[7] Dove was born in Liegnitz, Prussian Silesia, and grew up in the midst of the turmoil of the Napoleonic wars. He studied mathematics and physics in Breslau and Berlin. From 1826 to 1829 he was docent at Königsberg University. He then became an extraordinary professor of physics in Berlin. To supplement his meager income from this post he taught in addition in a high school and a military academy. Even after assuming a chair of physics in 1845, he still had to continue his other part-time activities. As a liberal, he became involved in the political upheavals of 1848. He had also succeeded Mahlmann as head of the Prussian Meteorological Institute at about that time. In 1858 he was elected rector of the University. It is amazing that he had the time to publish 234 papers on meteorology and 104 in physics. The honors conferred upon him reflected the esteem in which he was held. They included numerous honorary fellowships in learned societies. Among them were elections to the American Academy of Arts and Sciences (1860) and to the National Academy of Sciences (1867). In his later years he was also vice chancellor of the peace class of the prestigious order "Pour le Mérite." A celebration of the 50th anniversary of his doctorate became a public occasion with many tributes. In failing health due to a stroke, he died in 1879. (Anonymous (37), Neumann (38).)

tions, in time and space: "We have come to the conclusion that in the turbulent motions of the air no point can be viewed in isolation; each phenomenon appears to be caused by others and, in turn, causes others."

Dove plainly treats in his work the problem of singularities. He regards, on the basis of his analysis, the Central European cold snap of the middle of May as a date-bound recurrent phenomenon. Buchan elaborated on this problem two decades later in greater detail.

He also had some decided ideas on the Asiatic Monsoon for which he seeks a cause outside the tropical zone in the interior of Asia. This cause, in his opinion, is centered at higher levels in the atmosphere rather than at sea level.

In his earlier climatic treatise (39), Dove also gives the first comprehensive view of rainfall over the surface of the earth. His explanation of the vast differences is still mainly geared to the distribution of land and ocean, disregarding dynamic reasons for precipitation.

In Dove's second major climatological monograph (40) we find a number of more sophisticated elements elaborated, among them the concepts of continentality and oceanicity as expressed in diurnal and annual temperature variations, and general temperature variability. The effect of sea ice on the air above is well recognized, and so are mountain influences. He also notes that the general circulation of the northern hemisphere differs from that of the southern hemisphere. He further begins to appreciate the role of meridional flows in central North America and Siberia, but his explanations are dynamically erroneous. But he specifically speaks of outbreaks of "polar air," an early forerunner of air mass labelling.

In his climatographic work he expanded his monthly world isothermal charts on the basis of records from 1,684 stations. And in his data tabulations he listed departures from average for 13 years (1856-1868) for 426 stations with long record. On the basis of these records he notes teleconnections of anomalies and discovers the tendency for compensation in space of major anomaly patterns. He invokes against a judgment of the "unusual" in weather departures on the basis of local conditions, and also throws his weight against "popular" explanations on the basis of lunar and planetary constellations.

The importance of Dove for climatology lies no less in his own work than in his extensive teaching practice and a wide correspondence. He influenced a whole generation of younger meteorologists. Among them, for example, Voeikof (Wojeikov), whose dissertation he inspired (41). From his data collections, charts, and analyses, it was only one small step to the age of the broad inventory of the earth's climates (42) and the understanding of their origin undertaken by the immediately succeeding generation. Without his work, the attempts at climatic classification which followed would also have been hampered by lack of analyzed data.

Here we stand at the threshold of the classical period in climatology which lasted for half a century after Dove's death. It was the era of the great triumvirate Julius Hann (1839-1921) (43), Alexander Voeikof (1842-1916) (44), and Wladimir Koeppen (1846-1940). Their papers, handbooks, and text laid the foundation for the present healthy state and proliferation of our science.

References

(1) Ward, R. DeC. Lorin Blodgett's "Climatology of the United States": An appreciation. Mo. Wea. Rev. *42*, 23-27 (1914).

(2) Hellmann, G. Entwicklungsgeschichte des klimatologischen Lehrbuches; No. 11, pp. 1-4, in Beiträge zur Geschichte der Meterologie, 3rd vol., Veröff. Preuss. Meteorol. Inst. No. 315, Berlin (1922).

(3) Societas Meteorologica Palatina. Ephemerides-Observationes, vol. 1-12, Mannhein (1784-1795).

(4) Humboldt, A. de. Des lignes isothermes et de la distribution de la chaleur sur le globe. Mém. phys. et chim. Soc. Arceuil *3*, 462-602 (1817). (Full engl. translation: On isothermal lines and the distribution of heat over the

globe; Edinb. Phil. Journ. *3*, No. 5, 1-19 (1820), 256-274 (1820); *4*, 23-27, 262-281 (1820-21); *5*, 28-39 (1821).

(5) Humboldt, A. de. Fragmens de Geologie et de Climatologie Asiatiques, 2 vols., Paris (1831). Translated, enlarged and edited by W. Mahlmann, Central Asien; Unterunchungen über Gebirgsketten und die vergleichende Klimatologie. 2 vols., Berlin, Carl J. Klemann (1844).

(6) Kamtz, L. F. Lehrbuch der Meteorologie *2* Halle 595 (1832).

(7) Mahlmann, W. Mittlere Verteilung der Wärme auf der Edorberfläche; in the 11th section of "Repertorium der Physik", ed. H. W. Dover, *4* 174 (1841).

(8) Dove, H. W. Remarks on his recently constructed maps of the monthly isothermal lines of the globe and some of the principal conclusions in regard to climatology deducible from them (By Professor Dove with an introductory notice by Lieut. Col. Edward Sabine), from Report Brit. Assoc. Adv. Sci. for 1848, 19 (London, 1849).

(9) Buchan, A. The mean pressure of the atmosphere over the globe for the months and for the year. Part I—January, July, and the year; Proc. Roy. Soc. Edinb. *6*, 303-307. Same title, Part II; Trans. Roy. Soc. Edinb. *25*, 575-637 and Plates XXV to XXVII (1868, 1869).

(10) Kassner, C. Carl Heinrich Wilhelm Mahlmann; Met. Zeitschr. *29*, 309-318 (1912).

(11) Coffin, J. H. Winds of the northern hemisphere. Smithsonian Contributions to Knowledge *6*, 197 (Washington, 1853).

(12) Coffin, J. H. The winds of the globe or the laws of atmospheric circulation over the surface (tables were completed and maps drawn after the author's death by Selden Jennings Coffin, with a discussion and an analysis by Alexander Woeikof). Smithsonian Contributions to Knowledge *268*, 756 (Washington, 1875).

(13) Maury, M. F. Explanations and Sailing Directions to Accompany the Wind and Current Charts, 315 pp., XII plates, C. Alexander, Washington, 1851.

(14) Maury, M. F. Physical Geography of the Sea, 389 pp., XIII plates, Harper & Brothers, New York, 1855 (6th ed. 1859).

(15) Murphy, P., Esq. The Anatomy of the Seasons. Weather Guide Book and Perpetual Companion to the Almanac, 360 (London, 1834).

(16) Murphy, P. Esq. Meteorology. Considered in its connexion with Astronomy, Climate and the Geographical Distribution of Animals and Plants Equally as With the Seasons and Changes of the Weather, 277, J.B. Balliere, London, 1836.

(17) Schouw, F. J. Grundzüge einer allgemeinen Pflanzengeographie, Reimer, Berlin, 1823.

(18) Schuow, F. J. Beiträge zur vergleichenden Klimatologie; Erstes Heft, Copenhagen, 1827.

(19) Schübler, G. Grundsätze der Meteorologie in näherer Beziehung auf Deutschland's Clima, 296, Leipzig, 1831.

(20) Neuffer, P. Untersuchungen über die Temperaturveränderungen der Vegetabilien und verschiedene damit in Beziehung stehende Gegenstände, 41, Dissertation Tübingen, 1829.

(21) Werner, H. Beobachtungen über jährlich periodisch wiederkehrende Erscheinungen im Thier-und Pflanzenreich, 35, Dissertation Tübingen, 1831.

(22) Klauprecht, J. L. Die Lehre vom Klima in land- und forstwirtschaftlicher Beziehung, 172, Karlsruhe, 1840.

(23) Gasparin, LeComte A. E. de. Cours d'Agriculture, (Vol. II—Météorologie Agricole, Part 2 "Climatologie", 211-373), Libraire Agricole de la Maison Rustique, Paris, 1844, 1852.

(24) Becquerel, A. C. Des Climats et de l'influence qui exercent les sols boisés et non boisés, 562, Firmin Didot frères, Paris, 1853.

(25) Hoffmann, H. Witterung and Wachstum oder *Grundzüge der Pflanzen-klimatologie*, 583, A. Förstnersche Buchhandlung, Leipzig, 1857.

(26) Koeppen, W. Wärme, and Pflanzenwachstum, Dissertation Leipzig. (Publ. in Bull. Soc. Imp. des Naturalistes de Moscou, *43* (3/4), 41-110 (1870).

(27) Koeppen, W. Versuch einer Klassifikation der Klimate, vorzügsweise nach ihren Beziehungen zur Pflanzenwelt, Met. Zeitschr. *18*, 106-120 (1901).

(28) Lovell, J. Meteorological Register 1822-1825, from observations made by the Surgeons of the Army, 63 (Washington, 1826).

(29) Lawson, T. Meteorological Register 1826-1830, 161 (Philadelphia, 1840).

(30) Forry, S. The Climate of the United States and its Endemic Influences, 378 (New York, 1842).

(31) Mühry, A. Klimatographische Ubersicht der Erde, 744, C. P. Wintersche Verlagshandlung, Leipzig and Heidelberg, 1862.

(32) Mühry, A. Supplement zur klimatographischen Ubersicht der Erde, ibid., 320 (1865).

(33) Armand, — Traité de Climatologie Générale du Globe (Etudes Médicales sur Tous les Climats), 868, G. Mason, Paris, 1873.

(34) Dove, H. W. Meteorologie; 11th section in "Repertorium der Physik", *III*, 263-404 (Berlin, 1839).

(35) Dana, J. D. Biographical memoir of Arnold Guyot, Natl. Acad. Sci. Biog. Memoirs, *2*, 309-347 (1886).

(36) Dove, H. W. De barometri mutationibus, 48, Dissertation Berlin, 1826.

(37) Anonymous. Heinrich Wilhelm Dove.

Proc. Am. Acad. Arts & Sci., (N.S.) 7, 383-391 (1880).

(38) Neumann, H. Heinrich Wilhelm Dove, eine Naturforscher Biographie, 88, Liegnitz, 1925.

(39) Dove, H. W. Klimatologische, Beiträge, 1^{ter} Teil, 297, Reimer, Berlin, 1869.

(40) Dove, H. W. Klimatologische Beiträge, 2^{ter} Teil, 314, Reimer, Berlin, 1869.

(41) Wojeikoff (Voeikov), A. v. Uber die direkte Insolation und Strahlung an verschiedenen Orten der Erdoberfläche, 78, Dissertation Goettingen, R. A. Huth, 1865.

(42) Voeikof, A. I. Klimati Zemnago Shara (The Climates of the Earth), 640, St. Petersburg, 1884.

(43) Hann, J. Handbuch der Klimatologie, 784, J. Engelhorn, Stuttgart, 1883.

(44) Woeikof (Voeikof), A. Die Klimate der Erde (expanded German version), Pt. I (396 pp.), Pt. II (422 pp.), Hermann Costenoble, Jena, 1887.

National Bureau of Standards Is Reorganized

The Department of Commerce announced on February 2 a realignment of several of its technical activities. At the heart of the new plan, which is designed to enhance the efficiency of operation and to provide improved service to science and industry, is a major reorganization of the technical programs of the National Bureau of Standards into four autonomous institutes.

Director of NBS is Allen V. Astin, and the deputy director is Irl C. Schoonover.

The four institutes and their directors are as follows: Institute for Basic Standards, Robert D. Huntoon; Institute for Materials Research, Irl C. Schoonover (acting); Central Radio Propagation Laboratory, C. Gordon Little; Institute for Applied Technology, Donald A. Shon. The Department's Office of Technical Services, formerly headed by Dr. Shon, and the civilian technology program in textiles will become part of the Institute for Applied Technology in the new organization.

Under the new alignment, the Institute for Basic Standards will conduct the historic NBS programs in the field of basic measurement standards. It will include, as well, the newly-established National Standard Reference Data program. Programs in chemistry and metallurgy will be combined in the Institute for Materials Research, with the objective of developing reliable and uniform methods of measurement for the properties of materials. The Central Radio Propagation Laboratory, located at Boulder, Colo., consists of those NBS divisions which conduct research and provide essential services to government and industry in the field of radio propagation.

The establishment of the Institute for Applied Technology, in particular, represents a step toward making science more useful to industry. This institute will bring together previously scattered activities related to the stimulation of technological progress in industry. One of the concerns of the Institute will be the promotion of technological innovation in industry, while another will be to provide industry with performance criteria that are both objective and broadly applicable. Product development as such will not be a part of the Institute's activities.

The move has been under study for some time. During this interval it was considered thoroughly by the scientific, technical, and industrial advisers to the Department in order to make certain that the needs of the professional and business communities would be fully and effectively met. The timing of the reorganization is particularly important in view of the relocation of NBS, now in progress, to new laboratories and facilities at Gaithersburg, Md.

The divisional grouping under the new organization is as follows:

Office of Director and Deputy Director
- Manager, Boulder Laboratories*
- Office of Public Information
- Technical Analysis Group
- Office of Program Planning and Evaluation
- Seven administrative divisions
- Five technical support divisions

Institute for Basic Standards
- Office of Standard Reference Data
- Electricity Division
- Metrology Division
- Heat Division
- Radiation Physics Division
- Mechanics Division
- Applied Mathematics Division
- Atomic Physics Division
- Physical Chemistry Division
- Laboratory Astrophysics Division*
- Radio Standards Laboratory*
- Radio Standards Physics Division*
- Radio Standards Engineering Division *

Institute for Materials Research
- Office of Standard Reference Materials
- Analytical Chemistry Division
- Polymers Division
- Metallurgy Division
- Inorganic Materials Division
- Reactor Radiations Division
- Cryogenics Division*

Central Radio Propagation Laboratory*
- Ionosphere Research and Propagation Division*
- Troposphere and Space Telecommunications Division*
- Radio Systems Division*
- Upper Atmosphere and Space Physics Division*

Institute for Applied Technology
- Office of Technical Services (and Technical Documentation Center)
- Office of Industrial Services
- Office of Weights and Measures
- Office of Engineering Standards
- Textiles and Apparel Technology Center
- Building Research Division
- Industrial Equipment Technology Division
- Information Technology Division
- Performance Test Development Division
- Instrumentation Division
- Transport Systems Division

*Located at Boulder, Colo.

Academy Proceedings

April Meeting

(480th Meeting of the Washington Academy of Sciences)

JOINT MEETING WITH WASHINGTON JUNIOR ACADEMY OF SCIENCES

SPEAKER: **ALVIN M. LIBERMAN**
Professor of Psychology, University of Connecticut. Member, Research Staff, Haskins Laboratories

SUBJECT: **THE PERCEPTION OF SPEECH**

DATE: **THURSDAY, APRIL 16, 1964—**
8:15 P.M.

PLACE: **JOHN WESLEY POWELL AUDITORIUM, COSMOS CLUB**
2170 Florida Ave., N.W.

Abstract of Address—The purpose of the talk is to describe some research on speech perception that has been carried out over the past 15 years at the Haskins Laboratories. From the beginning, this work has been directed at finding out why the sounds of speech, alone among acoustic signals, are such highly efficient vehicles of information transmission. The first task, as in studying the perception of anything, is to find the controlling stimuli or cues. In the case of speech this is no small problem, since the cues must be isolated from within a signal that is both complex and transitory. To do this we built a machine which converts (hand-painted) spectrograms into sound. We are able, then, to make a wide variety of changes in what we guessed to be the important parameters of the speech spectrum, and to listen to the effects of these changes on the sound as heard. On this basis we have found many, perhaps most, of the acoustic cues. With the cues in hand we were able to investigate more broadly some of the properties of the speech perception system. Among the findings of this aspect of the research are several which help, we think, to explain why speech sounds are uniquely distinctive in perception.

The Speaker—Alvin M. Liberman was born in Missouri and spent almost half of his life in his native state. He received the B.A. degree from the University of Missouri in 1938. He then moved to the East Coast, where he has remained ever since. In 1942, he earned the Ph.D. degree at Yale, where he stayed four more years as an instructor. After three years as an assistant professor at Wesleyan University, he joined the staff of the University of Connecticut, where he is now professor of psychology and head of the Department. While still an instructor at Yale, he became a member of the research staff of Haskins Laboratories in New York. He has continued to divide his time and talents between Connecticut and New York for almost 20 years.

ELECTIONS TO FELLOWSHIP

The following persons were elected to fellowship in the Academy at the Board of Managers meeting on February 20:

William J. Ambs, physical chemist, National Bureau of Standards, "in recognition of his contribution to corrosion research, especially in the application of field emission microscopy to the study of the oxidation of metals." (Sponsors: Lawrence M. Kushner, George A. Ellinger, H. P. R. Frederikse.)

Lawrence H. Bennett, physicist, National Bureau of Standards, "in recognition of his contributions to solid state physics, and in particular his researches on nuclear magnetic resonance in metals." (Sponsors: Lawrence M. Kushner, George A. Ellinger, H. P. R. Frederikse.)

Louis Costrell, chief of Nucleonic Instrumentations Section, National Bureau of Standards, "in recognition of his contributions in the field of nucleonic instrumentation and measurement and in particular his development of large scale monitoring systems and high speed systems for nuclear research." (Sponsors: Archibald T. McPherson, Lawrence A. Wood.)

Langdon T. Crane, Jr., assistant program director, Solid State and Low Temperature Physics, MPE Division, National Science Foundation, "in recognition of his contributions to low temperature physics and in particular his research in superconductivity." (Sponsors: Howard W. Etzel, J. Howard McMillen, James H. Schulman.)

John R. Cuthill, solid state physicist, National Bureau of Standards, "in recognition of his contributions to the study of metallurgical reactions by the application of new experimental techniques." (Sponsors: Lawrence M. Kushner, George A. Ellinger, H. P. R. Frederikse.)

Roland deWit, physicist, National Bureau of Standards, "in recognition of his extremely significant contributions to the theory of dislocations in solids." (Sponsors: Lawrence M. Kushner, George A. Ellinger, H. P. R. Frederikse.)

Robert E. Howard, physicist, National Bureau of Standards, "in recognition of his outstanding contributions to the theory of point defects in crystalline solids." (Sponsors: Lawrence M. Kushner, George A. Ellinger, H. P. R. Frederikse.)

John R. Manning, physicist, Metal Physics Section, National Bureau of Standards, "in recognition of his major contributions to the development of the theory of diffusion in crystalline solids." (Sponsors: Lawrence M. Kushner, George A. Ellinger, H. P. R. Frederikse.)

Robert L. Parker, physicist, National Bureau of Standards, "in recognition of his outstanding researches on the kinetics and mechanisms of the growth of metal crystals." (Sponsors: Lawrence M. Kushner, George A. Ellinger, H. P. R. Frederikse.)

Morton J. Rubin, chief, Office of Special Programs, Weather Bureau, "in recognition of his outstanding contributions to the analysis and understanding of the atmospheric circulation in the Southern Hemisphere in general, and of the Antarctic in particular." (Sponsors: H. E. Landsberg, J. Murray Mitchell, Jr., Paul H. Putnins.)

Robert M. White, chief, Weather Bureau, "in recognition of his outstanding contributions to the knowledge of the general circulation of the atmosphere and the practice of weather forecasting through empirical functions." (Sponsors: H. E. Landsberg, Jerome Namias, George P. Cressman.)

Norman M. Wolcott, physicist, National Bureau of Standards, "in recognition of his contributions to low temperature physics, and in particular to the thermal and magnetic properties of metals and superconductors." (Sponsors: Lawrence M. Kushner, George A. Ellinger, H. P. R. Frederikse.)

Capt. Alfred G. Zimmerman, U.S.N. (Ret.), "in recognition of his contributions to naval gunnery and the firing of torpedoes and in particular of his contributions to the design and production of the first radially expanded naval guns produced in this country as well as the use of hydraulic testing machines as the source of pressure." (Sponsors: Carl I. Aslakson, Lansing G. Simmons, Donald A. Rice.)

ELECTIONS TO MEMBERSHIP

Over the past several months, the following persons have been elected to membership in the Academy by action of the Committee on Membership:

George Abraham
Caroline L. Adams
Priscilla A. Beach
Clarence R. Breedlove, Jr.
S. D. Bruck
Col. Gale W. Cleven
Carl T. Contee
Wade M. Edmunds
H. Kenneth Edwards
J. L. Finan
Donald G. Fletcher
Gerald J. Franz
Raymond A. Galloway
James Q. Gant, Jr.
Louis A. Hansborough
Col. F. H. Holmes
William T. Kabisch
Barrett L. McKown
Elizabeth D. Peacock
Helen L. Reynolds
Charles Schertenleib
Raymond G. Smith
Walter S. Shropshire, Jr.
Marie C. Taylor
Charles A. Thomas
J. E. Uhlaner
Sanford H. Vernick
Willis H. Wheeler
Lillian E. Willier

BOARD OF MANAGERS MEETING NOTES

February Meeting

The Board of Managers held its 562nd meeting on February 20, 1964 at the Cosmos Club, with President Frenkiel presiding.

The minutes of the 561st meeting were approved as previously distributed, with minor corrections.

Announcements. Dr. Frenkiel announced appointment of the following committee chairmen: R. K. Cook, Membership; B. D. Van Evera, Policy Planning; B. F. Scribner, Ways and Means; M. L. Robbins, Meetings; Margaret Pittman, Awards for Scientific Achievement; A. T. McPherson, Grants-in-Aid; Rev. Francis J. Heyden, Encouragement of Science Talent; Watson Davis, Public Information; John K. Taylor, Science Education; and L. A. Wood, Bylaws and Standing Rules.

Executive Committee. Dr. Frenkiel outlined briefly the topics discussed at the committee's meeting on February 18, namely, Standing Rules, Budget, and the Journal. He elected to discuss with the Board major changes in the Standing Rules at this time as part of the report of the Executive Committee, with the objective of obtaining Board approval of rules changes in principle for guidance of the Committee on Bylaws and Standing Rules in its preparation of a systematic rewriting for subsequent Board approval.

Chairman Wood of the Bylaws and Standing Rules Committee indicated that other members of the committee had not yet been appointed, and that no meeting to consider the Standing Rules revisions had yet been held. He noted that the American Chemical Society had requested the Academy to revise its Bylaws at first opportunity to include a "protective clause" with respect to its affiliates. Dr. Frenkiel asked Dr. Wood to develop suitable language for such a Bylaws change and present it for Board consideration at the March meeting; and if the Board approved, to assist the Secretary in obtaining approval of the Academy membership by mail ballot, and informing the American Chemical Society of the Academy's intent.

Dr. Frenkiel indicated that the Board would consider major Standing Rules changes in the order listed in the explanatory memorandum sent to Board members in advance of the present meeting.

The Board approved the proposed changes in Rule 1 (meetings, delegates), as modified to delete from the first sentence in Rule 1(b) (substitute delegates) the words, "and with the agreement of the President."

As concerns proposed changes in Rule 6 (membership), the Board authorized Dr. Wood, in consultation with the chairman of the Committee on Membership, to exercise considerable latitude and discretion in revising the language of this rule, to eliminate duplications and conflicts with the Bylaws, to take into account discussions at the present meeting, and to make other non-substantive and editorial changes.

Before considering proposed changes in Rule 15 (Journal), the Board permitted Mr. Detwiler to present the report of the Editor.

Editor. Mr. Detwiler distributed a financial summary of Journal operations for 1963, with brief explanations for the information of the Board. He announced that the Journal's staffing situation had been considerably improved with the appointment of the following able individuals: Roger G. Bates, National Bureau of Standards; Russell B. Stevens, George Washington University; Ralph G. H. Siu, Department of Defense; J. Murray Mitchell, Weather Bureau; and Helen L. Reynolds, Food and Drug Administration. He reported that the March issue of the Journal would contain four feature articles instead of only one or two as in the recent past. And he indicated that, with the stimulation and encouragement of Dr. Frenkiel, he was exploring means to make the Journal serve even more adequately the Academy and its affiliates. For example, the April issue will be considerably expanded and addressed primarily to the microbiologists who will be meeting in convention here in May; extra copies will be printed for local microbiologists. Similarly, the May issue will be addressed primarily to the geologists of Washington. Additional costs will be involved, a point to be considered by the Board in its establishment of the budget.

Executive Committee (Contd.). The proposed changes in Rule 15 (Journal) were further considered. A motion to approve the changes, with deletion of the word "archival" as a description of the Journal, was tabled.

Membership. On motion of Chairman Cook, the Board elected the following 13 individuals to fellowship in the Academy: Roland deWit, Robert E. Howard, William J. Ambs, Lawrence H. Bennett, John R. Manning, Robert L. Parker, John R. Cuthill, Norman M. Wolcott, Robert M. White, Morton J. Rubin, Langdon T. Crane, Jr., Louis Costrell, and Alfred G. Zimmerman.

Treasurer. Treasurer Henderson distributed a tentative budget for 1964 for subsequent consideration by the Board.

Because of the lateness of the hour, the meeting was recessed until February 28.

The 562nd meeting of the Board was reconvened on February 28 at the Cosmos Club, with President Frenkiel presiding.

Announcements. Dr. Frenkiel announced that Alfonse F. Forziati had accepted chairmanship of a new Special Events Committee.

Revision of Standing Rules. On motion of Dr. Henderson, the Board accepted in principle the draft Standing Rules previously circulated, leaving refinement of language to the Committee on Bylaws and Standing Rules, which will report its review to the Board for approval at a forthcoming meeting.

Meetings. Chairman Robbins discussed plans for the next meeting of the Academy —a "Conversazione"—to be held March 19 in the Powell Auditorium. She distributed a proof of the invitation, which indicated in part: "Fellows and Members of the Washington Academy of Sciences are invited to an informal interdisciplinary *Conversazione*, a social evening to discuss ideas and problems with a cup or a glass in hand. A few special guests are also invited. Participants may move from table to table to discuss any subjects of mutual interest. Some of the suggested subjects are: Can scientific ability be tested? Are Government in-house laboratories effective? Are we being computerized into automation? Is science lengthening life? Are science fairs hindering science education? Are the Washington universities successful in educating scientists? Is the new administration science minded? Shall we nationalize the universities?"

Dr. Robbins also announced that at the meeting of April 16, honoring the Washington Junior Academy of Sciences, Alvin M. Liberman of the Department of Pschology, University of Connecticut, would give a lecture and demonstration entitled, "Analysis of Speech." The May meeting was expected to be held at John Hopkins' Applied Physics Laboratory in Howard County, Md.

Awards for Scientific Achievement. Chairman Pittman indicated that appointment of a committee roster was in progress.

Encouragement of Science Talent. Dr. Frenkiel indicated that he had received a request from the Junior Academy of Sciences for approval of its Bylaws. The Board approved these Bylaws in principle, with the stipulation that the Committee on Bylaws and Standing Rules should consider needed editorial revision and revisions and refinements, and report such revisions to the Board for approval at a forthcoming meeting.

Editor. Editor Detwiler supplemented his earlier report by announcing that the March issue of the Journal was in page proof, and would consist of 32 pages. Issues of greater length were planned for April and May.

Archivist. Dr. Frenkiel indicated that he was negotiating with a good prospect for this position.

Treasurer. Treasurer Henderson reported the following balances: WAS checking account, $2,960.97; JAS checking account, $1,710.80; JAS savings account, $843.52; Joint Board checking account, $2,261.14.

Dr. Henderson read a list of 17 Academy members whose dues had been in arrears for more than two years. The Board approved action to drop them from the rolls.

New Business. The issuance of certificates of Fellowship or Membership was discussed. It was agreed that the Secretary would have completed, and the Treasurer would mail, such certificates when specific requests were received, billing the requestor in the amount of $1.00. The present supply of certificates would be used until depleted, at which time the Executive Committee would revise the format, which is considered in need of revision. The Editor was asked to announce occasionally in the Journal that certificates can be obtained for present and new members and fellows, on request, at $1.00 per copy.

The next meeting of the Executive Committee was set for March 17, at a Cosmos Club luncheon. The next meeting of the Board was set for 5.00 p.m. on March 19, also at the Cosmos Club.

Membership Certificates Available

Certificates of membership in the Academy, suitable for framing, will be supplied by the Secretary upon specific request from Fellows or Members. A nominal charge of $1.00 is made for the certificates. Requests accompanied by remittance may be forwarded to the Academy office at 1530 P St., N.W.

Science in Washington

CALENDAR OF EVENTS

April 11—Society of American Foresters

Mrs. Orville L. Freeman, "A Woman Looks at Russia" (colored slides). Southgate Motel, Arlington, Va., 7:00 p.m. Dinner at 7:45.

April 13—Computer Science Center, University of Maryland

James Stewart, University of Maryland, "Specific Algorithms of the X-ray 63 System for Crystallographic Computing."

Room 26, Computer Science Center, 4:00 p.m.

April 17—American Society of Heating, Refrigerating, and Air-Conditioning Engineers

Seminar, "Selection of Electric Motors and Controls."

Presidential Arms, 1320 G St., N.W., 10:00 a.m. to 4:00 p.m.

April 20—Computer Science, Center, University of Maryland

James R. Holden, Naval Ordnance Laboratory, "Discussion and Demonstration of the Programs Available in the X-ray 63 System."

Room 26, Computer Science Center, 4:00 p.m.

April 21-24—American Geophysical Union

Forty-fifth annual meeting. Scientific papers on the latest advances in geophysics will be presented.

National Academy of Sciences, 2101 Constitution Ave., N.W.

April 21—James Curley Lectures in Science

E. R. Piore, vice-president for research, IBM, "Impact of New Materials and New Instrumentation on Our Foreseeable Technology."

Gaston Hall, Georgetown University, 8:30 p.m.

April 21-23—American Federation of Information Processing Societies

Spring computer conference on subject, "Computers '64: Problem-solving in a Changing World." (Program brochure can be obtained from Mike Healy, P.O. Box 5896, Washington, D.C.)

Sheraton Park Hotel.

April 27—Computer Science Center, University of Maryland

Howard E. Tompkins, University of Maryland, "Structures for Scientific Information Storage."

Room 26, Computer Science Center, 4:00 p.m.

April 27-29—NAS-NRC

101st annual meeting of the National Academy of Sciences.

National Academy of Sciences, 2101 Constitution Ave., N.W.

April 29-May 2—NAS-NRC

U. S. National Committee of the International Scientific Radio Union.

National Academy of Sciences, 2101 Constitution Ave., N.W.

April 28-30—Office of Naval Research

Symposium on Non-nuclear Weapons Effectiveness.

Industrial College of the Armed Forces, ICAF, Fort Leslie McNair. (Additional information from executive secretary, Room 808, Old Post Office Building, 12th St. & Pennsylvania Ave., N.W.

May 1—James Curley Lectures in Science

Phillip Morse, professor of physics, MIT, "Design for a Brain."

Gaston Hall, Georgetown University, 8:30 p.m.

May 6—University of Maryland Symposium

Sterling B. Hendricks, Mineral Nutrition Laboratory, USDA, "Biological Timing Mechanisms."

McKeldin Library, Room 405, 4:00 p.m. Coffee will be served at 3:00 p.m. in Room 114 Sylvester Hall.

May 11-14—Society for Industrial and Applied Mathematics

Symposium on Applied Mathematics and Mechanics, held jointly with Air Force office of Scientific Research. (For further information call Maj. B. S. Morgan, Jr., OX 6-1302.)

May 19—James Curley Lectures in Science

Bentley Glass, Department of Biology, Johns Hopkins University, "The Revolution in Biology and Medicine."

Gaston Hall, Georgetown University, 8:30 p.m.

SCIENTISTS IN THE NEWS

Contributions to this column may be addressed to Harold T. Cook, Associate Editor, c/o Department of Agriculture, Agricultural Marketing Service, Federal Center Building, Hyattsville, Md.

AGRICULTURE DEPARTMENT

Roy J. Barker, formerly with the Pioneering Laboratory in Insect Physiology, Agricultural Research Service is now a senior entomologist with the Rohm and Haas Company Research Laboratories at Bristol, Pa.

Lawrence Zeleny was the United States delegate to the first meeting of the Expert Committee on Oils and Fats of the Codex Alimentarius Commission, sponsored jointly by FAO and WHO and held in London, February 25-27. The objective of the Commission is to establish international standards for edible oils and fats.

APPLIED PHYSICS LABORATORY

Frank T. McClure, chairman of APL's Research Center, has been given a Department of Defense Certificate of Appreciation for coordinating and contributing to a national effort which has led to significant advances in understanding combustion instability in solid fuel rockets.

HARRIS RESEARCH LABORATORIES

Julian Berch was co-author of a paper presented at the February 14 meeting of the Washington Section, American Association of Textile Chemists and Colorists, entitled, "Effect of Finishes on the Launderability of Cottons."

HOWARD UNIVERSITY

Floyd N. Ferguson spent January 23-24 at Harpur College, Binghamton, N. Y. as visiting scientist for the American Chemical Society's Division of Chemical Education. He gave a seminar talk on his research, held an organic chemistry class session, and discussed chemical curricula with the faculty.

Moddie D. Taylor recently served as visiting lecturer before chemistry student and teacher groups at the following institutions: Atlanta University, Atlanta, Ga., Savannah State College, Savannah, Ga.; and Bridgewater College, Bridgewater, Va.

Elton Price joined the faculty in February as assistant professor, after spending over a year with Ernest Grunwald at the Bell Telephone Laboratories and two years with Robert Taft at Pennsylvania State University. Dr. Price gave a paper, "Rates of Proton Transfer and Solvation of Amines in Glacial Acetic Acid," before the Physical Chemistry Section of the metropolitan regional meeting of the American Chemical Society in New York, January 27.

NATIONAL BUREAU OF STANDARDS

David R. Lide, an NBS staff member since 1954, has been named chief of infrared spectroscopy. Dr. Lide has specialized in investigations of microwave and infrared spectroscopy and molecular structure. In his new post he will direct research aimed at determining highly accurate molecular constants, and also will direct studies of the fine details of molecular structure.

George C. Paffenbarger, senior research associate of the American Dental Association at the Bureau, has been awarded the 1963 Alpha Omega Achievement Medal in recognition of his research and standardizing activities in the field of dental materials. The medal was presented at the 56th Annual National Convention of the Alpha Omega Dental Fraternity, held in Miami Beach, Fla. The Alpha Omega Medal was first awarded on 1936; outstanding past recipients include Albert Einstein, Jonas Salk, and Selman A. Waksman.

Roger G. Bates was a tour speaker for the American Chemical Society in March, addressing 10 local sections of the Society in Tennessee, Alabama, and Georgia on the subject "Acids and Bases in Alcohol-Water Solvents."

The following Bureau employees have received the Department of Commerce Gold Medal Exceptional Service Award, its highest employee honor, which is conferred for outstanding contributions to the public service, the nation, or humanity:

Samuel N. Alexander, chief of the Data Processing Systems Division, "for inspired leadership in establishing and directing the first laboratory entirely oriented to research and development in the design and application of automated information processing devices and systems for the Government."

Harry C. Allen, Jr., chief of the Inorganic Solids Division, "in recognition of highly distinguished accomplishments in research in molecular spectroscopy and of effective leadership in the organization and administration of research programs in analytical and inorganic chemistry."

Richard K. Cook, chief of the Sound Section, Mechanics Division, "for outstanding contributions and leadership in the field of acoustics including the development of an absolute method for the calibration of microphones, pioneering studies of infrasound in the atmosphere, and important researches on the transmission and absorption of sound in building materials and structures."

Silver Medal Meritorious Service Awards have been given to the following staff members for services of unusual value to the Department:

Gerhard M. Brauer, physical chemist in the Dental Research Section, Polymers Division, "in recognition of his valuable contributions to the science of polymers, in particular for his basic studies on the chemical and physical properties of polymeric and other materials which have led to improved materials for dental restoration."

Julian C. Eisenstein, physicist in the Cryogenic Physics Section, Heat Division, "for distinguished contributions to theory in the field of solid state physics, and particularly in the magnetic and optical properties of solids."

NATIONAL INSTITUTES OF HEALTH

Bernice E. Eddy, chief of the Section of Experimental Virology, Division of Biologics Standards, with Ralph B. Young and George E. Grubbs presented a paper, "Method for Inhibiting Oncogenesis in Hamsters Infected when Newborn with SV 40," at the Fourth Gustav Stern Symposium on Perspectives in Virology.

UNIVERSITY OF MARYLAND

The Department of Physics and Astronomy has announced several new appointments of regular and visiting staff members during the current academic year, as follows: **Claude Kacser** from Columbia University, as assistant professor of physics; **David L. Harris** from Goddard Space Flight Center, as research associate; **Harold S. Zapolsky** from NASA's Institute for Space Studies in New York, as research associate; **Peter D. Forsyth** from Rice University, as visiting assistant professor of physics; **Carl Westerhout** from the Division of Radiophysics of the Australian CSIRO, as visiting associate professor; **Gunnar Kallen** from the University of Lund, as visiting professor of physics; **Pierre Longe** from the University of Liege, as visiting postdoctoral research fellow in physics; **Lovro Picman** from the University of Zagreb, as visiting assistant professor in physics; **Hong-Yee Chiu** from NASA's Institute for Space Studies in New York, as visiting associate research professor in physics and astronomy; and **Harry C. Allen** from the National Bureau of Standards, as visiting lecturer.

UNCLASSIFIED

Henry Hopp, agricultural attache at the American Embassy, Mexico City, gave four lectures on Latin American Agriculture at the University of Maryland in December.

Roy C. Dawson represented the Food and Agriculture Organization at the annual meeting of the Association of Southern Agricultural Workers, held in Atlanta, Ga., February 3-5, and at the annual meeting of the American Society of Range Management, held in Wichita, Kans., February 10-14.

Louis C. Graton, professor emeritus of mining geology at Harvard University, received an honorary LL.D. degree on February 13 at Charter Day ceremonies at the University of California, Riverside. The citation read as follows: "Distinguished earth scientist; professor emeritus of mining geology at Harvard University, who during a long career has contributed signally to both the academic and the practical aspects of his chosen profession. For fifty years a leader in the study of ore deposits and the processes by which they originate, and noted also for his original work in mineralography and volcanology. An inspiring teacher, he has, through the accomplishments of his many outstanding students, added greatly to the impact of his own personal achievements. The University of California salutes him today and welcomes him to honorary membership in its company."

SCIENCE AND DEVELOPMENT

The December-January issue of NSF's *Scientific Information Notes* carried, among numerous interesting items, a comment on the plight of the librarian trying to cope with the rapid expansion of his research holdings—doubling in size every 16 to 20 years over the past century. According to James T. Babb of Yale University, selective book retirement, which is the practice of putting into compact, closed storage those items that are rarely consulted, will ease but not solve the problem. In his experience, cost is reduced to about one-fourth that of conventional shelving, and volume count per square foot is 64 in contrast to 14 in the open-access bookstacks.

Possibly the problem is, in the final analysis, insoluble, as suggested in Garrett Hardin's matchless satire, "The Last Canute" (*Scientific Monthly 63*, 203-208 (1946)). There, as you will recall, only a colony of termites was found to be making effective headway.

Sand and gravel, mundane as they may seem, form a valuable resource in the United States, particularly in view of our needs for these materials as aggregates in concrete and in highway construction. By 1970, annual production is expected to reach about one billion tons.

A comprehensive investigation of metropolitan Washington, aimed at updating the geologic knowledge of the region, indicates significant gravel resources in the Beltsville area. Charles F. Withington, of the Geological Survey, points out that increased urbanization may well extend over areas underlain by this gravel and that better knowledge of its whereabouts should aid in future planning and zoning.

The Food and Drug Administration, in its newly-published regulations controlling prescription drug advertising, makes certain allowances for what are considered "old drugs"—drugs long in use in medicine, which have substantial clinical experience to support their therapeutic claims, but which have not actually been subjected to controlled investigations as now required. The general purpose of the regulations is to insure that prescription drug advertisements will show not only established beneficial effects, but also any likely side effects or contraindications.

An adaptive enzyme formed by a species of *Arthrobacter*, a soil-inhabiting bacterium, has proved capable of so altering the herbicide Dalapon as to render it harmless as pyruvic acid. Studies by Philip C. Kearney, Donald D. Kaufman, and Millard L. Beall, Jr., at Beltsville, indicate that the organism removes two chlorine atoms from the molecule (2,2-dichloropropionate) and utilizes the carbon in its own metabolism, a discovery based on tracer techniques. Practically, of course, the breakdown of the herbicide insures that it can be used in situations where harmful, or at least questionable, residues must be avoided.

One more theory on the origin and nature of the moon has been suggested recently by Charles R. Warren of the Geological Survey. In his view the parent body of the moon, some 4½ billion years ago, may have had a composition similar to that of a comet's nucleus, although larger and heavier, a mixture of dust and ice. As this mass then approached the sun, the ices were volatized and began to stream away, while the dust was held by gravity and accumulated to a thickness of many miles. Then, perhaps 3 billion years ago, the mass was captured as an earth satellite which, in its first orbits, was subject to tremendous tides. Heat generated by these tidal frictions might then have vaporized much of the remaining ice, producing a lunar atmosphere which, as it accumulated, permitted liquid water to condense. If so, the hypothesis runs, the moon's maria may in fact, for a brief span have actually been filled with water, in line with interpretations of many years ago. Presently, Dr. Warren feels that the maria represent deposits of a pumice-like material that floated on these bodies of water initially. If he is correct, the maria materials should provide a reasonably firm foundation for vehicles and astronauts. Water, even, in the form of a dilute gas, might be obtainable on the moon by drilling wells, and would, if available even under these apparently adverse conditions, be of great value in manned explorations.

Since January 1 of this year, weather information exchange between North America and Europe has utilized a newly-completed cable circuit, replacing the usual radioteletypewriter system. The latter, understandably, often proves unsatisfactory when propagation is disrupted by, of all things, weather. Increasing demand for rapid and reliable service is leading those concerned with international weather information exchange to plan toward communications satellites and high-speed computer processing.

A Computer Sharing Exchange and a Computer Service Center have recently been established at the National Bureau of Standards on an experimental basis. The new facilities were created in response to a request of the Bureau of the Budget, which has found that great savings in both time and money can be realized through computer sharing. The Sharing Exchange will coordinate requests of Federal agencies in the Washington metropolitan area for help in locating appropriate computer time and services for their essential work. The Exchange will maintain records of the availability for sharing purposes of the electronic computer facilities of these agencies.

Delegates to the Washington Academy of Sciences, Representing the Local Affiliated Societies*

Philosophical Society of Washington	Urner Liddel
Anthropological Society of Washington	Regina Flannery Herzfeld
Biological Society of Washington	John L. Paradiso
Chemical Society of Washington	William A. Zisman
Entomological Society of Washington	Harold H. Shepard
National Geographic Society	Alexander Wetmore
Geological Society of Washington	Luna Leopold
Medical Society of the District of Columbia	Frederick O. Coe
Columbia Historical Society	U. S. Grant, III
Botanical Society of Washington	Wilbur D. McClellan
Society of American Foresters	Harry A. Fowells
Washington Society of Engineers	Martin A. Mason
Institute of Electrical and Electronics Engineers	Delegate not appointed
American Society of Mechanical Engineers	William G. Allen
Helminthological Society of Washington	Marion M. Farr
American Society for Microbiology	Frank Hettrick
Society of American Military Engineers	Delegate not appointed
American Society of Civil Engineers	Thorndike Saville, Jr.
Society for Experimental Biology and Medicine	Falconer Smith
American Society for Metals	Hugh L. Logan
International Association for Dental Research	George Dickson
American Institute of Aeronautics and Astronautics	A. W. Betts
American Meteorological Society	J. Murray Mitchell, Jr.
Insecticide Society of Washington	Robert A. Fulton
Acoustical Society of America	Malcolm C. Henderson
American Nuclear Society	George L. Weil
Institute of Food Technologists	Richard P. Farrow
American Ceramic Society	J. J. Diamond
Electrochemical Society	Kurt H. Stern

* Delegates continue in office until new selections are made by the respective affiliated societies.

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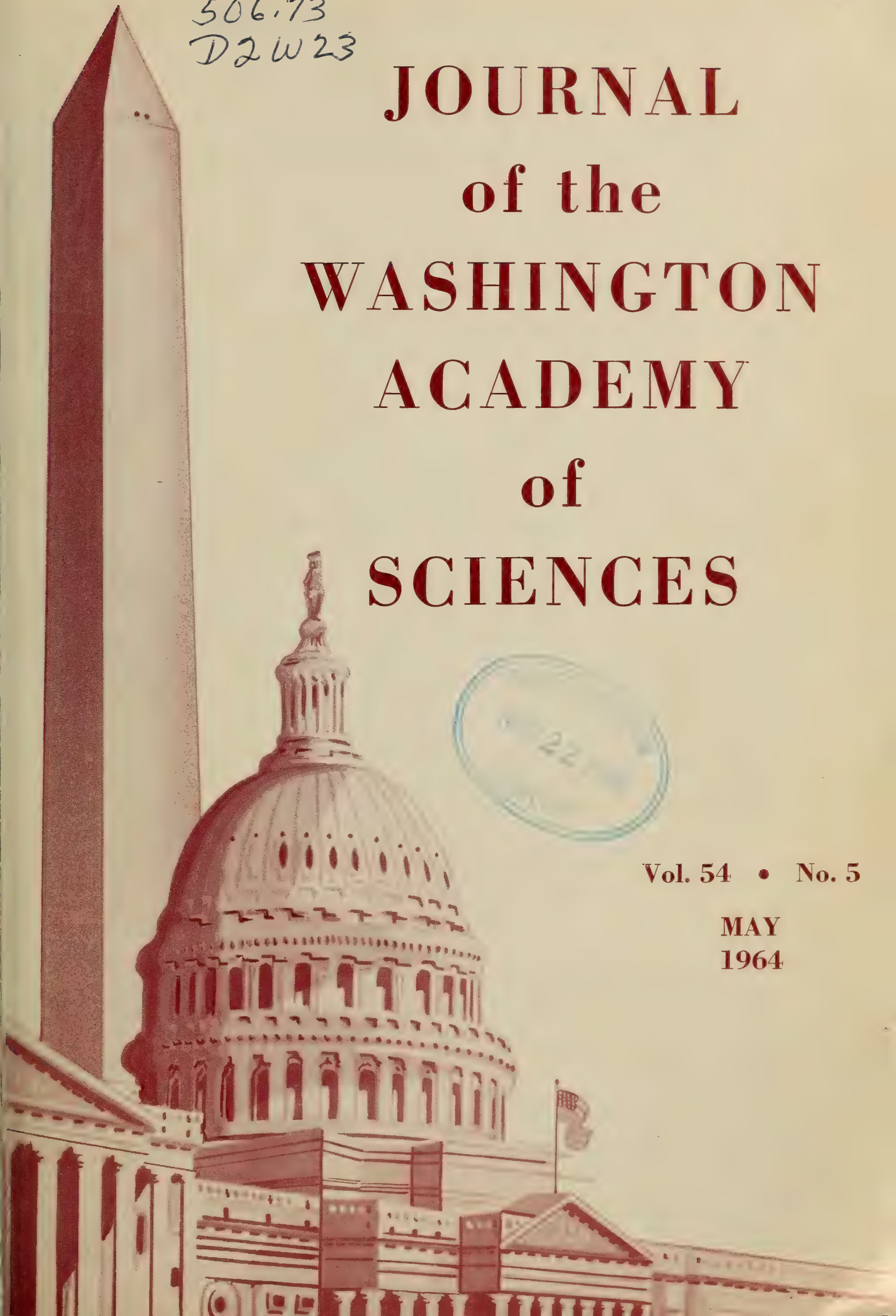

JOURNAL of the WASHINGTON ACADEMY of SCIENCES

Vol. 54 • No. 5

MAY
1964

This Journal, the official organ of the Washington Academy of Sciences, publishes historical articles, critical reviews, and scholarly scientific articles; notices of meetings and abstract proceedings of meetings of the Academy and its affiliated societies; and regional news items, including personal news, of interest to the entire membership. The Journal appears nine times a year, in January to May and September to December. It is included in the dues of all active members and fellows.

Subscription rate to non-members: $7.50 per year (U.S.) or $1.00 per copy; foreign postage extra. Subscription orders should be sent to the Washington Academy of Sciences, 1530 P St., N.W., Washington, D.C. Remittances should be made payable to "Washington Academy of Sciences."

Back issues, volumes, and sets of the Journal can be purchased direct from the Johnson Reprint Corporation, 111 5th Avenue, New York 3, N.Y. This firm also handles the sale of the Proceedings of the Academy (Volumes 1-13, 1898-1910), the Index, and the Monograph.

Current issues of the Journal (past two calendar years) may still be obtained directly from the Academy office at 1530 P Street, N.W., Washington 5, D.C.

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Comments at Press Time

This issue of the Journal is particularly devoted to the interests of the geologists of Washington. With the active collaboration of President William T. Pecora of the Geological Society of Washington, we present a discussion of interesting geological formations of the local area; the first geological report on this region, by Captain John Smith; the GSW Proceedings for 1963; and the society's roster of officers and committeemen. Free copies of the issue are being sent to some 650 local members of GSW.

Other disciplines have not been neglected. Program highlights of the forthcoming national meeting of the Institute of Food Technologists have been summarized; a physicist discusses stellar photometry in Washington; a botanist looks at science education; and two meteorologists describe Washington's climate and the difficulties of long-range forecasting.

This is the second of two experimental issues aimed at establishing closer liaison between the Academy and its affiliated societies. Budgetary considerations permitting, the experiment will be continued next fall.

Selected Geologic Localities In the Washington Area*

H. W. Coulter and G. V. Carroll

U. S. Geological Survey

The geology of Washington attracts widespread interest because so many scientists live or visit here. Furthermore, it bears relevance to rapidly evolving concepts that are important facets of general geosynclinal theory. If this article provides a context in which resident scientists, and visiting American and foreign geologists as well, can "orient" observations of their own, it will have accomplished its purpose.

This paper describes ancient metamorphosed sedimentary and igneous rocks of the Washington Area and, particularly, directs attention to easily accessible localities where they are well exposed, and where features that bear on their origins can be observed. Young sedimentary rocks underlie a large part of Washington but for want of good, permanent, local exposures are not discussed here. Specialized terminology that would be unfamiliar to many scientists who are not geologists is avoided if possible, or explained. Emphasis is placed on field observations that can readily be made by scientists or other interested persons, who need not have had formal training in geology. The general distribution of rock units and the selected localities are shown in the figure.

From late Precambrian time, over 500 million years ago, through the Paleozoic Era, which ended about 200 million years ago, the geography of eastern North America was very different from what it is today. It was very similar to the present geography off the Asian mainland, with its bordering seas and its earthquake-prone, volcano-topped island arcs, such as those of Japan and of Indonesia, beyond which lie the abyssal basins of the Pacific and Indian oceans. That is, eastern North America was bordered by a geosyncline or great downwarped trough, in portions of which island arcs were raised by mountain-building forces, while sediments continued to collect in neighboring portions that were depressed by the same forces.

The eroded remnants of these ancient geosynclinal rocks are visible today in that portion of the eastern seaboard known as the Appalachian Piedmont province. East of the Piedmont province is the Coastal Plain province, underlain by much younger, soft sedimentary rocks. Washington lies on the border between these two provinces. Briefly, the metamorphic rocks of the Appalachian Piedmont province are predominantly of sedimentary origin. These geosynclinal sedimentary rocks, along with igneous rocks associated with them, were ultimately carried to great depths in the crust of the earth as portions of the geosyncline collapsed or buckled in response to mountain-building forces. In this deep-crustal environment of high pressures, stresses, and temperatures, the rocks underwent the physical and chemical readjustments, or dynamothermal metamorphism, that gave them the character they have today. Original sedimentary features were mostly obscured but not obliterated. Confining attention to the Washington area, little is known, directly, of events that followed dynamothermal metamorphism, which seems likely to have been accomplished rather early in the Paleozoic Era, perhaps no later than 360 million years

* Publication authorized by the director, U.S. Geological Survey.

ago. About 130 million years ago, late in the Mesozoic Era, the ancient geosynclinal rocks of the Piedmont province, as a result of uplift and erosion, were exposed at the earth's surface. They then became the basement upon which young sedimentary rocks of the Coastal Plains province began to accumulate as the Atlantic Ocean encroached upon the continental margin.

The missing Paleozoic and Mesozoic chapters in the geological history of the Washington area can only be reconstructed from what is known of other regions. Thus, west of the Blue Ridge there are geosynclinal deposits of all Paleozoic periods, and in local basins east of the Blue Ridge there are Mesozoic deposits older than those of the Coastal Plains province.

Metamorphosed Sedimentary Rocks

Rocks interpreted as metamorphosed geosynclinal sedimentary rocks are particularly well exposed along the Potomac River and Rock Creek. Elsewhere large areas of outcrop have undergone extensive chemical decomposition by weathering and might be mistaken for unconsolidated sediments. In general the unweathered rocks are distinguishable from other rocks of the area by their gray color and by a uniform, fine-grained matrix in which more or less abundant masses of quartz and fragments of rock of diverse types, unlike the matrix, are included. These quartz and rock inclusions are scattered randomly throughout the matrix. At most outcrops there is no clear evidence of bedding that originated during sedimentation. However, there is a planar structure, inclined steeply to the west (west-dipping cleavage), imposed during dynamothermal metamorphism. This cleavage may easily be mistaken for bedding, particularly where secondary, open fractures (joints) are developed parallel to the cleavage.

The quartz and rock inclusions show no preferred orientation of their long axes where cleavage is weakly developed. Where cleavage is strongly developed, parallelism becomes apparent, and if very strongly developed, rock inclusions are flattened to mere wafers and quartz inclusions are elongated markedly.

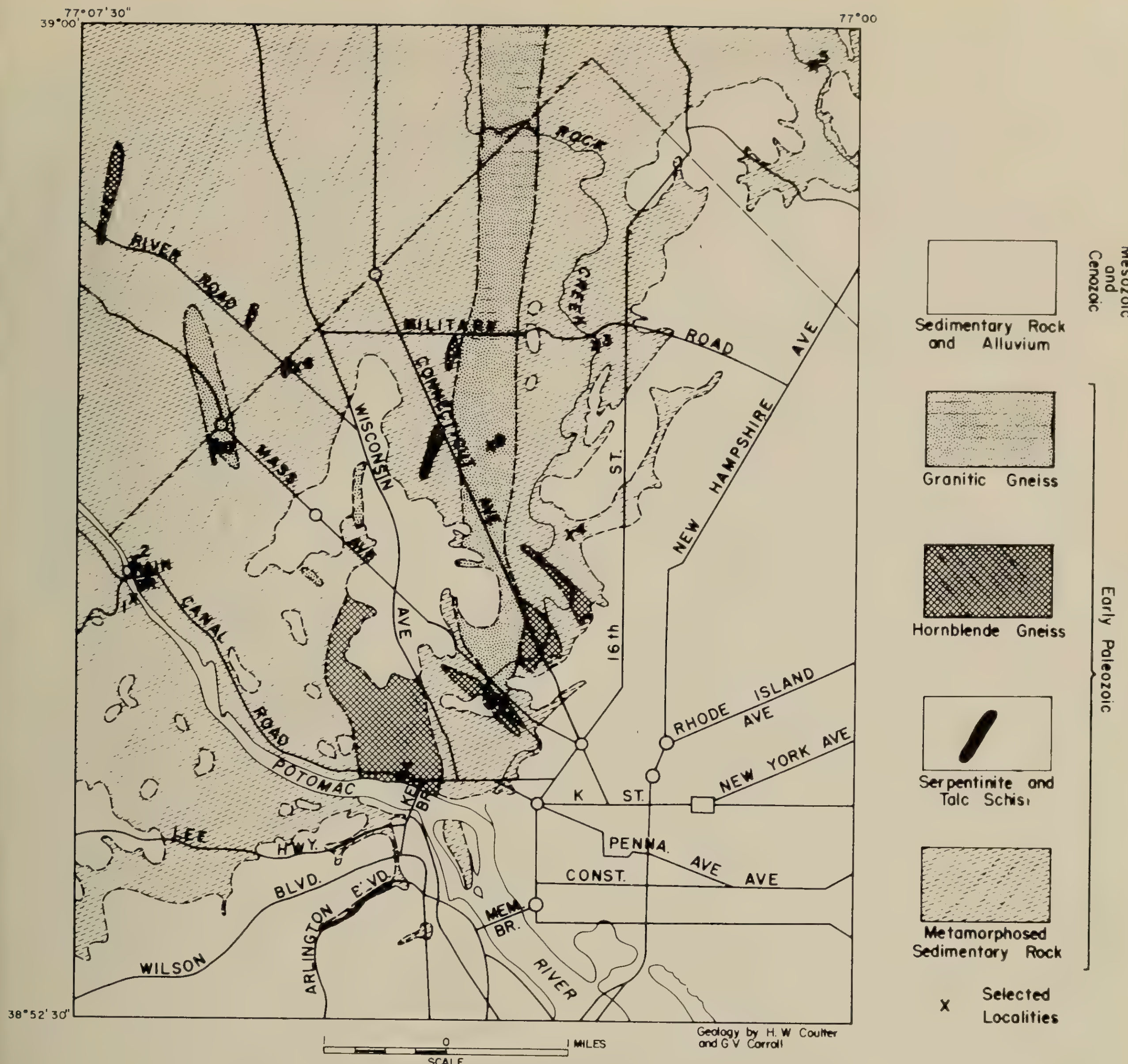
In any single locality where rock inclusions are abundant, one lithology may predominate over others, and from place to place there are considerable differences in the predominant lithology; there is also a considerable variation from place to place in the proportions of quartz inclusions to rock inclusions and in the proportion of both to the matrix.

Selected Localities for Metamorphosed Sedimentary Rocks

(1) Near Chain Bridge: Virginia shore of Potomac River between Pimmit Run and Gulf Branch.

In most outcrops here, both quartz and rock inclusions are present; cleavage is well developed so that the inclusions are elongate somewhat east of north and with a gentle northward inclination of long axes. Rock inclusions are flattened rather than blocky; chlorite-rich, blackish-green masses are particularly conspicuous, but there are many other types as well. In many, internal texture and structure are entirely unlike the matrix. Some rock inclusions show reaction rims consisting of marked concentrations of chlorite, mica, garnet, or other minerals at the contact between inclusion and matrix.

At a very few outcrops, the generally homogeneous gray rock shows individual thin beds (6 inches or less) of lighter color, thrown into small convolutions (drag folds) whose axes (hinges) are aligned with the gently northward-plunging long dimensions of quartz and rock inclusions. To find such outcrops, careful observation is necessary. One particular outcrop showing such a bed is marked by a long iron pipe (bent downstream) driven into the rock. The true sedimentary bed is much more nearly horizontal than the steep, west-dipping, false bedding effect produced by cleavage in the more typical rock that



Geologic Sketch Map of the Washington West Quadrangle D.C.–Md.–Va.

makes up the greater part of this exposure. Bedding with especially good development of drag folds is also well displayed in a large loose block lying at the base of the cliff within 100 yards southwest of the exposure marked by the iron pipe.

(2) On the Washington shore of the Potomac for a few hundred feet above Chain Bridge, rocks similar to the foregoing are exposed, except that here the mineralogy of the rock inclusions is different. Light-colored rock inclusions with an exceptional abundance of garnets are common in many outcrops; in other outcrops dark inclusions prevail, and hornblende rather than chlorite is their characteristic dark mineral.

(3) Rock Creek near Military Road: West bank of Rock Creek just south of the Joyce Street bridge.

Here cleavage is weakly developed and may even escape detection in some outcrops. The texture of the matrix is coarser than near Chain Bridge, quartz inclusions are more angular, and rock inclusions are more irregular. Alignment of inclusions is weak or absent and no inclusions have been flattened to wafers. Rock inclusions are unlike those near Chain Bridge. Some are fine-grained, thin-layered, quartzofeldspathic, light-colored rock, while others are highly micaceous; the latter show reaction rims. Chlorite-rich, hornblende-rich, or markedly garnetiferous inclusions are lacking here. The rocks at this locality, being less modified by cleavage during dynamothermal metamorphism, are interpreted as more closely approximating an original massive condition than those near Chain Bridge.

(4) Piney Branch: Piney Branch Parkway west of Beach Drive.

Here rocks similar to those at Chain Bridge are associated with others in which layering, in a manner suggestive of sedimentary bedding, is delineated by changes of color and mineral composition. Quartz inclusions are sparse and small, or lacking, and rock inclusions are either inconspicuous, by virtue of having been reduced to wafers or even to shredded wafers, or are absent. The layering is even and regular and conforms to the west-dipping cleavage. Accordingly, it is conceivable that in this locality the layering might not be original sedimentary bedding but a by-product of local intense development of cleavage (metamorphic differentiation). However, in other places where rock fragments have been wafered and shredded to near obliteration, there is no concomitant production of compositional layering in the matrix.

(5) Sligo Creek Parkway between Carroll Avenue and Wayne Street.

Near Carroll Avenue the rocks are very similar to those near Military Road. Northward near Piney Branch Road, cleavage in the rocks becomes increasingly prominent, and the texture of both the matrix and the mica-rich inclusions becomes increasingly coarse-grained. Between Piney Branch Road and Wayne Street the effects of dynamothermal metamorphism have modified the rocks as greatly as at any place within the immediate vicinity of Washington.

Origin of the Metamorphosed Sedimentary Rocks

The metamorphosed sedimentary rocks of Washington extend far northward into Maryland, where their appearance becomes more and more like that of igneous rock, until at Sykesville, Md., they have the appearance of a granite contaminated by xenoliths. At Sykesville an igneous origin was ascribed to these rocks (Jonas, 1928). Subsequently the Sykesville "granite" was traced southward into Montgomery County and Washington by Cloos and Cooke (1953), who changed the name to Sykesville formation to take account of increasing evidence that the unit originated as sedimentary rock. In collaboration with Cloos, Hopson (1963) undertook a regional study of the Sykesville formation and the associated Wissahickon formation to the west.

From detailed work in the Washington area, the authors of the present paper had tentatively interpreted the Sykesville formation as a metamorphosed analogue of certain "pebbly mudstones" of California (Crowell, 1957). The California "pebbly mudstones" were dumped by turbidity currents (Kuenen and Migliorini, 1950) in a rapidly subsiding basin, as successive influxes of chaotically mixed fine and coarse debris. Our interpretation required corroborative evidence, which has been supplied by Hopson's painstakingly documented regional study. Hopson (manuscript in press) shows that the well-bedded to delicately laminated rocks of the Wissahickon formation and the massive mixtures of fine and coarse debris that constitute most of the Sykesville formation are very different, yet essentially synchronous and genetically related members of the same depositional complex.

Rocks of Igneous Origin

Rocks of igneous origin are of three dissimilar types: serpentinite and talc schist derived from it, hornblende gneisses, and diverse granitic gneisses.

Serpentinite and Talc Schist

(6) Fort Bayard Park, Western Avenue and River Road.

At Fort Bayard Park there are several large exposures of talc schist. This is a very soft, flaky, pale-greenish rock with prominent rusty staining and a characteristic slippery feel. No serpentinite crops out at this locality.

Serpentinite and talc schists were exposed in excavations at the head of Soapstone Valley (Connecticut Avenue and Albemarle Street) during 1963. The extent of such rocks along Connecticut Avenue is known from older geologic maps (Keith and Darton, 1901) and from sub-surface data.

These two occurrences are the most easterly known in the Washington area. They are portions of the eastern of two belts of serpentinite that extend through the Appalachian geosynclinal complex from western North Carolina to Newfoundland (Hess, 1955). The origins of geosynclinal serpentinites are problematic but Hess (op. cit.) postulates that they are among the oldest rocks of igneous origin present in geosynclinal complexes and are emplaced only during the first great deformation of a mountain belt eventually developed on the site of a geosyncline.

The local serpentinites have partaken of the dynamothermal metamorphism that affected the metamorphosed sedimentary rocks, as is indicated by the cleavage common to both. However or whenever the serpentinite itself originated, talc schists developed from it, probably as the thermal intensity of metamorphism waned but while deformation was still strong.

Hornblende Gneisses

The hornblende gneisses are readily distinguishable from other local rock by the black color imparted to them by abundant hornblende. Contacts between hornblende gneisses and metamorphosed sedimentary rocks are not exposed in Washington. However, as the concealed contact zones are approached, cleavage becomes more pronounced. In small, narrow bodies of hornblende gneiss, the cleavage closely parallels, both in direction and degree of development, that of the enclosing metamorphosed sedimentary rocks.

Before metamorphism, the hornblende rocks probably had gabbroic or dioritic mineral assemblages. The larger bodies are complex internally, as is shown by local details of structure, texture, and mineral composition. While intense dynamothermal metamorphism is capable of inducing such effects in such rocks, the fact that the hornblende gneisses which show the strongest cleavage are the most homogeneous suggests that the textural and compositional complexities were original.

(7) Georgetown University Bluff: Canal Road between Glover-Archibold Park and Key Bridge.

The outcrops at this locality show variability of texture, both in grain size and grain arrangement. Generally the rock is rather coarse-grained, and its hornblende prisms show no marked preferred orientation where cleavage is poorly developed. Dikes of fine-grained rock locally cutting through coarser-grained rocks and through zones of compositional layering can be seen.

(8) Rock Creek at Dumbarton Oaks Park.

The hornblende gneisses are also well exposed along Rock Creek at the foot of Dumbarton Oaks Park and in the quarry below the southeast end of Taft Bridge. At both places, compositional layering and textural variations are shown particularly well.

Granitic Gneisses

Granitic rocks, most of them more or less gneissic in texture and concordant to cleavage in metamorphosed sedimentary rocks, but a few massive in texture and markedly discordant to cleavage in adjacent metamorphosed sedimentary rocks, are abundant in Washington. All are light-colored because the proportions of feldspar and quartz to biotite are very large. There is considerable petrographic diversity among them; they are designated as "granitic" to characterize their general appearance in the field, but true granites in a technical sense are less common than granodiorites and tonalites.

(9) Broad Branch Quarry: Broad Branch Road just south of Grant Road.

At this locality there is a large quarry in a belt of granitic rock that extends from the vicinity of the National Zoo well into Montgomery County, Md. Of all the granitic rocks of Washington, this is both the most extensive and the most singular in appearance. The distinctive feature of the gneiss is the presence of evenly distributed dark spots up to the size of a dime, composed chiefly of biotite flakes. The texture of the rock is that of an augen gneiss with individual lenses, or augen, made up of feldspar and quartz about 10 mm x 3 mm and oriented so as to give the rock a gneissic foliation. This foliation dips steeply west as does the cleavage of nearby metasedimentary rocks.

Downstream from the quarry, the augen gneiss is in contact with metamorphosed sedimentary rocks and the passage from one to the other is abrupt. To the west near the contact zone, the gneiss becomes more and more divided by screens of metamorphosed sedimentary rock. Foliation of the gneiss and cleavage of the metasediments of the screens are essentially parallel but not perfectly so, and the contacts of the augen gneiss are concordant to cleavage of the metasedimentary rocks. In a few places the contacts are nearly perpendicular to cleavage of the metasedimentary rocks for distances of several feet. There is no hint of granitization of the metamorphosed sedimentary rocks. The abrupt nature of the eastern contact and transitional nature of the western contact of the gneiss are also characteristic of exposures along Klingle Road and in Melvin Hazen Park.

Unlike the hornblende gneiss in which foliation and cleavage seem to have been imposed upon older structures and textures by deformation and metamorphism, the texture of the augen gneiss at Broad Branch seems to be the original texture. That is, magma seems to have been intruded during the time when cleavage was imposed on the enclosing metamorphosed sedimentary rocks.

(10) Dalecarlia Parkway at the first bridge south of Westmoreland Circle.

At the bridge, dikes of granitic rock cut across the cleavage of the metamorphosed sedimentary rocks at low angles and are in turn cut by faults. These discordant dikes are interpreted as relatively young granitic rocks, intruded along fractures in the metasedimentary rocks as deformation was waning.

Upstream, nearer Massachusetts Avenue, granite augen gneisses are extensively exposed. Like the augen gneisses at Broad Branch which they resemble (except for the lack of biotite "spots"), these rocks are interpreted as being of a somewhat older generation than the dikes near the bridge.

Dikes of granitic rock are also well exposed, just west of the area mapped, on Goldsboro Road north of MacArthur Boulevard. Some of these dikes are foliated; others are sensibly massive and cross-cutting. The latter are interpreted as being among the youngest granitic rocks of the area.

Age Relationships Between Rocks of Igneous Origin

Resolution of the age relations among the serpentinites, the hornblende gneisses, and the granitic rocks of Washington has not yet been fully possible, nor fully possible for the diverse granitic rocks themselves. Most critical of all field relations are outcrops in which younger igneous rocks unambiguously cut across older ones, and there is a dearth of such outcrops within Washington. New exposures are continuously being created in the course of construction projects, however, so that one may anticipate the eventual resolution of unsolved problems. Little faith can be placed in degrees of textural complexity as criteria of relative age when comparison is made between rocks from widely separated localities. Thus, from place to place the metamorphosed sedimentary rocks themselves show great differences in degrees of textural complexity. It is thus quite possible that a dike of macroscopically massive igneous rock at one place may be older than a well-foliated one elsewhere, if the former is enclosed by metamorphosed sedimentary rocks in which cleavage is poorly developed, and the latter in metamorphosed sedimentary rocks in which cleavage is very well developed. Nevertheless, such cross-cutting relations as there are between younger and older igneous rocks, and textural comparisons between outcrops of unlike igneous rocks that are not widely separated from one another, suggest strongly (1) that the hornblende gneisses are derived from rocks intruded before cleavage was imposed on metasedimentary rocks, (2) that some granitic rocks were intruded as cleavage was developing in the metasedimentary rocks, and (3) that small dikes of granitic rock were intruded during the waning stages of deformation. Such a sequence from dark to increasingly light-colored rock is commonplace in many regions where age relations between igneous rocks of these types can clearly be established. Except for the concept that serpentinites are probably among the oldest rocks of igneous origin in geosynclinal complexes as a whole (Hess, op. cit.), there is no hint within Washington of their age relationships to the other rocks of igneous origin.

References

Cloos, Ernst, and Cook, C. W., Geological map of Montgomery County and the District of Columbia: (Scale 1:62,500) Maryland Dept. Geology, Mines and Water Resources, 1953.

Crowell, J. C. Origin of pebbly mudstones. Geol. Soc. Amer., Bull. *68*, 993-1009 (1957).

Hess, H. H. Serpentines, orogeny, and epeirogeny. Geol. Soc. Amer., Spec. Paper 62, 391-407 (1955).

Hopson, C. A. Premetamorphic features of the Wissahickon Schist, Maryland Piedmont. Geol. Soc. Amer., Spec. Paper 76, 24 (1963).

Jonas, A. I. Geologic map of Carroll County, Maryland. Maryland Geol. Survey, 1928.

Keith, Arthur, and Darton, N. H. Description of the Washington quadrangles. U.S. Geol. Survey Geol. Atlas, Folio 70, 1901.

Kuenen, P. H., and Migliorini, C. I. Turbidity currents as a cause of graded bedding. Jour. Geology *58*, No. 1, 49-54 (1950).

The Sixt Voyage (1606)*

To Another Part of Virginia

Where now are planted our English Colonies

Whom God Increase and

Preserve

Discovered and Described

By

Captaine John Smith

Sometimes Governour of the Countrey

The Sommer is hot as in Spaine; the Winter cold as in France or England. The heat of sommer is in June, July, and August, but commonly the coole Breeses asswage the vehemency of the heat. The chiefs of winter is halfe December, January, February, and halfe March. The colde is extreame sharpe, but here the Proverbe is true, that no extreame long continueth.

The ship sailed from England December 20, 1606. In the yeare 1607 was an extraordinary frost in most of Europe, and this frost was found as extreame in Virginia. But the next yeare of 8 or 10 dayes of ill weather, other 14 dayes would be as Sommer.

The windes here are variable, but the like thunder and lightning to purifie the ayre, I have seldome either seene or heard in Europe. From the Southwest came the greatest gusts with thunder and heat. The Northwest winds is commonly coole and bringeth faire weather with it. From the North is the greatest cold, and from the East and Southeast as from the Barmudas, fogs and raines.

Sometimes there are great droughts, other times much raine, yet great necessitie of neither, by reason we see not but that all the raritie of needful fruits in Europe, may be there in great plentie, by the industry of men, as appearath by those we there planted.

There is but one entrance by Sea into this Country, and that is at the mouth of a very goodly Bay, 18 or 20 myles broad. The cape on the South is called Cape Henry, in honour of our most noble Prince. The land white hilly sands like unto the Downes, and all along the shores great plentie of Pines and Firres.

The North Cape is called Cape Charles, in honour of the Worthy Duke of Yorke. The Isles before it, Smith's Isles, by the name of the discover. Within is a country that may have the prerogative over the most pleasant places knowne, for large and pleasant navigable Rivers, heaven and earth never agreed better to frame a place for mans habitation; were it fully manured

* No account of the geology of the Washington area would be complete without reference to the very first geological reports on the area, the reports on the early explorations of Captain John Smith. These writings included information on geography, surface features, drainage, climate, geology, and natural resources. The following extracts have been taken from a visitor's guide prepared for the third general meeting of the International Mineralogical Association, April 17-20, 1962.

and inhabited by industrious people. Here are mountaines, hils, plaines, valleyes, rivers, and brookes, all running most pleasantly into a faire Bay, compassed but for the mouth, with fruitful and delightsome land. In the Bay and rivers are many Isles both great and small, some woody, some plaine, most of them low and not inhabited. This bay lyeth North and South, in which the water floweth neare 200 myles, and hath a channell for 140 miles of a depth betwixt 6 and 15 fadome, holding a breadth for the most part 10 or 14 myles. From the head of the Bay to the Northwest, the land is mountanous, and so in a manner from thence by a Southwest line; so that the more Sourhward, the farther off from the Bay are those mountains. From which fall certaine brookes which after some to five principll navigable rivers. These run from the Northwest into the Southeast, and so into the West side of the Bay, where the fall of every River is within 20 or 15 myles one of the other.

The mountaines are of diverse natures: for at the head of the Bay the rockes are of a composition like Mill stones. Some of Marble, &c. And many peeces like Christall we found, as throwne downe by water from those mountaines. For in Winter they are covered with much snow, and when it dissolveth the waters fall with such violence, that it causeth great inundations in some narrow valleys, which is scarce preceived being once in the rivers. These water wash from the rocks such glistering tinctures, that the ground in some places doth manifestly prove the nature of the soyle to be lusty and very rich. The colur of the earth we found in diverse places, resembleth bole Armoniac, terra a sigillata, and Lemnia, Fullers earth, Marle, and divers and other such appearances. But generally for the most part it is a blacke sandy mould, in some places a fat slimy clay, in other places a very barren gravell. But the best ground is knowne by the vesture it beareth, as by the greatnesse of trees, or abundance of weeds, &c.

The Country is not mountanous, nor yet low, but such pleasand plaine hils, and fertile valleyes, one prettily crossing another, and watered so conveniently with fresh brookes and springs, no lesse commodious, then delightsome. By the rivers are many plaine marishes, containing some 20 some 100, some 200 Acres, some more, some lesse. Other plaines there are few, but onely where the Salvages inhabit: but all overgrowne with trees and weeds, being a plaine wildernesse as God first made it.

On the west side of the Bay, we sayed were 5. faire and delightful navigable rivers.

The fourth river is called Patawomeke, (Potomac) 6 or 7 miles in breadth. It is navigable 240 myles, and fed as the rest with many sweet rivers and springs, which fall from the bordering hills. These hills many of them are planted, and yeeld no lesse plentie and variete of fruit, then the river exceedeth with abundance of fish. . . . Here doth the river divide itself into 3 or 4 convenient branches. The greatest of the least is called Quiyough (Occoquan) trending Northwest, but the river it selfe turneth Northeast, and is still a navigable streame. . . . The river above this place maketh his passage downe a low pleasant valley overshaddowed in many places with high rocky mountaines; from whence distill innumerable sweet and pleasant springs.

Concerning the entrailes of the earth, little can be said for certaintie. There wanted good Refiners; for those that tooke upon them to have skill this way, tooke up the washings from the mountaines, and some moskered shining stones and spangles which the water brought downe, flattering themselves in their owne vaine conceits to have been supposed that they were not, by the meanes of that ore, if it proved as their arts and judgments expected. Onely this is certaine, that many regions lying in the same lattitude, affort Mines very rich of diverse natures. The crust also of these rockes would easily persuade a man to believe there are other Mines then iron and steele, if there were but meanes and men of experience that knew the Mine (ore) from Spar (dross). . . .

THE COMMODITIES IN VIRGINIA, or that may be had by Industrie.

The mildnesee of the ayre, the fertilitie of the soyle, and situation of the rivers are so propitious to the nature and use of man, as no place is more convenient for pleasure, profit, and mans sustenance, under that lattitude or climate. Here will live any beasts, as horses, goats, sheepe, asses, hens, &c. as appeared by them that were carried thether. The waters, Isles, and shoales, are full of safe harbours for ships of warre or marchandize, for boats of all sorts, for transportation or fishing, &c. The Bay and rivers have much marchantable fish, and places fit for Salt coats, building of ships, and making of iron, &c. (Smith. 1629)

Geological Society of Washington: Proceedings for 1963

842nd Meeting

The 842nd meeting of the Society was held in the John Wesley Powell Auditorium on January 9 with President Luna B. Leopold presiding. The president announced the deaths of Joseph J. Tregoning and Donald W. Kessler.

Informal Communication. George Cohee reported on the meeting of the International Commission for the Geologic Map of the World in Paris.

Program

Harry Rose, Isidore Adler, and Francis Flanagan: "X-ray Fluorescence Analysis of Rocks." Discussed by Mr. McKelvey.

Isidore Adler: "Electron-probe Microanalysis of Minerals." Discussed by Messrs. Henbest, Doe, Fawcett, Kinkle, and Guild.

Louis Conant: "Geology in Libya." Discussed by Messrs. Warren, Kinkle, Thayer, Neuman, Cohee, McKelvey, Johnston, Guild, Goudarzi, and the Chair.

843rd Meeting

The 843rd meeting of the Society was held in the John Wesley Powell Auditorium on January 23 with First Vice-President David B. Stewart presiding.

Program

E. P. Henderson: "The Clovis Meteorite." Discussed by Messrs. Stewart, Warren, Skinner, Guild, Jackson, and Roedder.

E. Dale Jackson: "Compositional Changes in Coexisting Olivines and Chromites in Layered Chromites." Disussed by Messrs. Thayer, Roedder, Sampson, and Wones.

Andrew Griscom: "Appalachian Gravity and Tectonics." Discussed by Messrs. Doe, Stewart, Hadley, and Robertson.

844th Meeting

The 844th meeting of the Society was held in the John Wesley Powell Auditorium on February 13 with First Vice-President David B. Stewart presiding. The vice-president announced the death of H. E. Merwin. Edwin McKnight read a memorial to A. H. Kosehmann.

Informal Communication. Lynton S. Land of Johns Hopkins University discussed Eolian Cross Bedding in the Beach-dune Environment, Sapelo Island, Georgia.

Program

Thomas C. Hoering: "Reduced Carbon

in Precambrian Rocks." Discussed by Messrs. Stewart, Goldich, and Breger.

Clifford Hopson: "Chaotic Metasedimentary Rocks in the Maryland Piedmont." Discussed by Messrs. Thayer, Leo, Cox, Neuman, Coulter, Davis, Altschuler, and Goldich.

O. J. Ferrians: "Till-like Glaciolacustrine Deposits in the Copper River Basin, Alaska."

845th Meeting

The 845th meeting of the Society was held in the John Wesley Powell Auditorium on February 27 with First Vice-President David B. Stewart presiding.

Program

William L. Straws: "Oreopithecus Bambolii, a Lower Pliocene Nominaid Primate." Discussed by Messrs. Whitmore, Jones, and Hanshaw.

Bruce Velde: "Natural Illite Potytypes."

Paul Seaber: "Relation of Ground-water Chemistry to Topography, Geology, and Flow Patterns in the New Jersey Coastal Plain." Discussed by Messrs. Davis, Neuman, Stewart, Wiesnet, Rubin, Le Grand, and Warren.

846th Meeting

The 846th meeting of the Society was held in the John Wesley Powell Auditorium on March 13 with President Luna B. Leopold presiding.

Program

Harry E. Legrand: "Hydrologic Zonation of Limestone Formations." Discussed by Messrs. Neuman, Lohman, McKelvey, Kiilsgaard, and McKnight.

Brian T. C. Davis: "Petrology of Part of the Adirondack Anorthosite." Discussed by Messrs. Stewart and Fournier.

Robert H. Rose: "Contributions of the Geologic Profession to National Parks."

847th Meeting

The 847th meeting of the Society was held in the John Wesley Powell Auditorium on March 27 with President Luna B. Leopold presiding.

Program

Louis Peselnick: "Stress-wave Velocity in Limestone." Discussed by Messrs. Stewart, Milton, Faul, Tauner, Carder, Robertson, and Toulman.

Raymond T. Benack: "Water and Diseases." Discussed by Messrs. Carder, Callahan, and Leopold.

Sam Rosenblum: "Geochemistry and Heart Disorders." Discussed by Messrs. Ericksen, Benack, and Callahan.

848th Meeting

The 848th meeting of the Society was held in the John Wesley Powell Auditorium on April 10 with First Vice-President David B. Stewart presiding.

Informal Communication. Edwin Roedder discussed the technique of neutron activation analysis of fluid inclusions.

Program

A. P. Crary: "Glaciology in Antarctica." Discussed by Messrs. Denny, Zen, Milton, Stewart, Broughton, and Boudette.

Harold E. Gill: "Evaluation of Geologic and Hydrologic Data from the Island Beach, N.J., Test Drilling Program." Discussed by Messrs. Birdsall, Tracey, McKnight, Kinney, Roedder, Altschuler, Owens, Milton, and Denny.

David Wones: "Biotite in Volcanic Rocks." Discussed by Messrs. Toulman, Fournier, Roedder, Greenwood, Zen, Cox, Barton, and Jones.

849th Meeting

The 849th meeting of the Society was held in the John Wesley Powell Auditorium on April 24 with President Luna B. Leopold presiding. The president introduced the following two high school students who had been awarded prizes by the Society for their projects at area science fairs: Linda M. White of Hyattsville for her seismograph, and Kenneth J. Wiewara of Alexandria for his study of variations in the earth's magnetic field. Both projects were exhibited at the meeting. A memorial to H. E. Merwin was read by J. W. Greig.

Informal Communication. Allen Heyl discussed clay mineral alteration in the upper Mississippi Valley zinc district.

Program

E. W. Rodoslovick: "Recent Ideas about Layer Silicate Structures." Discussed by Messrs. Roedder, Zen, and Toulmin.

George Ericksen: "Geologic and Chemical Features of the Chilean Nitrate Deposits." Discussed by Messrs. Stewart, Roedder, Schopf, and Altschuler.

Frank C. Whitmore, Jr.: "Tertiary Mammals from the Panama Canal Zone."

850th Meeting

The 850th meeting of the Society was held in the John Wesley Powell Auditorium on October 9 with President Luna B. Leopold presiding. The president announced the deaths of Roger Miller and James E. Pepper. The president announced that an anonymous giver had presented the Society with a silver trophy to be awarded annually for the best technical paper.

Program

W. D. Carter: "Structural Geology of Central Chile." Discussed by Messrs. Erickson and Stewart.

Thor Kiilsgaard: "Zinc reserves of the World." Discussed by Messrs. Guild, Neuman, McKnight, and Genson.

Charles Milton: "Carbonatite Lava of Tanganyika." Discussed by Messrs. Roedder, Zen, Toulman, Guild, Pecora, Murata, Barton, and Rosenblum.

851st Meeting

The 851st meeting of the Society was held in the John Wesley Powell Auditorium on November 13 with President Luna B. Leopold presiding.

Program

Donald H. Lindsley: "Petrology and Paleomagnetism of Three Basalt Flows." Discussed by Messrs. Tanner, Thayer, and Robertson.

W. R. Muehlberger and S. S. Goldich: "Age Determinations on Basement Rocks of the Central United States." Discussed by Messrs. White, Anderson, and Fleischer.

852nd Meeting

The 852nd meeting of the Society was held in the John Wesley Powell Auditorium on November 29 with Second Vice-President William E. Benson presiding.

Program

Harry Rodis: "Ground-water Geology of Kordorfan Province, Republic of Sudan." Discussed by Messrs. Rozanski, Neuman, Callahan, and Snyder.

Adolph Seilacher: "Transport and Reworking of Cephalapod Shells." Discussed by Messrs. Stewart, Rozanski, Sohn, Mello, Gordon, Hembest, Palmer, Squires, and Bromery.

853rd Meeting

The 853rd meeting of the Society was held in the John Wesley Powell Auditorium on December 11 with First Vice-President David B. Stewart presiding. The vice-president announced the death of William E. Wrothers.

Program

Presidential address by Luna B. Leopold: "Process and Probability."

71st Annual Meeting

The 71st Annual Meeting was held immediately following the 853rd regular meeting. The reports of the secretaries, treasurer, and Auditing Committee were read and approved. The award for the best paper went to David Wones for his paper, "Biotite in Volcanic Rocks." Clifford Hopson was awarded second prize, and Donald Lindsley honorable mention. The Great Dane Award for the best informal communication was awarded to Edwin Roedder for his note on "Neutron Activation Analysis of Fluid Inclusions." The Sleeping Bear Award was made to Luna B. Leopold.

Officers for the year 1964 were then elected as follows:

President	William T. Pecora
First Vice-President	Mackenzie Gordon, Jr.
Second Vice-President	Linn Hoover
Secretary	Bruce B. Hanshaw (for two years)
Treasurer	Jane H. Wallace
Council	George E. Ericksen, Wenonah E. Bergquist and Donald H. Lindsley (for two years)

The Society nominated Luna B. Leopold to be delegate to the Washington Academy of Sciences for the year 1964.

—*Avery A. Drake, Jr., Secretary.*

GEOLOGICAL SOCIETY OF WASHINGTON

Officers for 1964

President	William T. Pecora
First Vice-President	Mackenzie Gordon, Jr.
Second Vice-President	Linn Hoover
Secretaries	Avery A. Drake, Jr.
	Bruce B. Hanshaw
Treasurer	Jane H. Wallace
Members-at-Large of the Council	Wenonah E. Bergquist
	George E. Ericksen
	Gilbert Espenshade
	Donald H. Lindsley
	Louis Pavlides
	Martin Russell

Committee on Communications

Montis R. Klepper, *Chairman*
Robert D. Brown, Jr.
George H. Davis
J. Thomas Dutro, Jr.
Stanley R. Hart
Clifford A. Hopson
Robert M. Moxham
Eugene H. Roseboom
Verl R. Wilmarth

Committee on Finance

George V. Cohee, *Chairman*
Carle H. Dane
Lloyd G. Henbest
Charles L. McGuinness
Priestly Toulmin
Philip M. Bethke, *Alternate*
Malcolm Ross, *Alternate*
Jane H. Wallace, *ex officio*

Chairmen of Ad Hoc Committees

Awards	P. M. Bethke
Auditing	K. E. Lohman
Bylaws	Mackenzie Gordon, Jr.

Meetings

Meetings of the Society are held on the second and fourth Wednesdays of each month, October through April, from 8 to 10 p.m. in the John Wesley Powell Auditorium. Meeting dates for the fall of 1964 are October 14 and 28, November 11 and 25, and December 9.

THE WASHINGTON ACADEMY OF SCIENCES

Objectives

The objectives of the Washington Academy of Sciences are (a) to stimulate interest in the sciences, both pure and applied, and (b) to promote their advancement and the development of their philosophical aspects by the Academy membership and through cooperative action by the affiliated societies.

Activities

The Academy pursues its objectives through such activities as (a) publication of a periodical and of occasional scientific monographs; (b) holding of public lectures on scientific subjects; (c) sponsorship of a Washington Junior Academy of Sciences; (d) promotion of science education and a professional interest in science among people of high school and college age; (e) accepting or making grants of funds to aid special research projects; (f) sponsorship of scientific symposia and conferences; (g) assistance in scientific expeditions; (h) cooperation with other academies and scientific organizations; and (i) award of prizes and citations for special merit in science.

Membership

The membership consists of two major classes—**members** and **fellows**.

Members are persons who are interested in science and are willing to support the Academy's objectives as described above. A letter or form initiated by the applicant and requesting membership may suffice for action by the Academy's Committee on Membership; approval by the Committee constitutes election to membership.
Dues for members are $7.50 a year.

Fellows are persons who have performed original research or have made other outstanding contributions to the sciences, mathematics, or engineering. Candidates for fellowship must be nominated by at least two fellows, recommended by the Committee on Membership, and elected by the Board of Managers.
Dues are $10.00 a year for resident fellows (living within 50 miles of the White House) and $7.50 a year for nonresident fellows.
Persons who join the Academy as members may later be considered for fellowship.

Application forms for membership may be obtained from the office of the Washington Academy of Sciences, 1530 P St., N.W., Washington, D. C.

Institute of Food Technologists Holds Annual Meeting Here

The 25th annual meeting of the Institute of Food Technologists will be held May 25-28 at the Sheraton Park Hotel. Of major interest to food scientists and technologists will be the technical program comprising 215 papers, and an exhibit consisting of 160 displays.

The Institute of Food Technologists is a professional society representing about 7,500 food scientists and technologists engaged in all aspects of the food industry. Individual members are associated with government, educational, and industrial organizations. The Washington Section of IFT is affiliated with the Washington Academy of Sciences.

Since the first small gathering in 1939, each annual meeting has grown in size and scope, so that in recent years the meeting has become the foremost forum for the presentation of new findings in food processing, utilization, packaging, and related fields. The host section arranges the meeting and prepares the program. The 1964 meeting is the first to be held in Washington, and is sponsored jointly by the Washington and the Maryland sections. Cochairmen of the General Arrangements Committee are W. J. Hoover, Corn Industries Research Foundation, and W. J. Hart, Dulany Foods. Amihud Kramer, University of Maryland, is chairman of the technical program.

From preliminary indications, attendance at this 25th meeting is expected to reach a new high of 4,000 food scientists. The number of papers and exhibits to be presented is the largest in the IFT's history.

Since the time for the program is limited to three days, presentations have had to be scheduled in four and even five concurrent sessions. Papers contributed by members, which occupy most of the program, have been organized in 16 half-day sessions of 7 to 14 papers each. In addition, special sessions have been arranged as symposia with invited speakers; some round-table discussions also will be held.

A special feature of the 1964 program is a symposium on international food standards immediately following the general introductory session on Monday morning, May 25—the only time during the three days when not more than one session is listed concurrently. Participating in this symposium will be 14 outstanding authorities, four from the United States and ten from foreign countries. Chairman of the morning session is Nathan Koenig of the Department of Agriculture, United States representative on the Codex Alimentarius commission, who will begin the symposium with a review of work and progress in the development of internationally acceptable standards for foods. Following Mr. Koenig will be Otto Hogl, president of the Codex Alimentarius in Switzerland, who will speak more specifically on the Codex Alimentarius and its relations to the European Economic Community. Justin L. Powers, director of the Food Chemical Codex, NAS-NRC, will then describe the work of the Food Chemicals Codex and its relation to food standards. Professor Abramson of the Swedish Institute of Health will discuss the position and importance of different types of standards, such as wholesomeness, identity, and quality when applied to international conditions. The morning session will end with a summary by Emil Mrak, chancellor of the University of California (Davis).

The symposium will continue in the afternoon of May 25. Speakers from other foreign countries will discuss specific aspects and problems of food standards as they affect their own country and region, and will also emphasize specific problems with certain plant materials and animal products; problems of shipment from countries of the Far East, Mid East, Near East, and West, and from the United States; and problems of trans-shipment. Frank Gunderson will be chairman of the afternoon session, while Chancellor Mrak will again summarize and lead the final discussion.

On Monday evening these same participants will meet in a round-table discussion with representatives of the food industry and of the various Federal agencies involved in making standards. Moderator of the evening session will be John Riordan of the Department of Defense.

In addition to the symposium, three sessions of contributed papers will be given on Monday afternoon. The current emphasis on chromatographic methods, particularly gas chromatography, is recognized by an entire session of 11 papers on the application of this technique to the measurement and identification of volatile materials in fruits, vegetables, spices, oils, meats, cereals, and cheese, and their relation to flavor. A concurrent session on fruits, also consisting of 11 papers, will be about evenly divided between new developments in fruit drying, such as foam-mat drying, and effects of sprays, ripening rates, and other growing conditions on the biochemical constitution, composition, and quality of the processed fruit products. The third concurrent session for Monday afternoon will consist of 13 contributions on meats and meat products, including the use of the rabbit as experimental material, reflectance and transmittance spectrophotometric methods for pigment and color evaluation, histochemical and chemical observations, post-mortem and ante-mortem rate studies, and palatability and tenderness studies.

Food standards at the national level will be the feature of a symposium on the morning of Tuesday, May 26. M. R. Stephens will represent the Food and Drug Admnistration; V. E. Stewart of the Florida Department of Agriculture, regulation at the State level; R. H. Cotton of the Continental Baking Company, the freezing and baking industries; and James Bell and Carlos Campbell the processing industry in general.

This symposium on national food standards will be followed by another on food technology as a career and profession. Several hundred high school students and counselors, whose participation was organized by the education committees of the Washington and Maryland sections of the Institute, will attend.

A symposium on technical assistance to developing countries, arranged by Harold Rafson of Topco Associates, chairman of the Institute's committee on this subject, will be held concurrently. J. M. Jackson of the Green Giant Company will moderate presentations by Leona Baumgartner, assistant administrator of the Office of Human Resources and Social Development, Agency for International Development; Richard Reuter, special assistant to the President; Frank Goffio, director of CARE; Hans Friend of the U.N. Technical Assistance Board; and others.

A session of contributed papers for Tuesday morning will be devoted to new objective methods for measuring quality. Various instruments and procedures will be described, which are capable of objectively measuring such properties of foods as viscosity or texture, flavor, and odor, or detecting moisture or pathogens.

The keen interest and research activity in irradiation of foods is recognized by another session of 13 papers, all dealing with sterlization or pasteurization of various foods by irradiation. The session will include reports on the effect of irradiation on uncleotides, vitamins, and survival of microorganisms.

The fifth session for Tuesday morning will concern new processing methods other than irradiation or freeze-drying; the latter are covered in separate sessions. These new methods include an electronic process for juice concentration, other methods for concentrating and drying, and freezing with liquid nitrogen.

Sensory evaluation is the subject of the symposium for Tuesday afternoon. Elsie Dawson of the Agricultural Research Service, chairman of the Institute's committee on sensory evaluation, will present the sensory testing guide developed by the committee. Other contributors will discuss rating scales, statistical evaluation, subjective versus objective evaluations, and comparison testing.

Space feeding, survival feeding, and other special nutritional problems will be considered in a concurrent session comprising presentations by speakers from India, Vietnam, Israel, and United States Army laboratories at Natick, NASA, and General Dynamics.

In a session on packaging, attention will be directed to new edible coatings, transparent plastics, and aluminum pouches, as well as to problems with the tin can.

Freeze-drying will be discussed separately in another concurrent session scheduled for Tuesday afternoon. Several papers will attack the problem of its high costs by reporting on freeze-drying rates in model systems. In other papers, quality of freeze-dried mushrooms, beef, and pork will be evaluated. Still other papers will report on viability of microorganisms in freeze-dried products.

In addition to a number of papers in scattered sessions, survival and hazards of microorganisms in foods will be the subject of two entire sessions in the morning and afternoon of Wednesday, May 27. The morning session of 12 papers will be devoted almost exclusively to reports on thermal resistance and spore growth of *Clostridium botulinum*. The afternoon session will include papers on development of spoilage-causing microorganisms and yeasts in poultry, fish, meat, and fruit products.

The session on poultry on Wednesday morning will open with a special symposium on the technology of further-processed poultry products, and will continue with contributed papers reporting on methods of chilling and cooking, evaluation of toughness and color, flavor precursors, and composition of the lipid fraction.

A concurrent symposium on quality control will be devoted to applications of operations research to quality control problems of the food industry, and will cover specific ways in which evolutionary operations are applied to the fruit, vegetable, and dairy processing industries.

The session on vegetables scheduled for Wednesday morning will begin with reports on the instrumental measurement of quality of sweet corn, peas, and beans, and will continue with papers on the effect of enzymatic changes on the rheology of cucumber, tomato, and potato products, and the use of antioxidants and synergists on the stability of precooked products.

Hydrocolloids will be discussed at the symposium scheduled for Wednesday afternoon. Martin Glicksman of General Foods will introduce the subject by describing the importance of hydrophyllic gums in processed foods. Stanley Charm of Tufts University will describe physical methods for measuring gum quality, and John Jonas of National Dairy Products Corp. will discuss the use of carbohydrate colloids in foods. Other papers on properties and uses of gelatins and starches will follow.

Also scheduled for Wednesday afternoon is a session on chemistry and nutrition, covering special problems with lipids, flavonoids, amino acids, carotenoids, and oxalates.

Also on Wednesday afternoon, a symposium on natural food toxicants will be conducted by D. G. Crosby, chairman of the Department of Pesticide Residue Research, University of California at Davis.

The final session of the program is allotted to a collection of papers dealing with enzymatic changes in cane, citrus, papaya, strawberry, avocado, and eggplant, with some general presentations of protein-carbonyl browning systems, proteolytic action of pepsin, and pectinesterase inhibition.

Thursday, May 28, will be devoted to a

series of tours through various laboratories, plants, and other points of interest in the Washington-Baltimore area.

This summary of the technical program is intended to indicate the breadth and depth of the presentations. Chemists, physicists, and microanalysts, as well as engineers and biologists, all should find something of interest.

The registration fee for the sessions is $10 for national members of IFT and $20 for nonmembers. The registration desk will be located in the front of the exhibit hall at the Sheraton Park Hotel; it will be open all day Sunday the 24th until 6:30 p.m., and from 8 to 5 on weekdays. Further information on the program may be obtained from C. N. Grinnell at 338-2030.

Stellar Photometry in Washington

Robert E. Wilson

Georgetown College Observatory

Stellar photometry is the measurement of the apparent brightnesses of the stars. Apparent brightness is simply the brightness as seen from the earth, with no correction for interstellar absorption or distance effect, and is one of the few characteristics of the stars which is measured directly. It is usually expressed as a stellar magnitude, where the magnitude, m, is given by

$$m - m_s = -2.5 \log I/I_s,$$

where m_s is the magnitude of an adopted standard star, I is the measured intensity of the given star, and I_s is the intensity of the standard star. The unit of intensity may be arbitrary because the ratio is used.

Before discussing the title issue, the problem of making maximum use of photometric equipment in the Washington area, it seems in order to mention some of the major uses for photometric measurements and to explain how corrections are made for atmospheric extinction. An important application of apparent stellar magnitudes is to provide data for both the horizontal and vertical coordinates of the very useful color-magnitude diagram. Here it is necessary to define two quantities, color index and absolute magnitude. A star's color index is its difference in magnitude as measured in two different spectral regions. It can be shown that, for black bodies, color index is an indicator of temperature, T, according to a linear relation in $1/T$. Since the stars are reasonably good approximations to black body radiators, a color index scale for stars is essentially a temperature scale. Absolute magnitude is the magnitude a star would have if it were at the standard distance of 10 parsecs. A star's absolute magnitude can be found by correcting its apparent magnitude for interstellar absorption and distance (inverse square law) effects, if these corrections are known for the given star. If stars are now selected whose color indices and absolute magnitudes are known, these can now be plotted as the two parameters in a diagram, known as the color-magnitude diagram, which has been of inestimable value in the study of stellar evolution and related fields.

Although it is beyond the scope of this article to go into the significance of the various observed color-magnitude diagram configurations, it is probably a safe statement to say that this diagram, along with certain variations which also plot a temperature indicator versus an intrinsic brightness indicator, is the single most important diagram in stellar astronomy. Notice that measurements for both coordinates are supplied by photometry. Further, there is a case in which apparent magnitudes may be used directly in place of absolute magnitudes, thus eliminating the troublesome distance corrections. This is the case in which all the stars considered are at nearly the same distance. This occurs when they are all members of the same star cluster. Here then, a color-magnitude diagram can be plotted with photometric data only. In the case of variable stars, much useful information can be obtained by measuring only the *change* in magnitude. Here the investigator may never determine the actual magnitude of the star, but may simply choose a comparison star of constant, but unknown, brightness, and measure the magnitude difference between the variable star and the comparison star as a function of time.

The problem of determining magnitudes would be greatly simplified if the required observations could be made from an airless planet, but for earth-bound observations, a correction for absorption of light in the atmosphere (atmospheric extinction) must be made. We assume that this correction is proportional to the amount of air between the observer and a given star. This amount of air is called the airmass, and is usually denoted by X. The airmass is naturally a function of the angular distance, Z, between the star and the zenith, and for Z not greater than about 70° is nearly equal to secant Z if we define unit airmass for the zenith direction. Thus, calling m_i the inside atmosphere magnitude and m_o the outside atmosphere magnitude, one can write

$$m_i = m_o + KX$$

If typical medium band color filters, which are about 800 A wide at the half-transmission points are used, there is a further complication due to the fact that K is only constant for stars which have identical radiation curves. This is because atmospheric extinction is strongly dependent on wavelength, and the effective wavelength of a star-filter-photocell combination depends on the shape of the radiation curve of the star. This means that the effective wavelength of the observations of a very red star will be to the long wavelength side of that for a very blue star, even though both are observed with exactly the same instrumentation. Fortunately it has been found empirically that K is very nearly a linear function of color index, so that we may replace K by an expression of the form $K_1 + K_2$ [CI].

Our previous equation now becomes:

$$m_i = m_o + (K_1 + K_2 \text{ [CI]}) X,$$

where X can be calculated from the known position of the star and m_i is the directly measured quantity. The inside atmosphere color index is also a measured quantity. It can be reduced to outside atmosphere by a relation similar to the above magnitude equation before the magnitudes are treated. K_1, K_2, and m_o remain as the unknowns to be determined. If the inside atmosphere magnitudes are measured for a number of stars—say 10—during a single night, this equation can be used as an equation of condition for a least squares fit to the observed data. This involves the inherent assumption that K_1 and K_2 are constant throughout the night.

Of course the airmass for each star changes steadily during the night and reaches a minimum value as the star crosses the meridian. Each star should be observed at both high and low airmass in order to have a long baseline for determining the extinction coefficients. Considerable care is required in selecting the stars to be observed so that each one will be at high airmass for one of the two observations and at low airmass for the other. A long baseline in color index is also desirable so that K_2 may be found accurately. Therefore both red and blue stars should be included. With K_1 and K_2 determined, the equation can now be used to give the outside atmosphere magnitude for any star whose color index and inside atmosphere magnitude have been measured. For variable star photometry, the full extinction correction for both variable and comparison stars is not usually made. Since only a magnitude *difference* is measured, only a differential extinction

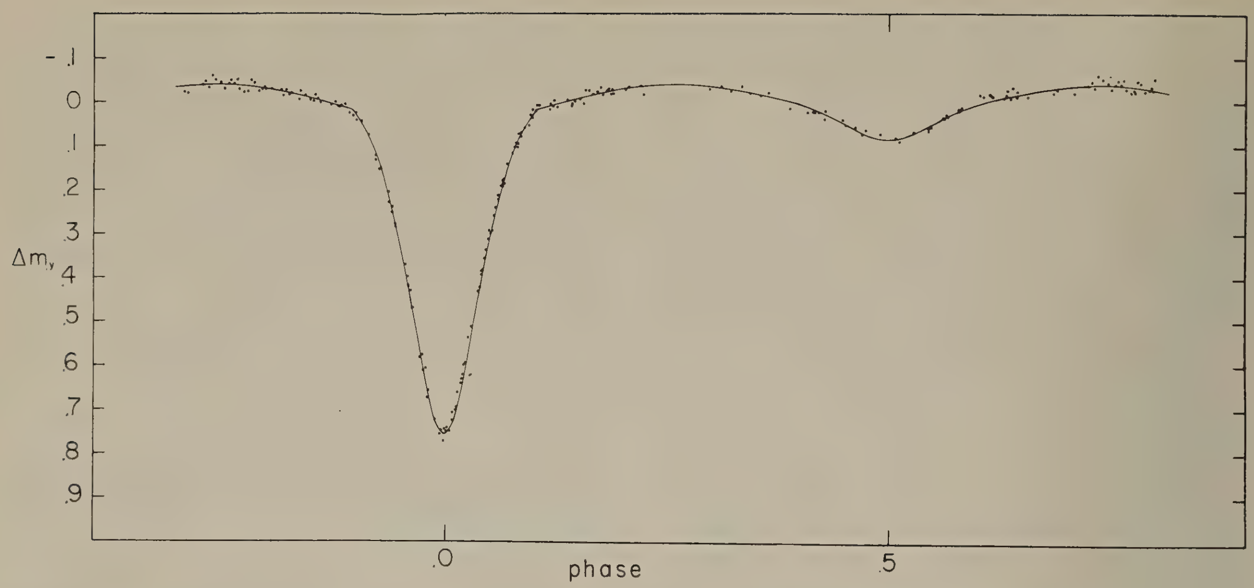


Fig. 1. Typical light curve of an eclipsing variable star, observed through a yellow filter.

correction is required—that is, a correction for the difference in extinction between the variable and comparison stars is to be applied. This correction is found by calculating the difference in airmass for the two stars, which will be sec Z_{var} minus sec Z_{comp} if we use the secant Z approximation, and multiplying this by the extinction coefficient for the night, K. Since K is a function of color index, this is strictly permissible only if the comparison star has the same color index as the variable star, so it is very important to choose a comparison star which fills this requirement or very nearly does so. In reality it is unlikely that the variable and comparison stars could have the same color indices at all times because most stars which have a variable brightness also have a variable color index. However, the effect of this on the observed magnitude differences is small and is usually ignored in practice unless the color index variation is large.

With this preliminary material now at least partially settled, the next question of interest is the main topic—what can one reasonably expect to achieve in photoelectric photometry in the Washington, D.C., area? To begin, recall two basic assumptions of the extinction analysis: (1) that the extinction is constant throughout the night, and (2) that extinction varies over the sky as a smooth function of zenith distance, secant Z being a sufficiently good approximation. If these assumptions do not hold, the method will not give reliable results. To determine magnitudes accurately, extinction corrections must be made accurately, so the sky at a photometric observing site should meet conditions (1) and (2) on a reasonably large fraction of the nights during a typical year. Experience has shown that, in general, these conditions are not met on a reasonable fraction of nights for observing sites in the eastern United States. This is probably due partly to high humidity and partly to concentration of industry. The extinction problem is naturally most acute in large eastern cities where the most industrial smoke is found. In this respect, Washington is not a typical case because it has comparatively few industrial plants. Visual inspection seems to indicate that the air here is clearer than in most large cities, and the fact that practical photometric programs are carried on at the U.S. Naval Observatory and at Georgetown University Observatory would seem to substantiate this. I should be inclined to say that such programs would be, although not entirely impossible, at least very difficult in other large cities. This is because an astronomer can usually expect one night in perhaps four or five to be sufficiently cloudless to make photometry possible. If on only one of several such nights the wind is blowing in just the proper direction so that no smoke is being carried over his observatory, he is reduced to one night in a dozen or so when he could expect good results. It may not be necessary to go very far from a city to find a marked improvement in the situation. For instance, much accurate photometry of eclipsing variable stars has been done at the Flower and Cook Observatory of the University of Pennsylvania, which is only about 20 miles from Philadelphia. Yet photometry at the University of Pennsylvania's Student Observatory, which is in Philadelphia itself, can be done profitably only on nights when the wind is blowing in certain directions. Special photometric programs are carried out at this observatory, but their nature is such that they are not affected by transparency variations.

In Washington, specifically at the Georgetown Observatory, it has been found that most nights which one would expect to be of photometric quality, because of absence of obvious clouds and haze, really are so. Therefore, the Washington atmosphere seems to be a pleasant exception to the general rule for eastern cities. Nevertheless, it is still an eastern atmosphere, and, as such, cannot be considered a rival to atmospheres at the best sites.

In the West, the situation is quite different. There, especially in the southwestern states, low humidity is the rule and industrial smoke is almost completely absent in some areas. Furthermore, the general elevation is high and numerous mountains provide an opportunity to observe from above much of the worst part of the atmosphere. These conditions result in extinction coefficients which are often nearly constant throughout the night, and also vary much less from one night to another than those for eastern observatories. Also, the coefficients at these excellent sites are generally rather small. This means that the extinction corrections will be small, so that a given percent error in a correction will correspond to a small error in the final magnitude. In addition, this area contains most of the world's large telescopes, including the Palomar 200-inch, the Lick 120-inch, the Mount Wilson 100-inch, the Kitt Peak 84-inch, and the MacDonald 82-inch reflectors, and the Lick 36-inch refractor.

All these factors considered, it would appear that all photometry should be done at observatories in the western United States. This would be an accurate appraisal of the situation if only there were enough telescopes in the West, but the fact that the number of stars in the sky is much greater than the number of astronomical telescopes in the entire world makes it obvious that there can never be enough telescopes to do all possible useful photometry. On the other hand, there is such a discrepancy between the accuracies to be obtained in determining stellar magnitudes in eastern as opposed to (south) western sites that anyone attempting these measures in the East is, at best, certainly doing things the hard way, and should probably be advised to pursue another observing program. This other observing program could very well be in photometry because, as has already been mentioned, there is another type of photometry, namely variable star photometry, which is not affected so severely by uncertainties in the extinction corrections.

Figure 1 shows a typical light curve of an eclipsing variable star, observed through a yellow filter. The points are individual photoelectric measurements of the difference in magnitude between the variable star and a comparison star, and the curve is calculated from eclipsing binary theory. Naturally, as with any physical measurements, the points do not all lie on the calculated curve, but scatter about it because of accidental errors. It is the main problem of the photometric observer to make such errors as small as possible. To do this, he must carefully consider the various sources of these errors and try to eliminate or minimize them one by one. In some cases he will have to choose between two kinds of errors. That is, if he plans his program so that the first is small, the second will unavoidably be large, and vice versa.

To illustrate this point, one source of error in variable star observing comes from errors in the differential extinction corrections due to the fact that the extinction on some nights may not vary nearly as secant Z, but in a somewhat irregular way because the sky may be a bit mottled. To minimize this source of error, it is advantageous to choose a comparison star which is very close to the variable in the sky. A second source of error is the already mentioned effect that the extinction for stars of different color is not the same. Thus the observer may have to choose between one comparison star which is only 10 minutes of arc away from the variable but differs in color index by 0.3 magnitudes, and another which is a degree away, but differs in color index by only 0.05 magnitudes.

These are by no means the only considerations, for the comparison star must also be invariable and should be of nearly the same brightness as the variable star. The observing site will certainly influence the choice among these criteria for good comparison stars, for if the observations are to be made in a very clear, uniform sky, one need not worry so much about the proximity requirement as one would with a sky which is often suspected of being patchy. However, the factors determining accuracy which depend most on the conditions at the observing site have not been mentioned to this point. These are the relative amounts of the star, sky, and dark currents from the photocell. The latter two terms perhaps deserve some brief explanation.

Dark current is simply the current produced by the photocell in the absence of light and exists because electrons can be liberated from the photocathode by the thermal energy of its component atoms as well as by light. The sky current is caused by the small amount of light from the sky in the immediate vicinity of the star which is measured along with the starlight. When a star's brightness is observed with a photoelectric photometer, an opaque sheet with a small hole is placed in the focal plane of the telescope so that the smallest possible amount of sky light will pass through to the photocell. For a typical moderate sized telescope the diameter of the small circle of sky light passing through this hole may be perhaps 15 seconds of arc. The lower limit of this diameter is set chiefly by the quality of the telescope drive—the mechanism which moves the telescope to follow the diurnal motion of the stars—and by the quality of the image. If the drive is very good, a very small hole can be used without danger of the starlight ever being occulted by the opaque sheet as the star moves about. Also, if the image is very good (*i.e.*, very small—only about as large as the theoretical diffraction disk for a point source), a small hole can be used. Let us omit consideration of the angular size hole permitted, because this depends on the telescope and we are concerned here with the observing site. Let us rather assume a given angular size for the hole and see how the ratio star:sky:dark current depends on the conditions of observation.

In order to increase the signal-to-noise ratio, it is obviously good to make both sky and dark currents as small as possible. Furthermore, the greater the star brightness the better, within certain practical limits. Reducing the dark current is an instrumental problem and need not concern us here, but it is important to note that the desirability of decreasing the dark current depends largely on the sky brightness and on the telescope aperture. If the sky is very bright, as in a major city, then this will usually be the major source of background signal, and dark current will be negligible. On the other hand, if the sky brightness is very small, as on a desert mountain peak, it is to the observer's advantage to make the dark current small, for the dark current is then the major source of background signal.

In these remarks, sky brightness denotes the brightness of the sky image in the focal plane of the telescope in units of energy per solid angle per area of collector surface. (By collector I mean the main lens or mirror of the telescope.) Thus it will increase with the area of the lens or mirror just as does the surface brightness on the retina of an eye when the pupil dilates. Therefore the sky current produced by the photocell depends on the telescope aperture.

At the Georgetown University Observatory we have a situation intermediate between the extremes mentioned. That is, the ratio of sky to dark current is such that it is a definite advantage to take pains to reduce the dark current, but not nearly so much of an advantage as it would be at a very isolated, dark sky observatory. How this comes about can be illustrated by a comparison between the Flower and Cook 28-inch telescope and the Georgetown 12-inch. With the former, the sky and dark current are roughly equal. Since it is located in an almost unpopulated area, whereas the Georgetown telescope is located in the city of Washington, one might expect that the Georgetown sky current would be greater than the dark current by a large factor. However, the ratio of collection areas of the two telescopes is $(28/12)^2$, or about five, so that if they were at the same location with identical photocells, the smaller telescope would have a five-times-smaller sky current for a given angular sky area. This explains the fact that the sky and dark currents are also roughly equal for the Georgetown 12-inch telescope, making it advantageous to reduce the dark current. This we do by cooling the photocell by evaporation of liquid carbon dioxide.

With a very small dark current now added to our given sky current, the major remaining factor which influences the signal-to-noise ratio is the brightness of the star. Naturally, the photocurrent produced by a star image depends on the aperture of the telescope as well as on the brightness of the star. In fact, it is proportional to the square of the aperture, just as is the sky current. Therefore, when a factor of five in sky current was lost in changing from a 28-inch to a 12-inch telescope at the same site, a factor of five in star current also was lost, so that our star-to-sky ratio was unchanged. However, the previous discussion of the sky-to-dark current ratio indicated that the Washington sky was roughly a factor of five brighter than the sky at the Pennsylvania 28-inch, so the star-to-sky ratio in Washington would be only one-fifth that of a rather dark suburban locale, such as that of the Pennsylvania telescope. To regain this factor of five, stars should be observed which are five times as bright as those observed in dark sky areas. An intensity factor of five corresponds to slightly less than two stellar magnitudes, so if our 12-inch telescope were transported from a relatively dark place to its present location, about the same results should be expected for seventh-magnitude stars that previously were obtained for ninth-magnitude stars.

Following this circumstance, it is our policy at Georgetown to observe only stars brighter than about the seventh magnitude. The presently active programs involve compiling light curves of variable stars brighter than this limiting magnitude. Such bright stars are rarely observed with large telescopes because they do not require large telescopes. As a result, there are no intensively observed, accurate light curves for a surprising number of bright variables. This is especially true for those with fairly long periods—perhaps 5 to 20 days—because such a program on a large telescope would require a large amount of very precious observing time.

I should like to stress that the foregoing discussion of signal ratios and signal-to-noise ratios was given with a number of simplifications so that it could be presented in a reasonable space. Most prominent of these was the simplification of constant angular sky sample as the telescope aperture was varied. In reality, it is generally possible to use a somewhat smaller angular sky circle with large telescopes than with small ones, but including this fact would have introduced an entire new dimension to the complexity of the situation. Also, space does not permit discussion of the important effects of scintillation and shot noise.

In photometry, as in many fields of astronomy, the need for observations enormously exceeds the capabilities of present facilities. Even if the world never experienced a cloudy night, there are enough variable stars to keep every astronomical telescope busy full time. In such a situation we must take advantage of every suitably-equipped telescope. The photometric quality of the Washington atmosphere makes it possible to do so here.

I should like to thank Harvey W. Banks, Fr. Francis J. Heyden, and Bernice G. Lamberton of the Georgetown College Observatory, and William Blitzstein and Frank Bradshaw Wood of the Flower and Cook Observatory, for inspecting and correcting the manuscript.

K-9 Botany*

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Not long ago I came to the somewhat sudden realization that my 12-year old son was learning, in his grade school biology, things that I should be teaching at the University, and that I was in turn working overtime trying to teach to college freshmen and sophomores a point of view they should have picked up six years earlier. If this topsy-turvy situation prevails widely—and I'm very certain that it does—it is high time to see what can be done about it.

Not long before his death some years ago, my father remarked that he had then lived long enough to have done all of the things he had most emphatically vowed he would never do. For me to undertake an analysis of education perhaps falls in a comparable category; in any event, it is too late to change now. My subject, translated from current educational jargon, reads: "Kindergarten to 9th Grade Botany"; we shall concern ourselves with science education and particularly with plant sciences in the elementary schools.

Everyone seems to know just what should be done in matters of education, and of course none can prove them wrong. Small wonder that the outpourings of published literature and verbal debate in this area are truly mountainous. I would refrain from adding even so small an increment, did I not feel that I had stumbled—this is the honest term for it—recently upon some items of great potential significance for

*Address of the retiring president before the Botanical Society of Washington, December 3, 1963.

the plant sciences. This is because I was privileged this past summer to exchange the dense, diurnal traffic of our capital city for the equally dense but completely unstructured and unpredictable traffic of Minneapolis, there to work for eight non-airconditioned weeks at the job of "writing science" for the elementary schools. I think we must now consider, however sketchily, five topics. Each will in due time relate to our central theme. These are: science for the citizen, biology in the colleges and universities, the "new" biology in the high schools, elementary school science, and K-9 botany.

Science for the Citizen

As college attendance becomes more and more fashionable, the question of science for the non-scientist is of increasing concern. It is really a concern of undergraduate liberal arts education and is being investigated and discussed quite literally from coast to coast. Of the many statements I have seen, none is more suitable than that by Gerald Holton, and I cannot improve upon it:

"What, then, can be our own valid reasons for presenting science to the nonscientist, and what are the consequences that follow from these reasons?

". . . One is, through an increased understanding, to help us *orient* ourselves, as individuals and social groups, to our external surroundings, to one another, toward our own internal capabilities and deficiencies. . . . The total orienting process of a young student in college, it seems to me, has at least five goals. If he is to emerge as an educated and sane person from our educational institutions, the student should be well on the road to recognizing which are his own talents, whatever they may be; second, he should know enough about his physical home, this universe, not to feel either overwhelmed by it or a total stranger in it; third, he should know how to be in fruitful relationship with his fellow men; fourth, he should know what the past means and what the probable future may be; and fifth, he should know the difference between, and the relative functions of, his mind and his soul.

". . . the student who will not go on in scientific studies can and should have science courses which attempt to contribute meaningfully to each of these general goals of education . . . to do justice to the first goal would mean seriously challenging, helping, testing, and watching the student, to enable him to discover his abilities in scientific work including the laboratory . . . The second goal implies the all-but-impossible attempt to teach him, in the limited time available, enough basic and substantive material to show that the natural universe is fundamentally knowable . . . The third goal implies that the student should hear and read at least occasionally about the social activity called Science . . . The fourth goal implies that such courses will not shrink from showing at the proper time that science has its historic tradition as well as its characteristic way of growing and, as it were, of anticipating the future. The fifth goal would require us to convey to our students, at least on occasion, what has been thought to be the philosophical meaning of scientific knowledge."

Finally, Dr. Holton is careful to underscore the dangers of science course improvement studies which overemphasize the "Big Show," the "Great National Biology Course," and which discriminate against "small groups, those below the megaton range, which do not intend to make themselves felt immediately throughout the nation." I would agree most heartily with his view that we must "at all costs preserve an honored and perhaps even a preferred place for the individual and for the small group that does not pretend to know already what is good for every student in the U.S.A."

Biology in the Colleges and Universities

It is a commonplace to point out that there is a ferment in biology at the present time. One hears such terms as the "new" biology, or references to "molecular," "regulatory," "developmental" as subdivisions of the life sciences. What I think all this really means is that the methods and the points of view of the physical sciences have now been proved so immensely helpful in attacking certain kinds of biological problems that we have fooled ourselves into thinking that the biology itself has changed. Yet there does remain a fundamental distinction, which too often degenerates into misunderstanding, between the primarily analytic and the largely synthetic points of view—between, if you will, the biochemist and the ecologist. And the chief obstacle to the resolution of this conflict lies not in the ill will and suspicions of the individuals concerned but in the sheer impossibility of anyone being fully conversant with both aspects of the field. It is a lack of understanding more than it is a misunderstanding.

Of more immediate concern to plant scientists as a group is their firm conviction that their specialties fare poorly in relation to the zoological emphasis in college biology. Botanists are somewhat paranoid about this matter, but with good reason. They feel themselves the victims of a vicious cycle wherein biology to most persons means zoology, where teachers quite naturally pass along what they themselves were taught, and so plants get short shrift generation after student generation. Look where you will—in biology texts, biology courses, biology departments—botanists and botany are, like Republicans, a consistent minority. In spite of this, most of us would agree, I think, that this state of affairs would be acceptable if it were in the best interests of the students and of the life sciences—but it isn't, and it behooves us to redress the balance as best we may.

Just as an aside, I think it entirely possible to solve the problem, in the orientation kind of biology, of the greatly differing backgrounds of the staff members of departments essaying one of these courses by a rather simple device. Quite contrary to the usual practice of developing texts and laboratory manuals designed to bring maximum uniformity to a course taught by a diverse assemblage of faculty, I would suggest that we devise teaching materials which permit, even encourage, wide selection on the part of the individual instructor as to how he puts across a particular concept. One of my tasks last summer was to block out a course in general biology for prospective teachers of elementary school classes—a course, incidentally, which would be permitted only a single quarter of the students' time. Under these severe restrictions, there is no choice but to single out a very few generalizations considered absolutely essential and to emphasize these strongly.

Suppose, to continue the argument a bit further, we assume development and morphogenesis to be one of the pervasive biological phenomena that belong in such a "general education" course. Why should not a botanist teach this concept largely from the point of view of the growth of, say, the onion root tip, and the zoologist, in his lecture and laboratory sections, deal mostly with the amphibian larva? Only college registrars or deans are likely to object that two students enrolled for the same course with the same catalog number are learning their biology with different illustrations, and there is no need whatsoever to let them in on the secret. As for the student, it is the biological significance of development and growth that are crucial, not whether the route to understanding leads through the onion or the frog. I am strongly persuaded that biology courses so designed that "every staff member teaches everything" are doomed to sink to a rather low least common denominator. College catalogs are strewn with the carcasses of such dead and dying efforts.

The "New" Biology in the High Schools

SMSG, PSSC, CBA, BSCS—these and other symbols are becoming as familiar in the educational jargon of the day as were the alphabetical agencies of the Roosevelt era and the New Deal. They signify, as you well know, the so-called new science courses for our nation's high schools. They would be the "Big Shows," in Professor Holton's terminology. They have involved many persons and cost many millions.

I confess to something far less than unbounded enthusiasm for the BSCS—the "blue," the "yellow," and the "green" versions of biology texts and manuals put out by the Biological Sciences Curriculum Study. This opinion is based on a rather careful review of the first edition and a more than cursory look at the revised versions. Even if we make allowances for the Madison Avenue promotional advertising —after all, every educational "experiment" is reported as an overwhelming success— I think it not unfair to say that the BSCS has signally failed to do, in biology, anything significant to solve the problem which Arnold Arons has noted in relation to his Amherst students, who

> ". . . come to us out of a secondary school experience which, despite all of the . . . improvements under way, simply does not prepare them with certain attitudes and ideas that seem to me necessary for successful progress in higher education . . . they have developed no self-consciousness whatsoever about the character of thought or of the nature of the knowledge they assume they possess. They haven't any idea of what *knowledge* means. They have been encouraged to accept the notion, passively, that knowing names is knowing something; and they have for years been flinging around fancy names in all sorts of ways without being challenged on their use of them or on the meanings of the ideas they are supposed to express. It seems to me that one of the most significant functions of higher education at this point is to try to make young people aware that there is an idea first and a name afterwards. I submit that very little of our textbook productivity and pile of educational materials is oriented in the direction of making clear notions of this kind to our students."

To be blunt about it, the BSCS has done little more than transfer college biology—good college biology, I grant you—to the 10th grade. This is just what I think Holton warns us that we should expect if we assemble a "name band" to do the job. One can only wonder, futilely, what eight to ten sufficiently obscure biologists, with a budget limited to $100,000, might have been able to accomplish. That one of the products of our new biology courses cannot easily be distinguished from an equally able student who has had the "old" biology was admitted to me, inadvertently of course, by one of the enthusiasts this past summer when we discussed the matter of examinations. More on that point later.

Elementary School Science

We come then to the question of elementary school science. As I see it, because of the factors pointed out somewhat sketchily above, and of course others, the crucial level in science education at the present time lies in the grades below the high school. Why is this so?

In the first place, science has been, and is being, pushed ever backwards in the high schools. What used to be taught in the 10th grade is being put increasingly into the 9th, and so on. Secondary school material is showing up in the elementary school.

In the second place, the climate of public opinion, for the moment at least, creates an understandable urge to begin science early. We are told that we shall lose out in the international kite-flying contest with the Soviets if we do not produce more scientists, and that one thing we must do to avoid this is to begin earlier the formal instruction of potential scientists.

Thirdly, and this to me is the only truly important basis for action, unless something is done, and done well, for grade school science, the enormous investments of money and labor which have gone and are going into high school and college science teaching materials will be largely wasted. We will, in short, continue the unfortunate situation I alluded to earlier—college biology taught to 12-year olds, and seventh-grade biology thus perforce taught to college students.

There is an impressive amount of effort now being spent in trying to do something about elementary school science. A look at the recent summary of NSF-supported course improvement projects discloses, for example: a "Coordinated Science and Mathematics Curriculum for Grades K-9" at the University of Minnesota; a "Science Curriculum Improvement Study" at the University of California; and an "Elementary School Science Project" at the same institution. The University of Illinois is working on an elementary school science project in astronomy; Cornell University is associated with Educational Services, Inc., on still another program; and the AAAS has developed an extensive effort. Just what will come of these projects it is too early to say for certain, but materials are now appearing and are being subjected to testing at a number of places. Writing science for elementary schools has become, in short, the thing to do.

Certain distinct advantages, and certain dangers, attend any attempt to intensify science education in the lower grades. For a time at least, it is an especially exciting challenge, because in quite a general sense science teaching at this level hasn't a long history of being done wrongly. It hasn't been done wrongly largely because it hasn't been done at all, but the advantage of starting with a clean slate, so to speak, must not be minimized. It is exciting, too, because of the sheer magnitude of the task—one is dealing, potentially at least, with thirty million kids and about one million teachers! It is exciting above all else, I suppose, because of the priceless opportunity to start the child in the "right" direction, as far as that can be discerned.

But the stakes are high and the cost of failure alarming. One faces the handicaps of a corps of teachers who, through no special fault of their own, have very little background in science and, often, neither liking nor aptitude for it. Or, at least, little liking or aptitude for what they think science to be. Many are even fearful of science; its uncertainties, its exploratory approach, its provisional conclusions often sit ill with teachers who, by tradition, have long operated in a situation where everyone expects them to have the answer.

We work also against a culture which insures that many of the children, even by the time they reach kindergarten, have had a steady diet of "cute" nature stories, television productions in which animals are shown to have near-human personalities and intelligence, and, often, a church school background in which biological phenomena are explained on the basis of supernatural intervention.

The most frightening possibility is that, given the golden opportunity to start rightly, we shall through carelessness or poor judgment start wrongly instead and compound the total damage.

We must not, I think, turn the errors of the new high school science (I am thinking here mostly of biology, but the other sciences are probably making the same mistakes) into an elementary school catastrophe by simply pushing high school biology on down into the earlier grades. If we deplore the fact that the high school biology has changed from memorizing the terminology of leaf margins (the "old" biology) to memorizing the teminology of the citric acid cycle (the "new" biology), how much worse it would be to have the elementary school students memorizing the stages in cellular division—the very thing, incidentally, which my seventh-grade son was doing at the moment I made the comparison cited in my opening sentence!

No, I think we have a chance to do two very important things at one and the same time: (1) provide the elementary school children with a start in science which will make them aware of what the scientific process is all about, and (2) by so doing, provide the points of view and the methods of attack which will capitalize on the new high school science. If we do this well and quickly, it may just be that the new high school courses will be successful, for they will have students coming to them who are ready to profit from their experience. If we do not, I think both elementary and high school science must almost certainly fail.

K-9 Botany

At long last we arrive at the topic stated in the title, botany for kindergarten and the early grades. Because this must seem, on the face of it, a ridiculous suggestion, let me point out immediately that I haven't the slightest intention of arguing for a formal course in botany in the high schools, much less in the earlier grades. The botany emphasis appropriate to elementary school biology is, in fact, as much of a surprise to me as to anyone else. Perhaps if I show how this realization developed it will be clear.

The "Minnemast" program, with which I was privileged to work this past summer, is an extensive effort to prepare mathematics and science teaching materials for the early school years, under the general direction of Paul Rosenbloom of the University of Minnesota. This is a long-range program and aims to produce a thoroughly integrated series of courses for all of the grades up through the junior high school. In the summer of 1963, 35 scientists, teachers, and psychologists from colleges, high schools, and elementary schools assembled in Minneapolis for eight weeks for the first of what is planned as a series of writing conferences. They were teamed up in smaller groups in such a way that various levels, various backgrounds, and various specialties were represented. Needless to say, the job was no more than started in the time available, and the sampling of materials was very nearly random—that is, the subject matter chosen and the grade level for which it was aimed were left to the whim of the particular team involved. Diversity, if nothing else, was most assuredly the outcome. A considerable portion of the draft material was tried out in experimental classes at about the second and the fifth grades. It is pointless to expect that you could judge the quality of these teaching units without actually examining them first-hand, but a few titles will suggest the range of coverage: objects and their properties; the senses; variation; measurement; interaction and systems; temperature, substances, and energy; light; biological photoreception; density; and chemical models. Not all are of equal caliber, but some are most provocative and will, I think, have a desirable impact on elementary science. I must not leave this point without recognizing that valuable work is being done in comparable programs elsewhere—the Minnemast effort is the only one I know first hand.

Now the development which so astonished me this summer was that, almost irrespective of the participant's background or the immediate objective of his exercise, within two weeks he was involved in botanical material. Specifically, as I now recall it, a professor of zoology trying to develop a unit on "variation" for kindergarten found himself using leaf shapes for illustration; a professor of physics was using celery stalks (he thought they were stems, naturally) for capillarity and trying to show the interrelation of environmental factors with bean plants growing in bell jars. One of the elementary school teachers was trying to put across the concept of growth by using seedlings, and the college chemist was using plants for his exercises on photoreception. It is important to note that they did this not because they planned to, not because they wanted to, or even because they knew how to—believe me, there was some appallingly bad botany demonstrated by these men and women.

No—they used plants for one reason only, because they were in a sense forced to. Because it turns out that to the extent that elementary school science deals with the organic world—and it does so very importantly—it must do so very largely in relation to plants as distinct from animals or microorganisms.

One wonders why this is so. Although not all of the reasons are apparent, certain ones do suggest themselves:

(1) Plants are cheap, abundant, and readily available.

(2) Their reactions to many external stimuli are comparatively slow; superficially they appear simple and thus are within the grasp of the children's understanding.

(3) Like it or not, we must recognize that there are fewer emotional problems and involvements in experimenting with plants than with animals—there are no bills before the Congress, to my knowledge, which seek to regulate work with plants, and the antivivisectionists are not likely to give us any trouble here.

(4) There are fewer children who bring to a consideration of plants the teleologic, subjective viewpoint that so clutters their thinking about living organisms in general, although there is no question that by the time a youngster is of school age he will have been misled many times by the irrational explanations offered him by his elders. Perhaps to free him of this should be one of our chief objectives.

(5) There is the very practical consideration that plants are much easier to care for in a classroom situation than are vertebrate animals, insects, or any of the other organsms which might otherwise be useful in teaching youngsters.

Conclusion

Make no mistake about it, then, science is going to be increasingly emphasized in the elementary schools. Furthermore, it is going to have a life sciences component, whether we have the wit and the enterprise to influence its content and methods as we think they should go or stand aside and leave the task to others. Botanists have complained for decades that their science doesn't get a fair shake in the high school and college biology courses; they now have an unparalleled opportunity to assist in a very vital way, for biology in the elementary schools can best be taught, more often than not, with plants. The development of these teaching materials is too important to be left to non-botanists. Here is a priceless chance to promote the plant sciences in the best sense of that term —not in a parochial dispute over enrollments with our colleagues in other fields —but because we have the best material there is to start youngsters toward an awareness of the *process* of science as distinct from an accumulation of data about science. All we have to do is to develop teaching materials—they must be very detailed, specific, and suitable for the age group concerned—which convincingly show the elementary school teachers and their supervisors that science can be taught as an exercise in discovery.

I cannot emphasize this last point too strongly. If you will examine the units coming out of the several elementary school projects now in operation in this country, you will notice one very remarkable feature—they are keyed to the notion that the young child can and should discover relationships on his own initiative, that to impart information is perhaps the poorest possible way of introducing science, and that first priority must go to developing a point of view and a method of attack.

And, of course, if we botanists can get our story successfully before 30 million kids early in their schooling, we shall have established a safe lead which will permit no other discipline to catch up with us later. Both we and the students will be the winners thereby.

If you will think for a moment you will realize that there is an elementary school not far from where you live.

The Climate of Washington

Ralph H. Frederick

Office of Climatology, U. S. Weather Bureau

The climate of the Nation's Capital is a popular topic of discussion, be it in cocktail lounges or the hallowed halls of the Capitol. Congressmen are often loathe to spend the summer here. Abraham Lincoln sometimes spent summer nights at Soldier's Home in an attempt to escape the heat. Be that as it may, when the facts and figures are carefully considered, the climate is found in many respects to be a rather moderate one. The summer heat and humidity (which supposedly constitute the worst part of the local climate) are not the source of discomfort that they are in many parts of the southeastern states. Nor does Washington have the winter snow and cold typical of many northern states.

The skeleton of statistics on which the climate is conventionally hung is portrayed in Table 1. Here are shown the normals, means, and extremes of various elements. This table is, however, a statistician's fruit salad in the sense that some of the figures cited are from different locations and instrumental exposure. Nevertheless, all the figures are based on "official observations" of the Weather Bureau accumulated since 1870. It may be helpful at this point to describe briefly the origins of Washington weather.

Late autumn and winter storms originate mostly in Texas, the Gulf of Mexico, or near Cape Hatteras. These move generally northeastward and many pass close enough to Washington to affect its weather. In a normal year, about five of these storms deliver an inch or more of snow to this area. Others produce rain, and frequently are accompanied or followed by strong winds. As a rule, an outbreak of colder air follows such storms. Our area, however, is removed far enough from the source regions of the cold air masses (central Canada and Hudson Bay) that some moderation of their temperatures can take place by the time they arrive.

Summer weather in Washington is frequently dominated by a northward flow of air from subtropical latitudes. Summer storm tracks are displaced far enough north of the District that they do not bring us adverse weather. Only the cold fronts that dip southward behind them pass this area. These cold fronts are the producers of local showers and thunderstorms that constitute the main source of summer precipitation. As these cold fronts pass over the Appalachian mountains before approaching Washington, they frequently produce more rainfall in the mountains than here. Each summer, in fact, several of them produce not so much as a shower of any consequence. These cold fronts are preceded by a southerly flow of warm and increasingly humid air, and are followed by a period of drier, cooler, and generally pleasant weather with winds out of the west or north quadrant.

In the late summer and autumn, storms of tropical origin, including full-blown hurricanes, occasionally pass northeastward along the Atlantic coastline, and these are the source of a large portion of our rainfall at that time of year. About 20 percent of the rainfall in August and 30 percent in September is produced by such storms (1). Luckily for Washington area residents, they have usually lost some of their punch by the time they reach this area. If they approach from the southwest over land, surface friction weakens their winds; if they approach from the southeast, they start to lose their tropical characteristics before they arrive and again their winds have moderated.

TABLE 1

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
TEMPERATURE													
Normal													
Daily maximum	44.3	46.1	53.8	65.8	75.5	83.4	87.0	85.0	78.6	68.3	56.5	45.6	65.8
Daily minimum	29.5	29.4	35.8	45.6	56.0	64.9	69.3	67.9	60.7	49.6	38.9	30.5	48.2
Monthly	36.9	37.8	44.8	55.7	65.8	74.2	78.2	76.5	69.7	59.0	47.7	38.1	57.0
Extremes													
Record highest	79	84	93	96	97	102	106	106	102	96	87	75	106
Year	1950	1930	1907	1960	1925	1874	1930	1918	1953	1941	1950	1946	Jul'30-Aug'18
Record lowest	-14	-15	4	15	33	43	52	49	36	26	11	-3	-15
Year	1881	1899	1873	1923	1906	1897	1895*	1890*	1904	1893*	1929	1917	1899
Normal degree days	871	762	626	288	74	0	0	0	33	217	519	834	4224
PRECIPITATION													
Normal total	3.03	2.47	3.21	3.15	4.14	3.21	4.15	4.90	3.83	3.07	2.84	2.78	40.78
Maximum monthly	7.09	6.84	8.84	9.13	10.69	10.94	11.06	14.41	17.45	8.81	6.43	6.12	17.45
Year	1882	1884	1891	1889	1889*	1900	1945	1928	1934	1937	1932	1881	Sept.'34
Minimum monthly	.31	.62	.57	.26	.87	.86	.82	.55	.14	T	.53	.19	T
Year	1955	1901	1910	1942	1911	1940	1872	1962	1884	1963	1917	1889	Oct.'63
Maximum in 24 hrs.	2.98	2.29	3.43	3.21	4.32	4.16	5.80	7.31	5.66	4.98	3.20	2.70	7.31
Year	1915	1896	1958	1889	1953	1886	1878	1928	1874	1955	1942	1888	Aug.'28
Snow, Sleet													
Mean total	4.5	4.6	2.7	T	T	0	0	0	0	T	0.7	3.9	16.4
Maximum monthly	31.5	35.2	19.3	5.0	T	0	0	0	0	2.2	6.7	16.2	35.2
Year	1922	1899	1914	1924						1925	1953	1962	Feb.'99
Maximum in 24 hrs.	21.0	14.4	11.5	5.0	T	0	0	0	0	2.2	6.6	11.5	21.0
Year	1922	1936	1942	1924						1925	1953	1932	Jan.'22
RELATIVE HUMIDITY													
1:00 a.m. EST	71	67	66	69	76	78	79	82	82	80	74	70	75
7:00 a.m. EST	74	71	71	70	75	75	77	81	82	82	77	72	76
1:00 p.m. EST	57	51	49	46	51	53	53	54	54	54	52	54	52
7:00 p.m. EST	62	57	54	53	60	61	63	67	68	68	63	62	62
WIND													
Mean hourly speed	10.4	10.7	11.5	11.0	9.5	9.0	8.4	8.2	8.5	8.8	9.4	9.4	9.6
Prevailing direction	NW	S	NW	S	S	S	S	S	S	SSW	S	NW	S
Fastest mile													
Speed	56	57	60	56	48	57	54	49	62	78	60	62	78
Direction	NW	NW	E	N	S	NW	E	NE	SE	SE	E	SW	SE
Year	1957	1956*	1951	1952	1952	1954	1951	1955	1896	1954	1952	1957	Oct.'54
Pct. of possible sunshine	48	50	56	56	57	65	65	63	63	61	53	50	58
Mean sky cover sunrise to sunset	6.6	6.5	6.2	6.4	6.3	5.7	5.8	5.6	5.3	5.1	5.9	6.2	6.0
MEAN NUMBER OF DAYS													
Sunrise to sunset													
Clear	7	7	8	7	7	8	8	10	11	13	9	10	105
Partly cloudy	8	7	9	9	11	12	12	9	8	6	8	6	105
Cloudy	16	14	14	14	13	10	11	12	11	12	13	15	155
Precipitation .01 inch or more	11	9	12	10	11	9	10	9	8	7	8	9	114
Snow, sleet 1.0 inch or more	2	1	1	0	0	0	0	0	0	0	#	1	5
Thunderstorms	#	#	1	3	6	5	6	5	2	1	#	0	30
Heavy fog	2	2	1	1	1	#	#	#	1	2	2	2	14
Temperatures													
Maximum													
90° and above	0	0	0	0	2	4	11	6	5	0	0	0	28
32° and below	7	4	#	0	0	0	0	0	0	0	0	5	16
Minimum													
32° and below	26	20	7	1	0	0	0	0	0	#	3	24	80
0° and below	#	#	0	0	0	0	0	0	0	0	0	#	0

*Also in later years
#Less than 1/2 day

Severe Storms

Although a few tornadoes have occasionally been sighted in the Metropolitan area over the years, happily they are rare. During the warm season, squall-line and thunderstorm conditions can result in funnel clouds (tornadoes aloft), and the possibility of their occasionally touching the ground is ever present. When tornadoes do occur, only a small area of destruction is likely to result. During most summers, several thunderstorms pass by, which being accompanied by strong winds, also cause damage in certain parts of the District. Occasionally hail is borne by these thunderstorms. About 25 percent of all hailstorms here occur in the month of May.

Day-to-Day Changeability of Temperature

The change of temperature from one day to the next is an important element of the climate. In winter, three or four out of every 10 days are characterized by a change in maximum temperature of less than 5°. On two out of 10 days the change is greater than 12°. Minimum temperatures are less variable, with interdiurnal changes being less than 5° on more than half the days of winter. Changes are even less in summer when five to seven out of every 10 days bring a change of less than 5° in daytime maximum temperatures and over seven out of 10 bring an equally small change in nighttime minimum temperature. In summer, changes greater than 12° from one day to the next are rare.

Weather by Seasons

Spring (March, April and May)—Normal daily mean temperatures increase about 10° during each month of spring. Mean temperatures start at about 41° on March 1 and end at just over 70° on May 31. At the beginning of March most record daily high temperatures are below 80°. Record highs increase to 90° or more early in April, and reach 95° or more the last half of May. Daily record low temperatures increase from about 15° in early March to over 40° by mid-May. April 10 is the average date of the last freezing temperature in the spring, although in some years freezes have occurred as late as May 12.

The total monthly precipitation exceeds 5 in. during about one month in five during spring. An average of one spring month in 10 years has less than 1 in. Snowfall is fairly common in March, and in over half of the years 1 in. or more of snow has been recorded in that month. Once in a while, some snow also falls in April.

Spring is usually the windiest time of the year in Washington. Afternoons have an average wind speed of over 11 mph in March, but only 8 to 9 mph by the end of May.

On an average afternoon, relative humidities are lower during April than at any other time of the year. The April average afternoon humidity is 44 percent. Humidity during the night runs between 62 and 71 percent during the spring months.

With the advance of spring, there is a marked seasonal change in the character of the weather systems. At the beginning of March, precipitation is caused largely by low-pressure areas that pass close to Washington. Gradually the storm tracks shift northward, and in April and May rainfall is of a more showery kind, caused by the passage of cold fronts associated with low-pressure areas well north of the Mason-Dixon line.

Summer (June, July, and August)—In summer, daytime high temperatures under 70° are exceptional in Washington, and 90° or higher can be expected one-fifth to one-third of the time. Record high temperatures have been under 95° on only two days (both in June). After the middle of June, record low temperatures of 50° or less are exceptionally rare. The annual temperature curve reaches a peak just after the middle of July, but it is a flat curve and in August the fall of daily mean temperatures between the 1st and 31st of the month is only about 4°.

Almost a third of all summer months have 5 in. or more of rainfall. At the other extreme, slightly less than 10 percent of the summer months have less than 1 in. of rainfall. Less than 10 percent of all hours in summer have precipitation at any time during the hour. Since most outdoor activity in Washington is scheduled for the afternoon or evening hours, it is interesting to note that the probability of precipitation in summer during the five hours from 2 p.m. to 7 p.m. is about 25 percent, and that for the five hours from 7 p.m. to midnight also is nearly 25 percent. Precipitation at this time of the year is derived almost exclusively from showers and thunderstorms. These are caused either by a frontal or squall-line system, or from heating of moist, unstable air ("air mass showers").

Although transient thunderstorms are often accompanied by strong, gusty winds, on an average summer is the time of year having the least wind speed. Afternoon speeds average 7 or 8 mph, and the period from late evening until early morning has an average of less than 5 mph.

During summer nights, the average relative humidity is over 80 percent, but during the afternoon this average falls to around 50 percent or less.

Autumn (September, October, and November)—Summer weather in Washington often seems to linger into September, but by the end of that month the average daily temperature is almost 10° cooler than at the beginning. Mean temperatures continue to fall about 10° per month in October and November. Whereas September usually has 25 or 26 days with a high temperature of 70° or more, by November less than 3 days as warm as this can be expected. Temperatures over 100° have been experienced in early September, but by the end of November all record daily high temperatures are below 75°. Record lowest temperatures start at around 50° in early September and drop below 15° toward the end of November. The first freezing temperature of autumn normally occurs during the last few days of October or the first few days of November. It has, however, been known to occur as early as October 2.

Almost 15 percent of all autumn months have 5 in. or more of total rainfall (September of 1934 had a record of 17.45 in.). Monthly rainfall of less than 1 in. also occurs in about 15 percent of all months (October of 1963 had no measurable rain at all). On a few occasions snow has been recorded in October. In nearly a quarter of Novembers, a snowfall of 1 inch or more is to be expected.

A period of Indian Summer, characterized by clear or hazy, warm, calm days, and cool nights, is quite usual in October or early November. This pleasant condition comes about when a large high-pressure area stagnates or moves only very sluggishly overhead.

The ragweed pollen season usually begins about mid-August, but it reaches its peak late in the first week of September and gradually subsides after that. By the end of September, the pollen count has crept downward to bearable levels.

Winter (December, January, and February)—The mean daily temperature at the beginning of December is usually around 42°. By the latter third of the month it levels off at around 36°, where it remains until it starts to increase again after the first of February. By the end of February it has reached early December levels once more. Record daily high temperatures range between 65° and 75° all during December, January, and the first 20 days of February. Toward the end of February, record high temperatures are over 75° and have reached as high as 84°. Record daily low temperatures start near 15° during the first few days of December and drop to 5° or somewhat below zero on most days during January and the first 20 days of February. After that a few record daily lows are no lower than 10°.

Winter precipitation is relatively uniform, with only 12 percent of the months having more than 5 in., and less than 4 per cent receiving under 1 in. of melted water content. Over 15 percent of all hours during winter have precipitation sometime during the hour. Although snowfall is quite common, a third of all Decembers have less than 1 in. of snowfall. January and February usually have more snow than December but one-fifth of all Januarys and Februarys have nonetheles recorded less than 1 in. of snowfall. Precipitation during the winter season in Washington is derived almost exclusively from well-developed low-pressure areas that move through or near the Middle Atlantic States.

Wind speeds during winter afternoons average 9-10 mph, but during the night they drop to 6 or 7 mph.

Nighttime relative humidity is less than in summer and averages between 70 and 80 percent. Afternoon humidity averages around 55 percent.

Some Outstanding Weather Events

The Knickerbocker Storm of January 27-29, 1922—Probably the most famous storm in Washington's weather records is what is known as the "Knickerbocker Storm." This storm first showed up on weather maps as a rain and shower producer in southeast Texas on January 24. By the 25th it was causing rain over a wide area including Mississippi, Alabama, and Georgia. At 8:00 a.m. on the 27th the storm center was off the Atlantic coast east of the Georgia-South Carolina border. From there it tried to move northeastward along the coast, but high pressure over the northeastern states held on with remarkable persistence and blocked its progress. By the 29th the center had moved no further than to a point east of Washington and south of Cape Cod. It then began a more easterly course and finally relaxed its grip on the Washington area the afternoon of the 29th. Under the influence of this unusual storm, snow began in Washington at 4:20 p.m. on the 27th and fell wet and heavy until after 9:00 p.m. on the 28th. It finally stopped about 12:30 a.m. on the 29th. The total fall was between 28 in. and 30 in. in this area. Under its crushing weight, the roof of the Knickerbocker theater suddenly collapsed during a performance on the evening of the 29th, killing about 100 people and injuring perhaps another 100. This grave tragedy lent the storm its infamous name.

Heavy rainstorm of April 8-12, 1918—At 5:15 p.m. on April 8, 1918, precipitation began which was to continue until 2:45 p.m. on the 12th. It began with a weak low-pressure and trough system moving eastward through the South Atlantic states. By the morning of April 9, this system had become a vigorous storm located just off the South Carolina coast. At the same time, a high-pressure system was moving slowly eastward through the northeastern states and blocked the storm's progress. The storm had reached only as far as the Maryland-Pennsylvania border by the morning of the 12th. Rainfall in Washington due to this storm totalled 4 in. On the 11th and 12th, 3 in. of snow and some sleet became mixed in with the rain.

The cold spell of February 5-15, 1899—On the midnight of February 4, 1899, temperatures in Washington fell below freezing and remained constantly below freezing until the afternoon of February 15. Between the 5th and 8th of the month there were four separate snowstorms. Snow began again on February 11 and lasted until late on February 13. This latter storm dropped 20.5 in. of snow and brought the accumulation on the ground to 34.2 in. Winds reached 40 mph at the time, qualifying the storm as a genuine blizzard. During four days of this cold period, below-zero temperatures were recorded. An all time-record low temperature for Washington, which still stands, was reached on the morning of February 11. It was 15° below zero.

The hot spells of August 5-9, 1918, and July 18-22, 1930—Summer hot spells in Washington are usually caused by a strong northerly drift of air from the subtropics that accompanies a westward extension of the Bermuda high-pressure area inland over the South Atlantic states. This condition was present for both of the spells discussed here.

The hot spell of August, 1918, was marked by an average maximum temperature of 99.6° and an average overnight minimum of 76.4°. A temperature of 105.5° was recorded at Weather Bureau headquarters (24th and M Streets, N.W.) on August 6, and numerous Washington residents were prostrated by the heat. A thunderstorm brought relief on the evening of August 7 by dropping the temperature from 102° at 5 p.m. to 73° at 8:30. During this period the humidity also was oppressively high; the dewpoint averaged

72.3°, and reached a record high of 82° on the 8th.

In the heat wave of July 1930, the average maximum temperature was 101.2° for five days. Minimum temperatures averaged 75.2° in the same period. Although the average temperature was slightly higher than in the August, 1918, hot spell, the humiditv was less, with dewpoints averaging 65.9°.

An interesting contrast to these statistics on heat was the situation on July 18, 1891. At 4 p.m. that day, normally the hour of hottest weather, the temperature dipped to only 54°. This very cool summer weather was due to an unseasonable northeaster moving along the coast and bringing heavy rain to Washington.

Distribution of Climate in Washington

Every city alters its own climate to some extent. Studies have recently been made of the areal distribution of temperature and precipitation over metropolitan Washington. It may be of interest to summarize the principal results (2).

One of the most significant effects of a city on its climate is its creation of a "heat island"—an area of higher temperatures in the most built-up parts of the city—that is particularly evident at night. In Washington this "heat island" encompasses the National Airport to the south, parallels the Potomac river nearly as far as Georgetown to the west, and extends to Brightwood and Takoma Park to the northeast and to the Anacostia river to the east. In this "heat island," lowest nocturnal temperatures average some 6° to 8° warmer than the coldest peripheral portion of the metropolitan area—namely, the area northeast of town around Greenbelt and the Baltimore-Washington Parkway. In contrast to those of some other cities, Washington's heat island appears to be better developed in summer than in winter.

During the afternoon hours, the "heat island" is less conspicuous. That is to say, the difference between urban and suburban maximum daily temperatures is not so great. The daytime thermal maximum appears to extend from northeast Washington to University Park, Md. A secondary afternoon maximum may exist between Falls Church and Waverly Hills, Va. Temperature differences are, however, only about 2° to 3° across town during the day.

Annual total precipitation varies by somewhat over 4½ in. between the driest and wettest parts of the metropolitan area. The least precipitation falls at National Airport and to the southeast along the Potomac river. The wettest portion of the area lies well to the north. There is a logical explanation for this. In the summer the relatively cool water of the Potomac river tends to cool the air from below, thus stabilizing it and minimizing shower activity locally. The area north of the city, on the other hand, is at a relatively higher elevation. Since most rainy summer weather is accompanied by a south to southwest wind, the orographic lifting of air that results, together with the upwind addition of heat from the city (which tends to create greater instability), encourages greater shower development to the north.

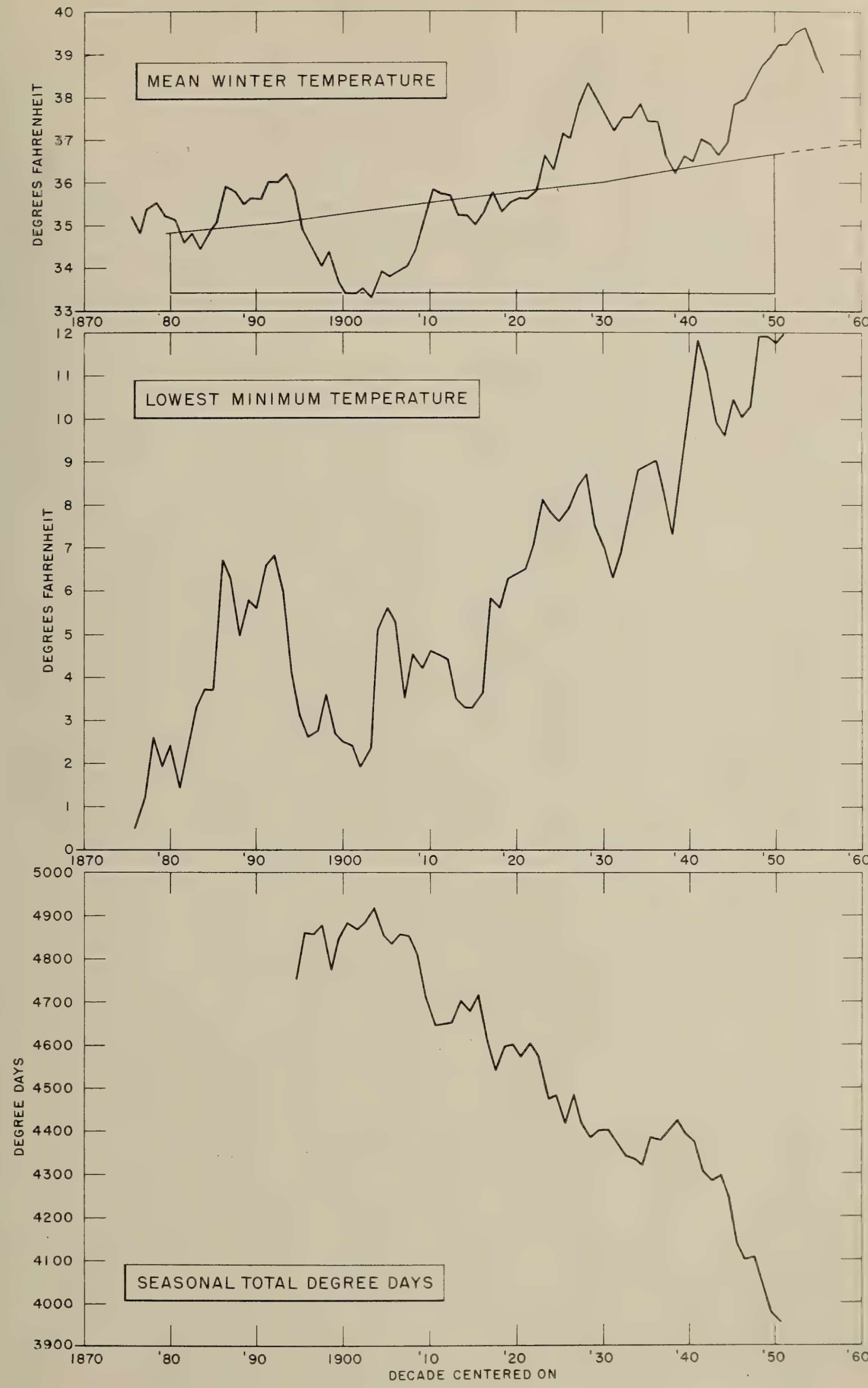
Although snowfall has not been studied to the same extent as temperature and water content of precipitation, it appears that the area south and east of the city receives considerably less snow than sections to the northwest.

Climatic Trends

To a first approximation, the climate of Washington has been invariant with

Trends of winter temperature in Washington, D. C., since 1870, based on Weather Bureau records at M and 24th Streets, N. W. All data shown as 10-year moving averages. *Upper curve:* mean temperature of 3-month season December-February; estimated rate of warming due to growth of city is given by background trend line. *Middle curve:* lowest temperature reached in each winter season. *Lower curve:* seasonal total heating degree-days, defined as cumulative daily mean temperature departure below base temperature 65°F. (From (12) in bibliography.)

WINTER COLDNESS AT WASHINGTON, D. C.



time during the past 90 years of available records. Nevertheless, slight systematic changes have been noted in many elements, which fit a worldwide pattern of documentable climatic trends. For example, various indices of winter temperature for Washington reveal a gradual warming trend in that season, as show in the figure. Summer temperatures also have been rather uniformly on the increase, at least until some time in the decade of the 1950's. In passing, it may be significant that a worldwide warming trend was in progress from about 1880 to the 1940's, after which the warming apparently yielded to a cooling phase that is presumably still under way. Inasmuch as Washington participated in the worldwide warming phase, the fact that we have had a run of cold winters and cool summers in very recent years may be indicative that Washington climate has begun to participate also in the present worldwide cooling trend. Nevertheless, it will be difficult for the urban center of Washington to cool again all the way down to its 19th-century levels, even if the climate at large continues to cool. The reason is that the intensity of the urban "heat island" has locally increased over the years as the city has become ever larger and more densely built up. This tendency for the city to make itself increasingly warmer is undoubtedly the reason why the curves in the figure contain strong trend components. Comparable curves based on rural climatological records indeed show smaller net trends.

Since winter mean temperatures in Washington are not far from the freezing point, the trends of temperature shown in the figure have important implications for the fraction of winter precipitation that falls as snow and for the length of time that snow cover can persist on the ground. All in all, Washington winters have become less and less "wintry" over the years, at least until quite recently. Unfortunately, we are not able to predict with any certainty whether these tendencies will continue or change direction in the future.

This is but a brief, generalized description of Washington's climate. For the benefit of those desiring greater detail of some particular element, the following bibliography is provided.

Bibliography

(1) Cry, G. W. Personal communication, 1964.

(2) Woollum, C. A. Unpublished manuscript, 1964.

(3) Abbot, C. G. Correlation of solar variation with Washington weather. AGU Transactions *26*, No. 3 (1945).

(4) Abbot, C. G. Periodic influences on Washington and New York weather of 1949-1950. Smithsonian Misc. Coll. VIII, No. 17 (1950).

(5) Abbot, C. G. Report on the 27.0074-day cycle in Washington precipitation. Smithsonian Misc. Coll., 1944.

(6) Dickey, W. W. Estimating the probability of a large fall in temperature at Washington, D.C. Monthly Weather Rev. *77*, No. 3 (1949).

(7) Fergusson, S. P. The great snow of Jan. 27-29, 1922. Unpublished manuscript.

(8) Holleyman, J. B. The Washington, D.C., storm of June 26, 1954. Monthly Weather Rev. *82*, No. 7 (1954).

(9) Landsberg, H. E. Comfortable living depends on microclimate. Weatherwise *3*, No. 1 (1950).

(10) Landsberg, H. E. Some recent climatic changes in Washington, D. C. Archiv für Meteorologie, Geophysik, und Bioklimatologie, Serie B, Band III (1951).

(11) Ludlum, D. M. The Washington and Jefferson snowstorm. Weatherwise *10*, No. 6 (1957).

(12) Mitchell, J. M. Jr. Link warmer climate to city growth. Heating, Piping, and Air Conditioning, Aug. 1956.

(13) Mook, C. P. The Knickerbocker snowstorm of January 1922 at Washington, D. C. Weatherwise *9*, No. 6 (1956).

(14) Mook, C. P., and Price, S. Objective methods of forecasting winter minimum temperatures at Washington, D. C., U.S. Weather Bureau, Research Paper No. 27 (1947).

(15) Rapp, R. R. On forecasting winter precipitation amounts at Washington, D. C. Monthly Weather Review 77, No. 9 (1949).

(16) Slocum, G. The annual march of temperature at Washington, D. C. Bulletin AMS *22*, No. 5 (1941).

(17) Zoch, R. T. The trend in temperature at Washington, D. C., for 1862-1949. J. Washington Acad. Sci. *40*, No. 11 (1950).

(18) Zoch, R. T. On the variation of the aver-

age daily temperature at Washington, D. C. J. Washington Acad. Sci. *42*, No. 4 (1952).

(19) U. S. Weather Bureau. The climatic handbook for Washington, D. C. Tech. Paper No. 8, U.S. Govt. Printing Office, 1949.

(20) U. S. Weather Bureau. Climatography of the United States. No. 82-50 Decennial Census of the United States, Summary of hourly observations, Washington, D. C., 1962.

(21) U.S. Weather Bureau. Local climatological data, Washington National Airport, Washington, D. C. 1963.

Problems of Long-range Weather Forecasting*

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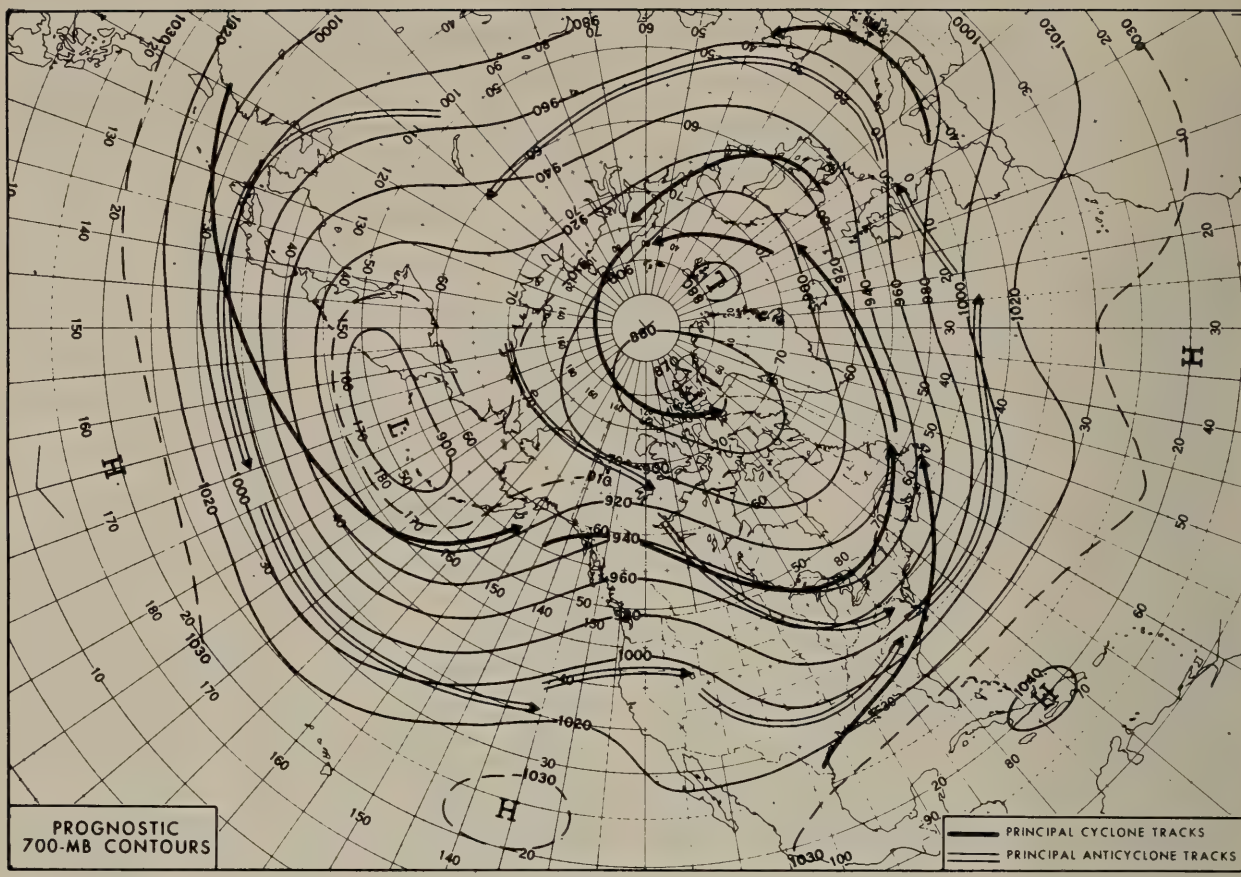
Scientists who work in long-range weather forecasting encounter great difficulties, not only in the intricacies of their chosen field but also in getting across to other scientists and the lay public the essential nature of their problem and the reasons for their painfully slow progress in the modern-day milieu of satellites, computers, and atomic reactors. When solar eclipses can be predicted to fractions of a second and the position of a satellite pinpointed millions of miles out in space, it is not readily understandable why reliable weather predictions cannot be made for a week, month, season, or even a year in advance. Indeed, eminent scientists from disciplines other than meteorology, underestimating the complexity of the long-range problem, have tried to solve it only to come way with a feeling of humility in the face of what the late John von Neumann called "the second most difficult problem in the world" (human behavior presumably being the first). Why, then, is the problem so intractable?

In the first place, the methodology of long-range forecasting is largely dependent on routine observations of natural phenomena gathered over vast areas—and by vast we mean at least hemisphere-wide coverage in three dimensions. More probably the entire world's atmosphere must be surveyed because of large-scale interactions within a fluid which has no lateral boundaries but surrounds the entire earth. In contrast to the physicist, the meteorologist has no adequate laboratory in which to perform controlled experiments on this scale, although some recent work with electronic computers holds out hope for useful simulation.

When the immense scale of the atmosphere is realized, it becomes clear that the present network of meteorological observations is woefully inadequate. Even in temperate latitudes of the Northern Hemisphere, relatively well covered by surface and upper-air reports, there are "blind" areas of a size greater than that of the United States. The tropics are only very sparsely covered by reports, and the data coverage in the Southern Hemisphere is still poorer by an order of magnitude. There, a moat thousands of miles in diameter separates the data-rich Antartic continent from the temperate latitudes, making it virtually impossible to get a coordinated picture of what is occurring *now*, let alone what may occur in the future. Thus, the "secrets of long-range fore-

* A modified form of this paper was submitted to "Der Mensch und die Technik" of *Suddeutsche Zeitung*, in connection with a special edition on the occasion of World Meteorological Day, March 23, 1964.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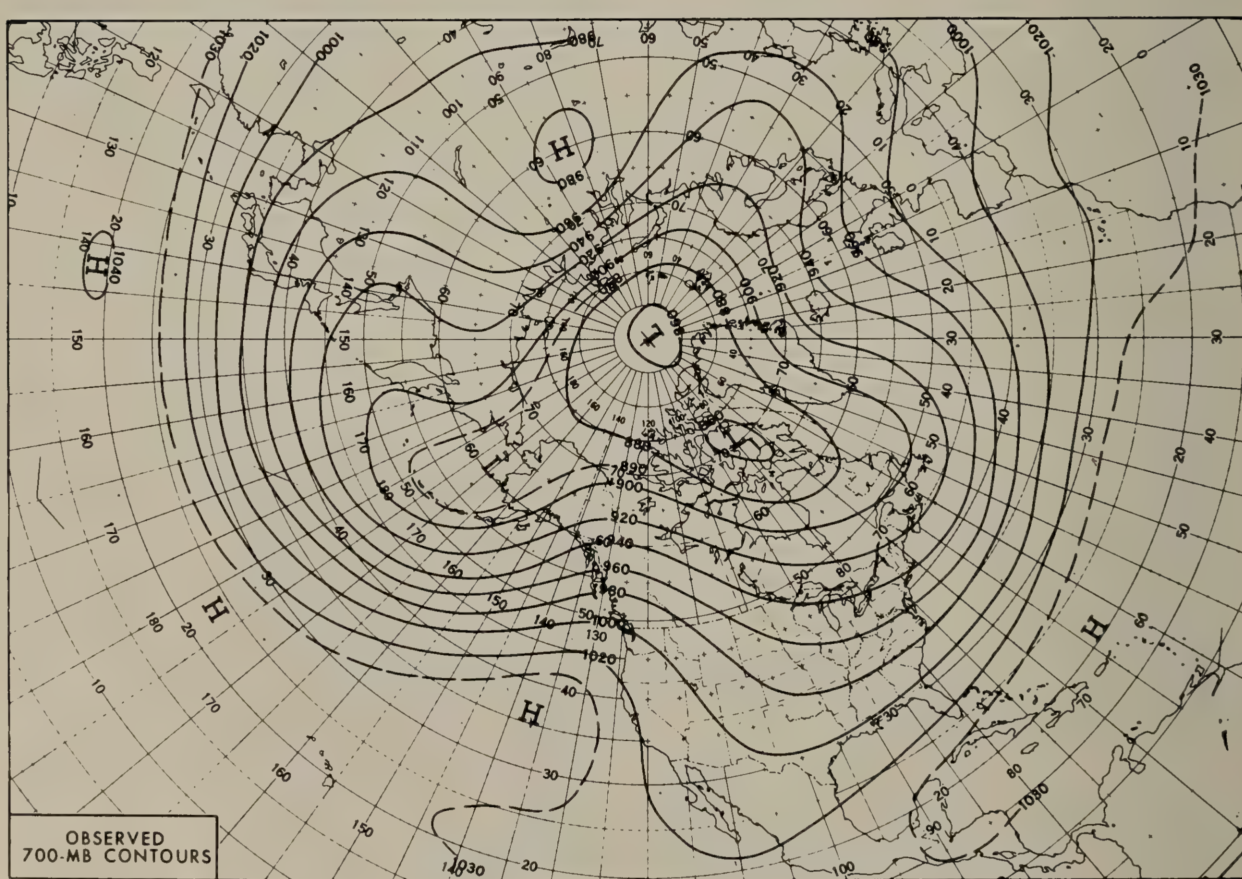
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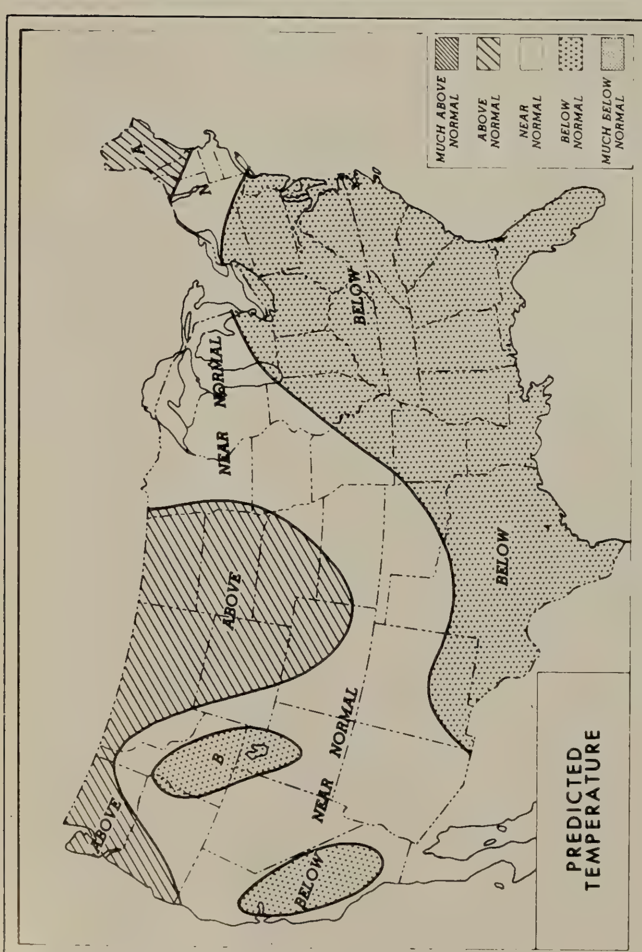
casting locked in Antartica"—a cliché often found in press articles—are indeed securely locked. Of course, cloud and radiation observations from satellites will assist to an ever-increasing degree, but better methods of determining the atmosphere's pressure, wind, and temperature distribution from satellite observations are urgently needed.

Even if every cubic mile of the atmosphere up to a height of 20 km. were continuously surveyed (and there are 2500 million such volumes), reliable long-range forecasts would still not now be realizable, because, regardless of their frequency and density, *observations are not forecasts;* they merely provide "input data" for extended forecasting. Meteorologists have yet to develop a sufficient *understanding* of the physics of the atmosphere to use these input data effectively in long-range forecasting.

In view of this state of affairs, it is surprising that long-range predictions enjoy as much success as they do. That they do is attributable to a few fortunate aspects of atmospheric behavior. In the first place, the systems which produce most of the weather over the world, the cyclones and anticyclones of the weather map, are so large that a fine mesh of observations is not needed to detect and describe them. A lattice of stations on the order of 300 km. apart is quite adequate for that. Secondly, the birth, growth, movement, and death of these systems essentially depend on phenomena of a still larger scale of size, namely the long "planetary waves" found in upper-air currents flowing between altitudes of 10,000 and 50,000 feet. Another fortunate circumstance is that, in many aspects of their behavior, cyclones, anticyclones, and planetary waves are persistently recurrent over weeks and sometimes months. Thus, meteorological time series are serially correlated, and average variations around a normal (for a week, month, or season, for example) are much larger than would be expected if daily weather were randomly distributed. This statistical property implies that there are forces *external* to the atmosphere which force it again and again to repeat essentially the same series of weather developments. An extreme example of this phenomenon is offered by the abnormally cold European winter of 1962-63.

What are these external forces? Of course, complex geographical influences produced by mountains, ocean-land contrasts, and the like are highly important in producing certain recurrent wind and weather patterns, the net result of which shows up in climatological statistics—particularly in means computed for many decades. But since individual winters usually differ markedly from one another, *other* external factors besides geography must operate. Long-range forecasters disagree, however, as to what the most important of these factors are.

Franz Baur in Germany and H. C. Willett in America have pursued the idea that variations in solar activity are the primary external stimuli. Another school of thought, of which the author is a proponent, believes that the thermal character of the earth's surface over both continent and ocean provides the principal means for quasiperiodically restoring certain wind and weather patterns within a given month or season. These surface variations result from abnormalities in snow cover, ocean temperatures, Arctic ice, etc.—abnormalities affected by the preceding and contemporary atmospheric behavior. Whether these external influences be solar or terrestrial, our present knowledge is insufficient to apply them in a physically-based scheme of long-range prediction. Much more observation and study, particularly with the help of electronic computers, must be carried on before this will be possible. Therefore, statistical and synoptic methods, together with qualitative reasoning, form the basis for most long-range forecast methods practiced today. By these methods we take advantage of the fact that the influence of external factors is implicit in meteorological time series, so that some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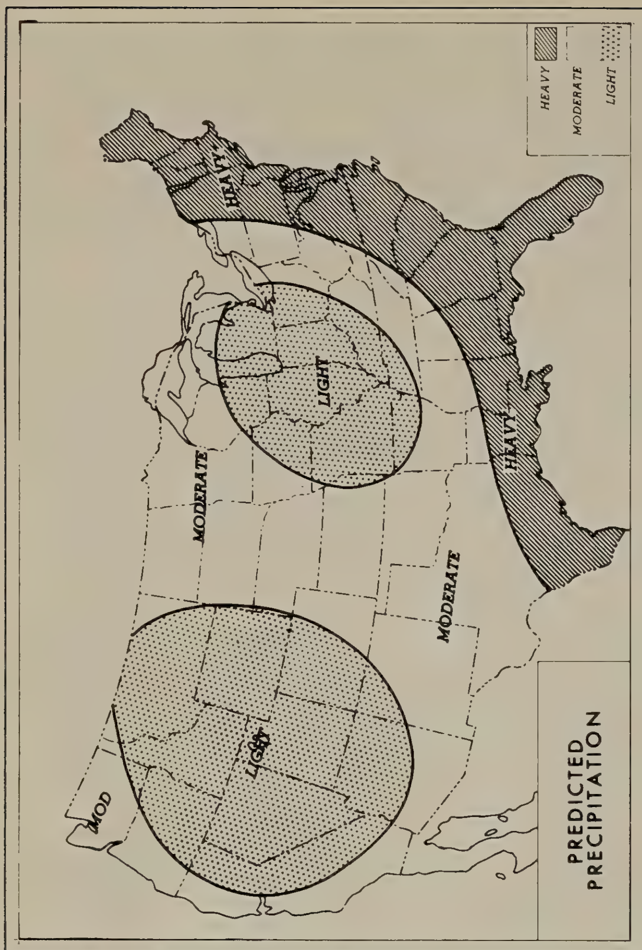
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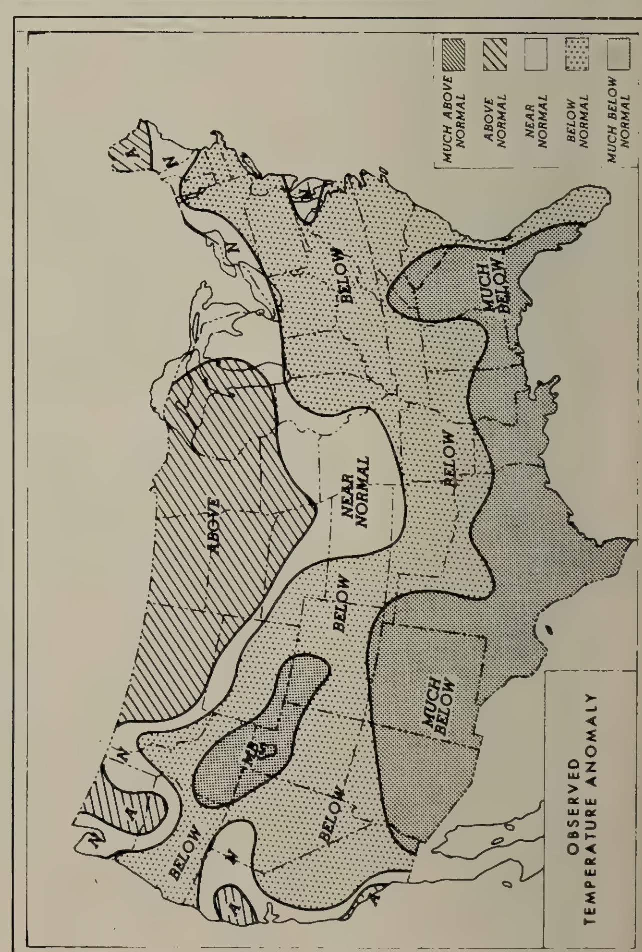
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degree of success in prediction can be achieved. The statistical methods automatically incorporate the coherence or persistence factor, and some methods also utilize cross-correlations or orthogonal polynomials which describe some of the interactions between remote portions of the atmosphere. Naturally, this work has been greatly facilitated by high-speed computers.

Predictions are frequently made from hemispheric wind and pressure patterns at one or more levels and from sequences of *average* patterns computed for a week, month, or season. The primary prediction is usually made for the prevailing pressure pattern of a subsequent period. This output is then transformed into probabilistic temperature and precipitation patterns which are usually expressed in terms of departures from normal climatological expectancy. Such predictions have been made in the United States for a week * with reasonable skill, for a month with modest skill, and for a season with marginal skill. No one in the world has demonstrated to the satisfaction of his scientific colleagues an ability to predict *day-to-day* weather for more than 4 to 6 days ahead. An example of a recent 30-day prediction for the the coterminous United States is shown in the charts.

In spite of the rather discouraging state of affairs described above, the future of long-range prediction appears bright. There are four reasons that justify such optimism.

First, a new generation of young meteorologists, well trained in mathematics, physics, statistics, and synoptics has appeared on the scene and is beginning to show a keen interest in the long-range prediction problem—formerly a haven for a small number of scientists and a larger number of charlatans. Secondly, machinery is now available to handle the necessarily complex dynamical and statistical computations. Thirdly, through world-wide effort (largely through the World Meteorological Organization) adequate worldwide meteorological coverage necessary to long-range prediction may soon become a reality.

Finally, man now clearly sees this problem as one of tremendous economic importance, and as one whose solution is prerequisite for an attack on another challenging problem: weather and climate modification. With such stimuli as these, important advances in long-range prediction skill will surely follow.

Charts

Predicted and observed contours (labeled in tens of feet) of the 700-mb. pressure surface for February, 1964, representing the prevailing wind flow in mid-troposphere. Undulations are planetary waves.

Predicted and observed temperature departures from normal for February, 1964, expressed in categories determined from the frequency of occurrence of February temperatures in past climatological records.

Predicted and observed precipitation patterns for February, 1964, expressed in three classes as determined from climatological records of February precipitation amounts.

* For periods of three and four days, the use of numerical (i.e., dynamical) methods has been very helpful, and these are supplemented with statistical and synoptic techniques for weekly forecasts.

Academy Proceedings

May Meeting

(481st Meeting of the Washington Academy of Sciences)

COMMEMORATION OF THE 400th ANNIVERSARY OF GALILEO'S BIRTH

Dr. Gibson

DATE: **THURSDAY, MAY 21, 1964**

PLACE: **HOWARD COUNTY BUILDING, APPLIED PHYSICS LABORATORY**

Before-Dinner Program at 6:30

SPEAKER: **RALPH E. GIBSON**
Director of the Applied Physics Laboratory, Johns Hopkins University

SUBJECT: **WHAT HAS BECOME OF GALILEO'S IDEAS TODAY?**

Dr. Kershner

After-Dinner Program at 8:15

SPEAKER: **RICHARD B. KERSHNER**

Supervisor of Space Development Division, Applied Physics Laboratory

SUBJECT: **NAVIGATION BY SATELLITES**

Dinner *will be served from 7:00 to 7:30 in the APL cafeteria. Advance reservations are required; they may be obtained from Dr. Mary Louise Robbins at the GWU Medical School, FE 3-9000, Ext. 510.*

Directions: *APL's Howard County Building is off US 29, 15 miles northeast of the center of Silver Spring (intersection of Georgia Avenue and Colesville Pike). Proceeding on US 29, enter Howard County, pass through Scaggsville (intersection with Md 216), and watch for a blue-and-white sign marked "Johns Hopkins Applied Physics Laboratory." Turn left at next intersection, on to Johns Hopkins Road. Continue to end of this road; the Howard County Building will be visible on the right.*

Abstract of Dr. Kershner's Address—The usefulness of artificial satellites for providing worldwide aid to navigation is discussed. A number of different possible schemes are described with an indication of the advantages and disadvantages of the various possibilities. The importance of satellite altitude is discussed. It is shown that the factor which limits the accuracy is the knowledge of the earth's gravitational field. Thus, progress in navigation is intimately tied to progress in geodesy. This is true whether the

navigation is accomplished by satellites or by earth-bound systems. An indication of the present status of geodesy and prospects for the future are given.

The Speakers—Richard B. Kershner was born in Ohio, but he obtained his entire education in Baltimore. At the age of 23, he received the Ph.D. degree in mathematics from Johns Hopkins University. He taught mathematics at the University of Wisconsin, then at Johns Hopkins. During World War II he was engaged in development of ballistics systems at the Geophysical Laboratory of the Carnegie Institution of Washington, and in application of the principles of rocket propulsion at the Allegany Ballistics Laboratory, Cumberland, Md. Since 1946 he has been at the Applied Physics Laboratory, first in the Launching Group, then as supervisor of the Guidance and Control Group. He now heads the division responsible for development of a satellite navigation system and for the Laboratory's space research programs. He has twice received the Navy's Distinguished Public Service Award—first in 1958, for his leading role in the *Terrier* missile development; and second in 1961, for contributions to the *Polaris* missile system.

Ralph E. Gibson, a native of England, came to the United States in 1924 and joined the staff of the Geophysical Laboratory, Carnegie Institution of Washington. He has been with the Applied Physics Laboratory since 1946, and its director since 1948. In addition to achieving a brilliant scientific career in his research on physical chemistry, rockets, and guided missiles, and in his administration of research and development, he has found time to serve as organist and choir director of Saint Columba's Episcopal Church since 1935.

1964 Budget Approved

The following budget for 1964 was approved by the Board of Managers at its meeting of March 19. For comparative purposes, estimated and actual figures for 1963 also are included.

	1963 estimated	1963 actual	1964 estimated
Receipts			
Dues	$ 9,050	$ 9,846.00	$10,000
Journal subscriptions, back issues, reprints	2,000	2,953.99	3,000
Interest, dividends	2,000	2,209.15	2,300
Services to Joint Board	400	400.00	200
Receipts from meetings, committees, dinners	500	745.86	750
Estd. sales of back issues to W. J. Johnson, Inc.	50	71.50	50
Total	$14,000	$16,226.50	$16,300
Expenses			
Journal printing, addressing, postage, miscellaneous	$ 8,000	$ 7,341.64	$ 8,000
Grants (total)	1,300	915.20	1,000
Meetings Committee (hall, refreshments, etc.)	2,500	2,806.90	3,500
Secretary (printing, mailing, list maintenance)	1,000	713.59	700
Treasurer (headquarters office equipment, printing, mailing, etc.)	1,000	1,175.26	1,000
Headquarters office, salaries and taxes	3,000	2,606.62	3,750
Miscellaneous, including Joint Board salary and subvention	1,100	2,245.73	1,500
Total	$17,900	$17,804.94	$19,450

ELECTIONS TO FELLOWSHIP

The following persons were elected to fellowship in the Academy at the Board of Managers meeting on March 19:

Louis C. W. Baker, chairman of Chemistry Department, Georgetown University, "in recognition of his contributions to inorganic chemistry, particularly his researches on the structures and properties of heteropoly anions." (Sponsors: E. A. Mason, H. W. Schamp, and C. E. White.)

Gale W. Cleven (colonel, USAF) project manager, C&C Office, Advanced Research Projects Agency, Department of Defense, "in recognition of his contributions to the field of astrometry (stellar position and motion), and in particular his researches on a mathematical approach to the problem of rectifying astrographic catalogues (thereby achieving precision of position) by means of electronic computers." (Sponsors: M. Apstein, P. J. Franklin, A. F. Forziati.)

Norman H. C. Griffiths, chairman, Division of Dental Prosthesis, Dental School, Howard University, "in recognition of his contributions to prosthodontics, his aid in stimulating research in underdeveloped countries, and in particular his dissemination of knowledge of dental science to practitioners in the United States and several foreign countries." (Sponsors: G. M. Brauer, George Dickson, G. Paffenbarger.)

The following persons were elected to fellowship in the Academy at the Board of Managers meeting on April 16:

George Abraham, head of Experimental Devices Section, Naval Research Laboratory, "in recognition of his research on solid state phenomena leading to generation of multistable states having broad application to digital computers, communications, and microelectronics, and for his role in graduate training programs at various universities in the Washington area." (Sponsors: S. H. Liebson, L. A. DePue.)

Irving Gray (colonel, USA), professor of biology (biochemistry), Georgetown University, "in recognition of his contributions to biophysics and biochemistry, and in particular his studies on the biochemical effects of radiation and trauma." (Sponsors: C. R. Treadwell, R. B. Roberts, B. D. Van Evera.)

Gregory K. Hartmann, technical director, Naval Ordnance Laboratory, "in recognition of his contributions to underwater acoustics, explosives research, and administration of research and development." (Sponsors: H. Polachek, F. Frenkiel, Z. I. Slawsky.)

Albert J. Herz, research physicist, Naval Research Laboratory, "in recognition of his contributions to high energy physics and cosmic ray physics, and in particular of his effective exploitation of nuclear-emulsion techniques in these disciplines." (Sponsors: M. M. Shapiro, John McElhinney, Bertram Stiller.)

Freeman H. Quimby, chief, Exobiology Branch, National Aeronautics and Space Administration, "in recognition of his work in developing a program of systematic research and development aimed at the discovery and study of extra-terrestrial life." (Sponsors: Orr E. Reynolds, H. E. Finley.)

David C. Rife, head, Biological Sciences Section, Research Grants Branch, National Institute of General Medical Science, "in recognition of his background of experience in various aspects of the general field of genetics and of his written contributions to the field, . . . especially the genetics of behavior." (Sponsors: Paul W. Bowman, B. D. Van Evera, N. T. Grisamore.)

Aaron Seamster, director, Educational Programs Branch, National Aeronautics and Space Administration, "in recognition of his research work in parasitology, in particular with the monogenetic trematodes of fish, and in recognition of his leadership in science education and administration." (Sponsors: H. L. Dryden, Urner Liddel, M. Tepper.)

Charles S. Tidball, acting chairman, Physiology Department, George Washington University, "in recognition of his contribution to gastro-intestinal physiology, and in particular his research on the mechanisms responsible for the movement of water across the intestinal epithelial membrane." (Sponsors: M. L. Robbins, B. E. Eddy, R. C. Parlett, C. R. Treadwell.)

Irvin E. Wallen, assistant director for oceanography, Museum of Natural History, Smithsonian Institution, "in recognition of his notable contributions to the science of biology, and in particular his contributions to the development of the national oceanographic program." (Sponsors: M. L. Robbins, N. D. Stewart, P. H. Oehser.)

ELECTIONS TO MEMBERSHIP

The following persons were elected to membership in the Academy by action of the Committee on Membership at its meeting on March 23:

Frank D. Allan, associate professor of anatomy, George Washington University;

John C. Bartone, assistant professor of anatomy, George Washington University;

Suzanne F. Bershad, oceanographer, National Oceanographic Data Center;

George W. Cry, meteorologist, Weather Bureau;

Wade M. Edmunds, executive secretary, Joint Board on Science Education;

Vannie E. Gray, chemist, National Bureau of Standards;

Frank Hetrick, assistant professor of microbiology, University of Maryland;

Torrence H. MacDonald, meteorologist, Meteorological Satellite Laboratory, Weather Bureau;

Sidney O. Marcus, Jr., oceanographer, National Oceanographic Data Center;

Frederick A. Moran, meteorologist and analyst, Valley Forge Space Technology Center;

William H. Myers, oceanographer, National Oceanographic Data Center;

Augustine Y. M. Yao, research meteorologist, Weather Bureau;

Nina S. Zikeev, meteorologist, Office of Climatology, Weather Bureau.

WASHINGTON JUNIOR ACADEMY OF SCIENCES

The following is a summary of WJAS activities since December:

The Academy held its annual convention on December 30 in the White Gravenor Building at Georgetown University. Student speakers presented papers in the morning sessions, and John D. Nicolaides, special assistant to the director of the Offices of Space Science at NASA, spoke after luncheon.

On February 1, Louise H. Marshall of NIH addressed the Academy on "The Physiology of Dextran."

The annual joint meeting of WJAS and the Chemical Society of Washington was held on February 13.

A "Summer Research Job Opportunities" meeting of WJAS was held on February 29.

Dean L. Mitchell of the Naval Research Laboratory spoke at the meeting of March 28, on "The Production and Use of High Magnetic Fields."

LETTERS

In examining the March issue of the Journal I was impressed by the quality of the articles and the fields of interest represented. The Journal is now beginning to approach the level which had been proposed when it was reorganized—a good balance of articles of scientific interest combined with Academy news and notices. I note that in this issue 24 pages are devoted to articles and 8 pages to notices and news; this appears to be a desirable ratio. I feel also that the type of general interest article found in this issue is appropriate for the Academy and will stimulate reader interest.

Bourdon F. Scribner
National Bureau of Standards

I am delighted with William J. Youden's seminar talk, "Statistics in Its Proper

Place," published in the March Journal. His very strong statement about using statistical methods to plan the collection of data rather than to attempt their salvage should be very helpful to scientists in avoiding wasted effort. I have asked Dr. Youden for a supply of reprints of his article, for distribution to geologists who come to me with statistical problems.

William G. Schlecht
Geological Survey

After teaching statistical astronomy for about 15 years, I found that the content of the course gradually forced me to shorten all discussion of such interesting topics as least squares. . . I think that Churchill Eisenhart's essay in the February Journal, on "The Meaning of 'Least' in Least Squares," should be read by every student who must some day evaluate not only his own work but that of others.

Francis J. Heyden, S.J.
Georgetown College Observatory

Report of Committee on Encouragement of Science Talent, 1963-1964

The following members were appointed to the committee for the current year: Francis J. Heyden, S.J., chairman, Alfred Weissler, Lloyd Ferguson, John K. Taylor, Howard B. Owens, and Roy Barker. Roy Barker, who resigned in February because he left the Washington area, was replaced by Nate Haseltine.

The committee has performed the following tasks:

Counseling the Junior Academy. Members of the committee have served as counselors for the Junior Academy and assisted them in arranging their meetings. Most of the meetings of the Junior Academy and of the Governing Council have been held at Georgetown University because facilities such as projectors were readily available. The convention on December 27 was well attended and the luncheon that followed was a great success. However, the committee noted with regret that members from Virginia and Maryland greatly outnumbered those from the District of Columbia. The committee plans to make a special effort before next year's convention to interest Washington students in attending.

Science Fair Arrangements. Georgetown University was unable to offer the use of its gymnasium because of its 175th anniversary celebration. A number of other facilities suggested were too expensive. Finally the U.S. Air Force offered the use of Hangar No. 2 at Bolling Field. The offer was arranged through Col. Gale Cleven, USAF, a former graduate student of Father Heyden.

Selection of Honors Winners. The next task of the committee will be the selection of the 40 winners to be honored by the Senior Academy in May. These 40 will be selected from among the honor group of the Westinghouse Science Talent Search, Science Fair winners, and others especially recommended by science supervisors of local schools.

—*Francis J. Heyden, S.J., Chairman*

Science in Washington

CALENDAR OF EVENTS

May 19—Anthropological Society of Washington

Saul Riesenberg and Clifford Evans, Smithsonian Institution, "The Ethnology and Archeology of Ponape."

Rm. 43, National Museum, 10th St. & Constitution Ave., N.W., 8:15 p.m.

May 20—Paleontological Society of Washington

Porter M. Kier, Smithsonian Institution, "Evolution of Paleozoic Echmoids."

Rm. 43, National Museum, 10th St. & Constitution Ave., N.W., 8:15 p.m.

May 28—School of Advanced International Studies, JHU

Richard B. Kershner, Space Development Division, Applied Physics Laboratory, "The Use of Artificial Satellites in Geodesy."

1906 Florida Ave., N.W., 8:00 p.m.

June 16-17—Office of Naval Research

Symposium on Computer Augmentation of Human Reasoning, held jointly with TRW Computer Division.

Rm. 1315 New State Department Bldg., 23rd St. between C & E Sts., N.W.

SCIENTISTS IN THE NEWS

Contributions to this column may be addressed to Harold T. Cook, Associate Editor, c/o Department of Agriculture, Agricultural Marketing Service, Federal Center Building, Hyattsville, Maryland.

AGRICULTURE DEPARTMENT

Calvin Golumbic attended the International Symposium on Mycotoxins in Foodstuffs held at MIT, March 18-19. He presented a paper on "Fungal Spoilage in Stored Food Crops."

N. R. Ellis participated in a series of U. S. feed grain symposia at the London (England) Trade Center, at Belfast, and at Dublin during the period of March 1 to 13; his subject was "New Trends in Swine Nutrition." These meetings are a part of a continuing program to encourage improved livestock feeding in the United Kingdom and Ireland.

A. L. Taylor, nematologist at Beltsville, is taking a year's leave of absence to accept an assignment abroad with the Food and Agriculture Organization. Initially scheduled to go to Cyprus, he is serving temporarily with FAO headquarters in Rome, pending the establishment of more favorable circumstances in Cyprus, or assignment elsewhere.

W. T. Pentzer attended a fruit and vegetable perishables handling conference at the University of California, Davis, March 23 to 25. He served as chairman of sessions on quality evaluation and description of vegetables, and modified atmospheres for the storage and transport of fruits and vegetables.

Justus C. Ward was a USDA representative at the invitation meeting of the National Health Forum, held at Pittsburgh from March 9 to 11.

At the Golden Anniversary Celebration of Committee D-13 on Textiles, American Society for Testing Materials, held in New York City on March 5, **Robert W. Webb** was awarded honorary membership "in recognition of outstanding service to this Committee and in appreciation of his devotion to its objectives." Dr. Webb was chairman of the Raw Cotton Section of D-13 for 9 years, 1934 to 1943; under his leadership ASTM's first cotton fiber test methods were developed.

Edson J. Hambleton retired in March after more than 22 years of Government service dedicated to technical assistance in foreign plant protection. He was in charge of Foreign Technical Programs, Plant Pest Control Division, Agricultural Research Service. Mr. Hambleton joined the former

Office of Foreign Agricultural Relations as Field Service Consultant in entomology in 1943, later assuming responsibility for administering the Regional Insect Control Project, a cooperative program with the Agency for International Development in the Near East and Africa. Prior to his service with USDA, Mr. Hambleton spent 14 years in entomological research and teaching in Brazil and Peru.

ARMY ENGINEERS

Werner K. Weihe, an employee of the Army Mobility Command's Engineer Research and Development Laboratories, Fort Belvoir, and internationally known for his work in infrared physics, recently was elected a fellow of the Optical Society of America. Fellowship in the Society is accorded only to those who have "served with distinction in the advancement of optics."

GEORGETOWN UNIVERSITY

Rev. Francis J. Heyden, S.J., was awarded an honorary Doctor of Science degree at the University's 175th anniversary convocation on March 19. The citation read in part: "The dynamic force of the human intellect stimulates men as they lift their gaze to the star-studded domains of heaven not only to acknowledge the Invisible Creator of these visible signs, but also to discover the intimate secrets of nature. The mind which advances far beyond the flaming ramparts of the world and traverses the vastness of space returns to us a victor laden with the fruit of victory.

"We assembled today in convocation gladly render our debt of gratitude to a colleague of our own, who by his observations and investigations of the sun, planets and stars has increased the fund of astronomical knowledge and by a more accurate measurement of the positions of the moon's craters has facilitated a more reliable lunar cartography."

HARRIS RESEARCH LABORATORIES

Alfred E. Brown received the annual Honor Scroll of the Washington Chapter, American Institute of Chemists, at a dinner held in his honor on May 5, at the Presidential Arms. Dr. Brown was cited for his contributions to professional societies and science organizations in the Washington area.

Dr. Brown participated in the Ninth Institute on Research Administration sponsored by the Center for Technology and Administration at American University, April 20-24.

Henry Peper and **Julian Berch** presented a paper at the 34th annual meeting of the Textile Research Institute in New York on April 9. The paper was entitled "Surface properties of cotton finishes and their relation to wet soiling and soil removal."

Arnold Sookne attended the spring meeting of the Fiber Society, April 15 to 17, at Charlotte, N. C. He served as chairman of a session on mechanical behavior of cotton and wool fibers.

NAS-NRC

Frank L. Campbell, a past president of the Washington Academy of Sciences (1959), will retire on June 30 from the staff of the National Academy of Sciences —National Research Council, where for the past 10 years he has been executive secretary of the Division of Biology and Agriculture. He has been invited to be a guest investigator during the next academic year in the II Zoologisches Institut der Universität Wien, Wien I., Dr. Karl-Lueger-Ring 1, Austria. This address, in care of Professor Dr. Wilhelm Kühnelt, should serve for communication. Dr. Campbell reports that he will probably dabble in cockroaches, as well as in Wein, Weib, und Gesang.

NATIONAL INSTITUTES OF HEALTH

Paul N. Baer of the National Institute of Dental Research has been appointed a visiting associate professor of periodontology in the Graduate School of Dentistry, Boston University.

Wade H. Marshall, chief of the National Institute of Mental Health's Laboratory of Neurophysiology, is spending two months at the Institut Marey, Université de Paris, lecturing and collaborating in research on central somatic mechanisms in cats. His wife, **Louise H. Marshall,** on leave from the Laboratory of Physical Biology, National Institute of Arthritis and Metabolic Diseases, is preparing for publication her research on the anaphylactoid reaction of rats to dextran.

Ernestine Thurman, executive secretary of the Tropical Medicine and Parasitology Study Section, Division of Research Grants, has transferred to New Orleans where she will be associated with the Department of Pathology at Louisiana State University School of Medicine. Dr. Thurman, the only woman entomologist commissioned officer in the Public Health Service, had been with the Service since 1944.

NAVAL RESEARCH LABORATORY

Albert W. Saenz gave a series of lectures on the mathematical foundations of quantum mechanics and quantum statistics in March and April, in a seminar on statistical mechanics at Johns Hopkins University.

WEATHER BUREAU

J. Murray Mitchell, Jr., has been awarded the Department of Commerce silver medal for meritorious service, "for a very valuable contribution to science through meritorious authorship in the field of climatic stability and change."

UNCLASSIFIED

Roy C. Dawson spoke at the luncheon meeting of the Norfolk (Virginia) Rotary International on March 17. The occasion was Rotary's dedication to "World Understanding Week." Dr. Dawson's topic was "World Food Problems and Technical Assistance Programs."

Elvin C. Stakman has been selected to receive the first Cosmos Club Award for his distinguished contributions to the field of plant pathology. The presentation ceremonies are scheduled for May 13.

DEATHS

Lynn H. Rumbaugh, a physicist and expert in tactical nuclear weaponry, died recently of a heart attack at his Bethesda home. He was a senior staff member and research director at the Research Analysis Corporation. Dr. Rumbaugh was a native of Ira, Iowa. He was a graduate of Miami University of Oxford, Ohio, and received the Ph.D degree from California Institute of Technology in 1932. Miami University conferred an honorary doctorate on him in 1953. Dr. Rumbaugh was formerly a physicist with the Department of the Navy.

SCIENCE AND DEVELOPMENT

Despite overwhelming popular interest in nuclear warfare, the Army continues its efforts to improve the conventional weapons and their use. Fort Belvoir laboratory scientists, for example, are continuing their search for better "old-fashioned" explosives through an approach originated by Fritz Zwicky of Cal Tech. Dr. Zwicky has suggested that certain chemical reactions such as combinations of carbon and titanium to form titanium-carbide have potential for producing up to six times the energy of an equivalent of TNT. If successfully modified for demolition use, these high energy chemical reactions would yield significant improvements on present methods. The Army is also trying out, by comparative tests, various techniques of such apparently routine things as blasting craters in roads as antitank defense. By this means they have found appreciable advantages in particular spacings and depths of boreholes for explosive charges, and that craters angled at 45 degrees to the roadway are more effective than those perpendicular.

Even the table lamp built from a discarded artillery shell may be soon a thing of the past. Atlantic Research Corporation, at its Pine Ridge Plant near Gainsville, Va., has started pilot production of semi-combustible cartridge cases, aimed at reducing cost, weight, metal use in wartime, and disposal in combat. Fabricated of fibers processed in slurry form, suggestive of today's grocery store egg cartons, they are already available in experimental quantities.

Georgetown University's Biology Department has received grant awards from NIH and NSF in support of two research programs in microbial genetics; Otto E. Landman, associate professor of biology, is in charge of both programs. The NIH-supported program, "Mode of Entry of DNA into Bacteria," has as its aim exploration of the characteristics of a newly-discovered step in bacterial transformation. The NSF-supported program is entitled, "Membrane-associated Inheritance in Bacteria."

By virtue of very-short-wavelength ultraviolet light, extracted from the National Bureau of Standards' synchrotron, and by so accelerating and controlling electrons in a new spectrometer that they travel at nearly identical speeds, two new tools are available for studying excitation of atoms and molecules in the intermediate energy range. This lies between the lower range involved in common chemical reactions and the higher ones involved in nuclear and X-ray phenomena. Lack of well-defined, controllable energies in this middle range has hampered past research on the properties of atoms and molecules in this context. Twelve substances, including all the rare gases, already have been examined by these tools.

One more step, presumably forward, in the gigantic task of putting the scientific worker in touch with published information, has been taken by the space scientists. In this instance, some 500 volunteer scientists have permitted their "interest profile" to be coded into a computer program, which can then be matched with the subject matter codes of the NASA abstract journal. When there is a sufficiently high correlation between pattern of investigator interest and abstracted item, the latter is automatically noted and mailed directly to the individual concerned. Provision is made for prompt receipt, where needed, of the full report in addition to the abstract.

Continuing and expanding interest in oceanography was marked recently by the completion of the newest vessel to bear the name "Oceanographer," a 3800 ton craft built for the Coast and Geodetic Survey at a cost in the neighborhood of $7,000,000. It, and a twin ship to be called the "Discoverer," will be highly automated in the sense that a control system permits remote starting and stopping of machinery, programming of fuel and ballast, and automatic recording of operating data. Closed circuit television will be provided throughout the engine room, and there will be a central well in the ship which permits equipment, divers, and so on to be lowered into the water. Bow viewing ports below the water line and some 4100 feet of laboratory space are added features.

Delegates to the Washington Academy of Sciences, Representing the Local Affiliated Societies*

Philosophical Society of Washington	Urner Liddel
Anthropological Society of Washington	Regina Flannery Herzfeld
Biological Society of Washington	John L. Paradiso
Chemical Society of Washington	William A. Zisman
Entomological Society of Washington	Harold H. Shepard
National Geographic Society	Alexander Wetmore
Geological Society of Washington	Luna Leopold
Medical Society of the District of Columbia	Frederick O. Coe
Columbia Historical Society	U. S. Grant, III
Botanical Society of Washington	Wilbur D. McClellan
Society of American Foresters	Harry A. Fowells
Washington Society of Engineers	Martin A. Mason
Institute of Electrical and Electronics Engineers	Delegate not appointed
American Society of Mechanical Engineers	William G. Allen
Helminthological Society of Washington	Marion M. Farr
American Society for Microbiology	Frank Hettrick
Society of American Military Engineers	Delegate not appointed
American Society of Civil Engineers	Thorndike Saville, Jr.
Society for Experimental Biology and Medicine	Falconer Smith
American Society for Metals	Hugh L. Logan
International Association for Dental Research	George Dickson
American Institute of Aeronautics and Astronautics	Eugene Ehrlich
American Meteorological Society	J. Murray Mitchell, Jr.
Insecticide Society of Washington	Robert A. Fulton
Acoustical Society of America	Malcolm C. Henderson
American Nuclear Society	George L. Weil
Institute of Food Technologists	Richard P. Farrow
American Ceramic Society	J. J. Diamond
Electrochemical Society	Kurt H. Stern

* Delegates continue in office until new selections are made by the respective affiliated societies.

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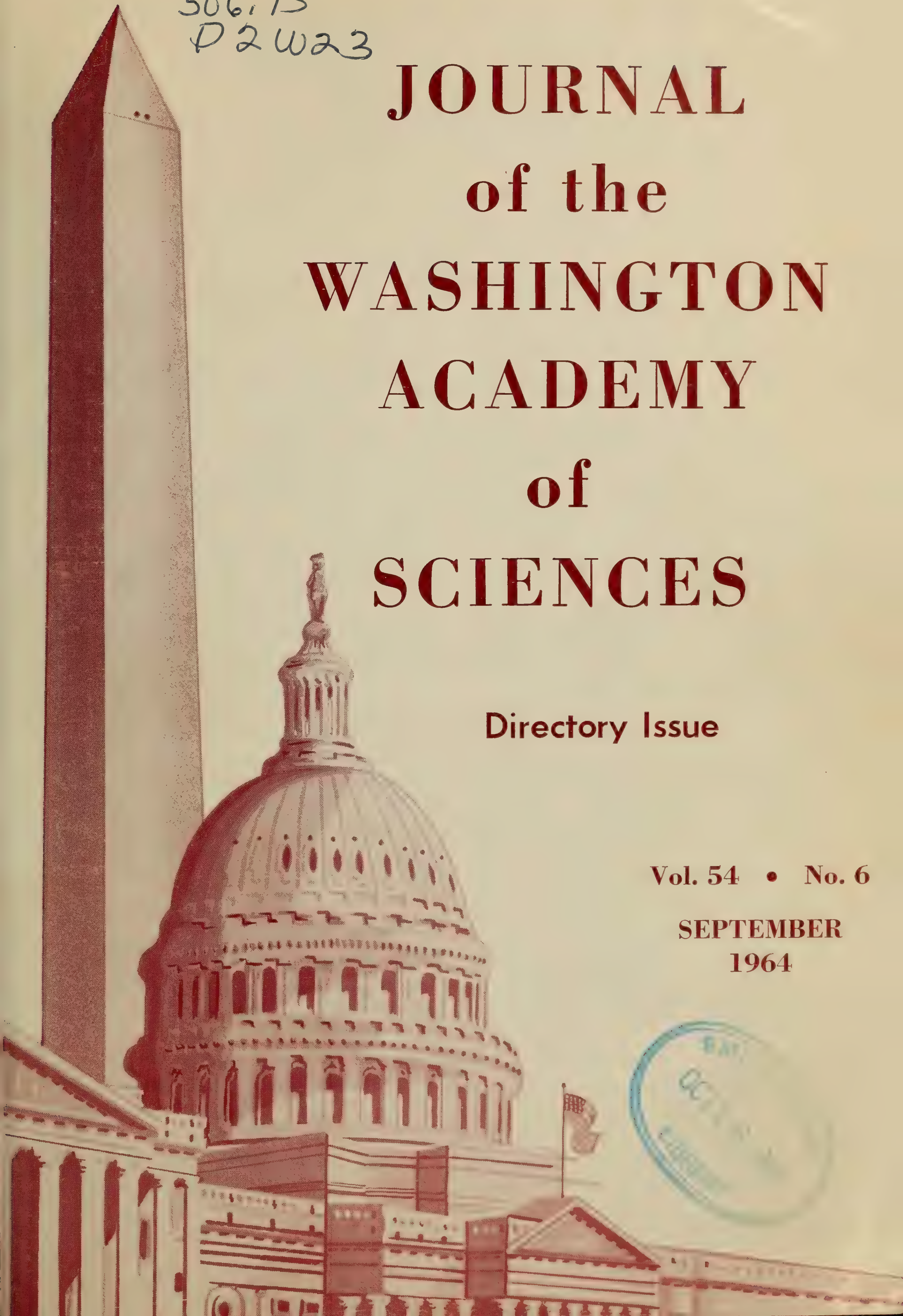

Directory Issue

Vol. 54 • No. 6

SEPTEMBER
1964

JOURNAL OF THE WASHINGTON ACADEMY OF SCIENCES

This Journal, the official organ of the Washington Academy of Sciences, publishes historical articles, critical reviews, and scholarly scientific articles; notices of meetings and abstract proceedings of meetings of the Academy and its affiliated societies; and regional news items, including personal news, of interest to the entire membership. The Journal appears nine times a year, in January to May and September to December. It is included in the dues of all active members and fellows.

Subscription rate to non-members: $7.50 per year (U.S.) or $1.00 per copy; foreign postage extra. Subscription orders should be sent to the Washington Academy of Sciences, 1530 P St., N.W., Washington, D.C. Remittances should be made payable to "Washington Academy of Sciences."

Back issues, volumes, and sets of the Journal (Volumes 1-52, 1911-1962) can be purchased direct from Walter J. Johnson, Inc., 111 Fifth Avenue, New York 3, N. Y. This firm also handles the sale of the Proceedings of the Academy (Volumes 1-13, 1898-1910), the Index (to Volumes 1-13 of the Proceedings and Volumes 1-40 of the Journal), and the Academy's monograph, "The Parasitic Cuckoos of Africa."

Current issues of the Journal (past two calendar years) may still be obtained directly from the Academy office at 1530 P Street, N.W., Washington 5, D.C.

Claims for missing numbers will not be allowed if received more than 60 days after date of mailing plus time normally required for postal delivery and claim. No claims will be allowed because of failure to notify the Academy of a change of address.

Changes of address should be sent promptly to the Academy Office, 1530 P St., N.W., Washington, D.C. Such notification should include both old and new addresses and postal zone number, if any.

Second class postage paid at Washington, D.C.

ACADEMY OFFICERS FOR 1964

Washington Academy of Sciences

1964 Directory

of

The Academy and Nine of Its Affiliated Societies

Foreword

The present, 39th issue of the Academy's directory is again this year issued as the September issue of the Journal.

As was the case last year, we have attempted to produce an up-to-date listing of the membership at minimum cost to the Academy. Between the classified listing and the Washington area telephone books, there should be little difficulty in getting in touch with local members; hence we have not given the addresses of members. Also, the Academy office at 1530 P Street N.W. (AD 4-5323) is in a position to supply addresses for all members, whether local or nonresident, upon request.

Again this year, members are classified by three listings—alphabetically, by place of employment, and by membership in local societies affiliated with the Academy. Thus, the directory attempts to answer the basic questions that arise when the name of a scientist is mentioned: Where does he work? and What does he do? The knowledge that John Jones works in the Agricultural Research Service and that he belongs to the Entomological Society is the key to whether we have anything in common with him, and if so, how to seek him out.

With a few exceptions, we have not indicated places of employment for nonresident members, since this would lead to a very complex coding system; and such codes would scarcely be a reliable guide for written contacts. Nor, generally, have we classified emeritus members by place of employment, since most of them, presumably, have retired from gainful employment.

Assignment of codes for place of employment and membership in affiliated societies is based upon results of a postcard questionnaire sent to the Academy membership. Where the questionnaire was not answered, the coding was made on the basis of other available information. Corrections should be called to the attention of the Academy office.

Last year, as an innovation, we included complete membership rosters for four of the Academy's 29 affiliated societies, whether or not the persons were members of the Academy. In return for their cooperation, the four affiliates were provided with a supply of copies of the directory at a very nominal cost.

This year, the practice has been extended to nine of the Academy's affiliates, namely, the Philosophical Society of Washington, the Entomological Society of Washington, the Botanical Society of Washington, the Society of American Foresters, the American Society for Microbiology, the International Association for Dental Research, the American Meteorological Society, the Institute of Food Technologists, and the Electrochemical Society. It remains to be determined whether cost considerations will permit further expansion of this practice in future years.

Explanation of Listings

Academy Fellows and Members

The alphabetical listing purports to include all fellows and members on the Academy rolls as of July 1, 1964, whether resident or nonresident (i.e., living more than 50 miles from the White House), and whether active (dues-paying) or emeritus (retired).

Employment.—The first column of code symbols after the name is a semi-mnemonic cross-reference to place of employment, as shown in the first classified listing. In the employment code, 1 refers to Government agencies (and 1A to Agriculture, 1C to Commerce, etc.; and 1CNBS refers to the National Bureau of Standards in the Department of Commerce); 2 refers to educational institutions, both higher (2H) and secondary (2S) (2HUMD is the University of Maryland); 3A refers to associations and 3I to private institutions; 4 refers to consultants, physicians, and other self-employed persons; 5 refers to business concerns (5HARE is the Harris Research Laboratories, for example); 6 refers to foreign and international groups (embassies, UN organizations, etc.); 7 refers to retired persons; and 8 and 9 refer to persons whose places of employment, if any, are not known or not coded.

Places of employment are given primarily for resident active fellows and members, with few exceptions.

Affiliation.—The second column of code symbols refers to the person's membership in one or more of the societies affiliated with the academy, as given in the following list, which includes also the year of the societies' affiliation with the Academy:

Code	
2B	Philosophical Society of Washington (1898)
2C	Anthropological Society of Washington (1898)
2D	Biological Society of Washington (1898)
2E	Chemical Society of Washington (1898)
2F	Entomological Society of Washington (1898)
2G	National Geographic Society (1898)
2H	Geological Society of Washington (1898)
2I	Medical Society of the District of Columbia (1898)
2J	Columbia Historical Society (1899)
2K	Botanical Society of Washington (1902)
2L	Society of American Foresters, Washington Section (1904)
2M	Washington Society of Engineers (1907)
2N	Institute of Electrical and Electronics Engineers, Washington Section (1912)[1]
2O	American Society of Mechanical Engineers, Washington Section (1923)
2P	Helminthological Society of Washington (1923)
2Q	American Society for Microbiology, Washington Branch (1923)
2R	Society of American Military Engineers, Washington Post (1927)
2S	American Society of Civil Engineers, National Capital Section (1942)
2T	Society for Experimental Biology and Medicine, D. C. Section (1952)
2U	American Society for Metals, Washington Chapter (1953)
2V	International Association for Dental Research, Washington Section (1953)
2W	American Institute of Aeronautics and Astronautics, Washington Section (1953)[2]
2X	American Meteorological Society, D. C. Branch (1954)
2Y	Insecticide Society of Washington (1959)
2Z	Acoustical Society of America, Washington Chapter (1959)
3B	American Nuclear Society, Washington Section (1960)
3C	Institute of Food Technologists, Washington Section (1961)
3D	American Ceramic Society, Baltimore-Washington Section (1962)
3E	Electrochemical Society, Washington-Baltimore Section (1963)

Academy Status.—The third column of symbols refers to membership status in the Academy. AF refers to a *fellow* of the

[1] In 1963 the American Institute of Electrical Engineers (affiliated 1912) was merged with the Institute of Radio Engineers (affiliated 1933) to become the Institute of Electrical and Electronics Engineers. IEEE has been assigned the same seniority as the elder of the two merged societies.

[2] In 1963 the Institute of the Aerospace Sciences (affiliated 1953) absorbed the American Rocket Society and assumed the new name, American Institute of Aeronautics and Astronautics.

Academy, and AM to an Academy *member.* RA refers to a resident active fellow or member; NA refers to a nonresident active fellow or member (living more than 50 miles from the White House); and RE and NE refer respectively to resident and nonresident emeritus fellows.

Nonmembers of the Academy

In the case of nine Academy affiliates (Codes 2B, 2F, 2K, 2L, 2Q, 2V, 2X, 3C, and 3E), all members of the affiliates are listed in the directory, whether or not they belong to the Academy. Such persons are coded in the first code column by place of employment, where known. They are of course coded by affiliation, in the second code column. Non-Academy members are not coded, in the third code column, by membership status, since practices vary in the different affiliates. However, generally speaking, affiliate listings are restricted to persons in the Washington area; and persons known to be retired are designated as "7RETD".

Number of Listings

The directory lists the names of about 3,820 individuals. Of these, about 1,200 are members or fellows of the Academy. The remainder are members of one or more of the nine affiliates mentioned above but not members of the Academy.

Organization, Objectives, and Activities

The Washington Academy of Sciences had its origin in the Philosophical Society of Washington. The latter, organized in 1871, was for a few years the only scientific society of Washington. As other more specialized local scientific societies were formed, need was felt for federation of all such societies under an academy of sciences. Therefore 14 local scientific leaders moved to establish the Washington Academy of Sciences, which was incorporated on February 18, 1898. In that year the first eight societies listed above became affiliated with the Academy. The Philosophical Society heads the list because of its key position in the establishment of the Academy; the other seven are listed in alphabetical order, and the remaining 21 in chronological order of affiliation. Some of these 29 societies are local, without other affiliation; most are local sections or branches of national societies; one, the National Geographic Society, became a popular national society, whose present affiliation with the Academy is only of historical significance.

It should be noted that the Academy has had a total of 30 affiliations, but that two societies—the electrical engineers and the radio engineers—were recently merged as mentioned above.

The primary purpose of the Academy is the promotion of science in various ways through cooperation among natural scientists and engineers of the Washington metropolitan area. Except during the summer, the Academy holds monthly meetings, stressing subjects of general scientific interest. It publishes a monthly journal, which is intended to facilitate and report the organized scientific activity of the Washington area. It may sponsor conferences or symposia and publish their proceedings, or it may publish suitable scientific monographs. In many ways, the Academy encourages excellence in scientific research and education, e.g., by sponsoring the Washington Junior Academy of Sciences; by sponsoring through the Joint Board on Science Education, experiments in and services to secondary scientific education in the public and private schools of the area; by making annual awards to promising high school students and to a few outstanding young professional scientists for their achievements in research or teaching; and by making small grants-in-aid for support of research. The Academy also may aid public understanding of important scientific developments through sponsored conferences and teacher training. It may make recommendations on public policy involving scientific matters.

The Academy acts as the federal head of its affiliated societies, each of which is represented on the Board of Managers by a delegate appointed by his society. Annual elections are by mail ballot.

The membership consists of three general classes: members, fellows, and patrons. At present the membership is composed principally of resident active fellows who by reason of scientific attainment are deemed eligible. Nominations for fellowship, endorsed by at least two fellows of the Academy, and changes in the status of members, are acted upon by the Board of Managers upon recommendation of the Committee on Membership. The new category, "member," is open, upon application, to any interested person who is approved by the Committee on Membership.

Further information on membership in the Academy is given in a statement elsewhere in this issue.

As of July 1, 1964, the total membership of the Academy was approximately 1200.

Organization for 1964

Officers

President	Francois N. Frenkiel	David Taylor Model Basin
President-Elect	Leo Schubert	American University
Secretary	George W. Irving, Jr.	Department of Agriculture
Treasurer	Malcolm C. Henderson	Catholic University of America

Managers-at-Large

1962-64	Harold H. Shepard	Department of Agriculture
1962-64	Russell B. Stevens	George Washington University
1963-65	Mary Louise Robbins	George Washington University
1963-65	John K. Taylor	National Bureau of Standards
1964-66	Allen L. Alexander	Naval Research Laboratory
1964-66	Francis W. Reichelderfer	Weather Bureau (retired)

Standing Committees

Executive Committee	Francois N. Frenkiel, *Chairman*	David Taylor Model Basin
	Leo Schubert	American University
	George W. Irving, Jr.	Department of Agriculture
	Malcolm C. Henderson	Catholic University of America
	Allen L. Alexander	Naval Research Laboratory
	Francis W. Reichelderfer	Weather Bureau (retired)
Committee on Membership	Richard K. Cook, *Chairman*	National Bureau of Standards
	William G. Allen	Maritime Administration
	Bernice E. Eddy	National Institutes of Health
	Harold E. Finley	Howard University
	Robert B. Hobbs	National Bureau of Standards
	Solomon Kullback	George Washington University
	Raymond L. Nace	Geological Survey

Chairmen of Membership Committee Panels

(1) Agricultural Sciences	William E. Bickley (acting)	University of Maryland
(2) Chemistry	Robert B. Hobbs	National Bureau of Standards
(3) Earth Sciences	Raymond L. Nace	Geological Survey
(4) General Biology	Harold E. Finley	Howard University
(5) Mathematical Sciences	Solomon Kullback	George Washington University
(6) Medical Sciences	Bernice E. Eddy	National Institutes of Health
(7) Physics and Astronomy	Richard K. Cook (acting)	National Bureau of Standards
(8) Engineering	William G. Allen	Maritime Administration
Committee on Policy Planning	B. D. Van Evera, *Chairman*	George Washington University
	Maurice Apstein	Harry Diamond Laboratory
	Dean Cowie	Dept. of Terrestrial Magnetism
	Raymond J. Seeger	National Science Foundation
	Mary Warga	Optical Society of America
Committee on Ways and Means	Bourdon F. Scribner, *Chairman*	National Bureau of Standards
	Alfred E. Brown	Harris Research Laboratories
	Paul D. Foote	NAS-NRC
	Martin A. Mason	George Washington University
	Paul H. Oehser	Smithsonian Institution
Committee on Meetings	Jacinto Steinhardt, *Chairman*	Georgetown University
	John S. Coleman	NAS-NRC
	Ernest P. Gray	Applied Physics Laboratory
	Paul H. Oehser	Smithsonian Institution
	Mary L. Robbins	George Washington University
	Edwin Roedder	Geological Survey
	David Rosenblatt	National Bureau of Standards
	Shirleigh Silverman	National Bureau of Standards
	Arnold M. Sookne	Harris Research Laboratories
Committee on Awards for Scientific Achievement	Edward A. Mason, *Chairman*	University of Maryland

Subcommittees of Awards Committee

Biological Sciences	E. T. Bolton, *Chairman*	Dept. of Terrestrial Magnetism
	Louis S. Baron	Walter Reed Medical Center
	Ira B. Hansen	George Washington University
	Edward F. Knipling	Department of Agriculture
	Marshall W. Nirenberg	National Institutes of Health
	Marion W. Parker	Department of Agriculture
Engineering Sciences	Martin A. Mason, *Chairman*	George Washington University
	Frank A. Biberstein	Catholic University
	Joseph L. Gillman, Jr.	Consultant
	Jacob Rabinow	Rabinow Engineering
	James B. Small	Coast & Geodetic Survey
	Eugene W. Weber	Army Corps of Engineers
Physical Sciences	Samuel N. Foner, *Chairman*	Applied Physics Laboratory
	Harry C. Allen, Jr.	National Bureau of Standards
	Louis R. Maxwell	Naval Ordnance Laboratory
	John McElhiney	Naval Research Laboratory
	Jerome Namias	Weather Bureau
	Meyer Rubin	Geological Survey

Mathematical Sciences	HARRY POLACHEK, *Chairman*	David Taylor Model Basin
	FRANZ L. ALT	National Bureau of Standards
	ABOLGHASSEN GHAFFARI	Goddard Space Research Center
	MONROE H. MARTIN	University of Maryland
	MALCOLM W. OLIPHANT	Georgetown University
	HORACE M. TRENT	Naval Research Laboratory
Teaching of Science	LEO SCHUBERT, *Chairman*	American University
	KEITH C. JOHNSON	D. C. Public Schools
	PHOEBE H. KNIPLING	Arlington County Schools
	GEORGE M. KOEHL	George Washington University
	DAVID LOCKARD	University of Maryland
	MARIE C. TAYLOR	Howard University

Committee on Grants-in-Aid For Research	ARCHIBALD T. MCPHERSON, *Chairman*	National Bureau of Standards
	DON R. BOYLE	National Bureau of Standards
	RALPH I. COLE	Melpar
	ASHLEY B. GURNEY	Department of Agriculture
	CLIFFORD HEWITT	National Institutes of Health
	ELIZABETH D. PEACOCK	
Committee on Encouragement of Science Talent	REV. FRANCIS J. HEYDEN, S.J., *Chairman*	Georgetown University
	LLOYD N. FERGUSON	Howard University
	NATE HASELTINE	Washington Post
	HOWARD B. OWENS	Prince Georges County Schools
	JOHN K. TAYLOR	National Bureau of Standards
	ALFRED WEISSLER	Air Force
Committee on Public Information	WATSON DAVIS, *Chairman*	Science Service
	FRANCIS E. CAREY	Associated Press
	THOMAS R. HENRY	
Committee on Science Education*	JOHN K. TAYLOR, *Chairman*	National Bureau of Standards
	HAROLD E. FINLEY	Howard University
	EDWARD HACSKAYLO	Department of Agriculture
	KEITH C. JOHNSON	D. C. Public Schools
	DAVID LOCKARD	University of Maryland
	MALCOLM W. OLIPHANT	Georgetown University
	WILLIAM F. SAGER	George Washington University
	LEO SCHUBERT	American University
	ZAKA I. SLAWSKY	Naval Ordance Laboratory

Special Committees

Committee on Bylaws and Standing Rules	LAWRENCE A. WOOD, *Chairman*	National Bureau of Standards
Committee on Special Events	ALPHONSE F. FORZIATI, *Chairman*	Department of Defense
Committee on Membership Promotion	J. MURRAY MITCHELL, JR., *Chairman*	Weather Bureau

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* The Academy contingent of the Joint Board on Science Education, which is sponsored by the Academy and the D. C. Council of Engineering and Architectural Societies. Messrs. Sager and Hacskaylo are the vice-chairman and secretary, respectively, of the Joint Board.

The Journal

Delegates of Affiliated Societies

See inside rear cover.

Past Presidents

1898	John R. Eastman	1927	Alexander Wetmore	1946	Hugh L. Dryden
1899-1910	Charles D. Walcott	1928	Robert B. Sosman	1947	Waldo L. Schmitt
1911	Frank W. Clarke	1929	Ales Hrdlicka	1948	Frederick D. Rossini
1912	Frederick V. Coville	1930	William Bowie	1949	F. H. H. Roberts, Jr.
1913	Otto H. Tittmann	1931	Nathan Cobb	1950	Francis B. Silsbee
1914	David White	1932	Leason H. Adams	1951	Nathan R. Smith
1915	Robert S. Woodward	1933	Robert F. Griggs	1952	Walter Ramberg
1916	Leland O. Howard	1934	Louis B. Tuckerman	1953	Frank M. Setzler
1917	William H. Holmes	1935	George W. McCoy	1954	Francis M. Defandorf
1918	Lyman J. Briggs	1936	Oscar E. Meinzer	1955	Margaret Pittman
1919	Frederick L. Ransome	1937	Charles Thom	1956	Ralph E. Gibson
1920	Carl L. Alsberg	1938	Paul E. Howe	1957	William M. Rubey
1921	Alfred H. Brooks	1939	Charles E. Chambliss	1958	Archibald T. McPherson
1922	William J. Humphreys	1940	Eugene C. Crittenden	1959	Frank L. Campbell
1923	Thomas W. Vaughan	1941	Austin H. Clark	1960	Lawrence A. Wood
1924	Arthur L. Day	1942	Harvey L. Curtis	1961	Philip H. Abelson
1925	Vernon Kellogg	1943	Leland W. Parr	1962	Benjamin D. Van Evera
1926	George K. Burgess	1944	Clement L. Garner	1963	Benjamin D. Van Evera
		1945	John E. Graf		

Bylaws

The Bylaws of the Academy, as last amended in September 1963, appear in the November 1963 issue of the Journal, pages 208-212. They will be reprinted in the near future.

THE WASHINGTON ACADEMY OF SCIENCES

Objectives

The objectives of the Washington Academy of Sciences are (a) to stimulate interest in the sciences, both pure and applied, and (b) to promote their advancement and the development of their philosophical aspects by the Academy membership and through cooperative action by the affiliated societies.

Activities

The Academy pursues its objectives through such activities as (a) publication of a periodical and of occasional scientific monographs; (b) holding of public lectures on scientific subjects; (c) sponsorship of a Washington Junior Academy of Sciences; (d) promotion of science education and a professional interest in science among people of high school and college age; (e) accepting or making grants of funds to aid special research projects; (f) sponsorship of scientific symposia and conferences; (g) assistance in scientific expeditions; (h) cooperation with other academies and scientific organizations; and (i) award of prizes and citations for special merit in science.

Membership

The membership consists of two major classes—**members** and **fellows.**

Members are persons who are interested in science and are willing to support the Academy's objectives as described above. A letter or form initiated by the applicant and requesting membership may suffice for action by the Academy's Committee on Membership; approval by the Committee constitutes election to membership.

Dues for members are $7.50 a year.

Fellows are persons who have performed original research or have made other outstanding contributions to the sciences, mathematics, or engineering. Candidates for fellowship must be nominated by at least two fellows, recommended by the Committee on Membership, and elected by the Board of Managers.

Dues are $10.00 a year for resident fellows (living within 50 miles of the White House) and $7.50 a year for nonresident fellows.

Persons who join the Academy as members may later be considered for fellowship.

Application forms for membership may be obtained from the office of the Washington Academy of Sciences, 1530 P St., N.W., Washington, D. C.

Alphabetical List of Members

ABBOT, CHARLES G	7RETD	2B2X	AFRE
ABELSON, PHILIP H	3IGEL	2B2E2H2Q3B	AFRA
ABLARD, JAMES E	9CLUN	2B	
ABRAHAM, GEORGE	1DNRL	2B2G2N	AFRA
ABRAMS, ALBERT M	1D-IP	2V	
ABRAMS, ARTHUR	1DAWR	2Q	
ABRAMS, ESTELLE	2HHOU	2V	
ACHTER, MEYER R	1DNRL	2U	AFRA
ACKER, ROBERT S	1DNOR	2Q	
ACKERMAN, WILLIAM L	1ARFR	2K	
ADAIR, CHARLES R	1ARFR	2K	
ADAMS, A NORWOOD	1DNOB	2B	
ADAMS, CAROLINE	2HGWU	2K	AMRA
ADAMS, ELLIOT Q	8NRNC		AFNE
ADAMS, GRAYSON	9CLUN	2Q	
ADAMS, JEAN R	1ARFR	2F	
ADAMS, LEASON H	8NRNC	2B2E2G2H	AFNE
ADELMAN, DAVID M	2SMOC		AMRA
ADEM, JULIAN	1CWEB	2X	
ADLER, GERHARD A	1CWEB	2X	
ADLER, VICTOR E	1ARFR	2F	
AFFRONTI, LEWIS F	2HGWU	2Q	
AGUILU, LUIS A	1DAWR	2Q	
AITCHISON, CLYDE S	8NRNC	2B	
AKERS, ROBERT P	1HNIH	2G	AFRA
ALBERTS, HUGO	9CLUN	2K	
ALDRICH, JOHN W	1IFWS	2D	AFRA
ALDRICH, LOYAL B	7RETD	2B	
ALDRICH, ROBERT C	1AFOR	2L	
ALDRIDGE, MARY H	2HAMU	2B	
ALEXANDER, AARON D	1DAWR	2Q2T	AFRA
ALEXANDER, ALLEN L	1DNRL	2E	AFRA
ALEXANDER, BENJAMIN H	1DAWR	2E	AFRA
ALEXANDER, LYLE T	1ASCS	2E	AFRA
ALEXANDER, SAMUEL N	1CNBS	2B2N	AFRA
ALFORD, HAROLD G	1ARRP	2F	
ALFORD, JOHN A	1ARNI	2Q3C	
ALKIRE, H L	1CWEB	2X	
ALLAN, FRANK D	2HGWU		AMRA
ALLARD, ROBERT L	1CWEB	2X	
ALLEE, PAUL A	1CWEB	2X	
ALLEN, GEORGE C	1CWEB	2X	
ALLEN, HAROLD B	1IFWS	2Q3C	
ALLEN, HARRY C JR	1CNBS	2B2E2G	AFRA
ALLEN, ROGER A	1CWEB	2X	
ALLEN, WILLIAM G	1CMAA	2O	AFRA
ALLENDER, CLARK	1DNOC	2X	
ALLGAIER, ROBERT S	1DNOL	2B	
ALLISON, FRANKLIN E	7RETD	2E2G2Q	AFRA
ALLISON, LEWIS J	1XNAS	2X	
ALT, FRANZ L	1CNBS	2B	AFRA
ALTER, HARVEY	5HARE	2E	AFRA
ALTIMUS, ROBERT R	3ADIS	3C	
ALTMAN, HARRY E	1CWEB	2X	
ALTMAN, R M	1DASG	2F	
AMANTE, WILMA	1CWEB	2X	
AMBLER, ERNEST	1CNBS	2B	
AMBS, WILLIAM J	8NRNC		AFNA
AMES, LAWRENCE M	7RETD	2G2K	AFRA
AMIRIKIAN, ARSHAM	1DNBY	2R2S	AFRA
AMOROSE, CARL A	1CWEB	2X	
AMRINE, MICHAEL	9NCOC		AMRA
ANDERSEN, ALICE M	1AMRP	2K	
ANDERSON, BRUCE E	7RETD	2B	
ANDERSON, CALVIN E	1CWEB	2X	
ANDERSON, CHARLES C JR	1CWEB	2X	
ANDERSON, DONALD M	1ARFR	2F	
ANDERSON, ELMER E	1DNOL	2B	
ANDERSON, MYRON S	7RETD	2E	AFRA
ANDERSON, RALPH K	1CWEB	2X	

ANDERSON, ROBERT W	1DNOC	2X	
ANDERSON, WENDELL L	1DNRL	2E	AFRA
ANDERSON, WILLIAM E	1DFWS	2X	
ANDERSON, WILLIAM H	1ARFR	2F	
ANDRE, MILO J	1DFWS	2X	
ANDREWS, HOWARD L	1HPHS		AFRA
ANDREWS, JAMES F	1CWEB	2X	
ANDREWS, JOHN S	1ARFR	2P	AFRA
ANDREWS, REBECCA E	7RETD	2B	
ANDREWS, T G	2HUMD		AFRA
ANGELO, ALDO T	1CWEB	2X	
ANGERS, WILLIAM P	8NRNC	2B	
ANGLERO, JESUS M	1DNOD	2X	
ANNIS, WILBERT	1D-X	2B	
APEL, JOHN	3IAPL	2B	
APELT, ARMIN O	1XNAS	3E	
APP, BERNARD A	1ARFR	2F	
APPEL, WILLIAM D	3AATC	2E	AFRA
APPLEBAUM, ALBERT	1DNOL	2B	
APPLEBY, J C	1DNBW	2X	
APPLEMAN, CHARLES O	7RETD	2K	
APSTEIN, MAURICE	1DAHD	2B2N	AFRA
ARBUCKLE, W S	2HUMD	3C	
ARCHAMBAULT, CHARLES E	1CWEB	2X	
AREFIAN, DANIEL	2HHOU	2V	
ARISTEI, JEROME	8NRNC	2B	
ARKIN, MORRIS A	1CWEB	2X	
ARKING, ALBERT	8NRNC	2B	
ARM, HERBERT	1DNMR	2Q	
ARMSTRONG, CHARLES	7RETD	2Q	AFRE
ARMSTRONG, GEORGE T	1CNBS	2B2E2G	AFRA
ARMSTRONG, LORENZ C	1CWEB	2X	
ARNETT, ROSS H JR	2HCUA	2F	
ARNOLD, DALE L	1AFOR	2L	
ARNOLD, FRANCIS A JR	1HNIH	2V	
ARNOLD, JOE E	1CWEB	2X	
ARNOLD, R KEITH	1AFOR	2L	
ARNST, ALBERT	1AFOR	2L	
ARON, STEPHEN A	1XVET	2Q	
ARONSON, C J	1DNOL	2B	
ARSEM, COLLINS	1DAHD	2G2N2W	AMRA
ARSEM, WILLIAM C	4CONS	3E	
ARTMAN, JOSEPH O	3IAPL	2B	
ARTZ, LENA	7RETD	2K	
ASHBY, WINIFRED M	7RETD	2Q	
ASHCROFT, JOSEPH M	1DAX	2B	
ASHE, WARREN K	1HNIH	2Q	
ASLAKSON, CARL I	4CONS	2B2M2R2S	AFRA
ASTIN, ALLEN V	1CNBS	2B2N2W	AFRA
ATKINS, ELBERT W	1CWEB	2X	
ATKINSON, GARY D	1DFWS	2X	
ATKINSON, PETER T	1ARFR	2K	
AUSLOOS, PIERRE J	1CNBS	2E	AFRA
AUSTIN, WALTER E	9CLUN	2B	
AUTRY, HOMER V JR	1ARRP	2F	
AVERY, KENNETH R	1DFWS	2X	
AVISE, HERBERT J	1DFX	2X	
AXILROD, BENJAMIN M	1CNBS	2B	AFRA
AYTON, JOHN S	9CLUN	2L	
AZAROWICZ, E N	5BIRE	2Q	
BABCOCK, MARY C	1DNMR	2Q	
BABERS, FRANK H	1DAX	2G	AFNA
BACK, GOLDIE	9CLUN	2B	
BACKUS, ROBERT C	1HNIH	2Q	
BADNER, JULIUS	1CWEB	2X	
BAER, EDWARD	1HFDA	2Q	
BAER, HAROLD	1HNIH	2Q	

BAER, PAUL N	1HNIH	2V	
BAHR, HENRY	9CLUN	2L	
BAILEY, EMMET C	8NRNC	2B	
BAILEY, ROBERT H	8NRNC	3C	
BAILEY, WILLIAM J	2HUMD	2E	AFRA
BAKER, ARTHUR A	1IGES	2H	AFRA
BAKER, DONALD R	1CWEB	2X	
BAKER, EDWARD W	1ARRP	2F	
BAKER, HOWARD	7RETD	2F	
BAKER, LOUIS C W	2HGEU	2E	AFRA
BAKER, ROBERT L	2HUMD	2K	
BAKER, W L	9CLUN	2F	
BAKICH, STANLEY M	1CWEB	2X	
BALDES, EDWARD J	1DARO	2B2G	AFRA
BALDWIN, JOHN L	1CWEB	2X	
BALL, HOWARD E	9CLUN	2L	
BALL, JOSEPH J	1CNBS	2B	
BALLENZWEIG, EMANUEL M	1XFAA	2X	
BAMFORD, RONALD	2HUMD	2K	AFRA
BANDEEN, WILLIAM R	1XNAS	2X	
BANVILLE, ROBERT R	1ARNI	2Q	
BARBEAU, MARIUS	8NRNC		AFNA
BARBROW, LOUIS E	1CNBS	2B2N	AFRA
BARCLAY, ARTHUR S	1ARFR	2K	
BARDROW, JANE	1ARNI	2Q	
BARFIELD, VIVIAN S	1CNBS	2B	
BARGESKI, ALBERT M	1DNOD	2X	
BARILE, MICHAEL F	1HNIH	2Q	
BARKER, HENRY D	7RETD	2K	
BARKER, ROY J	8NRNC	2E2F2G2Y	AFNA
BARNES, R PERCY	2HHOU	2E	AFRA
BARNHART, CLYDE S	1DAX	2F	AFNA
BARON, LOUIS S	1DAWR	2Q	AFRA
BARRE, H W	7RETD	2K	
BARRETT, MARGARET D	1HNIH	2G2T	AFRA
BARRETT, MORRIS K	1HNIH	2T	AFRA
BARROWS, JACK S	1AFOR	2L	
BARRY, CORNELIUS	2HUMD	2F	
BARRY, JOHN P	1DNRL	2B	
BARSS, HOWARD P	7RETD	2D2K	AFNE
BARTELS, WILLIAM C	1XAEC	2B	
BARTLETT, RICHARD P JR	1AMRP	3C	
BARTLETT, WAYNE H	1CWEB	2X	
BARTRAM, M THOMAS	1HFDA	2Q3C	
BASLER, CHARLES W	1DFWS	2X	
BASS, ARNOLD M	1CNBS	2B	AFRA
BASSETT, JAMES V	1CWEB	2X	
BATCHER, OLIVE M	1ARNI	3C	
BATEMAN, ALAN M	4CONS	2H	AFNE
BATES, CHARLES C	3IAPL	2B	
BATES, PHAON H	7RETD		AFNE
BATES, ROGER G	1CNBS	2E	AFRA
BATLIN, ALEXANDER	1DAX	2Q	
BATTISTONE, G C	1DAWR	2V	
BAUER, HUGO	1HNIH	2E	AFRA
BAYNE-JONES, STANHOPE	7RETD	2Q	
BEACH, JAMES E	9CLUN	2L	
BEACH, LOUIS A	1DNRL	2B2G	AFRA
BEACH, PRISCILLA A	4CONS		AMRA
BEACHAM, LOWRIE M	1HFDA	3C	
BEAL, JAMES A	1AFOR	2F2L	
BEALL, JAMES M	1CWEB	2X	
BEAMAN, H CLAYTON	3IAPL	2B	
BEAN, GEORGE A	1INPS	2K	
BEAN, HOWARD S	4CONS	2D	AFRA
BEAR, DANIEL H	1DAX	2L	
BEAR, FRED G JR	1CWEB	2X	
BEARCE, HENRY W	7RETD	2B	AFNE
BEATTIE, BYRON B	1AFOR	2L	
BECK, ROBERT E	1D-X	2X	
BECKER, EDWIN D	1HNIH	2E	AFRA
BECKER, WILLIAM J	1DFX	2X	
BECKETT, CHARLES W	1CNBS	2B2E	AFRA
BEDARD, PAUL W	1SAID	2L	
BEDELL, DONALD A	1DNOC	2X	
BEE, GERALD R	3ANCA	2Q3C	
BEETHAN, CARL V	1DFWS	2X	
BEHRE, C EDWARD	7RETD	2L	

BEIJ, K HILDING	7RETD	2B	AFNA
BEKKEDAHL, NORMAN	1CNBS	2B2E2G	AFRA
BELKIN, MORRIS	1HNIH		AFRA
BELKNAP, RAYMOND L	1CWEB	2X	
BELL, JAMES W	3ANCA	3C	
BELLANTI, JOSEPH A	1DAWR	2Q	
BELOIAN, ARAM	1ARNI	2Q	
BELSHEIM, ROBERT O	1DNRL	2B2G2M2O	AFRA
BELT, GEORGE H SR	1CWEB	2X	
BENDER, ALVA H	9CLUN	2F	
BENDER, EDWARD K	9CLUN	2F	
BENDER, MAURICE	1HPHS	2E3C	AFRA
BENEDICT, WARREN V	1AFOR	2L	
BENEDICT, WILLIAM S	2HJHU		AFRA
BENESCH, WILLIAM	2HUMD	2B	AFRA
BENJAMIN, CHESTER R	1ARFR	2D2G2K	AFRA
BENNETT, BRADLEY F	1DNRL	2B	
BENNETT, CLAUDIUS E	8NRNC	2B	
BENNETT, DELMA L	1DNOD	2X	
BENNETT, JOHN A	1CNBS	2G2U	AFRA
BENNETT, LAWRENCE H	1CNBS	2U	AFRA
BENNETT, MARTIN T	4CONS	2E	AFRA
BENNETT, REGINALD W	1HFDA	2Q	
BENNETT, ROBERT R	1IGES	2H	AFRA
BENNETT, WILLARD H	8NRNC	2B	AFNA
BENSON, LOREN A	1D-X	2B	
BENTON, BRUCE M	1CWEB	2X	
BERAHA, SAMI	2SMAR	2B	
BERCH, JULIAN	5HARE	2E	AMRA
BERGER, ROBERT L	1HNIH	2B	
BERGOFFEN, GENE S	1AFOR	2L	
BERGOFFEN, WILLIAM W	1AFOR	2L	
BERKNER, L V	8NRNC	2B	AFNA
BERKOFSKY, BENJAMIN	1CWEB	2X	
BERL, WALTER G	3IAPL	2B2E2W	AFRA
BERLINER, ROBERT W	1HNIH	2B2T	AFRA
BERMAN, MORRIS D	1ARNI	3C	
BERNDT, HERBERT W	1AFOR	2L	
BERNHEIM, BARBARA C	1HNIH	2Q	
BERNIER, CHARLES L	1D-X	2B	
BERNIER, JOSEPH L	1D-IP	2V	
BERNSTEIN, ABRAM B	1CWEB	2X	
BERNSTEIN, ARTHUR	8NRNC	2B	
BERNTON, HARRY S	4PHYS	2I	AFRA
BERSHADER, DANIEL	8NRNC	2B	
BESTUL, ALDEN B	1CNBS	2B	
BETTS, SHERMAN W	1C-S	2X	
BHASKAR, SURINDAR N	1DAWR	2V	
BHUSSRY, B R	2HGEU	2V	
BIBERSTEIN, FRANK A JR	2HCUA	2B2M2S	AFRA
BICKLEY, WILLIAM E	2HUMD	2F2Y	AFRA
BIEDINGER, RAYMOND E	1CWEB	2X	
BIEN, CORABEL	7RETD	2K	
BIERLEY, EUGENE	1XAEC	2X	
BIGLER, STUART G	1CWEB	2X	
BILL, HARTHON L	1INPS	2L	
BILLINGS, SAMUEL C	1ARRP	2F	
BINN, LEONARD N	1DAWR	2Q	
BIRCKNER, VICTOR	7RETD		AFRE
BIRD, H R	8NRNC		AFNA
BIRD, JOSEPH F	3IAPL	2B	
BIRKS, LAVERNE S	1DNRL		AFRA
BISAGNI, RENATO	1CWEB	2X	
BISHOPP, FRED C	7RETD	2F	AFNE
BISSELL, T L	2HUMD	2F	
BITTINGER, CHARLES	9CLUN	2B	
BITTNER, FRED E	1CWEB	2X	
BLACK, RICHARD B	1DNOR	2G	AFRA
BLACKBURN, WILLIAM J	1CCGS	2B	
BLADEN, HOWARD A	1HNIH	2Q	
BLAIN, JOHN S JR	1CWEB	2X	
BLAKE, DORIS H	1XSMI	2F	AFRE
BLAKE, LAMONT V	1DNRL	2B	
BLANC, MILTON L	1CWEB	2X	AFNA
BLAU, EDMUND J	3IAPL	2B	
BLEIL, DAVID F	1DNOL	2B	
BLEMENTHAL, RICHARD B	1DNOC	2X	
BLICKENSTAFF, CARL C	1ARFR	2F	

BLIGH, ALAN B	9CLUN	2B	
BLINDER, S M	8NRNC	2B	
BLOMQUIST, VICTOR H	1HFDA	3C	
BLOOM, MORTIMER C	1DNRL	2B2E3E	AFRA
BLUM, WILLIAM	4CONS	2E2G3E	AFRE
BLUMSTEIN, ALFRED	9CLUN	2B	
BLUNDELL, GEORGE P	5HUAS	2Q	
BLUNT, ROBERT F	1CNBS		AFRA
BOCK, GEORGE	1DFWS	2X	
BODENSTEIN, WILLIAM G	1ARFR	2F	
BODLE, RALPH R	8NRNC	2B	
BOETTCHER, RICHARD E	1HNIH	2F	
BOGLE, ROBERT W	5DERE	2B	AFNA
BOHL, VERNON G	1CWEB	2X	
BOHRER, C WALLACE	3ANCA	2Q3C	
BOLTON, ELLIS T	3ICIW	2G	AFRA
BOND, HOWARD W	1HPHS	2E	AFRA
BONDELID, ROLLON O	1DNRL		AFRA
BONGBERG, JACK W	1AFOR	2F2L	
BORDEN, AVIS	1DNDT	2B	
BORTHWICK, HARRY A	1ARFR	2D2G2K	AFRA
BOSEN, JULIUS F	1CWEB	2X	
BOSWELL, VICTOR R	1ARFR		AFRA
BOSWORTH, LESLIE W	1CWEB	2X	
BOULDIN, ISABELLA	3IATC	2Q	
BOUMA, CECELIA	1ARNI	2Q	
BOURGEOIS, LOUIS D	1HNIH	2Q	
BOURKE, ANNE R	7RETD	2Q	
BOURLAND, LANGFORD T	1DNRL	2B	
BOUTWELL, JOHN M	4CONS	2G2H	AFNA
BOWEN, CALVIN M	1IBLM	2L	
BOWEN, RAEFEL L	1CNBS	2V	
BOWER, VINCENT E	1CNBS		AFRA
BOWERS, FREDERIC M	1DNOL	3E	
BOWIE, GLENN L	1CWEB	2X	
BOWLES, ROMALD E	5BOEN	2G2W	AFRA
BOWMAN, DEAN D	1DFWS	2X	
BOWMAN, FRANCES W	1HFDA	2Q	
BOWMAN, PAUL W	1HNIH	2D2K	AFRA
BOWMAN, ROBERT L	1HNIH	2B	
BOWMAN, THOMAS E	1XSMI	2D	AFRA
BOWYER, C STUART	2HCUA	2B	
BOWYER, DONALD W	1CWEB	2X	
BOYD, DONALD M	5REAN	2Q3C	
BOYD, EARL N	1ACSR	3C	
BOYD, HELEN C	1ANAL	2K	
BOYD, MARJORIE E	1CNBS	2B	
BOYLE, DON R	1CNBS	2N	AMRA
BOYLE, GARY L	9CLUN	2L	
BOYLE, IRA D	1CWEB	2X	
BOZEMAN, F MARILYN	1DAWR	2Q2T	AFRA
BRAATEN, NORMAN F	1CCGS	2B2M2R	AFRA
BRACKETT, FREDERICK S	5AMMA	2B	
BRACKMAN, OLIVER W	9CLUN	2L	
BRADFORD, ROBERT E	1CWEB	2X	
BRADLEY, FRANK	7RETD	2Q	
BRADLEY, MARY A	7RETD	2K	
BRADLEY, ROBERT B	1HNIH	2B	
BRADLEY, WILLIAM E	3IIDA	3E	
BRADT, PAUL	8NRNC	2B	
BRAMHALL, ERVIN H	8NRNC	2B	
BRANCATO, E L	1DNRL	3E	
BRANCHE, WILLIAM C JR	1DAWR	2Q	
BRANDIS, PHILIP G	1CWEB	2X	
BRANDLY, PAUL J	1ARRP	3C	
BRANDT, WALTER E	1DAWR	2Q	
BRANSON, HERMAN	2HHOU	2B	AFRA
BRANT, E L	1DFWS	2X	
BRAUER, GERHARD M	1CNBS	2E2V	AFRA
BRECKENRIDGE, F C	7RETD	2B	AFRA
BRECKENRIDGE, ROBERT G	8NRNC		AFNA
BREEDLOVE, C H JR	2SMOC		AMRA
BREIT, GREGORY	8NRNC		AFNA
BREMER, HANS O	9CLUN	2B	
BRENNAN, EDWARD J	1CWEB	2X	
BRENNAN, JAMES G	2HCUA	2B	
BRENNER, ABNER	1CNBS	2E2G3E	AFRA
BREWER, A KEITH	1DNNO	2B2E2G	AFRA
BREWER, CARL R	1HNIH	2Q	AFRA
BRICKWEDDE, F G	8NRNC	2B	AFNE
BRICKWEDDE, LANGHORNE	8NRNC	2B	
BRIERLEY, PHILIP	7RETD	2K	
BRIERLEY, ROBERT P	8NRNC	2L	
BRIGGS, WILLIAM M L	1CWEB	2X	
BRIGHAM, H IRVING	9CLUN	2F	
BRINTZENHOFE, RICHARD	1CWEB	2X	
BRISTOR, CHARLES L	1CWEB	2X	
BROADBENT, SAM R	1XBOB	2L	
BROCK, JOSEPH S	1DNDT	2B	
BROCKS, SAMUEL M	1IBLM	2L	
BRODD, RALPH J	8NRNC	2B	
BRODE, WALLACE R	7RETD	2B2E	
BRODIE, BERNARD B	1HNIH	2E2T	AFRA
BRODIE, WILLIAM P	1CWEB	2X	
BRODRICK, HAROLD J JR	1CWEB	2X	
BRODZINSKY, ALBERT	1DNRL	2B	
BROGDEN, JOHN W	9CLUN	2B	
BROGDON, JENNIE L	1ARNI	3C	
BROMBACHER, W G	7RETD	2B	AFRA
BROMLEY, EDMUND JR	1XFAA	2X	
BROOKMAN, MARJORIE D	1HNIH	2Q	
BROOKS, DONALD B	7RETD		AFRA
BROOKS, MARCUS W	1CWEB	2X	
BROWN, ALFRED E	5HARE	2B2E2G	AFRA
BROWN, ARTHUR A	1AFOR	2L	
BROWN, B F	1DNRL	2U	AFRA
BROWN, C BRADNER	1DNOL	2B	
BROWN, CALVIN F	9CLUN	2B	
BROWN, DONALD N	1DNWS	2X	
BROWN, EDGAR	7RETD	2D2K	AFRE
BROWN, FLOYD	1DNRL	3E	
BROWN, GEORGE E	1DAER	2B	
BROWN, GEORGE H	1CWEB	2X	
BROWN, HARRY E	1CWEB	2X	
BROWN, JOSHUA R C	2HUMD	2G	AFRA
BROWN, PHILIP T	1CWEB	2X	
BROWN, RICHARD W	1DNOL	2B	
BROWN, RUSSELL G	2HUMD	2K	AFRA
BROWN, THOMAS H	1DNX	2X	
BROWN, THOMAS H	2HGWU	2I2Q	AFRA
BROWN, WALTER E	1CNBS	2V	
BROWNE, RICHARD F	1CWEB	2X	
BRUCE, MASON B	1AFOR	2L	
BRUCH, CARL W	1XNAS	2Q	
BRUCK, STEPHEN D	AMRA		
BRUCK, STEPHEN D	9CLUN		AMRA
BRUECKNER, KEITH A	3IIDA	2B	
BRYAN, KIRK	1CWEB	2X	
BRYAN, MILTON M	1AFOR	2L	
BRYANT, MARVIN P	1ARAO	2Q	
BRYANT, ROBERT W	9CLUN	2B	
BUCCI, ANDREW A	1CWEB	2X	
BUCK, CHARLES C	1AFOR	2L	
BUCK, RAYMOND W	1ARFR	2K	
BUCKINGHAM, BURDETTE H	3IAPL	2B	
BUCKINGHAM, STEPHEN A	3IAPL	2B	
BUCKWALTER, GEORGE E	1DNX	2B	
BUEHLER, JOHN H	8NRNC	2B	
BUELL, MABEL R	1HNIH	2Q	
BUGGS, C W	2HHOU	2Q	
BUHRER, EDNA M	7RETD	2P2G	AFRA
BULLARD, WILLIAM E JR	1HX	2L	
BULLOCK, HOWARD R	1ARFR	2F	
BUNN, RALPH W	3AESA	2F2Y	AFRA
BUNTYM, JAMES R	1DAX	2X	
BURAS, EDMUND M JR	5HARE	2E	AFRA
BURBANK, JEANNE B	1DNRL	3E	
BURCHAM, LEVI T	9CLUN	2L	
BURGERS, J M	2HUMD	2B2W	AFRA
BURGESS, EMORY D	1ARFR	2F	
BURGNER, NEWTON M	1DFWS	2X	
BURGTORF, CARL	1AFOR	2L	
BURINGTON, RICHARD S	1DNBW	2B2G	AFRA
BURK, DEAN	1HNIH	2E2T	AFRA
BURKE, BERNARD F	3ICIW		AFRA
BURKE, FREDERIC G	4PHYS	2I	AFRA

BURKEY, LLOYD A	7RETD	2Q	AFRE
BURKHART, MARVIN D	1DNOC	2X	
BURKS, BARNARD D	1ARFR	2F	
BURKS, GEORGE F	1AFOR	2L	
BURNETT, FRANK W	1CWEB	2X	
BURNETT, GEORGE W	1DAWR	2Q2V	
BURNETT, HARRY C	1CNBS	2G2U	AFRA
BURNS, CLAIRE L	1CNBS	2V	
BURNS, ROBERT O	1DNNO	2B	
BURROWS, CHARLES R	5RAEN	2B	
BURSTONE, M S	1HNIH	2V	
BURTON, J H	7RETD	2Q	
BUSBEY, RUTH L	1ARFR	2F	
BUSH, DORIS M	1DNOC	2X	
BUSH, M BRUCE	2HCOU	3C	
BUTLER, CHARLES	1IFWS	3C	
BUTLER, FRANCIS E	1DNOL	2G2O	AMRA
BUTLER, WARREN L	1AX	2B	
BYERLY, PERRY	8NRNC		AFNA
BYERLY, THEODORE C	1ACSR	2T	AFRA
BYLE, WILLIAM K	1CWEB	2X	
BYRNE, JAMES J	1AFOR	2L	
BYRNE, ROBERT J	1HNIH	2Q	AFRA
CADIGAN, FRANCIS C	1DAWR	2Q	
CAHILL, WILLIAM F	1XNAS	2B	
CALABRESE, PHILIP A	1CWEB	2X	
CALDWELL, FRANK R	1CNBS	2B2G	AFRA
CALDWELL, JOSEPH M	1DAEB	2S	AFRA
CALDWELL, PAUL A	1DAHD	2B	
CALHOUN, DONALD C	9CLUN	2L	
CALHOUN, MIRIAM P	1HFDA	2Q	
CALIO, ANTHONY J	5MVRE	2B	
CALISHER, CHARLES H	5MIAS	2Q	
CALLAWAY, MINNIE	1ARRP	2F	
CALLEN, EARL R	1DNOL	2B	AFRA
CALNAN, K DOROTHY	1HNIH	2Q	
CALVERT, CATHERINE R	1HPHS	3C	
CAMALIER, WILLARD C	4DENT	2V	
CAMERON, JOSEPH M	1CNBS	2B	
CAMERON, LOUIS M	1DNRL	2B	
CAMMAROTA, V ANTHONY	9CLUN	3E	
CAMP, ELIZABETH	3HARL	2Q	
CAMP, GLEN D	8NRNC	2B	
CAMPAIGNE, HOWARD H	1D-X		AFRA
CAMPBELL, ALEXANDER	1CWEB	2X	
CAMPBELL, ALFRED D	1HFDA	3C	
CAMPBELL, FRANK L	7RETD	2B2D2E2F2Y	AFNA
CAMPBELL, JANIS	1DAWR	2Q	
CAMPBELL, JOHN H	1DNRL	2B	
CANDELA, GEORGE A	1CNBS		AFRA
CANNON, EDWARD W	1CNBS	2B	AFRA
CANTWELL, GEORGE E	1ARFR	2F	
CARDER, DEAN S	1CCGS	2B2H2R	AFRA
CARDWELL, CARROLL K	1AFCA	2L	
CAREY, FRANCIS E	5ASPR		AFRA
CAREY, RICHARD T	1AMRP	3C	
CARHART, HOMER W	1DNRL	2E2G	AFRA
CARLETON, PHILLIPS G	9CLUN	2B	
CARLIN, ALBERT V	1CWEB	2X	
CARLSON, HARVE J	1XNSF	2Q	
CARLSON, MARGARET J	1HNIH	2Q	
CARLSON, STURE T	1INPS	2L	
CARLTON, A GEORGE	3IAPL	2B	
CARMAN, DAVID R	1DNOC	2X	
CARMICHAEL, LEONARD	3INGS	2B2G2J2T	AFRA
CARNS, HARRY R	1ARFR	2K	
CARRELL, VIRGIL R	1AFOR	2L	
CARRINGTON, TUCKER	1CNBS	2B2E	AFRA
CARROLL, THOMAS J	5BERA	2B	AFRA
CARROLL, WILLIAM R	1HNIH	2E	AFRA
CARROW, MAXWELL K	1IGES	2E2H	AFRA
CARSKI, THEO J	5BABI	2Q	
CARTER, HUGH	1HPHS		AFRA
CARTWRIGHT, GORDON D	1CWEB	2X	
CARTWRIGHT, O L	1XSMI	2F	
CARTWRIGHT, ROBERT C	1DFWS	2X	

CARY, SYLVIA G	1DAWR	2Q	
CASE, ALFRED L	5VERS	2B	
CASH, EDITH K	7RETD	2D2K	AFRE
CASH, LILLIAN	7RETD	2K	
CASKEY, JAMES E JR	1CWEB	2X	
CASMAN, EZRA P	1HFDA	2Q	
CASSEL, JAMES M	1CNBS	2E	AFRA
CASTELLAN, GILBERT W	2HCUA	3E	
CASTELLANO, GABRIEL	5MIAS	2Q	
CASTIGLIOLA, JULIUS	1DNOL	2B	
CATTANEO, LOUIS E	1CNBS	2B	
CAUL, HAROLD J	1CNBS	2E2U2V	AFRA
CENTOLA, DAVID D	4PATA	2B	
CERCEO, J MICHAEL	9CLUN	2B	
CHA, MOON H	1DNOL	2B	
CHAET, ALFRED B	2HAMU	2B	
CHAFFEE, ELMER F	1D-IP	2Q	
CHALKLEY, HAROLD W	7RETD	2T	AFRE
CHAMBERLAYNE, EARL C	6WOHE	3C	
CHANDLER, ROBERT A	1DNWS	2X	
CHANESMAN, STANLEY	1DNOC	2X	
CHANG, SING C	1D-IP	2Q	
CHAPARAS, S D	1HNIH	2Q	
CHAPIN, EDWARD A	7RETD		AFNE
CHAPIN, EDWARD J	1DNRL	2G2U	AFRA
CHAPLIN, HARVEY R JR	1DNDT	2W	AFRA
CHAPLINE, W R	7RETD	2G2K2L	AFRE
CHAPMAN, VELMA J	1ARNI	3C	
CHARTER, W V	9CLUN	2V	
CHASE, FLORENCE M	7RETD	2K	
CHATHAM, THOMAS K	1DNOL	2B	
CHAVASSE, NICHOLAS H	1DAX	2X	
CHEEK, CONRAD H	1DNRL	2E	AFRA
CHERTOCK, GEORGE	1DNDT	2B	
CHERVENAK, JOHN	1DNRL	2B	
CHI, ANDREW R	9CLUN	2B	
CHILDERS, H MALCOLM	5GETE	2B	
CHILTON, CHARLES A	1CWEB	2X	
CHRISTENSEN, FRANK E	1CWEB	2X	
CHRISTENSON, LEROY D	1ARFR	2F2G2Y	AFRA
CHRISTIAN, MADELEINE H	1CWEB	2X	
CHURCH, LLOYD E	1D-IP	2V	
CHURGIN, JAMES	1DNOD	2X	
CLAIRE, CHARLES N	1CCGS	2B2M	AFRA
CLAPP, PHILIP F	1CWEB	2X	
CLARK, FRANCIS E	1AX		AFNA
CLARK, GEORGE E JR	5ARCO		AFRA
CLARK, J ALLEN	7RETD	2K	
CLARK, JOHN F	1XNAS	2B	
CLARK, KENNETH G	7RETD	2E2G	AFRA
CLARK, MARJORIE A	1CWEB	2X	
CLARK, VIOLET	2SFCH	2B	
CLARK, WILLIAM A	3IATC	2Q	AMRA
CLARKE, JAMES W	1CWEB	2X	
CLAUSEN, CURTIS P	7RETD	2F	AFNE
CLEAVER, OSCAR P	1DAER	2N2R	AFRA
CLEMENCE, G M	1DNOB	2B	
CLEMENT, J REID JR	1DNRL		AFRA
CLEVEN, GALE W	1D-S	2B	AFRA
CLINE, CLIFFORD H	1DNOC	2X	
CLINGAN, IRVINE C	5EASS	3E	
COCHRAN, DORIS M	1XSMI		AFRA
COCHRAN, EDWARD L	3IAPL	2B	
COCHRAN, LLOYD C	1ARFR	2K	
COCHRANE, CALVIN W	1CWEB	2X	
COE, MAYNE R	7RETD		AFNE
COFFMAN, FRANKLIN A	1ARFR	2K	
COHEN, LEON W	2HUMD	2B	
COHEN, LESLIE	1DNRL	2B	
COHEN, SAMUEL L	1DNRL	2B	
COHN, ROBERT	1DNHS	2B	AFRA
COLBRY, VERA L	1AMRP	2K	
COLBY, WALTER F	7RETD	2B	
COLE, HAROLD B	1CWEB	2X	
COLE, HOWARD I	7RETD	2G	AFNE
COLE, KENNETH S	1HNIH	2B	AFRA
COLE, PHILIP B	1DNOL	3E	
COLE, ROGER M	1HNIH	2Q	

COLEMAN, FRANK	7RETD	2B	
COLLIER, CHARLES S	9CLUN	2B	
COLLINS, HENRY B	1XSMI	2C	AFRA
COLLINS, JOHN E	1HFDA	2Q	
COLON, ALBA E	1HNIH	2Q	
COLSON, DE VER	1CWEB	2X	
COLWELL, RITA R	2HGEU	2Q	
COMPTON, W DALE	8NRNC		AFNA
CONANT, JAMES S	3HGDH	2B	
CONDAXIS, JAMES P	1CWEB	2X	
CONDELL, WILLIAM J JR	1D-X	2B	
CONGER, PAUL S	1XSMI		AFRA
CONKLE, HERBERT J	1ARRP	2F	
CONLAN, JAMES	1DNOL	2B	
CONNER, RAY M	1ARRP	2Q	
CONRAD, EDWARD E	1DAHD	2B	
CONTEE, CARL T	9CLUN		AMRA
CONWAY, CHARLES L	1CWEB	2X	
COOK, GUY S	7RETD	2B	
COOK, HAROLD T	1ARMR	2B2K3C	AFRA
COOK, J WILLIAM	1HFDA	3C	
COOK, M KATHERINE	1HNIH	2Q	
COOK, RICHARD K	1CNBS	2B2Z	AFRA
COOK, ROBERT C	5PORB	2K	AFRA
COOK, ROBERT P	1CWEB	2X	
COOKE, C WYTHE	1XSMI	2H	AFRE
COOLEY, J S	7RETD	2K	
COOLIDGE, HAROLD J	3INAS	2G	AFRA
COOLIDGE, WILLIAM D	7RETD		AFNA
COON, ROBERT G	1XNSF	2Q	
COONS, GEORGE H	7RETD	2K	AFRE
COOPER, G ARTHUR	1XSMI	2H	AFRA
COOPER, JAMES F	1ARFR	2F	
COOPER, STEWART R	7RETD		AFRE
COOPERMAN, ARTHUR I	1CWEB	2X	
COOTER, IRWIN L	1CNBS	2B2N	AFRA
COPELAND, JOHN A	1DAX	2X	
CORLISS, CHARLES H	1CNBS	2B	
CORNFIELD, JEROME	1HNIH		AFRA
CORNYN, JOHN	1D-IP	2V	
CORSON, EDWARD M	2HGEU	2B	
CORTON, EDWARD L	1DNOC	2X	
CORWIN, E F	1DNBW	2X	
CORY, ERNEST N	7RETD	2F2Y	AFRE
COSTRELL, LOUIS	1CNBS	2B2N	AFRA
COTTAM, CLARENCE	8NRNC	2D	AFNA
COULSON, E JACK	1ARNI	2E2T	AFRA
COULSON, JACK R	1ARFR	2F	
COUNCIL, THOMAS C	1CWEB	2X	
COURT, LOUIS M	2HGWU	2B	
COVILLE, CABOT	9CLUN	2B	
COWAN, CLYDE L JR	2HCUA	2B	
COWAN, LESLIE W	1DFX	2X	
COWAN, RICHARD S	1XSMI	2K	
COWIE, DEAN B	3ICIW		AFRA
COX, CLAIRE B	1HNIH	2Q	
CRAFT, CHARLES C	1AX		AFNA
CRAFTON, PAUL A	2HGWU	2G2N2O2W	AFRA
CRAGOE, CARL S	7RETD	2B2G	AFRE
CRAIG, D NORMAN	1CNBS	3E	
CRAIG, NORMAN C	1DFWS	2X	
CRAIG, O E	1DNBW	2X	
CRAIG, ROBERT W	1CWEB	2X	
CRAM, VICTOR E	1DFWS	2X	
CRAMER, RAYMOND H	3IAPL	2B	
CRANE, LANGDON T JR	1XNSF	2B	AFRA
CRAVEN, JOHN P	1DNSP	2B2Z	AFRA
CRAWFORD, ARTHUR B	7RETD	2Q	
CREITZ, E CARROLL	1CNBS	2E	AFRA
CREITZ, JOSEPH	1DAX	2Q	
CRESSMAN, GEORGE P	1CWEB	2X	AFRA
CRISS, WILLIAM H	3ADIS	3C	
CROCKER, J ALLEN	1XNAS	2B	
CROCKETT, CURTIS W	1CWEB	2X	
CROOKS, DONALD M	1ARFR	2K	
CROTTY, PAUL G	1DFWS	2X	
CROWTHER, HAROLD E	1IFWS	3C	
CRUMP, STUART F	1DNDT	2B	
CRY, GEORGE W	1CWEB	2X	AMRA
CUATRECASAS, JOSE	1XSMI	2K	
CULBERTSON, JOSEPH O	1ARFR	2K	
CULLEN, THOMAS P	1CWEB	2X	
CULLINAN, FRANK P	1ARFR	2K	AFRA
CULNAN, ROBERT N	1CWEB	2X	
CULVER, WILLIAM H	3IIDA	2B	
CUMMINGS, MAURICE H	1CWEB	2X	
CUNNINGHAM, FRED G	1XNAS	2B	
CURCIO, JOSEPH A	1DNRL	2B	
CURRAN, HAROLD R	1ARNI	2G2Q	AFRA
CURRIE, JULIUS A	1DAWR	2Q	
CURRIER, LOUIS W	7RETD	2H	AFRE
CURTIS, ROGER W	8NRNC	2B2G	AFNA
CURTIS, WESTLEY F	1DNDT	2B	
CURTISS, LEON F	7RETD	2B	AFNE
CURTISS, P R	2HAMU	2Q	
CUSHMAN, HELENE G	1ANAL	2F	
CUTCHINS, ERNEST C	2HCUA	2Q	
CUTCHIS, PYTHAGORAS	9CLUN	2B	
CUTHILL, ELIZABETH H	1DNDT	2B	
CUTHILL, JOHN R	9CLUN		AFRA
CUTLER, EDWIN P	5LISY	2B	
CUTTITTA, FRANK	1IGES	2E2G2H	AFRA
DAFT, FLOYD S	7RETD	2E2U2T	AFRA
DAHLSTROM, ROBERT K	3IAPL	2B	
DAHMS, REYNOLD G	1ARFR	2F	
DAIL, MARTHA C	1DAWR	2Q	
DALES, PHILIP A JR	1CWEB	2X	
DALMAT, HERBERT T	9CLUN	2F	
DALZELL, R CARSON	1XAEC	2O2U3B	AFRA
DANE, CARLE H	1IGES	2H	AFRA
DANNER, ARTHUR C	9CLUN	2X	
DARLING, EUGENE M JR	1XNAS	2X	
DARLING, FREDRIC L	1CWEB	2X	
DARROW, BERTHA S	9CLUN	2K	
DARROW, G M	7RETD	2K	
DARROW, ROBERT A	1DAFD	2K	
DARWENT, BASIL DE B	2HCUA	2B2E	AFRA
DAUER, CARL C	1HPHS		AFRA
DAVIDSON, JOHN A	2HCOU	2F	
DAVIDSON, ROBERT A	2HCUA	2K	
DAVIS, DAVID W	1ARFR	2K	
DAVIS, DON R	1XSMI	2F	
DAVIS, DORLAND J	1HNIH	2Q	
DAVIS, GEORGE E	8NRNC	2B	
DAVIS, LOUIS G	1ARRP	2F	
DAVIS, MARION M	1CNBS	2E2G	AFRA
DAVIS, PHILIP J	8NRNC		AFNA
DAVIS, R F	2HUMD	2T	AFRA
DAVIS, RAYMOND	7RETD	2B2E	AFRE
DAVIS, ROBERT J	1ASCS	2Q	
DAVIS, RUTH M	1D-S	2B	
DAVIS, WATSON	3ISCS	2B2M2H	AFRA
DAVISSON, JAMES W	1DNRL	2B	AFRA
DAWSON, CLARENCE E	4DENT	2V	
DAWSON, ELSIE H	1ARNI	3C	
DAWSON, PAUL R	7RETD		AFNE
DAWSON, REED B	8NRNC		AFNA
DAWSON, ROY C	6FAOR	2Q	AFRA
DAWSON, ROY C MRS	7RETD	2Q	
DAYHOFF, EDWARD S	1DNOL	2B	
DE ANGELIS, RICHARD M	1CWEB	2X	
DE FERIET, J KAMPE	8NRNC		AFNA
DE LAUNAY, JULES R	1DNRL		AFNA
DE LEONIBUS, P S	1DNOC	2X	
DE MACEDO, PEDRO B	1CNBS	2B	
DE MARCO, FRANCIS D	5BECO	3E	
DE NOVENS, MARIE	1XNAS	2B	
DE PACKH, DAVID C	1DNRL	2B	AFRA
DE PIAN, LOUIS	2HGWU	2B	
DE PUE, LELAND A	1DNRL	2G2U	AFRA
DE SAVAGE, BERNARD F	1DNOL	2B	
DE VORE, CHARLES	1DNOR	2B	
DE WANE, HAROLD J	1CNBS	3E	
DE WIT, ROLAND	1CNBS		AFRA

DE WITT, HENRY A	1DNBS	2B	
DEAN, HORACE S	7RETD	2K	
DEBORD, GEORGE G	7RETD	2Q	AFNE
DECKER, ROBERT F	1XFAA	2X	
DEDRICK, ROBERT L	2HGWU	2B	
DEES, BOWEN C	1XNSF	2B	
DEITCHMAN, SEYMOUR J	1D-S	2B	
DEITZ, VICTOR R	1DNRL	2E	AFRA
DEL GROSSO, VINCENT A	1DNRL	2B	
DELLERT, GEORGE T JR	1CWEB	2X	
DEMAREE, J B	7RETD	2K	
DEMING, W EDWARDS	4CONS	2B	
DENHARD, ELBERT E JR	5ARST	3E	
DENISON, I A	7RETD	2B	
DENNY, CLEVE B	3ANCA	2Q3C	
DENT, ELLIOD	1DNRL	2B	
DERMEN, HAIG	1ARFR	2K	AFRA
DEROCCO, ANDREW G	9CLUN	2B	
DETERS, OWEN J	3IAPL	2B	
DETWILER, CHARLES R	1DNRL	2B	
DETWILER, SAMUEL B	7RETD	2K2L	AFRA
DETWILER, SAMUEL B JR	1ARNI	2E	AFRA
DEVINE, JAMES F	1IBMI	2B	
DEWS, SAM C	1DAX	2F	
DIAMOND, JACOB J	1CNBS	2E3D	AFRA
DIAMOND, PAULINE	2SMOC		AFRA
DICKSON, GEORGE	1CNBS	2G2V	AFRA
DICKSON, ROBERT R	1CWEB	2X	
DIEHL, WALTER S	4CONS	2W	AFRA
DIEHL, WILLIAM W	7RETD	2K	AFRE
DIEKE, G H	2HJHU	2F	
DIENER, THEODOR O	1ARFR	2K	
DIETRICH, CARL F	1DAX	2X	
DIGGES, THOMAS G	7RETD	2U	AFRE
DILLER, J D	1AFOR	2K	
DINGER, HAROLD E	9CLUN	2B	
DINGER, JACOB E	1DNRL	2B	
DISTAD, MERRIL F	1DAHD	2B	
DOCKSTADER, W B	1HNIH	2Q	
DOCTOR, NORMAN J	1DAHD	2N	AFRA
DOETSCH, RAYMOND N	2HUMD	2Q	AFRA
DOHERTY, JAMES L	1CWEB	2X	
DOLECEK, RICHARD L	1DNRL	2B2G	AFRA
DONEHOO, IRENE A	1CWEB	2X	
DONIHEE, JAMES B	1IBMI	3E	
DONNELLY, PAUL C	1XNAS	3E	
DONOVAN, JOSEPHINE R	9CLUN	2K	
DONOVAN, WILLIAM J	1AERS	2L	
DOORE, G STANLEY	1CWEB	2X	
DORER, CHARLES F	1CWEB	2X	
DORSEY, HERBERT G	7RETD	2B	
DORTIGNAC, EDWARD J	1AFOR	2L	
DORWARD, KELVIN	1ARRP	2F	
DOSS, MILDRED A	2HUMD	2P	AFRA
DOUGLAS, CHARLES A	1CNBS	2B2G	AFRA
DOUGLAS, GEORGE W	1HNIH	2Q	
DOUGLAS, THOMAS B	1CNBS	2E	AFRA
DOVERSPIKE, GEORGE E	1AFOR	2L	
DOWDEN, PHILIP B	1ARFR	2F	
DOWNING, LEWIS K	2HHOU	2S	AFRA
DOWNS, ROBERT J	1ARFR	2K	
DOYLE, JAMES F	1IBLM	2L	
DRAEGER, R HAROLD	4PHYS		AFNE
DRAKE, CARL J	1XSMI	2F	
DRAVES, ERNEST E	1AFOR	2L	
DRECHSLER, CHARLES	1ARFR	2G2K	AFRA
DREGUSS, MIKLOS N	1HNIH	2Q	
DREWES, WILLIAM J	1CWEB	2X	
DREYFUS, JOSEPH C III	1DAWR	2Q	
DRIMMER, BERNARD E	1DNBW	2B	
DRUMMETER, LOUIS F JR	1DNRL		AFRA
DRYDEN, HUGH L	1XNAS	2B2G2O2W	AFRA
DU MOULIN, R K MRS	9CLUN	2K	
DUBACH, HAROLD W	1DNOD	2X	
DUCKWORTH, W DONALD	1XSMI	2F	
DUERKSEN, JACOB A	7RETD	2B2G	AFRE
DUFFEY, DICK	2HUMD	2B	
DUGGAN, REO E	1HFDA	3C	

DUKE, JAMES A	1ARFR	2K	
DUNCAN, BLANTON C	1CNBS	3E	
DUNCAN, HELEN M	1IGES	2H	AFRA
DUNN, CARLOS R	1CWEB	2X	
DUNNE, HAROLD E	8NRNC	2B	
DUNNIGAN, ARTHUR P	1HFDA	2Q	
DUNNING, KENNETH L	1DNRL	2B	AFRA
DURBIN, CHARLES G	1HFDA	2G2P	AFRA
DUTILLY, ARTHEME	2HCUA	2K	AFRA
DUTKY, SAMSON R	1ARFR	2F	
DUTKY, SAMSON R	1ARFR	2Q	
DUTTON, JOHN A	1DFWS	2X	
DUTTON, WALT	7RETD	2L	
DWYER, MARY C	1DNSO	3C	
DYE, LUCIUS W	1CWEB	2X	
DYER, J GLENN	1CWEB	2X	
DYKE, EDWIN	5HOWR	2N	AMRA
DZULYNSKY, LUBOMYR P	9CLUN	2L	
EAGLESON, HALSON V	2HHOU	2B	
EAKIN, OTHO M JR	1CWEB	2X	
EASTER, DONALD	1XNAS	2E	AMRA
EASTER, STEPHEN S	9CLUN	2F	
EATON, ALVIN R	3IAPL	2B	
EATON, HERBERT N	8NRNC	2B	
EBDON, DAVID W	2HUMD	3E	
EBERLY, JOHN H	1CWEB	2X	
EBY, RONALD K	1CNBS	2B	
ECKERT, W J	8NRNC		AFNA
ECKHARDT, E A	8NRNC		AFNE
ECKLUND, EVERETT T	3IDTM	2B	
EDDLEMAN, DAVID J	1DFX	2X	
EDDY, BERNICE E	1HNIH	2G2Q2T	AFRA
EDDY, NATHAN B	1HNIH	2G2T	AFRA
EDDY, ROBERT P	1DNDT	2B	
EDELMAN, SEYMOUR	1CNBS	2B	
EDELSTEIN, MAX W	1DNWS	2X	
EDMONDS, SUZANNE E	1CWEB	2X	
EDMONDSON, LOCKE F	1ARNI	3C	
EDMUNDS, LAFE R	1XNSF	2F	AFRA
EDMUNDS, WADE M	3IJBS	2M2N3B	AMRA
EDSALL, DOUGLAS W	1DNOD	2X	
EDWARDS, CLARK W	1DAWR	2Q	
EDWARDS, H KENNETH	1SX	2E	AMRA
EDWARDS, SHIRLEY	1CWEB	2X	
EGGERT, WILLIAM E	1XFAA	2X	
EGLI, PAUL H	1DNRL	2B2E	AFRA
EGOLF, DONALD R	1ARFR	2K	AFRA
EHEART, JAMES F	1ARNI	3C	
EHEART, MARY S	2HUMD	3C	
EICHORN, LARRY M	1XGAO	2B	
EICKE, WOODWARD G	1CNBS	3E	
EIDUSON, HYMAN P	1HFDA	3C	
EISENBERG, WILLIAM	1HFDA	2K	
EISENHART, CHURCHILL	1CNBS	2B	AFRA
EISENSTEIN, JULIAN C	1CNBS		AFRA
EIWEN, CHARLES J	5AMMA	2B	
ELAM, CLARENCE B JR	1DFWS	2X	
ELBOURN, ROBERT D	1CNBS	2B2N	AFRA
ELCHIBEGOFF, IVAN M	4CONS	2L	
ELDER, ROBERT B	1DNOC	2X	
ELKINS, EDGAR R JR	3ANCA	3C	
ELLINGER, GEORGE A	1CNBS	2G2U3E	AFRA
ELLINWOOD, MARY E	1D-X	2X	
ELLIOTT, CHARLOTTE	7RETD	2G2K	AFNE
ELLIOTT, F E	8NRNC		AFNA
ELLIOTT, JOSEPH E JR	1AFOR	2L	
ELLIS, JAMES D	1CWEB	2X	
ELLIS, JOHN O	1CWEB	2X	
ELLIS, NED R	7RETD	2E2G2T	AFRA
ELLSWORTH, WILLIAM M	5PNDY	2B	
ELSTINS, RUTA	3HWHC	2Q	
ELY, RICHARD K	1IBIA	2L	
EMERSON, K C	9CLUN	2F	
EMERSON, W B	9CLUN		AFRE
EMERY, ALDEN H	3AACS	2E2G	AFRA
EMMART, EMILY W	1HNIH	2Q2T	AFRA

EMMONS, CHESTER W	1HNIH 2K2Q	
EMSWELLER, SAMUEL L	1ARFR 2K	AFRA
ENDICOTT, KENNETH M	1HNIH 2T	AFRA
ENGEL, LOUISE S	7RETD 2X	
ENGELBRECHT, HOWARD H	1CWEB 2X	
ENGLAND, C WALTER	5ENLA 3C	
ENIG, JULIUS W	1DNOL 2B	
ENNIS, WILLIAM B JR	1ARFR	AFRA
ENNIS, WILLIAM W	9CLUN 2B	
EPSTEIN, EDWARD S	1C-S 2X	
ERICKSON, CARL O	1CWEB 2X	
ERIKSON, EDWIN B	4DENT 2V	
ERNST, WALLACE R	1XSMI 2K	
ESTELLE, EARL W	1CWEB 2X	
ESTERMANN, IMMANUEL	1DNX 2B	AFNA
ETZEL, HOWARD W	1XNSF 2G	AFRA
EVANS, ALICE C	7RETD 2Q	AFRE
EVANS, TODD	1HNIH 2Q	
EVANS, W D	8NRNC	AFNA
EVERARD, WILLIAM P	1AFOR 2L	
EWERS, JOHN C	1XSMI 2C	AFRA
EWING, ANN M	3ISCS 2B	
EYDE, RICHARD H	1XSMI 2K	
EYRE, F H	7RETD 2L	
EZEKIEL, WALTER N	1DNX 2K	
FABER, JOHN E	2HUMD 2Q	AFRA
FAGG, LAWRENCE W	5ATRE 2B	
FAHEY, JAMES M	1DFX 2X	
FAHEY, JOSEPH J	1IGES 2E2G2H	AFRA
FALES, JOHN H	1ARFR 2F	
FALGOUT, BARNEY T	1DAWR 2Q	
FALLER, ALAN J	2HUMD 2X	
FALLON, ROBERT J	5MELP 2B2G	AFRA
FANO, U	1CNBS 2B	
FARKAS, LESLIE F	1DFWS 2X	
FARR, MARIE L	1ARFR 2K	
FARR, MARION M	1ARFR 2P	AFRA
FARRELL, JOHN H	1AFOR 2L	
FARROW, RICHARD P	3ANCA 2E2G3C	AFRA
FAUST, GEORGE T	1IGES 2H	AFRA
FAUST, WILLIAM R	1DNRL 2B2G	AFRA
FAWCETT, EDWIN B	1CWEB 2X	
FEDKIW, JOHN	1AFOR 2L	
FEELEY, JOHN C	1HNIH 2Q	
FEESE, LARS O	1CWEB 2X	
FEINSILBER, MAX M	1CWEB 2X	
FELDMAN, CHARLES	5MELP 2B	
FELDMAN, JEROME P	1DNDT 2B	
FELSENFELD, AMPHAN D	1D-IP 2Q	
FELSENFELD, OSCAR	1DAWR 2Q	
FERGUSON, EDWARD W	1CWEB 2X	
FERGUSON, HENRY G	9CLUN	AFRE
FERGUSON, LLOYD N	2HHOU 2E	AFRA
FERGUSON, ROBERT E	1CNBS 2E	AFRA
FERLAZZO, GAETANO	8NRNC 2B	
FERRAL, ROBERT L	1CWEB 2X	
FERRELL, RALPH H	1DFWS 2X	
FERRELL, RICHARD A	2HUMD 2G	AFRA
FERRIS, CLIFFORD D	8NRNC 2B	
FETT, ROBERT W	1CWEB 2X	
FETZER, CARL D	1ASCS 2L	
FIACCO, ANTHONY V	5REAN 2B	
FIDLER, JAMES C	1CWEB 2X	
FIELD, WILLIAM D	1XSMI	AFRA
FIELDNER, ARNO C	7RETD 2E2G2M	AFRA
FIELDS, MELVIN D	1XGSA 3C	
FIELDS, RICHARD W	9CLUN 2F2K	
FIFE, EARL H	1DAWR 2Q	
FINAN, JOHN L	2HGWU	AMRA
FINE, PAUL C	1XAEC 2B	
FINGER, FREDERICK G	1CWEB 2X	
FINKELSTEIN, RICHARD A	1DAWR 2Q	
FINLEY, HAROLD E	2HHOU 2D	AFRA
FINN, EDWARD J	9CLUN 2B	
FINNICAN, RONALD J	1CWEB 2X	
FIOCK, ERNEST F	8NRNC 2B	
FISCHBACH, HENRY	1HFDA 3C	
FISCHLER, JORDAN	1CWEB 2X	
FISHER, HAROLD E	1AFOR 2L	
FISHER, LEO J	1DNOC 2X	
FISK, BERT	1DNRL	AFRA
FITZGERALD, ROBERT J	1HNIH 2Q2V	
FIVAZ, ALFRED E	7RETD 2G2L	AFRE
FLANDERS, ALLEN F	1CWEB 2X	
FLEMING, HENRY E	1CWEB 2X	
FLEMING, JAMES A	1CWEB 2X	
FLETCHER, DONALD G	1CNBS 2E	AMRA
FLETCHER, FRANKLIN M	9CLUN 2B	
FLETCHER, HEWITT G JR	1HNIH 2E	AFRA
FLINT, OLIVER S	1XSMI 2F	
FLOCKEN, FRED B	1CWEB 2X	
FLORIN, ROLAND E	1CNBS 2E	AFRA
FLUNO, JOHN A	1ARFR 2F	
FOARD, JOHN M	1CWEB 2X	
FOAT, DARREL J	1CWEB 2X	
FOECKLER, FRANCIS	5HUAS 2Q	
FOGELMAN, MURRAY	1DNOD 2X	
FOGIE, HAROLD W	1ARFR 2K	
FOLEY, EUGENE P	1XSBA 2B	
FOLEY, ROBERT T	5MELP 3E	
FOLK, JOHN E	1HNIH 2V	
FOLLIN, JAMES W JR	3IAPL 2B	
FONER, SAMUEL N	3IAPL 2B	AFRA
FOOTE, PAUL D	3INAS 2B	AFRA
FOOTE, RICHARD H	1ARFR 2F	
FOPAY, C F	1CWEB 2X	
FORBUSH, SCOTT E	3IDTM 2B	
FORD, JOHN L	1CWEB 2X	
FORD, T F	1DNRL 2E	AFRA
FORDHAM, DAVID G	1CWEB 2X	
FORMAL, SAMUEL B	1DAWR 2Q	
FORSMAN, JOHN S	9CLUN 2L	
FORST, ALBERT L	1DFWS 2X	
FORSYTH, PAUL S	1DFX 2B	
FORZIATI, ALPHONSE F	1D-S 2E2V3E	AFRA
FORZIATI, FLORENCE H	1ARNI 2E	AFRA
FOSKETT, LAURENCE W	1CWEB 2X	
FOSSETT, GEORGE L	1CWEB 2X	
FOSTER, AUREL O	1ARFR 2P	AFRA
FOSTER, ELLERY A	1CX 2L	
FOSTER, JAMES R	2HUMD 2F	
FOSTER, ROBERT I	1CWEB 2X	
FOURNELLE, HAROLD J	1HNIH 2Q	
FOURNIER, ROBERT O	1IGES 2H	AFRA
FOURT, LYMAN	5HARE 2E	AFRA
FOWELLS, HARRY A	1AFOR 2K2L	AFRA
FOWLER, HOWLAND A	1CNBS 2B	
FOWLER, RICHARD	2HGWU 2Q	
FOX, ADRIAN C	9CLUN 2K	
FOX, GORDON D	1AFOR 2L	
FOX, JAMES F	9CLUN 2B	
FOX, M R	1HFDA 2E2G2T	AFRA
FOX, ROBERT B	1DNRL 2E2G	AFRA
FRACKER, STANLEY B	7RETD 2F	
FRAME, ELIZABETH G	1HNIH 2E2T	AFRA
FRANEL, JACOB	1CWEB 2X	
FRANK, BERNARD	8NRNC	AFNA
FRANK, KARL	1HNIH	AFRA
FRANKEL, MORRIS H	1CWEB 2X	
FRANKLIN, PHILIP J	1D-S 2E2N	AFRA
FRANKLIN, TEMPIE R	2SARC	AFRA
FRANKS, JAMES W	9CLUN 2L	
FRANZ, GERALD J	1DNDT 2G2Z	AMRA
FRAPS, RICHARD M	1ARFR 2B2T	AFRA
FRASER, LORENCE W	3IAPL 2B	
FRAZIER, JOSEPH H	1D-X 2X	
FREAR, SCOTT E	2HUMD 3C	
FRECHETTE, ARTHUR R	1DNMS 2V	
FREDERICK, RALPH H	1CWEB 2X	
FREDERIKSE, H P R	1CNBS	AFRA
FREDINE, C G	1INPS 2L	
FREEMAN, ANDREW F	1ARNI 2E	AMRA
FREEMAN, HAROLD B	9CLUN 2L	
FREEMAN, JACOB J	5FRAS 2B	

FREEMAN, MONROE E	1XSMI	2E2T	AFRA
FREEMAN, OLIVER H	7RETD	2K	
FRENCH, HOWARD V	1DNOC	2X	
FRENCH, WILLIAM O JR	1CWEB	2X	
FRENKEL, LOTHAR	9CLUN	2B	
FRENKIEL, FRANCOIS N	1DNDT	2B2W2X	AFRA
FRICKE, GERTRUDE A	1CWEB	2X	
FRIEDMAN, HERBERT	1DNRL	2B	
FRIEDMAN, LEO	8NRNC	2G2T	AFNA
FRIEND, BERTA	1ARNI	3C	
FRIESS, SEYMOUR L	1DNMR	2E	AFRA
FRITZ, SIGMUND	1CWEB	2X	
FROELICH, KATHRYN	3IAPL	2B	
FROESCHNER, RICHARD C	1ARFR	2F	
FRONTENAC, THEODORE	1DNOC	2X	
FRUSH, HARRIET L	1CNBS	2E	AFRA
FRYSINGER, GALEN R	1DAER	3E	
FUGATE, GUY JR	1ARRP	2Q	
FULKERSON, JOHN F	1ACSR	2K	
FULLER, EVERETT	1CNBS	2B	
FULLER, HENRY S	1DAX	2Q	
FULLER, OTHA JR	1CWEB	2X	
FULLER, VERNON J	1HNIH	2Q	
FULLMER, HAROLD M	1HNIH	2V	
FULLMER, IRVIN H	1CNBS	2B2G2O	AFRA
FULTON, H R	7RETD	2K	
FULTON, ROBERT A	1ARFR	2E2Y	AFRA
FUNK, WILLIAM F	9CLUN	2L	
FURLOW, EDWARD P	1XUST	2L	
FURNIVAL, GEORGE M	1AFOR	2L	
FURUKAWA, GEORGE T	1CNBS	2B2E2G	AFRA
FUSILLO, MATTHEW H	1XVET	2Q	AMRA
FUSON, ROGER B	1HNIH	2Q	
FUSSELL, WILLIAM B	1XNAS	2B	
GABRIELSON, IRA N	3IWMI		AFRA
GADDIS, ADAM M	1ARNI	3C	
GAFAFER, WILLIAM M	7RETD	2V	AFNE
GAINES, SIDNEY	1DAWR	2Q	
GALES, DONALD M	1CWEB	2X	
GALLAGHER, JAMES F	1DNOD	2X	
GALLIE, WALTER A	1DFX	2X	
GALLOWAY, RAYMOND A	2HUMD	2K	AMRA
GALTSOFF, PAUL S	7RETD	2D	AFNE
GAMMON, ALVIN D	1AFOR	2L	
GAMMONS, JOHN G	1ARRP	2F	
GAMOW, GEORGE	8NRNC	2B	AFNA
GANAWAY, JAMES R	1HNIH	2Q	
GANT, JAMES Q JR	4PHYS	2G2I2L2X	AMRA
GARBACZ, MICHAEL L	1XNAS	2X	
GARCIA, LUIS F	9CLUN	2B	
GARDNER, IRVINE C	7RETD	2B	AFRA
GARDNER, V E	9CLUN	3E	
GARGUS, JAMES L	5HALA		AMRA
GARNER, CLEMENT L	7RETD	2B2G2M2R2S	AFRE
GARNER, RICHARD G	1ACSR	3C	
GARRETT, DAVID L	9CLUN	2B	
GARRETT, JOHN H	8NRNC	2B	
GARRETT, WALLACE T	2HUMD	2F	
GARSTENS, HELEN L	2HUMD		AFRA
GARVER, RAYMOND D	7RETD	2L	
GARVIN, DAVID	1CNBS		AFRA
GARVIN, LOYD C	1DFWS	2X	
GARY, ROBERT	1CNBS		AFRA
GATES, G E	8NRNC	2D	AFNA
GAUCH, HUGH	2HUMD	2K	
GAYLORD, RICHARD H	3IIDA	2B	
GAZIN, CHARLES L	1XSMI	2D2H	AFRA
GEBHARD, JACK W	3IAPL	2B	
GEHMAN, JEAN R	9CLUN	2B	
GEIL, GENE W	1CWEB	2X	
GEIL, GLENN W	1CNBS	2U	AFRA
GELHARD, ROBERT H	1CWEB	2X	
GELLER, ROMAN F	7RETD	2B2G3D	AFRA
GELTMAN, SYDNEY	8NRNC		AFNA
GEMMILL, WILLIAM H	1DNOC	2X	
GENEVESE, F	8NRNC	2B	

GENYS, JOHN B	2HUMD	2L	
GEORGE, LESTER D	1CWEB	2X	
GERBERG, EUGENE J	5INCR	2F	
GERIG, JOHN S	5SCOP	2B	
GERSON, DONALD J	1DNOC	2X	
GESSERT, ROBERT A	3IIDA	2B	
GHAFFARI, ABOLGHASSEM	1XNAS	2B	AFRA
GIARRUSSO, ANTHONY	1CWEB	2X	
GIBBS, C J JR	1HNIH	2Q	
GIBBS, R C	3INAS	2B	
GIBSON, JOHN E	1DNRL	2N	AFRA
GIBSON, KASSON S	7RETD	2B2G	AFRE
GIBSON, RALPH E	3IAPL	2B2E	AFRA
GIFFEN, W D	1AFOR	2L	
GILBERT, ENGEL L	1ARRP	2F	
GILL, CHARLES W	1DNX	2B	
GILL, JOCELYN	1XNAS	2B	
GILL, THOMAS G	1AFOR	2L	
GILL, TOM	3IPAC	2L	
GILLETT, CHARLES A	9CLUN	2L	
GILLMAN, JOSEPH L JR	4CONS	2E2M2O2U	AFRA
GILMAN, DONALD L	1CWEB	2X	
GILMORE, ELEANOR L	1DAWR	2Q	
GILPIN, GLADYS L	1ARNI	3C	
GINNINGS, DEFOE C	1CNBS	2E	AFRA
GINSBERG, DAVID M	1DAWR	2Q	
GINTHER, ROBERT J	1DNRL	3E	AFRA
GIORDANO, WALLY	8NRNC	3E	
GIRAYTYS, JAMES	1DFWS	2X	
GIROUARD, PHILIAS H	8NRNC	2B	
GISH, OLIVER H	7RETD	2B	AFNE
GLADDEN, SANFORD C	8NRNC	2B	
GLADNEY, TILLMAN F	1CWEB	2X	
GLAHN, HARRY R	1CWEB	2X	
GLASER, HAROLD	1DNOR	2B	
GLASGOW, AUGUSTUS R JR	1CNBS	2E2G	AFRA
GLASS, JEWELL J	1IGES	2G2H	AFRA
GLASSER, ROBERT G	1DNRL	2B	AFRA
GLEITER, THEODORE P	1CWEB	2X	
GLOVER, JERRY C	1DFWS	2X	
GODDARD, HELEN L	1CWEB	2X	
GODEK, THEODORE D	9CLUN	2F	
GODFREY, THEODORE B	1DAHD		AFRA
GODLOVE, TERRY F	1DNRL	2B	
GODSHALL, FREDRIC A	1CWEB	2X	
GOHD, ROBERT S	1DFX	2Q	
GOLD, HAROLD K JR	1CWEB	2X	
GOLDBERG, BENJAMIN	1DAX	2B	
GOLDBERG, MICHAEL	7RETD	2B	AFRA
GOLDBERG, RICHARD A	1XNAS	2B	
GOLDSMITH, MARGARET T	1HNIH	2Q	
GOLDSTEIN, GORDON D	1DNOR	2B	
GOLDSTEIN, HERBERT	1CNBS	2B	
GOLDSWORTHY, M C	7RETD	2K	
GOLL, F L	7RETD	2K	
GOLOVIN, NICHOLAS E	1XOST	2B	
GOLUMBIC, CALVIN	1ARMR	2E3C	AFRA
GONET, FRANK	1XUST	2E	AFRA
GOODMAN, STANLEY I	5SSAS	2B	
GOODRIDGE, RICHARD S	1XFPC	2X	
GOODWIN, JOHN T JR	3ICIR	3C	
GOODWIN, WILLIAM M	1XVET	2V	
GOODYEAR, HUGO V	1CWEB	2X	
GOOS, ROGER D	1HNIH	2K	
GORBICS, STEVEN G	1DNRL	2B	
GORDON, ALEXANDER R JR	1DNOC	2X	
GORDON, CHARLES L	1CNBS	2B2E2G	AFRA
GORDON, CLIFFORD M	1DNRL	2B	
GORDON, FRANCIS B	1DNMR	2Q	
GORDON, RUTH E	8NRNC	2Q	AFNA
GORNICK, FRED	1CNBS	2B	
GORRELL, JOSEPH W	1AFOR	2L	
GOSS, WILBUR H	3IAPL	2B	
GOSSETT, CHARLES R	1DNRL	2B	
GOTH, ROBERT W	1ARFR	2K	
GOTTLIEB, R	1DNX	2X	
GOUGH, BOBBY J	1ARNI	2Q	
GOULAIT, ROLAND V	1CWEB	2X	

GOULD, IRA A	8NRNC		AFNA
GRABHAM, ANCIL L	1DNOC	2X	
GRACE, MARSHALL F	1CWEB	2X	
GRAF, JOHN E	7RETD	2F	AFRA
GRAHAM, C E	6HURE	3C	
GRAHAM, EDWARD H	1ASCS	2G	AFRA
GRAHAM, RODERICK D	1CWEB	2X	
GRAMANN, RICHARD H	5REAN	2B	
GRANGER, CHRISTOPHER M	7RETD	2L	
GRANT, F A	8NRNC	2B	
GRANT, ULYSSES S III	7RETD	2G2J2M2R2S	AFRA
GRASSL, CARL O	1ARFR		AFNA
GRASSMYER, EDDA	3HDCG	2Q	
GRATON, LOUIS C	8NRNC		AFNA
GRAVATT, ANNIE R	7RETD	2K	
GRAVATT, G F	7RETD	2K2L	AFRA
GRAVES, JACOB D	5GETE	2B	
GRAY, DWIGHT E	1XNSF	2B	
GRAY, ERNEST P	3IAPL	2B	AMRA
GRAY, IRVING	2HGEU	2G	AFRA
GRAY, THOMAS I JR	1CWEB	2X	
GRAY, VANNIE E	1CNBS	2E	AMRA
GREELEY, ARTHUR W	1AFOR	2L	
GREEN, ALAN W	1AFOR	2L	
GREEN, C B	8NRNC	2B	
GREEN, GEORGE H	1DNMC	2Q	
GREEN, LOWELL F	1DNOL	2B	
GREEN, MELVILLE S	1CNBS	2B	AFRA
GREEN, RAYMOND A	1CWEB	2X	
GREENE, JOHN C	1HNIH	2V	
GREENLEAF, CARLOS A	3ANCA	3C	
GREENLEE, MALCOLM B	3IAPL	2B	
GREENOUGH, M L	1CNBS	2G	AFRA
GREENSPAN, LEWIS	9CLUN	2B	
GREENSPAN, MARTIN	1CNBS	2B2G2Z	AFRA
GREENSTONE, REYNOLD	5OPRE	2B	
GREST, EDWARD G	1AFOR	2L	
GRIFFITHS, NORMAN H C	2HHOU	2V	AFRA
GRINNELL, CHARLES N	3ANCA	3C	
GRISAMORE, NELSON T	2HGWU	2B2G2N	AFRA
GROSS, NOEL H	1HNIH	2Q	
GROSVENOR, GILBERT	7RETD	2G2J	AFRA
GROVER, FREDERICK W	1AFOR	2L	
GRUBB, RUSSELL C	1CWEB	2X	
GRUNER, WAYNE R	1XNSF	2B	
GUARINO, P A	1DAHD	2N	AFRA
GUARRAIA, LEONARD J	1XSMI	2Q	
GUAY, RAYMOND J	1DNOL	2B	
GUIER, WILLIAM H	3IAPL	2B	
GUILDNER, LESLIE A	1CNBS	2B	
GULLEDGE, IRENE S	9CLUN	2B	
GULLETT, WILLIAM W	5CHDE	3E	
GUNDERSON, FRANK L	4CONS	3C	
GUNNARSON, LENNART A	1CWEB	2X	
GURNEY, ASHLEY B	1ARFR	2D2F2G	AFRA
GUSTAFSON, ARTHUR F	1CWEB	2X	
GUTEKUNST, RICHARD R	1DNMR	2Q	
GUTIERREZ, JOSE	1DNMR	2Q	

HAAS, PETER H	9CLUN		AMRA
HABEL, KARL	1HNIH	2Q	
HACIA, HENRY	1CWEB	2X	
HACKMAN, EMORY E	7RETD	2B	
HACSKAYLO, EDWARD	1AFOR	2G2K2L	AFRA
HADSELL, PHILIP R	1DNOD	2X	
HAEGELE, CHARLES B	1CWEB	2X	
HAEUSSLER, GILBERT J	7RETD	2F	
HAFER, LE ROY F	1CWEB	2X	
HAFSTAD, L R	8NRNC	2B	
HAGAN, JOHN C	1CWEB	2X	
HAGARTY, JOSEPH H	1CWEB	2X	
HAGARTY, WILLIAM	1CWEB	2X	
HAGEN, JOHN P	8NRNC		AFNA
HAGEN, THOMAS L	1HPHS	2V	
HAGERTY, LAURENCE J	1DNOL	2B	
HAGUE, JOHN L	1CNBS	2E2G	AFRA
HAHN, ELISABETH H	3ANCA	3C	
HAHN, FRED E	1DAWR		AFRA
HAHN, OSCAR M	1AFOR	2L	
HAINES, DONALD A	1CWEB	2X	
HAINES, KENNETH A	1ARAO	2F2G2Y	AFRA
HAINSWORTH, WILLIAM C	1CWEB	2X	
HAIR, DWIGHT	1AFOR	2L	
HAISLMAIER, ROBERT J	1DNOL	2B	
HAKALA, REINO W	8NRNC		AFNA
HALE, MASON E JR	1XSMI	2K	
HALL, ALBERT G	4CONS	2L	
HALL, DAVID G	1ARAO	2F	
HALL, E R	8NRNC		AFNA
HALL, FERGUSON	1CWEB	2X	
HALL, JOHN F	9CLUN	2L	
HALL, R C	7RETD	2L	AFRE
HALL, ROBERT W	1DAMC	2B	
HALL, STANLEY A	1ARFR	2E2Y	AFRA
HALL, WAYNE C	1DNRL	2B2G2N	AFRA
HALLANGER, N L	5BOAL	2X	
HALLER, HERBERT L	7RETD	2E2F2G2Y	AFRA
HALLIGAN, DON K	1CWEB	2X	
HALMINSKI, S J	1DNBW	2X	
HALPERT, GERALD	5MELP	3E	
HALSTEAD, BRUCE W	8NRNC	2T	AFNA
HALVEY, DAVID B	1DFWS	2X	
HAMADA, MASARU	1CWEB	2X	
HAMANN, JOHN A	1ARMR	3C	
HAMBLETON, EDSON J	7RETD	2D2F2G	AFRA
HAMBLETON, JAMES I	7RETD	2F	AFRA
HAMER, WALTER J	1CNBS	2E2G2N3E	AFRA
HAMMERLE, WILLIAM C	3AAPA	2L	
HAMMERSCHMIDT, W W	1D-S	2B	AMRA
HAMMERSMITH, JOHN L	1XNAS	2B	
HAMMOND, H D	2HHOU	2K	AMRA
HAMPAR, BERGE	1HNIH	2Q	
HAMPP, EDWARD G	1HNIH	2Q2V	AFRA
HAMPTON, CHARLES M	1DAWR	2Q	
HAMRE, VERNON O	1AFOR	2L	
HAND, CADET H JR	8NRNC		AFNA
HAND, JAMES M	1CWEB	2X	
HANN, WILLIAM D	2HGWU	2Q	
HANSBOROUGH, LOUIS A	2HHOU		AMRA
HANSBROUGH, JOHN R	1AFOR	2L	
HANSBROUGH, RAYMOND	1AFOR	2K	
HANSCOME, THOMAS D	8NRNC	2B	
HANSEN, EILEEN A	1D-S	2B	
HANSEN, IRA B	2HGWU	2D2G	AFRA
HANSEN, LOUIS S	1D-IP	2V	
HANSEN, MORRIS H	1CBUC		AFRA
HANSEN, P A	2HUMD	2Q	
HANSON, DONALD M	1CWEB	2X	
HANSSEN, GEORGE L	1DNOC	2X	
HARBISON, JOSEPH S	9CLUN	2L	
HARDENBURG, ROBERT E	1ARMR		AFRA
HARDER, E C	8NRNC		AFNA
HARDING, E T	1DNWS	2X	
HARDING, WALLACE G JR	2HUMD	2F	
HARDT, JOHN P	5REAN	2B	
HARDY, FRANK M	5MELP	2Q	
HARDY, MALCOLM E	1AFOR	2L	
HARDY, ROBERT C	1CNBS	2B	
HARKIN, DUNCAN C	7RETD	2B	
HARMANTAS, CHRISTOS	1CWEB	2B2X	
HARMON, DANIEL	1ARFR	2K	
HARMON, GEORGE G JR	1CNBS	2B	
HARMON, STANLEY M	1HFDA	2Q	
HARNED, R W	7RETD	2F	
HARPER, VERNE L	1AFOR	2L	
HARRELL, JOHN J	1CWEB	2X	
HARRINGTON, LEE P	9CLUN	2L	
HARRINGTON, MARSHALL C	9CLUN	2B	
HARRIS, DALE R	1CWEB	2X	
HARRIS, FOREST K	1CNBS	2N	AFRA
HARRIS, MARSHALL E	1AMRP	3C	
HARRIS, MILES F	1CWEB	2X	
HARRIS, MILTON	5GECO	2E	AFRA
HARRIS, RICHARD L	1AFOR	2L	
HARRISON, FLOYD P	2HUMD	2F	

HARRISON, HARRY	1XNAS	2B	
HARRISON, MARK	2HAMU	2B2Z	AFRA
HARRISON, WILLIAM N	1CNBS	2B	AFRA
HARSHBARGER, HAROLD B	1CWEB	2X	
HART, ROBERT W	3IAPL	2B	
HART, WILLIAM J	1IBOR	2L	
HARTLEY, C F	7RETD	2F	
HARTLEY, JANET W	1HNIH	2Q	
HARTLEY, WILLIAM	6AUSO	2K	
HARTMAN, ROBERTA S	1DAWR	2Q	
HARTMANN, GREGORY K	1DNOL	2B2Z	AFRA
HARTWICK, ROBERT A	1AFOR	2L	
HARTZLER, A J	8NRNC	2B	
HARVALIK, Z V	1DAER	2E	AFRA
HARWOOD, PAUL D	8NRNC		AFNA
HASELTINE, NATE	5WAPO		AFRA
HASENCLEVER, H F	1HNIH	2Q	
HASKINS, CARYL P	3ICIW	2F2R	AFRA
HASS, GEORGE H	1DAER		AFRA
HASS, WILLIAM A	1CWEB	2X	
HASSEN BEY, MANODE	1DFWS	2X	
HATZENBUHLER, GEORGE	1CWEB	2X	
HAUPT, RALPH F	1DNOB	2B	
HAUPTMAN, HERBERT	1DNRL	2B2G	AFRA
HAVARD, JESSE B	1DFWS	2X	
HAVILAND, ELIZABETH E	7RETD	2F	
HAWORTH, ELLIS	2HDCT	2B	
HAWTHORNE, EDWARD W	2HHOU		AFRA
HAYDEN, IDA	2HHOU	2V	
HAYDEN, LEONARD O	1DNRL	2B	
HAYES, DORIS W	1AFOR	2K2L	
HAYES, HARVEY C	8NRNC	2B	
HAYES, R L	2HHOU	2V	
HAZLETON, LLOYD W	5HALA	2E2G2T	AFRA
HEADY, DONALD R	1IBLM	2L	
HEALD, ROY H	1CNBS	2B	
HEBB, EMMA L	1DAHD	3E	
HEER, RAY R JR	1XNSF	2B	
HEERMAN, RUBEN M	1ACSR	2K	
HEGGESTAD, HOWARD E	1ARFR	2K	
HEID, RICHARD W	9CLUN	2L	
HEILMAN, DOROTHY H	1XVET	2Q	
HEILPRIN, LAURENCE B	1CNBS	2B	
HEIM, ALLEN H	5HALA	2Q	
HEIN, ROBERT A	1DNX	2B	
HEINZE, PETER H	1ARMR	2E2G2K3C	AFRA
HELBUSH, ROBERT E	1CWEB	2X	
HELFERT, NORBERT F	1CWEB	2X	
HELLER, ISADOR	2HCUA		AFRA
HELLER, ROBERT C	1AFOR	2L	
HELLERMAN, SOLOMON	1CWEB	2X	
HELLFRITZSCH, ALVIN G	1DNOL	3E	
HELMICK, BENJAMIN	1CWEB	2X	
HELPRIN, JEROME J	1HNIH	2Q	
HELZ, ARMIN W	1IGES	2B	
HEMBREE, G D	1CWEB	2X	
HENDEE, CLARE W	1AFOR	2L	
HENDERSON, E P	1XSMI	2H	AFRA
HENDERSON, MALCOLM C	2HCUA	2B2Z	AFRA
HENLEY, ROBERT R	7RETD	2G	AFRE
HENNEBERRY, THOMAS J	1ARFR	2F2Y	AFNA
HENNEY, ALAN G	1DNOL	2B	
HENNEY, DAGMAR R	2HUMD	2B	
HENNIGAN, THOMAS J	1XNAS	3E	
HENRY, JOSEPH L	2HHOU	2V	
HENRY, MERTON	5X	2L	
HENRY, THOMAS R	4X	2B	AFRA
HENSLOY, CARL C	1DFWS	2X	
HENZE, PAUL B	1CNBS	2B	
HERBERT, GARY A	1CWEB	2X	
HERLING, GARY H	1DNRL	2B	
HERMAN, CARLTON M	1IFWS	2P2T	AFRA
HERMAN, LLOYD G	1HNIH	2Q	
HERMAN, ROBERT C	8NRNC		AFNA
HERMAN, STANLEY	1CWEB	2X	
HERMAN, YAYE	1DAWR	2Q	
HERR, ROBERT R	2HGWU	2K	
HERRICK, DAVID E	1AFOR	2L	

HERRING, JON L	1ARFR	2F	
HERSCHER, ARNOLD B	1D-X	2X	
HERSCHMAN, HARRY K	1CBDS	2U	AFRA
HERSEY, MAYO D	8NRNC	2B	AFNA
HERTZ, HANS G	1XNAS	2B	
HERTZLER, RICHARD A	1DAX	2L	
HERZ, ALBERT J	1DNRL	2B	AFRA
HERZ, NORMAN	1IGES	2H	AFRA
HERZFELD, CHARLES M	1D-S	2B	AFRA
HERZFELD, KARL F	2HCUA	2B	AFRA
HERZFELD, REGINA F	2HCUA	2C	AFRA
HESS, WALTER C	9CLUN	2V	AFRE
HESS, WILMOT N	1XNAS	2B	
HETRICK, FRANK	2HUMD	2Q	AMRA
HEWITT, CLIFFORD A	1HNIH		AMRA
HEYDEN, FRANCIS J SJ	2HGEU	2B2G	AFRA
HIATT, CASPAR W	1HNIH	2E2G2Q2T	AFRA
HIATT, WILLIAM E	1CWEB	2X	
HICKLEY, THOMAS J	1CCGS	2S2Z	AFRA
HICKOX, GEORGE H	8NRNC	2G2O2R2S	AFNA
HICKS, GRADY T	1DNRL	2G	AMRA
HICKS, VICTOR	8NRNC		AFNA
HIDROGO, EDUARDO	1DFWS	2X	
HIGGINS, ELMER	9CLUN		AFRE
HIGGINS, JOSEPH J	1ARFR	2K	
HIGHLEY, JOHN N	1DFX	2X	
HIGHTOWER, C	9CLUN	3E	
HILBERT, GUIDO E	1ARAO	2E3C	
HILDEBRAND, BERNARD	1DNRL	2B	
HILDEBRAND, EARL M	1ARFR	2K2Q	
HILL, AUGUSTUS N	1CWEB	2X	
HILL, BERTON F	3INAS	2G	AMRA
HILL, FREEMAN K	3IAPL	2B2W	AFRA
HILL, W W	1DFWS	2X	
HILLIG, FRED	5DRDE	2E3C	
HILSENRATH, JOSEPH	1CNBS	2B	
HILTON, JAMES L	1ARFR		AFRA
HINER, RICHARD L	1ARFR	3C	
HINMAN, WILBUR S JR	4CONS	2S	AFRA
HIPP, FRED C	5REAN	2B	
HIRES, ROBERT G	3IAPL	2B	
HIRSCHEL, LOUIS R	1DNOL	2B	
HIRST, JOHN M	1DNMC	2F	
HIVON, KATHARINE J	1ARNI	3C	
HOAR, CROSBY A	7RETD	2L	
HOBBS, HERMAN H	2HGWU	2B	
HOBBS, ROBERT B	1CNBS	2B2E2G	AFRA
HOCHWALD, FRITZ G	9CLUN	2K	AMRA
HODGE, MARY W	1CWEB	2B2X	
HODGE, ORLANDO J	8NRNC	2B	
HODGE, W H	1XNSF	2K	
HODGES, RALPH D JR	9CLUN	2L	
HODGES, RONALD W	1ARFR	2F	
HOECKER, WALTER H	1CWEB	2X	
HOERING, THOMAS C	3ICIW	2E2H	AFRA
HOEVE, C A	1CNBS	2B	
HOFFMAN, JOHN D	1CNBS	2B2F2L2Y	AFRA
HOFFMAN, RICHARD E	8NRNC	2F	
HOFFMANN, CLARENCE H	1ARFR	2F2L2Y	AFRA
HOFFMANN, EDWARD J	1IBLM	2L	
HOFFMASTER, EDMUND S	9CLUN		AMRA
HOGE, HAROLD J	1DAX	2B	AFNA
HOLBERTON, JOHN V	1DNBS	2B	
HOLCOMBE, RICHARD M	1DNOC	2X	
HOLLAND, J Z	1XAEC	2X	
HOLLENBAUGH, GEORGE W	1CWEB	2X	
HOLLIDAY, CHARLES R	2HUMD	2X	
HOLLINGSHEAD, ROBERT S	7RETD	2G3C	AFRE
HOLLINSHEAD, A C	2HGWU	2Q	
HOLLIS, NORMAN R	5HARE	2E	AFRA
HOLLOWAY, J L JR	1CWEB	2X	
HOLLOWAY, MARSHALL G	8NRNC	2B	
HOLLYER, ROBERT N JR	8NRNC	2B	
HOLMES, DAVID	1CWEB	2X	
HOLMES, FRANK H	2SMOC	2E2G2U	AMRA
HOLMGREN, HARRY D	2HUMD	2B	AFRA
HOLSHOUSER, WILLIAM L	1XCAB	2G2U	AFRA
HOLSTON, JOHN A	1IFWS	3C	

HOLTBY, BERT E	1AFOR	2L	
HOLTON, WILLIAM B	1XAEC	2B	
HOLTZSCHEITER, EARL W	1DFWS	2X	
HONES, EDWARD W JR	9CLUN	2B	
HONIG, JOHN C	5HONE	2B	
HOOK, WILLIAM A	1DAWR	2Q	
HOOKER, MARJORIE	1IGES	2H	AFRA
HOOVER, EUGENE W	1CWEB	2X	
HOOVER, JOHN I	1DNRL	2B	AFRA
HOOVER, ROBERT A	1CWEB	2X	
HOOVER, ROLAND A	5ALCH	2B	
HOOVER, SAM R	1ARNI	3C	
HOOVER, THOMAS B	1CNBS	2E	AFRA
HOOVER, WILLIAM J	3ICIR	3C	
HOPFIELD, HELEN S	3IAPL	2B	
HOPKINS, JOHN J	8NRNC	2B	
HOPKINS, WALTER S	1AFOR	2L	
HOPP, HENRY	1AFAS	2L	AFNA
HOPPS, HOPE E	1HNIH	2Q	
HOPTMAN, JULIAN	9CLUN	2Q	
HORL, ERWIN M	2HHOU	2B	
HORN, PETER H	7RETD	2B	
HORNBECK, GEORGE A	1CNBS	2B	
HORNSTEIN, IRWIN	1ARMR	3C	
HORNYAK, WILLIAM F	2HUMD	2B	
HORTON, BILLY M	1DAHD	2B2G2N	AFRA
HOSKINSON, ALBERT J	1CCGS	2B	
HOSTETTER, J C	8NRNC		AFNE
HOTTLE, GEORGE A	8NRNC	2G2Q	AFNA
HOUGH, FLOYD W	7RETD	2G2R2S	AFNA
HOUSTON, OLIN R	1CWEB	2X	
HOUSTON, W S JR	1DNWS	2X	
HOVERMALE, JOHN B	1CWEB	2X	
HOWARD, GEORGE W	1DAER	2S	AFRA
HOWARD, ROBERT E	1CNBS		AFRA
HOWCROFT, JAMES G	1CWEB	2X	
HOWE, PAUL E	4CONS	2E2T	AFRA
HOWELL, ARDEN J	1HNIH	2V	
HUANG, SU SHU	1XNAS	2B	
HUBBARD, DONALD	7RETD	2E2G	AFRA
HUBBARD, O E	1DNX	2X	
HUBBARD, WILLIAM M	1DNOL	2B	
HUBBELL, JOHN H	1CNBS	2B	
HUBERT, LESTER F	1CWEB	2X	AMRA
HUDDLE, FRANKLIN P	9CLUN	2B	
HUDSON, JOSEPH L	1CWEB	2X	
HUDSON, RALPH P	1CNBS	2B	
HUDSON, RICHARD L	3IAPL	2B	
HUG, EDWARD H	1DNOL	2B	
HUGH, RUDOLPH	2HGWU	2Q2T	AMRA
HUGHES, CLYDE L	1CWEB	2X	
HUGHES, GROVER D	1CWEB	2X	
HUGHES, JOHN H	1HPHS	2F	
HUGHES, PATRICK E	1CWEB	2X	
HULL, ROBERT B	1CPAO	2B	
HULL, WILLIAM B	1DNMS	2F	
HUMPHREYS, CURTIS J	1DNOL	2B	AFNA
HUNDLEY, JAMES M	1HPHS		AFRA
HUNT, HOWARD L JR	9CLUN	2F	
HUNT, N REX	7RETD	2K	
HUNT, W HAWARD	1AMRP	2G	AMRA
HUNTER, DONALD H	1DAWR	2Q	
HUNTER, GEORGE W III	8NRNC	2P	AFNE
HUNTER, JACK A	1DNX	2Q	
HUNTER, JAMES C	1CWEB	2X	
HUNTER, MARVIN N	1CWEB	2X	
HUNTER, RICHARD S	5HUAS		AFRA
HUNTER, WILLIAM R	1DNRL	2B2G	AFRA
HUNTING, C EUGENE	1XNSF	2B	
HUNTOON, JAMES K	1CWEB	2X	
HUNTOON, ROBERT D	1CNBS	2B2N	AFRA
HURLBURT, EVERETT H	1XNSF	2B	
HURLEY, JOHN C	1CWEB	2X	
HUTCHINS, LEE M	8NRNC	2K2L	AFNA
HUTCHINSON, LEONARD H	1DFWS	2X	
HUTTON, GEORGE L	1DNBY	2F2G	AFRA
HWANG, SHUH WEI	3IATC	2K	
HYLAND, HOWARD L	1ARFR	2K	

IKARI, NORMAN S	1HNIH	2Q	
IMAI, ISAO	8NRNC		AFNA
IMLAY, FREDERICK H	1DNDT	2B	
IMLE, E P	3IACR	2K	
INGBERG, S H	7RETD	2B	
INGRAM, DAVID M	1DFWS	2X	
INSLEY, HERBERT	4CONS	2B2G2H3D	AFRA
IRVIN, WESLEY	1CWEB	2X	
IRVING, GEORGE W JR	1ARAO	2E3C	AFRA
IRWIN, GEORGE R	1DNRL	2B2G	AFRA
IRWIN, ISABEL	1ARNI	3C	
ISBELL, HORACE S	1CNBS	2E	AFRA
IVORY, JOHN E	1DNRL	2B	
JACKSON, ELIZABETH B	2HUMD	2Q	
JACKSON, HARTLEY H T	7RETD	2D	AFRE
JACKSON, JOHN E	1D-S	2B	
JACKSON, JULIUS L	1CNBS	2B	AFRA
JACKSON, WILLIAM E	1CWEB	2X	
JACOB, KENNETH D	4CONS	2E	AFRA
JACOBS, WALTER W	1D-X	2B	AFRA
JACOBS, WOODROW C	1XNOD	2X	AFRA
JACOBSEN, VERNON G	1CWEB	2X	
JACOBSON, MARTIN	1ARFR	2E2Y	AMRA
JAFFE, DANIEL L	5VILA	2B	
JAFFE, DAVID	5AMMA	2B	
JAMES, L H	8NRNC	2G2Q2V3C	AFNA
JAMES, MAURICE T	8NRNC	2F	AFNA
JAMES, RICHARD W	1DNOC	2X	
JANICKI, BERNARD W	1XVET	2Q	
JAQUES, ALVIN T	1DNOL	2B	
JASHEMSKI, STANLEY A	1DNOL	2B	
JAY, GEORGE E JR	5MIAS	2G	AFRA
JEFFRIES, JAMES D	3HDCG	2Q	
JEHLE, HERBERT	2HGWU	2B	
JEMISON, GEORGE M	1AFOR	2L	
JEN, CHIH K	3IAPL	2B	AFRA
JENKINS, ANNA E	7RETD	2K	AFNE
JENKINS, CHARLES E	1CWEB	2X	
JENKINS, DALE W	1XNAS	2F	
JENKINS, WILLIAM D	1CNBS	2U	AMRA
JENNER, J SLATEN 4	4CONS	2B	
JENNESS, DIAMOND	9CLUN		AFNE
JENNINGS, ANNE E	1HNIH	2Q	
JENNINGS, ARTHUR H	1CWEB	2X	
JENNINGS, ROBERT K	1DNOR	2Q	
JENSEN, MALCOLM W	1CNBS	2B	
JEPSEN, STANLEY M	9CLUN	2L	
JESS, EDWARD O	1DFWS	2X	
JESSUP, RALPH S	7RETD	2B2G	AFRA
JOHANNESEN, MARK M	1AFOR	2L	
JOHANNESEN, ROLF B	1CNBS	2E2G	AFRA
JOHNSON, A G	7RETD	2K	
JOHNSON, ARTHUR W	1CWEB	2X	
JOHNSON, CARL J	9CLUN	2L	
JOHNSON, CARMEN R	1DNOD	2X	
JOHNSON, D R	1SAID	2F	
JOHNSON, DANIEL P	1CNBS	2B2G	AFRA
JOHNSON, DAVID S	1CWEB	2X	
JOHNSON, DONALD W	1DNWS	2X	
JOHNSON, E FRANKLIN	1DNOD	2X	
JOHNSON, ELLIS A	1DAHD	2B	
JOHNSON, FALBA	7RETD	2K	
JOHNSON, JIMMIE D	1DNOC	2X	
JOHNSON, KEITH C	2SDCP	2B	AFRA
JOHNSON, LE ROY C	1DFWS	2X	
JOHNSON, LESTER A	1CWEB	2X	
JOHNSON, M H	9CLUN	2B	
JOHNSON, MELVIN A	1CWEB	2X	
JOHNSON, PAUL E	3INAS	3C	AFRA
JOHNSON, PAUL S	1DFX	2B	
JOHNSON, PHYLLIS T	8NRNC	2F2G	AFNA
JOHNSON, WILLIAM L	1DNOC	2X	
JOHNSTON, FRANCIS E	7RETD	2B	AFRE
JOHNSTON, FREDERICK A	1ARRP	2K	
JOHNSTON, H FREEBORN	7RETD	2B	
JOHNSTON, ROBERT W	1XNSF	2B	

JOHNSTON, THOMAS F	1DNOL	2B	
JONES, CHARLES W	5VILA	2B	
JONES, CYRIL J	7RETD	2Q	
JONES, FRANK E	1CNBS	2B	
JONES, GEORGE	1CWEB	2X	
JONES, HENRY A	8NRNC		AFNA
JONES, JACK C	2HUMD	2F	
JONES, JAMES B	1CWEB	2X	
JONES, JOHN L JR	1DNOL	2B	
JONES, ROZELL B	1CWEB	2X	
JONES, SLOAN E	1ARFR	2F	
JONES, WILLIAM E	1CWEB	2X	
JONES, WILLIAM V	1AFOR	2L	
JORANSON, PHILIP N	1ACSR	2L	
JORDAN, CLARENCE R	1CWEB	2X	
JORDAN, HAROLD M	1CWEB	2X	
JORDAN, HAROLD V	1HNIH	2Q	
JORDAN, LUZERNE G	1HNIH	2V	
JOSEPH, ELLIS J	1DNOC	2X	
JOSEPH, HORACE M	1CNBS	2B	
JOSEPH, S W	1DNMR	2Q	
JOSEPH, STANLEY R	2HUMD	2F	
JOSEPHSON, H R	1AFOR	2L	
JOYCE, J WALLACE	1SX	2B2G	AFRA
JUDD, DEANE B	1CNBS	2B	AFRA
JUDD, NEIL M	7RETD	2C2G	AFRE
JUDSON, LEWIS V	7RETD	2B2G	AFRE
JUHN, MARY	7RETD	2T	AFRA
JUNGHANS, R C	1DNX	2X	
JUSTICE, OREN L	1ARMR	2K	
JUSTIN, A CHRISTINE	1DNSO	3C	
KABISCH, WILLIAM T	3AAAS	2G	AMRA
KAGARISE, RONALD E	1DNRL		AFNA
KAHN, ARNOLD H	1CNBS		AFRA
KAISER, HERMAN F	1DNRL	2B	
KALMUS, HENRY P	1DAHD	2N	AFRA
KAMMER, ERWIN W	1DNRL	2B	
KANAGY, JOSEPH R	1CNBS	2E	AFRA
KANE, EDWARD A	1ARFR	2E	AFRA
KAPLAN, HARRY	4DENT	2V	
KAPLAN, JOSEPH	3INAS	2B	
KARKENNY, MOSES	9CLUN		AMRA
KARLE, ISABELLA	1DNRL	2G	AFRA
KARLE, JEROME	1DNRL	2B2E	AFRA
KARPOVITCH, ALBERT A	1CWEB	2X	
KARR, PHILIP R	8NRNC		AFNA
KARRER, ANNIE M H	7RETD		AFRE
KARRER, SEBASTIAN	7RETD	2B2E2G	AFRA
KASE, ALICE	1DAWR	2Q	
KATZ, EDWARD	2HGEU	2Q	
KAUFFMAN, ERLE	5X	2L	
KAUFFMANN, GLADYS	7RETD	2Q	
KAUFMAN, DONALD D	1ARFR	2Q	
KAUFMAN, H PAUL	4CONS	2M2R	AFRA
KAUTTER, DONALD A	1HFDA	2Q	
KECK, DAVID K	1XNSF	2K	
KEE, DAVID N	1AFOR	2L	
KEE, RICHARD M	1XNAS	2X	
KEEGAN, HARRY J	1CNBS	2E2G	AFRA
KEENY, SPURGEON M JR	1XOST	2B	
KEGELES, GERSON	8NRNC		AFNA
KEIM, SHEWELL D	1DNBS	2B	
KEISTER, JAMES L	1CWEB	2X	
KEITH, HUBERT C	1CWEB	2X	
KELLER, GEOFFREY	1XNSF	2B	
KELLEY, MARION R	1DNX	2B	
KELLEY, WILBERT H	1DNOD	2X	
KELLIHER, RAYMOND	1DFWS	2X	
KELLINGTON, MYRTLE R	8NRNC	2B	
KELLUM, LEWIS B	8NRNC	2G	AFNA
KELLY, ELIZABETH	8NRNC	2B	
KEMPNER, ELLIS S	1HNIH	2B	
KENAHAN, CHARLES B	1IBMI	3E	
KENDALL, J M	8NRNC	2B	
KENK, ROMAN	1XLIC	2G	AFRA
KENNARD, RALPH B	7RETD	2B	AFRE

KENNARD, WILLIAM C	1ACSR	2K	
KENNEDY, E R	2HCUA	2G2Q	AFRA
KENNEDY, JAMES J	4DENT	2V	
KENNEY, ARTHUR W	1XNSF	2B	AFRA
KENWORTHY, FRANCIS T	1ARRP	2K	
KEPHART, GEORGE S	1IBIA	2L	
KEPHART, L W	7RETD	2K	
KERESZTESY, JOHN C	1HPHS	2E	AFRA
KERN, JACK C	1AFOR	2L	
KERR, ELIZABETH B	9CLUN	2K	
KERR, ROSE G	1IFWS	3C	
KERR, THOMAS	1ARFR	2K	
KERSHNER, RICHARD B	3IAPL	2B	
KESSLER, KARL G	1CNBS	2B	AFRA
KEULEGAN, GARBIS H	1DAX	2B	AFNA
KEVILLE, BART F	1DNOC	2X	
KEY, MARVIN E JR	1CWEB	2X	
KEYES, PAUL H	1HNIH	2V	
KEYSER, J J	1DNWS	2X	
KIBLER, CLARENCE L	1CWEB	2X	
KIES, JOSEPH A	1DNRL	2B2G2U	AFRA
KIESS, CARL C	2HGEU	2G	AFRA
KIGUEL, ENRIQUE B	2HGEU	2V	
KIHLMIRE, PAUL M	1AFOR	2L	
KILBOURNE, ELAINE M	2SDCP	2B	
KILLIAN, THOMAS J	8NRNC		AFNA
KILTZ, BURTON F	1DAEC	2K	
KIMLER, ALEXANDER	1HNIH	2Q	
KING, DAVID B	1AFOR	2L	
KING, PETER	1DNRL	2B2E	AFNA
KING, RAYMOND L	2HUMD	3C	
KINGSOLVER, JOHN	1XSMI	2F	
KINNEY, JAY P	8NRNC	2L	AFNE
KIPPER, JOHN M JR	1DNOC	2X	
KIRKLAND, GLENN I	3IAPL	2B	
KIRSCHNER, BURTON H	1CWEB	2X	
KIRSHBAUM, AMIEL	1HFDA	2Q	
KIRSTEIN, MYRON	8NRNC	2B	
KITCHENS, J WESLEY	1DNOB	2B	
KLAPPENBACH, EDWARD W	1DNWS	2X	
KLASSEN, HARVEY J	1CWEB	2X	
KLEBANOFF, PHILIP S	1CNBS	2B	
KLEIN, RALPH	1CNBS	2B	
KLEIN, TRUMAN S	1SX	2B	
KLEIN, WILLIAM H	1CWEB	2X	AFRA
KLINE, DWIGHT B	1CWEB	2X	
KLINE, ORAL L	1HFDA	3C	
KLUTE, CHARLES H	1DAHD	2B2E	AFRA
KNAPP, DAVID G	1CCGS	2G	AFRA
KNEER, ARTHUR R	1CWEB	2X	
KNIGHT, ROBERT J	9CLUN	2K	
KNIPLING, EDWARD F	1ARFR	2F2Y	AFRA
KNIPLING, PHOEBE H	2SARC		AFRA
KNOBLOCK, EDWARD C	1DAWR	2E	AFRA
KNOLL, EVERETT W	1HFDA	2Q	
KNOPF, ELEANORA B	8NRNC		AFNE
KNOWLES, ZELDA	9CLUN	2F	
KNOWLTON, KATHRYN	7RETD	2E2T	AFRA
KOCHANSKI, ADAM	1CWEB	2X	
KOFFLER, RUSSELL	1CWEB	2X	
KOHLER, HANS W	1DAHD	2G2N	AFRA
KOHLER, MAX A	1CWEB	2X	
KOLB, ALAN C	1DNRL	2B	AFRA
KOLB, ROBERT W	1HNIH	2Q	
KOLODNY, SAMUEL	1DAHD	2B	
KOLYER, RICHARD D	1DFWS	2X	
KOMHYR, WALTER D	1CWEB	2X	
KOOMEN, MARTIN J	1DNRL	2B	
KOPEC, CASIMIR S	1CNBS	2B	
KOPP, ROBERT	1SACD	2B	
KOPPANYI, THEODORE	2HGEU	2T	AFRA
KORAB, HARRY E	3AABC	2Q3C	
KOROBKIN, IRVING	5IBMC	2B	
KORTE, AUGUST F	1CWEB	2X	
KOSTKOWSKI, HENRY J	1CNBS	2B	AFRA
KOTTER, F RALPH	1CNBS	2N	AFRA
KOTULA, ANTHONY W	1ARMR	3C	
KOWAL, STANLEY J	3IAPL	2B	

KOWKABANY, GEORGE N	2HCUA	2B	
KRAFFT, JOSEPH M	1DNRL	2B	
KRAFT, K CHARLES	1CWEB	2X	
KRAHL, GEORGE M	1CWEB	2X	
KRAMER, AMIHUD	2HUMD	3C	
KRAMER, JAMES P	1ARFR	2F	
KRAMER, JULIAN	1HFDA	2Q	
KRAMISH, ARNOLD	5RACO	2B	
KRANK, JOSEPH P	1CWEB	2X	
KRANZ, ARTHUR C	1DNWS	2X	
KRASLEY, PAUL A	1TBEP	3E	
KRASNY, JOHN F	5HARE		AFRA
KRAUSS, ROBERT W	2HUMD	2K	AFRA
KREBS, JAMES J	1DNRL	2B	
KREITLOW, KERMIT W	1ARFR	2G2K	AFRA
KRESGE, RALPH F	1CWEB	2X	
KRESHOVER, SEYMORE J	1HNIH	2V	
KRESTENSEN, ELROY R	2HUMD	2F	
KRETSCHMAIER, HENRY	5DFCO	2Q	
KROGH, HAROLD W	4DENT	2V	
KROMBEIN, KARL V	1ARFR	2F	
KRONEBACH, GEORGE W	1DFWS	2X	
KRUEGER, ARTHUR	1CWEB	2X	
KRUGER, GUSTAV O	2HGEU	2V	
KRUGER, JEROME	1CNBS	2E3E	AFRA
KRULFELD, MYER	1DNRL	2B3E	
KSANDA, CHARLES J	8NRNC	2B	
KSULA, WILLIAM M	8NRNC	2B	
KUCK, JOHN H	3IAPL	2B	
KUDRAVCEV, VSEVOLOD	1HNIH	2B	
KUDZMA, ROBERT	1DFWS	2X	
KUENZEL, JOHN G	9CLUN	2L	
KULIK, MARTIN M	1AMRP	2K	
KULLBACK, SOLOMON	2HGWU	2N	AFRA
KULLERUD, GUNNAR	3IGEL	2G	AFRA
KULWICH, ROMAN	1HNIH	3C	
KUMAR, S S	9CLUN	2F	
KUMPULA, JOHN W	1CNBS	2V	
KUNDERT, OTTO R	1DAX	2B	
KUNST, EGBERT D	9CLUN	2B	
KURIHARA, YOSHIO	1CWEB	2X	
KURTZ, FLOYD E	1ARNI	2E	AFRA
KURZWEG, HERMAN H	1XNAS	2B2W	AFRA
KUSHNER, LAWRENCE M	1CNBS	2U	AFRA
KUTSCHENREUTER, PAUL H	1CWEB	2X	
KUTULAS, JOHN E	1DFWS	2X	
KUYATT, CHRIS E	1CNBS	2B	
KVAM, ERNEST L	1CWEB	2X	
KYLE, CURTIS H	7RETD	2K	
LA BOULIERE, PAULINE E	1HFDA	3C	
LA GOW, HERMAN E	1XNAS	2B	
LA RUE, JERROLD A	1CWEB	2X	
LA VILLA, ROBERT E	1CNBS	2B	
LABREC, EUGENE H	1DAWR	2Q	
LABRIE, ROGER J	1DNRL	3E	
LACNY, FRANCIS J	1CWEB	2X	
LACY, STANLEY J	1CWEB	2X	
LAFFER, NORMAN C	2HUMD	2Q	
LAKI, KOLOMAN	1HNIH	2D	AFRA
LAKIN, HUBERT W	1IGES	2H	AFNA
LALOS, GEORGE T	1DNOL	2B	
LAMANNA, CARL	1DARO	2Q2T	AFRA
LAMB, FRANK W	8NRNC		AFNA
LAMB, VERNON A	1CNBS	3E	
LAMBERT, CHARLES E	1CWEB	2X	
LAMBERT, EDMUND B	1ARFR	2G2K	AFRA
LAMBERT, JOSEPH K	1DFWS	2X	
LAMBERT, WALTER D	7RETD	2B	AFNE
LAMOREAUX, WALLACE W	1CWEB	2X	
LANCHESTER, HORACE P	1ARFR	2F	
LAND, PATTERSON B	1DNOC	2X	
LANDER, JAMES F	1CCGS	2B	
LANDIS, PAUL E	1DAHD	2S	AFRA
LANDIS, ROBERT C	1DNOC	2X	
LANDON, HARRY H JR	1CNBS	2B	
LANDSBERG, HELMUT E	1CWEB	2X	AFRA

LANG, WALTER B	7RETD		AFRE
LANGFORD, GEORGE S	2HUMD	2E2Y	AFRA
LANGFORD, GEORGE S	2HUMD	2F	
LANSDELL, HERBERT C	1HNIH	2B	
LAPHAM, EVAN G	8NRNC		AFNA
LAPP, CLAUDE J	3INAS	2B2G	AFRA
LAPP, RALPH E	5QUSI	2B	AFRA
LARKIN, CHARLES R	1DNOL	2B	
LARO, ROLAND M	1CWEB	2X	
LARRABEE, ALLAN R	1DAWR	2Q	
LARRICK, BENJAMIN F	1DNOL	3E	
LARRIMER, WALTER H	3INAS	2G2L2Y	AFRA
LARSEN, RACHEL H	1HNIH	2V	
LARSON, JAMES E	9CLUN	2L	
LARSON, ROBERT W	1AFOR	2L	
LASHOF, THEODORE W	1CNBS	2B2G	AFRA
LASSEN, LEON	7RETD	2L	
LASTER, HOWARD J	2HUMD	2B	AFRA
LATTA, RANDALL	6FAOR	2F	AFNE
LAUDANI, HAMILTON	1AMRP	2F	
LAVENDER, ROBERT A	7RETD	2B	
LAVINDER, GEORGE W	9CLUN	2L	
LAW, CATHERINE	1CNBS	3E	
LAWSON, DAVID A JR	1DAX	2X	
LAY, EDWIN T	1CWEB	2X	
LAYTON, L LAMAR	1XNAS	2B	
LE BLANC, BEN J	1CWEB	2X	
LE CLERG, ERWIN L	1ARFR	2K	AFRA
LEAKE, JAMES P	7RETD	2Q	
LEDER, LEWIS B	8NRNC	2B	AFNA
LEDFORD, ROY H	1AFOR	2L	
LEE, MARCIA R A M	1HNIH	2Q	
LEE, RICHARD H	2SMSA		AFRA
LEESE, BERNARD M	1AMRP	2K	
LEFEBVRE, CAMILLE L	1ACSR	2K	
LEFFINGWELL, THOMAS C	1HX	2B	
LEHNERT, RICHARD	1DNOL	2B	
LEHR, PAUL E	1CWEB	2X	
LEIGHTY, CLYDE E	7RETD	2G2K	AFRE
LEIKIND, MORRIS C	1HNIH		AFRA
LEINER, ALAN L	8NRNC		AFNA
LEININGER, HAROLD V	1HFDA	2Q	
LEISE, JOSHUA M	1XNSF	2Q	
LEJINS, PETER P	2HUMD	2K	
LEMMON, PAUL E	1ASCS	2L	
LENNAHAN, CHARLES M	1CWEB	2X	
LENTZ, PAUL L	1ARFR	2K	
LEONARD, LORRAINE I	9CLUN		AMRA
LEONARD, MORTIMER D	7RETD	2F	
LEOPOLD, SIDNEY	1HPHS	2Q	
LEPSON, BENJAMIN	1DNRL	2B	
LERCHEN, ROBERT A	9CLUN	2L	
LERNER, EDWIN M II	1HNIH	2Q	
LESSEL, ERWIN F JR	3IATC	2Q	
LEUKEL, ROBERT W	7RETD	2K	
LEVERTON, RUTH W	1ARNI		AFRA
LEVY, HILTON B	1HNIH	2Q	
LEVY, LILLIAN	9CLUN	2B	
LEVY, SAMUEL	8NRNC		AFNA
LEWIS, BILLY M	1CWEB	2X	
LEWIS, FRANK	1DFWS	2X	
LEWIS, THOMAS H IV	1DFWS	2X	
LEXEN, BERT R	1ARAO	2L	
LEY, HERBERT L JR	8NRNC		AFNA
LI, C P	1HNIH	2Q	
LI, HUI-LIN	8NRNC		AFNA
LIBELO, LOUIS F JR	9CLUN	2B	
LIBEN, WILLIAM	3IAPL	2B	
LICHTENSTEIN, HAROLD	1ARNI	2Q	
LICKLIDER, JOSEPH C R	8NRNC		AFNA
LIDDEL, URNER	1XNAS	2B2N2W	AFRA
LIDE, DAVID R JR	1CNBS		AFRA
LIEB, HERBERT S	1CWEB	2X	
LIEBERMAN, MORRIS	1ARMR	2E	AFRA
LIEBSON, SIDNEY H	8NRNC	2B	AFNA
LIEURANCE, NEWTON A	1CWEB	2X	
LIIMATAINEN, T M	8NRNC	2B	
LIKINS, ROBERT C	1HNIH	2V	AFRA

LILLY, DOUGLAS K	1CWEB	2X	
LILLY, JOHN C	8NRNC		AFNA
LILLY, TIMOTHY JR	1HFDA	2Q	
LIMING, FRANKLIN G	1AFOR	2L	
LINDBERG, R	9CLUN	3E	
LINDQUIST, ARTHUR W	7RETD		AFNA
LINDSAY, CHARLES V	1CWEB	2X	
LING, LEE	6FAOR		AFNA
LINK, CONRAD B	2HUMD	2K	
LINNENBOM, VICTOR J	1DNRL	2E2G	AFRA
LIPNICK, MILTON	1DAHD	2B	
LIPPINCOTT, ELLIS R	2HUMD	2B2E	AFRA
LIPPMANN, HAROLD S	1CWEB	2X	
LIPSCOMB, BERNARD R	1ARFR	2K	
LITOVITZ, THEODORE A	2HCUA	2B2Z	AFRA
LITTLE, CHARLES A	3IDTM	2B	
LITTLE, ELBERT L JR	1AFOR	2K2L	AFRA
LITTLE, RUBY R	1ARNI	2K3C	
LIVINGSTON, ROBERT L	1DNX	2X	
LLOYD, EDWARD C	1CNBS	2B	
LLOYD, GEORGE W	1ARRP	2F	
LOCKHART, LUTHER B JR	1DNRL	2E	AFRA
LOEGERING, WILLIAM Q	1ARFR	2K	
LOFQUIST, ETSUKO O	7RETD	2T	AFRA
LOGAN, ALLEN J	1AFOR	2L	
LOGAN, HUGH L	1CNBS	2U3E	AFRA
LOGAN, JAMES H	1DFWS	2X	
LOGAN, JOHN K	9CLUN	2B	
LOHR, ANNIE	7RETD	2K	
LONBERGER, STANLEY T	5AMMA	2B	
LONES, G W	1HNIH	2Q	
LONG, JOSEPH E	1XNAS	2B	
LONG, ROBERT F	1DFWS	2X	
LONGACRE, ARTHUR M	1DFWS	2X	
LOPEZ, ANTHONY	8NRNC	3C	
LORIMOR, ELZA G	1CWEB	2X	
LORING, BLAKE M	4CONS	2U	AFRA
LOTHROP, S K	8NRNC		AFNA
LOTT, GEORGE A	1CWEB	2X	
LOTTI, THOMAS	1AFOR	2L	
LOVE, S KENNETH	1IGES	2E2H2G	AFRA
LOVELESS, BURTON F	1CWEB	2X	
LOVERIDGE, MELVIN E	1AFOR	2L	
LOWDEN, MERLE S	1AFOR	2L	
LOWENTHAL, JOSEPH P	1DAWR	2Q	
LOWRY, DALE A	1CWEB	2X	
LOWRY, LANCASTER	7RETD	2B3E	
LOY, HENRY W	1HFDA	3C	
LUCAS, EDWIN C	1CWEB	2X	
LUDFORD, GEOFFREY S S	8NRNC		AFNA
LUDWIG, CORA G	1CWEB	2X	
LUDWIG, GEORGE H	1XNAS	2B	
LUGENBILL, PHILIP JR	1ARFR	2F	
LUMSDEN, DAVID V	1ARFR	2K	
LUNCHICK, MYRON E	5BOAL	2B	
LUND, EVERETT E	1ARFR	2Q	
LUND, PAULINE G	1ARNI	2Q	
LUTZ, JACOB M	1ARMR	2K3C	AFRA
LUTZ, ROGER A JR	8NRNC	3C	
LYMAN, CHALMER K	1AFOR	2L	
LYMAN, F EARLE	1HNIH	2V	
LYMAN, JOHN	1IFWS	2E	AFRA
LYNCH, DANIEL F	4DENT	2V	
LYNCH, DONALD W	1AFOR	2L	
LYND, HAROLD C	1IBLM	2L	
LYNN, W GARDNER	2HCUA	2B	AFRA
LYNT, RICHARD K JR	1HFDA	2Q	
LYON, HARVEY W	1DNMR	2V	
MA, ROBERTA M	1HFDA	2K	
MAC CARDLE, ROSS C	1HNIH	2B	
MAC DONALD, TORRENCE H	1CWEB	2X	AMRA
MAC DONALD, WILLIAM M	2HUMD	2B	
MAC DOUGALL, GORDON H	1DNOC	2X	
MAC QUARRIE, R A	1DNBW	2X	
MAC QUILLAN, ANTHONY M	2HUMD	2Q	
MAC QUIVEY, DONALD R	8NRNC	2B	

MACAULEY, JOHN B	7RETD	2B	
MACEK, ANDREJ	5ATRE	2B	
MACHTA, LESTER	1CWEB	2X	
MACLAY, W DAYTON	1ARNI	3C	
MACURDY, ARTHUR C	8NRNC	2B	
MACURDY, L B	8NRNC	2B	
MADDOX, LOUISE	1DAWR	2Q	
MADORSKY, SAMUEL L	7RETD	2E	AFRA
MAENGWYN-DAVIES, G D	2HGEU	2B	
MAGIN, GEORGE B JR	1XAEC	2E2H3B	AFRA
MAGNESS, J R	7RETD	2K	
MAGNUSSON, HARRIS W	3INFI	3C	
MAHAN, ARCHIE I	3IAPL	2B	AFRA
MAHONEY, CHARLES H	3ANCA	3C	
MAISCH, WILLIAM G	1DNRL	2B	
MAKOSKY, FRANK	1CWEB	2X	
MAKSYMIUK, BOHDAN	1AFOR	2F2L	
MALETZ, F J	9CLUN	2B	
MALETZ, RED	9CLUN	2B	
MALLACK, JERRY	2HUMD	2F	
MALMBERG, PHILIP R	1DNRL	2B	
MALONE, W F	1DNBW	2X	
MALONEY, JOHN T	1DAWR	2Q	
MALSTROM, ALVIN I	7RETD	2B	
MALURKAR, S L	1XNAS	2B	
MANABE, SYUKURO	1CWEB	2X	
MANDEL, H GEORGE	2HGWU	2E2T	AFRA
MANDEL, JOHN	1CNBS	2B2E	AFRA
MANDELKERN, LEO	8NRNC	2B	
MANN, DAVID E	1CNBS	2E	AFRA
MANN, WILFRID B	1CNBS	2B	
MANNING, IRWIN	1DNRL	2B	
MANNING, JOHN R	1CNBS	2G	AFRA
MARCH, RICHARD W	2HUMD	2Q	
MARCUS, JULIUS	1DNOC	2X	
MARCUS, MARVIN	8NRNC		AFNA
MARCUS, SIDNEY O JR	1DNOD	2X	AMRA
MARDER, STANLEY	3IIDA	2B	
MARGETIS, PETER M	1DAWR	2V	
MARIER, DONALD W	1CWEB	2X	
MARKOWITZ, WILLIAM	1DNOB	2B	
MARSCHER, JOHN C	1CWEB	2X	
MARSDEN, CHARLES P	1CNBS	3E	
MARSH, R E	7RETD	2L	
MARSHALL, JOHN D	1DAX	2Q	
MARSHALL, LOUISE H	1HNIH		AFRA
MARSHALL, SAMSON A JR	8NRNC	2B	
MARSHALL, WADE H	1HNIH	2B	AFRA
MARTIN, GEORGE W	8NRNC		AFNE
MARTIN, GORDON M	1CNBS	2B	
MARTIN, JOHN H	7RETD	2G2K	AFRA
MARTIN, JOSEPH P	9CLUN	2B	
MARTIN, MONROE H	2HUMD		AFRA
MARTIN, ROBERT H	AMRA		
MARTIN, ROBERT H	1DNWS	2X	AMRA
MARTINEZ, CONRAD	1CWEB	2X	
MARTON, L L	1CNBS	2B	AFRA
MARTON, TIBOR W	1CNBS	2B	
MARVIN, ROBERT S	1CNBS	2B2E2G	AFRA
MARYOTT, ARTHUR A	1CNBS	2E2G	AFRA
MARZKE, OSCAR T	8NRNC	2U	AFNA
MASON, A HUGHLETT	1DAX	2B	
MASON, CHARLES N JR	9CLUN	2B	
MASON, EDWARD A	2HUMD	2B2E	AFRA
MASON, HENRY L	1CNBS	2B	
MASON, HORATIO C	1ARFR	2F	
MASON, IRA J	7RETD	2L	
MASON, MARTIN A	2HGWU	2G2M2O2S	AFRA
MASON, RALPH B	1CWEB	2X	
MASON, THOMAS C	1CX	2L	
MASSEY, JOSEPH T	3IAPL	2B	AFRA
MASTERS, CLAUDE B	1DFWS	2X	
MATCHETT, JOHN R	1ARNI	3C	
MATHERS, ALEX P	1TIRS	2E	AFRA
MATHERS, JESSE A JR	1CWEB	2X	
MATHESON, HARRY	1CNBS	2B	
MATHEWS, OSCAR	7RETD	2K	
MATLACK, MARION	7RETD	2E2G	AFRE

MATOSSI, FRANK	8NRNC		AFNA
MATSON, NORMAN A	1CWEB	2X	
MATTHEWS, MILDRED M	1CWEB	2X	
MATTHEWS, RUTH H	1ARNI	3C	
MATTICK, JOSEPH F	2HUMD	3C	
MAUER, FLOYD A	1CNBS	2B	
MAUSS, BESSE D	7RETD		AFRA
MAXWELL, LOUIS R	1DNOL	2B	AFRA
MAY, ALBERT	1DNOL	2B	
MAY, CURTIS	1ARFR	2K	
MAY, DONALD C JR	1DNBW	2B	AFRA
MAY, EUGENE	7RETD	2K	
MAY, IRVING	1IGES	2E2G2H	AFRA
MAY, RICHARD H	1XUST	2L	
MAY, VERNON B	5CARE	3E	
MAYER, CORNELL H	1DNRL	2B2N	AFRA
MAYHEW, WILLIAM A JR	1DFWS	2X	
MAYKUT, E S	1DFWS	2X	
MAYOR, JOHN R	3AAAS	2G	AFRA
MAYS, JOHN M	1XNSF	2B	
MAYS, L K	1AFOR	2L	
MAZUR, JACOB	1CNBS	2B2G	AFRA
MC ARDLE, RICHARD C	1D-X	2L	
MC ARDLE, RICHARD E	3IIPA	2L	
MC BIRNEY, HAROLD R	1CWEB	2X	
MC BRIDE, GORDON W	5UNCA	2E3C	AFRA
MC CABE, LOUIS C	5RERS	2E2G	AFRA
MC CANN, HAROLD G	1HNIH	2V	
MC CARTEN, W G	2HGWU	2Q	
MC CARTER, ROY M	1CWEB	2X	
MC CARTY, MIRIAM E	1CWEB	2X	
MC CAWLEY, FRANK X	1IBMI	3E	
MC CLAIN, E PAUL	1CWEB	2X	
MC CLAIN, EDWARD F JR	1DNRL	2B	AFRA
MC CLELLAN, JAMES C	9CLUN	2L	
MC CLELLAN, WILBUR D	1ARFR	2G2K	AFRA
MC CLURE, FLOYD A	1XSMI	2K	
MC CLURE, FRANK J	1HNIH	2E2G2T2V	AFRA
MC CLURE, FRANK T	3IAPL	2B2E	AFRA
MC CLURG, GREGG H	1DAX	2B	
MC COMB, CHARLES W	2HUMD	2F	
MC COOK, JOHN W	1CWEB	2X	
MC COY, DONALD W	1ARRP	2Q	
MC CRAW, TOMMY F	1DFX	2B	
MC CULLEY, ROBERT D	1AFOR	2L	
MC CULLOH, KENNETH E	1CNBS	2B	
MC CULLOUGH, NORMAN B	1HNIH	2G2I2Q	AFRA
MC DONALD, EDWINA	1DNSO	3C	
MC DONALD, EMMA J	1CNBS	2E	AFRA
MC DONALD, FRANK B	1XNAS	2B	
MC DONELL, JAMES E	1CWEB	2X	
MC ELHINNEY, JOHN	1DNRL	2B2G	AFRA
MC EWEN, ROBERT L	1CWEB	2X	
MC FADDEN, MAX	1XSMI	2F	
MC GINNIS, LAURENCE P	1DAHD	3E	
MC GOVRAN, EDWARD R	1ACSR	2F	
MC GRATH, HILDE M	1ARFR	2K	
MC GREW, JOHN R	1ARFR	2K	
MC GRIFF, STUART G	5IONC	3E	
MC GUIRE, JUDSON U JR	1ARFR	2F	
MC GUIRE, T R	8NRNC	2B	
MC HENRY, RICHARD K	1D-X	2L	
MC INTOSH, ALLEN	7RETD	2G2P	AFRA
MC KAY, HAZEL H	1AFOR	2K	
MC KAY, JOHN W	1ARFR	2K	
MC KEE, SAMUEL A	7RETD		AFRA
MC KEE, W P	8NRNC	2B	
MC KELLAR, ALFRED D	1CX	2L	
MC KELVEY, VINCENT E	1IGES	2H	AFRA
MC KENNAN, RUSSELL B	1AFOR	2L	
MC KENZIE, LAWSON M	8NRNC	2B	AFNA
MC KINLEY, FRANK	1HFDA	3C	
MC KINLEY, JOHN D	1CNBS	2B	
MC KINLEY, WILLIAM G	1CWEB	2X	
MC KINNEY, HAROLD H	7RETD	2G2K2Q	AFRE
MC KINNEY, JOHN E	1CNBS	2B	
MC KNIGHT, EDWIN T	1IGES	2H	AFRA
MC KOWN, BARRETT L	2SPGC	2G	AMRA

MC LEAN, RUTH A	1ARNI	2Q3C	
MC MAHON, JOAN C	1XNSF	2Q	
MC MILLEN, J HOWARD	1XNSF	2B	AFRA
MC MINIMY, MARGARET	2HUMD	3C	
MC MINN, WILLIAM O	9CLUN	2B	
MC MULLEN, DONALD B	1DAWR	2P	AFRA
MC MURDIE, HOWARD F	1CNBS	3D2G	AFRA
MC MURTREY, JAMES E JR	1ARFR	2K	
MC NAIRY, JOHN V	1D-X	2X	
MC NALLY, EDMUND H	1ARFR	3C	
MC NAUGHTON, FINLEY H	1AFOR	2L	
MC NEIL, ETHEL C	1ARNI	2Q3C	
MC NESBY, JAMES R	1CNBS	2B2E	AFRA
MC NISH, ALVIN G	1CNBS	2B	
MC PHEE, HUGH C	7RETD	2G	AFRE
MC PHERSON, ARCHIBALD	1CNBS	2B2E2G	AFRA
MC QUOWN, JOHN R	1DFWS	2X	
MC ROREY, RUSSELL P	1AFOR	2L	
MC WHORTER, FRANK P	8NRNC		AFNE
MC WILLIAMS, JAMES P	1XUST	2L	
MC WILLIAMS, T G JR	2HUMD	3E	
MEAD, STERLING V	4DENT	2V	
MEADE, BUFORD K	1CCGS	2R	AFRA
MEANS, LYNN L	1CWEB	2X	
MEANS, URA M	1ARFR	2Q	
MEARS, ATHERTON H	7RETD		AFRE
MEARS, FLORENCE M	2HGWU		AFRA
MEARS, THOMAS W	1CNBS	2B	
MEBS, RUSSELL W	1CNBS	2M	AFRA
MECKLER, ALVIN	9NCOC	2B	
MEGGERS, WILLIAM F	4CONS	2B2G	AFRA
MEIJER, P H E	2HCUA	2B	
MEINTEL, RALPH H	1CWEB	2X	
MEISINGER, H PETER	5VERS	2B	
MELMED, ALLAN J	1CNBS		AFRA
MELTON, BEN S	1DFX	2B	
MENCHER, JORDAN R	1ARNI	2Q	
MENDLOWITZ, HAROLD	1CNBS		AFRA
MENDOUSSE, JEAN S	2HCUA	2B	
MENKART, JOHN H	5HARE	2E	AFRA
MENZIES, JAMES D	1ARFR	2Q	
MERCURI, ARTHUR J	1ARMR	3C	
MERKEL, EUGENE E	1D-X	2B	
MERRIAM, CARROLL F	7RETD	2G	AFNA
MERZ, ALBERT R	7RETD	2E	AFRE
METCALF, WALTER B	1AFOR	2L	
MEUSSNER, R A	1DNRL	3E	
MEYER, ARTHUR B	3ASAF	2L	
MEYER, FREDERICK G	1ARFR	2K	
MEYERHOFF, HOWARD A	8NRNC	2G2H	AFNA
MEYERING, JOHN R	3ASAF	2L	
MEYERSON, MELVIN R	1CNBS	2U2R	AFRA
MEYROWITZ, ROBERT	1IGES	2E	AFRA
MICHAEL, ALBERT S	1ARFR	2F	
MICKEY, WENDELL V	1CCGS	2B	
MIDDLETON, HOWARD E	7RETD		AFNE
MIDER, G BURROUGHS	1HNIH	2G	AFRA
MIELCZAREK, EUGENIE V	2HCUA	2B	
MIELCZAREK, STANLEY R	1CNBS	2B	
MILES, RICHARD V III	9CLUN	2L	
MILLAR, ZELMA A	5HOSH	3C	
MILLER, A L	1DNBW	2X	
MILLER, ALLEN F	1AFOR	2L	
MILLER, ALVIN H	1ARFR	2K	
MILLER, AUGUSTUS	1DAWR	2Q	
MILLER, CARL F	1XSMI	2C2G	AFRA
MILLER, CLEM O	1HFDA	2E2G	AFRA
MILLER, DAVID C	8NRNC	2B	
MILLER, DAVID J	1HFDA	3C	
MILLER, DAVID R	7RETD	2B	
MILLER, HARRY A	1CWEB	2X	
MILLER, J CHARLES	7RETD	2H	AFRA
MILLER, JAMES E	9CLUN	2L	
MILLER, JOHN F	1CWEB	2X	
MILLER, LULA A	2SDCP	2K	
MILLER, MARLIN L	1DNDT	2B	
MILLER, PAUL R	1ARFR	2K	AFRA
MILLER, ROBERT H	1ARFR	2K	

MILLER, ROMAN R	1DNRL 2E2G	AFRA
MILLIKEN, LEWIS T	1CNBS 2B	
MILLS, RICHARD H	9CLUN 2X	
MILTON, CHARLES	1IGES 2B	
MINARD, DAVID	8NRNC	AFNA
MISER, HUGH D	1IGES 2H	AFRE
MISKOVSKY, MILAN C	9CLUN 2L	
MITCHELL, CHARLES L	8NRNC 2B	
MITCHELL, J MURRAY JR	1CWEB 2G2X	AFRA
MITCHELL, JOHN W	1ARFR	AFRA
MITCHELL, ROBERT T	1IFWS 2F	
MITTLEMAN, DON	1CNBS 2B	AFRA
MIYAKODA, KIKURO	1CWEB 2X	
MIZELL, LOUIS R	5HARE 2E	AFRA
MODINE, NORMAN F	1HPHS 2B	
MOFFATT, RONALD E	1DNOD 2X	
MOHLER, FRED L	7RETD 2B	AFRE
MOHLER, P I	1DFWS 2X	
MOLANSKY, SIDNEY	1CWEB 2X	
MOLLARI, MARIO	7RETD 2Q	AFRE
MOLLOHAN, ROBERT E	9CLUN 2L	
MOLO, WILLIAM L	1DNOD 2X	
MONCHICK, LOUIS	3IAPL 2B	AFRA
MONTROLL, ELLIOTT W	3IIDA 2B	AFRA
MOORE, DONALD F	1DFX 2X	
MOORE, DWIGHT G	1CNBS 2B	
MOORE, GEORGE A	1CNBS 2G2U3E	AFRA
MOORE, GRANVILLE M	1DNX 2Q	
MOORE, HARRY J	1ARRP 2L	
MOORE, HARVEY C	2HAMU 2C	AFRA
MOORE, ROBERT M	2HGWU 2B	
MOORE, RUTH E	2HHOU 2Q	
MOORE, WILLIAM R	1AFOR 2L	
MOORHEAD, JOHN G	1DAHD 2B	
MORAN, FREDERICK A	8NRNC 2G2X	AMNA
MORELAND, M B	1DNWS 2X	
MOREY, HAROLD F	1AFOR 2L	
MORGAN, DELBERT T	2HUMD 2K	
MORGAN, DEWITT N	1CWEB 2X	
MORGAN, OMAR D JR	2HUMD 2K	
MORGAN, RAYMOND	2HUMD 2B	AFRA
MORRIS, J A	1HNIH 2P2Q	AMRA
MORRIS, JOSEPH B	2HHOU 2E	AFRA
MORRIS, KELSO B	2HHOU 2E	AFRA
MORRIS, WALTER W JR	1HFDA 3C	
MORRISON, BENJAMIN Y	7RETD	AFNE
MORRISON, COHN L	5AMMA 2B	
MORRISON, JOSEPH P	1XSMI 2D	AFRA
MORRISON, THOMAS H	1DAWR 2Q	
MORRISON, WILLIAM	1CWEB 2X	
MORRISS, D J	1AFOR 2L	
MORSCHER, L N JR	1DNOR 2B	
MORTON, CONRAD V	1XSMI 2K	
MORTON, HAROLD S JR	8NRNC 2B	
MOSCHELLI, JUDITH A	1CWEB 2X	
MOSKOWITZ, LIONEL I	1DNOC 2X	
MOSS, MAY K	2HHOU 2K	
MOSTOFI, F K	1D-IP 2T3B	AFRA
MOTTAZ, CONSTANCE E	1CWEB 2X	
MOTTERN, R E	1DNBW 2X	
MOXON, GEORGE W	1DFWS 2X	
MOYER, JAMES W	8NRNC 2B	
MOYER, WILBUR J	1DFWS 2X	
MUCCIONE, VINCENT J	2HUMD 2Q	
MUCKENFUSS, R S	7RETD 2Q	
MUEHLHAUSE, CARL O	1CNBS 2B3B	AFRA
MUELLER, EUGENE F	8NRNC 2B	
MUENCH, NILS L	9CLUN 2B	
MUESEBECK, CARL F W	7RETD 2F2D	AFRE
MULLEN, ALLEN H	1AFOR 2L	
MUNCY, GERALDINE	3HDCG 2Q	
MUNIS, RICHARD H	1CNBS 2B	
MUNN, RAYMOND O	1CWEB 2X	
MUNSON, S C	2HGWU 2F	
MURDOCK, EUGENE A	1DFWS 2X	
MURINO, VINCENT S	1CWEB 2X	
MURPHY, ALVIN D	1CWEB 2X	
MURPHY, LAWRENCE J	1CWEB 2X	
MURPHY, LEONARD M	1CCGS 2B	AFRA
MURPHY, PAUL S	7RETD 2B	
MURPHY, W A JR	1DNWS 2X	
MURPHY, WARREN T	1AFOR 2L	
MURRAY, KENNETH M JR	1DNRL 2B	
MURRAY, RODERICK	1HNIH 2Q	
MURRAY, WILLIAM S	1DNX 2F	
MURRILL, ROBERT D	1HNIH 2F	
MUTCH, WILLIAM W	1DNRL 2B	
MUZZEY, DAVID S JR	1DNOL 2B	
MYERS, ALFRED T	1IGES 2E2G	AFNA
MYERS, RALPH D	2HUMD 2B	AFRA
MYERS, VANCE A	1CWEB 2X	
MYERS, WILLIAM H	1XNOD 2X	AMRA
NACE, RAYMOND L	1IGES 2H	AFRA
NAESER, CHARLES R	2HGWU 2E2G2H	AFRA
NAGLE, AUSTEN H	1CWEB 2X	
NAGLE, STANLEY C JR	1DAFD 2Q	
NAGLER, KENNETH M	1CWEB 2X	
NALL, JULIAN C	9CLUN 2B	
NAMIAS, JEROME	1CWEB 2B2X	AFRA
NANCE, NELLIE	7RETD 2K	
NARGIZIAN, ANDREW A	9CLUN 2B	
NASH, WILLIAM P	1CWEB 2X	
NAUGLE, JOHN E	1XNAS 2B	
NEAL, T J	1DAWR 2F	
NEEBE, DAVID J	1AFOR 2L	
NEEDELS, THEODORE S	5REAN 2B	
NEGELE, JACK H	1DNWS 2X	
NEILON, JAMES R	1CWEB 2X	
NELSEN, ROBERT J	4DENT 2V	
NELSON, JOHN M	5NECO 2L	
NELSON, M M	1AFOR 2L	
NELSON, R H	3AESA 2F2G2Y	AFRA
NELSON, THOMAS C	1AFOR 2L	
NEMES, J L	2HGEU 2Q2V	
NENON, ULMER H	1DFWS 2X	
NESLEY, WILLIAM L	1D-X 2X	
NETTLETON, RICHARD E	1CNBS 2B	
NEUENDORFFER, J A	1DNX 2G	AFRA
NEUMANN, FRANK	8NRNC	AFNA
NEUMANN, META A	3HSTE 2B	
NEWHALL, FRANKLIN	1ASCS 2X	
NEWMAN, MORRIS	1CNBS	AFRA
NEWMAN, SANFORD B	1CNBS	AFRA
NEWMAN, WALKER P	1AFOR 2L	
NEWSON, HAROLD D	9CLUN 2F	
NEWTON, CLARENCE J	1CNBS	AFRA
NEWTON, ROBERT R	3IAPL 2B	
NICHOLAS, GEORGE W	1XNAS 2X	
NICKERSON, DOROTHY	1ARMR 2G	AFRA
NICOLAIDES, JOHN D	8NRNC 2B	
NICOLSON, DAN H	1XSMI 2K	
NIELSEN, JEAN K	1HFDA 2Q	
NIIMOTO, DOROTHY H	1ARFR 2K	
NIKIFOROFF, C C	7RETD 2G2H	AFRE
NILSESTUEN, ROLF M	1DFWS 2X	
NIRENBERG, MARSHALL W	1HNIH 2E	AFRA
NOBLE, FRANK W	1HNIH 2B	
NOEL, JAMES D	1DNOD 2X	
NOFFSINGER, TERRELL L	1CWEB 2X	
NOLLA, JOSE A B	8NRNC	AFNA
NORDENSON, TOR J	1CWEB 2X	
NORMAN, MARGARET C	1DAWR 2Q	
NORQUEST, KENNETH S	1CWEB 2X	
NORRIS, KARL H	1ARMR 3C	AFRA
NORSETH, HOWARD G	5VILA 2B	
NORTH, WILLIAM R JR	7RETD 2Q	
NORTON, J B	7RETD 2K	
NORTON, MATTHEW F	2HAMU 2B	
NORWOOD, JAMES P	1DFWS 2X	
NOYES, HOWARD E	1DAWR 2Q2T	AFNA
NUCKOLLS, R G	8NRNC 2B	
NUGENT, LEONARD J	8NRNC 2B	
NUTTALL, RALPH L	1CNBS 2B	
NUTTING, P G JR	1D-S 2B	

NUTTONSON, M Y	3IICE	2K	
NYHAN, JOHN C	1CWEB	2X	
NYLEN, MARIE U	1HNIH	2V	
O BARR, THOMAS P	1ARNI	2Q	
O BRIEN, GERALD F	1CWEB	2X	
O BRIEN, JOHN A JR	2HCUA	2K	AFRA
O BRYAN, HENRY M	8NRNC	2N2W	AFRA
O CONNELL, ROBERT C	9CLUN	2Q	
O CONNOR, JAMES F	1CWEB	2X	
O DELL, FRANCIS W	1DNRL	2B	
O HARE, JOSEPH E	1DNOC	2X	
O HERN, ELIZABETH M	2HGWU	2Q	AMRA
O KEEFE, JOHN A	1XNAS	2B	AFRA
O NEAL, NOLAN C	1AFOR	2L	
O NEILL, HUGH T	7RETD		AFRE
O NEILL, KELLIE	1ARRP	2F	
O ROURKE, RAYMOND C	8NRNC	2B	
OAKES, ALBERT J JR	1ARFR	2K	
OAKES, WINSLOW B	1DNWS	2X	
OBOURN, ELLSWORTH S	1HOED	2B	AFRA
OCHINERO, ROBERT V	1DNOD	2X	
ODISHAW, HUGH	9CLUN	2B	
ODUM, WILLIAM H III	1DNOD	2X	
OEHSER, PAUL H	1XSMI	2B2D	AFRA
OGBURN, FIELDING	1CNBS	3E	
OHLENBUSCH, ROBERT E	1DAWR	2Q	
OKABE, HIDEO	1CNBS	2E	AFRA
OKADA, JOSEPH M	1DNRL	2B	
OKLAND, HANS R K	1CWEB	2X	
OLIN, DANIEL D	1AFOR	2L	
OLIPHANT, MALCOLM W	2HGEU		AFRA
OLIVER, VINCENT J	1CWEB	2X	
OLSEN, CARL F	1AFOR	2L	
OLSON, BYRON J JR	8NRNC		AFNA
OLSON, F G	1DNWS	2X	
OLSON, HENRY W	2HDCT		AFRA
OLSON, ROY W	1AFOR	2L	
OMAN, PAUL W	1ARFR	2F	
OMATA, ROBERT R	1HNIH	2V	
OMIDVAR, KAZEM	1XNAS	2B	
OPALSKY, CHESTER	1ARRP	2Q	
OPIK, ERNST J	2HUMD	2B	
ORELLANA, RODRIGO G	1ARFR	2K	
OREM, THEODORE H	1CNBS	2U	AFRA
OREN, EUGENE A	1ASCS	2L	
ORTENZIO, LOUIS F	1ARRP	2Q	
OSBORN, ROBERT A	1HFDA	3C	
OSBORNE, RAYMOND L	9CLUN	2L	
OSGOOD, WILLIAM R	2HCUA	2O2S	AFRA
OSMUN, J W	1CWEB	2X	AFRA
OSTAPOFF, FEODOR	1CWEB	2X	
OSTEN, EDWARD J	1XLIC	2B2W	AMRA
OSTRANDER, ELINOR H	1DNOL	3E	
OSTROFF, EUGENE	1XSMI	2B	
OSTROM, C A	1DNMR	2V	
OSTROM, CARL E	1AFOR	2K2L	
OSWALD, ELIZABETH J	1HFDA	2Q	
OTLIN, SAMUEL	1CWEB	2X	
OTTING, WILLIAM J JR	1D-X	2B	
OTTMAN, PETER L	1CWEB	2X	
OTTO, EARL M	1CNBS	3E	
OVERTON, WILLIAM C JR	8NRNC	2B2G	AFNA
OWEN, LUDWELL JR	1HNIH	2Q	
OWENS, HOWARD B	2SPGC	2D2F2G	AFRA
OWENS, JAMES M	1CX	2L	
OWENS, JAMES P	1IGES	2G2H	AFRA
OWENS, LOWELL D	1ARFR	2Q	
PABLO, MANUEL R	1DNRL	2B	
PACK, DONALD H	1CWEB	2X	AFRA
PAFFENBARGER, GEORGE C	1CNBS	2V	AFRA
PAGE, BENJAMIN L	7RETD	2B2G	AFRE
PAGE, CHESTER H	1CNBS	2B2G2N	AFRA
PAGE, ROBERT M	1DNRL	2N	AFRA
PAI, SHIH-I	2HUMD	2B	

PALLOTTA, ARTHUR J	9CLUN		AMRA
PALMER, GERALD L JR	8NRNC	2B	
PALMER, JOHN G	1AFOR	2K	
PALMER, WAYNE C	1CWEB	2X	
PAMMEL, HAROLD E	9CLUN	2L	
PANKEY, LINDAL H	5WRMC	3C	
PAPAVIZAS, GEORGE C	1ARFR	2K	
PARIKH, GOKALDAS C	5MELP	2Q	
PARIS, CHARLES D	1AFOR	2L	
PARK, CHOONG H	2HUMD	2Q	
PARK, HELEN D	1HPHS	2G	AFRA
PARK, J HOWARD	8NRNC	2N	AFNA
PARKE, WILLIAM N	1AFOR	2L	
PARKER, JOHN G	3IAPL	2B	
PARKER, KENNETH W	1AFOR	2K2L	AFRA
PARKER, KITTIE	9CLUN	2K	
PARKER, LANSING A	1IFWS	2L	
PARKER, MARION W	1ARFR	2K	AFRA
PARKER, ROBERT L	1CNBS		AFRA
PARKINSON, DANA	7RETD	2L	
PARKS, ARTHUR O	1DNRL	2B	
PARLETT, ROBERT C	2HGWU	2Q	AFRA
PARR, LELAND W	7RETD	2Q	AFRE
PARRISH, DALE W	1DAWR	2F	
PARRY, H DEAN	1CWEB	2X	
PARSONS, C LELAND	1XNAS	2B	
PARSONS, DOUGLAS E	4CONS	2B2S	AFRE
PARSONS, PHILIP C	3ANCA	3C	
PARTYKA, EUGENE J	1DNX	2L	
PASTA, JOHN R	8NRNC	2B	
PATERSON, ROBERT A	2HUMD	2K	
PATTERSON, MARGARET E	3IFOF		AFRA
PATTERSON, WILBUR I	1ARNI	3C	
PATTON, DWIGHT L	1IBOR	2L	
PAULHUS, JOSEPH L	1CWEB	2X	
PAULUS, WILLIAM C	1DNOD	2X	
PAYNE, BURNETT H	1AFOR	2L	
PAYNE, JAMES O	1DFWS	2X	
PAYNE, LAWRENCE B	2HUMD		AFRA
PEACOCK, ELIZABETH D	9NCOC		AMRA
PEARSE, CABELL A	1DNRL	2B	
PECHOUSEK, THOMAS W	8NRNC	2B	
PECKHAM, DEAN A	1CWEB	2X	
PECOT, REBECCA	1ARNI	3C	
PEISER, H STEFFEN	1CNBS	2B2E3D	AFRA
PELCZAR, MICHAEL J JR	2HUMD	2Q	AFRA
PELL, WILLIAM H	1CNBS	2G	AFRA
PELLAM, JOHN R	8NRNC		AFNA
PELLINI, WILLIAM S	1DNRL	2U	AFRA
PELTIER, PAUL X	1ARRP	2F	
PENN, JOAN C	2HHOU	2V	
PENNINGTON, WILLIAM A	1IX	2U	AFNA
PENTZER, WILBUR T	1ARMR	2B	AFRA
PERDUE, ROBERT E JR	1ARFR	2K	
PEREZ, GEORGE E	1DNOC	2X	
PERIDIER, PAUL H	1CWEB	2X	
PERLMUTTER, SAMUEL H	1HFDA	3C	
PERLROTH, IRVING	1DNOD	2X	
PERROS, THEODORE P	2HGWU	2B2E	AFRA
PESELNICK, LOUIS	1IGES	2B	
PETERSEN, EMMANUEL J	1IBLM	2L	
PETERSEN, GERALD A	1CWEB	2X	
PETERSEN, RICHARD G	1DNOL	2B	
PETERSEN, VERNON L	1CWEB	2X	
PETERSON, A DELBERT	1DFWS	2X	
PETERSON, ARTHUR C	1CWEB	2X	
PETERSON, EUGENE K	1IBLM	2L	
PETERSON, GEORGE W	1DFWS	2X	
PETERSON, KENDALL R	1CWEB	2X	
PETERSON, ROBERT A	1DNOC	2X	
PETREE, MARCELLA C	1DNOL	2B	
PETRITZ, RICHARD L	8NRNC	2B	
PETRUCELLI, ROSE M	9CLUN	2Q	
PFEIFFER, EDWARD G	1D-X	2X	
PFEIFFER, ROBERT M	1DFWS	2X	
PHAIR, GEORGE	1IGES	2H	AFRA
PHELPS, JOHN B	9CLUN	2B	
PHELPS, ROBERT B	1AFOR	2L	

PHILBRICK, JANE V	1D-X	2B	
PHILLIPS, BYRON B	1CWEB	2X	
PHILLIPS, GEORGE R	1ASCS	2L	
PHILLIPS, MARCELLA L	4CONS	2B2N	AFRA
PHILLIPS, WILLIAM G	9CLUN	2F	
PIEPER, GEORGE F	3IAPL	2B	
PIERDON, ARTHUR G	5ARMF	3E	
PIEROVICH, JOHN M	1AFOR	2L	
PIEZ, KARL A	1HNIH	2V	
PIGMAN, W WARD	8NRNC		AFNA
PIKL, JOSEF	8NRNC		AFNA
PIORE, E R	8NRNC	2B2N	AFNA
PIRINGER, ALBERT A	1ARFR	2K	
PISKUR, FRANK	1IFWS	3C	
PITMAN, ARTHUR L	7RETD	3E	
PITTMAN, MARGARET	1HNIH	2Q2T	*AFRA
PITTS, JOSEPH W	1CNBS	2U3D	AFRA
PLAIR, THEODORE B	1ASCS	2L	
PLETCHER, CHARLES B	1DAEC	2L	
PLOTKIN, HENRY H	1XNAS	2B	
PLUMB, HARMON H	1CNBS	2B	
PLYLER, EARLE K	1CNBS	2B	
PODOLAK, EDWARD	1XFAA	2B	
POELMA, PAUL L	1HFDA	2Q	
POLACHEK, HARRY	1DNDT	2B	AFRA
POLHAMUS, L G	7RETD	2K	
POLING, AUSTIN C	1CCGS	2N	AFRA
POLLOCK, BRUCE M	1ARFR	2G2K	AFRA
POLSTON, JAMES A	1DFWS	2X	
POMEROY, JOHN H	1XAEC	2B	
POMEROY, KENNETH B	3AAFA	2L	
POMMER, ALFRED M	1ARNI	2E2G2T2H	AFRA
POOLER, LOUIS G	4CONS	2B	
POOS, FRED W	7RETD	2F2G2Y	AFRA
POPE, BRUCE M	5SCPR	2Q	
POPE, MERRITT N	7RETD	2K	AFNE
POPENOE, WILSON	8NRNC		AFNE
POPHAM, WILLIAM L	7RETD	2F	
PORE, NORMAN A	1CWEB	2X	
PORTER, B A	7RETD	2F2G2Y	AFRA
PORTER, JOHN M	1CWEB	2X	
PORTER, STANLEY C	1DNOD	2X	
PORTERFIELD, W M JR	9NCOC	2K	
POSEY, GILBERT B	7RETD	2L	
POSEY, JULIAN W	1CWEB	2X	
POSNER, AARON S	8NRNC	2V	AFNA
POSSEHL, CARROLL D	3HDCG	2Q	
POST, HOWARD A	9CLUN	2L	
POTOCSKY, GABRIEL J	1DNOC	2X	
POTTER, JOHN R	9CLUN	2L	
POTTER, ROBERT V	1AFOR	2L	
POTTER, THOMAS D	1DFWS	2X	
POURNARAS, STEPHEN W	1DFWS	2X	
POWELL, CALVIN J JR	1DAWR	2Q	
POWERS, JOSEPH	1CNBS	2B	
PRATER, LELAND J	1AFOR	2L	
PRATHER, JOHN L	8NRNC	2B	
PRATT, HARRY D	1HPHS		AFNA
PREDOEHL, MARTIN C	1CWEB	2X	
PRESCOTT, LAWRENCE M	2HGWU	2Q	
PRESLEY, JOHN T	1ARFR		AFRA
PRESNALL, CLIFFORD C	1IFWS	2L	
PRESTON, EUGENE R	1DFWS	2X	
PRESTON, JOHN F	1INPS	2L	
PRICE, E W	8NRNC	2D2P	AFNE
PRICE, SAMUEL	1ARFR	2K	
PRO, MAYNARD J	1TIRS	2E2G3B	AFRA
PROBUS, JAMES H	1D-X	2B	
PROCHAZKA, MILLO W	1HFDA	3C	
PROSEN, EDWARD J	1CNBS	2E	AFRA
PRYCE, AUBREY W	1DNOR	2B	
PUGH, GEORGE E	5DERE	2B	
PUGLIESE, FRANK G	1HFDA	2Q	
PULLEN, WILLIAM T JR	1CWEB	2X	
PULLEY, CHARLES T	1CWEB	2X	
PULTZ, LEON M	1ARFR	2K	
PURCELL, J D	1DNRL	2B	
PURDY, DOUGLAS C	1DFX	2X	

PUTNINS, PAUL H	1CWEB	2G2X	AFRA
PYLE, ROBERT L	1CWEB	2X	
PYLES, HAMILTON K	1AFOR	2L	
QUAN, ALICE D	1DNMR	2Q	
QUILL, JOHN J	1DNOL	2B	
QUIMBY, FREEMAN H	1XNAS		AFRA
QUINN, JOHN J	8NRNC	2B	
QUIROZ, RODERICK S	1DFWS	2X	
RABIN, HERBERT	1DNRL	2B	
RABINOW, JACOB	5RBEN	2B2N	AFRA
RADCLIFFE, ALEC	3IAPL	2B	
RADO, GEORGE T	1DNRL	2B	AFRA
RAEZER, SPENCER D	3IAPL	2B	
RAFF, SAMUEL J	5RAAN	2B	
RAGLAND, ADRIAN J	1D-X	2X	
RAHMLOW, H W	1CWEB	2X	
RAINER, YOUNG W	3ASAF	2L	
RAINWATER, CLYDE F	1ARFR	2F	
RAINWATER, H IVAN	1ARRP	2F	
RALL, DAVID R	1HNIH	2T	AFRA
RALL, JOSEPH E	1HNIH	2B	
RAMBERG, WALTER	1SX	2B2O2W	AFNA
RAMEY, LEWIS H	1CWEB	2X	
RAMMER, WILLIAM A	1CWEB	2X	
RAMSAY, BERTRAND P	1DNOL	2B	
RAND, SINAI	9CLUN	2B	
RANDALL, CHARLES E	7RETD	2L	
RANDALL, RAYMOND	2HUMD	2Q	
RANDS, ROBERT D	7RETD	2G2K	AFNE
RANSFORD, RICHARD B	1DAWR	2Q	
RAO, P KRISHNA	1CWEB	2X	
RAPP, DENNIS A	1XBOB	2L	
RAPPLEYE, HOWARD S	7RETD	2B2G2M2R2S	AFRA
RASMUSSEN, BOYD	1AFOR	2L	
RATNER, BENJAMIN	1CWEB	2X	
RAULT, CLEMENS V	2HGEU	2V	
RAUSCH, ROBERT	1HPHS	2D2G2P	AFNA
RAVITSKY, CHARLES	1DAX		AFNA
RAYCHOWDHURY, PRATIP N	2HGWU	2B	
READ, W T	7RETD	2E	AFRA
READING, OLIVER S	8NRNC	2B	AFNE
REAGEN, EUGENE P	1ARRP	2F	
REAM, DONALD F	1DNBS		AFRA
REDMOND, JOHN P	3IAPL	2B	
REDSTROM, RUTH A	1ARNI	3C	
REED, CHARLES K	1DFOS	2B	
REED, HERBERT B JR	1DNOL	2B	
REED, JAMES M	3ANCA	3C	
REED, LUCIUS B	1ARFR	2F	
REED, WILLIAM D	1DAEC	2F2G2R2Y	AFRA
REEVE, E WILKINS	2HUMD	2E	AFRA
REEVES, CHARLES G	1CWEB	2X	
REHDER, HARALD A	1XSMI	2D2G	AFRA
REICHARDT, CHARLES H	1XAEC	2B	
REICHELDERFER, F W	7RETD	2B2X	AFRA
REICHEN, LAURA E	1IGES	2E	AFRA
REID, MARY E	7RETD	2K2T	AFRE
REID, WALTER E JR	1CNBS	3E	
REID, WILLIAM H	1AFOR	2L	
REIDEL, JOHN T	1CWEB	2X	
REINHARDT, ROBERT E	1AFOR	2L	
REINHART, FRANK W	4CONS	2E2G	AFRA
REINHART, FRED M	1DNX		AFNA
REITEMEIER, ROBERT F	1XAEC		AFRA
RENKIN, EUGENE M	8NRNC	2G	AFNA
REYNOLDS, CLARENCE W	1CWEB	2X	
REYNOLDS, HELEN L	1HFDA	2E2G	AMRA
REYNOLDS, HOWARD	1ARNI	2Q3C	AFRA
REYNOLDS, ORR E	1D-S	2V	AFRA
REYNOLDS, W H	9CLUN	2B	
RHINE, LLOYD R	1CWEB	2X	
RHOADS, AUSTIN T	3ANCA	3C	
RHOADS, FRANKLIN J	1DNRL	2B	
RHODES, IDA	1CNBS		AFRA

RICE, DONALD A	1CCGS	2R	AFRA
RICE, FRANCIS O	8NRNC	2E	AFNA
RICE, STUART A	5SURE		AFRA
RICH, ROBERT P	3IAPL	2B	
RICHARD, OSCAR E	1DFWS	2X	
RICHARDS, LEIFIELD W	1DNOC	2X	
RICHARDS, MARSHALL M	1CWEB	2X	
RICHARDSON, EARL C	1DAWR	2Q	
RICHMOND, JOSEPH C	1CNBS	2B2G2M2W3D	AFRA
RICHMOND, SUSAN V	7RETD	2B	
RICHTER, DONALD A	1CWEB	2X	
RICKER, DANIEL L	1AOIG	2L	
RICKER, PERCY L	7RETD	2G2K	AFRE
RIDDLE, JOHN L	1CNBS	2B	
RIDDLE, OSCAR	8NRNC		AFNE
RIFE, DAVID C	1HNIH		AFRA
RINDT, CHARLES A	1AFOR	2L	
RIOCH, DAVID M	1DAWR	2G2I	AFRA
RIPPY, HAROLD R	1DFWS	2X	
RISHELL, CARL A	4CONS	2L	
RITT, PAUL E	5MELP	3D3E	AFRA
RITTER, EDWARD	1AFOR	2L	
RITTS, ROY E JR	8NRNC	2Q2T	AFNA
RITZ, VICTOR H	1DNRL	2B	
RITZMANN, O F	8NRNC	2B	
RIVELLO, ROBERT M	2HUMD	2O2W	AFRA
RIVLIN, RONALD S	8NRNC		AFNA
RIZZO, ANTHONY A	1HNIH	2Q	
ROBBINS, MARY L	2HGWU	2G2Q2T	AFRA
ROBERG, JANE	1DNOL	2B	
ROBERT, ALICE L	1ARFR	2K	
ROBERTS, CHARLES F	1CWEB	2X	
ROBERTS, ELLIOTT B	4CONS	2B2G2R2S	AFRA
ROBERTS, FRANK H H	1XSMI	2C	AFRA
ROBERTS, IRENA Z	2HTRI	2E	AMRA
ROBERTS, KENNETH J	1CWEB	2X	
ROBERTS, RICHARD B	3IDTM		AFRA
ROBERTSON, A F	1CNBS	2G	AFRA
ROBERTSON, ALBION L	3IAPL	2B	
ROBERTSON, FINIS D	1AFOR	2L	
ROBERTSON, MYRNA J	8NRNC		AFNA
ROBERTSON, RANDAL M	1XNSF	2B2G2L	AFRA
ROBINSON, CECIL C	1CWEB	2X	
ROBINSON, GERALDINE G	1DAWR	2Q	
ROBINSON, H	8NRNC	2F	
ROBINSON, HENRY E	1CNBS		AFRA
ROCHLIN, BERNARD	1CWEB	2X	
ROCK, GEORGE D	2HCUA		AFRA
ROCKNEY, VAUGHN D	1CWEB	2X	
RODDY, PATRICIA M	1HNIH	2B	
RODDY, VINCENT S	1DFX	2B	
RODENHISER, HERMAN A	1ARFR	2K	
RODGERS, LYNDON T	1CWEB	2X	
RODNEY, WILLIAM S	1XNSF	2B	AFRA
RODRIGUEZ, RAUL	1DAER	2G2R	AFRA
ROE, ROBERT S	1HFDA	3C	
ROEDDER, EDWIN	1IGES	2B2H	AFRA
ROEGNER, FRANK R	1HFDA	2Q	
ROESER, WILLIAM F	1CNBS	2B2G2R	AFRA
ROGERS, LORE A	7RETD	2Q	AFNE
ROGERS, MARVIN R	1CWEB	2X	
ROGERS, NANCY G	1HNIH	2Q	
ROGOSA, MORRISON	1HNIH	2Q2V	
ROGUL, MARVIN	1DAWR	2Q	
ROHDE, PAUL A	5BABI	2Q	
ROLLER, JANE W	1AFOR	2K	
ROLLER, PAUL S	5LIPR	2B2E2G	AFRA
ROLLOW, J DOUGLAS	5CAPC	2F	
ROMAN, NANCY G	9CLUN	2B	
ROMNEY, CARL F	1DFX	2H	AFRA
ROPEK, JOHN F	1DNOC	2X	
ROSANOFF, BORIS P	1ARMR	2B	
ROSE, EDYTHE	7RETD	2Q	
ROSE, JOHN C	2HGEU	2T2I	AFRA
ROSENBLATT, DAVID	1CNBS	2B	AFRA
ROSENBLATT, JOAN R	1CNBS	2B	
ROSENBLOOM, ABE	1CWEB	2X	
ROSENDAL, HANS E	1CWEB	2X	

ROSENTHAL, SANFORD M	1HNIH		AFRA
ROSS, ROBERT B	1CWEB	2X	
ROSS, SHERMAN	3AAPS		AFRA
ROSSINI, FREDERICK D	8NRNC	2B	AFNA
ROTH, FRANK L	7RETD	2G	AFNA
ROTHENBERG, LEON	1CWEB	2X	
ROTHSCHILD, LOUIS JR	5FOCN	3C	
ROTKIN, ISRAEL	1DAHD	2B2N	AFRA
ROTTY, ROLAND	1AFOR	2L	
ROVELSTAD, GORDON H	1DNMC	2V	
ROWE, MARVIN H	1DNOL	2B	
ROWE, WALLACE P	1HNIH		AFRA
ROZEBOOM, L E	2HJHU	2F	
RUARK, ARTHUR E	1XAEC	2B	
RUBEY, WILLIAM W	8NRNC	2H	AFNA
RUBIN, LOUIS	1CWEB	2X	
RUBIN, MEYER	1IGES	2H3C	AFRA
RUBIN, MORTON J	1CWEB	2X	AFRA
RUBIN, ROBERT J	1CNBS	2B	AFRA
RUBIN, VERA C	2HGEU	2B	AFRA
RUDD, VELVA E	1XSMI	2K	
RUEGER, LAUREN J	3IAPL	2B	
RUFF, ARTHUR W JR	1CNBS	2G	AFRA
RUFF, IRWIN	1CWEB	2X	
RUHOFF, F A	1XSMI	2F	
RUMMELL, ROBERT S	1AFOR	2L	
RUSCITTO, PETER A	1CWEB	2X	
RUSKIN, ROBERT E	1DNRL	2B	
RUSSELL, ALBERT L	1HNIH	2V	
RUSSELL, LOUISE M	1ARFR	2D2F2G	AFRA
RUSSELL, MORTIMER	1XNSF	2Q	
RUST, J H JR	1DAWR	2Q	
RUTHERFORD, R M	7RETD	2L	
RUZECKI, MARY A	1CWEB	2X	
RYALL, A LLOYD	1ARMR	2K3C	AFRA
RYALS, JAMES E	1D-X	2X	
RYERSON, KNOWLES A	7RETD	2G	AFNA
RYMER, FRANK P JR	1D-X	2X	
SABROSKY, CURTIS W	1ARFR	2F	
SADOWSKI, ALEXANDER F	1CWEB	2X	
SAENZ, ALBERT W	1DNRL		AFRA
SAFFRAN, HERMAN E	1DNOL	2B	
SAGER, WILLIAM F	2HGWU	2E	AFRA
SAIEDY, FUAD	1CWEB	2X	
SAILER, REECE I	1ARFR	2F	AFNA
SALAMAT, KHODABAKHSH	2HHOU	2V	
SALKIN, HAROLD	1HFDA	3C	
SALKOVITZ, EDWARD I	1DNOR	2B	AFRA
SALMON, S C	7RETD	2K	
SALMOND, GORDON R	7RETD	2L	
SALZMAN, FRANKLIN	1AFOR	2L	
SALZMAN, LOIS A	2HGEU	2Q	
SAMBUROFF, SERGE N	3IAPL	2B	
SAMUELS, ROBERT M	1HFDA	2Q	
SAN ANTONIO, JAMES P	1ARFR	2K	
SANBORN, WARREN R	1DNMR	2Q	
SANCHEZ, MOISES G	5DACH	3E	
SANDER, HERMAN J	1DFOS	2B	
SANDERS, ARVEY C	1DAX	2Q	
SANDERS, WILLIAM H	1DNRL	2B	
SANDERSON, JOHN A	1DNRL	2B	AFRA
SANDOR, JOHN A	1AFOR	2L	
SANDOZ, GEORGE	1DNRL	2U2G	AFRA
SANFORD, RAYMOND L	7RETD	2B	AFRE
SANGSTER, HAROLD L	9CLUN	2B	
SANGSTER, LOU A	1CWEB	2X	
SANGSTER, WAYNE E	1CWEB	2X	
SANSONETTI, S JOHN	8NRNC	3E	
SARLES, MERRITT P	2HCUA	2G2P2Y	AFRA
SASAKI, WESLEY K	1XBOB	2L	
SAVILLE, THORNDIKE	1DAEB	2S	AFRA
SAVITZ, MAXINE L	1DAER	3E	
SAXTON, HAROLD L	1DNRL	2B	
SAYERS, WILSON B	9CLUN	2L	
SAYLOR, CHARLES P	9CLUN		AFRA
SAYLOR, HARLAN K	1CWEB	2X	

SCANLON, JOHN P	1CWEB 2X			SCOTT, L E	2HUMD 3C	
SCHADE, ARTHUR L	1HNIH 2Q			SCOTTEN, JOHN W	1CWEB 2X	
SCHAEFFER, CLAUDE E	1IX	AFNA		SCOVILLE, HERBERT JR	9NCOC	AFRA
SCHAFER, WOODFORD W	1CWEB 2X			SCRIBNER, BOURDON F	1CNBS 2E	AFRA
SCHAFFER, JACOB M	1CBDS 3C			SEAMON, LILBURN H	1CWEB 2X	
SCHAFFER, ROBERT	1CNBS 2E	AFRA		SEAMSTER, AARON	1XNAS	AFRA
SCHALL, THOMAS J	1HFDA 2Q			SEAQUIST, EDGAR O	7RETD 2B	
SCHALLER, WALDEMAR T	1IGES 2E2H	AFRE		SEEBODE, ALVIN F	1CWEB 2X	
SCHALLERT, WILLIAM L	1CWEB 2X			SEEBOTH, CONRAD M	9CLUN 2B	
SCHAMP, HOMER W JR	2HUMD 2B	AFRA		SEEGER, RAYMOND J	1XNSF 2B	AFRA
SCHAREN, ALBERT L	1ARFR 2K			SEEMAN, NATHAN	1DNRL 2B	
SCHARNHORST, M P	9CLUN 2B			SELIGER, HOWARD H	2HJHU 2B	
SCHAUSS, CHARLES E	1CWEB 2X			SELLERS, RONALD E JR	1DFX 2B	
SCHECHTER, MILTON S	1ARFR 2E2Y	AFRA		SERVICE, JERRY H	7RETD	AFNE
SCHEER, MILTON D	1CNBS 2B2E	AFRA		SETTE, WILLIAM J	1DNDT 2B	
SCHELL, EMIL D	8NRNC 2B			SETZLER, FRANK M	7RETD 2C2G	AFNE
SCHERESCHEWSKY, P L	9CLUN 2B			SEVERIENS, JOHANNES C	1XAEC 2B	
SCHERP, HENRY	1HNIH 2Q			SHADOMY, JEAN	1HNIH 2Q	
SCHERR, DAVID	1XMDG 2Q			SHADOMY, SMITH	1DAWR 2Q	
SCHERTENLEIB, CHARLES	6MOCO	AMRA		SHAFRIN, ELAINE G	1DNRL 2E	AMRA
SCHIEFER, HERBERT F	1CNBS 2B	AFRA		SHALOWITZ, AARON L	1CCGS 2R	AFRA
SCHIESL, JOSEPH W	1CWEB 2X			SHANAHAN, ARTHUR J	1XNSF 2Q	AFRA
SCHINDLER, ALBERT I	1DNRL 2B	AFRA		SHANEY, JENNIE	1ARNI 3C	
SCHIPULL, WALTER L	7RETD 2L			SHANK, MITCHELL K JR	1DNOC 2X	
SCHLAIN, DAVID	1IBMI 3E			SHANKLIN, JOHN F	1IBOR 2L	
SCHLEGELMILCH, R O	8NRNC 2B			SHANKS, DANIEL	1DNDT 2B	
SCHLOEMER, ROBERT W	1CWEB 2X			SHANNON, JAMES A	1HNIH 2T	AFRA
SCHLOSSER, GEORGIA C	1ARNI 3C			SHAPIRO, GUSTAVE	1CNBS 2N	AFRA
SCHMIDT, REINHART C	1CWEB 2X			SHAPIRO, JAY R	9CLUN 2B	
SCHMITT, HERMAN P	3ANAF 3C			SHAPIRO, LEONARD	1IGES 2E	AFRA
SCHMITT, WALDO L	1XSMI 2D	AFRA		SHAPIRO, MAURICE M	1DNRL 2B	AFRA
SCHNAPER, EDNA S	1HNIH 2Q			SHAPIRO, PHILIP	1DNRL 2B	
SCHNAPER, HAROLD W	2HGEU 2B			SHAPLEY, A H	1CNBS	AFNA
SCHNEIDER, HERMAN	2HUMD 2Q			SHAPOVALOV, MICHAEL	7RETD 2G	AFNE
SCHNURR, RICHARD G	1CWEB 2X			SHARPE, THOMAS F	5AMMA 3E	
SCHOEN, JAMES F	1ARRP 2K			SHAW, ARCHIE	1CWEB 2X	
SCHOEN, LOUIS J	1CNBS	AFRA		SHAW, EUGENE D	1DAWR 2Q	
SCHOENBORN, HENRY W	2HUMD	AFRA		SHAW, JOSEPH C	8NRNC	AFNA
SCHOENEMAN, ROBERT L	1TIRS	AFRA		SHELDON, DONALD R	5MIAS 2Q	
SCHOENING, HARRY W	7RETD 2P	AFRA		SHELLEY, MARYANN B	1XNAS 2B	
SCHOENING, HARRY W	7RETD 2Q			SHELTON, EMMA	1HNIH	AFRA
SCHOLL, GEORGE S	5AEGE 2B			SHELTON, L R JR	1HFDA 2Q3C	
SCHONER, ROBERT W	1CWEB 2X			SHEN, SHAN-FU	8NRNC	AFNA
SCHOOLEY, ALLEN H	1DNRL 2B2G2N	AFNA		SHEPARD, HAROLD H	1AASC 2F2Y	AFRA
SCHOONOVER, IRL C	1CNBS 2B2E2V	AFRA		SHEPHERD, CLARENCE M	1DNRL 3E	
SCHOPMEYER, CLIFFORD S	1AFOR 2L			SHEPPARD, DONALD C	8NRNC 2B	
SCHRECKER, ANTHONY W	1HNIH 2E	AFRA		SHEPPARD, THOMAS W	3IAPL 2B	
SCHREINER, OSWALD	7RETD 2D2E2G2K	AFNE		SHERESHEFSKY, J LEON	2HHOU 2E	AFRA
SCHRODER, ARTHUR	1CBDS 3E			SHERFEY, JOSEPH M	1XNAS 3E	
SCHUBAUER, GALEN B	1CNBS 2B2G	AFRA		SHERLIN, GROVER C	9CLUN 2B	
SCHUBERT, BERNICE G	9CLUN 2K			SHERMAN, RALPH W	1ARRP 2F	
SCHUBERT, DAVID C	1CNBS 2B			SHERRY, EDWIN J	1CWEB 2X	
SCHUBERT, LEO	2HAMU 2B2E	AFRA		SHERWIN, CHALMERS W	1D-X 2B	
SCHUETZ, JOHN	1CWEB 2X			SHETLER, STANWYN G	1XSMI 2K	
SCHULDINER, SIGMUND	1DNRL 3E			SHIELDS, CHESTER A	1AFOR 2L	
SCHULE, JOHN J	1DNOC 2X			SHIELDS, JOHN F	1AFOR 2L	
SCHULMAN, JAMES H	1DNRL 2B3E	AFRA		SHIMER, H W	8NRNC	AFNE
SCHULTZ, EDWARD W	1AFOR 2L			SHIMKIN, DEMITRI B	8NRNC 2C	AFNA
SCHULTZ, EUGENE S	1ARFR 2K	AFRE		SHINNERS, WILLARD W	1CWEB 2X	
SCHULTZE, W D	1ARFR 2Q			SHIOTA, TETSUO	1HNIH 2V	
SCHULZ, ALVIN G JR	3IAPL 2B			SHISHA, OVED	8NRNC 2B	
SCHUMANN, WILLIAM A	8NRNC 2B			SHMUKLER, LEON	8NRNC 2D2E	AMNA
SCHUYLER, G L	7RETD 2B			SHNEIDEROV, ANATOL J	3IARC 2B	
SCHWALB, ARTHUR	1CWEB 2X			SHOPE, JOHN I	1CWEB 2X	
SCHWARTZ, ANTHONY M	5HARE 2E	AFRA		SHORB, DOYS A	1ARFR 2P	AFRA
SCHWARTZ, BENJAMIN	7RETD	AFRE		SHORB, MARY S	2HUMD 2G2Q2T	AFRA
SCHWARTZ, CHARLES M	9CLUN 2L			SHOSTAK, ARNOLD A	1DNOR 2B	
SCHWARTZ, ROBERT B	1CNBS 2B			SHOTLAND, EDWIN	3IAPL 2B	
SCHWARZ, FRANCIS K	1CWEB 2X			SHRIVER, REBECCA F	3ANCA 3C	
SCHWEDER, WILLIAM H	2HGEU 2B			SHROPSHIRE, WALTER A	1XSMI 2K	AMRA
SCOFIELD, CARL S	7RETD 2K			SHULER, KURT E	1CNBS 2B2E	AFRA
SCOFIELD, FRANCIS	3ANPV 2E	AMRA		SHUMAKER, JOHN B JR	9CLUN 2B	
SCOFIELD, HENRY	1DNMC 2V			SHUMAN, FREDERICK G	1CWEB 2X	
SCOTT, ARNOLD H	1CNBS 2B2G2N	AFRA		SHUPING, RALPH E	5MXRE 2B	
SCOTT, DAVID B	1HNIH 2G2V	AFRA		SHURTLEFF, ROBERT G	9CLUN 2L	
SCOTT, DONALD H	1ARFR 2K			SHUTE, BARBARA E	9CLUN 2B	
SCOTT, E J	1DNOL 2B			SIEGLER, EDOUARD H	9CLUN	AFRE
SCOTT, HAROLD A	1CWEB 2X			SIEGLER, EUGENE A	7RETD 2K	

SIEKER, JOHN H	7RETD	2L	
SIEVERS, ARTHUR F	7RETD	2K	
SIK, ALVER E	1CWEB	2X	
SILBERBERG, REIN	1DNRL	2B	
SILBERSCHMIDT, KARL M	8NRNC		AFNA
SILBERWEIT, MARIA	2HHOU	2V	
SILSBEE, FRANCIS B	4CONS	2B2G2N	AFRA
SILVERBERG, ROSALIE J	1HNIH	2Q	
SILVERMAN, SHIRLEIGH	1CNBS	2B2G	AFRA
SILVERSTEIN, ABRAHAM	1DNOL	2B	
SIMHA, ROBERT	8NRNC		AFNA
SIMMONS, JOHN A	1CNBS	2G	AFRA
SIMMONS, LANSING G	1CCGS	2S	AFRA
SIMMONS, RALPH C	1DFX	2X	
SIMON, ALBERT C	1DNRL	3E	
SIMONTON, LOIS A	1DAWR	2Q	
SIMPSON, GEORGIE I	1DNMC	2Q	
SIMPSON, LLOYD S	1DNOC	2X	
SIMPSON, ROBERT H	1CWEB	2X	
SIMS, IVAN H	7RETD	2L	
SINGER, IRA	2HGEU	2Q	
SINGER, S FRED	2HUMD	2B2X	
SINGH, SOHAN	2HHOU	2B	
SINGLETERRY, CURTIS R	1DNRL	2E	AFRA
SINGMAN, DAVID	1DAHD	3E	
SISLER, FREDERICK D	4X	2Q	
SITTERLY, BANCROFT W	2HAMU	2B	AFRA
SITTERLY, CHARLOTTE M	1CNBS	2B2G	AFRA
SKILES, FRANK L	1DNOC	2X	
SKILLMAN, W C	1DFWS	2X	
SKINNER, HENRY T	1ARFR	2K	
SLACK, LEWIS	3INAS	2B2G	AFRA
SLADEK, JAROMIL V	1HFDA	2E	AFRA
SLAWSKY, MILTON M	1DFOS	2G2M2W	AFRA
SLAWSKY, ZAKA I	1DNOL	2B2G	AFRA
SLEATER, JOSEPH K JR	1DFWS	2X	
SLOCUM, GILES	1CWEB	2X	
SLOCUM, GLENN G	1HFDA	2Q3C	AFRA
SLOOP, JOHN L	1XNAS	2B	
SMAGORINSKY, JOSEPH	1CWEB	2X	
SMALL, HAROLD E JR	9CLUN	2F	
SMALL, JAMES B	1CCGS	2B2M2R	AFRA
SMART, J SAMUEL	8NRNC	2B	AFNA
SMART, ROBERT A	1AFOR	2L	
SMATHERS, EARL E	1DNOD	2X	
SMEDLEY, DAVID	1CWEB	2X	
SMILEY, ROBERT L	1ARRP	2F	
SMITH, ALBERT C	8NRNC	2K	
SMITH, ALVIN L JR	1DFWS	2X	
SMITH, AUGUSTINE V P	2SDCP	2K	
SMITH, C EARLE JR	1ARFR	2K	
SMITH, CHARLES M	7RETD	2Y	AFRE
SMITH, CHAUNCEY W	1DAWR	2Q	
SMITH, DONALD W	1AFOR	2L	
SMITH, EDGAR R	7RETD	2E	AFNE
SMITH, FALCONER	1HNIH	2B2T	AFRA
SMITH, FLOYD F	1ARFR	2F2Y	AFRA
SMITH, FRANCIS A	7RETD		AFNE
SMITH, HELEN T	3HDCG	2Q	
SMITH, HENRY L JR	8NRNC		AFNA
SMITH, HORACE L JR	8NRNC	3C	
SMITH, HOWARD B	1AFOR	2L	
SMITH, JACK C	1CNBS		AFRA
SMITH, JAMES L	1ARNI	2Q	
SMITH, LAWRENCE W	7RETD	2L	
SMITH, LEE W	9CLUN	2Q	
SMITH, LYMAN B	1XSMI	2K	
SMITH, NATHAN R	7RETD	2G2K2Q	AFNE
SMITH, PAUL A	5RACO	2G2H2S2W	AFRA
SMITH, PAUL L	1DNRL	2S2N	AFRA
SMITH, RAYMOND G	1CWEB	2X	AMRA
SMITH, SARAH L	1DAWR	2Q	
SMITH, SCOTT W	1CNBS	2B	
SMITH, SIDNEY T	1DNRL	2N	AFRA
SMITH, STEPHEN J	8NRNC	2B	
SMITH, THOMAS B	1D-IP	2Q	
SMITH, WALDO E	4CONS	2B	
SMITH, WARREN	1CWEB	2X	
SMITH, WILLIAM E	1HFDA	2Q	
SMITH, WILLIAM O	1IGES	2B	
SMITH, WILLIE W	1HNIH	2T	AFRA
SNAVELY, BENJAMIN L	1DNOL	2G2Z	AFRA
SNAY, HANS G	1DNOL	2G2Z	AFRA
SNIDERO, MIRCO P	1CWEB	2X	
SNIESZKO, STANISLAS F	9CLUN	2Q	
SNODGRASS, R E	9CLUN	2F	
SNOKE, HUBERT R	7RETD		AFRA
SNOW, GEORGE A	2HUMD	2B	
SNYDER, DONALD G	1IFWS	3C	
SNYDER, JANET	9CLUN	2B	
SNYDER, MARLIN H	1DNOC	2X	
SNYDER, THOMAS E	1XSMI	2F	
SODERSTROM, THOMAS R	1XSMI	2K	
SOKOLOWSKI, THOMAS J	9CLUN	2B	
SOLEM, ANSON D	1DNOL	2B	
SOLLER, RALPH R	1CWEB	2X	
SOLLERS-RIEDEL, HELEN	1ARRP	2F	
SOLLINS, A D	8NRNC	2B	
SOLLNER, KARL	1HNIH	2E3E	AFRA
SOLOMON, IRVING	1DFWS	2X	
SOLOW, MAX	5MART	2B	
SOLOWEY, MATHILDE	1HNIH	2Q	
SOMERS, IRA I	3ANCA	3C	
SOMERSON, NORMAN L	1HNIH	2Q	
SOMMER, HELMUT	1DAHD	2N	AFRA
SOOKNE, ARNOLD M	5HARE	2E	AFRA
SORDELLI, A	9CLUN		AFNE
SOUDER, WILMER	4CONS	2E2V	
SOULES, STANLEY D	1CWEB	2X	
SOWDER, ARTHUR M	1AFES	2L	
SPADA, BENJAMIN	1AFOR	2L	
SPANGLER, PAUL J	1ARFR	2F	
SPARHAWK, WILLIAM N	7RETD	2L	AFNE
SPECHT, HEINZ	1HNIH	2B	AFNA
SPECK, EUGENE L	2HGWU	2Q	
SPEER, JOHN F	3AAIC	3C	
SPENCE, ROBERT J	2HUMD	3C	
SPENCER, J T	1XNSF	2G	AFRA
SPENCER, LEWIS V	8NRNC		AFNA
SPENCER, ROSCOE R	7RETD		AFNE
SPICER, H CECIL	7RETD	2H	AFNA
SPIES, JOSEPH R	1ARNI	2E	AFRA
SPILLERS, ARTHUR R	1AFOR	2L	
SPILMAN, THEODORE J	1ARFR	2F	
SPINDLER, ROBERT J JR	8NRNC	2B	
SPODEN, F G JR	1IFWS	2L	
SPOONER, CHARLES S JR	5RAYC	2G	AFRA
SPOWART, D J	1DNWS	2X	
SPRAGUE, GEORGE F	1ARFR		AFRA
SPREEN, WILLIAM C	1XNAS	2X	
SPRINGER, DONALD P	1CWEB	2X	
SPRINGER, HAROLD S	1CWEB	2X	
SPROLES, EDWARD S	1CWEB	2X	
SQUILLARO, N	1DNX	2X	
SREB, JULES H	1D-X	2B	
ST CLAIR, GILBERT L	1CWEB	2X	
ST GEORGE, RAYMOND A	1AFOR	2D2F2L	AFRA
STAATS, WAYNE F	1CWEB	2X	
STADTMAN, E R	1HNIH		AFRA
STAHL, WILLIAM J	1AFOR	2L	
STAIR, RALPH	1CNBS	2G2N	AFRA
STAKMAN, E C	8NRNC		AFNA
STANFIELD, JOHN T	3HDCG	2Q	
STANFORD, JOHN W	1CNBS	2V	
STANLEY, ALFRED R	1HNIH	2Q	
STANTON, T R	7RETD	2K	
STANWICK, TAD	5PNDY	2B	
STAPLES, BERT R	2HUMD	3E	
STARCKE, HELLE	9CLUN	2F	
STARK, LOYAL P	1CWEB	2X	
STASSINOPOULOS, E G	1XNAS	2B	
STAUFFER, EVA M	1DAWR	2Q	
STAUSS, HENRY E	1XNAS	2U	AFRA
STEARN, JOSEPH L	1CCGS		AFRA
STEELE, ERNEST K	1AMRP	3C	
STEERE, RUSSELL L	1ARFR	2K	AFRA

STEFANSSON, VILHJALMUR	8NRNC		AFNE
STEGUN, IRENE A	1CNBS		AFRA
STEIGER, RONALD L	9CLUN	2B	
STEIN, ROBERT P	1DNOD	2X	
STEIN, WALTER L	1CWEB	2X	
STEINBERG, R A	7RETD	2K	
STEINBERGER, RAYMOND L	1DNRL	2B	
STEINER, HAROLD A	1DFWS	2X	
STEINER, ROBERT F	1DNMR	2B2E	AFRA
STEINER, WILLIAM F	3IDTM	2B	
STEINHARDT, JACINTO	2HGEU	2E	AFRA
STEINHAUER, ALLEN L	2HUMD	2F	
STEPHAN, ROBERT M	1HNIH	2V	AFRA
STEPHENS, ROBERT E	1CNBS	2B	AFRA
STEPHENSON, JOHN L	1HNIH	2B	
STERN, ARTHUR M	9CLUN	2Q	
STERN, JOSHUA	1CNBS	2B	
STERN, KURT H	1CNBS	2E3E	AFRA
STERN, WILLIAM L	1XSMI	2K	
STERNBERG, RICHARD W	3AABC	3C	
STERNE, THEODORE E	9CLUN	2B	
STETSON, ROBERT F	9CLUN	2B	
STETTEN, DEWITT JR	1HNIH	2B	
STEVENS, DONALD K	1XAEC	2B	
STEVENS, HENRY	1ARNI	2E2G2T	AFRA
STEVENS, ROLLIN E	8NRNC		AFNA
STEVENS, RUSSELL B	2HGWU	2K	AFRA
STEVENSON, FREDERICK J	4CONS	2G	AFRA
STEVENSON, JOHN A	7RETD	2G2K	AFRE
STEWART, DEWEY	1ARFR	2G2K	AFRA
STEWART, ILEEN E	1XNSF		AFRA
STEWART, ROBERT N	1ARFR	2K	
STEWART, SARAH E	1HNIH	2T	AFRA
STEWART, T DALE	1XSMI	2C	AFRA
STEYSKAL, GEORGE C	1ARFR	2F	
STIEBELING, HAZEL K	7RETD	2E	AFRA
STIEHLER, ROBERT D	1CNBS	2B2E2G2O	AFRA
STIEWIG, NATHAN W	1CWEB	2X	
STILL, JOSEPH W	4PHYS	2B	AFNA
STILLER, BERTRAM	1DNRL	2B2G	AFRA
STIMSON, HAROLD F	7RETD	2B2G	AFRE
STINSON, AUBREY	1HFDA	2Q	
STIREWALT, EDWARD N	5ANSE	2B	
STIRLING, MATHEW W	7RETD	2C2G	AFRA
STITT, MERIE E	1INPS	2L	
STOBER, ALFRED K	1XNAS	2B	
STODDARD, CHARLES H	1IBLM	2L	
STOFFER, DWIGHT R	1CWEB	2X	
STOKES, ILEY E	1ARFR	2K	
STOMMEL, HERMAN G	1CWEB	2X	
STONE, ALAN	1ARFR	2F	
STONE, ALBERT M	3IAPL	2B	
STONE, JOSEPH C	3HDCG	2Q	
STONE, LEON	1DFX	2X	
STOREY, HERBERT C	1AFOR	2L	
STOUT, NEIL J	1IBOR	2L	
STOWELL, DAVID J	1CWEB	2X	
STRALKA, RAYMOND J	1CWEB	2L2X	
STRAND, KAJ A	1DNOB	2B	
STRASBERG, MURRAY	1DNDT	2Z	AFRA
STRAUB, HARALD W	1CCGS		AFRA
STRAUSS, SIMON W	1DNRL	2B	
STREEVER, RALPH L JR	1CNBS		AFRA
STRICKLER, ROBERT F	1CWEB	2X	
STRINGFIELD, VICTOR T	1IGES	2G2H2L	AFRA
STUART, NEIL W	1ARFR	2K	AFRA
SUCHARD, MINNIE R	2HGEU	2Q	
SUDDETH, JIMMIE A	1CNBS	2B	
SUITOR, EARL C JR	1DNMR	2Q	
SULLIVAN, DANIEL A JR	2HUMD		AMRA
SULLIVAN, WILLIAM N JR	1ARFR	2F	
SULZBACHER, WILLIAM L	1ARNI	2Q3C	
SUMMERS, DONALD	1HPHS	3C	
SUMNER, HOWARD C	1CWEB	2X	
SUMP, ALBERT W	1AFOR	2L	
SUNDERLAND, LAWRENCE B	1XUST	2L	
SUPPLEE, MARGARET V	1CWEB	2X	
SURGEN, RAYMOND C	9CLUN	2Q	

SUTCLIFFE, WALTER D	7RETD	2B2G2M2R	AFRE
SUYDAM, BERGEN R	9CLUN	2B	
SVENSON, H K	1IGES	2K	
SVIRBELY, WILLIAM J	2HUMD	2B	
SWALLEN, J R	1XSMI	2K	
SWANNER, WILLIAM C	1D-X	2X	
SWANSON, DWIGHT W	1ASCS	2X	
SWANSON, HENRY A	4DENT	2V	
SWANSON, NILS	1CNBS	2B	
SWARTHOUT, PAUL A	1AFOR	2L	
SWAYNE, WILLIAM W	1CWEB	2X	
SWEENEY, JAMES P	1ARNI	3C	
SWEENEY, WILLIAM T	1CNBS	2E2U2V	AFRA
SWEFT, JAMES S	1CWEB	2X	
SWEM, THEODOR R	1INPS	2L	
SWICK, CLARENCE H	7RETD	2B	AFRE
SWIFT, CLIFTON E	1ARNI	3C	
SWIFT, LLOYD W	7RETD	2L	
SWINDELLS, JAMES F	1CNBS	2B	AFRA
SWINGLE, CHARLES F	7RETD		AFNA
TABER, ROBERT W	1DNOD	2X	
TALBERT, PRESTON T	2HHOU	2E	AFRA
TALBOT, W WADE	1HFDA	2Q	
TALBOTT, F LEO	2HCUA	2B2G	AFRA
TALCOTT, MARION G	1CWEB	2X	
TALIAFERRO, W H	1XAEC		AFNA
TALLEY, J WALLACE	9CLUN	2B	
TAPAGER, JAMES R D	1DNOC	2X	
TAPKE, VICTOR F	7RETD	2K	
TARRANT, CARL J	1DAWR	2Q	
TASAKI, ICHIJI	1HNIH		AFRA
TATE, DOUGLAS R	1CNBS	2B2G	AFRA
TATUM, G R	5VILA	2B	
TAUBENSEE, ROBERT E	1CWEB	2X	
TAUSSKY, OLGA	8NRNC		AFNA
TAYLOR, ALBERT L	1ARFR	2K	AFNA
TAYLOR, GLENN R	1XMDG	2Q	
TAYLOR, JAMES H	2HGWU		AFRE
TAYLOR, JOHN K	1CNBS	2B2E2G3E	AFRA
TAYLOR, LAURISTON S	1CNBS		AFRA
TAYLOR, MARIE C	2HHOU	2K	AMRA
TAYLOR, MODDIE D	2HHOU	2E	AFRA
TAYLOR, RAYMOND L	3AAAS		AFRA
TAYLOR, ROBERT L	1DAWR	2Q	
TAYLOR, ROBERT T	1DNX	2F	
TAYLOR, W BRUCE	9CLUN	2B	
TAYLOR, WILLIAM	1DFWS	2X	
TCHEN, CHAN-MOU	1CNBS	2B	AFRA
TEELE, RAY P	1CNBS	2B2G	AFRA
TELFORD, IRA R	2HGWU	2T	AFRA
TEMPLE, C E	7RETD	2K	
TEMPLETON, DAVID F	9CLUN	2B	
TEMPLETON, GEORGE S	1CWEB	2X	
TEMPLIN, HERMAN A	1DNOL	2B	
TENNANT, RAYMOND W	5MIAS	2Q	
TENNYSON, GEORGE P JR	1XNAS	2X	
TEPPER, MORRIS	1XNAS	2W2X	AFRA
TERRELL, EDWARD E	1ARFR	2K	
TERWILLIGER, RICHARD G	1DARO	2X	
TEWELES, SIDNEY	1CWEB	2X	AFRA
THALER, WILLIAM J	2HGEU		AFRA
THAYER, THOMAS P	1IGES	2H	AFRA
THEODORIDES, PHRIXOS J	7RETD	2B	
THIEL, GORDON D	1CWEB	2X	
THOM, HERBERT C S	1CWEB	2X	AFRA
THOMAS, ARTHUR R	1DFWS	2X	
THOMAS, BILLY D	1CWEB	2X	
THOMAS, CHARLES A	1ARFR	2K	AMRA
THOMAS, H REX	1ARFR	2K	
THOMAS, HARRY F	1CWEB	2X	
THOMAS, JAMES L	4CONS		AFRA
THOMAS, L KAY JR	1INPS	2K	
THOMAS, LEON R	1AFOR	2L	
THOMAS, PAUL D	1DNOC		AFRA
THOMAS, R F	1DNWS	2X	
THOMPSON, BERTRAND J	1DNOC	2X	

THOMPSON, DONALD R	1DFWS	2X	
THOMPSON, EDWIN S	1CWEB	2X	
THOMPSON, HAROLD P	1XNAS	2X	
THOMPSON, HERBERT J	1CWEB	2X	
THOMPSON, JACK C	1CWEB	2X	AFRA
THOMPSON, JOHN I	1ARMR	3C	
THOMPSON, JOHN V	1ARFR	2F	
THOMPSON, PHILIP D	8NRNC		AFNA
THOMPSON, RANDALL L	1HNIH	2Q	
THOMPSON, RICHARD L	9CLUN	2L	
THOMPSON, ROSCOE E	1CWEB	2X	
THOMSON, JAMES E	1ARMR	3C	
THORNTON, PHILIP L	1AFOR	2L	
THURMAN, ERNESTINE B	1HNIH	2F2G	AFNA
TICKLES, JOSEPH JR	3HDCG	2Q	
TIDMAN, DEREK A	2HUMD	2B	
TIDSALL, CHARLES S	2HGWU	2I2T	AFRA
TIEDEMAN, JOHN A	3IAPL	2B	
TIERNAN, EDWARD V	1DFWS	2X	
TILDEN, EVELYN B	7RETD	2G	AFNE
TILFORD, SHELBY G	1DNRL	2B	
TILLSON, ALBERT H	1HFDA	2K	
TILLYER, E D	8NRNC		AFNA
TIMCHALK, ANDREW	1CWEB	2X	
TIMMS, MARY L	1DNX	2B	
TINER, JACK D	5MELP	2Q	
TINGLE, ADRIAN A	1DNWS	2X	
TIPSON, R STUART	1CNBS	2E	AFRA
TITTSLER, RALPH P	1ARNI	2Q3C	AFRA
TITUS, HARRY M	4X	2G	AFNA
TOBIAS, JEROME	1XDCG	2B	
TOBIN, RALPH A	1DNRL	2B	
TOBIN, WILLIAM T	1AOIG	2L	
TODD, EDWARD L	1ARFR	2F	
TODD, FRANK E	1ARFR	2F2Y	AFRA
TODD, MARGARET R	1IGES	2G2H	AFRA
TOEPFER, EDWARD W	1ARNI	3C	
TOLDBY, VERNER	8NRNC	3C	
TOLL, JOHN S	2HUMD	2B	AFRA
TOLLE, CHESTER D	1HFDA	3C	
TOMKINS, GORDON	1HNIH	2B	
TOMLINSON, HARRY R	1TIRS	2L	
TOMS, M ELAINE	1DNRL	2B	
TOOL, ARTHUR Q	1CNBS	3D	AFRA
TOOLE, EBEN H	7RETD	2K	
TOOLE, VIVIAN K	1ARFR	2K	
TORGESEN, JOHN L	1CNBS	2E2G	AFRA
TORRESON, OSCAR W	7RETD	2B	AFRE
TOULMIN, PRIESTLEY	1IGES	2H	AFRA
TOUSEY, RICHARD	1DNRL	2B	AFRA
TOWNSEND, JAMES G	9CLUN	2B	
TOWNSEND, JOHN R	4CONS	2B	AFRA
TRAGER, GEORGE L	8NRNC	2C	AFNA
TRAPP, ORLIN D	5WEEL	3E	
TRAUB, R G	1HNIH	2Q	
TRAUB, ROBERT	2HUMD	2D2F2P	AFRA
TRAVIS, CLARENCE W	1XDCG	2F	AMRA
TREADWELL, CARLETON R	2HGWU	2T	AFRA
TREBBE, WILLIAM J	1CWEB	2X	
TRENT, EVA M	1DNRL	2B	
TRENT, HORACE M	1DNRL	2B2Z	AFRA
TRESSIER, WILLIS L	1DNOC	2G	AFRE
TREXLER, JAMES H	1DNRL	2B2G2S	AFRA
TROGOLO, ALBERT G	1DNOC	2X	
TROMBA, FRANCIS G	1ARFR	2P	AFRA
TROUNSON, EDWARD P	1DNOL	2B	
TRUEBLOOD, CHARLES K	7RETD		AFRA
TRUEBLOOD, EMILY	1HNIH	2Q	
TRUESDELL, DONOVAN F	1CWEB	2X	
TRUESDELL, PAGE E	1DNPI	2H	AFRA
TRYON, MAX	1CNBS	2E	AFRA
TRYTTEN, M H	3INAS	2B	
TSAI, DONALD H	1CNBS	2B	
TULANE, VICTOR J	8NRNC		AFNA
TULLY, JOSEPH G	1HNIH	2Q	
TUNELL, GEORGE	8NRNC	2H	AFNA
TURNER, DAVID M JR	1DNOL	2B	
TURNER, JAMES E	8NRNC	2B	
TURNER, JAMES H	1ARFR	2P	AFRA
TURNER, JOSEPH	9CLUN	2B	
TURNER, ROBERT	3IAPL	2B	
TURPIN, JEAN M	5SNUR	2K	
TURRELL, GEORGE C	2HHOU		AFRA
TUTTELL, JOHN J	1DNOC	2X	
TUVE, MERLE A	3IDTM	2B	AFRA
TWIGG, BERNARD A	2HUMD	3C	
TYLER, GEORGE W	9CLUN	2B	

UHLANER, J E	1DAX		AMRA
UHLER, FRANCIS M	1IFWS		AFRA
UHRING, JOSEPH	1ARFR	2K	
ULLRICH, DONALD E	5SHCH	2F	
UMPLEBY, JOSEPH B	7RETD	2H	AFNE
UNDERWOOD, ELTON H	9CLUN	2L	
UYEHARA, GEOFFREY U	9CLUN	2B	

VACHER, HERBERT C	7RETD		AFRE
VALITSKI, ROBERT	1DNOC	2X	
VAN CLEEF, FREDERICK L	1CWEB	2X	
VAN DERSAL, WILLIAM R	1ASCS		AFRA
VAN DYKEN, ALEXANDER R	1XAEC	2B	
VAN EVERA, BENJAMIN D	2HGWU	2E2G	AFRA
VAN EVERA, R W	9CLUN		AMRA
VAN HOESEN, RICHARD W	9CLUN	2B	
VAN REEN, ROBERT	1DNMR	2V	
VAN TASSELL, EILEEN R	2HCUA	2F	
VAN VALKENBURG, ALVIN	1CNBS	2B	
VANCE, ARLO M	1ARFR	2F	
VANDERMAN, LLOYD W	1CWEB	2X	
VANDERSLICE, JOSEPH T	2HUMD	2B2E	AFRA
VANDIVERE, EDGAR F JR	5PACO	2B	
VANE, FRANCIS F	1DNX	2B	
VANGELI, MARIO G	8NRNC	2G	AMRA
VARGOSKO, ANDREW J	1HNIH	2Q	
VASAITIS, ANTHONY J	1AFOR	2L	
VASQUEZ, ALBERTO W	1HFDA	2F	
VAUGHAN, WILLIAM H	1DNRL	2B	
VAUGHN, M W	8NRNC	3C	
VEDROS, N A	1DNMR	2Q	
VEITCH, FLETCHER P JR	2HUMD	2E2T	AFRA
VEITH, ANTHONY J	1CWEB	2X	
VERDER, ELIZABETH	1HNIH	2Q	
VERNICK, SANFORD H	2HGEU		AMRA
VERNON, EDWARD M	1CWEB	2X	
VERWIEBE, FRANK L	2HMJC	2B	
VESTINE, E H	8NRNC		AFNA
VIEBROCK, HERBERT J	1CWEB	2X	
VIGLOTTI, CLEMENT F	1DNBS	3E	
VIGNESS, IRWIN	1DNRL	2B2G2Z	AFRA
VIGUE, KENNETH J	5ITTC	2N	AMRA
VILLAREJO, JAMES	1CWEB	2X	
VINAL, GEORGE W	7RETD	2B2G	AFNE
VINCENT, R H	1DFX	2F	
VINTI, JOHN P	1CNBS	2B2G	AFRA
VISCO, EUGENE P	8NRNC	2B	
VITAS, GEORGE	1AFOR	2L	
VIVONA, STEFANO	1DAWR	2Q	
VOGT, GEORGE B	1ARFR	2F	
VOLWILER, ERNEST H	7RETD	2G	AFNA
VON BRAND, THEODOR C	1HNIH	2P2T	AFRA
VON BRETZEL, JAMES JR	1DNOL	2B	
VON BRIESEN, ROY JR	9CLUN	2B	
VORE, CHARLES W	1CWEB	2X	
VORIS, LEROY	3INAS		AFRA
VOZZO, JOHN A	1AFOR	2K	

WACHTMAN, JOHN B JR	1CNBS	2B2G	AFRA
WADDEL, RAMOND C	1XNAS		AFRA
WADE, EARL V	1AFOR	2L	
WADEY, WALTER G	5OPRE		AFRA
WADLEY, F M	7RETD	2F	
WAGGONER, MARY L	1CWEB	2X	
WAGNER, JOSEPH A	1IBIA	2L	

WALDO, GEORGE V	1XFCC 2B	
WALES, CHARLES P	1DNRL 3E	
WALKER, EARNEST A	1ARRP 2K2Q	
WALKER, EGBERT H	7RETD 2K	AFRA
WALKER, JAMES H	3IAPL 2B	
WALKER, ROBERT L	1ARFR 2F	
WALKER, SYLVESTER E	1DFWS 2X	
WALKER, WILLIAM C	8NRNC 3C	
WALKLEY, LUELLA M	1ARFR 2F	
WALL, LEO A	1CNBS 2B2E	AFRA
WALLACE, J ALLEN JR	1CWEB 2X	
WALLACE, JAMES D	9CLUN 2B	
WALLEN, IRVIN E	1XSMI 2G	AFRA
WALLER, SYLVIA L	9CLUN 2B	
WALLIS, M W MRS	9CLUN 2B	
WALLIS, RICHARD F	1DNRL 2B	
WALLS, EDGAR P	7RETD 2K	
WALSH, J PAUL	5MATR 2B	
WALTER, HOMER E	1ARNI 3C	
WALTHER, CARL H	2HGWU 2G2S	AFRA
WALTON, GEORGE P	7RETD	AFRE
WALTON, MARGARET	1ARRP 2F	
WALTON, RONALD J	1DNOD 2X	
WALTON, THOMAS S	1DNDT 2B	
WALTON, WILLIAM W	1CNBS 2E	AFRA
WARBURTON, DONALD L	9CLUN 3E	
WARBURTON, FRED W	9CLUN 2B	
WARD, HENRY P	7RETD 2E	AFRE
WARD, JUSTUS C	1ARRP	AFRA
WARD, RAY	1XCON 2L	
WARD, THOMAS G	5MIAS 2Q2T	AFRA
WARGA, MARY E	3AOSA 2B2E2G	AFRA
WARING, JOHN A	4CONS 2G	AMRA
WARK, DAVID Q	1CWEB 2X	
WARNER, JACOB L	1DNOR 2B	
WARNER, ROSE E	1XSMI 2F	
WASHER, F E	1CNBS	AFRA
WASHINGTON, OTHELLO	1DAWR 2Q	
WASIK, STANLEY P	1CNBS 2E	AMRA
WASSALL, ROBERT B	1CWEB 2X	
WATERMAN, ALAN T	7RETD 2B2W	AFRA
WATERMAN, PETER	1DNRL 2G2N	AFRA
WATERS, WELLINGTON	1DNOD 2X	
WATKINS, ROGER R	1CWEB 2X	
WATKINS, WILLIAM N	9CLUN 2L	
WATSON, ALICE J	1ARFR 2K	
WATSTEIN, DAVID	1CNBS	AFRA
WATTS, CHESTER B	7RETD 2B2G	AFRA
WAY, KATHARINE	8NRNC 2B	
WEAVER, CLAYTON N	1AFOR 2L	
WEAVER, DE FORREST E	1IGES	AMRA
WEAVER, ELMER R	7RETD 2C2E	AFRA
WEAVER, LESLIE O	2HUMD 2K	
WEAVER, LORAN A	1DFWS 2X	
WEBB, ALFRED M	1HNIH 2Q	
WEBB, BYRON H	1ARNI 3C	
WEBB, CHARLES E	1DFWS 2X	
WEBB, J E JR	7RETD 2F	
WEBB, RAYMON E	1ARFR 2K	
WEBB, ROBERT W	1ARMR 2B2K	AFRA
WEBBER, JOHN P	1CWEB 2X	
WEBBER, PAUL E	1CWEB 2X	
WEBBER, ROBERT T	1SX	AFNA
WEBER, EUGENE W	1DAEX 2M2R2S	AFRA
WEBER, FREDERICK P	1AFOR 2L	
WEBER, JOSEPH	2HUMD 2B	
WEIDA, FRANK M	7RETD 2B	AFRE
WEIDLEIN, EDWARD R	8NRNC	AFNE
WEIFFENBACH, GEORGE C	3IAPL 2B	
WEIGEL, C A	7RETD 2F	
WEIGLE, DAVID J	8NRNC 2B	
WEIHE, WERNER K	1DAER 2G2N	AFRA
WEIL, GEORGE R	4CONS 3B	AFRA
WEINBERG, HAROLD P	5VAEN 2U	AFRA
WEINSTEIN, MARVIN S	5UNSY 2B	
WEINTRAUB, ROBERT L	2HGWU 2E2K	AFRA
WEINTRAUB, STANLEY	5EMRE 2B	
WEIR, C EDITH	1ARNI 3C	

WEIR, CHARLES E	1CNBS	AFRA
WEISMAN, DONALD M	1ARFR 2F	
WEISS, EMILIO	1DNMR 2Q	
WEISS, FRANCIS J	1XLIC 2B2E2G2K2Q	AFRA
WEISS, FRANCIS J	1XLIC 3B3C	AFRA
WEISS, FREEMAN A	7RETD 2Q	AFNE
WEISS, LEONARD L	1CWEB 2X	
WEISS, RICHARD A	1DARO	AFRA
WEISSBERG, SAMUEL G	1CNBS 2B2E	AFRA
WEISSLER, ALFRED	1DFOS 2B2E2W2Z	AFRA
WEISSMAN, STANLEY	2HUMD 2B	AFRA
WELD, CLARK J	7RETD 2K	
WELDON, ROGER B	1DFWS 2X	
WELLMAN, FREDERICK L	8NRNC	AFNE
WELLS, FRED E	1CWEB 2X	
WELLS, HARRY W	3INAS 2B	
WELLS, HOWARD J	1CWEB 2X	
WELSH, PATRICIA D	1HNIH 2Q	
WENDT, LORINA	9CLUN 2K	
WENNERSTEN, DWIGHT L	1DFX 2B	
WENSCH, GLEN W	1XAEC 2G2U3B	AFRA
WENTZ, BARRY A	1HFDA 2Q	
WERSHING, HENRY F	1IBIA 2L	
WESKE, JOHN R	2HUMD 2B	
WESSEIA, CONRAD P	1AFOR 2L	
WESSEL, PAUL R	1DNOL 2B	
WEST, ALMA B	1CWEB 2X	
WEST, EDWARD J	1DNRL 2B	
WEST, ESTAL D	1CNBS 2B	
WEST, JAMES C	1DNWS 2X	
WEST, RICHARD K	1HNIH 2Q	
WESTENBERG, ARTHUR A	3IAPL 2E	AFRA
WESTER, HORACE V	1INPS 2K	
WESTER, ROBERT E	1ARFR 2K	
WETMORE, ALEXANDER	7RETD 2D2G	AFRA
WEXLER, ARNOLD	1CNBS 2B	AFRA
WEYANT, WILLIAM S	1CWEB 2X	
WEYL, F JOACHIM	1DNOR 2B	AFRA
WEYRES, WALTER J	1CWEB 2X	
WHEELER, NANCY H	9CLUN 2F	
WHEELER, RONALD E	2HUMD 2F	
WHEELER, WILLIS H	1ARRP 2G2K	AMRA
WHELAN, WILLIAM T	5ACFE 2B	
WHERRY, EDGAR T	7RETD	AFNE
WHITE, BOYD P	1CWEB 2X	
WHITE, CHARLES E	2HUMD 2E	AFRA
WHITE, HUGH S	1D-X 2X	
WHITE, JOSEPH C	1DNRL 3E	
WHITE, MACK	1HFDA 2Q	
WHITE, ORLAND E	7RETD	AFNE
WHITE, RICHARD O	1ARRP 2F	
WHITE, ROBERT M	1CWEB 2X	AFRA
WHITELY, THOMAS D	1CWEB 2X	
WHITESIDE, JOHN M	1AFOR 2L	
WHITMAN, MERRILL J	1XAEC 3B2U	AFRA
WHITNEY, LINWOOD F JR	1CWEB 2X	
WHITTAKER, COLIN W	1ARFR 2E2G	AFRA
WHITTEN, CHARLES A	1CCGS 2B2G2R	AFRA
WICHERS, EDWARD	3INAS 2E	AFRA
WIENER, ALFRED A	1AFOR 2L	
WIGGINS, THOMAS B	2HGWU 2B	
WILCOX, MARGUERITE	7RETD 2K	
WILDER, THOMAS V	1XLIC 2L	
WILDHACK, WILLIAM A	1CNBS 2B2G2W	AFRA
WILEY, ROBERT C	2HUMD 3C	
WILKIE, JOHN B	1HX 2B	
WILKINS, GEORGE R	5CONC 3C	
WILKINS, JUDD R	3IERF 2Q	
WILKOFF, LEE J	5WORE 2Q	
WILLIAMS, DONALD H	3ADIS 2G3C	AMRA
WILLIAMS, ELLIS T	1AFOR 2L	
WILLIAMS, JAMES T	1CWEB 2X	
WILLIAMS, LLEWELYN	1ARFR 2K	
WILLIAMS, VERNON L	9CLUN 2B	
WILLIAMS, W K	1AFOR 2L	
WILLIER, LILLIAN E	1SAID 2K	AMRA
WILSON, B JAMES	1DNRL 2B	
WILSON, BRUCE L	1CNBS 2B2G	AFRA

WILSON, CLYDE R	1HFDA	2Q	
WILSON, H M	1DNX	2X	
WILSON, KATHERINE	9CLUN	2K	
WILSON, RAYMOND E	8NRNC	2B2G	AFNA
WILSON, ROBERT E	1DNOL	2B	
WILSON, WALTER T	1CWEB	2X	
WILSON, WILLIAM E JR	3IAPL	2B	
WILSON, WILLIAM K	1CNBS	2E2G	AFRA
WINER, DAVID E	5AMMA	2B	
WINNER, JOHN P	1CWEB	2X	
WINNINGHOFF, FRANCIS J	1CWEB	2X	
WINSTON, CLEMENT	1CX	2B	
WINSTON, JAY S	1CWEB	2X	
WINT, CECIL T	8NRNC		AFNA
WINTERS, HAROLD F	1ARFR	2K	
WINTERS, ROBERT K	1AFOR	2L	
WIRTH, WILLIS W	1ARFR	2F	
WISE, JAMES W	1CWEB	2X	
WISPE, LAUREN G	9CLUN	2B	
WITHERINGTON, JAMES D	1DFWS	2X	
WITHROW, ALICE P	1XNSF	2K	AFRA
WITKOP, BERNHARD	1HNIH	2E	AFRA
WITTLER, RUTH G	1DAWR	2Q	
WITTMANN, WALTER I	1DNOC	2X	
WOFFINDEN, CHARLES M	1CWEB	2X	
WOHLIETER, JOHN A	1DAWR	2Q	
WOJCIK, B H	8NRNC	3E	
WOKE, PAUL A	1HNIH	2F	
WOLBARSHT, MYRON L	1DNMR	2F	
WOLCOTT, NORMAN M	1CNBS		AMRA
WOLF, HARRY E	1DNOL	2B	
WOLF, KENNETH E	1IFWS	2Q	
WOLF, ROBERT E	1IBLM	2L	
WOLF, VIRGINIA S	1ARFR	2F	
WOLFF, JOHN H	1DNDT	2B	
WOLFLE, DAEL	3AAAS		AFRA
WOLICKI, ELIGIUS A	1DNRL		AFRA
WOLK, MARTY	1CWEB	2X	
WOLLMAN, SEYMOUR H	1HNIH	2B	
WOMACK, MADELYN	1ARNI	2E2T	AFRA
WOOD, CHARLES B	8NRNC	3C	
WOOD, CHARLES P	1XNAS	2X	
WOOD, ERNEST A	1CWEB	2X	
WOOD, GARNETT	1DAWR	2Q	
WOOD, GWENDOLYN B	1DAHD	3E	
WOOD, JESSIE I	7RETD	2K	
WOOD, LAWRENCE A	1CNBS	2B2E	AFRA
WOOD, LLOYD A	9CLUN	2B	
WOOD, REUBEN E	2HGWU	2E3E	AFRA
WOOD, ROBERT C	2HGWU	2Q	
WOOD, W B	7RETD	2F	
WOOD, WILLIAM E	9CLUN	2B	
WOOD, WILLIAM H	5HOSH	3C	
WOODBURY, C G	7RETD	2K	
WOODS, G FORREST	2HUMD	2E	AFRA
WOODS, GILBERT N	1DFWS	2X	
WOODS, MARK W	1HNIH	2K2T	AFRA
WOODSTOCK, LOWELL W	1AX	2K	
WOOLF, HAROLD M	1CWEB	2X	
WOOLHISER, J E	1CCGS	2B	
WOOLLEY, JOHN P	9CLUN	3E	
WOOLLUM, CLARENCE A	1CWEB	2X	
WORF, DOUGLAS L	1XNAS	2B	
WORKMAN, WILLIAM G	7RETD	2G	AFRA
WRAGG, JUNE B	1ARNI	2Q	
WRENCH, JOHN W JR	1DNDT	2G	AFRA
WRIGHT, G R	1CWEB	2X	
WRIGHT, GERAIL G	1IBLM	2L	
WRIGHT, ROBERT	7RETD	2K	
WRIGHT, WILLIAM E	1DNOR	2B	
WULF, OLIVER B	8NRNC		AFNA
WURDACK, JOHN J	1XSMI	2K	
WYATT, SAMUEL V	1CWEB	2X	
WYCKOFF, HAROLD O	1CNBS	2B	
WYETT, ROY E	1CWEB	2X	
WYMAN, LEROY L	1CNBS	2G2U	AFRA
YAGODA, HERMAN	8NRNC	2B	

YAMAMOTO, ROBERT T	1ARFR	2F	
YANCEY, FRANCES S	2HUMD	2Q	
YAO, AUGUSTINE Y M	1CWEB	2X	AMRA
YAPLEE, BENJAMIN S	1DNRL	2N	AFRA
YARKIN, STANLEY	1CWEB	2X	
YATES, LUCILLE	1ARRP	2F	
YEAGER, J FRANKLIN	1HNIH		AFRA
YEAGER, LEE E	9CLUN	2L	
YEANDLE, STEPHEN S	2HGWU	2B	
YEATMAN, JOHN N	1ARMR	3C	
YEOMANS, ALFRED H	1ARFR		AFRA
YERGEN, WALTER E	1DNOC	2X	
YESAIR, JOHN	7RETD	2Q	
YIP, GEORGE	1HFDA	3C	
YOCUM, L EDWIN	7RETD	2K	AFNE
YODER, HATTEN S JR	3ICIW	2E2H	AFRA
YOKLEY, CHARLES R	1CNBS	2B	
YOST, CHARLES F	1D-X	2B	
YOUDEN, WILLIAM J	1CNBS	2B2E2G	AFRA
YOUDEN, WILLIAM W	1CNBS	2B	
YOUMANS, ARTHUR W	1CWEB	2X	
YOUNG, DAVID A JR	8NRNC	2F	AFNA
YOUNG, EDWARD J	2HGEU	2Q	
YOUNG, JESSIE M	1CNBS	2B	
YOUNG, MURRAY J	1DFWS	2X	
YOUNG, ROBERT T JR	1DAHD	2G2N	AFRA
YOUNG, THEODORE R	1CNBS	2B	
YOUNG, VIOLA M	1HNIH	2Q	
YOUNKIN, RUSSELL J	1CWEB	2X	
YUHAS, MELVIN L	9CLUN	2L	
YUILL, JOSEPH S	1AFOR	2F2G2L2Y	AFRA
ZAIDLICZ, EDWIN	1IBLM	2L	
ZAMBORSKY, ANDREW V	1CWEB	2X	
ZARTMAN, IRA F	9CLUN	2B	
ZAUMEYER, WILLIAM J	1ARFR	2K	
ZEGEL, FERDINAND H	1CWEB	2X	
ZEHRING, ROBERT W	1XAEC	2B	
ZEITLER, ELMAR K	9CLUN	2B	
ZELEN, MARVIN	1HNIH	2B	AFRA
ZELENY, LAWRENCE	1AMRP	2E2G	AFRA
ZEN, E-AN	1IGES	2H	AFRA
ZIERDT, CHARLES H	1HNIH	2Q	
ZIES, EMANUEL G	7RETD	2E2H2G	AFRE
ZIKEEV, NINA	1CWEB	2X	AMRA
ZIMERMANN, ALFRED G	7RETD	2G	AFRA
ZIPKIN, ISADORE	1HNIH	2V	
ZISMAN, WILLIAM A	1DNRL	2E	AFRA
ZMUDA, ALFRED J	3IAPL	2B	AFRA
ZOCH, RICHMOND T	7RETD	2X	AFRA
ZUFFANTE, S M	1HFDA	2Q	
ZUMWALT, EUGENE V	1IBLM	2L	
ZWANZIG, ROBERT W	1CNBS	2B2G	AFRA
ZWEMER, RAYMUND L	3AAPH		AFRA
ZYLINSKI, JOSEPH	1AFOR	2L	

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PARKER, KENNETH W	2K2L	AFRA
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SHIELDS, CHESTER A	2L	
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ST GEORGE, RAYMOND A	2D2F2L	AFRA
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HALL, DAVID G	2F	
HILBERT, GUIDO E	2E3C	
IRVING, GEORGE W JR	2E3C	AFRA
LEXEN, BERT R	2L	

1ARFR FARM RESEARCH

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ANDERSON, WILLIAM H	2F	
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BOSWELL, VICTOR R		AFRA
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DOWNS, ROBERT J	2K	
DRECHSLER, CHARLES	2G2K	AFRA
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DUTKY, SAMSON R	2Q	
EGOLF, DONALD R	2K	AFRA
EMSWELLER, SAMUEL L	2K	AFRA
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GURNEY, ASHLEY B	2D2F2G	AFRA
HALL, STANLEY A	2E2Y	AFRA
HARMON, DANIEL	2K	
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HENNEBERRY, THOMAS J	2F2Y	AFNA
HERRING, JON L	2F	
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HILDEBRAND, EARL M	2K2Q	
HILTON, JAMES L		AFRA
HINER, RICHARD L	3C	
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HYLAND, HOWARD L	2K	
JACOBSON, MARTIN	2E2Y	AMRA
JONES, SLOAN E	2F	
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KAUFMAN, DONALD D	2Q	
KERR, THOMAS	2K	
KNIPLING, EDWARD F	2F2Y	AFRA
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KROMBEIN, KARL V	2F	
LAMBERT, EDMUND B	2G2K	AFRA
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LE CLERG, ERWIN L	2K	AFRA
LENTZ, PAUL L	2K	
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LOEGERING, WILLIAM Q	2K	
LUGENBILL, PHILIP JR	2F	
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LUND, EVERETT E	2Q	
MASON, HORATIO C	2F	
MAY, CURTIS	2K	
MC CLELLAN, WILBUR D	2G2K	AFRA
MC GRATH, HILDE M	2K	
MC GREW, JOHN R	2K	
MC GUIRE, JUDSON U JR	2F	
MC KAY, JOHN W	2K	
MC MURTREY, JAMES E JR	2K	
MC NALLY, EDMUND H	3C	
MEANS, URA M	2Q	
MENZIES, JAMES D	2Q	
MEYER, FREDERICK G	2K	
MICHAEL, ALBERT S	2F	
MILLER, ALVIN H	2K	
MILLER, PAUL R	2K	AFRA
MILLER, ROBERT H	2K	
MITCHELL, JOHN W		AFRA
NIIMOTO, DOROTHY H	2K	
OAKES, ALBERT J JR	2K	
OMAN, PAUL W	2F	
ORELLANA, RODRIGO G	2K	
OWENS, LOWELL D	2Q	
PAPAVIZAS, GEORGE C	2K	
PARKER, MARION W	2K	AFRA
PERDUE, ROBERT E JR	2K	
PIRINGER, ALBERT A	2K	
POLLOCK, BRUCE M	2G2K	AFRA
PRESLEY, JOHN T		AFRA
PRICE, SAMUEL	2K	
PULTZ, LEON M	2K	
RAINWATER, CLYDE F	2F	
REED, LUCIUS B	2F	
ROBERT, ALICE L	2K	
RODENHISER, HERMAN A	2K	
RUSSELL, LOUISE M	2D2F2G	AFRA
SABROSKY, CURTIS W	2F	
SAILER, REECE I	2F	AFNA
SAN ANTONIO, JAMES P	2K	
SCHAREN, ALBERT L	2K	
SCHECHTER, MILTON S	2E2Y	AFRA
SCHULTZ, EUGENE S	2K	AFRE
SCHULTZE, W D	2Q	
SCOTT, DONALD H	2K	
SHORB, DOYS A	2P	AFRA
SKINNER, HENRY T	2K	
SMITH, C EARLE JR	2K	
SMITH, FLOYD F	2F2Y	AFRA
SPANGLER, PAUL J	2F	
SPILMAN, THEODORE J	2F	
SPRAGUE, GEORGE F		AFRA
STEERE, RUSSELL L	2K	AFRA
STEWART, DEWEY	2G2K	AFRA
STEWART, ROBERT N	2K	
STEYSKAL, GEORGE C	2F	
STOKES, ILEY E	2K	
STONE, ALAN	2F	
STUART, NEIL W	2K	AFRA
SULLIVAN, WILLIAM N JR	2F	
TAYLOR, ALBERT L	2K	AFNA
TERRELL, EDWARD E	2K	
THOMAS, CHARLES A	2K	AMRA
THOMAS, H REX	2K	
THOMPSON, JOHN V	2F	
TODD, EDWARD L	2F	
TODD, FRANK E	2F2Y	AFRA
TOOLE, VIVIAN K	2K	
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VANCE, ARLO M	2F	
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WEISMAN, DONALD M	2F	
WESTER, ROBERT E	2K	
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LIEBERMAN, MORRIS	2E	AFRA
LUTZ, JACOB M	2K3C	AFRA
MERCURI, ARTHUR J	3C	
NICKERSON, DOROTHY	2G	AFRA
NORRIS, KARL H	3C	AFRA
PENTZER, WILBUR T	2B	AFRA
ROSANOFF, BORIS P	2B	
RYALL, A LLOYD	2K3C	AFRA
THOMPSON, JOHN I	3C	
THOMSON, JAMES E	3C	
WEBB, ROBERT W	2B2K	AFRA
YEATMAN, JOHN N	3C	

1ARNI NUTR, CONSUMER & INDUSTRIAL USE

ALFORD, JOHN A	2Q3C	
BANVILLE, ROBERT R	2Q	
BARDROW, JANE	2Q	
BATCHER, OLIVE M	3C	
BELOIAN, ARAM	2Q	
BERMAN, MORRIS D	3C	
BOUMA, CECELIA	2Q	
BROGDON, JENNIE L	3C	
CHAPMAN, VELMA J	3C	
COULSON, E JACK	2E2T	AFRA
CURRAN, HAROLD R	2G2Q	AFRA
DAWSON, ELSIE H	3C	
DETWILER, SAMUEL B JR	2E	AFRA
EDMONDSON, LOCKE F	3C	
EHEART, JAMES F	3C	
FORZIATI, FLORENCE H	2E	AFRA
FREEMAN, ANDREW F	2E	AMRA
FRIEND, BERTA	3C	
GADDIS, ADAM M	3C	
GILPIN, GLADYS L	3C	
GOUGH, BOBBY J	2Q	
HIVON, KATHARINE J	3C	
HOOVER, SAM R	3C	
IRWIN, ISABEL	3C	
KURTZ, FLOYD E	2E	AFRA
LEVERTON, RUTH W		AFRA
LICHTENSTEIN, HAROLD	2Q	
LITTLE, RUBY R	2K3C	
LUND, PAULINE G	2Q	
MACLAY, W DAYTON	3C	
MATCHETT, JOHN R	3C	
MATTHEWS, RUTH H	3C	
MC LEAN, RUTH A	2Q3C	
MC NEIL, ETHEL C	2Q3C	
MENCHER, JORDAN R	2Q	
O BARR, THOMAS P	2Q	
PATTERSON, WILBUR I	3C	
PECOT, REBECCA	3C	
POMMER, ALFRED M	2E2G2T2H	AFRA
REDSTROM, RUTH A	3C	
REYNOLDS, HOWARD	2Q3C	AFRA
SCHLOSSER, GEORGIA C	3C	
SHANEY, JENNIE	3C	

SMITH, JAMES L	2Q	
SPIES, JOSEPH R	2E	AFRA
STEVENS, HENRY	2E2G2T	AFRA
SULZBACHER, WILLIAM L	2Q3C	
SWEENEY, JAMES P	3C	
SWIFT, CLIFTON E	3C	
TITTSLER, RALPH P	2Q3C	AFRA
TOEPFER, EDWARD W	3C	
WALTER, HOMER E	3C	
WEBB, BYRON H	3C	
WEIR, C EDITH	3C	
WOMACK, MADELYN	2E2T	AFRA
WRAGG, JUNE B	2Q	

1ARRP ARS REGULATORY PROGRAMS

ALFORD, HAROLD G	2F	
AUTRY, HOMER V JR	2F	
BAKER, EDWARD W	2F	
BILLINGS, SAMUEL C	2F	
BRANDLY, PAUL J	3C	
CALLAWAY, MINNIE	2F	
CONKLE, HERBERT J	2F	
CONNER, RAY M	2Q	
DAVIS, LOUIS G	2F	
DORWARD, KELVIN	2F	
FUGATE, GUY JR	2Q	
GAMMONS, JOHN G	2F	
GILBERT, ENGEL L	2F	
JOHNSTON, FREDERICK A	2K	
KENWORTHY, FRANCIS T	2K	
LLOYD, GEORGE W	2F	
MC COY, DONALD W	2Q	
MOORE, HARRY J	2L	
O NEILL, KELLIE	2F	
OPALSKY, CHESTER	2Q	
ORTENZIO, LOUIS F	2Q	
PELTIER, PAUL X	2F	
RAINWATER, H IVAN	2F	
REAGEN, EUGENE P	2F	
SCHOEN, JAMES F	2K	
SHERMAN, RALPH W	2F	
SMILEY, ROBERT L	2F	
SOLLERS-RIEDEL, HELEN	2F	
WALKER, EARNEST A	2K2Q	
WALTON, MARGARET	2F	
WARD, JUSTUS C		AFRA
WHEELER, WILLIS H	2G2K	AMRA
WHITE, RICHARD O	2F	
YATES, LUCILLE	2F	

1ASCS SOIL CONSERVATION SERVICE

ALEXANDER, LYLE T	2E	AFRA
DAVIS, ROBERT J	2Q	
FETZER, CARL D	2L	
GRAHAM, EDWARD H	2G	AFRA
LEMMON, PAUL E	2L	
NEWHALL, FRANKLIN	2X	
OREN, EUGENE A	2L	
PHILLIPS, GEORGE R	2L	
PLAIR, THEODORE B	2L	
SWANSON, DWIGHT W	2X	
VAN DERSAL, WILLIAM R		AFRA

1AX AGRICULTURE MISC

BUTLER, WARREN L	2B	
CLARK, FRANCIS E		AFNA
CRAFT, CHARLES C		AFNA
WOODSTOCK, LOWELL W	2K	

1C COMMERCE DEPARTMENT

1C-S OFFICE OF SECRETARY

BETTS, SHERMAN W	2X	
EPSTEIN, EDWARD S	2X	

1CBDS BUSINESS & DEFENSE SERVICES ADM

HERSCHMAN, HARRY K	2U	AFRA
SCHAFFER, JACOB M	3C	
SCHRODER, ARTHUR	3E	

1CBUC BUREAU OF THE CENSUS

HANSEN, MORRIS H		AFRA

1CCGS COAST & GEODETIC SURVEY

BLACKBURN, WILLIAM J	2B	
BRAATEN, NORMAN F	2B2M2R	AFRA
CARDER, DEAN S	2B2H2R	AFRA
CLAIRE, CHARLES N	2B2M	AFRA
HICKLEY, THOMAS J	2S2Z	AFRA
HOSKINSON, ALBERT J	2B	
KNAPP, DAVID G	2G	AFRA
LANDER, JAMES F	2B	
MEADE, BUFORD K	2R	AFRA
MICKEY, WENDELL V	2B	
MURPHY, LEONARD M	2B	AFRA
POLING, AUSTIN C	2N	AFRA
RICE, DONALD A	2R	AFRA
SHALOWITZ, AARON L	2R	AFRA
SIMMONS, LANSING G	2S	AFRA
SMALL, JAMES B	2B2M2R	AFRA
STEARN, JOSEPH L		AFRA
STRAUB, HARALD W		AFRA
WHITTEN, CHARLES A	2B2G2R	AFRA
WOOLHISER, J E	2B	

1CMAA MARITIME ADMINISTRATION

ALLEN, WILLIAM G	2O	AFRA

1CNBS NATIONAL BUREAU OF STANDARDS

ALEXANDER, SAMUEL N	2B2N	AFRA
ALLEN, HARRY C JR	2B2E2G	AFRA
ALT, FRANZ L	2B	AFRA
AMBLER, ERNEST	2B	
ARMSTRONG, GEORGE T	2B2E2G	AFRA
ASTIN, ALLEN V	2B2N2W	AFRA
AUSLOOS, PIERRE J	2E	AFRA
AXILROD, BENJAMIN M	2B	AFRA
BALL, JOSEPH J	2B	
BARBROW, LOUIS E	2B2N	AFRA
BARFIELD, VIVIAN S	2B	
BASS, ARNOLD M	2B	AFRA
BATES, ROGER G	2E	AFRA
BECKETT, CHARLES W	2B2E	AFRA
BEKKEDAHL, NORMAN	2B2E2G	AFRA
BENNETT, JOHN A	2G2U	AFRA
BENNETT, LAWRENCE H	2U	AFRA
BESTUL, ALDEN B	2B	
BLUNT, ROBERT F		AFRA
BOWEN, RAEFEL L	2V	
BOWER, VINCENT E		AFRA
BOYD, MARJORIE E	2B	
BOYLE, DON R	2N	AMRA
BRAUER, GERHARD M	2E2V	AFRA
BRENNER, ABNER	2E2G3E	AFRA
BROWN, WALTER E	2V	
BURNETT, HARRY C	2G2U	AFRA
BURNS, CLAIRE L	2V	
CALDWELL, FRANK R	2B2G	AFRA
CAMERON, JOSEPH M	2B	
CANDELA, GEORGE A		AFRA
CANNON, EDWARD W	2B	AFRA
CARRINGTON, TUCKER	2B2E	AFRA
CASSEL, JAMES M	2E	AFRA
CATTANEO, LOUIS E	2B	
CAUL, HAROLD J	2E2U2V	AFRA
COOK, RICHARD K	2B2Z	AFRA
COOTER, IRWIN L	2B2N	AFRA
CORLISS, CHARLES H	2B	
COSTRELL, LOUIS	2B2N	AFRA
CRAIG, D NORMAN	3E	
CREITZ, E CARROLL	2E	AFRA
DAVIS, MARION M	2E2G	AFRA
DE MACEDO, PEDRO B	2B	
DE WANE, HAROLD J	3E	
DE WIT, ROLAND		AFRA
DIAMOND, JACOB J	2E3D	AFRA

DICKSON, GEORGE	2G2V	AFRA
DOUGLAS, CHARLES A	2B2G	AFRA
DOUGLAS, THOMAS B	2E	AFRA
DUNCAN, BLANTON C	3E	
EBY, RONALD K	2B	
EDELMAN, SEYMOUR	2B	
EICKE, WOODWARD G	3E	
EISENHART, CHURCHILL	2B	AFRA
EISENSTEIN, JULIAN C		AFRA
ELBOURN, ROBERT D	2B2N	AFRA
ELLINGER, GEORGE A	2G2U3E	AFRA
FANO, U	2B	
FERGUSON, ROBERT E	2E	AFRA
FLETCHER, DONALD G	2E	AMRA
FLORIN, ROLAND E	2E	AFRA
FOWLER, HOWLAND A	2B	
FREDERIKSE, H P R		AFRA
FRUSH, HARRIET L	2E	AFRA
FULLER, EVERETT	2B	
FULLMER, IRVIN H	2B2G2O	AFRA
FURUKAWA, GEORGE T	2B2E2G	AFRA
GARVIN, DAVID		AFRA
GARY, ROBERT		AFRA
GEIL, GLENN W	2U	AFRA
GINNINGS, DEFOE C	2E	AFRA
GLASGOW, AUGUSTUS R JR	2E2G	AFRA
GOLDSTEIN, HERBERT	2B	
GORDON, CHARLES L	2B2E2G	AFRA
GORNICK, FRED	2B	
GRAY, VANNIE E	2E	AMRA
GREEN, MELVILLE S	2B	AFRA
GREENOUGH, M L	2G	AFRA
GREENSPAN, MARTIN	2B2G2Z	AFRA
GUILDNER, LESLIE A	2B	
HAGUE, JOHN L	2E2G	AFRA
HAMER, WALTER J	2E2G2N3E	AFRA
HARDY, ROBERT C	2B	
HARMON, GEORGE G JR	2B	
HARRIS, FOREST K	2N	AFRA
HARRISON, WILLIAM N	2B	AFRA
HEALD, ROY H	2B	
HEILPRIN, LAURENCE B	2B	
HENZE, PAUL B	2B	
HILSENRATH, JOSEPH	2B	
HOBBS, ROBERT B	2B2E2G	AFRA
HOEVE, C A	2B	
HOFFMAN, JOHN D	2B2F2L2Y	AFRA
HOOVER, THOMAS B	2E	AFRA
HORNBECK, GEORGE A	2B	
HOWARD, ROBERT E		AFRA
HUBBELL, JOHN H	2B	
HUDSON, RALPH P	2B	
HUNTOON, ROBERT D	2B2N	AFRA
ISBELL, HORACE S	2E	AFRA
JACKSON, JULIUS L	2B	AFRA
JENKINS, WILLIAM D	2U	AMRA
JENSEN, MALCOLM W	2B	
JOHANNESEN, ROLF B	2E2G	AFRA
JOHNSON, DANIEL P	2B2G	AFRA
JONES, FRANK E	2B	
JOSEPH, HORACE M	2B	
JUDD, DEANE B	2B	AFRA
KAHN, ARNOLD H		AFRA
KANAGY, JOSEPH R	2E	AFRA
KEEGAN, HARRY J	2E2G	AFRA
KESSLER, KARL G	2B	AFRA
KLEBANOFF, PHILIP S	2B	
KLEIN, RALPH	2B	
KOPEC, CASIMIR S	2B	
KOSTKOWSKI, HENRY J	2B	AFRA
KOTTER, F RALPH	2N	AFRA
KRUGER, JEROME	2E3E	AFRA
KUMPULA, JOHN W	2V	
KUSHNER, LAWRENCE M	2U	AFRA
KUYATT, CHRIS E	2B	
LA VILLA, ROBERT E	2B	
LAMB, VERNON A	3E	
LANDON, HARRY H JR	2B	

LASHOF, THEODORE W	2B2G	AFRA
LAW, CATHERINE	3E	
LIDE, DAVID R JR		AFRA
LLOYD, EDWARD C	2B	
LOGAN, HUGH L	2U3E	AFRA
MANDEL, JOHN	2B2E	AFRA
MANN, DAVID E	2E	AFRA
MANN, WILFRID B	2B	
MANNING, JOHN R	2G	AFRA
MARSDEN, CHARLES P	3E	
MARTIN, GORDON M	2B	
MARTON, L L	2B	AFRA
MARTON, TIBOR W	2B	
MARVIN, ROBERT S	2B2E2G	AFRA
MARYOTT, ARTHUR A	2E2G	AFRA
MASON, HENRY L	2B	
MATHESON, HARRY	2B	
MAUER, FLOYD A	2B	
MAZUR, JACOB	2B2G	AFRA
MC CULLOH, KENNETH E	2B	
MC DONALD, EMMA J	2E	AFRA
MC KINLEY, JOHN D	2B	
MC KINNEY, JOHN E	2B	
MC MURDIE, HOWARD F	3D2G	AFRA
MC NESBY, JAMES R	2B2E	AFRA
MC NISH, ALVIN G	2B	
MC PHERSON, ARCHIBALD	2B2E2G	AFRA
MEARS, THOMAS W	2B	
MEBS, RUSSELL W	2M	AFRA
MELMED, ALLAN J		AFRA
MENDLOWITZ, HAROLD		AFRA
MEYERSON, MELVIN R	2U2R	AFRA
MIELCZAREK, STANLEY R	2B	
MILLIKEN, LEWIS T	2B	
MITTLEMAN, DON	2B	AFRA
MOORE, DWIGHT G	2B	
MOORE, GEORGE A	2G2U3E	AFRA
MUEHLHAUSE, CARL O	2B3B	AFRA
MUNIS, RICHARD H	2B	
NETTLETON, RICHARD E	2B	
NEWMAN, MORRIS		AFRA
NEWMAN, SANFORD B		AFRA
NEWTON, CLARENCE J		AFRA
NUTTALL, RALPH L	2B	
OGBURN, FIELDING	3E	
OKABE, HIDEO	2E	AFRA
OREM, THEODORE H	2U	AFRA
OTTO, EARL M	3E	
PAFFENBARGER, GEORGE C	2V	AFRA
PAGE, CHESTER H	2B2G2N	AFRA
PARKER, ROBERT L		AFRA
PEISER, H STEFFEN	2B2E3D	AFRA
PELL, WILLIAM H	2G	AFRA
PITTS, JOSEPH W	2U3D	AFRA
PLUMB, HARMON H	2B	
PLYLER, EARLE K	2B	
POWERS, JOSEPH	2B	
PROSEN, EDWARD J	2E	AFRA
REID, WALTER E JR	3E	
RHODES, IDA		AFRA
RICHMOND, JOSEPH C	2B2G2M2W3D	AFRA
RIDDLE, JOHN L	2B	
ROBERTSON, A F	2G	AFRA
ROBINSON, HENRY E		AFRA
ROESER, WILLIAM F	2B2G2R	AFRA
ROSENBLATT, DAVID	2B	AFRA
ROSENBLATT, JOAN R	2B	
RUBIN, ROBERT J	2B	AFRA
RUFF, ARTHUR W JR	2G	AFRA
SCHAFFER, ROBERT	2E	AFRA
SCHEER, MILTON D	2B2E	AFRA
SCHIEFER, HERBERT F	2B	AFRA
SCHOEN, LOUIS J		AFRA
SCHOONOVER, IRL C	2B2E2V	AFRA
SCHUBAUER, GALEN B	2B2G	AFRA
SCHUBERT, DAVID C	2B	
SCHWARTZ, ROBERT B	2B	
SCOTT, ARNOLD H	2B2G2N	AFRA

SCRIBNER, BOURDON F	2E	AFRA
SHAPIRO, GUSTAVE	2N	AFRA
SHAPLEY, A H		AFNA
SHULER, KURT E	2B2E	AFRA
SILVERMAN, SHIRLEIGH	2B2G	AFRA
SIMMONS, JOHN A	2G	AFRA
SITTERLY, CHARLOTTE M	2B2G	AFRA
SMITH, JACK C		AFRA
SMITH, SCOTT W	2B	
STAIR, RALPH	2G2N	AFRA
STANFORD, JOHN W	2V	
STEGUN, IRENE A		AFRA
STEPHENS, ROBERT E	2B	AFRA
STERN, JOSHUA	2B	
STERN, KURT H	2E3E	AFRA
STIEHLER, ROBERT D	2B2E2G2O	AFRA
STREEVER, RALPH L JR		AFRA
SUDDETH, JIMMIE A	2B	
SWANSON, NILS	2B	
SWEENEY, WILLIAM T	2E2U2V	AFRA
SWINDELLS, JAMES F	2B	AFRA
TATE, DOUGLAS R	2B2G	AFRA
TAYLOR, JOHN K	2B2E2G3E	AFRA
TAYLOR, LAURISTON S		AFRA
TCHEN, CHAN-MOU	2B	AFRA
TEELE, RAY P	2B2G	AFRA
TIPSON, R STUART	2E	AFRA
TOOL, ARTHUR Q	3D	AFRA
TORGESEN, JOHN L	2E2G	AFRA
TRYON, MAX	2E	AFRA
TSAI, DONALD H	2B	
VAN VALKENBURG, ALVIN	2B	
VINTI, JOHN P	2B2G	AFRA
WACHTMAN, JOHN B JR	2B2G	AFRA
WALL, LEO A	2B2E	AFRA
WALTON, WILLIAM W	2E	AFRA
WASHER, F E		AFRA
WASIK, STANLEY P	2E	AMRA
WATSTEIN, DAVID		AFRA
WEIR, CHARLES E		AFRA
WEISSBERG, SAMUEL G	2B2E	AFRA
WEST, ESTAL D	2B	
WEXLER, ARNOLD	2B	AFRA
WILDHACK, WILLIAM A	2B2G2W	AFRA
WILSON, BRUCE L	2B2G	AFRA
WILSON, WILLIAM K	2E2G	AFRA
WOLCOTT, NORMAN M		AMRA
WOOD, LAWRENCE A	2B2E	AFRA
WYCKOFF, HAROLD O	2B	
WYMAN, LEROY L	2G2U	AFRA
YOKLEY, CHARLES R	2B	
YOUDEN, WILLIAM J	2B2E2G	AFRA
YOUDEN, WILLIAM W	2B	
YOUNG, JESSIE M	2B	
YOUNG, THEODORE R	2B	
ZWANZIG, ROBERT W	2B2G	AFRA

1CPAO PATENT OFFICE

HULL, ROBERT B	2B	

1CWEB WEATHER BUREAU

ADEM, JULIAN	2X	
ADLER, GERHARD A	2X	
ALKIRE, H L	2X	
ALLARD, ROBERT L	2X	
ALLEE, PAUL A	2X	
ALLEN, GEORGE C	2X	
ALLEN, ROGER A	2X	
ALTMAN, HARRY E	2X	
AMANTE, WILMA	2X	
AMOROSE, CARL A	2X	
ANDERSON, CALVIN E	2X	
ANDERSON, CHARLES C JR	2X	
ANDERSON, RALPH K	2X	
ANDREWS, JAMES F	2X	
ANGELO, ALDO T	2X	
ARCHAMBAULT, CHARLES E	2X	
ARKIN, MORRIS A	2X	
ARMSTRONG, LORENZ C	2X	
ARNOLD, JOE E	2X	
ATKINS, ELBERT W	2X	
BADNER, JULIUS	2X	
BAKER, DONALD R	2X	
BAKICH, STANLEY M	2X	
BALDWIN, JOHN L	2X	
BARTLETT, WAYNE H	2X	
BASSETT, JAMES V	2X	
BEALL, JAMES M	2X	
BEAR, FRED G JR	2X	
BELKNAP, RAYMOND L	2X	
BELT, GEORGE H SR	2X	
BENTON, BRUCE M	2X	
BERKOFSKY, BENJAMIN	2X	
BERNSTEIN, ABRAM B	2X	
BIEDINGER, RAYMOND E	2X	
BIGLER, STUART G	2X	
BISAGNI, RENATO	2X	
BITTNER, FRED E	2X	
BLAIN, JOHN S JR	2X	
BLANC, MILTON L	2X	AFNA
BOHL, VERNON G	2X	
BOSEN, JULIUS F	2X	
BOSWORTH, LESLIE W	2X	
BOWIE, GLENN L	2X	
BOWYER, DONALD W	2X	
BOYLE, IRA D	2X	
BRADFORD, ROBERT E	2X	
BRANDIS, PHILIP G	2X	
BRENNAN, EDWARD J	2X	
BRIGGS, WILLIAM M L	2X	
BRINTZENHOFE, RICHARD	2X	
BRISTOR, CHARLES L	2X	
BRODIE, WILLIAM P	2X	
BRODRICK, HAROLD J JR	2X	
BROOKS, MARCUS W	2X	
BROWN, GEORGE H	2X	
BROWN, HARRY E	2X	
BROWN, PHILIP T	2X	
BROWNE, RICHARD F	2X	
BRYAN, KIRK	2X	
BUCCI, ANDREW A	2X	
BURNETT, FRANK W	2X	
BYLE, WILLIAM K	2X	
CALABRESE, PHILIP A	2X	
CAMPBELL, ALEXANDER	2X	
CARLIN, ALBERT V	2X	
CARTWRIGHT, GORDON D	2X	
CASKEY, JAMES E JR	2X	
CHILTON, CHARLES A	2X	
CHRISTENSEN, FRANK E	2X	
CHRISTIAN, MADELEINE H	2X	
CLAPP, PHILIP F	2X	
CLARK, MARJORIE A	2X	
CLARKE, JAMES W	2X	
COCHRANE, CALVIN W	2X	
COLE, HAROLD B	2X	
COLSON, DE VER	2X	
CONDAXIS, JAMES P	2X	
CONWAY, CHARLES L	2X	
COOK, ROBERT P	2X	
COOPERMAN, ARTHUR I	2X	
COUNCIL, THOMAS C	2X	
CRAIG, ROBERT W	2X	
CRESSMAN, GEORGE P	2X	AFRA
CROCKETT, CURTIS W	2X	
CRY, GEORGE W	2X	AMRA
CULLEN, THOMAS P	2X	
CULNAN, ROBERT N	2X	
CUMMINGS, MAURICE H	2X	
DALES, PHILIP A JR	2X	
DARLING, FREDRIC L	2X	
DE ANGELIS, RICHARD M	2X	
DELLERT, GEORGE T JR	2X	
DICKSON, ROBERT R	2X	
DOHERTY, JAMES L	2X	
DONEHOO, IRENE A	2X	

DOORE, G STANLEY	2X	
DORER, CHARLES F	2X	
DREWES, WILLIAM J	2X	
DUNN, CARLOS R	2X	
DYE, LUCIUS W	2X	
DYER, J GLENN	2X	
EAKIN, OTHO M JR	2X	
EBERLY, JOHN H	2X	
EDMONDS, SUZANNE E	2X	
EDWARDS, SHIRLEY	2X	
ELLIS, JAMES D	2X	
ELLIS, JOHN O	2X	
ENGELBRECHT, HOWARD H	2X	
ERICKSON, CARL O	2X	
ESTELLE, EARL W	2X	
FAWCETT, EDWIN B	2X	
FEESE, LARS O	2X	
FEINSILBER, MAX M	2X	
FERGUSON, EDWARD W	2X	
FERRAL, ROBERT L	2X	
FETT, ROBERT W	2X	
FIDLER, JAMES C	2X	
FINGER, FREDERICK G	2X	
FINNICAN, RONALD J	2X	
FISCHLER, JORDAN	2X	
FLANDERS, ALLEN F	2X	
FLEMING, HENRY E	2X	
FLEMING, JAMES A	2X	
FLOCKEN, FRED B	2X	
FOARD, JOHN M	2X	
FOAT, DARREL J	2X	
FOPAY, C F	2X	
FORD, JOHN L	2X	
FORDHAM, DAVID G	2X	
FOSKETT, LAURENCE W	2X	
FOSSETT, GEORGE L	2X	
FOSTER, ROBERT I	2X	
FRANEL, JACOB	2X	
FRANKEL, MORRIS H	2X	
FREDERICK, RALPH H	2X	
FRENCH, WILLIAM O JR	2X	
FRICKE, GERTRUDE A	2X	
FRITZ, SIGMUND	2X	
FULLER, OTHA JR	2X	
GALES, DONALD M	2X	
GEIL, GENE W	2X	
GELHARD, ROBERT H	2X	
GEORGE, LESTER D	2X	
GIARRUSSO, ANTHONY	2X	
GILMAN, DONALD L	2X	
GLADNEY, TILLMAN F	2X	
GLAHN, HARRY R	2X	
GLEITER, THEODORE P	2X	
GODDARD, HELEN L	2X	
GODSHALL, FREDRIC A	2X	
GOLD, HAROLD K JR	2X	
GOODYEAR, HUGO V	2X	
GOULAIT, ROLAND V	2X	
GRACE, MARSHALL F	2X	
GRAHAM, RODERICK D	2X	
GRAY, THOMAS I JR	2X	
GREEN, RAYMOND A	2X	
GRUBB, RUSSELL C	2X	
GUNNARSON, LENNART A	2X	
GUSTAFSON, ARTHUR F	2X	
HACIA, HENRY	2X	
HAEGELE, CHARLES B	2X	
HAFER, LE ROY F	2X	
HAGAN, JOHN C	2X	
HAGARTY, JOSEPH H	2X	
HAGARTY, WILLIAM	2X	
HAINES, DONALD A	2X	
HAINSWORTH, WILLIAM C	2X	
HALL, FERGUSON	2X	
HALLIGAN, DON K	2X	
HAMADA, MASARU	2X	
HAND, JAMES M	2X	
HANSON, DONALD M	2X	

HARMANTAS, CHRISTOS	2B2X	
HARRELL, JOHN J	2X	
HARRIS, DALE R	2X	
HARRIS, MILES F	2X	
HARSHBARGER, HAROLD B	2X	
HASS, WILLIAM A	2X	
HATZENBUHLER, GEORGE	2X	
HELBUSH, ROBERT E	2X	
HELFERT, NORBERT F	2X	
HELLERMAN, SOLOMON	2X	
HELMICK, BENJAMIN	2X	
HEMBREE, G D	2X	
HERBERT, GARY A	2X	
HERMAN, STANLEY	2X	
HIATT, WILLIAM E	2X	
HILL, AUGUSTUS N	2X	
HODGE, MARY W	2B2X	
HOECKER, WALTER H	2X	
HOLLENBAUGH, GEORGE W	2X	
HOLLOWAY, J L JR	2X	
HOLMES, DAVID	2X	
HOOVER, EUGENE W	2X	
HOOVER, ROBERT A	2X	
HOUSTON, OLIN R	2X	
HOVERMALE, JOHN B	2X	
HOWCROFT, JAMES G	2X	
HUBERT, LESTER F	2X	AMRA
HUDSON, JOSEPH L	2X	
HUGHES, CLYDE L	2X	
HUGHES, GROVER D	2X	
HUGHES, PATRICK E	2X	
HUNTER, JAMES C	2X	
HUNTER, MARVIN N	2X	
HUNTOON, JAMES K	2X	
HURLEY, JOHN C	2X	
IRVIN, WESLEY	2X	
JACKSON, WILLIAM E	2X	
JACOBSEN, VERNON G	2X	
JENKINS, CHARLES E	2X	
JENNINGS, ARTHUR H	2X	
JOHNSON, ARTHUR W	2X	
JOHNSON, DAVID S	2X	
JOHNSON, LESTER A	2X	
JOHNSON, MELVIN A	2X	
JONES, GEORGE	2X	
JONES, JAMES B	2X	
JONES, ROZELL B	2X	
JONES, WILLIAM E	2X	
JORDAN, CLARENCE R	2X	
JORDAN, HAROLD M	2X	
KARPOVITCH, ALBERT A	2X	
KEISTER, JAMES L	2X	
KEITH, HUBERT C	2X	
KEY, MARVIN E JR	2X	
KIBLER, CLARENCE L	2X	
KIRSCHNER, BURTON H	2X	
KLASSEN, HARVEY J	2X	
KLEIN, WILLIAM H	2X	AFRA
KLINE, DWIGHT B	2X	
KNEER, ARTHUR R	2X	
KOCHANSKI, ADAM	2X	
KOFFLER, RUSSELL	2X	
KOHLER, MAX A	2X	
KOMHYR, WALTER D	2X	
KORTE, AUGUST F	2X	
KRAFT, K CHARLES	2X	
KRAHL, GEORGE M	2X	
KRANK, JOSEPH P	2X	
KRESGE, RALPH F	2X	
KRUEGER, ARTHUR	2X	
KURIHARA, YOSHIO	2X	
KUTSCHENREUTER, PAUL H	2X	
KVAM, ERNEST L	2X	
LA RUE, JERROLD A	2X	
LACNY, FRANCIS J	2X	
LACY, STANLEY J	2X	
LAMBERT, CHARLES E	2X	
LAMOREAUX, WALLACE W	2X	

LANDSBERG, HELMUT E	2X	AFRA
LARO, ROLAND M	2X	
LAY, EDWIN T	2X	
LE BLANC, BEN J	2X	
LEHR, PAUL E	2X	
LENNAHAN, CHARLES M	2X	
LEWIS, BILLY M	2X	
LIEB, HERBERT S	2X	
LIEURANCE, NEWTON A	2X	
LILLY, DOUGLAS K	2X	
LINDSAY, CHARLES V	2X	
LIPPMANN, HAROLD S	2X	
LORIMOR, ELZA G	2X	
LOTT, GEORGE A	2X	
LOVELESS, BURTON F	2X	
LOWRY, DALE A	2X	
LUCAS, EDWIN C	2X	
LUDWIG, CORA G	2X	
MAC DONALD, TORRENCE H	2X	AMRA
MACHTA, LESTER	2X	
MAKOSKY, FRANK	2X	
MANABE, SYUKURO	2X	
MARIER, DONALD W	2X	
MARSCHER, JOHN C	2X	
MARTINEZ, CONRAD	2X	
MASON, RALPH B	2X	
MATHERS, JESSE A JR	2X	
MATSON, NORMAN A	2X	
MATTHEWS, MILDRED M	2X	
MC BIRNEY, HAROLD R	2X	
MC CARTER, ROY M	2X	
MC CARTY, MIRIAM E	2X	
MC CLAIN, E PAUL	2X	
MC COOK, JOHN W	2X	
MC DONELL, JAMES E	2X	
MC EWEN, ROBERT L	2X	
MC KINLEY, WILLIAM G	2X	
MEANS, LYNN L	2X	
MEINTEL, RALPH H	2X	
MILLER, HARRY A	2X	
MILLER, JOHN F	2X	
MITCHELL, J MURRAY JR	2G2X	AFRA
MIYAKODA, KIKURO	2X	
MOLANSKY, SIDNEY	2X	
MORGAN, DEWITT N	2X	
MORRISON, WILLIAM	2X	
MOSCHELLI, JUDITH A	2X	
MOTTAZ, CONSTANCE E	2X	
MUNN, RAYMOND O	2X	
MURINO, VINCENT S	2X	
MURPHY, ALVIN D	2X	
MURPHY, LAWRENCE J	2X	
MYERS, VANCE A	2X	
NAGLE, AUSTEN H	2X	
NAGLER, KENNETH M	2X	
NAMIAS, JEROME	2B2X	AFRA
NASH, WILLIAM P	2X	
NEILON, JAMES R	2X	
NOFFSINGER, TERRELL L	2X	
NORDENSON, TOR J	2X	
NORQUEST, KENNETH S	2X	
NYHAN, JOHN C	2X	
O BRIEN, GERALD F	2X	
O CONNOR, JAMES F	2X	
OKLAND, HANS R K	2X	
OLIVER, VINCENT J	2X	
OSMUN, J W	2X	AFRA
OSTAPOFF, FEODOR	2X	
OTLIN, SAMUEL	2X	
OTTMAN, PETER L	2X	
PACK, DONALD H	2X	AFRA
PALMER, WAYNE C	2X	
PARRY, H DEAN	2X	
PAULHUS, JOSEPH L	2X	
PECKHAM, DEAN A	2X	
PERIDIER, PAUL H	2X	
PETERSEN, GERALD A	2X	
PETERSEN, VERNON L	2X	
PETERSON, ARTHUR C	2X	
PETERSON, KENDALL R	2X	
PHILLIPS, BYRON B	2X	
PORE, NORMAN A	2X	
PORTER, JOHN M	2X	
POSEY, JULIAN W	2X	
PREDOEHL, MARTIN C	2X	
PULLEN, WILLIAM T JR	2X	
PULLEY, CHARLES T	2X	
PUTNINS, PAUL H	2G2X	AFRA
PYLE, ROBERT L	2X	
RAHMLOW, H W	2X	
RAMEY, LEWIS H	2X	
RAMMER, WILLIAM A	2X	
RAO, P KRISHNA	2X	
RATNER, BENJAMIN	2X	
REEVES, CHARLES G	2X	
REIDEL, JOHN T	2X	
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RHINE, LLOYD R	2X	
RICHARDS, MARSHALL M	2X	
RICHTER, DONALD A	2X	
ROBERTS, CHARLES F	2X	
ROBERTS, KENNETH J	2X	
ROBINSON, CECIL C	2X	
ROCHLIN, BERNARD	2X	
ROCKNEY, VAUGHN D	2X	
RODGERS, LYNDON T	2X	
ROGERS, MARVIN R	2X	
ROSENBLOOM, ABE	2X	
ROSENDAL, HANS E	2X	
ROSS, ROBERT B	2X	
ROTHENBERG, LEON	2X	
RUBIN, LOUIS	2X	
RUBIN, MORTON J	2X	AFRA
RUFF, IRWIN	2X	
RUSCITTO, PETER A	2X	
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SADOWSKI, ALEXANDER F	2X	
SAIEDY, FUAD	2X	
SANGSTER, LOU A	2X	
SANGSTER, WAYNE E	2X	
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SCHAFER, WOODFORD W	2X	
SCHALLERT, WILLIAM L	2X	
SCHAUSS, CHARLES E	2X	
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SCHLOEMER, ROBERT W	2X	
SCHMIDT, REINHART C	2X	
SCHNURR, RICHARD G	2X	
SCHONER, ROBERT W	2X	
SCHUETZ, JOHN	2X	
SCHWALB, ARTHUR	2X	
SCHWARZ, FRANCIS K	2X	
SCOTT, HAROLD A	2X	
SCOTTEN, JOHN W	2X	
SEAMON, LILBURN H	2X	
SEEBODE, ALVIN F	2X	
SHAW, ARCHIE	2X	
SHERRY, EDWIN J	2X	
SHINNERS, WILLARD W	2X	
SHOPE, JOHN I	2X	
SHUMAN, FREDERICK G	2X	
SIK, ALVER E	2X	
SIMPSON, ROBERT H	2X	
SLOCUM, GILES	2X	
SMAGORINSKY, JOSEPH	2X	
SMEDLEY, DAVID	2X	
SMITH, RAYMOND G	2X	AMRA
SMITH, WARREN	2X	
SNIDERO, MIRCO P	2X	
SOLLER, RALPH R	2X	
SOULES, STANLEY D	2X	
SPRINGER, DONALD P	2X	
SPRINGER, HAROLD S	2X	
SPROLES, EDWARD S	2X	
ST CLAIR, GILBERT L	2X	

STAATS, WAYNE F	2X	
STARK, LOYAL P	2X	
STEIN, WALTER L	2X	
STIEWIG, NATHAN W	2X	
STOFFER, DWIGHT R	2X	
STOMMEL, HERMAN G	2X	
STOWELL, DAVID J	2X	
STRALKA, RAYMOND J	2L2X	
STRICKLER, ROBERT F	2X	
SUMNER, HOWARD C	2X	
SUPPLEE, MARGARET V	2X	
SWAYNE, WILLIAM W	2X	
SWEET, JAMES S	2X	
TALCOTT, MARION G	2X	
TAUBENSEE, ROBERT E	2X	
TEMPLETON, GEORGE S	2X	
TEWELES, SIDNEY	2X	AFRA
THIEL, GORDON D	2X	
THOM, HERBERT C S	2X	AFRA
THOMAS, BILLY D	2X	
THOMAS, HARRY F	2X	
THOMPSON, EDWIN S	2X	
THOMPSON, HERBERT J	2X	
THOMPSON, JACK C	2X	AFRA
THOMPSON, ROSCOE E	2X	
TIMCHALK, ANDREW	2X	
TREBBE, WILLIAM J	2X	
TRUESDELL, DONOVAN F	2X	
VAN CLEEF, FREDERICK L	2X	
VANDERMAN, LLOYD W	2X	
VEITH, ANTHONY J	2X	
VERNON, EDWARD M	2X	
VIEBROCK, HERBERT J	2X	
VILLAREJO, JAMES	2X	
VORE, CHARLES W	2X	
WAGGONER, MARY L	2X	
WALLACE, J ALLEN JR	2X	
WARK, DAVID Q	2X	
WASSALL, ROBERT B	2X	
WATKINS, ROGER R	2X	
WEBBER, JOHN P	2X	
WEBBER, PAUL E	2X	
WEISS, LEONARD L	2X	
WELLS, FRED E	2X	
WELLS, HOWARD J	2X	
WEST, ALMA B	2X	
WEYANT, WILLIAM S	2X	
WEYRES, WALTER J	2X	
WHITE, BOYD P	2X	
WHITE, ROBERT M	2X	AFRA
WHITELY, THOMAS D	2X	
WHITNEY, LINWOOD F JR	2X	
WILLIAMS, JAMES T	2X	
WILSON, WALTER T	2X	
WINNER, JOHN P	2X	
WINNINGHOFF, FRANCIS J	2X	
WINSTON, JAY S	2X	
WISE, JAMES W	2X	
WOFFINDEN, CHARLES M	2X	
WOLK, MARTY	2X	
WOOD, ERNEST A	2X	
WOOLF, HAROLD M	2X	
WOOLLUM, CLARENCE A	2X	
WRIGHT, G R	2X	
WYATT, SAMUEL V	2X	
WYETT, ROY E	2X	
YAO, AUGUSTINE Y M	2X	AMRA
YARKIN, STANLEY	2X	
YOUMANS, ARTHUR W	2X	
YOUNKIN, RUSSELL J	2X	
ZAMBORSKY, ANDREW V	2X	
ZEGEL, FERDINAND H	2X	
ZIKEEV, NINA	2X	AMRA

1CX COMMERCE MISC

FOSTER, ELLERY A	2L	
MASON, THOMAS C	2L	
MC KELLAR, ALFRED D	2L	
OWENS, JAMES M	2L	
WINSTON, CLEMENT	2B	

1D DEFENSE DEPARTMENT

1D-IP ARMED FORCES INST PATHOLOGY

ABRAMS, ALBERT M	2V	
BERNIER, JOSEPH L	2V	
CHAFFEE, ELMER F	2Q	
CHANG, SING C	2Q	
CHURCH, LLOYD E	2V	
CORNYN, JOHN	2V	
FELSENFELD, AMPHAN D	2Q	
HANSEN, LOUIS S	2V	
MOSTOFI, F K	2T3B	AFRA
SMITH, THOMAS B	2Q	

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DAVIS, RUTH M	2B	
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FORZIATI, ALPHONSE F	2E2V3E	AFRA
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HAMMERSCHMIDT, W W	2B	AMRA
HANSEN, EILEEN A	2B	
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JACKSON, JOHN E	2B	
NUTTING, P G JR	2B	
REYNOLDS, ORR E	2V	AFRA

1D-X DEFENSE MISC

ANNIS, WILBERT	2B	
BECK, ROBERT E	2X	
BENSON, LOREN A	2B	
BERNIER, CHARLES L	2B	
CAMPAIGNE, HOWARD H		AFRA
CONDELL, WILLIAM J JR	2B	
ELLINWOOD, MARY E	2X	
FRAZIER, JOSEPH H	2X	
HERSCHER, ARNOLD B	2X	
JACOBS, WALTER W	2B	AFRA
MC ARDLE, RICHARD C	2L	
MC HENRY, RICHARD K	2L	
MC NAIRY, JOHN V	2X	
MERKEL, EUGENE E	2B	
NESLEY, WILLIAM L	2X	
OTTING, WILLIAM J JR	2B	
PFEIFFER, EDWARD G	2X	
PHILBRICK, JANE V	2B	
PROBUS, JAMES H	2B	
RAGLAND, ADRIAN J	2X	
RYALS, JAMES E	2X	
RYMER, FRANK P JR	2X	
SHERWIN, CHALMERS W	2B	
SREB, JULES H	2B	
SWANNER, WILLIAM C	2X	
WHITE, HUGH S	2X	
YOST, CHARLES F	2B	

1DA DEPARTMENT OF ARMY

1DAEB ENG CORPS BEACH EROSION BD

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1DAEC OFFICE OF CHIEF OF ENGINEERS

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1DAER ENGINEER RES & DEV LABS

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FRYSINGER, GALEN R	3E	
HARVALIK, Z V	2E	AFRA
HASS, GEORGE H		AFRA
HOWARD, GEORGE W	2S	AFRA
RODRIGUEZ, RAUL	2G2R	AFRA

SAVITZ, MAXINE L	3E	
WEIHE, WERNER K	2G2N	AFRA

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1DAFD BIOLOGICAL LAB FT. DETRICK

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CALDWELL, PAUL A	2B	
CONRAD, EDWARD E	2B	
DISTAD, MERRIL F	2B	
DOCTOR, NORMAN J	2N	AFRA
GODFREY, THEODORE B		AFRA
GUARINO, P A	2N	AFRA
HEBB, EMMA L	3E	
HORTON, BILLY M	2B2G2N	AFRA
JOHNSON, ELLIS A	2B	
KALMUS, HENRY P	2N	AFRA
KLUTE, CHARLES H	2B2E	AFRA
KOHLER, HANS W	2G2N	AFRA
KOLODNY, SAMUEL	2B	
LANDIS, PAUL E	2S	AFRA
LIPNICK, MILTON	2B	
MC GINNIS, LAURENCE P	3E	
MOORHEAD, JOHN G	2B	
ROTKIN, ISRAEL	2B2N	AFRA
SINGMAN, DAVID	3E	
SOMMER, HELMUT	2N	AFRA
WOOD, GWENDOLYN B	3E	
YOUNG, ROBERT T JR	2G2N	AFRA

1DAMC MATERIEL COMMAND HEADQUARTERS

HALL, ROBERT W	2B	

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ALTMAN, R M	2F	

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ALEXANDER, BENJAMIN H	2E	AFRA
BARON, LOUIS S	2Q	AFRA
BATTISTONE, G C	2V	
BELLANTI, JOSEPH A	2Q	
BHASKAR, SURINDAR N	2V	
BINN, LEONARD N	2Q	
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BRANCHE, WILLIAM C JR	2Q	
BRANDT, WALTER E	2Q	
BURNETT, GEORGE W	2Q2V	
CADIGAN, FRANCIS C	2Q	
CAMPBELL, JANIS	2Q	
CARY, SYLVIA G	2Q	
CURRIE, JULIUS A	2Q	
DAIL, MARTHA C	2Q	
DREYFUS, JOSEPH C III	2Q	
EDWARDS, CLARK W	2Q	
FALGOUT, BARNEY T	2Q	
FELSENFELD, OSCAR	2Q	
FIFE, EARL H	2Q	
FINKELSTEIN, RICHARD A	2Q	
FORMAL, SAMUEL B	2Q	
GAINES, SIDNEY	2Q	
GILMORE, ELEANOR L	2Q	
GINSBERG, DAVID M	2Q	
HAHN, FRED E		AFRA
HAMPTON, CHARLES M	2Q	
HARTMAN, ROBERTA S	2Q	
HERMAN, YAYE	2Q	
HOOK, WILLIAM A	2Q	
HUNTER, DONALD H	2Q	
KASE, ALICE	2Q	
KNOBLOCK, EDWARD C	2E	AFRA
LABREC, EUGENE H	2Q	
LARRABEE, ALLAN R	2Q	
LOWENTHAL, JOSEPH P	2Q	
MADDOX, LOUISE	2Q	
MALONEY, JOHN T	2Q	
MARGETIS, PETER M	2V	
MC MULLEN, DONALD B	2P	AFRA
MILLER, AUGUSTUS	2Q	
MORRISON, THOMAS H	2Q	
NEAL, T J	2F	
NORMAN, MARGARET C	2Q	
NOYES, HOWARD E	2Q2T	AFNA
OHLENBUSCH, ROBERT E	2Q	
PARRISH, DALE W	2F	
POWELL, CALVIN J JR	2Q	
RANSFORD, RICHARD B	2Q	
RICHARDSON, EARL C	2Q	
RIOCH, DAVID M	2G2I	AFRA
ROBINSON, GERALDINE G	2Q	
ROGUL, MARVIN	2Q	
RUST, J H JR	2Q	
SHADOMY, SMITH	2Q	
SHAW, EUGENE D	2Q	
SIMONTON, LOIS A	2Q	
SMITH, CHAUNCEY W	2Q	
SMITH, SARAH L	2Q	
STAUFFER, EVA M	2Q	
TARRANT, CARL J	2Q	
TAYLOR, ROBERT L	2Q	
VIVONA, STEFANO	2Q	
WASHINGTON, OTHELLO	2Q	
WITTLER, RUTH G	2Q	
WOHLIETER, JOHN A	2Q	
WOOD, GARNETT	2Q	

1DAX ARMY MISC

ASHCROFT, JOSEPH M	2B	
BABERS, FRANK H	2G	AFNA
BARNHART, CLYDE S	2F	AFNA
BATLIN, ALEXANDER	2Q	
BEAR, DANIEL H	2L	
BUNTYM, JAMES R	2X	
CHAVASSE, NICHOLAS H	2X	
COPELAND, JOHN A	2X	
CREITZ, JOSEPH	2Q	
DEWS, SAM C	2F	
DIETRICH, CARL F	2X	
FULLER, HENRY S	2Q	
GOLDBERG, BENJAMIN	2B	
HERTZLER, RICHARD A	2L	
HOGE, HAROLD J	2B	AFNA
KEULEGAN, GARBIS H	2B	AFNA
KUNDERT, OTTO R	2B	
LAWSON, DAVID A JR	2X	
MARSHALL, JOHN D	2Q	
MASON, A HUGHLETT	2B	
MC CLURG, GREGG H	2B	
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SANDERS, ARVEY C	2Q	
UHLANER, J E		AMRA

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WEISSLER, ALFRED	2B2E2W2Z	AFRA

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GARVIN, LOYD C	2X
GIRAYTYS, JAMES	2X
GLOVER, JERRY C	2X
HALVEY, DAVID B	2X
HASSEN BEY, MANODE	2X
HAVARD, JESSE B	2X
HENSLOY, CARL C	2X
HIDROGO, EDUARDO	2X
HILL, W W	2X
HOLTZSCHEITER, EARL W	2X
HUTCHINSON, LEONARD H	2X
INGRAM, DAVID M	2X
JESS, EDWARD O	2X
JOHNSON, LE ROY C	2X
KELLIHER, RAYMOND	2X
KOLYER, RICHARD D	2X
KRONEBACH, GEORGE W	2X
KUDZMA, ROBERT	2X
KUTULAS, JOHN E	2X
LAMBERT, JOSEPH K	2X
LEWIS, FRANK	2X
LEWIS, THOMAS H IV	2X
LOGAN, JAMES H	2X
LONG, ROBERT F	2X
LONGACRE, ARTHUR M	2X
MASTERS, CLAUDE B	2X
MAYHEW, WILLIAM A JR	2X
MAYKUT, E S	2X
MC QUOWN, JOHN R	2X
MOHLER, P I	2X
MOXON, GEORGE W	2X
MOYER, WILBUR J	2X
MURDOCK, EUGENE A	2X
NENON, ULMER H	2X
NILSESTUEN, ROLF M	2X
NORWOOD, JAMES P	2X
PAYNE, JAMES O	2X
PETERSON, A DELBERT	2X
PETERSON, GEORGE W	2X
PFEIFFER, ROBERT M	2X
POLSTON, JAMES A	2X
POTTER, THOMAS D	2X
POURNARAS, STEPHEN W	2X
PRESTON, EUGENE R	2X
QUIROZ, RODERICK S	2X
RICHARD, OSCAR E	2X
RIPPY, HAROLD R	2X
SKILLMAN, W C	2X
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TAYLOR, WILLIAM	2X
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THOMPSON, DONALD R	2X
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WALKER, SYLVESTER E	2X
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JOHNSON, PAUL S	2B	
MC CRAW, TOMMY F	2B	
MELTON, BEN S	2B	
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PURDY, DOUGLAS C	2X	
RODDY, VINCENT S	2B	
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SELLERS, RONALD E JR	2B	
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SNAVELY, BENJAMIN L	2G2Z	AFRA
SNAY, HANS G	2G2Z	AFRA
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BONDELID, ROLLON O		AFRA
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FAUST, WILLIAM R	2B2G	AFRA
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FRIEDMAN, HERBERT	2B	
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GLASSER, ROBERT G	2B	AFRA
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HALL, WAYNE C	2B2G2N	AFRA
HAUPTMAN, HERBERT	2B2G	AFRA
HAYDEN, LEONARD O	2B	
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HERZ, ALBERT J	2B	AFRA
HICKS, GRADY T	2G	AMRA
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HUNTER, WILLIAM R	2B2G	AFRA
IRWIN, GEORGE R	2B2G	AFRA
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KAISER, HERMAN F	2B	
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KARLE, JEROME	2B2E	AFRA
KIES, JOSEPH A	2B2G2U	AFRA
KING, PETER	2B2E	AFNA
KOLB, ALAN C	2B	AFRA
KOOMEN, MARTIN J	2B	
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KRULFELD, MYER	2B3E	
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LOCKHART, LUTHER B JR	2E	AFRA
MAISCH, WILLIAM G	2B	
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MANNING, IRWIN	2B	
MAYER, CORNELL H	2B2N	AFRA
MC CLAIN, EDWARD F JR	2B	AFRA
MC ELHINNEY, JOHN	2B2G	AFRA
MEUSSNER, R A	3E	
MILLER, ROMAN R	2E2G	AFRA
MURRAY, KENNETH M JR	2B	
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O DELL, FRANCIS W	2B	
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PAGE, ROBERT M	2N	AFRA
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RADO, GEORGE T	2B	AFRA
RHOADS, FRANKLIN J	2B	
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SANDERS, WILLIAM H	2B	
SANDERSON, JOHN A	2B	AFRA

SANDOZ, GEORGE	2U2G	AFRA
SAXTON, HAROLD L	2B	
SCHINDLER, ALBERT I	2B	AFRA
SCHOOLEY, ALLEN H	2B2G2N	AFNA
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SMITH, SIDNEY T	2N	AFRA
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1HNIH NATIONAL INSTITUTES OF HEALTH

AKERS, ROBERT P	2G	AFRA
ARNOLD, FRANCIS A JR	2V	
ASHE, WARREN K	2Q	
BACKUS, ROBERT C	2Q	
BAER, HAROLD	2Q	
BAER, PAUL N	2V	
BARILE, MICHAEL F	2Q	
BARRETT, MARGARET D	2G2T	AFRA
BARRETT, MORRIS K	2T	AFRA
BAUER, HUGO	2E	AFRA
BECKER, EDWIN D	2E	AFRA
BELKIN, MORRIS		AFRA
BERGER, ROBERT L	2B	
BERLINER, ROBERT W	2B2T	AFRA
BERNHEIM, BARBARA C	2Q	
BLADEN, HOWARD A	2Q	
BOETTCHER, RICHARD E	2F	
BOURGEOIS, LOUIS D	2Q	
BOWMAN, PAUL W	2D2K	AFRA
BOWMAN, ROBERT L	2B	
BRADLEY, ROBERT B	2B	
BREWER, CARL R	2Q	AFRA
BRODIE, BERNARD B	2E2T	AFRA
BROOKMAN, MARJORIE D	2Q	
BUELL, MABEL R	2Q	
BURK, DEAN	2E2T	AFRA
BURSTONE, M S	2V	
BYRNE, ROBERT J	2Q	AFRA
CALNAN, K DOROTHY	2Q	
CARLSON, MARGARET J	2Q	
CARROLL, WILLIAM R	2E	AFRA
CHAPARAS, S D	2Q	
COLE, KENNETH S	2B	AFRA
COLE, ROGER M	2Q	
COLON, ALBA E	2Q	
COOK, M KATHERINE	2Q	
CORNFIELD, JEROME		AFRA
COX, CLAIRE B	2Q	
DAVIS, DORLAND J	2Q	
DOCKSTADER, W B	2Q	
DOUGLAS, GEORGE W	2Q	
DREGUSS, MIKLOS N	2Q	
EDDY, BERNICE E	2G2Q2T	AFRA
EDDY, NATHAN B	2G2T	AFRA
EMMART, EMILY W	2Q2T	AFRA
EMMONS, CHESTER W	2K2Q	
ENDICOTT, KENNETH M	2T	AFRA
EVANS, TODD	2Q	
FEELEY, JOHN C	2Q	
FITZGERALD, ROBERT J	2Q2V	
FLETCHER, HEWITT G JR	2E	AFRA
FOLK, JOHN E	2V	
FOURNELLE, HAROLD J	2Q	
FRAME, ELIZABETH G	2E2T	AFRA
FRANK, KARL		AFRA
FULLER, VERNON J	2Q	
FULLMER, HAROLD M	2V	
FUSON, ROGER B	2Q	
GANAWAY, JAMES R	2Q	
GIBBS, C J JR	2Q	
GOLDSMITH, MARGARET T	2Q	
GOOS, ROGER D	2K	
GREENE, JOHN C	2V	
GROSS, NOEL H	2Q	
HABEL, KARL	2Q	
HAMPAR, BERGE	2Q	
HAMPP, EDWARD G	2Q2V	AFRA
HARTLEY, JANET W	2Q	
HASENCLEVER, H F	2Q	
HELPRIN, JEROME J	2Q	
HERMAN, LLOYD G	2Q	
HEWITT, CLIFFORD A		AMRA
HIATT, CASPAR W	2E2G2Q2T	AFRA
HOPPS, HOPE E	2Q	
HOWELL, ARDEN J	2V	
IKARI, NORMAN S	2Q	
JENNINGS, ANNE E	2Q	

JORDAN, HAROLD V	2Q	
JORDAN, LUZERNE G	2V	
KEMPNER, ELLIS S	2B	
KEYES, PAUL H	2V	
KIMLER, ALEXANDER	2Q	
KOLB, ROBERT W	2Q	
KRESHOVER, SEYMORE J	2V	
KUDRAVCEV, VSEVOLOD	2B	
KULWICH, ROMAN	3C	
LAKI, KOLOMAN	2D	AFRA
LANSDELL, HERBERT C	2B	
LARSEN, RACHEL H	2V	
LEE, MARCIA R A M	2Q	
LEIKIND, MORRIS C		AFRA
LERNER, EDWIN M II	2Q	
LEVY, HILTON B	2Q	
LI, C P	2Q	
LIKINS, ROBERT C	2V	AFRA
LONES, G W	2Q	
LYMAN, F EARLE	2V	
MARSHALL, LOUISE H		AFRA
MARSHALL, WADE H	2B	AFRA
MC CANN, HAROLD G	2V	
MC CLURE, FRANK J	2E2G2T2V	AFRA
MC CULLOUGH, NORMAN B	2G2I2Q	AFRA
MIDER, G BURROUGHS	2G	AFRA
MORRIS, J A	2P2Q	AMRA
MURRAY, RODERICK	2Q	
MURRILL, ROBERT D	2F	
NIRENBERG, MARSHALL W	2E	AFRA
NOBLE, FRANK W	2B	
NYLEN, MARIE U	2V	
OMATA, ROBERT R	2V	
OWEN, LUDWELL JR	2Q	
PIEZ, KARL A	2V	
PITTMAN, MARGARET	2Q2T	AFRA
RALL, DAVID R	2T	AFRA
RALL, JOSEPH E	2B	
RIFE, DAVID C		AFRA
RIZZO, ANTHONY A	2Q	
RODDY, PATRICIA M	2B	
ROGERS, NANCY G	2Q	
ROGOSA, MORRISON	2Q2V	
ROSENTHAL, SANFORD M		AFRA
ROWE, WALLACE P		AFRA
RUSSELL, ALBERT L	2V	
SCHADE, ARTHUR L	2Q	
SCHERP, HENRY	2Q	
SCHNAPER, EDNA S	2Q	
SCHRECKER, ANTHONY W	2E	AFRA
SCOTT, DAVID B	2G2V	AFRA
SHADOMY, JEAN	2Q	
SHANNON, JAMES A	2T	AFRA
SHELTON, EMMA		AFRA
SHIOTA, TETSUO	2V	
SILVERBERG, ROSALIE J	2Q	
SMITH, FALCONER	2B2T	AFRA
SMITH, WILLIE W	2T	AFRA
SOLLNER, KARL	2E3E	AFRA
SOLOWEY, MATHILDE	2Q	
SOMERSON, NORMAN L	2Q	
SPECHT, HEINZ	2B	AFNA
STADTMAN, E R		AFRA
STANLEY, ALFRED R	2Q	
STEPHAN, ROBERT M	2V	AFRA
STEPHENSON, JOHN L	2B	
STETTEN, DEWITT JR	2B	
STEWART, SARAH E	2T	AFRA
TASAKI, ICHIJI		AFRA
THOMPSON, RANDALL L	2Q	
THURMAN, ERNESTINE B	2F2G	AFNA
TOMKINS, GORDON	2B	
TRAUB, R G	2Q	
TRUEBLOOD, EMILY	2Q	
TULLY, JOSEPH G	2Q	
VARGOSKO, ANDREW J	2Q	
VERDER, ELIZABETH	2Q	
VON BRAND, THEODOR C	2P2T	AFRA

WEBB, ALFRED M	2Q	
WELSH, PATRICIA D	2Q	
WEST, RICHARD K	2Q	
WITKOP, BERNHARD	2E	AFRA
WOKE, PAUL A	2F	
WOLLMAN, SEYMOUR H	2B	
WOODS, MARK W	2K2T	AFRA
YEAGER, J FRANKLIN		AFRA
YOUNG, VIOLA M	2Q	
ZELEN, MARVIN	2B	AFRA
ZIERDT, CHARLES H	2Q	
ZIPKIN, ISADORE	2V	

1HOED OFFICE OF EDUCATION

OBOURN, ELLSWORTH S	2B	AFRA

1HPHS PUBLIC HEALTH SERVICE

ANDREWS, HOWARD L		AFRA
BENDER, MAURICE	2E3C	AFRA
BOND, HOWARD W	2E	AFRA
CALVERT, CATHERINE R	3C	
CARTER, HUGH		AFRA
DAUER, CARL C		AFRA
HAGEN, THOMAS L	2V	
HUGHES, JOHN H	2F	
HUNDLEY, JAMES M		AFRA
KERESZTESY, JOHN C	2E	AFRA
LEOPOLD, SIDNEY	2Q	
MODINE, NORMAN F	2B	
PARK, HELEN D	2G	AFRA
PRATT, HARRY D		AFNA
RAUSCH, ROBERT	2D2G2P	AFNA
SUMMERS, DONALD	3C	

1HX HEW MISC

BULLARD, WILLIAM E JR	2L	
LEFFINGWELL, THOMAS C	2B	
WILKIE, JOHN B	2B	

1I INTERIOR DEPARTMENT

1IBIA BUREAU OF INDIAN AFFAIRS

ELY, RICHARD K	2L	
KEPHART, GEORGE S	2L	
WAGNER, JOSEPH A	2L	
WERSHING, HENRY F	2L	

1IBLM BUREAU OF LAND MANAGEMENT

BOWEN, CALVIN M	2L	
BROCKS, SAMUEL M	2L	
DOYLE, JAMES F	2L	
HEADY, DONALD R	2L	
HOFFMANN, EDWARD J	2L	
LYND, HAROLD C	2L	
PETERSEN, EMMANUEL J	2L	
PETERSON, EUGENE K	2L	
STODDARD, CHARLES H	2L	
WOLF, ROBERT E	2L	
WRIGHT, GERAIL G	2L	
ZAIDLICZ, EDWIN	2L	
ZUMWALT, EUGENE V	2L	

1IBMI BUREAU OF MINES

DEVINE, JAMES F	2B	
DONIHEE, JAMES B	3E	
KENAHAN, CHARLES B	3E	
MC CAWLEY, FRANK X	3E	
SCHLAIN, DAVID	3E	

1IBOR BUREAU OF OUTDOOR RECREATION

HART, WILLIAM J	2L	
PATTON, DWIGHT L	2L	
SHANKLIN, JOHN F	2L	
STOUT, NEIL J	2L	

1IFWS FISH & WILDLIFE SERVICE

ALDRICH, JOHN W	2D	AFRA
ALLEN, HAROLD B	2Q3C	
BUTLER, CHARLES	3C	
CROWTHER, HAROLD E	3C	
HERMAN, CARLTON M	2P2T	AFRA
HOLSTON, JOHN A	3C	
KERR, ROSE G	3C	
LYMAN, JOHN	2E	AFRA
MITCHELL, ROBERT T	2F	
PARKER, LANSING A	2L	
PISKUR, FRANK	3C	
PRESNALL, CLIFFORD C	2L	
SNYDER, DONALD G	3C	
SPODEN, F G JR	2L	
UHLER, FRANCIS M		AFRA
WOLF, KENNETH E	2Q	

1IGES GEOLOGICAL SURVEY

BAKER, ARTHUR A	2H	AFRA
BENNETT, ROBERT R	2H	AFRA
CARROW, MAXWELL K	2E2H	AFRA
CUTTITTA, FRANK	2E2G2H	AFRA
DANE, CARLE H	2H	AFRA
DUNCAN, HELEN M	2H	AFRA
FAHEY, JOSEPH J	2E2G2H	AFRA
FAUST, GEORGE T	2H	AFRA
FOURNIER, ROBERT O	2H	AFRA
GLASS, JEWELL J	2G2H	AFRA
HELZ, ARMIN W	2B	
HERZ, NORMAN	2H	AFRA
HOOKER, MARJORIE	2H	AFRA
LAKIN, HUBERT W	2H	AFNA
LOVE, S KENNETH	2E2H2G	AFRA
MAY, IRVING	2E2G2H	AFRA
MC KELVEY, VINCENT E	2H	AFRA
MC KNIGHT, EDWIN T	2H	AFRA
MEYROWITZ, ROBERT	2E	AFRA
MILTON, CHARLES	2B	
MISER, HUGH D	2H	AFRE
MYERS, ALFRED T	2E2G	AFNA
NACE, RAYMOND L	2H	AFRA
OWENS, JAMES P	2G2H	AFRA
PESELNICK, LOUIS	2B	
PHAIR, GEORGE	2H	AFRA
REICHEN, LAURA E	2E	AFRA
ROEDDER, EDWIN	2B2H	AFRA
RUBIN, MEYER	2H3C	AFRA
SCHALLER, WALDEMAR T	2E2H	AFRE
SHAPIRO, LEONARD	2E	AFRA
SMITH, WILLIAM O	2B	
STRINGFIELD, VICTOR T	2G2H2L	AFRA
SVENSON, H K	2K	
THAYER, THOMAS P	2H	AFRA
TODD, MARGARET R	2G2H	AFRA
TOULMIN, PRIESTLEY	2H	AFRA
WEAVER, DE FORREST E		AMRA
ZEN, E-AN	2H	AFRA

1INPS NATIONAL PARK SERVICE

BEAN, GEORGE A	2K	
BILL, HARTHON L	2L	
CARLSON, STURE T	2L	
FREDINE, C G	2L	
PRESTON, JOHN F	2L	
STITT, MERIE E	2L	
SWEM, THEODOR R	2L	
THOMAS, L KAY JR	2K	
WESTER, HORACE V	2K	

1IX INTERIOR MISC

PENNINGTON, WILLIAM A	2U	AFNA
SCHAEFFER, CLAUDE E		AFNA

1S STATE DEPARTMENT

1SACD ARMS CONTROL & DISARM AGENCY

KOPP, ROBERT	2B	

1SAID AGENCY FOR INTERNAT DEVELOPMENT

BEDARD, PAUL W	2L	

JOHNSON, D R 2F
WILLIER, LILLIAN E 2K AMRA

1SX STATE MISC
EDWARDS, H K 2E AMRA
KLEIN, TRUMAN S 2B
JOYCE, J WALLACE 2B2G AFRA
RAMBERG, WALTER 2B2O2W AFNA
WEBBER, ROBERT T AFNA

1T TREASURY DEPARTMENT

1TBEP BUREAU OF ENGRAVING & PRINTING
KRASLEY, PAUL A 3E

1TIRS INTERNAL REVENUE SERVICE
MATHERS, ALEX P 2E AFRA
PRO, MAYNARD J 2E2G3B AFRA
SCHOENEMAN, ROBERT L AFRA
TOMLINSON, HARRY R 2L

1X OTHER GOVERNMENT AGENCIES

1XAEC ATOMIC ENERGY COMMISSION
BARTELS, WILLIAM C 2B
BIERLEY, EUGENE 2X
DALZELL, R CARSON 2O2U3B AFRA
FINE, PAUL C 2B
HOLLAND, J Z 2X
HOLTON, WILLIAM B 2B
MAGIN, GEORGE B JR 2E2H3B AFRA
POMEROY, JOHN H 2B
REICHARDT, CHARLES H 2B
REITEMEIER, ROBERT F AFRA
RUARK, ARTHUR E 2B
SEVERIENS, JOHANNES C 2B
STEVENS, DONALD K 2B
TALIAFERRO, W H AFNA
VAN DYKEN, ALEXANDER R 2B
WENSCH, GLEN W 2G2U3B AFRA
WHITMAN, MERRILL J 3B2U AFRA
ZEHRING, ROBERT W 2B

1XBOB BUREAU OF THE BUDGET
BROADBENT, SAM R 2L
RAPP, DENNIS A 2L
SASAKI, WESLEY K 2L

1XCAB CIVIL AERONAUTICS BOARD
HOLSHOUSER, WILLIAM L 2G2U AFRA

1XCON CONGRESS STAFF
WARD, RAY 2L

1XDCG DISTRICT OF COLUMBIA GOVT
TOBIAS, JEROME 2B
TRAVIS, CLARENCE W 2F AMRA

1XFAA FEDERAL AVIATION AGENCY
BALLENZWEIG, EMANUEL M 2X
BROMLEY, EDMUND JR 2X
DECKER, ROBERT F 2X
EGGERT, WILLIAM E 2X
PODOLAK, EDWARD 2B

1XFCC FEDERAL COMMUNICATIONS COMM
WALDO, GEORGE V 2B

1XFPC FEDERAL POWER COMMISSION
GOODRIDGE, RICHARD S 2X

1XGAO GENERAL ACCOUNTING OFFICE
EICHORN, LARRY M 2B

1XGSA GENERAL SERVICES ADMINISTRATION
FIELDS, MELVIN D 3C

1XLIC LIBRARY OF CONGRESS
KENK, ROMAN 2G AFRA
OSTEN, EDWARD J 2B2W AMRA
WEISS, FRANCIS J 2B2E2G2K2Q AFRA
WEISS, FRANCIS J 3B3C AFRA
WILDER, THOMAS V 2L

1XMDG MARYLAND GOVERNMENT
SCHERR, DAVID 2Q
TAYLOR, GLENN R 2Q

1XNAS NAT AERONAUTICS & SPACE AGENCY
ALLISON, LEWIS J 2X
APELT, ARMIN O 3E
BANDEEN, WILLIAM R 2X
BRUCH, CARL W 2Q
CAHILL, WILLIAM F 2B
CLARK, JOHN F 2B
CROCKER, J ALLEN 2B
CUNNINGHAM, FRED G 2B
DARLING, EUGENE M JR 2X
DE NOVENS, MARIE 2B
DONNELLY, PAUL C 3E
DRYDEN, HUGH L 2B2G2O2W AFRA
EASTER, DONALD 2E AMRA
FUSSELL, WILLIAM B 2B
GARBACZ, MICHAEL L 2X
GHAFFARI, ABOLGHASSEM 2B AFRA
GILL, JOCELYN 2B
GOLDBERG, RICHARD A 2B
HAMMERSMITH, JOHN L 2B
HARRISON, HARRY 2B
HENNIGAN, THOMAS J 3E
HERTZ, HANS G 2B
HESS, WILMOT N 2B
HUANG, SU SHU 2B
JENKINS, DALE W 2F
KEE, RICHARD M 2X
KURZWEG, HERMAN H 2B2W AFRA
LA GOW, HERMAN E 2B
LAYTON, L LAMAR 2B
LIDDEL, URNER 2B2N2W AFRA
LONG, JOSEPH E 2B
LUDWIG, GEORGE H 2B
MALURKAR, S L 2B
MC DONALD, FRANK B 2B
NAUGLE, JOHN E 2B
NICHOLAS, GEORGE W 2X
O KEEFE, JOHN A 2B AFRA
OMIDVAR, KAZEM 2B
PARSONS, C LELAND 2B
PLOTKIN, HENRY H 2B
QUIMBY, FREEMAN H AFRA
SEAMSTER, AARON AFRA
SHELLEY, MARYANN B 2B
SHERFEY, JOSEPH M 3E
SLOOP, JOHN L 2B
SPREEN, WILLIAM C 2X
STASSINOPOULOS, E G 2B
STAUSS, HENRY E 2U AFRA
STOBER, ALFRED K 2B
TENNYSON, GEORGE P JR 2X
TEPPER, MORRIS 2W2X AFRA
THOMPSON, HAROLD P 2X
WADDEL, RAMOND C AFRA
WOOD, CHARLES P 2X
WORF, DOUGLAS L 2B

1XNOD NAT OCEANOGRAPHIC DATA CENTER
JACOBS, WOODROW C 2X AFRA
MYERS, WILLIAM H 2X AMRA

1XNSF NATIONAL SCIENCE FOUNDATION
CARLSON, HARVE J 2Q
COON, ROBERT G 2Q
CRANE, LANGDON T JR 2B AFRA
DEES, BOWEN C 2B
EDMUNDS, LAFE R 2F AFRA
ETZEL, HOWARD W 2G AFRA

GRAY, DWIGHT E	2B	
GRUNER, WAYNE R	2B	
HEER, RAY R JR	2B	
HODGE, W H	2K	
HUNTING, C EUGENE	2B	
HURLBURT, EVERETT H	2B	
JOHNSTON, ROBERT W	2B	
KECK, DAVID K	2K	
KELLER, GEOFFREY	2B	
KENNEY, ARTHUR W	2B	AFRA
LEISE, JOSHUA M	2Q	
MAYS, JOHN M	2B	
MC MAHON, JOAN C	2Q	
MC MILLEN, J HOWARD	2B	AFRA
ROBERTSON, RANDAL M	2B2G2L	AFRA
RODNEY, WILLIAM S	2B	AFRA
RUSSELL, MORTIMER	2Q	
SEEGER, RAYMOND J	2B	AFRA
SHANAHAN, ARTHUR J	2Q	AFRA
SPENCER, J T	2G	AFRA
STEWART, ILEEN E		AFRA
WITHROW, ALICE P	2K	AFRA

1XOST OFFICE OF SCIENCE & TECHNOLOGY

GOLOVIN, NICHOLAS E	2B	
KEENY, SPURGEON M JR	2B	

1XSBA SMALL BUSINESS ADMINISTRATION

FOLEY, EUGENE P	2B	

1XSMI SMITHSONIAN INSTITUTION

BLAKE, DORIS H	2F	AFRE
BOWMAN, THOMAS E	2D	AFRA
CARTWRIGHT, O L	2F	
COCHRAN, DORIS M		AFRA
COLLINS, HENRY B	2C	AFRA
CONGER, PAUL S		AFRA
COOKE, C WYTHE	2H	AFRE
COOPER, G ARTHUR	2H	AFRA
COWAN, RICHARD S	2K	
CUATRECASAS, JOSE	2K	
DAVIS, DON R	2F	
DRAKE, CARL J	2F	
DUCKWORTH, W DONALD	2F	
ERNST, WALLACE R	2K	
EWERS, JOHN C	2C	AFRA
EYDE, RICHARD H	2K	
FIELD, WILLIAM D		AFRA
FLINT, OLIVER S	2F	
FREEMAN, MONROE E	2E2T	AFRA
GAZIN, CHARLES L	2D2H	AFRA
GUARRAIA, LEONARD J	2Q	
HALE, MASON E JR	2K	
HENDERSON, E P	2H	AFRA
KINGSOLVER, JOHN	2F	
MC CLURE, FLOYD A	2K	
MC FADDEN, MAX	2F	
MILLER, CARL F	2C2G	AFRA
MORRISON, JOSEPH P	2D	AFRA
MORTON, CONRAD V	2K	
NICOLSON, DAN H	2K	
OEHSER, PAUL H	2B2D	AFRA
OSTROFF, EUGENE	2B	
REHDER, HARALD A	2D2G	AFRA
ROBERTS, FRANK H H	2C	AFRA
RUDD, VELVA E	2K	
RUHOFF, F A	2F	
SCHMITT, WALDO L	2D	AFRA
SHETLER, STANWYN G	2K	
SHROPSHIRE, WALTER A	2K	AMRA
SMITH, LYMAN B	2K	
SNYDER, THOMAS E	2F	
SODERSTROM, THOMAS R	2K	
STERN, WILLIAM L	2K	
STEWART, T DALE	2C	AFRA
SWALLEN, J R	2K	
WALLEN, IRVIN E	2G	AFRA
WARNER, ROSE E	2F	
WURDACK, JOHN J	2K	

1XUST TARIFF COMMISSION

FURLOW, EDWARD P	2L	
GONET, FRANK	2E	AFRA
MAY, RICHARD H	2L	
MC WILLIAMS, JAMES P	2L	
SUNDERLAND, LAWRENCE B	2L	

1XVET VETERANS ADMINISTRATION

ARON, STEPHEN A	2Q	
FUSILLO, MATTHEW H	2Q	AMRA
GOODWIN, WILLIAM M	2V	
HEILMAN, DOROTHY H	2Q	
JANICKI, BERNARD W	2Q	

2 EDUCATION

2H HIGHER EDUCATION

2HAMU AMERICAN UNIVERSITY

ALDRIDGE, MARY H	2B	
CHAET, ALFRED B	2B	
CURTISS, P R	2Q	
HARRISON, MARK	2B2Z	AFRA
MOORE, HARVEY C	2C	AFRA
NORTON, MATTHEW F	2B	
SCHUBERT, LEO	2B2E	AFRA
SITTERLY, BANCROFT W	2B	AFRA

2HCOU COLUMBIA UNION COLLEGE

BUSH, M BRUCE	3C	
DAVIDSON, JOHN A	2F	

2HCUA CATHOLIC UNIVERSITY OF AMERICA

ARNETT, ROSS H JR	2F	
BIBERSTEIN, FRANK A JR	2B2M2S	AFRA
BOWYER, C STUART	2B	
BRENNAN, JAMES G	2B	
CASTELLAN, GILBERT W	3E	
COWAN, CLYDE L JR	2B	
CUTCHINS, ERNEST C	2Q	
DARWENT, BASIL DE B	2B2E	AFRA
DAVIDSON, ROBERT A	2K	
DUTILLY, ARTHEME	2K	AFRA
HELLER, ISADOR		AFRA
HENDERSON, MALCOLM C	2B2Z	AFRA
HERZFELD, KARL F	2B	AFRA
HERZFELD, REGINA F	2C	AFRA
KENNEDY, E R	2G2Q	AFRA
KOWKABANY, GEORGE N	2B	
LITOVITZ, THEODORE A	2B2Z	AFRA
LYNN, W GARDNER	2B	AFRA
MEIJER, P H E	2B	
MENDOUSSE, JEAN S	2B	
MIELCZAREK, EUGENIE V	2B	
O BRIEN, JOHN A JR	2K	AFRA
OSGOOD, WILLIAM R	2O2S	AFRA
ROCK, GEORGE D		AFRA
SARLES, MERRITT P	2G2P2Y	AFRA
TALBOTT, F LEO	2B2G	AFRA
VAN TASSELL, EILEEN R	2F	

2HDCT D C TEACHERS COLLEGE

HAWORTH, ELLIS	2B	
OLSON, HENRY W		AFRA

2HGEU GEORGETOWN UNIVERSITY

BAKER, LOUIS C W	2E	AFRA
BHUSSRY, B R	2V	
COLWELL, RITA R	2Q	
CORSON, EDWARD M	2B	
GRAY, IRVING	2G	AFRA
HEYDEN, FRANCIS J SJ	2B2G	AFRA
KATZ, EDWARD	2G	
KIESS, CARL C	2G	AFRA
KIGUEL, ENRIQUE B	2V	
KOPPANYI, THEODORE	2T	AFRA

KRUGER, GUSTAV O	2V	
MAENGWYN-DAVIES, G D	2B	
NEMES, J L	2Q2V	
OLIPHANT, MALCOLM W		AFRA
RAULT, CLEMENS V	2V	
ROSE, JOHN C	2T2I	AFRA
RUBIN, VERA C	2B	AFRA
SALZMAN, LOIS A	2Q	
SCHNAPER, HAROLD W	2B	
SCHWEDER, WILLIAM H	2B	
SINGER, IRA	2Q	
STEINHARDT, JACINTO	2E	AFRA
SUCHARD, MINNIE R	2Q	
THALER, WILLIAM J		AFRA
VERNICK, SANFORD H		AMRA
YOUNG, EDWARD J	2Q	

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ADAMS, CAROLINE	2K	AMRA
AFFRONTI, LEWIS F	2Q	
ALLAN, FRANK D		AMRA
BROWN, THOMAS H	2I2Q	AFRA
COURT, LOUIS M	2B	
CRAFTON, PAUL A	2G2N2Q2W	AFRA
DE PIAN, LOUIS	2B	
DEDRICK, ROBERT L	2B	
FINAN, JOHN L		AMRA
FOWLER, RICHARD	2Q	
GRISAMORE, NELSON T	2B2G2N	AFRA
HANN, WILLIAM D	2Q	
HANSEN, IRA B	2D2G	AFRA
HERR, ROBERT R	2K	
HOBBS, HERMAN H	2B	
HOLLINSHEAD, A C	2Q	
HUGH, RUDOLPH	2Q2T	AMRA
JEHLE, HERBERT	2B	
KULLBACK, SOLOMON	2N	AFRA
MANDEL, H GEORGE	2E2T	AFRA
MASON, MARTIN A	2G2M2Q2S	AFRA
MC CARTEN, W G	2Q	
MEARS, FLORENCE M		AFRA
MOORE, ROBERT M	2B	
MUNSON, S C	2F	
NAESER, CHARLES R	2E2G2H	AFRA
O HERN, ELIZABETH M	2Q	AMRA
PARLETT, ROBERT C	2Q	AFRA
PERROS, THEODORE P	2B2E	AFRA
PRESCOTT, LAWRENCE M	2Q	
RAYCHOWDHURY, PRATIP N	2B	
ROBBINS, MARY L	2G2Q2T	AFRA
SAGER, WILLIAM F	2E	AFRA
SPECK, EUGENE L	2Q	
STEVENS, RUSSELL B	2K	AFRA
TAYLOR, JAMES H		AFRE
TELFORD, IRA R	2T	AFRA
TIDSALL, CHARLES S	2I2T	AFRA
TREADWELL, CARLETON R	2T	AFRA
VAN EVERA, BENJAMIN D	2E2G	AFRA
WALTHER, CARL H	2G2S	AFRA
WEINTRAUB, ROBERT L	2E2K	AFRA
WIGGINS, THOMAS B	2B	
WOOD, REUBEN E	2E3E	AFRA
WOOD, ROBERT C	2Q	
YEANDLE, STEPHEN S	2B	

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BRANSON, HERMAN	2B	AFRA
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DOWNING, LEWIS K	2S	AFRA
EAGLESON, HALSON V	2B	
FERGUSON, LLOYD N	2E	AFRA
FINLEY, HAROLD E	2D	AFRA
GRIFFITHS, NORMAN H C	2V	AFRA
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HANSBOROUGH, LOUIS A		AMRA
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HENRY, JOSEPH L	2V	
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MORRIS, KELSO B	2E	AFRA
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ROZEBOOM, L E	2F	
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SCOFIELD, FRANCIS 2E AMRA

3AOSA OPTICAL SOCIETY OF AMERICA

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3ASAF SOCIETY OF AMERICAN FORESTERS

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MEYERING, JOHN R	2L	
RAINER, YOUNG W	2L	

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3HDCG D C GENERAL HOSPITAL

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TICKLES, JOSEPH JR	2Q	

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3HSTE ST ELIZABETHS HOSPITAL

NEUMANN, META A	2B	

3HWHC WASHINGTON HOSPITAL CENTER

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GOSS, WILBUR H	2B	
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HIRES, ROBERT G	2B	
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KERSHNER, RICHARD B	2B	
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KOWAL, STANLEY J	2B	
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MENKART, JOHN H 2E AFRA
MIZELL, LOUIS R 2E AFRA
SCHWARTZ, ANTHONY M 2E AFRA
SOOKNE, ARNOLD M 2E AFRA

5HONE HONEYWELL
HONIG, JOHN C 2B

5HOSH HOT SHOPPES
MILLAR, ZELMA A 3C
WOOD, WILLIAM H 3C

5HOWR HOWARD RESEARCH CORP
DYKE, EDWIN 2N AMRA

5HUAS HUNTER ASSOCIATES LAB
BLUNDELL, GEORGE P 2Q
FOECKLER, FRANCIS 2Q
HUNTER, RICHARD S AFRA

5IBMC INTERNATIONAL BUSINESS MACHINES
KOROBKIN, IRVING 2B

5INCR INSTRUMENT CONTROL & RESEARCH
GERBERG, EUGENE J 2F

5IONC IONICS INCORPORATED
MC GRIFF, STUART G 3E

5ITTC INTERNATIONAL TELEPHONE & TELEG
VIGUE, KENNETH J 2N AMRA

5LIPR LIQUIDS PROCESS CO
ROLLER, PAUL S 2B2E2G AFRA

5LISY LITTON SYSTEMS MD DIV
CUTLER, EDWIN P 2B

5MART THE MARTIN CO %BALTO¤
SOLOW, MAX 2B

5MATR MATRIX CORP
WALSH, J PAUL 2B

5MELP MELPAR INC
FALLON, ROBERT J 2B2G AFRA
FELDMAN, CHARLES 2B
FOLEY, ROBERT T 3E
HALPERT, GERALD 3E
HARDY, FRANK M 2Q
PARIKH, GOKALDAS C 2Q
RITT, PAUL E 3D3E AFRA
TINER, JACK D 2Q

5MIAS MICROBIOLOGICAL ASSOCIATES
CALISHER, CHARLES H 2Q
CASTELLANO, GABRIEL 2Q
JAY, GEORGE E JR 2G AFRA
SHELDON, DONALD R 2Q
TENNANT, RAYMOND W 2Q
WARD, THOMAS G 2Q2T AFRA

5MVRE MT VERNON RESEARCH CO
CALIO, ANTHONY J 2B

5MXRE MEDICAL EXRAY RESEARCH LAB
SHUPING, RALPH E 2B

5NECO NELSON COMPANY
NELSON, JOHN M 2L

5OPRE OPERATIONS RESEARCH INC
GREENSTONE, REYNOLD 2B
WADEY, WALTER G AFRA

5PACO PAGE COMMUNICATIONS ENGINEERS
VANDIVERE, EDGAR F JR 2B

5PNDY PNEUMO DYNAMICS CORP
ELLSWORTH, WILLIAM M 2B
STANWICK, TAD 2B

5PORB POPULATION REFERENCE BUREAU
COOK, ROBERT C 2K AFRA

5QUSI QUADRI-SCIENCE INC
LAPP, RALPH E 2B AFRA

5RAAN RAFF ANALYTIC STUDY ASSOCIATES
RAFF, SAMUEL J 2B

5RACO RAND CORPORATION
KRAMISH, ARNOLD 2B
SMITH, PAUL A 2G2H2S2W AFRA

5RAEN RADIO ENGINEERING LABS

BURROWS, CHARLES R	2B	

5RAYC RAYTHEON CORPORATION

SPOONER, CHARLES S JR	2G	AFRA

5RBEN RABINOW ENGINEERING CO

RABINOW, JACOB	2B2N	AFRA

5REAN RESEARCH ANALYSIS CORP

BOYD, DONALD M	2Q3C	
FIACCO, ANTHONY V	2B	
GRAMANN, RICHARD H	2B	
HARDT, JOHN P	2B	
HIPP, FRED C	2B	
NEEDELS, THEODORE S	2B	

5RERS RESOURCES RESEARCH CORP

MC CABE, LOUIS C	2E2G	AFRA

5SCOP SCOPE INC

GERIG, JOHN S	2B	

5SCPR SCIENTIFIC PRODUCTS

POPE, BRUCE M	2Q	

5SHCH SHELL CHEMICAL CORP

ULLRICH, DONALD E	2F	

5SNUR A H SMALL & SONS NURSERY

TURPIN, JEAN M	2K	

5SSAS S-S ASSOCIATES

GOODMAN, STANLEY I	2B	

5SURE SURVEYS & RESEARCH CORP

RICE, STUART A		AFRA

5UNCA UNION CARBIDE CHEMICALS

MC BRIDE, GORDON W	2E3C	AFRA

5UNSY UNDERWATER SYSTEMS INC

WEINSTEIN, MARVIN S	2B	

5VAEN VALUE ENGINEERING CO

WEINBERG, HAROLD P	2U	AFRA

5VERS VERSITRON INC

CASE, ALFRED L	2B	
MEISINGER, H PETER	2B	

5VILA VITRO LABORATORIES

JAFFE, DANIEL L	2B	
JONES, CHARLES W	2B	
NORSETH, HOWARD G	2B	
TATUM, G R	2B	

5WAPO WASHINGTON POST

HASELTINE, NATE		AFRA

5WEEL WESTINGHOUSE ELECTRIC CO %BALTO

TRAPP, ORLIN D	3E	

5WORE WOODARD RESEARCH CORP

WILKOFF, LEE J	2Q	

5WRMC WILKENS-ROGERS MILLING CO

PANKEY, LINDAL H	3C	

5X UNIDENTIFIED PRIVATE BUSINESS

HENRY, MERTON	2L	
KAUFFMAN, ERLE	2L	

6 FOREIGN & INTERNATIONAL

6AUSO AUSTRALIAN SCIENTIFIC OFFICE

HARTLEY, WILLIAM	2K	

6FAOR FOOD & AGRICULTURE ORG, UN

DAWSON, ROY C	2Q	AFRA
LATTA, RANDALL	2F	AFNE
LING, LEE		AFNA

6HURE HUNTINGDON RESEARCH CENTRE

GRAHAM, C E	3C	

6MOCO MONOCAN CONSULATE

SCHERTENLEIB, CHARLES		AMRA

6WOHE WORLD HEALTH ORGANIZATION

CHAMBERLAYNE, EARL C	3C	

7RETD RETIRED

ABBOT, CHARLES G	2B2X	AFRE
ALDRICH, LOYAL B	2B	
ALLISON, FRANKLIN E	2E2G2Q	AFRA
AMES, LAWRENCE M	2G2K	AFRA
ANDERSON, BRUCE E	2B	
ANDERSON, MYRON S	2E	AFRA
ANDREWS, REBECCA E	2B	
APPLEMAN, CHARLES O	2K	
ARMSTRONG, CHARLES	2Q	AFRE
ARTZ, LENA	2K	
ASHBY, WINIFRED M	2Q	
BAKER, HOWARD	2F	
BARKER, HENRY D	2K	
BARRE, H W	2K	
BARSS, HOWARD P	2D2K	AFNE
BATES, PHAON H		AFNE
BAYNE-JONES, STANHOPE	2Q	
BEARCE, HENRY W	2B	AFNE
BEHRE, C EDWARD	2L	
BEIJ, K HILDING	2B	AFNA
BIEN, CORABEL	2K	
BIRCKNER, VICTOR		AFRE
BISHOPP, FRED C	2F	AFNE
BOURKE, ANNE R	2Q	
BRADLEY, FRANK	2Q	
BRADLEY, MARY A	2K	
BRECKENRIDGE, F C	2B	AFRA
BRIERLEY, PHILIP	2K	
BRODE, WALLACE R	2B2E	
BROMBACHER, W G	2B	AFRA
BROOKS, DONALD B		AFRA
BROWN, EDGAR	2D2K	AFRE
BUHRER, EDNA M	2P2G	AFRA
BURKEY, LLOYD A	2Q	AFRE
BURTON, J H	2Q	
CAMPBELL, FRANK L	2B2D2E2F2Y	AFNA
CASH, EDITH K	2D2K	AFRE
CASH, LILLIAN	2K	
CHALKLEY, HAROLD W	2T	AFRE
CHAPIN, EDWARD A		AFNE
CHAPLINE, W R	2G2K2L	AFRE
CHASE, FLORENCE M	2K	
CLARK, J ALLEN	2K	
CLARK, KENNETH G	2E2G	AFRA
CLAUSEN, CURTIS P	2F	AFNE
COE, MAYNE R		AFNE
COLBY, WALTER F	2B	
COLE, HOWARD I	2G	AFNE
COLEMAN, FRANK	2B	
COOK, GUY S	2B	
COOLEY, J S	2K	
COOLIDGE, WILLIAM D		AFNA
COONS, GEORGE H	2K	AFRE
COOPER, STEWART R		AFRE
CORY, ERNEST N	2F2Y	AFRE
CRAGOE, CARL S	2B2G	AFRE
CRAWFORD, ARTHUR B	2Q	
CURRIER, LOUIS W	2H	AFRE
CURTISS, LEON F	2B	AFNE
DAFT, FLOYD S	2E2U2T	AFRA
DARROW, G M	2K	
DAVIS, RAYMOND	2B2E	AFRE
DAWSON, PAUL R		AFNE
DAWSON, ROY C MRS	2Q	

DEAN, HORACE S	2K	
DEBORD, GEORGE G	2Q	AFNE
DEMAREE, J B	2K	
DENISON, I A	2B	
DETWILER, SAMUEL B	2K2L	AFRA
DIEHL, WILLIAM W	2K	AFRE
DIGGES, THOMAS G	2U	AFRE
DORSEY, HERBERT G	2B	
DUERKSEN, JACOB A	2B2G	AFRE
DUTTON, WALT	2L	
ELLIOTT, CHARLOTTE	2G2K	AFNE
ELLIS, NED R	2E2G2T	AFRA
ENGEL, LOUISE S	2X	
EVANS, ALICE C	2Q	AFRE
EYRE, F H	2L	
FIELDNER, ARNO C	2E2G2M	AFRA
FIVAZ, ALFRED E	2G2L	AFRE
FRACKER, STANLEY B	2F	
FREEMAN, OLIVER H	2K	
FULTON, H R	2K	
GAFAFER, WILLIAM M	2V	AFNE
GALTSOFF, PAUL S	2D	AFNE
GARDNER, IRVINE C	2B	AFRA
GARNER, CLEMENT L	2B2G2M2R2S	AFRE
GARVER, RAYMOND D	2L	
GELLER, ROMAN F	2B2G3D	AFRA
GIBSON, KASSON S	2B2G	AFRE
GISH, OLIVER H	2B	AFNE
GOLDBERG, MICHAEL	2B	AFRA
GOLDSWORTHY, M C	2K	
GOLL, F L	2K	
GRAF, JOHN E	2F	AFRA
GRANGER, CHRISTOPHER M	2L	
GRANT, ULYSSES S III	2G2J2M2R2S	AFRA
GRAVATT, ANNIE R	2K	
GRAVATT, G F	2K2L	AFRA
GROSVENOR, GILBERT	2G2J	AFRA
HACKMAN, EMORY E	2B	
HAEUSSLER, GILBERT J	2F	
HALL, R C	2L	AFRE
HALLER, HERBERT L	2E2F2G2Y	AFRA
HAMBLETON, EDSON J	2D2F2G	AFRA
HAMBLETON, JAMES I	2F	AFRA
HARKIN, DUNCAN C	2B	
HARNED, R W	2F	
HARTLEY, C F	2F	
HAVILAND, ELIZABETH E	2F	
HENLEY, ROBERT R	2G	AFRE
HOAR, CROSBY A	2L	
HOLLINGSHEAD, ROBERT S	2G3C	AFRE
HORN, PETER H	2B	
HOUGH, FLOYD W	2G2R2S	AFNA
HUBBARD, DONALD	2E2G	AFRA
HUNT, N REX	2K	
INGBERG, S H	2B	
JACKSON, HARTLEY H T	2D	AFRE
JENKINS, ANNA E	2K	AFNE
JESSUP, RALPH S	2B2G	AFRA
JOHNSON, A G	2K	
JOHNSON, FALBA	2K	
JOHNSTON, FRANCIS E	2B	AFRE
JOHNSTON, H FREEBORN	2B	
JONES, CYRIL J	2Q	
JUDD, NEIL M	2C2G	AFRE
JUDSON, LEWIS V	2B2G	AFRE
JUHN, MARY	2T	AFRA
KARRER, ANNIE M H		AFRE
KARRER, SEBASTIAN	2B2E2G	AFRA
KAUFFMANN, GLADYS	2Q	
KENNARD, RALPH B	2B	AFRE
KEPHART, L W	2K	
KNOWLTON, KATHRYN	2E2T	AFRA
KYLE, CURTIS H	2K	
LAMBERT, WALTER D	2B	AFNE
LANG, WALTER B		AFRE
LASSEN, LEON	2L	
LAVENDER, ROBERT A	2B	
LEAKE, JAMES P	2Q	
LEIGHTY, CLYDE E	2G2K	AFRE
LEONARD, MORTIMER D	2F	
LEUKEL, ROBERT W	2K	
LINDQUIST, ARTHUR W		AFNA
LOFQUIST, ETSUKO O	2T	AFRA
LOHR, ANNIE	2K	
LOWRY, LANCASTER	2B3E	
MACAULEY, JOHN B	2B	
MADORSKY, SAMUEL L	2E	AFRA
MAGNESS, J R	2K	
MALSTROM, ALVIN I	2B	
MARSH, R E	2L	
MARTIN, JOHN H	2G2K	AFRA
MASON, IRA J	2L	
MATHEWS, OSCAR	2K	
MATLACK, MARION	2E2G	AFRE
MAUSS, BESSE D		AFRA
MAY, EUGENE	2K	
MC INTOSH, ALLEN	2G2P	AFRA
MC KEE, SAMUEL A		AFRA
MC KINNEY, HAROLD H	2G2K2Q	AFRE
MC PHEE, HUGH C	2G	AFRE
MEARS, ATHERTON H		AFRE
MERRIAM, CARROLL F	2G	AFNA
MERZ, ALBERT R	2E	AFRE
MIDDLETON, HOWARD E		AFNE
MILLER, DAVID R	2B	
MILLER, J CHARLES	2H	AFRA
MOHLER, FRED L	2B	AFRE
MOLLARI, MARIO	2Q	AFRE
MORRISON, BENJAMIN Y		AFNE
MUCKENFUSS, R S	2Q	
MUESEBECK, CARL F W	2F2D	AFRE
MURPHY, PAUL S	2B	
NANCE, NELLIE	2K	
NIKIFOROFF, C C	2G2H	AFRE
NORTH, WILLIAM R JR	2Q	
NORTON, J B	2K	
O NEILL, HUGH T		AFRE
PAGE, BENJAMIN L	2B2G	AFRE
PARKINSON, DANA	2L	
PARR, LELAND W	2Q	AFRE
PITMAN, ARTHUR L	3E	
POLHAMUS, L G	2K	
POOS, FRED W	2F2G2Y	AFRA
POPE, MERRITT N	2K	AFNE
POPHAM, WILLIAM L	2F	
PORTER, B A	2F2G2Y	AFRA
POSEY, GILBERT B	2L	
RANDALL, CHARLES E	2L	
RANDS, ROBERT D	2G2K	AFNE
RAPPLEYE, HOWARD S	2B2G2M2R2S	AFRA
READ, W T	2E	AFRA
REICHELDERFER, F W	2B2X	AFRA
REID, MARY E	2K2T	AFRE
RICHMOND, SUSAN V	2B	
RICKER, PERCY L	2G2K	AFRE
ROGERS, LORE A	2Q	AFNE
ROSE, EDYTHE	2Q	
ROTH, FRANK L	2G	AFNA
RUTHERFORD, R M	2L	
RYERSON, KNOWLES A	2G	AFNA
SALMON, S C	2K	
SALMOND, GORDON R	2L	
SANFORD, RAYMOND L	2B	AFRE
SCHIPULL, WALTER L	2L	
SCHOENING, HARRY W	2P	AFRA
SCHOENING, HARRY W	2Q	
SCHREINER, OSWALD	2D2E2G2K	AFNE
SCHUYLER, G L	2B	
SCHWARTZ, BENJAMIN		AFRE
SCOFIELD, CARL S	2K	
SEAQUIST, EDGAR O	2B	
SERVICE, JERRY H		AFNE
SETZLER, FRANK M	2C2G	AFNE
SHAPOVALOV, MICHAEL	2G	AFNE
SIEGLER, EUGENE A	2K	
SIEKER, JOHN H	2L	

SIEVERS, ARTHUR F	2K	
SIMS, IVAN H	2L	
SMITH, CHARLES M	2Y	AFRE
SMITH, EDGAR R	2E	AFNE
SMITH, FRANCIS A		AFNE
SMITH, LAWRENCE W	2L	
SMITH, NATHAN R	2G2K2Q	AFNE
SNOKE, HUBERT R		AFRA
SPARHAWK, WILLIAM N	2L	AFNE
SPENCER, ROSCOE R		AFNE
SPICER, H CECIL	2H	AFNA
STANTON, T R	2K	
STEINBERG, R A	2K	
STEVENSON, JOHN A	2G2K	AFRE
STIEBELING, HAZEL K	2E	AFRA
STIMSON, HAROLD F	2B2G	AFRE
STIRLING, MATHEW W	2C2G	AFRA
SUTCLIFFE, WALTER D	2B2G2M2R	AFRE
SWICK, CLARENCE H	2B	AFRE
SWIFT, LLOYD W	2L	
SWINGLE, CHARLES F		AFNA
TAPKE, VICTOR F	2K	
TEMPLE, C E	2K	
THEODORIDES, PHRIXOS J	2B	
TILDEN, EVELYN B	2G	AFNE
TOOLE, EBEN H	2K	
TORRESON, OSCAR W	2B	AFRE
TRUEBLOOD, CHARLES K		AFRA
UMPLEBY, JOSEPH B	2H	AFNE
VACHER, HERBERT C		AFRE
VINAL, GEORGE W	2B2G	AFNE
VOLWILER, ERNEST H	2G	AFNA
WADLEY, F M	2F	
WALKER, EGBERT H	2K	AFRA
WALLS, EDGAR P	2K	
WALTON, GEORGE P		AFRE
WARD, HENRY P	2E	AFRE
WATERMAN, ALAN T	2B2W	AFRA
WATTS, CHESTER B	2B2G	AFRA
WEAVER, ELMER R	2C2E	AFRA
WEBB, J E JR	2F	
WEIDA, FRANK M	2B	AFRE
WEIGEL, C A	2F	
WEISS, FREEMAN A	2Q	AFNE
WELD, CLARK J	2K	
WETMORE, ALEXANDER	2D2G	AFRA
WHERRY, EDGAR T		AFNE
WHITE, ORLAND E		AFNE
WILCOX, MARGUERITE	2K	
WOOD, JESSIE I	2K	
WOOD, W B	2F	
WOODBURY, C G	2K	
WORKMAN, WILLIAM G	2G	AFRA
WRIGHT, ROBERT	2K	
YESAIR, JOHN	2Q	
YOCUM, L EDWIN	2K	AFNE
ZIES, EMANUEL G	2E2H2G	AFRE
ZIMERMANN, ALFRED G	2G	AFRA
ZOCH, RICHMOND T	2X	AFRA

8NRNC NONRESIDENT, EMPLOYER NOT CODED

9CLUN CLASSIFICATION UNKNOWN

9NCOC NOT CLASSIFIED BY OCCUPATION

Classification by Membership in Affiliated Societies

2B PHILOSOPHICAL SOCIETY OF WASHINGTON

ABBOT, CHARLES G	7RETD	AFRE
ABELSON, PHILIP H	3IGEL	AFRA
ABLARD, JAMES E	9CLUN	
ABRAHAM, GEORGE	1DNRL	AFRA
ADAMS, A NORWOOD	1DNOB	
ADAMS, LEASON H	8NRNC	AFNE
AITCHISON, CLYDE S	8NRNC	
ALDRICH, LOYAL B	7RETD	
ALDRIDGE, MARY H	2HAMU	
ALEXANDER, SAMUEL N	1CNBS	AFRA
ALLEN, HARRY C JR	1CNBS	AFRA
ALLGAIER, ROBERT S	1DNOL	
ALT, FRANZ L	1CNBS	AFRA
AMBLER, ERNEST	1CNBS	
ANDERSON, BRUCE E	7RETD	
ANDERSON, ELMER E	1DNOL	
ANDREWS, REBECCA E	7RETD	
ANGERS, WILLIAM P	8NRNC	
ANNIS, WILBERT	1D-X	
APEL, JOHN	3IAPL	
APPLEBAUM, ALBERT	1DNOL	
APSTEIN, MAURICE	1DAHD	AFRA
ARISTEI, JEROME	8NRNC	
ARKING, ALBERT	8NRNC	
ARMSTRONG, GEORGE T	1CNBS	AFRA
ARONSON, C J	1DNOL	
ARTMAN, JOSEPH O	3IAPL	
ASHCROFT, JOSEPH M	1DAX	
ASLAKSON, CARL I	4CONS	AFRA
ASTIN, ALLEN V	1CNBS	AFRA
AUSTIN, WALTER E	9CLUN	
AXILROD, BENJAMIN M	1CNBS	AFRA
BACK, GOLDIE	9CLUN	
BAILEY, EMMET C	8NRNC	
BALDES, EDWARD J	1DARO	AFRA
BALL, JOSEPH J	1CNBS	
BARBROW, LOUIS E	1CNBS	AFRA
BARFIELD, VIVIAN S	1CNBS	
BARRY, JOHN P	1DNRL	
BARTELS, WILLIAM C	1XAEC	
BASS, ARNOLD M	1CNBS	AFRA
BATES, CHARLES C	3IAPL	
BEACH, LOUIS A	1DNRL	AFRA
BEAMAN, H CLAYTON	3IAPL	
BEARCE, HENRY W	7RETD	AFNE
BECKETT, CHARLES W	1CNBS	AFRA
BEIJ, K HILDING	7RETD	AFNA
BEKKEDAHL, NORMAN	1CNBS	AFRA
BELSHEIM, ROBERT O	1DNRL	AFRA
BENESCH, WILLIAM	2HUMD	AFRA
BENNETT, BRADLEY F	1DNRL	
BENNETT, CLAUDIUS E	8NRNC	
BENNETT, WILLARD H	8NRNC	AFNA
BENSON, LOREN A	1D-X	
BERAHA, SAMI	2SMAR	
BERGER, ROBERT L	1HNIH	
BERKNER, L V	8NRNC	AFNA
BERL, WALTER G	3IAPL	AFRA
BERLINER, ROBERT W	1HNIH	AFRA
BERNIER, CHARLES L	1D-X	
BERNSTEIN, ARTHUR	8NRNC	
BERSHADER, DANIEL	8NRNC	
BESTUL, ALDEN B	1CNBS	
BIBERSTEIN, FRANK A JR	2HCUA	AFRA
BIRD, JOSEPH F	3IAPL	
BITTINGER, CHARLES	9CLUN	
BLACKBURN, WILLIAM J	1CCGS	
BLAKE, LAMONT V	1DNRL	
BLAU, EDMUND J	3IAPL	
BLEIL, DAVID F	1DNOL	
BLIGH, ALAN B	9CLUN	
BLINDER, S M	8NRNC	
BLOOM, MORTIMER C	1DNRL	AFRA
BLUMSTEIN, ALFRED	9CLUN	
BODLE, RALPH R	8NRNC	
BOGLE, ROBERT W	5DERE	AFNA
BORDEN, AVIS	1DNDT	
BOURLAND, LANGFORD T	1DNRL	
BOWMAN, ROBERT L	1HNIH	
BOWYER, C STUART	2HCUA	
BOYD, MARJORIE E	1CNBS	
BRAATEN, NORMAN F	1CCGS	AFRA
BRACKETT, FREDERICK S	5AMMA	
BRADLEY, ROBERT B	1HNIH	
BRADT, PAUL	8NRNC	
BRAMHALL, ERVIN H	8NRNC	
BRANSON, HERMAN	2HHOU	AFRA
BRECKENRIDGE, F C	7RETD	AFRA
BREMER, HANS O	9CLUN	
BRENNAN, JAMES G	2HCUA	
BREWER, A KEITH	1DNNO	AFRA
BRICKWEDDE, F G	8NRNC	AFNE
BRICKWEDDE, LANGHORNE	8NRNC	
BROCK, JOSEPH S	1DNDT	
BRODD, RALPH J	8NRNC	
BRODE, WALLACE R	7RETD	
BRODZINSKY, ALBERT	1DNRL	
BROGDEN, JOHN W	9CLUN	
BROMBACHER, W G	7RETD	AFRA
BROWN, ALFRED E	5HARE	AFRA
BROWN, C BRADNER	1DNOL	
BROWN, CALVIN F	9CLUN	
BROWN, GEORGE E	1DAER	
BROWN, RICHARD W	1DNOL	
BRUECKNER, KEITH A	3IIDA	
BRYANT, ROBERT W	9CLUN	
BUCKINGHAM, BURDETTE H	3IAPL	
BUCKINGHAM, STEPHEN A	3IAPL	
BUCKWALTER, GEORGE E	1DNX	
BUEHLER, JOHN H	8NRNC	
BURGERS, J M	2HUMD	AFRA
BURINGTON, RICHARD S	1DNBW	AFRA
BURNS, ROBERT O	1DNNO	
BURROWS, CHARLES R	5RAEN	
BUTLER, WARREN L	1AX	
CAHILL, WILLIAM F	1XNAS	
CALDWELL, FRANK R	1CNBS	AFRA
CALDWELL, PAUL A	1DAHD	
CALIO, ANTHONY J	5MVRE	
CALLEN, EARL R	1DNOL	AFRA
CAMERON, JOSEPH M	1CNBS	
CAMERON, LOUIS M	1DNRL	
CAMP, GLEN D	8NRNC	
CAMPBELL, FRANK L	7RETD	AFNA
CAMPBELL, JOHN H	1DNRL	
CANNON, EDWARD W	1CNBS	AFRA
CARDER, DEAN S	1CCGS	AFRA
CARLETON, PHILLIPS G	9CLUN	
CARLTON, A GEORGE	3IAPL	
CARMICHAEL, LEONARD	3INGS	AFRA
CARRINGTON, TUCKER	1CNBS	AFRA
CARROLL, THOMAS J	5BERA	AFRA
CASE, ALFRED L	5VERS	
CASTIGLIOLA, JULIUS	1DNOL	
CATTANEO, LOUIS E	1CNBS	
CENTOLA, DAVID D	4PATA	
CERCEO, J MICHAEL	9CLUN	
CHA, MOON H	1DNOL	

CHAET, ALFRED B	2HAMU	
CHATHAM, THOMAS K	1DNOL	
CHERTOCK, GEORGE	1DNDT	
CHERVENAK, JOHN	1DNRL	
CHI, ANDREW R	9CLUN	
CHILDERS, H MALCOLM	5GETE	
CLAIRE, CHARLES N	1CCGS	AFRA
CLARK, JOHN F	1XNAS	
CLARK, VIOLET	2SFCH	
CLEMENCE, G M	1DNOB	
CLEVEN, GALE W	1D-S	AFRA
COCHRAN, EDWARD L	3IAPL	
COHEN, LEON W	2HUMD	
COHEN, LESLIE	1DNRL	
COHEN, SAMUEL L	1DNRL	
COHN, ROBERT	1DNHS	AFRA
COLBY, WALTER F	7RETD	
COLE, KENNETH S	1HNIH	AFRA
COLEMAN, FRANK	7RETD	
COLLIER, CHARLES S	9CLUN	
CONANT, JAMES S	3HGDH	
CONDELL, WILLIAM J JR	1D-X	
CONLAN, JAMES	1DNOL	
CONRAD, EDWARD E	1DAHD	
COOK, GUY S	7RETD	
COOK, HAROLD T	1ARMR	AFRA
COOK, RICHARD K	1CNBS	AFRA
COOTER, IRWIN L	1CNBS	AFRA
CORLISS, CHARLES H	1CNBS	
CORSON, EDWARD M	2HGEU	
COSTRELL, LOUIS	1CNBS	AFRA
COURT, LOUIS M	2HGWU	
COVILLE, CABOT	9CLUN	
COWAN, CLYDE L JR	2HCUA	
CRAGOE, CARL S	7RETD	AFRE
CRAMER, RAYMOND H	3IAPL	
CRANE, LANGDON T JR	1XNSF	AFRA
CRAVEN, JOHN P	1DNSP	AFRA
CROCKER, J ALLEN	1XNAS	
CRUMP, STUART F	1DNDT	
CULVER, WILLIAM H	3IIDA	
CUNNINGHAM, FRED G	1XNAS	
CURCIO, JOSEPH A	1DNRL	
CURTIS, ROGER W	8NRNC	AFNA
CURTIS, WESTLEY F	1DNDT	
CURTISS, LEON F	7RETD	AFNE
CUTCHIS, PYTHAGORAS	9CLUN	
CUTHILL, ELIZABETH H	1DNDT	
CUTLER, EDWIN P	5LISY	
DAHLSTROM, ROBERT K	3IAPL	
DARWENT, BASIL DE B	2HCUA	AFRA
DAVIS, GEORGE E	8NRNC	
DAVIS, RAYMOND	7RETD	AFRE
DAVIS, RUTH M	1D-S	
DAVIS, WATSON	3ISCS	AFRA
DAVISSON, JAMES W	1DNRL	AFRA
DAYHOFF, EDWARD S	1DNOL	
DE MACEDO, PEDRO B	1CNBS	
DE NOVENS, MARIE	1XNAS	
DE PACKH, DAVID C	1DNRL	AFRA
DE PIAN, LOUIS	2HGWU	
DE SAVAGE, BERNARD F	1DNOL	
DE VORE, CHARLES	1DNOR	
DE WITT, HENRY A	1DNBS	
DEDRICK, ROBERT L	2HGWU	
DEES, BOWEN C	1XNSF	
DEITCHMAN, SEYMOUR J	1D-S	
DEL GROSSO, VINCENT A	1DNRL	
DEMING, W EDWARDS	4CONS	
DENISON, I A	7RETD	
DENT, ELLIOD	1DNRL	
DEROCCO, ANDREW G	9CLUN	
DETERS, OWEN J	3IAPL	
DETWILER, CHARLES R	1DNRL	
DEVINE, JAMES F	1IBMI	
DINGER, HAROLD E	9CLUN	
DINGER, JACOB E	1DNRL	
DISTAD, MERRIL F	1DAHD	

DOLECEK, RICHARD L	1DNRL	AFRA
DORSEY, HERBERT G	7RETD	
DOUGLAS, CHARLES A	1CNBS	AFRA
DRIMMER, BERNARD E	1DNBW	
DRYDEN, HUGH L	1XNAS	AFRA
DUERKSEN, JACOB A	7RETD	AFRE
DUFFEY, DICK	2HUMD	
DUNNE, HAROLD E	8NRNC	
DUNNING, KENNETH L	1DNRL	AFRA
EAGLESON, HALSON V	2HHOU	
EATON, ALVIN R	3IAPL	
EATON, HERBERT N	8NRNC	
EBY, RONALD K	1CNBS	
ECKLUND, EVERETT T	3IDTM	
EDDY, ROBERT P	1DNDT	
EDELMAN, SEYMOUR	1CNBS	
EGLI, PAUL H	1DNRL	AFRA
EICHORN, LARRY M	1XGAO	
EISENHART, CHURCHILL	1CNBS	AFRA
EIWEN, CHARLES J	5AMMA	
ELBOURN, ROBERT D	1CNBS	AFRA
ELLSWORTH, WILLIAM M	5PNDY	
ENIG, JULIUS W	1DNOL	
ENNIS, WILLIAM W	9CLUN	
ESTERMANN, IMMANUEL	1DNX	AFNA
EWING, ANN M	3ISCS	
FAGG, LAWRENCE W	5ATRE	
FALLON, ROBERT J	5MELP	AFRA
FANO, U	1CNBS	
FAUST, WILLIAM R	1DNRL	AFRA
FELDMAN, CHARLES	5MELP	
FELDMAN, JEROME P	1DNDT	
FERLAZZO, GAETANO	8NRNC	
FERRIS, CLIFFORD D	8NRNC	
FIACCO, ANTHONY V	5REAN	
FINE, PAUL C	1XAEC	
FINN, EDWARD J	9CLUN	
FIOCK, ERNEST F	8NRNC	
FLETCHER, FRANKLIN M	9CLUN	
FOLEY, EUGENE P	1XSBA	
FOLLIN, JAMES W JR	3IAPL	
FONER, SAMUEL N	3IAPL	AFRA
FOOTE, PAUL D	3INAS	AFRA
FORBUSH, SCOTT E	3IDTM	
FORSYTH, PAUL S	1DFX	
FOWLER, HOWLAND A	1CNBS	
FOX, JAMES F	9CLUN	
FRAPS, RICHARD M	1ARFR	AFRA
FRASER, LORENCE W	3IAPL	
FREEMAN, JACOB J	5FRAS	
FRENKEL, LOTHAR	9CLUN	
FRENKIEL, FRANCOIS N	1DNDT	AFRA
FRIEDMAN, HERBERT	1DNRL	
FROELICH, KATHRYN	3IAPL	
FULLER, EVERETT	1CNBS	
FULLMER, IRVIN H	1CNBS	AFRA
FURUKAWA, GEORGE T	1CNBS	AFRA
FUSSELL, WILLIAM B	1XNAS	
GAMOW, GEORGE	8NRNC	AFNA
GARCIA, LUIS F	9CLUN	
GARDNER, IRVINE C	7RETD	AFRA
GARNER, CLEMENT L	7RETD	AFRE
GARRETT, DAVID L	9CLUN	
GARRETT, JOHN H	8NRNC	
GAYLORD, RICHARD H	3IIDA	
GEBHARD, JACK W	3IAPL	
GEHMAN, JEAN R	9CLUN	
GELLER, ROMAN F	7RETD	AFRA
GENEVESE, F	8NRNC	
GERIG, JOHN S	5SCOP	
GESSERT, ROBERT A	3IIDA	
GHAFFARI, ABOLGHASSEM	1XNAS	AFRA
GIBBS, R C	3INAS	
GIBSON, KASSON S	7RETD	AFRE
GIBSON, RALPH E	3IAPL	AFRA
GILL, CHARLES W	1DNX	
GILL, JOCELYN	1XNAS	
GIROUARD, PHILIAS H	8NRNC	

GISH, OLIVER H	7RETD	AFNE
GLADDEN, SANFORD C	8NRNC	
GLASER, HAROLD	1DNOR	
GLASSER, ROBERT G	1DNRL	AFRA
GODLOVE, TERRY F	1DNRL	
GOLDBERG, BENJAMIN	1DAX	
GOLDBERG, MICHAEL	7RETD	AFRA
GOLDBERG, RICHARD A	1XNAS	
GOLDSTEIN, GORDON D	1DNOR	
GOLDSTEIN, HERBERT	1CNBS	
GOLOVIN, NICHOLAS E	1XOST	
GOODMAN, STANLEY I	5SSAS	
GORBICS, STEVEN G	1DNRL	
GORDON, CHARLES L	1CNBS	AFRA
GORDON, CLIFFORD M	1DNRL	
GORNICK, FRED	1CNBS	
GOSS, WILBUR H	3IAPL	
GOSSETT, CHARLES R	1DNRL	
GRAMANN, RICHARD H	5REAN	
GRANT, F A	8NRNC	
GRAVES, JACOB D	5GETE	
GRAY, DWIGHT E	1XNSF	
GRAY, ERNEST P	3IAPL	AMRA
GREEN, C B	8NRNC	
GREEN, LOWELL F	1DNOL	
GREEN, MELVILLE S	1CNBS	AFRA
GREENLEE, MALCOLM B	3IAPL	
GREENSPAN, LEWIS	9CLUN	
GREENSPAN, MARTIN	1CNBS	AFRA
GREENSTONE, REYNOLD	5OPRE	
GRISAMORE, NELSON T	2HGWU	AFRA
GRUNER, WAYNE R	1XNSF	
GUAY, RAYMOND J	1DNOL	
GUIER, WILLIAM H	3IAPL	
GUILDNER, LESLIE A	1CNBS	
GULLEDGE, IRENE S	9CLUN	
HACKMAN, EMORY E	7RETD	
HAFSTAD, L R	8NRNC	
HAGERTY, LAURENCE J	1DNOL	
HAISLMAIER, ROBERT J	1DNOL	
HALL, ROBERT W	1DAMC	
HALL, WAYNE C	1DNRL	AFRA
HAMMERSCHMIDT, W W	1D-S	AMRA
HAMMERSMITH, JOHN L	1XNAS	
HANSCOME, THOMAS D	8NRNC	
HANSEN, EILEEN A	1D-S	
HARDT, JOHN P	5REAN	
HARDY, ROBERT C	1CNBS	
HARKIN, DUNCAN C	7RETD	
HARMANTAS, CHRISTOS	1CWEB	
HARMON, GEORGE G JR	1CNBS	
HARRINGTON, MARSHALL C	9CLUN	
HARRISON, HARRY	1XNAS	
HARRISON, MARK	2HAMU	AFRA
HARRISON, WILLIAM N	1CNBS	AFRA
HART, ROBERT W	3IAPL	
HARTMANN, GREGORY K	1DNOL	AFRA
HARTZLER, A J	8NRNC	
HAUPT, RALPH F	1DNOB	
HAUPTMAN, HERBERT	1DNRL	AFRA
HAWORTH, ELLIS	2HDCT	
HAYDEN, LEONARD O	1DNRL	
HAYES, HARVEY C	8NRNC	
HEALD, ROY H	1CNBS	
HEER, RAY R JR	1XNSF	
HEILPRIN, LAURENCE B	1CNBS	
HEIN, ROBERT A	1DNX	
HELZ, ARMIN W	1IGES	
HENDERSON, MALCOLM C	2HCUA	AFRA
HENNEY, ALAN G	1DNOL	
HENNEY, DAGMAR R	2HUMD	
HENRY, THOMAS R	4X	AFRA
HENZE, PAUL B	1CNBS	
HERLING, GARY H	1DNRL	
HERSEY, MAYO D	8NRNC	AFNA
HERTZ, HANS G	1XNAS	
HERZ, ALBERT J	1DNRL	AFRA
HERZFELD, CHARLES M	1D-S	AFRA
HERZFELD, KARL F	2HCUA	AFRA
HESS, WILMOT N	1XNAS	
HEYDEN, FRANCIS J SJ	2HGEU	AFRA
HILDEBRAND, BERNARD	1DNRL	
HILL, FREEMAN K	3IAPL	AFRA
HILSENRATH, JOSEPH	1CNBS	
HIPP, FRED C	5REAN	
HIRES, ROBERT G	3IAPL	
HIRSCHEL, LOUIS R	1DNOL	
HOBBS, HERMAN H	2HGWU	
HOBBS, ROBERT B	1CNBS	AFRA
HODGE, MARY W	1CWEB	
HODGE, ORLANDO J	8NRNC	
HOEVE, C A	1CNBS	
HOFFMAN, JOHN D	1CNBS	AFRA
HOGE, HAROLD J	1DAX	AFNA
HOLBERTON, JOHN V	1DNBS	
HOLLOWAY, MARSHALL G	8NRNC	
HOLLYER, ROBERT N JR	8NRNC	
HOLMGREN, HARRY D	2HUMD	AFRA
HOLTON, WILLIAM B	1XAEC	
HONES, EDWARD W JR	9CLUN	
HONIG, JOHN C	5HONE	
HOOVER, JOHN I	1DNRL	AFRA
HOOVER, ROLAND A	5ALCH	
HOPFIELD, HELEN S	3IAPL	
HOPKINS, JOHN J	8NRNC	
HORL, ERWIN M	2HHOU	
HORN, PETER H	7RETD	
HORNBECK, GEORGE A	1CNBS	
HORNYAK, WILLIAM F	2HUMD	
HORTON, BILLY M	1DAHD	AFRA
HOSKINSON, ALBERT J	1CCGS	
HUANG, SU SHU	1XNAS	
HUBBARD, WILLIAM M	1DNOL	
HUBBELL, JOHN H	1CNBS	
HUDDLE, FRANKLIN P	9CLUN	
HUDSON, RALPH P	1CNBS	
HUDSON, RICHARD L	3IAPL	
HUG, EDWARD H	1DNOL	
HULL, ROBERT B	1CPAO	
HUMPHREYS, CURTIS J	1DNOL	AFNA
HUNTER, WILLIAM R	1DNRL	AFRA
HUNTING, C EUGENE	1XNSF	
HUNTOON, ROBERT D	1CNBS	AFRA
HURLBURT, EVERETT H	1XNSF	
IMLAY, FREDERICK H	1DNDT	
INGBERG, S H	7RETD	
INSLEY, HERBERT	4CONS	AFRA
IRWIN, GEORGE R	1DNRL	AFRA
IVORY, JOHN E	1DNRL	
JACKSON, JOHN E	1D-S	
JACKSON, JULIUS L	1CNBS	AFRA
JACOBS, WALTER W	1D-X	AFRA
JAFFE, DANIEL L	5VILA	
JAFFE, DAVID	5AMMA	
JAQUES, ALVIN T	1DNOL	
JASHEMSKI, STANLEY A	1DNOL	
JEHLE, HERBERT	2HGWU	
JEN, CHIH K	3IAPL	AFRA
JENNER, J SLATEN 4	4CONS	
JENSEN, MALCOLM W	1CNBS	
JESSUP, RALPH S	7RETD	AFRA
JOHNSON, DANIEL P	1CNBS	AFRA
JOHNSON, ELLIS A	1DAHD	
JOHNSON, KEITH C	2SDCP	AFRA
JOHNSON, M H	9CLUN	
JOHNSON, PAUL S	1DFX	
JOHNSTON, FRANCIS E	7RETD	AFRE
JOHNSTON, H FREEBORN	7RETD	
JOHNSTON, ROBERT W	1XNSF	
JOHNSTON, THOMAS F	1DNOL	
JONES, CHARLES W	5VILA	
JONES, FRANK E	1CNBS	
JONES, JOHN L JR	1DNOL	
JOSEPH, HORACE M	1CNBS	
JOYCE, J WALLACE	1SX	AFRA
JUDD, DEANE B	1CNBS	AFRA

JUDSON, LEWIS V	7RETD	AFRE
KAISER, HERMAN F	1DNRL	
KAMMER, ERWIN W	1DNRL	
KAPLAN, JOSEPH	3INAS	
KARLE, JEROME	1DNRL	AFRA
KARRER, SEBASTIAN	7RETD	AFRA
KEENY, SPURGEON M JR	1XOST	
KEIM, SHEWELL D	1DNBS	
KELLER, GEOFFREY	1XNSF	
KELLEY, MARION R	1DNX	
KELLINGTON, MYRTLE R	8NRNC	
KELLY, ELIZABETH	8NRNC	
KEMPNER, ELLIS S	1HNIH	
KENDALL, J M	8NRNC	
KENNARD, RALPH B	7RETD	AFRE
KENNEY, ARTHUR W	1XNSF	AFRA
KERSHNER, RICHARD B	3IAPL	
KESSLER, KARL G	1CNBS	AFRA
KEULEGAN, GARBIS H	1DAX	AFNA
KIES, JOSEPH A	1DNRL	AFRA
KILBOURNE, ELAINE M	2SDCP	
KING, PETER	1DNRL	AFNA
KIRKLAND, GLENN I	3IAPL	
KIRSTEIN, MYRON	8NRNC	
KITCHENS, J WESLEY	1DNOB	
KLEBANOFF, PHILIP S	1CNBS	
KLEIN, RALPH	1CNBS	
KLEIN, TRUMAN S	1SX	
KLUTE, CHARLES H	1DAHD	AFRA
KOLB, ALAN C	1DNRL	AFRA
KOLODNY, SAMUEL	1DAHD	
KOOMEN, MARTIN J	1DNRL	
KOPEC, CASIMIR S	1CNBS	
KOPP, ROBERT	1SACD	
KOROBKIN, IRVING	5IBMC	
KOSTKOWSKI, HENRY J	1CNBS	AFRA
KOWAL, STANLEY J	3IAPL	
KOWKABANY, GEORGE N	2HCUA	
KRAFFT, JOSEPH M	1DNRL	
KRAMISH, ARNOLD	5RACO	
KREBS, JAMES J	1DNRL	
KRULFELD, MYER	1DNRL	
KSANDA, CHARLES J	8NRNC	
KSULA, WILLIAM M	8NRNC	
KUCK, JOHN H	3IAPL	
KUDRAVCEV, VSEVOLOD	1HNIH	
KUNDERT, OTTO R	1DAX	
KUNST, EGBERT D	9CLUN	
KURZWEG, HERMAN H	1XNAS	AFRA
KUYATT, CHRIS E	1CNBS	
LA GOW, HERMAN E	1XNAS	
LA VILLA, ROBERT E	1CNBS	
LALOS, GEORGE T	1DNOL	
LAMBERT, WALTER D	7RETD	AFNE
LANDER, JAMES F	1CCGS	
LANDON, HARRY H JR	1CNBS	
LANSDELL, HERBERT C	1HNIH	
LAPP, CLAUDE J	3INAS	AFRA
LAPP, RALPH E	5QUSI	AFRA
LARKIN, CHARLES R	1DNOL	
LASHOF, THEODORE W	1CNBS	AFRA
LASTER, HOWARD J	2HUMD	AFRA
LAVENDER, ROBERT A	7RETD	
LAYTON, L LAMAR	1XNAS	
LEDER, LEWIS B	8NRNC	AFNA
LEFFINGWELL, THOMAS C	1HX	
LEHNERT, RICHARD	1DNOL	
LEPSON, BENJAMIN	1DNRL	
LEVY, LILLIAN	9CLUN	
LIBELO, LOUIS F JR	9CLUN	
LIBEN, WILLIAM	3IAPL	
LIDDEL, URNER	1XNAS	AFRA
LIEBSON, SIDNEY H	8NRNC	AFNA
LIIMATAINEN, T M	8NRNC	
LIPNICK, MILTON	1DAHD	
LIPPINCOTT, ELLIS R	2HUMD	AFRA
LITOVITZ, THEODORE A	2HCUA	AFRA
LITTLE, CHARLES A	3IDTM	
LLOYD, EDWARD C	1CNBS	
LOGAN, JOHN K	9CLUN	
LONBERGER, STANLEY T	5AMMA	
LONG, JOSEPH E	1XNAS	
LOWRY, LANCASTER	7RETD	
LUDWIG, GEORGE H	1XNAS	
LUNCHICK, MYRON E	5BOAL	
LYNN, W GARDNER	2HCUA	AFRA
MAC CARDLE, ROSS C	1HNIH	
MAC DONALD, WILLIAM M	2HUMD	
MAC QUIVEY, DONALD R	8NRNC	
MACAULEY, JOHN B	7RETD	
MACEK, ANDREJ	5ATRE	
MACURDY, ARTHUR C	8NRNC	
MACURDY, L B	8NRNC	
MAENGWYN-DAVIES, G D	2HGEU	
MAHAN, ARCHIE I	3IAPL	AFRA
MAISCH, WILLIAM G	1DNRL	
MALETZ, F J	9CLUN	
MALETZ, RED	9CLUN	
MALMBERG, PHILIP R	1DNRL	
MALSTROM, ALVIN I	7RETD	
MALURKAR, S L	1XNAS	
MANDEL, JOHN	1CNBS	AFRA
MANDELKERN, LEO	8NRNC	
MANN, WILFRID B	1CNBS	
MANNING, IRWIN	1DNRL	
MARDER, STANLEY	3IIDA	
MARKOWITZ, WILLIAM	1DNOB	
MARSHALL, SAMSON A JR	8NRNC	
MARSHALL, WADE H	1HNIH	AFRA
MARTIN, GORDON M	1CNBS	
MARTIN, JOSEPH P	9CLUN	
MARTON, L L	1CNBS	AFRA
MARTON, TIBOR W	1CNBS	
MARVIN, ROBERT S	1CNBS	AFRA
MASON, A HUGHLETT	1DAX	
MASON, CHARLES N JR	9CLUN	
MASON, EDWARD A	2HUMD	AFRA
MASON, HENRY L	1CNBS	
MASSEY, JOSEPH T	3IAPL	AFRA
MATHESON, HARRY	1CNBS	
MAUER, FLOYD A	1CNBS	
MAXWELL, LOUIS R	1DNOL	AFRA
MAY, ALBERT	1DNOL	
MAY, DONALD C JR	1DNBW	AFRA
MAYER, CORNELL H	1DNRL	AFRA
MAYS, JOHN M	1XNSF	
MAZUR, JACOB	1CNBS	AFRA
MC CLAIN, EDWARD F JR	1DNRL	AFRA
MC CLURE, FRANK T	3IAPL	AFRA
MC CLURG, GREGG H	1DAX	
MC CRAW, TOMMY F	1DFX	
MC CULLOH, KENNETH E	1CNBS	
MC DONALD, FRANK B	1XNAS	
MC ELHINNEY, JOHN	1DNRL	AFRA
MC GUIRE, T R	8NRNC	
MC KEE, W P	8NRNC	
MC KENZIE, LAWSON M	8NRNC	AFNA
MC KINLEY, JOHN D	1CNBS	
MC KINNEY, JOHN E	1CNBS	
MC MILLEN, J HOWARD	1XNSF	AFRA
MC MINN, WILLIAM O	9CLUN	
MC NESBY, JAMES R	1CNBS	AFRA
MC NISH, ALVIN G	1CNBS	
MC PHERSON, ARCHIBALD	1CNBS	AFRA
MEARS, THOMAS W	1CNBS	
MECKLER, ALVIN	9NCOC	
MEGGERS, WILLIAM F	4CONS	AFRA
MEIJER, P H E	2HCUA	
MEISINGER, H PETER	5VERS	
MELTON, BEN S	1DFX	
MENDOUSSE, JEAN S	2HCUA	
MERKEL, EUGENE E	1D-X	
MICKEY, WENDELL V	1CCGS	
MIELCZAREK, EUGENIE V	2HCUA	
MIELCZAREK, STANLEY R	1CNBS	
MILLER, DAVID C	8NRNC	

MILLER, DAVID R	7RETD	
MILLER, MARLIN L	1DNDT	
MILLIKEN, LEWIS T	1CNBS	
MILTON, CHARLES	1IGES	
MITCHELL, CHARLES L	8NRNC	
MITTLEMAN, DON	1CNBS	AFRA
MODINE, NORMAN F	1HPHS	
MOHLER, FRED L	7RETD	AFRE
MONCHICK, LOUIS	3IAPL	AFRA
MONTROLL, ELLIOTT W	3IIDA	AFRA
MOORE, DWIGHT G	1CNBS	
MOORE, ROBERT M	2HGWU	
MOORHEAD, JOHN G	1DAHD	
MORGAN, RAYMOND	2HUMD	AFRA
MORRISON, COHN L	5AMMA	
MORSCHER, L N JR	1DNOR	
MORTON, HAROLD S JR	8NRNC	
MOYER, JAMES W	8NRNC	
MUEHLHAUSE, CARL O	1CNBS	AFRA
MUELLER, EUGENE F	8NRNC	
MUENCH, NILS L	9CLUN	
MUNIS, RICHARD H	1CNBS	
MURPHY, LEONARD M	1CCGS	AFRA
MURPHY, PAUL S	7RETD	
MURRAY, KENNETH M JR	1DNRL	
MUTCH, WILLIAM W	1DNRL	
MUZZEY, DAVID S JR	1DNOL	
MYERS, RALPH D	2HUMD	AFRA
NALL, JULIAN C	9CLUN	
NAMIAS, JEROME	1CWEB	AFRA
NARGIZIAN, ANDREW A	9CLUN	
NAUGLE, JOHN E	1XNAS	
NEEDELS, THEODORE S	5REAN	
NETTLETON, RICHARD E	1CNBS	
NEUMANN, META A	3HSTE	
NEWTON, ROBERT R	3IAPL	
NICOLAIDES, JOHN D	8NRNC	
NOBLE, FRANK W	1HNIH	
NORSETH, HOWARD G	5VILA	
NORTON, MATTHEW F	2HAMU	
NUCKOLLS, R G	8NRNC	
NUGENT, LEONARD J	8NRNC	
NUTTALL, RALPH L	1CNBS	
NUTTING, P G JR	1D-S	
O DELL, FRANCIS W	1DNRL	
O KEEFE, JOHN A	1XNAS	AFRA
O ROURKE, RAYMOND C	8NRNC	
OBOURN, ELLSWORTH S	1HOED	AFRA
ODISHAW, HUGH	9CLUN	
OEHSER, PAUL H	1XSMI	AFRA
OKADA, JOSEPH M	1DNRL	
OMIDVAR, KAZEM	1XNAS	
OPIK, ERNST J	2HUMD	
OSTEN, EDWARD J	1XLIC	AMRA
OSTROFF, EUGENE	1XSMI	
OTTING, WILLIAM J JR	1D-X	
OVERTON, WILLIAM C JR	8NRNC	AFNA
PABLO, MANUEL R	1DNRL	
PAGE, BENJAMIN L	7RETD	AFRE
PAGE, CHESTER H	1CNBS	AFRA
PAI, SHIH-I	2HUMD	
PALMER, GERALD L JR	8NRNC	
PARKER, JOHN G	3IAPL	
PARKS, ARTHUR O	1DNRL	
PARSONS, C LELAND	1XNAS	
PARSONS, DOUGLAS E	4CONS	AFRE
PASTA, JOHN R	8NRNC	
PEARSE, CABELL A	1DNRL	
PECHOUSEK, THOMAS W	8NRNC	
PEISER, H STEFFEN	1CNBS	AFRA
PENTZER, WILBUR T	1ARMR	AFRA
PERROS, THEODORE P	2HGWU	AFRA
PESELNICK, LOUIS	1IGES	
PETERSEN, RICHARD G	1DNOL	
PETREE, MARCELLA C	1DNOL	
PETRITZ, RICHARD L	8NRNC	
PHELPS, JOHN B	9CLUN	
PHILBRICK, JANE V	1D-X	
PHILLIPS, MARCELLA L	4CONS	AFRA
PIEPER, GEORGE F	3IAPL	
PIORE, E R	8NRNC	AFNA
PLOTKIN, HENRY H	1XNAS	
PLUMB, HARMON H	1CNBS	
PLYLER, EARLE K	1CNBS	
PODOLAK, EDWARD	1XFAA	
POLACHEK, HARRY	1DNDT	AFRA
POMEROY, JOHN H	1XAEC	
POOLER, LOUIS G	4CONS	
POWERS, JOSEPH	1CNBS	
PRATHER, JOHN L	8NRNC	
PROBUS, JAMES H	1D-X	
PRYCE, AUBREY W	1DNOR	
PUGH, GEORGE E	5DERE	
PURCELL, J D	1DNRL	
QUILL, JOHN J	1DNOL	
QUINN, JOHN J	8NRNC	
RABIN, HERBERT	1DNRL	
RABINOW, JACOB	5RBEN	AFRA
RADCLIFFE, ALEC	3IAPL	
RADO, GEORGE T	1DNRL	AFRA
RAEZER, SPENCER D	3IAPL	
RAFF, SAMUEL J	5RAAN	
RALL, JOSEPH E	1HNIH	
RAMBERG, WALTER	1SX	AFNA
RAMSAY, BERTRAND P	1DNOL	
RAND, SINAI	9CLUN	
RAPPLEYE, HOWARD S	7RETD	AFRA
RAYCHOWDHURY, PRATIP N	2HGWU	
READING, OLIVER S	8NRNC	AFNE
REDMOND, JOHN P	3IAPL	
REED, CHARLES K	1DFOS	
REED, HERBERT B JR	1DNOL	
REICHARDT, CHARLES H	1XAEC	
REICHELDERFER, F W	7RETD	AFRA
REYNOLDS, W H	9CLUN	
RHOADS, FRANKLIN J	1DNRL	
RICH, ROBERT P	3IAPL	
RICHMOND, JOSEPH C	1CNBS	AFRA
RICHMOND, SUSAN V	7RETD	
RIDDLE, JOHN L	1CNBS	
RITZ, VICTOR H	1DNRL	
RITZMANN, O F	8NRNC	
ROBERG, JANE	1DNOL	
ROBERTS, ELLIOTT B	4CONS	AFRA
ROBERTSON, ALBION L	3IAPL	
ROBERTSON, RANDAL M	1XNSF	AFRA
RODDY, PATRICIA M	1HNIH	
RODDY, VINCENT S	1DFX	
RODNEY, WILLIAM S	1XNSF	AFRA
ROEDDER, EDWIN	1IGES	AFRA
ROESER, WILLIAM F	1CNBS	AFRA
ROLLER, PAUL S	5LIPR	AFRA
ROMAN, NANCY G	9CLUN	
ROSANOFF, BORIS P	1ARMR	
ROSENBLATT, DAVID	1CNBS	AFRA
ROSENBLATT, JOAN R	1CNBS	
ROSSINI, FREDERICK D	8NRNC	AFNA
ROTKIN, ISRAEL	1DAHD	AFRA
ROWE, MARVIN H	1DNOL	
RUARK, ARTHUR E	1XAEC	
RUBIN, ROBERT J	1CNBS	AFRA
RUBIN, VERA C	2HGEU	AFRA
RUEGER, LAUREN J	3IAPL	
RUSKIN, ROBERT E	1DNRL	
SAFFRAN, HERMAN E	1DNOL	
SALKOVITZ, EDWARD I	1DNOR	AFRA
SAMBUROFF, SERGE N	3IAPL	
SANDER, HERMAN J	1DFOS	
SANDERS, WILLIAM H	1DNRL	
SANDERSON, JOHN A	1DNRL	AFRA
SANFORD, RAYMOND L	7RETD	AFRE
SANGSTER, HAROLD L	9CLUN	
SAXTON, HAROLD L	1DNRL	
SCHAMP, HOMER W JR	2HUMD	AFRA
SCHARNHORST, M P	9CLUN	
SCHEER, MILTON D	1CNBS	AFRA

SCHELL, EMIL D	8NRNC	
SCHERESCHEWSKY, P L	9CLUN	
SCHIEFER, HERBERT F	1CNBS	AFRA
ŠCHINDLER, ALBERT I	1DNRL	AFRA
SCHLEGELMILCH, R O	8NRNC	
SCHNAPER, HAROLD W	2HGEU	
SCHOLL, GEORGE S	5AEGE	
SCHOOLEY, ALLEN H	1DNRL	AFNA
SCHOONOVER, IRL C	1CNBS	AFRA
SCHUBAUER, GALEN B	1CNBS	AFRA
SCHUBERT, DAVID C	1CNBS	
SCHUBERT, LEO	2HAMU	AFRA
SCHULMAN, JAMES H	1DNRL	AFRA
SCHULZ, ALVIN G JR	3IAPL	
SCHUMANN, WILLIAM A	8NRNC	
SCHUYLER, G L	7RETD	
SCHWARTZ, ROBERT B	1CNBS	
SCHWEDER, WILLIAM H	2HGEU	
SCOTT, ARNOLD H	1CNBS	AFRA
SCOTT, E J	1DNOL	
SEAQUIST, EDGAR O	7RETD	
SEEBOTH, CONRAD M	9CLUN	
SEEGER, RAYMOND J	1XNSF	AFRA
SEEMAN, NATHAN	1DNRL	
SELIGER, HOWARD H	2HJHU	
SELLERS, RONALD E JR	1DFX	
SETTE, WILLIAM J	1DNDT	
SEVERIENS, JOHANNES C	1XAEC	
SHANKS, DANIEL	1DNDT	
SHAPIRO, JAY R	9CLUN	
SHAPIRO, MAURICE M	1DNRL	AFRA
SHAPIRO, PHILIP	1DNRL	
SHELLEY, MARYANN B	1XNAS	
SHEPPARD, DONALD C	8NRNC	
SHEPPARD, THOMAS W	3IAPL	
SHERLIN, GROVER C	9CLUN	
SHERWIN, CHALMERS W	1D-X	
SHISHA, OVED	8NRNC	
SHNEIDEROV, ANATOL J	3IARC	
SHOSTAK, ARNOLD A	1DNOR	
SHOTLAND, EDWIN	3IAPL	
SHULER, KURT E	1CNBS	AFRA
SHUMAKER, JOHN B JR	9CLUN	
SHUPING, RALPH E	5MXRE	
SHUTE, BARBARA E	9CLUN	
SILBERBERG, REIN	1DNRL	
SILSBEE, FRANCIS B	4CONS	AFRA
SILVERMAN, SHIRLEIGH	1CNBS	AFRA
SILVERSTEIN, ABRAHAM	1DNOL	
SINGER, S FRED	2HUMD	
SINGH, SOHAN	2HHOU	
SITTERLY, BANCROFT W	2HAMU	AFRA
SITTERLY, CHARLOTTE M	1CNBS	AFRA
SLACK, LEWIS	3INAS	AFRA
SLAWSKY, ZAKA I	1DNOL	AFRA
SLOOP, JOHN L	1XNAS	
SMALL, JAMES B	1CCGS	AFRA
SMART, J SAMUEL	8NRNC	AFNA
SMITH, FALCONER	1HNIH	AFRA
SMITH, PAUL L	1DNRL	AFRA
SMITH, SCOTT W	1CNBS	
SMITH, STEPHEN J	8NRNC	
SMITH, WALDO E	4CONS	
SMITH, WILLIAM O	1IGES	
SNOW, GEORGE A	2HUMD	
SNYDER, JANET	9CLUN	
SOKOLOWSKI, THOMAS J	9CLUN	
SOLEM, ANSON D	1DNOL	
SOLLINS, A D	8NRNC	
SOLOW, MAX	5MART	
SPECHT, HEINZ	1HNIH	AFNA
SPINDLER, ROBERT J JR	8NRNC	
SREB, JULES H	1D-X	
STANWICK, TAD	5PNDY	
STASSINOPOULOS, E G	1XNAS	
STEIGER, RONALD L	9CLUN	
STEINBERGER, RAYMOND L	1DNRL	
STEINER, ROBERT F	1DNMR	AFRA
STEINER, WILLIAM F	3IDTM	
STEPHENS, ROBERT E	1CNBS	AFRA
STEPHENSON, JOHN L	1HNIH	
STERN, JOSHUA	1CNBS	
STERNE, THEODORE E	9CLUN	
STETSON, ROBERT F	9CLUN	
STETTEN, DEWITT JR	1HNIH	
STEVENS, DONALD K	1XAEC	
STIEHLER, ROBERT D	1CNBS	AFRA
STILL, JOSEPH W	4PHYS	AFNA
STILLER, BERTRAM	1DNRL	AFRA
STIMSON, HAROLD F	7RETD	AFRE
STIREWALT, EDWARD N	5ANSE	
STOBER, ALFRED K	1XNAS	
STONE, ALBERT M	3IAPL	
STRAND, KAJ A	1DNOB	
STRAUSS, SIMON W	1DNRL	
SUDDETH, JIMMIE A	1CNBS	
SUTCLIFFE, WALTER D	7RETD	AFRE
SUYDAM, BERGEN R	9CLUN	
SVIRBELY, WILLIAM J	2HUMD	
SWANSON, NILS	1CNBS	
SWICK, CLARENCE H	7RETD	AFRE
SWINDELLS, JAMES F	1CNBS	AFRA
TALBOTT, F LEO	2HCUA	AFRA
TALLEY, J WALLACE	9CLUN	
TATE, DOUGLAS R	1CNBS	AFRA
TATUM, G R	5VILA	
TAYLOR, JOHN K	1CNBS	AFRA
TAYLOR, W BRUCE	9CLUN	
TCHEN, CHAN-MOU	1CNBS	AFRA
TEELE, RAY P	1CNBS	AFRA
TEMPLETON, DAVID F	9CLUN	
TEMPLIN, HERMAN A	1DNOL	
THEODORIDES, PHRIXOS J	7RETD	
TIDMAN, DEREK A	2HUMD	
TIEDEMAN, JOHN A	3IAPL	
TILFORD, SHELBY G	1DNRL	
TIMMS, MARY L	1DNX	
TOBIAS, JEROME	1XDCG	
TOBIN, RALPH A	1DNRL	
TOLL, JOHN S	2HUMD	AFRA
TOMKINS, GORDON	1HNIH	
TOMS, M ELAINE	1DNRL	
TORRESON, OSCAR W	7RETD	AFRE
TOUSEY, RICHARD	1DNRL	AFRA
TOWNSEND, JAMES G	9CLUN	
TOWNSEND, JOHN R	4CONS	AFRA
TRENT, EVA M	1DNRL	
TRENT, HORACE M	1DNRL	AFRA
TREXLER, JAMES H	1DNRL	AFRA
TROUNSON, EDWARD P	1DNOL	
TRYTTEN, M H	3INAS	
TSAI, DONALD H	1CNBS	
TURNER, DAVID M JR	1DNOL	
TURNER, JAMES E	8NRNC	
TURNER, JOSEPH	9CLUN	
TURNER, ROBERT	3IAPL	
TUVE, MERLE A	3IDTM	AFRA
TYLER, GEORGE W	9CLUN	
UYEHARA, GEOFFREY U	9CLUN	
VAN DYKEN, ALEXANDER R	1XAEC	
VAN HOESEN, RICHARD W	9CLUN	
VAN VALKENBURG, ALVIN	1CNBS	
VANDERSLICE, JOSEPH T	2HUMD	AFRA
VANDIVERE, EDGAR F JR	5PACO	
VANE, FRANCIS F	1DNX	
VAUGHAN, WILLIAM H	1DNRL	
VERWIEBE, FRANK L	2HMJC	
VIGNESS, IRWIN	1DNRL	AFRA
VINAL, GEORGE W	7RETD	AFNE
VINTI, JOHN P	1CNBS	AFRA
VISCO, EUGENE P	8NRNC	
VON BRETZEL, JAMES JR	1DNOL	
VON BRIESEN, ROY JR	9CLUN	
WACHTMAN, JOHN B JR	1CNBS	AFRA
WALDO, GEORGE V	1XFCC	
WALKER, JAMES H	3IAPL	

WALL, LEO A	1CNBS	AFRA
WALLACE, JAMES D	9CLUN	
WALLER, SYLVIA L	9CLUN	
WALLIS, M W MRS	9CLUN	
WALLIS, RICHARD F	1DNRL	
WALSH, J PAUL	5MATR	
WALTON, THOMAS S	1DNDT	
WARBURTON, FRED W	9CLUN	
WARGA, MARY E	3AOSA	AFRA
WARNER, JACOB L	1DNOR	
WATERMAN, ALAN T	7RETD	AFRA
WATTS, CHESTER B	7RETD	AFRA
WAY, KATHARINE	8NRNC	
WEBB, ROBERT W	1ARMR	AFRA
WEBER, JOSEPH	2HUMD	
WEIDA, FRANK M	7RETD	AFRE
WEIFFENBACH, GEORGE C	3IAPL	
WEIGLE, DAVID J	8NRNC	
WEINSTEIN, MARVIN S	5UNSY	
WEINTRAUB, STANLEY	5EMRE	
WEISS, FRANCIS J	1XLIC	AFRA
WEISSBERG, SAMUEL G	1CNBS	AFRA
WEISSLER, ALFRED	1DFOS	AFRA
WEISSMAN, STANLEY	2HUMD	AFRA
WELLS, HARRY W	3INAS	
WENNERSTEN, DWIGHT L	1DFX	
WESKE, JOHN R	2HUMD	
WESSEL, PAUL R	1DNOL	
WEST, EDWARD J	1DNRL	
WEST, ESTAL D	1CNBS	
WEXLER, ARNOLD	1CNBS	AFRA
WEYL, F JOACHIM	1DNOR	AFRA
WHELAN, WILLIAM T	5ACFE	
WHITTEN, CHARLES A	1CCGS	AFRA
WIGGINS, THOMAS B	2HGWU	
WILDHACK, WILLIAM A	1CNBS	AFRA
WILKIE, JOHN B	1HX	
WILLIAMS, VERNON L	9CLUN	
WILSON, B JAMES	1DNRL	
WILSON, BRUCE L	1CNBS	AFRA
WILSON, RAYMOND E	8NRNC	AFNA
WILSON, ROBERT E	1DNOL	
WILSON, WILLIAM E JR	3IAPL	
WINER, DAVID E	5AMMA	
WINSTON, CLEMENT	1CX	
WISPE, LAUREN G	9CLUN	
WOLF, HARRY E	1DNOL	
WOLFF, JOHN H	1DNDT	
WOLLMAN, SEYMOUR H	1HNIH	
WOOD, LAWRENCE A	1CNBS	AFRA
WOOD, LLOYD A	9CLUN	
WOOD, WILLIAM E	9CLUN	
WOOLHISER, J E	1CCGS	
WORF, DOUGLAS L	1XNAS	
WRIGHT, WILLIAM E	1DNOR	
WYCKOFF, HAROLD O	1CNBS	
YAGODA, HERMAN	8NRNC	
YEANDLE, STEPHEN S	2HGWU	
YOKLEY, CHARLES R	1CNBS	
YOST, CHARLES F	1D-X	
YOUDEN, WILLIAM J	1CNBS	AFRA
YOUDEN, WILLIAM W	1CNBS	
YOUNG, JESSIE M	1CNBS	
YOUNG, THEODORE R	1CNBS	
ZARTMAN, IRA F	9CLUN	
ZEHRING, ROBERT W	1XAEC	
ZEITLER, ELMAR K	9CLUN	
ZELEN, MARVIN	1HNIH	AFRA
ZMUDA, ALFRED J	3IAPL	AFRA
ZWANZIG, ROBERT W	1CNBS	AFRA

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COLLINS, HENRY B	1XSMI	AFRA
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MILLER, CARL F	1XSMI	AFRA
MOORE, HARVEY C	2HAMU	AFRA
ROBERTS, FRANK H H	1XSMI	AFRA
SETZLER, FRANK M	7RETD	AFNE
SHIMKIN, DEMITRI B	8NRNC	AFNA
STEWART, T DALE	1XSMI	AFRA
STIRLING, MATHEW W	7RETD	AFRA
TRAGER, GEORGE L	8NRNC	AFNA
WEAVER, ELMER R	7RETD	AFRA

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BEAN, HOWARD S	4CONS	AFRA
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BORTHWICK, HARRY A	1ARFR	AFRA
BOWMAN, PAUL W	1HNIH	AFRA
BOWMAN, THOMAS E	1XSMI	AFRA
BROWN, EDGAR	7RETD	AFRE
CAMPBELL, FRANK L	7RETD	AFNA
CASH, EDITH K	7RETD	AFRE
COTTAM, CLARENCE	8NRNC	AFNA
FINLEY, HAROLD E	2HHOU	AFRA
GALTSOFF, PAUL S	7RETD	AFNE
GATES, G E	8NRNC	AFNA
GAZIN, CHARLES L	1XSMI	AFRA
GURNEY, ASHLEY B	1ARFR	AFRA
HAMBLETON, EDSON J	7RETD	AFRA
HANSEN, IRA B	2HGWU	AFRA
JACKSON, HARTLEY H T	7RETD	AFRE
LAKI, KOLOMAN	1HNIH	AFRA
MORRISON, JOSEPH P	1XSMI	AFRA
MUESEBECK, CARL F W	7RETD	AFRE
OEHSER, PAUL H	1XSMI	AFRA
OWENS, HOWARD B	2SPGC	AFRA
PRICE, E W	8NRNC	AFNE
RAUSCH, ROBERT	1HPHS	AFNA
REHDER, HARALD A	1XSMI	AFRA
RUSSELL, LOUISE M	1ARFR	AFRA
SCHMITT, WALDO L	1XSMI	AFRA
SCHREINER, OSWALD	7RETD	AFNE
SHMUKLER, LEON	8NRNC	AMNA
ST GEORGE, RAYMOND A	1AFOR	AFRA
TRAUB, ROBERT	2HUMD	AFRA
WETMORE, ALEXANDER	7RETD	AFRA

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ALEXANDER, ALLEN L	1DNRL	AFRA
ALEXANDER, BENJAMIN H	1DAWR	AFRA
ALEXANDER, LYLE T	1ASCS	AFRA
ALLEN, HARRY C JR	1CNBS	AFRA
ALLISON, FRANKLIN E	7RETD	AFRA
ALTER, HARVEY	5HARE	AFRA
ANDERSON, MYRON S	7RETD	AFRA
ANDERSON, WENDELL L	1DNRL	AFRA
APPEL, WILLIAM D	3AATC	AFRA
ARMSTRONG, GEORGE T	1CNBS	AFRA
AUSLOOS, PIERRE J	1CNBS	AFRA
BAILEY, WILLIAM J	2HUMD	AFRA
BAKER, LOUIS C W	2HGEU	AFRA
BARKER, ROY J	8NRNC	AFNA
BARNES, R PERCY	2HHOU	AFRA
BATES, ROGER G	1CNBS	AFRA
BAUER, HUGO	1HNIH	AFRA
BECKER, EDWIN D	1HNIH	AFRA
BECKETT, CHARLES W	1CNBS	AFRA
BEKKEDAHL, NORMAN	1CNBS	AFRA
BENDER, MAURICE	1HPHS	AFRA
BENNETT, MARTIN T	4CONS	AFRA
BERCH, JULIAN	5HARE	AMRA
BERL, WALTER G	3IAPL	AFRA
BLOOM, MORTIMER C	1DNRL	AFRA
BLUM, WILLIAM	4CONS	AFRE
BOND, HOWARD W	1HPHS	AFRA
BRAUER, GERHARD M	1CNBS	AFRA
BRENNER, ABNER	1CNBS	AFRA
BREWER, A KEITH	1DNNO	AFRA
BRODE, WALLACE R	7RETD	

BRODIE, BERNARD B	1HNIH	AFRA
BROWN, ALFRED E	5HARE	AFRA
BURAS, EDMUND M JR	5HARE	AFRA
BURK, DEAN	1HNIH	AFRA
CAMPBELL, FRANK L	7RETD	AFNA
CARHART, HOMER W	1DNRL	AFRA
CARRINGTON, TUCKER	1CNBS	AFRA
CARROLL, WILLIAM R	1HNIH	AFRA
CARROW, MAXWELL K	1IGES	AFRA
CASSEL, JAMES M	1CNBS	AFRA
CAUL, HAROLD J	1CNBS	AFRA
CHEEK, CONRAD H	1DNRL	AFRA
CLARK, KENNETH G	7RETD	AFRA
COULSON, E JACK	1ARNI	AFRA
CREITZ, E CARROLL	1CNBS	AFRA
CUTTITTA, FRANK	1IGES	AFRA
DAFT, FLOYD S	7RETD	AFRA
DARWENT, BASIL DE B	2HCUA	AFRA
DAVIS, MARION M	1CNBS	AFRA
DAVIS, RAYMOND	7RETD	AFRE
DEITZ, VICTOR R	1DNRL	AFRA
DETWILER, SAMUEL B JR	1ARNI	AFRA
DIAMOND, JACOB J	1CNBS	AFRA
DOUGLAS, THOMAS B	1CNBS	AFRA
EASTER, DONALD	1XNAS	AMRA
EDWARDS, H KENNETH	1SX	AMRA
EGLI, PAUL H	1DNRL	AFRA
ELLIS, NED R	7RETD	AFRA
EMERY, ALDEN H	3AACS	AFRA
FAHEY, JOSEPH J	1IGES	AFRA
FARROW, RICHARD P	3ANCA	AFRA
FERGUSON, LLOYD N	2HHOU	AFRA
FERGUSON, ROBERT E	1CNBS	AFRA
FIELDNER, ARNO C	7RETD	AFRA
FLETCHER, DONALD G	1CNBS	AMRA
FLETCHER, HEWITT G JR	1HNIH	AFRA
FLORIN, ROLAND E	1CNBS	AFRA
FORD, T F	1DNRL	AFRA
FORZIATI, ALPHONSE F	1D-S	AFRA
FORZIATI, FLORENCE H	1ARNI	AFRA
FOURT, LYMAN	5HARE	AFRA
FOX, M R	1HFDA	AFRA
FOX, ROBERT B	1DNRL	AFRA
FRAME, ELIZABETH G	1HNIH	AFRA
FRANKLIN, PHILIP J	1D-S	AFRA
FREEMAN, ANDREW F	1ARNI	AMRA
FREEMAN, MONROE E	1XSMI	AFRA
FRIESS, SEYMOUR L	1DNMR	AFRA
FRUSH, HARRIET L	1CNBS	AFRA
FULTON, ROBERT A	1ARFR	AFRA
FURUKAWA, GEORGE T	1CNBS	AFRA
GIBSON, RALPH E	3IAPL	AFRA
GILLMAN, JOSEPH L JR	4CONS	AFRA
GINNINGS, DEFOE C	1CNBS	AFRA
GLASGOW, AUGUSTUS R JR	1CNBS	AFRA
GOLUMBIC, CALVIN	1ARMR	AFRA
GONET, FRANK	1XUST	AFRA
GORDON, CHARLES L	1CNBS	AFRA
GRAY, VANNIE E	1CNBS	AMRA
HAGUE, JOHN L	1CNBS	AFRA
HALL, STANLEY A	1ARFR	AFRA
HALLER, HERBERT L	7RETD	AFRA
HAMER, WALTER J	1CNBS	AFRA
HARRIS, MILTON	5GECO	AFRA
HARVALIK, Z V	1DAER	AFRA
HAZLETON, LLOYD W	5HALA	AFRA
HEINZE, PETER H	1ARMR	AFRA
HIATT, CASPAR W	1HNIH	AFRA
HILBERT, GUIDO E	1ARAO	
HILLIG, FRED	5DRDE	
HOBBS, ROBERT B	1CNBS	AFRA
HOERING, THOMAS C	3ICIW	AFRA
HOLLIS, NORMAN R	5HARE	AFRA
HOLMES, FRANK H	2SMOC	AMRA
HOOVER, THOMAS B	1CNBS	AFRA
HOWE, PAUL E	4CONS	AFRA
HUBBARD, DONALD	7RETD	AFRA
IRVING, GEORGE W JR	1ARAO	AFRA

ISBELL, HORACE S	1CNBS	AFRA
JACOB, KENNETH D	4CONS	AFRA
JACOBSON, MARTIN	1ARFR	AMRA
JOHANNESEN, ROLF B	1CNBS	AFRA
KANAGY, JOSEPH R	1CNBS	AFRA
KANE, EDWARD A	1ARFR	AFRA
KARLE, JEROME	1DNRL	AFRA
KARRER, SEBASTIAN	7RETD	AFRA
KEEGAN, HARRY J	1CNBS	AFRA
KERESZTESY, JOHN C	1HPHS	AFRA
KING, PETER	1DNRL	AFNA
KLUTE, CHARLES H	1DAHD	AFRA
KNOBLOCK, EDWARD C	1DAWR	AFRA
KNOWLTON, KATHRYN	7RETD	AFRA
KRUGER, JEROME	1CNBS	AFRA
KURTZ, FLOYD E	1ARNI	AFRA
LANGFORD, GEORGE S	2HUMD	AFRA
LIEBERMAN, MORRIS	1ARMR	AFRA
LINNENBOM, VICTOR J	1DNRL	AFRA
LIPPINCOTT, ELLIS R	2HUMD	AFRA
LOCKHART, LUTHER B JR	1DNRL	AFRA
LOVE, S KENNETH	1IGES	AFRA
LYMAN, JOHN	1IFWS	AFRA
MADORSKY, SAMUEL L	7RETD	AFRA
MAGIN, GEORGE B JR	1XAEC	AFRA
MANDEL, H GEORGE	2HGWU	AFRA
MANDEL, JOHN	1CNBS	AFRA
MANN, DAVID E	1CNBS	AFRA
MARVIN, ROBERT S	1CNBS	AFRA
MARYOTT, ARTHUR A	1CNBS	AFRA
MASON, EDWARD A	2HUMD	AFRA
MATHERS, ALEX P	1TIRS	AFRA
MATLACK, MARION	7RETD	AFRE
MAY, IRVING	1IGES	AFRA
MC BRIDE, GORDON W	5UNCA	AFRA
MC CABE, LOUIS C	5RERS	AFRA
MC CLURE, FRANK J	1HNIH	AFRA
MC CLURE, FRANK T	3IAPL	AFRA
MC DONALD, EMMA J	1CNBS	AFRA
MC NESBY, JAMES R	1CNBS	AFRA
MC PHERSON, ARCHIBALD	1CNBS	AFRA
MENKART, JOHN H	5HARE	AFRA
MERZ, ALBERT R	7RETD	AFRE
MEYROWITZ, ROBERT	1IGES	AFRA
MILLER, CLEM O	1HFDA	AFRA
MILLER, ROMAN R	1DNRL	AFRA
MIZELL, LOUIS R	5HARE	AFRA
MORRIS, JOSEPH B	2HHOU	AFRA
MORRIS, KELSO B	2HHOU	AFRA
MYERS, ALFRED T	1IGES	AFNA
NAESER, CHARLES R	2HGWU	AFRA
NIRENBERG, MARSHALL W	1HNIH	AFRA
OKABE, HIDEO	1CNBS	AFRA
PEISER, H STEFFEN	1CNBS	AFRA
PERROS, THEODORE P	2HGWU	AFRA
POMMER, ALFRED M	1ARNI	AFRA
PRO, MAYNARD J	1TIRS	AFRA
PROSEN, EDWARD J	1CNBS	AFRA
READ, W T	7RETD	AFRA
REEVE, E WILKINS	2HUMD	AFRA
REICHEN, LAURA E	1IGES	AFRA
REINHART, FRANK W	4CONS	AFRA
REYNOLDS, HELEN L	1HFDA	AMRA
RICE, FRANCIS O	8NRNC	AFNA
ROBERTS, IRENA Z	2HTRI	AMRA
ROLLER, PAUL S	5LIPR	AFRA
SAGER, WILLIAM F	2HGWU	AFRA
SCHAFFER, ROBERT	1CNBS	AFRA
SCHALLER, WALDEMAR T	1IGES	AFRE
SCHECHTER, MILTON S	1ARFR	AFRA
SCHEER, MILTON D	1CNBS	AFRA
SCHOONOVER, IRL C	1CNBS	AFRA
SCHRECKER, ANTHONY W	1HNIH	AFRA
SCHREINER, OSWALD	7RETD	AFNE
SCHUBERT, LEO	2HAMU	AFRA
SCHWARTZ, ANTHONY M	5HARE	AFRA
SCOFIELD, FRANCIS	3ANPV	AMRA
SCRIBNER, BOURDON F	1CNBS	AFRA

SHAFRIN, ELAINE G	1DNRL	AMRA
SHAPIRO, LEONARD	1IGES	AFRA
SHERESHEFSKY, J LEON	2HHOU	AFRA
SHMUKLER, LEON	8NRNC	AMNA
SHULER, KURT E	1CNBS	AFRA
SINGLETERRY, CURTIS R	1DNRL	AFRA
SLADEK, JAROMIL V	1HFDA	AFRA
SMITH, EDGAR R	7RETD	AFNE
SOLLNER, KARL	1HNIH	AFRA
SOOKNE, ARNOLD M	5HARE	AFRA
SOUDER, WILMER	4CONS	
SPIES, JOSEPH R	1ARNI	AFRA
STEINER, ROBERT F	1DNMR	AFRA
STEINHARDT, JACINTO	2HGEU	AFRA
STERN, KURT H	1CNBS	AFRA
STEVENS, HENRY	1ARNI	AFRA
STIEBELING, HAZEL K	7RETD	AFRA
STIEHLER, ROBERT D	1CNBS	AFRA
SWEENEY, WILLIAM T	1CNBS	AFRA
TALBERT, PRESTON T	2HHOU	AFRA
TAYLOR, JOHN K	1CNBS	AFRA
TAYLOR, MODDIE D	2HHOU	AFRA
TIPSON, R STUART	1CNBS	AFRA
TORGESEN, JOHN L	1CNBS	AFRA
TRYON, MAX	1CNBS	AFRA
VAN EVERA, BENJAMIN D	2HGWU	AFRA
VANDERSLICE, JOSEPH T	2HUMD	AFRA
VEITCH, FLETCHER P JR	2HUMD	AFRA
WALL, LEO A	1CNBS	AFRA
WALTON, WILLIAM W	1CNBS	AFRA
WARD, HENRY P	7RETD	AFRE
WARGA, MARY E	3AOSA	AFRA
WASIK, STANLEY P	1CNBS	AMRA
WEAVER, ELMER R	7RETD	AFRA
WEINTRAUB, ROBERT L	2HGWU	AFRA
WEISS, FRANCIS J	1XLIC	AFRA
WEISSBERG, SAMUEL G	1CNBS	AFRA
WEISSLER, ALFRED	1DFOS	AFRA
WESTENBERG, ARTHUR A	3IAPL	AFRA
WHITE, CHARLES E	2HUMD	AFRA
WHITTAKER, COLIN W	1ARFR	AFRA
WICHERS, EDWARD	3INAS	AFRA
WILSON, WILLIAM K	1CNBS	AFRA
WITKOP, BERNHARD	1HNIH	AFRA
WOMACK, MADELYN	1ARNI	AFRA
WOOD, LAWRENCE A	1CNBS	AFRA
WOOD, REUBEN E	2HGWU	AFRA
WOODS, G FORREST	2HUMD	AFRA
YODER, HATTEN S JR	3ICIW	AFRA
YOUDEN, WILLIAM J	1CNBS	AFRA
ZELENY, LAWRENCE	1AMRP	AFRA
ZIES, EMANUEL G	7RETD	AFRE
ZISMAN, WILLIAM A	1DNRL	AFRA

2F ENTOMOLOGICAL SOCIETY OF WASHINGTON

ADAMS, JEAN R	1ARFR	
ADLER, VICTOR E	1ARFR	
ALFORD, HAROLD G	1ARRP	
ALTMAN, R M	1DASG	
ANDERSON, DONALD M	1ARFR	
ANDERSON, WILLIAM H	1ARFR	
APP, BERNARD A	1ARFR	
ARNETT, ROSS H JR	2HCUA	
AUTRY, HOMER V JR	1ARRP	
BAKER, EDWARD W	1ARRP	
BAKER, HOWARD	7RETD	
BAKER, W L	9CLUN	
BARKER, ROY J	8NRNC	AFNA
BARNHART, CLYDE S	1DAX	AFNA
BARRY, CORNELIUS	2HUMD	
BEAL, JAMES A	1AFOR	
BENDER, ALVA H	9CLUN	
BENDER, EDWARD K	9CLUN	
BICKLEY, WILLIAM E	2HUMD	AFRA
BILLINGS, SAMUEL C	1ARRP	
BISHOPP, FRED C	7RETD	AFNE
BISSELL, T L	2HUMD	
BLAKE, DORIS H	1XSMI	AFRE
BLICKENSTAFF, CARL C	1ARFR	
BODENSTEIN, WILLIAM G	1ARFR	
BOETTCHER, RICHARD E	1HNIH	
BONGBERG, JACK W	1AFOR	
BRIGHAM, H IRVING	9CLUN	
BULLOCK, HOWARD R	1ARFR	
BUNN, RALPH W	3AESA	AFRA
BURGESS, EMORY D	1ARFR	
BURKS, BARNARD D	1ARFR	
BUSBEY, RUTH L	1ARFR	
CALLAWAY, MINNIE	1ARRP	
CAMPBELL, FRANK L	7RETD	AFNA
CANTWELL, GEORGE E	1ARFR	
CARTWRIGHT, O L	1XSMI	
CHRISTENSON, LEROY D	1ARFR	AFRA
CLAUSEN, CURTIS P	7RETD	AFNE
CONKLE, HERBERT J	1ARRP	
COOPER, JAMES F	1ARFR	
CORY, ERNEST N	7RETD	AFRE
COULSON, JACK R	1ARFR	
CUSHMAN, HELENE G	1ANAL	
DAHMS, REYNOLD G	1ARFR	
DALMAT, HERBERT T	9CLUN	
DAVIDSON, JOHN A	2HCOU	
DAVIS, DON R	1XSMI	
DAVIS, LOUIS G	1ARRP	
DEWS, SAM C	1DAX	
DIEKE, G H	2HJHU	
DORWARD, KELVIN	1ARRP	
DOWDEN, PHILIP B	1ARFR	
DRAKE, CARL J	1XSMI	
DUCKWORTH, W DONALD	1XSMI	
DUTKY, SAMSON R	1ARFR	
EASTER, STEPHEN S	9CLUN	
EDMUNDS, LAFE R	1XNSF	AFRA
EMERSON, K C	9CLUN	
FALES, JOHN H	1ARFR	
FIELDS, RICHARD W	9CLUN	
FLINT, OLIVER S	1XSMI	
FLUNO, JOHN A	1ARFR	
FOOTE, RICHARD H	1ARFR	
FOSTER, JAMES R	2HUMD	
FRACKER, STANLEY B	7RETD	
FROESCHNER, RICHARD C	1ARFR	
GAMMONS, JOHN G	1ARRP	
GARRETT, WALLACE T	2HUMD	
GERBERG, EUGENE J	5INCR	
GILBERT, ENGEL L	1ARRP	
GODEK, THEODORE D	9CLUN	
GRAF, JOHN E	7RETD	AFRA
GURNEY, ASHLEY B	1ARFR	AFRA
HAEUSSLER, GILBERT J	7RETD	
HAINES, KENNETH A	1ARAO	AFRA
HALL, DAVID G	1ARAO	
HALLER, HERBERT L	7RETD	AFRA
HAMBLETON, EDSON J	7RETD	AFRA
HAMBLETON, JAMES I	7RETD	AFRA
HARDING, WALLACE G JR	2HUMD	
HARNED, R W	7RETD	
HARRISON, FLOYD P	2HUMD	
HARTLEY, C F	7RETD	
HASKINS, CARYL P	3ICIW	AFRA
HAVILAND, ELIZABETH E	7RETD	
HENNEBERRY, THOMAS J	1ARFR	AFNA
HERRING, JON L	1ARFR	
HIRST, JOHN M	1DNMC	
HODGES, RONALD W	1ARFR	
HOFFMAN, JOHN D	1CNBS	AFRA
HOFFMAN, RICHARD E	8NRNC	
HOFFMANN, CLARENCE H	1ARFR	AFRA
HUGHES, JOHN H	1HPHS	
HULL, WILLIAM B	1DNMS	
HUNT, HOWARD L JR	9CLUN	
HUTTON, GEORGE L	1DNBY	AFRA
JAMES, MAURICE T	8NRNC	AFNA
JENKINS, DALE W	1XNAS	
JOHNSON, D R	1SAID	
JOHNSON, PHYLLIS T	8NRNC	AFNA

JONES, JACK C	2HUMD	
JONES, SLOAN E	1ARFR	
JOSEPH, STANLEY R	2HUMD	
KINGSOLVER, JOHN	1XSMI	
KNIPLING, EDWARD F	1ARFR	AFRA
KNOWLES, ZELDA	9CLUN	
KRAMER, JAMES P	1ARFR	
KRESTENSEN, ELROY R	2HUMD	
KROMBEIN, KARL V	1ARFR	
KUMAR, S S	9CLUN	
LANCHESTER, HORACE P	1ARFR	
LANGFORD, GEORGE S	2HUMD	
LATTA, RANDALL	6FAOR	AFNE
LAUDANI, HAMILTON	1AMRP	
LEONARD, MORTIMER D	7RETD	
LLOYD, GEORGE W	1ARRP	
LUGENBILL, PHILIP JR	1ARFR	
MAKSYMIUK, BOHDAN	1AFOR	
MALLACK, JERRY	2HUMD	
MASON, HORATIO C	1ARFR	
MC COMB, CHARLES W	2HUMD	
MC FADDEN, MAX	1XSMI	
MC GOVRAN, EDWARD R	1ACSR	
MC GUIRE, JUDSON U JR	1ARFR	
MICHAEL, ALBERT S	1ARFR	
MITCHELL, ROBERT T	1IFWS	
MUESEBECK, CARL F W	7RETD	AFRE
MUNSON, S C	2HGWU	
MURRAY, WILLIAM S	1DNX	
MURRILL, ROBERT D	1HNIH	
NEAL, T J	1DAWR	
NELSON, R H	3AESA	AFRA
NEWSON, HAROLD D	9CLUN	
O NEILL, KELLIE	1ARRP	
OMAN, PAUL W	1ARFR	
OWENS, HOWARD B	2SPGC	AFRA
PARRISH, DALE W	1DAWR	
PELTIER, PAUL X	1ARRP	
PHILLIPS, WILLIAM G	9CLUN	
POOS, FRED W	7RETD	AFRA
POPHAM, WILLIAM L	7RETD	
PORTER, B A	7RETD	AFRA
RAINWATER, CLYDE F	1ARFR	
RAINWATER, H IVAN	1ARRP	
REAGEN, EUGENE P	1ARRP	
REED, LUCIUS B	1ARFR	
REED, WILLIAM D	1DAEC	AFRA
ROBINSON, H	8NRNC	
ROLLOW, J DOUGLAS	5CAPC	
ROZEBOOM, L E	2HJHU	
RUHOFF, F A	1XSMI	
RUSSELL, LOUISE M	1ARFR	AFRA
SABROSKY, CURTIS W	1ARFR	
SAILER, REECE I	1ARFR	AFNA
SHEPARD, HAROLD H	1AASC	AFRA
SHERMAN, RALPH W	1ARRP	
SMALL, HAROLD E JR	9CLUN	
SMILEY, ROBERT L	1ARRP	
SMITH, FLOYD F	1ARFR	AFRA
SNODGRASS, R E	9CLUN	
SNYDER, THOMAS E	1XSMI	
SOLLERS-RIEDEL, HELEN	1ARRP	
SPANGLER, PAUL J	1ARFR	
SPILMAN, THEODORE J	1ARFR	
ST GEORGE, RAYMOND A	1AFOR	AFRA
STARCKE, HELLE	9CLUN	
STEINHAUER, ALLEN L	2HUMD	
STEYSKAL, GEORGE C	1ARFR	
STONE, ALAN	1ARFR	
SULLIVAN, WILLIAM N JR	1ARFR	
TAYLOR, ROBERT T	1DNX	
THOMPSON, JOHN V	1ARFR	
THURMAN, ERNESTINE B	1HNIH	AFNA
TODD, EDWARD L	1ARFR	
TODD, FRANK E	1ARFR	AFRA
TRAUB, ROBERT	2HUMD	AFRA
TRAVIS, CLARENCE W	1XDCG	AMRA
ULLRICH, DONALD E	5SHCH	
VAN TASSELL, EILEEN R	2HCUA	
VANCE, ARLO M	1ARFR	
VASQUEZ, ALBERTO W	1HFDA	
VINCENT, R H	1DFX	
VOGT, GEORGE B	1ARFR	
WADLEY, F M	7RETD	
WALKER, ROBERT L	1ARFR	
WALKLEY, LUELLA M	1ARFR	
WALTON, MARGARET	1ARRP	
WARNER, ROSE E	1XSMI	
WEBB, J E JR	7RETD	
WEIGEL, C A	7RETD	
WEISMAN, DONALD M	1ARFR	
WHEELER, NANCY H	9CLUN	
WHEELER, RONALD E	2HUMD	
WHITE, RICHARD O	1ARRP	
WIRTH, WILLIS W	1ARFR	
WOKE, PAUL A	1HNIH	
WOLBARSHT, MYRON L	1DNMR	
WOLF, VIRGINIA S	1ARFR	
WOOD, W B	7RETD	
YAMAMOTO, ROBERT T	1ARFR	
YATES, LUCILLE	1ARRP	
YOUNG, DAVID A JR	8NRNC	AFNA
YUILL, JOSEPH S	1AFOR	AFRA

2G NATIONAL GEOGRAPHIC SOCIETY

ABRAHAM, GEORGE	1DNRL	AFRA
ADAMS, LEASON H	8NRNC	AFNE
AKERS, ROBERT P	1HNIH	AFRA
ALLEN, HARRY C JR	1CNBS	AFRA
ALLISON, FRANKLIN E	7RETD	AFRA
AMES, LAWRENCE M	7RETD	AFRA
ARMSTRONG, GEORGE T	1CNBS	AFRA
ARSEM, COLLINS	1DAHD	AMRA
BABERS, FRANK H	1DAX	AFNA
BALDES, EDWARD J	1DARO	AFRA
BARKER, ROY J	8NRNC	AFNA
BARRETT, MARGARET D	1HNIH	AFRA
BEACH, LOUIS A	1DNRL	AFRA
BEKKEDAHL, NORMAN	1CNBS	AFRA
BELSHEIM, ROBERT O	1DNRL	AFRA
BENJAMIN, CHESTER R	1ARFR	AFRA
BENNETT, JOHN A	1CNBS	AFRA
BLACK, RICHARD B	1DNOR	AFRA
BLUM, WILLIAM	4CONS	AFRE
BOLTON, ELLIS T	3ICIW	AFRA
BORTHWICK, HARRY A	1ARFR	AFRA
BOUTWELL, JOHN M	4CONS	AFNA
BOWLES, ROMALD E	5BOEN	AFRA
BRENNER, ABNER	1CNBS	AFRA
BREWER, A KEITH	1DNNO	AFRA
BROWN, ALFRED E	5HARE	AFRA
BROWN, JOSHUA R C	2HUMD	AFRA
BUHRER, EDNA M	7RETD	AFRA
BURINGTON, RICHARD S	1DNBW	AFRA
BURNETT, HARRY C	1CNBS	AFRA
BUTLER, FRANCIS E	1DNOL	AMRA
CALDWELL, FRANK R	1CNBS	AFRA
CARHART, HOMER W	1DNRL	AFRA
CARMICHAEL, LEONARD	3INGS	AFRA
CHAPIN, EDWARD J	1DNRL	AFRA
CHAPLINE, W R	7RETD	AFRE
CHRISTENSON, LEROY D	1ARFR	AFRA
CLARK, KENNETH G	7RETD	AFRA
COLE, HOWARD I	7RETD	AFNE
COOLIDGE, HAROLD J	3INAS	AFRA
CRAFTON, PAUL A	2HGWU	AFRA
CRAGOE, CARL S	7RETD	AFRE
CURRAN, HAROLD R	1ARNI	AFRA
CURTIS, ROGER W	8NRNC	AFNA
CUTTITTA, FRANK	1IGES	AFRA
DAVIS, MARION M	1CNBS	AFRA
DE PUE, LELAND A	1DNRL	AFRA
DICKSON, GEORGE	1CNBS	AFRA
DOLECEK, RICHARD L	1DNRL	AFRA
DOUGLAS, CHARLES A	1CNBS	AFRA
DRECHSLER, CHARLES	1ARFR	AFRA

DRYDEN, HUGH L	1XNAS	AFRA
DUERKSEN, JACOB A	7RETD	AFRE
DURBIN, CHARLES G	1HFDA	AFRA
EDDY, BERNICE E	1HNIH	AFRA
EDDY, NATHAN B	1HNIH	AFRA
ELLINGER, GEORGE A	1CNBS	AFRA
ELLIOTT, CHARLOTTE	7RETD	AFNE
ELLIS, NED R	7RETD	AFRA
EMERY, ALDEN H	3AACS	AFRA
ETZEL, HOWARD W	1XNSF	AFRA
FAHEY, JOSEPH J	1IGES	AFRA
FALLON, ROBERT J	5MELP	AFRA
FARROW, RICHARD P	3ANCA	AFRA
FAUST, WILLIAM R	1DNRL	AFRA
FERRELL, RICHARD A	2HUMD	AFRA
FIELDNER, ARNO C	7RETD	AFRA
FIVAZ, ALFRED E	7RETD	AFRE
FOX, M R	1HFDA	AFRA
FOX, ROBERT B	1DNRL	AFRA
FRANZ, GERALD J	1DNDT	AMRA
FRIEDMAN, LEO	8NRNC	AFNA
FULLMER, IRVIN H	1CNBS	AFRA
FURUKAWA, GEORGE T	1CNBS	AFRA
GANT, JAMES Q JR	4PHYS	AMRA
GARNER, CLEMENT L	7RETD	AFRE
GELLER, ROMAN F	7RETD	AFRA
GIBSON, KASSON S	7RETD	AFRE
GLASGOW, AUGUSTUS R JR	1CNBS	AFRA
GLASS, JEWELL J	1IGES	AFRA
GORDON, CHARLES L	1CNBS	AFRA
GRAHAM, EDWARD H	1ASCS	AFRA
GRANT, ULYSSES S III	7RETD	AFRA
GRAY, IRVING	2HGEU	AFRA
GREENOUGH, M L	1CNBS	AFRA
GREENSPAN, MARTIN	1CNBS	AFRA
GRISAMORE, NELSON T	2HGWU	AFRA
GROSVENOR, GILBERT	7RETD	AFRA
GURNEY, ASHLEY B	1ARFR	AFRA
HACSKAYLO, EDWARD	1AFOR	AFRA
HAGUE, JOHN L	1CNBS	AFRA
HAINES, KENNETH A	1ARAO	AFRA
HALL, WAYNE C	1DNRL	AFRA
HALLER, HERBERT L	7RETD	AFRA
HAMBLETON, EDSON J	7RETD	AFRA
HAMER, WALTER J	1CNBS	AFRA
HANSEN, IRA B	2HGWU	AFRA
HAUPTMAN, HERBERT	1DNRL	AFRA
HAZLETON, LLOYD W	5HALA	AFRA
HEINZE, PETER H	1ARMR	AFRA
HENLEY, ROBERT R	7RETD	AFRE
HEYDEN, FRANCIS J SJ	2HGEU	AFRA
HIATT, CASPAR W	1HNIH	AFRA
HICKOX, GEORGE H	8NRNC	AFNA
HICKS, GRADY T	1DNRL	AMRA
HILL, BERTON F	3INAS	AMRA
HOBBS, ROBERT B	1CNBS	AFRA
HOLLINGSHEAD, ROBERT S	7RETD	AFRE
HOLMES, FRANK H	2SMOC	AMRA
HOLSHOUSER, WILLIAM L	1XCAB	AFRA
HORTON, BILLY M	1DAHD	AFRA
HOTTLE, GEORGE A	8NRNC	AFNA
HOUGH, FLOYD W	7RETD	AFNA
HUBBARD, DONALD	7RETD	AFRA
HUNT, W HAWARD	1AMRP	AMRA
HUNTER, WILLIAM R	1DNRL	AFRA
HUTTON, GEORGE L	1DNBY	AFRA
INSLEY, HERBERT	4CONS	AFRA
IRWIN, GEORGE R	1DNRL	AFRA
JAMES, L H	8NRNC	AFNA
JAY, GEORGE E JR	5MIAS	AFRA
JESSUP, RALPH S	7RETD	AFRA
JOHANNESEN, ROLF B	1CNBS	AFRA
JOHNSON, DANIEL P	1CNBS	AFRA
JOHNSON, PHYLLIS T	8NRNC	AFNA
JOYCE, J WALLACE	1SX	AFRA
JUDD, NEIL M	7RETD	AFRE
JUDSON, LEWIS V	7RETD	AFRE
KABISCH, WILLIAM T	3AAAS	AMRA
KARLE, ISABELLA	1DNRL	AFRA
KARRER, SEBASTIAN	7RETD	AFRA
KEEGAN, HARRY J	1CNBS	AFRA
KELLUM, LEWIS B	8NRNC	AFNA
KENK, ROMAN	1XLIC	AFRA
KENNEDY, E R	2HCUA	AFRA
KIES, JOSEPH A	1DNRL	AFRA
KIESS, CARL C	2HGEU	AFRA
KNAPP, DAVID G	1CCGS	AFRA
KOHLER, HANS W	1DAHD	AFRA
KREITLOW, KERMIT W	1ARFR	AFRA
KULLERUD, GUNNAR	3IGEL	AFRA
LAMBERT, EDMUND B	1ARFR	AFRA
LAPP, CLAUDE J	3INAS	AFRA
LARRIMER, WALTER H	3INAS	AFRA
LASHOF, THEODORE W	1CNBS	AFRA
LEIGHTY, CLYDE E	7RETD	AFRE
LINNENBOM, VICTOR J	1DNRL	AFRA
LOVE, S KENNETH	1IGES	AFRA
MANNING, JOHN R	1CNBS	AFRA
MARTIN, JOHN H	7RETD	AFRA
MARVIN, ROBERT S	1CNBS	AFRA
MARYOTT, ARTHUR A	1CNBS	AFRA
MASON, MARTIN A	2HGWU	AFRA
MATLACK, MARION	7RETD	AFRE
MAY, IRVING	1IGES	AFRA
MAYOR, JOHN R	3AAAS	AFRA
MAZUR, JACOB	1CNBS	AFRA
MC CABE, LOUIS C	5RERS	AFRA
MC CLELLAN, WILBUR D	1ARFR	AFRA
MC CLURE, FRANK J	1HNIH	AFRA
MC CULLOUGH, NORMAN B	1HNIH	AFRA
MC ELHINNEY, JOHN	1DNRL	AFRA
MC INTOSH, ALLEN	7RETD	AFRA
MC KINNEY, HAROLD H	7RETD	AFRE
MC KOWN, BARRETT L	2SPGC	AMRA
MC MURDIE, HOWARD F	1CNBS	AFRA
MC PHEE, HUGH C	7RETD	AFRE
MC PHERSON, ARCHIBALD	1CNBS	AFRA
MEGGERS, WILLIAM F	4CONS	AFRA
MERRIAM, CARROLL F	7RETD	AFNA
MEYERHOFF, HOWARD A	8NRNC	AFNA
MIDER, G BURROUGHS	1HNIH	AFRA
MILLER, CARL F	1XSMI	AFRA
MILLER, CLEM O	1HFDA	AFRA
MILLER, ROMAN R	1DNRL	AFRA
MITCHELL, J MURRAY JR	1CWEB	AFRA
MOORE, GEORGE A	1CNBS	AFRA
MORAN, FREDERICK A	8NRNC	AMNA
MYERS, ALFRED T	1CGES	AFNA
MYERS, ALFRED T	1IGES	AFNA
NAESER, CHARLES R	2HGWU	AFRA
NELSON, R H	3AESA	AFRA
NEUENDORFFER, J A	1DNX	AFRA
NICKERSON, DOROTHY	1ARMR	AFRA
NIKIFOROFF, C C	7RETD	AFRE
OVERTON, WILLIAM C JR	8NRNC	AFNA
OWENS, HOWARD B	2SPGC	AFRA
OWENS, JAMES P	1IGES	AFRA
PAGE, BENJAMIN L	7RETD	AFRE
PAGE, CHESTER H	1CNBS	AFRA
PARK, HELEN D	1HPHS	AFRA
PELL, WILLIAM H	1CNBS	AFRA
POLLOCK, BRUCE M	1ARFR	AFRA
POMMER, ALFRED M	1ARNI	AFRA
POOS, FRED W	7RETD	AFRA
PORTER, B A	7RETD	AFRA
PRO, MAYNARD J	1TIRS	AFRA
PUTNINS, PAUL H	1CWEB	AFRA
RANDS, ROBERT D	7RETD	AFNE
RAPPLEYE, HOWARD S	7RETD	AFRA
RAUSCH, ROBERT	1HPHS	AFNA
REED, WILLIAM D	1DAEC	AFRA
REHDER, HARALD A	1XSMI	AFRA
REINHART, FRANK W	4CONS	AFRA
RENKIN, EUGENE M	8NRNC	AFNA
REYNOLDS, HELEN L	1HFDA	AMRA
RICHMOND, JOSEPH C	1CNBS	AFRA

RICKER, PERCY L	7RETD	AFRE
RIOCH, DAVID M	1DAWR	AFRA
ROBBINS, MARY L	2HGWU	AFRA
ROBERTS, ELLIOTT B	4CONS	AFRA
ROBERTSON, A F	1CNBS	AFRA
ROBERTSON, RANDAL M	1XNSF	AFRA
RODRIGUEZ, RAUL	1DAER	AFRA
ROESER, WILLIAM F	1CNBS	AFRA
ROLLER, PAUL S	5LIPR	AFRA
ROTH, FRANK L	7RETD	AFNA
RUFF, ARTHUR W JR	1CNBS	AFRA
RUSSELL, LOUISE M	1ARFR	AFRA
RYERSON, KNOWLES A	7RETD	AFNA
SANDOZ, GEORGE	1DNRL	AFRA
SARLES, MERRITT P	2HCUA	AFRA
SCHOOLEY, ALLEN H	1DNRL	AFNA
SCHREINER, OSWALD	7RETD	AFNE
SCHUBAUER, GALEN B	1CNBS	AFRA
SCOTT, ARNOLD H	1CNBS	AFRA
SCOTT, DAVID B	1HNIH	AFRA
SETZLER, FRANK M	7RETD	AFNE
SHAPOVALOV, MICHAEL	7RETD	AFNE
SHORB, MARY S	2HUMD	AFRA
SILSBEE, FRANCIS B	4CONS	AFRA
SILVERMAN, SHIRLEIGH	1CNBS	AFRA
SIMMONS, JOHN A	1CNBS	AFRA
SITTERLY, CHARLOTTE M	1CNBS	AFRA
SLACK, LEWIS	3INAS	AFRA
SLAWSKY, MILTON M	1DFOS	AFRA
SLAWSKY, ZAKA I	1DNOL	AFRA
SMITH, NATHAN R	7RETD	AFNE
SMITH, PAUL A	5RACO	AFRA
SNAVELY, BENJAMIN L	1DNOL	AFRA
SNAY, HANS G	1DNOL	AFRA
SPENCER, J T	1XNSF	AFRA
SPOONER, CHARLES S JR	5RAYC	AFRA
STAIR, RALPH	1CNBS	AFRA
STEVENS, HENRY	1ARNI	AFRA
STEVENSON, FREDERICK J	4CONS	AFRA
STEVENSON, JOHN A	7RETD	AFRE
STEWART, DEWEY	1ARFR	AFRA
STIEHLER, ROBERT D	1CNBS	AFRA
STILLER, BERTRAM	1DNRL	AFRA
STIMSON, HAROLD F	7RETD	AFRE
STIRLING, MATHEW W	7RETD	AFRA
STRINGFIELD, VICTOR T	1IGES	AFRA
SUTCLIFFE, WALTER D	7RETD	AFRE
TALBOTT, F LEO	2HCUA	AFRA
TATE, DOUGLAS R	1CNBS	AFRA
TAYLOR, JOHN K	1CNBS	AFRA
TEELE, RAY P	1CNBS	AFRA
THURMAN, ERNESTINE B	1HNIH	AFNA
TILDEN, EVELYN B	7RETD	AFNE
TITUS, HARRY M	4X	AFNA
TODD, MARGARET R	1IGES	AFRA
TORGESEN, JOHN L	1CNBS	AFRA
TRESSIER, WILLIS L	1DNOC	AFRE
TREXLER, JAMES H	1DNRL	AFRA
VAN EVERA, BENJAMIN D	2HGWU	AFRA
VANGELI, MARIO G	8NRNC	AMRA
VIGNESS, IRWIN	1DNRL	AFRA
VINAL, GEORGE W	7RETD	AFNE
VINTI, JOHN P	1CNBS	AFRA
VOLWILER, ERNEST H	7RETD	AFNA
WACHTMAN, JOHN B JR	1CNBS	AFRA
WALLEN, IRVIN E	1XSMI	AFRA
WALTHER, CARL H	2HGWU	AFRA
WARGA, MARY E	3AOSA	AFRA
WARING, JOHN A	4CONS	AMRA
WATERMAN, PETER	1DNRL	AFRA
WATTS, CHESTER B	7RETD	AFRA
WEIHE, WERNER K	1DAER	AFRA
WEISS, FRANCIS J	1XLIC	AFRA
WENSCH, GLEN W	1XAEC	AFRA
WETMORE, ALEXANDER	7RETD	AFRA
WHEELER, WILLIS H	1ARRP	AMRA
WHITTAKER, COLIN W	1ARFR	AFRA
WHITTEN, CHARLES A	1CCGS	AFRA
WILDHACK, WILLIAM A	1CNBS	AFRA
WILLIAMS, DONALD H	3ADIS	AMRA
WILSON, BRUCE L	1CNBS	AFRA
WILSON, RAYMOND E	8NRNC	AFNA
WILSON, WILLIAM K	1CNBS	AFRA
WORKMAN, WILLIAM G	7RETD	AFRA
WRENCH, JOHN W JR	1DNDT	AFRA
WYMAN, LEROY L	1CNBS	AFRA
YOUDEN, WILLIAM J	1CNBS	AFRA
YOUNG, ROBERT T JR	1DAHD	AFRA
YUILL, JOSEPH S	1AFOR	AFRA
ZELENY, LAWRENCE	1AMRP	AFRA
ZIES, EMANUEL G	7RETD	AFRE
ZIMERMANN, ALFRED G	7RETD	AFRA
ZWANZIG, ROBERT W	1CNBS	AFRA

2H GEOLOGICAL SOCIETY OF WASHINGTON

ABELSON, PHILIP H	3IGEL	AFRA
ADAMS, LEASON H	8NRNC	AFNE
BAKER, ARTHUR A	1IGES	AFRA
BATEMAN, ALAN M	4CONS	AFNE
BENNETT, ROBERT R	1IGES	AFRA
BOUTWELL, JOHN M	4CONS	AFNA
CARDER, DEAN S	1CCGS	AFRA
CARROW, MAXWELL K	1IGES	AFRA
COOKE, C WYTHE	1XSMI	AFRE
COOPER, G ARTHUR	1XSMI	AFRA
CURRIER, LOUIS W	7RETD	AFRE
CUTTITTA, FRANK	1IGES	AFRA
DANE, CARLE H	1IGES	AFRA
DAVIS, WATSON	3ISCS	AFRA
DUNCAN, HELEN M	1IGES	AFRA
FAHEY, JOSEPH J	1IGES	AFRA
FAUST, GEORGE T	1IGES	AFRA
FOURNIER, ROBERT O	1IGES	AFRA
GAZIN, CHARLES L	1XSMI	AFRA
GLASS, JEWELL J	1IGES	AFRA
HENDERSON, E P	1XSMI	AFRA
HERZ, NORMAN	1IGES	AFRA
HOERING, THOMAS C	3ICIW	AFRA
HOOKER, MARJORIE	1IGES	AFRA
INSLEY, HERBERT	4CONS	AFRA
LAKIN, HUBERT W	1IGES	AFNA
LOVE, S KENNETH	1IGES	AFRA
MAGIN, GEORGE B JR	1XAEC	AFRA
MAY, IRVING	1IGES	AFRA
MC KELVEY, VINCENT E	1IGES	AFRA
MC KNIGHT, EDWIN T	1IGES	AFRA
MEYERHOFF, HOWARD A	8NRNC	AFNA
MILLER, J CHARLES	7RETD	AFRA
MISER, HUGH D	1IGES	AFRE
NACE, RAYMOND L	1IGES	AFRA
NAESER, CHARLES R	2HGWU	AFRA
NIKIFOROFF, C C	7RETD	AFRE
OWENS, JAMES P	1IGES	AFRA
PHAIR, GEORGE	1IGES	AFRA
POMMER, ALFRED M	1ARNI	AFRA
ROEDDER, EDWIN	1IGES	AFRA
ROMNEY, CARL F	1DFX	AFRA
RUBEY, WILLIAM W	8NRNC	AFNA
RUBIN, MEYER	1IGES	AFRA
SCHALLER, WALDEMAR T	1IGES	AFRE
SMITH, PAUL A	5RACO	AFRA
SPICER, H CECIL	7RETD	AFNA
STRINGFIELD, VICTOR T	1IGES	AFRA
THAYER, THOMAS P	1IGES	AFRA
TODD, MARGARET R	1IGES	AFRA
TOULMIN, PRIESTLEY	1IGES	AFRA
TRUESDELL, PAGE E	1DNPI	AFRA
TUNELL, GEORGE	8NRNC	AFNA
UMPLEBY, JOSEPH B	7RETD	AFNE
YODER, HATTEN S JR	3ICIW	AFRA
ZEN, E-AN	1IGES	AFRA
ZIES, EMANUEL G	7RETD	AFRE

2I MEDICAL SOCIETY OF THE DIST OF COL

BERNTON, HARRY S	4PHYS	AFRA
BROWN, THOMAS H	2HGWU	AFRA

BURKE, FREDERIC G	4PHYS	AFRA
GANT, JAMES Q JR	4PHYS	AMRA
MC CULLOUGH, NORMAN B	1HNIH	AFRA
RIOCH, DAVID M	1DAWR	AFRA
ROSE, JOHN C	2HGEU	AFRA
TIDSALL, CHARLES S	2HGWU	AFRA

2J COLUMBIA HISTORICAL SOCIETY

CARMICHAEL, LEONARD	3INGS	AFRA
GRANT, ULYSSES S III	7RETD	AFRA
GROSVENOR, GILBERT	7RETD	AFRA

2K BOTANICAL SOCIETY OF WASHINGTON

ACKERMAN, WILLIAM L	1ARFR	
ADAIR, CHARLES R	1ARFR	
ADAMS, CAROLINE	2HGWU	AMRA
ALBERTS, HUGO	9CLUN	
AMES, LAWRENCE M	7RETD	AFRA
ANDERSEN, ALICE M	1AMRP	
APPLEMAN, CHARLES O	7RETD	
ARTZ, LENA	7RETD	
ATKINSON, PETER T	1ARFR	
BAKER, ROBERT L	2HUMD	
BAMFORD, RONALD	2HUMD	AFRA
BARCLAY, ARTHUR S	1ARFR	
BARKER, HENRY D	7RETD	
BARRE, H W	7RETD	
BARSS, HOWARD P	7RETD	AFNE
BEAN, GEORGE A	1INPS	
BENJAMIN, CHESTER R	1ARFR	AFRA
BIEN, CORABEL	7RETD	
BORTHWICK, HARRY A	1ARFR	AFRA
BOWMAN, PAUL W	1HNIH	AFRA
BOYD, HELEN C	1ANAL	
BRADLEY, MARY A	7RETD	
BRIERLEY, PHILIP	7RETD	
BROWN, EDGAR	7RETD	AFRE
BROWN, RUSSELL G	2HUMD	AFRA
BUCK, RAYMOND W	1ARFR	
CARNS, HARRY R	1ARFR	
CASH, EDITH K	7RETD	AFRE
CASH, LILLIAN	7RETD	
CHAPLINE, W R	7RETD	AFRE
CHASE, FLORENCE M	7RETD	
CLARK, J ALLEN	7RETD	
COCHRAN, LLOYD C	1ARFR	
COFFMAN, FRANKLIN A	1ARFR	
COLBRY, VERA L	1AMRP	
COOK, HAROLD T	1ARMR	AFRA
COOK, ROBERT C	5PORB	AFRA
COOLEY, J S	7RETD	
COONS, GEORGE H	7RETD	AFRE
COWAN, RICHARD S	1XSMI	
CROOKS, DONALD M	1ARFR	
CUATRECASAS, JOSE	1XSMI	
CULBERTSON, JOSEPH O	1ARFR	
CULLINAN, FRANK P	1ARFR	AFRA
DARROW, BERTHA S	9CLUN	
DARROW, G M	7RETD	
DARROW, ROBERT A	1DAFD	
DAVIDSON, ROBERT A	2HCUA	
DAVIS, DAVID W	1ARFR	
DEAN, HORACE S	7RETD	
DEMAREE, J B	7RETD	
DERMEN, HAIG	1ARFR	AFRA
DETWILER, SAMUEL B	7RETD	AFRA
DIEHL, WILLIAM W	7RETD	AFRE
DIENER, THEODOR O	1ARFR	
DILLER, J D	1AFOR	
DONOVAN, JOSEPHINE R	9CLUN	
DOWNS, ROBERT J	1ARFR	
DRECHSLER, CHARLES	1ARFR	AFRA
DU MOULIN, R K MRS	9CLUN	
DUKE, JAMES A	1ARFR	
DUTILLY, ARTHEME	2HCUA	AFRA
EGOLF, DONALD R	1ARFR	AFRA
EISENBERG, WILLIAM	1HFDA	
ELLIOTT, CHARLOTTE	7RETD	AFNE
EMMONS, CHESTER W	1HNIH	
EMSWELLER, SAMUEL L	1ARFR	AFRA
ERNST, WALLACE R	1XSMI	
EYDE, RICHARD H	1XSMI	
EZEKIEL, WALTER N	1DNX	
FARR, MARIE L	1ARFR	
FIELDS, RICHARD W	9CLUN	
FOGIE, HAROLD W	1ARFR	
FOWELLS, HARRY A	1AFOR	AFRA
FOX, ADRIAN C	9CLUN	
FREEMAN, OLIVER H	7RETD	
FULKERSON, JOHN F	1ACSR	
FULTON, H R	7RETD	
GALLOWAY, RAYMOND A	2HUMD	AMRA
GAUCH, HUGH	2HUMD	
GOLDSWORTHY, M C	7RETD	
GOLL, F L	7RETD	
GOOS, ROGER D	1HNIH	
GOTH, ROBERT W	1ARFR	
GRAVATT, ANNIE R	7RETD	
GRAVATT, G F	7RETD	AFRA
HACSKAYLO, EDWARD	1AFOR	AFRA
HALE, MASON E JR	1XSMI	
HAMMOND, H D	2HHOU	AMRA
HANSBROUGH, RAYMOND	1AFOR	
HARMON, DANIEL	1ARFR	
HARTLEY, WILLIAM	6AUSO	
HAYES, DORIS W	1AFOR	
HEERMAN, RUBEN M	1ACSR	
HEGGESTAD, HOWARD E	1ARFR	
HEINZE, PETER H	1ARMR	AFRA
HERR, ROBERT R	2HGWU	
HIGGINS, JOSEPH J	1ARFR	
HILDEBRAND, EARL M	1ARFR	
HOCHWALD, FRITZ G	9CLUN	AMRA
HODGE, W H	1XNSF	
HUNT, N REX	7RETD	
HUTCHINS, LEE M	8NRNC	AFNA
HWANG, SHUH WEI	3IATC	
HYLAND, HOWARD L	1ARFR	
IMLE, E P	3IACR	
JENKINS, ANNA E	7RETD	AFNE
JOHNSON, A G	7RETD	
JOHNSON, FALBA	7RETD	
JOHNSTON, FREDERICK A	1ARRP	
JUSTICE, OREN L	1ARMR	
KECK, DAVID K	1XNSF	
KENNARD, WILLIAM C	1ACSR	
KENWORTHY, FRANCIS T	1ARRP	
KEPHART, L W	7RETD	
KERR, ELIZABETH B	9CLUN	
KERR, THOMAS	1ARFR	
KILTZ, BURTON F	1DAEC	
KNIGHT, ROBERT J	9CLUN	
KRAUSS, ROBERT W	2HUMD	AFRA
KREITLOW, KERMIT W	1ARFR	AFRA
KULIK, MARTIN M	1AMRP	
KYLE, CURTIS H	7RETD	
LAMBERT, EDMUND B	1ARFR	AFRA
LE CLERG, ERWIN L	1ARFR	AFRA
LEESE, BERNARD M	1AMRP	
LEFEBVRE, CAMILLE L	1ACSR	
LEIGHTY, CLYDE E	7RETD	AFRE
LEJINS, PETER P	2HUMD	
LENTZ, PAUL L	1ARFR	
LEUKEL, ROBERT W	7RETD	
LINK, CONRAD B	2HUMD	
LIPSCOMB, BERNARD R	1ARFR	
LITTLE, ELBERT L JR	1AFOR	AFRA
LITTLE, RUBY R	1ARNI	
LOEGERING, WILLIAM Q	1ARFR	
LOHR, ANNIE	7RETD	
LUMSDEN, DAVID V	1ARFR	
LUTZ, JACOB M	1ARMR	AFRA
MA, ROBERTA M	1HFDA	
MAGNESS, J R	7RETD	
MARTIN, JOHN H	7RETD	AFRA
MATHEWS, OSCAR	7RETD	

MAY, CURTIS	1ARFR	
MAY, EUGENE	7RETD	
MC CLELLAN, WILBUR D	1ARFR	AFRA
MC CLURE, FLOYD A	1XSMI	
MC GRATH, HILDE M	1ARFR	
MC GREW, JOHN R	1ARFR	
MC KAY, HAZEL H	1AFOR	
MC KAY, JOHN W	1ARFR	
MC KINNEY, HAROLD H	7RETD	AFRE
MC MURTREY, JAMES E JR	1ARFR	
MEYER, FREDERICK G	1ARFR	
MILLER, ALVIN H	1ARFR	
MILLER, LULA A	2SDCP	
MILLER, PAUL R	1ARFR	AFRA
MILLER, ROBERT H	1ARFR	
MORGAN, DELBERT T	2HUMD	
MORGAN, OMAR D JR	2HUMD	
MORTON, CONRAD V	1XSMI	
MOSS, MAY K	2HHOU	
NANCE, NELLIE	7RETD	
NICOLSON, DAN H	1XSMI	
NIIMOTO, DOROTHY H	1ARFR	
NORTON, J B	7RETD	
NUTTONSON, M Y	3IICE	
O BRIEN, JOHN A JR	2HCUA	AFRA
OAKES, ALBERT J JR	1ARFR	
ORELLANA, RODRIGO G	1ARFR	
OSTROM, CARL E	1AFOR	
PALMER, JOHN G	1AFOR	
PAPAVIZAS, GEORGE C	1ARFR	
PARKER, KENNETH W	1AFOR	AFRA
PARKER, KITTIE	9CLUN	
PARKER, MARION W	1ARFR	AFRA
PATERSON, ROBERT A	2HUMD	
PERDUE, ROBERT E JR	1ARFR	
PIRINGER, ALBERT A	1ARFR	
POLHAMUS, L G	7RETD	
POLLOCK, BRUCE M	1ARFR	AFRA
POPE, MERRITT N	7RETD	AFNE
PORTERFIELD, W M JR	9NCOC	
PRICE, SAMUEL	1ARFR	
PULTZ, LEON M	1ARFR	
RANDS, ROBERT D	7RETD	AFNE
REID, MARY E	7RETD	AFRE
RICKER, PERCY L	7RETD	AFRE
ROBERT, ALICE L	1ARFR	
RODENHISER, HERMAN A	1ARFR	
ROLLER, JANE W	1AFOR	
RUDD, VELVA E	1XSMI	
RYALL, A LLOYD	1ARMR	AFRA
SALMON, S C	7RETD	
SAN ANTONIO, JAMES P	1ARFR	
SCHAREN, ALBERT L	1ARFR	
SCHOEN, JAMES F	1ARRP	
SCHREINER, OSWALD	7RETD	AFNE
SCHUBERT, BERNICE G	9CLUN	
SCHULTZ, EUGENE S	1ARFR	AFRE
SCOFIELD, CARL S	7RETD	
SCOTT, DONALD H	1ARFR	
SHETLER, STANWYN G	1XSMI	
SHROPSHIRE, WALTER A	1XSMI	AMRA
SIEGLER, EUGENE A	7RETD	
SIEVERS, ARTHUR F	7RETD	
SKINNER, HENRY T	1ARFR	
SMITH, ALBERT C	8NRNC	
SMITH, AUGUSTINE V P	2SDCP	
SMITH, C EARLE JR	1ARFR	
SMITH, LYMAN B	1XSMI	
SMITH, NATHAN R	7RETD	AFNE
SODERSTROM, THOMAS R	1XSMI	
STANTON, T R	7RETD	
STEERE, RUSSELL L	1ARFR	AFRA
STEINBERG, R A	7RETD	
STERN, WILLIAM L	1XSMI	
STEVENS, RUSSELL B	2HGWU	AFRA
STEVENSON, JOHN A	7RETD	AFRE
STEWART, DEWEY	1ARFR	AFRA
STEWART, ROBERT N	1ARFR	
STOKES, ILEY E	1ARFR	
STUART, NEIL W	1ARFR	AFRA
SVENSON, H K	1IGES	
SWALLEN, J R	1XSMI	
TAPKE, VICTOR F	7RETD	
TAYLOR, ALBERT L	1ARFR	AFNA
TAYLOR, MARIE C	2HHOU	AMRA
TEMPLE, C E	7RETD	
TERRELL, EDWARD E	1ARFR	
THOMAS, CHARLES A	1ARFR	AMRA
THOMAS, H REX	1ARFR	
THOMAS, L KAY JR	1INPS	
TILLSON, ALBERT H	1HFDA	
TOOLE, EBEN H	7RETD	
TOOLE, VIVIAN K	1ARFR	
TURPIN, JEAN M	5SNUR	
UHRING, JOSEPH	1ARFR	
VOZZO, JOHN A	1AFOR	
WALKER, EARNEST A	1ARRP	
WALKER, EGBERT H	7RETD	AFRA
WALLS, EDGAR P	7RETD	
WATSON, ALICE J	1ARFR	
WEAVER, LESLIE O	2HUMD	
WEBB, RAYMON E	1ARFR	
WEBB, ROBERT W	1ARMR	AFRA
WEINTRAUB, ROBERT L	2HGWU	AFRA
WEISS, FRANCIS J	1XLIC	AFRA
WELD, CLARK J	7RETD	
WENDT, LORINA	9CLUN	
WESTER, HORACE V	1INPS	
WESTER, ROBERT E	1ARFR	
WHEELER, WILLIS H	1ARRP	AMRA
WILCOX, MARGUERITE	7RETD	
WILLIAMS, LLEWELYN	1ARFR	
WILLIER, LILLIAN E	1SAID	AMRA
WILSON, KATHERINE	9CLUN	
WINTERS, HAROLD F	1ARFR	
WITHROW, ALICE P	1XNSF	AFRA
WOOD, JESSIE I	7RETD	
WOODBURY, C G	7RETD	
WOODS, MARK W	1HNIH	AFRA
WOODSTOCK, LOWELL W	1AX	
WRIGHT, ROBERT	7RETD	
WURDACK, JOHN J	1XSMI	
YOCUM, L EDWIN	7RETD	AFNE
ZAUMEYER, WILLIAM J	1ARFR	

2L SOCIETY OF AMERICAN FORESTERS

ALDRICH, ROBERT C	1AFOR
ARNOLD, DALE L	1AFOR
ARNOLD, R KEITH	1AFOR
ARNST, ALBERT	1AFOR
AYTON, JOHN S	9CLUN
BAHR, HENRY	9CLUN
BALL, HOWARD E	9CLUN
BARROWS, JACK S	1AFOR
BEACH, JAMES E	9CLUN
BEAL, JAMES A	1AFOR
BEAR, DANIEL H	1DAX
BEATTIE, BYRON B	1AFOR
BEDARD, PAUL W	1SAID
BEHRE, C EDWARD	7RETD
BENEDICT, WARREN V	1AFOR
BERGOFFEN, GENE S	1AFOR
BERGOFFEN, WILLIAM W	1AFOR
BERNDT, HERBERT W	1AFOR
BILL, HARTHON L	1INPS
BONGBERG, JACK W	1AFOR
BOWEN, CALVIN M	1IBLM
BOYLE, GARY L	9CLUN
BRACKMAN, OLIVER W	9CLUN
BRIERLEY, ROBERT P	8NRNC
BROADBENT, SAM R	1XBOB
BROCKS, SAMUEL M	1IBLM
BROWN, ARTHUR A	1AFOR
BRUCE, MASON B	1AFOR
BRYAN, MILTON M	1AFOR
BUCK, CHARLES C	1AFOR

BULLARD, WILLIAM E JR	1HX	
BURCHAM, LEVI T	9CLUN	
BURGTORF, CARL	1AFOR	
BURKS, GEORGE F	1AFOR	
BYRNE, JAMES J	1AFOR	
CALHOUN, DONALD C	9CLUN	
CARDWELL, CARROLL K	1AFCA	
CARLSON, STURE T	1INPS	
CARRELL, VIRGIL R	1AFOR	
CHAPLINE, W R	7RETD	AFRE
DETWILER, SAMUEL B	7RETD	AFRA
DONOVAN, WILLIAM J	1AERS	
DORTIGNAC, EDWARD J	1AFOR	
DOVERSPIKE, GEORGE E	1AFOR	
DOYLE, JAMES F	1IBLM	
DRAVES, ERNEST E	1AFOR	
DUTTON, WALT	7RETD	
DZULYNSKY, LUBOMYR P	9CLUN	
ELCHIBEGOFF, IVAN M	4CONS	
ELLIOTT, JOSEPH E JR	1AFOR	
ELY, RICHARD K	1IBIA	
EVERARD, WILLIAM P	1AFOR	
EYRE, F H	7RETD	
FARRELL, JOHN H	1AFOR	
FEDKIW, JOHN	1AFOR	
FETZER, CARL D	1ASCS	
FISHER, HAROLD E	1AFOR	
FIVAZ, ALFRED E	7RETD	AFRE
FORSMAN, JOHN S	9CLUN	
FOSTER, ELLERY A	1CX	
FOWELLS, HARRY A	1AFOR	AFRA
FOX, GORDON D	1AFOR	
FRANKS, JAMES W	9CLUN	
FREDINE, C G	1INPS	
FREEMAN, HAROLD B	9CLUN	
FUNK, WILLIAM F	9CLUN	
FURLOW, EDWARD P	1XUST	
FURNIVAL, GEORGE M	1AFOR	
GAMMON, ALVIN D	1AFOR	
GANT, JAMES Q JR	4PHYS	AMRA
GARVER, RAYMOND D	7RETD	
GENYS, JOHN B	2HUMD	
GIFFEN, W D	1AFOR	
GILL, THOMAS G	1AFOR	
GILL, TOM	3IPAC	
GILLETT, CHARLES A	9CLUN	
GORRELL, JOSEPH W	1AFOR	
GRANGER, CHRISTOPHER M	7RETD	
GRAVATT, G F	7RETD	AFRA
GREELEY, ARTHUR W	1AFOR	
GREEN, ALAN W	1AFOR	
GREST, EDWARD G	1AFOR	
GROVER, FREDERICK W	1AFOR	
HACSKAYLO, EDWARD	1AFOR	AFRA
HAHN, OSCAR M	1AFOR	
HAIR, DWIGHT	1AFOR	
HALL, ALBERT G	4CONS	
HALL, JOHN F	9CLUN	
HALL, R C	7RETD	AFRE
HAMMERLE, WILLIAM C	3AAPA	
HAMRE, VERNON O	1AFOR	
HANSBROUGH, JOHN R	1AFOR	
HARBISON, JOSEPH S	9CLUN	
HARDY, MALCOLM E	1AFOR	
HARPER, VERNE L	1AFOR	
HARRINGTON, LEE P	9CLUN	
HARRIS, RICHARD L	1AFOR	
HART, WILLIAM J	1IBOR	
HARTWICK, ROBERT A	1AFOR	
HAYES, DORIS W	1AFOR	
HEADY, DONALD R	1IBLM	
HEID, RICHARD W	9CLUN	
HELLER, ROBERT C	1AFOR	
HENDEE, CLARE W	1AFOR	
HENRY, MERTON	5X	
HERRICK, DAVID E	1AFOR	
HERTZLER, RICHARD A	1DAX	
HOAR, CROSBY A	7RETD	

HODGES, RALPH D JR	9CLUN	
HOFFMAN, JOHN D	1CNBS	AFRA
HOFFMANN, CLARENCE H	1ARFR	AFRA
HOFFMANN, EDWARD J	1IBLM	
HOLTBY, BERT E	1AFOR	
HOPKINS, WALTER S	1AFOR	
HOPP, HENRY	1AFAS	AFNA
HUTCHINS, LEE M	8NRNC	AFNA
JEMISON, GEORGE M	1AFOR	
JEPSEN, STANLEY M	9CLUN	
JOHANNESEN, MARK M	1AFOR	
JOHNSON, CARL J	9CLUN	
JONES, WILLIAM V	1AFOR	
JORANSON, PHILIP N	1ACSR	
JOSEPHSON, H R	1AFOR	
KAUFFMAN, ERLE	5X	
KEE, DAVID N	1AFOR	
KEPHART, GEORGE S	1IBIA	
KERN, JACK C	1AFOR	
KIHLMIRE, PAUL M	1AFOR	
KING, DAVID B	1AFOR	
KINNEY, JAY P	8NRNC	AFNE
KUENZEL, JOHN G	9CLUN	
LARRIMER, WALTER H	3INAS	AFRA
LARSON, JAMES E	9CLUN	
LARSON, ROBERT W	1AFOR	
LASSEN, LEON	7RETD	
LAVINDER, GEORGE W	9CLUN	
LEDFORD, ROY H	1AFOR	
LEMMON, PAUL E	1ASCS	
LERCHEN, ROBERT A	9CLUN	
LEXEN, BERT R	1ARAO	
LIMING, FRANKLIN G	1AFOR	
LITTLE, ELBERT L JR	1AFOR	AFRA
LOGAN, ALLEN J	1AFOR	
LOTTI, THOMAS	1AFOR	
LOVERIDGE, MELVIN E	1AFOR	
LOWDEN, MERLE S	1AFOR	
LYMAN, CHALMER K	1AFOR	
LYNCH, DONALD W	1AFOR	
LYND, HAROLD C	1IBLM	
MAKSYMIUK, BOHDAN	1AFOR	
MARSH, R E	7RETD	
MASON, IRA J	7RETD	
MASON, THOMAS C	1CX	
MAY, RICHARD H	1XUST	
MAYS, L K	1AFOR	
MC ARDLE, RICHARD C	1D-X	
MC ARDLE, RICHARD E	3IIPA	
MC CLELLAN, JAMES C	9CLUN	
MC CULLEY, ROBERT D	1AFOR	
MC HENRY, RICHARD K	1D-X	
MC KELLAR, ALFRED D	1CX	
MC KENNAN, RUSSELL B	1AFOR	
MC NAUGHTON, FINLEY H	1AFOR	
MC ROREY, RUSSELL P	1AFOR	
MC WILLIAMS, JAMES P	1XUST	
METCALF, WALTER B	1AFOR	
MEYER, ARTHUR B	3ASAF	
MEYERING, JOHN R	3ASAF	
MILES, RICHARD V III	9CLUN	
MILLER, ALLEN F	1AFOR	
MILLER, JAMES E	9CLUN	
MISKOVSKY, MILAN C	9CLUN	
MOLLOHAN, ROBERT E	9CLUN	
MOORE, HARRY J	1ARRP	
MOORE, WILLIAM R	1AFOR	
MOREY, HAROLD F	1AFOR	
MORRISS, D J	1AFOR	
MULLEN, ALLEN H	1AFOR	
MURPHY, WARREN T	1AFOR	
NEEBE, DAVID J	1AFOR	
NELSON, JOHN M	5NECO	
NELSON, M M	1AFOR	
NELSON, THOMAS C	1AFOR	
NEWMAN, WALKER P	1AFOR	
O NEAL, NOLAN C	1AFOR	
OLIN, DANIEL D	1AFOR	

OLSEN, CARL F	1AFOR	
OLSON, ROY W	1AFOR	
OREN, EUGENE A	1ASCS	
OSBORNE, RAYMOND L	9CLUN	
OSTROM, CARL E	1AFOR	
OWENS, JAMES M	1CX	
PAMMEL, HAROLD E	9CLUN	
PARIS, CHARLES D	1AFOR	
PARKE, WILLIAM N	1AFOR	
PARKER, KENNETH W	1AFOR	AFRA
PARKER, LANSING A	1IFWS	
PARKINSON, DANA	7RETD	
PARTYKA, EUGENE J	1DNX	
PATTON, DWIGHT L	1IBOR	
PAYNE, BURNETT H	1AFOR	
PETERSEN, EMMANUEL J	1IBLM	
PETERSON, EUGENE K	1IBLM	
PHELPS, ROBERT B	1AFOR	
PHILLIPS, GEORGE R	1ASCS	
PIEROVICH, JOHN M	1AFOR	
PLAIR, THEODORE B	1ASCS	
PLETCHER, CHARLES B	1DAEC	
POMEROY, KENNETH B	3AAFA	
POSEY, GILBERT B	7RETD	
POST, HOWARD A	9CLUN	
POTTER, JOHN R	9CLUN	
POTTER, ROBERT V	1AFOR	
PRATER, LELAND J	1AFOR	
PRESNALL, CLIFFORD C	1IFWS	
PRESTON, JOHN F	1INPS	
PYLES, HAMILTON K	1AFOR	
RAINER, YOUNG W	3ASAF	
RANDALL, CHARLES E	7RETD	
RAPP, DENNIS A	1XBOB	
RASMUSSEN, BOYD	1AFOR	
REID, WILLIAM H	1AFOR	
REINHARDT, ROBERT E	1AFOR	
RICKER, DANIEL L	1AOIG	
RINDT, CHARLES A	1AFOR	
RISHELL, CARL A	4CONS	
RITTER, EDWARD	1AFOR	
ROBERTSON, FINIS D	1AFOR	
ROBERTSON, RANDAL M	1XNSF	AFRA
ROTTY, ROLAND	1AFOR	
RUMMELL, ROBERT S	1AFOR	
RUTHERFORD, R M	7RETD	
SALMOND, GORDON R	7RETD	
SALZMAN, FRANKLIN	1AFOR	
SANDOR, JOHN A	1AFOR	
SASAKI, WESLEY K	1XBOB	
SAYERS, WILSON B	9CLUN	
SCHIPULL, WALTER L	7RETD	
SCHOPMEYER, CLIFFORD S	1AFOR	
SCHULTZ, EDWARD W	1AFOR	
SCHWARTZ, CHARLES M	9CLUN	
SHANKLIN, JOHN F	1IBOR	
SHIELDS, CHESTER A	1AFOR	
SHIELDS, JOHN F	1AFOR	
SHURTLEFF, ROBERT G	9CLUN	
SIEKER, JOHN H	7RETD	
SIMS, IVAN H	7RETD	
SMART, ROBERT A	1AFOR	
SMITH, DONALD W	1AFOR	
SMITH, HOWARD B	1AFOR	
SMITH, LAWRENCE W	7RETD	
SOWDER, ARTHUR M	1AFES	
SPADA, BENJAMIN	1AFOR	
SPARHAWK, WILLIAM N	7RETD	AFNE
SPILLERS, ARTHUR R	1AFOR	
SPODEN, F G JR	1IFWS	
ST GEORGE, RAYMOND A	1AFOR	AFRA
STAHL, WILLIAM J	1AFOR	
STITT, MERIE E	1INPS	
STODDARD, CHARLES H	1IBLM	
STOREY, HERBERT C	1AFOR	
STOUT, NEIL J	1IBOR	
STRALKA, RAYMOND J	1CWEB	
STRINGFIELD, VICTOR T	1IGES	AFRA
SUMP, ALBERT W	1AFOR	
SUNDERLAND, LAWRENCE B	1XUST	
SWARTHOUT, PAUL A	1AFOR	
SWEM, THEODOR R	1INPS	
SWIFT, LLOYD W	7RETD	
THOMAS, LEON R	1AFOR	
THOMPSON, RICHARD L	9CLUN	
THORNTON, PHILIP L	1AFOR	
TOBIN, WILLIAM T	1AOIG	
TOMLINSON, HARRY R	1TIRS	
UNDERWOOD, ELTON H	9CLUN	
VASAITIS, ANTHONY J	1AFOR	
VITAS, GEORGE	1AFOR	
WADE, EARL V	1AFOR	
WAGNER, JOSEPH A	1IBIA	
WARD, RAY	1XCON	
WATKINS, WILLIAM N	9CLUN	
WEAVER, CLAYTON N	1AFOR	
WEBER, FREDERICK P	1AFOR	
WERSHING, HENRY F	1IBIA	
WESSEIA, CONRAD P	1AFOR	
WHITESIDE, JOHN M	1AFOR	
WIENER, ALFRED A	1AFOR	
WILDER, THOMAS V	1XLIC	
WILLIAMS, ELLIS T	1AFOR	
WILLIAMS, W K	1AFOR	
WINTERS, ROBERT K	1AFOR	
WOLF, ROBERT E	1IBLM	
WRIGHT, GERAIL G	1IBLM	
YEAGER, LEE E	9CLUN	
YUHAS, MELVIN L	9CLUN	
YUILL, JOSEPH S	1AFOR	AFRA
ZAIDLICZ, EDWIN	1IBLM	
ZUMWALT, EUGENE V	1IBLM	
ZYLINSKI, JOSEPH	1AFOR	

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CLAIRE, CHARLES N	1CCGS	AFRA
DAVIS, WATSON	3ISCS	AFRA
EDMUNDS, WADE M	3IJBS	AMRA
FIELDNER, ARNO C	7RETD	AFRA
GARNER, CLEMENT L	7RETD	AFRE
GILLMAN, JOSEPH L JR	4CONS	AFRA
GRANT, ULYSSES S III	7RETD	AFRA
KAUFMAN, H PAUL	4CONS	AFRA
MASON, MARTIN A	2HGWU	AFRA
MEBS, RUSSELL W	1CNBS	AFRA
RAPPLEYE, HOWARD S	7RETD	AFRA
RICHMOND, JOSEPH C	1CNBS	AFRA
SLAWSKY, MILTON M	1DFOS	AFRA
SMALL, JAMES B	1CCGS	AFRA
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WEBER, EUGENE W	1DAEX	AFRA

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ASTIN, ALLEN V	1CNBS	AFRA
BARBROW, LOUIS E	1CNBS	AFRA
BOYLE, DON R	1CNBS	AMRA
CLEAVER, OSCAR P	1DAER	AFRA
COOTER, IRWIN L	1CNBS	AFRA
COSTRELL, LOUIS	1CNBS	AFRA
CRAFTON, PAUL A	2HGWU	AFRA
DOCTOR, NORMAN J	1DAHD	AFRA
DYKE, EDWIN	5HOWR	AMRA
EDMUNDS, WADE M	3IJBS	AMRA
ELBOURN, ROBERT D	1CNBS	AFRA
FRANKLIN, PHILIP J	1D-S	AFRA
GIBSON, JOHN E	1DNRL	AFRA
GRISAMORE, NELSON T	2HGWU	AFRA
GUARINO, P A	1DAHD	AFRA

HALL, WAYNE C	1DNRL	AFRA
HAMER, WALTER J	1CNBS	AFRA
HARRIS, FOREST K	1CNBS	AFRA
HORTON, BILLY M	1DAHD	AFRA
HUNTOON, ROBERT D	1CNBS	AFRA
KALMUS, HENRY P	1DAHD	AFRA
KOHLER, HANS W	1DAHD	AFRA
KOTTER, F RALPH	1CNBS	AFRA
KULLBACK, SOLOMON	2HGWU	AFRA
LIDDEL, URNER	1XNAS	AFRA
MAYER, CORNELL H	1DNRL	AFRA
O BRYAN, HENRY M	8NRNC	AFRA
PAGE, CHESTER H	1CNBS	AFRA
PAGE, ROBERT M	1DNRL	AFRA
PARK, J HOWARD	8NRNC	AFNA
PHILLIPS, MARCELLA L	4CONS	AFRA
PIORE, E R	8NRNC	AFNA
POLING, AUSTIN C	1CCGS	AFRA
RABINOW, JACOB	5RBEN	AFRA
ROTKIN, ISRAEL	1DAHD	AFRA
SCHOOLEY, ALLEN H	1DNRL	AFNA
SCOTT, ARNOLD H	1CNBS	AFRA
SHAPIRO, GUSTAVE	1CNBS	AFRA
SILSBEE, FRANCIS B	4CONS	AFRA
SMITH, PAUL L	1DNRL	AFRA
SMITH, SIDNEY T	1DNRL	AFRA
SOMMER, HELMUT	1DAHD	AFRA
STAIR, RALPH	1CNBS	AFRA
VIGUE, KENNETH J	5ITTC	AMRA
WATERMAN, PETER	1DNRL	AFRA
WEIHE, WERNER K	1DAER	AFRA
YAPLEE, BENJAMIN S	1DNRL	AFRA
YOUNG, ROBERT T JR	1DAHD	AFRA

2O AMERICAN SOCIETY OF MECH ENGINEERS

ALLEN, WILLIAM G	1CMAA	AFRA
BELSHEIM, ROBERT O	1DNRL	AFRA
BUTLER, FRANCIS E	1DNOL	AMRA
CRAFTON, PAUL A	2HGWU	AFRA
DALZELL, R CARSON	1XAEC	AFRA
DRYDEN, HUGH L	1XNAS	AFRA
FULLMER, IRVIN H	1CNBS	AFRA
GILLMAN, JOSEPH L JR	4CONS	AFRA
HICKOX, GEORGE H	8NRNC	AFNA
MASON, MARTIN A	2HGWU	AFRA
OSGOOD, WILLIAM R	2HCUA	AFRA
RAMBERG, WALTER	1SX	AFNA
RIVELLO, ROBERT M	2HUMD	AFRA
STIEHLER, ROBERT D	1CNBS	AFRA

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ANDREWS, JOHN S	1ARFR	AFRA
BUHRER, EDNA M	7RETD	AFRA
DOSS, MILDRED A	2HUMD	AFRA
DURBIN, CHARLES G	1HFDA	AFRA
FARR, MARION M	1ARFR	AFRA
FOSTER, AUREL O	1ARFR	AFRA
HERMAN, CARLTON M	1IFWS	AFRA
HUNTER, GEORGE W III	8NRNC	AFNE
MC INTOSH, ALLEN	7RETD	AFRA
MC MULLEN, DONALD B	1DAWR	AFRA
MORRIS, J A	1HNIH	AMRA
PRICE, E W	8NRNC	AFNE
RAUSCH, ROBERT	1HPHS	AFNA
SARLES, MERRITT P	2HCUA	AFRA
SCHOENING, HARRY W	7RETD	AFRA
SHORB, DOYS A	1ARFR	AFRA
TRAUB, ROBERT	2HUMD	AFRA
TROMBA, FRANCIS G	1ARFR	AFRA
TURNER, JAMES H	1ARFR	AFRA
VON BRAND, THEODOR C	1HNIH	AFRA

2Q AMERICAN SOCIETY FOR MICROBIOLOGY

ABELSON, PHILIP H	3IGEL	AFRA
ABRAMS, ARTHUR	1DAWR	
ACKER, ROBERT S	1DNOR	
ADAMS, GRAYSON	9CLUN	
AFFRONTI, LEWIS F	2HGWU	
AGUILU, LUIS A	1DAWR	
ALEXANDER, AARON D	1DAWR	AFRA
ALFORD, JOHN A	1ARNI	
ALLEN, HAROLD B	1IFWS	
ALLISON, FRANKLIN E	7RETD	AFRA
ARM, HERBERT	1DNMR	
ARMSTRONG, CHARLES	7RETD	AFRE
ARON, STEPHEN A	1XVET	
ASHBY, WINIFRED M	7RETD	
ASHE, WARREN K	1HNIH	
AZAROWICZ, E N	5BIRE	
BABCOCK, MARY C	1DNMR	
BACKUS, ROBERT C	1HNIH	
BAER, EDWARD	1HFDA	
BAER, HAROLD	1HNIH	
BANVILLE, ROBERT R	1ARNI	
BARDROW, JANE	1ARNI	
BARILE, MICHAEL F	1HNIH	
BARON, LOUIS S	1DAWR	AFRA
BARTRAM, M THOMAS	1HFDA	
BATLIN, ALEXANDER	1DAX	
BAYNE-JONES, STANHOPE	7RETD	
BEE, GERALD R	3ANCA	
BELLANTI, JOSEPH A	1DAWR	
BELOIAN, ARAM	1ARNI	
BENNETT, REGINALD W	1HFDA	
BERNHEIM, BARBARA C	1HNIH	
BINN, LEONARD N	1DAWR	
BLADEN, HOWARD A	1HNIH	
BLUNDELL, GEORGE P	5HUAS	
BOHRER, C WALLACE	3ANCA	
BOULDIN, ISABELLA	3IATC	
BOUMA, CECELIA	1ARNI	
BOURGEOIS, LOUIS D	1HNIH	
BOURKE, ANNE R	7RETD	
BOWMAN, FRANCES W	1HFDA	
BOYD, DONALD M	5REAN	
BOZEMAN, F MARILYN	1DAWR	AFRA
BRADLEY, FRANK	7RETD	
BRANCHE, WILLIAM C JR	1DAWR	
BRANDT, WALTER E	1DAWR	
BREWER, CARL R	1HNIH	AFRA
BROOKMAN, MARJORIE D	1HNIH	
BROWN, THOMAS H	2HGWU	AFRA
BRUCH, CARL W	1XNAS	
BRYANT, MARVIN P	1ARAO	
BUELL, MABEL R	1HNIH	
BUGGS, C W	2HHOU	
BURKEY, LLOYD A	7RETD	AFRE
BURNETT, GEORGE W	1DAWR	
BURTON, J H	7RETD	
BYRNE, ROBERT J	1HNIH	AFRA
CADIGAN, FRANCIS C	1DAWR	
CALHOUN, MIRIAM P	1HFDA	
CALISHER, CHARLES H	5MIAS	
CALNAN, K DOROTHY	1HNIH	
CAMP, ELIZABETH	3HARL	
CAMPBELL, JANIS	1DAWR	
CARLSON, HARVE J	1XNSF	
CARLSON, MARGARET J	1HNIH	
CARSKI, THEO J	5BABI	
CARY, SYLVIA G	1DAWR	
CASMAN, EZRA P	1HFDA	
CASTELLANO, GABRIEL	5MIAS	
CHAFFEE, ELMER F	1D-IP	
CHANG, SING C	1D-IP	
CHAPARAS, S D	1HNIH	
CLARK, WILLIAM A	3IATC	AMRA
COLE, ROGER M	1HNIH	
COLLINS, JOHN E	1HFDA	
COLON, ALBA E	1HNIH	
COLWELL, RITA R	2HGEU	
CONNER, RAY M	1ARRP	
COOK, M KATHERINE	1HNIH	
COON, ROBERT G	1XNSF	
COX, CLAIRE B	1HNIH	
CRAWFORD, ARTHUR B	7RETD	
CREITZ, JOSEPH	1DAX	

CURRAN, HAROLD R	1ARNI	AFRA
CURRIE, JULIUS A	1DAWR	
CURTISS, P R	2HAMU	
CUTCHINS, ERNEST C	2HCUA	
DAIL, MARTHA C	1DAWR	
DAVIS, DORLAND J	1HNIH	
DAVIS, ROBERT J	1ASCS	
DAWSON, ROY C	6FAOR	AFRA
DAWSON, ROY C MRS	7RETD	
DEBORD, GEORGE G	7RETD	AFNE
DENNY, CLEVE B	3ANCA	
DOCKSTADER, W B	1HNIH	
DOETSCH, RAYMOND N	2HUMD	AFRA
DOUGLAS, GEORGE W	1HNIH	
DREGUSS, MIKLOS N	1HNIH	
DREYFUS, JOSEPH C III	1DAWR	
DUNNIGAN, ARTHUR P	1HFDA	
DUTKY, SAMSON R	1ARFR	
EDDY, BERNICE E	1HNIH	AFRA
EDWARDS, CLARK W	1DAWR	
ELSTINS, RUTA	3HWHC	
EMMART, EMILY W	1HNIH	AFRA
EMMONS, CHESTER W	1HNIH	
EVANS, ALICE C	7RETD	AFRE
EVANS, TODD	1HNIH	
FABER, JOHN E	2HUMD	AFRA
FALGOUT, BARNEY T	1DAWR	
FEELEY, JOHN C	1HNIH	
FELSENFELD, AMPHAN D	1D-IP	
FELSENFELD, OSCAR	1DAWR	
FIFE, EARL H	1DAWR	
FINKELSTEIN, RICHARD A	1DAWR	
FITZGERALD, ROBERT J	1HNIH	
FOECKLER, FRANCIS	5HUAS	
FORMAL, SAMUEL B	1DAWR	
FOURNELLE, HAROLD J	1HNIH	
FOWLER, RICHARD	2HGWU	
FUGATE, GUY JR	1ARRP	
FULLER, HENRY S	1DAX	
FULLER, VERNON J	1HNIH	
FUSILLO, MATTHEW H	1XVET	AMRA
FUSON, ROGER B	1HNIH	
GAINES, SIDNEY	1DAWR	
GANAWAY, JAMES R	1HNIH	
GIBBS, C J JR	1HNIH	
GILMORE, ELEANOR L	1DAWR	
GINSBERG, DAVID M	1DAWR	
GOHD, ROBERT S	1DFX	
GOLDSMITH, MARGARET T	1HNIH	
GORDON, FRANCIS B	1DNMR	
GORDON, RUTH E	8NRNC	AFNA
GOUGH, BOBBY J	1ARNI	
GRASSMYER, EDDA	3HDCG	
GREEN, GEORGE H	1DNMC	
GROSS, NOEL H	1HNIH	
GUARRAIA, LEONARD J	1XSMI	
GUTEKUNST, RICHARD R	1DNMR	
GUTIERREZ, JOSE	1DNMR	
HABEL, KARL	1HNIH	
HAMPAR, BERGE	1HNIH	
HAMPP, EDWARD G	1HNIH	AFRA
HAMPTON, CHARLES M	1DAWR	
HANN, WILLIAM D	2HGWU	
HANSEN, P A	2HUMD	
HARDY, FRANK M	5MELP	
HARMON, STANLEY M	1HFDA	
HARTLEY, JANET W	1HNIH	
HARTMAN, ROBERTA S	1DAWR	
HASENCLEVER, H F	1HNIH	
HEILMAN, DOROTHY H	1XVET	
HEIM, ALLEN H	5HALA	
HELPRIN, JEROME J	1HNIH	
HERMAN, LLOYD G	1HNIH	
HERMAN, YAYE	1DAWR	
HETRICK, FRANK	2HUMD	AMRA
HIATT, CASPAR W	1HNIH	AFRA
HILDEBRAND, EARL M	1ARFR	
HOLLINSHEAD, A C	2HGWU	

HOOK, WILLIAM A	1DAWR	
HOPPS, HOPE E	1HNIH	
HOPTMAN, JULIAN	9CLUN	
HOTTLE, GEORGE A	8NRNC	AFNA
HUGH, RUDOLPH	2HGWU	AMRA
HUNTER, DONALD H	1DAWR	
HUNTER, JACK A	1DNX	
IKARI, NORMAN S	1HNIH	
JACKSON, ELIZABETH B	2HUMD	
JAMES, L H	8NRNC	AFNA
JANICKI, BERNARD W	1XVET	
JEFFRIES, JAMES D	3HDCG	
JENNINGS, ANNE E	1HNIH	
JENNINGS, ROBERT K	1DNOR	
JONES, CYRIL J	7RETD	
JORDAN, HAROLD V	1HNIH	
JOSEPH, S W	1DNMR	
KASE, ALICE	1DAWR	
KATZ, EDWARD	2HGEU	
KAUFFMANN, GLADYS	7RETD	
KAUFMAN, DONALD D	1ARFR	
KAUTTER, DONALD A	1HFDA	
KENNEDY, E R	2HCUA	AFRA
KIMLER, ALEXANDER	1HNIH	
KIRSHBAUM, AMIEL	1HFDA	
KNOLL, EVERETT W	1HFDA	
KOLB, ROBERT W	1HNIH	
KORAB, HARRY E	3AABC	
KRAMER, JULIAN	1HFDA	
KRETSCHMAIER, HENRY	5DFCO	
LABREC, EUGENE H	1DAWR	
LAFFER, NORMAN C	2HUMD	
LAMANNA, CARL	1DARO	AFRA
LARRABEE, ALLAN R	1DAWR	
LEAKE, JAMES P	7RETD	
LEE, MARCIA R A M	1HNIH	
LEININGER, HAROLD V	1HFDA	
LEISE, JOSHUA M	1XNSF	
LEOPOLD, SIDNEY	1HPHS	
LERNER, EDWIN M II	1HNIH	
LESSEL, ERWIN F JR	3IATC	
LEVY, HILTON B	1HNIH	
LI, C P	1HNIH	
LICHTENSTEIN, HAROLD	1ARNI	
LILLY, TIMOTHY JR	1HFDA	
LONES, G W	1HNIH	
LOWENTHAL, JOSEPH P	1DAWR	
LUND, EVERETT E	1ARFR	
LUND, PAULINE G	1ARNI	
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BURGNER, NEWTON M	1DFWS	
BURKHART, MARVIN D	1DNOC	
BURNETT, FRANK W	1CWEB	
BUSH, DORIS M	1DNOC	
BYLE, WILLIAM K	1CWEB	
CALABRESE, PHILIP A	1CWEB	
CAMPBELL, ALEXANDER	1CWEB	
CARLIN, ALBERT V	1CWEB	
CARMAN, DAVID R	1DNOC	
CARTWRIGHT, GORDON D	1CWEB	
CARTWRIGHT, ROBERT C	1DFWS	
CASKEY, JAMES E JR	1CWEB	
CHANDLER, ROBERT A	1DNWS	
CHANESMAN, STANLEY	1DNOC	
CHAVASSE, NICHOLAS H	1DAX	
CHILTON, CHARLES A	1CWEB	
CHRISTENSEN, FRANK E	1CWEB	
CHRISTIAN, MADELEINE H	1CWEB	
CHURGIN, JAMES	1DNOD	
CLAPP, PHILIP F	1CWEB	
CLARK, MARJORIE A	1CWEB	
CLARKE, JAMES W	1CWEB	
CLINE, CLIFFORD H	1DNOC	
COCHRANE, CALVIN W	1CWEB	
COLE, HAROLD B	1CWEB	
COLSON, DE VER	1CWEB	
CONDAXIS, JAMES P	1CWEB	
CONWAY, CHARLES L	1CWEB	
COOK, ROBERT P	1CWEB	
COOPERMAN, ARTHUR I	1CWEB	
COPELAND, JOHN A	1DAX	
CORTON, EDWARD L	1DNOC	
CORWIN, E F	1DNBW	
COUNCIL, THOMAS C	1CWEB	
COWAN, LESLIE W	1DFX	
CRAIG, NORMAN C	1DFWS	
CRAIG, O E	1DNBW	
CRAIG, ROBERT W	1CWEB	
CRAM, VICTOR E	1DFWS	
CRESSMAN, GEORGE P	1CWEB	AFRA
CROCKETT, CURTIS W	1CWEB	
CROTTY, PAUL G	1DFWS	
CRY, GEORGE W	1CWEB	AMRA
CULLEN, THOMAS P	1CWEB	
CULNAN, ROBERT N	1CWEB	
CUMMINGS, MAURICE H	1CWEB	
DALES, PHILIP A JR	1CWEB	
DANNER, ARTHUR C	9CLUN	
DARLING, EUGENE M JR	1XNAS	
DARLING, FREDRIC L	1CWEB	
DE ANGELIS, RICHARD M	1CWEB	
DE LEONIBUS, P S	1DNOC	
DECKER, ROBERT F	1XFAA	
DELLERT, GEORGE T JR	1CWEB	
DICKSON, ROBERT R	1CWEB	
DIETRICH, CARL F	1DAX	
DOHERTY, JAMES L	1CWEB	
DONEHOO, IRENE A	1CWEB	
DOORE, G STANLEY	1CWEB	
DORER, CHARLES F	1CWEB	
DREWES, WILLIAM J	1CWEB	
DUBACH, HAROLD W	1DNOD	
DUNN, CARLOS R	1CWEB	
DUTTON, JOHN A	1DFWS	
DYE, LUCIUS W	1CWEB	
DYER, J GLENN	1CWEB	
EAKIN, OTHO M JR	1CWEB	
EBERLY, JOHN H	1CWEB	
EDDLEMAN, DAVID J	1DFX	
EDELSTEIN, MAX W	1DNWS	
EDMONDS, SUZANNE E	1CWEB	
EDSALL, DOUGLAS W	1DNOD	
EDWARDS, SHIRLEY	1CWEB	
EGGERT, WILLIAM E	1XFAA	
ELAM, CLARENCE B JR	1DFWS	
ELDER, ROBERT B	1DNOC	
ELLINWOOD, MARY E	1D-X	
ELLIS, JAMES D	1CWEB	
ELLIS, JOHN O	1CWEB	
ENGEL, LOUISE S	7RETD	
ENGELBRECHT, HOWARD H	1CWEB	
EPSTEIN, EDWARD S	1C-S	
ERICKSON, CARL O	1CWEB	
ESTELLE, EARL W	1CWEB	
FAHEY, JAMES M	1DFX	
FALLER, ALAN J	2HUMD	
FARKAS, LESLIE F	1DFWS	
FAWCETT, EDWIN B	1CWEB	
FEESE, LARS O	1CWEB	
FEINSILBER, MAX M	1CWEB	
FERGUSON, EDWARD W	1CWEB	
FERRAL, ROBERT L	1CWEB	
FERRELL, RALPH H	1DFWS	
FETT, ROBERT W	1CWEB	
FIDLER, JAMES C	1CWEB	
FINGER, FREDERICK G	1CWEB	
FINNICAN, RONALD J	1CWEB	
FISCHLER, JORDAN	1CWEB	
FISHER, LEO J	1DNOC	
FLANDERS, ALLEN F	1CWEB	
FLEMING, HENRY E	1CWEB	
FLEMING, JAMES A	1CWEB	
FLOCKEN, FRED B	1CWEB	
FOARD, JOHN M	1CWEB	
FOAT, DARREL J	1CWEB	
FOGELMAN, MURRAY	1DNOD	
FOPAY, C F	1CWEB	
FORD, JOHN L	1CWEB	
FORDHAM, DAVID G	1CWEB	
FORST, ALBERT L	1DFWS	
FOSKETT, LAURENCE W	1CWEB	
FOSSETT, GEORGE L	1CWEB	
FOSTER, ROBERT I	1CWEB	
FRANEL, JACOB	1CWEB	
FRANKEL, MORRIS H	1CWEB	
FRAZIER, JOSEPH H	1D-X	
FREDERICK, RALPH H	1CWEB	
FRENCH, HOWARD V	1DNOC	
FRENCH, WILLIAM O JR	1CWEB	
FRENKIEL, FRANCOIS N	1DNDT	AFRA
FRICKE, GERTRUDE A	1CWEB	
FRITZ, SIGMUND	1CWEB	
FRONTENAC, THEODORE	1DNOC	
FULLER, OTHA JR	1CWEB	
GALES, DONALD M	1CWEB	
GALLAGHER, JAMES F	1DNOD	
GALLIE, WALTER A	1DFX	
GANT, JAMES Q JR	4PHYS	AMRA
GARBACZ, MICHAEL L	1XNAS	
GARVIN, LOYD C	1DFWS	
GEIL, GENE W	1CWEB	
GELHARD, ROBERT H	1CWEB	
GEMMILL, WILLIAM H	1DNOC	
GEORGE, LESTER D	1CWEB	

GERSON, DONALD J	1DNOC
GIARRUSSO, ANTHONY	1CWEB
GILMAN, DONALD L	1CWEB
GIRAYTYS, JAMES	1DFWS
GLADNEY, TILLMAN F	1CWEB
GLAHN, HARRY R	1CWEB
GLEITER, THEODORE P	1CWEB
GLOVER, JERRY C	1DFWS
GODDARD, HELEN L	1CWEB
GODSHALL, FREDRIC A	1CWEB
GOLD, HAROLD K JR	1CWEB
GOODRIDGE, RICHARD S	1XFPC
GOODYEAR, HUGO V	1CWEB
GORDON, ALEXANDER R JR	1DNOC
GOTTLIEB, R	1DNX
GOULAIT, ROLAND V	1CWEB
GRABHAM, ANCIL L	1DNOC
GRACE, MARSHALL F	1CWEB
GRAHAM, RODERICK D	1CWEB
GRAY, THOMAS I JR	1CWEB
GREEN, RAYMOND A	1CWEB
GRUBB, RUSSELL C	1CWEB
GUNNARSON, LENNART A	1CWEB
GUSTAFSON, ARTHUR F	1CWEB
HACIA, HENRY	1CWEB
HADSELL, PHILIP R	1DNOD
HAEGELE, CHARLES B	1CWEB
HAFER, LE ROY F	1CWEB
HAGAN, JOHN C	1CWEB
HAGARTY, JOSEPH H	1CWEB
HAGARTY, WILLIAM	1CWEB
HAINES, DONALD A	1CWEB
HAINSWORTH, WILLIAM C	1CWEB
HALL, FERGUSON	1CWEB
HALLANGER, N L	5BOAL
HALLIGAN, DON K	1CWEB
HALMINSKI, S J	1DNBW
HALVEY, DAVID B	1DFWS
HAMADA, MASARU	1CWEB
HAND, JAMES M	1CWEB
HANSON, DONALD M	1CWEB
HANSSEN, GEORGE L	1DNOC
HARDING, E T	1DNWS
HARMANTAS, CHRISTOS	1CWEB
HARRELL, JOHN J	1CWEB
HARRIS, DALE R	1CWEB
HARRIS, MILES F	1CWEB
HARSHBARGER, HAROLD B	1CWEB
HASS, WILLIAM A	1CWEB
HASSEN BEY, MANODE	1DFWS
HATZENBUHLER, GEORGE	1CWEB
HAVARD, JESSE B	1DFWS
HELBUSH, ROBERT E	1CWEB
HELFERT, NORBERT F	1CWEB
HELLERMAN, SOLOMON	1CWEB
HELMICK, BENJAMIN	1CWEB
HEMBREE, G D	1CWEB
HENSLOY, CARL C	1DFWS
HERBERT, GARY A	1CWEB
HERMAN, STANLEY	1CWEB
HERSCHER, ARNOLD B	1D-X
HIATT, WILLIAM E	1CWEB
HIDROGO, EDUARDO	1DFWS
HIGHLEY, JOHN N	1DFX
HILL, AUGUSTUS N	1CWEB
HILL, W W	1DFWS
HODGE, MARY W	1CWEB
HOECKER, WALTER H	1CWEB
HOLCOMBE, RICHARD M	1DNOC
HOLLAND, J Z	1XAEC
HOLLENBAUGH, GEORGE W	1CWEB
HOLLIDAY, CHARLES R	2HUMD
HOLLOWAY, J L JR	1CWEB
HOLMES, DAVID	1CWEB
HOLTZSCHEITER, EARL W	1DFWS
HOOVER, EUGENE W	1CWEB
HOOVER, ROBERT A	1CWEB
HOUSTON, OLIN R	1CWEB

HOUSTON, W S JR	1DNWS	
HOVERMALE, JOHN B	1CWEB	
HOWCROFT, JAMES G	1CWEB	
HUBBARD, O E	1DNX	
HUBERT, LESTER F	1CWEB	AMRA
HUDSON, JOSEPH L	1CWEB	
HUGHES, CLYDE L	1CWEB	
HUGHES, GROVER D	1CWEB	
HUGHES, PATRICK E	1CWEB	
HUNTER, JAMES C	1CWEB	
HUNTER, MARVIN N	1CWEB	
HUNTOON, JAMES K	1CWEB	
HURLEY, JOHN C	1CWEB	
HUTCHINSON, LEONARD H	1DFWS	
INGRAM, DAVID M	1DFWS	
IRVIN, WESLEY	1CWEB	
JACKSON, WILLIAM E	1CWEB	
JACOBS, WOODROW C	1XNOD	AFRA
JACOBSEN, VERNON G	1CWEB	
JAMES, RICHARD W	1DNOC	
JENKINS, CHARLES E	1CWEB	
JENNINGS, ARTHUR H	1CWEB	
JESS, EDWARD O	1DFWS	
JOHNSON, ARTHUR W	1CWEB	
JOHNSON, CARMEN R	1DNOD	
JOHNSON, DAVID S	1CWEB	
JOHNSON, DONALD W	1DNWS	
JOHNSON, E FRANKLIN	1DNOD	
JOHNSON, JIMMIE D	1DNOC	
JOHNSON, LE ROY C	1DFWS	
JOHNSON, LESTER A	1CWEB	
JOHNSON, MELVIN A	1CWEB	
JOHNSON, WILLIAM L	1DNOC	
JONES, GEORGE	1CWEB	
JONES, JAMES B	1CWEB	
JONES, ROZELL B	1CWEB	
JONES, WILLIAM E	1CWEB	
JORDAN, CLARENCE R	1CWEB	
JORDAN, HAROLD M	1CWEB	
JOSEPH, ELLIS J	1DNOC	
JUNGHANS, R C	1DNX	
KARPOVITCH, ALBERT A	1CWEB	
KEE, RICHARD M	1XNAS	
KEISTER, JAMES L	1CWEB	
KEITH, HUBERT C	1CWEB	
KELLEY, WILBERT H	1DNOD	
KELLIHER, RAYMOND	1DFWS	
KEVILLE, BART F	1DNOC	
KEY, MARVIN E JR	1CWEB	
KEYSER, J J	1DNWS	
KIBLER, CLARENCE L	1CWEB	
KIPPER, JOHN M JR	1DNOC	
KIRSCHNER, BURTON H	1CWEB	
KLAPPENBACH, EDWARD W	1DNWS	
KLASSEN, HARVEY J	1CWEB	
KLEIN, WILLIAM H	1CWEB	AFRA
KLINE, DWIGHT B	1CWEB	
KNEER, ARTHUR R	1CWEB	
KOCHANSKI, ADAM	1CWEB	
KOFFLER, RUSSELL	1CWEB	
KOHLER, MAX A	1CWEB	
KOLYER, RICHARD D	1DFWS	
KOMHYR, WALTER D	1CWEB	
KORTE, AUGUST F	1CWEB	
KRAFT, K CHARLES	1CWEB	
KRAHL, GEORGE M	1CWEB	
KRANK, JOSEPH P	1CWEB	
KRANZ, ARTHUR C	1DNWS	
KRESGE, RALPH F	1CWEB	
KRONEBACH, GEORGE W	1DFWS	
KRUEGER, ARTHUR	1CWEB	
KUDZMA, ROBERT	1DFWS	
KURIHARA, YOSHIO	1CWEB	
KUTSCHENREUTER, PAUL H	1CWEB	
KUTULAS, JOHN E	1DFWS	
KVAM, ERNEST L	1CWEB	
LA RUE, JERROLD A	1CWEB	
LACNY, FRANCIS J	1CWEB	

LACY, STANLEY J	1CWEB	
LAMBERT, CHARLES E	1CWEB	
LAMBERT, JOSEPH K	1DFWS	
LAMOREAUX, WALLACE W	1CWEB	
LAND, PATTERSON B	1DNOC	
LANDIS, ROBERT C	1DNOC	
LANDSBERG, HELMUT E	1CWEB	AFRA
LARO, ROLAND M	1CWEB	
LAWSON, DAVID A JR	1DAX	
LAY, EDWIN T	1CWEB	
LE BLANC, BEN J	1CWEB	
LEHR, PAUL E	1CWEB	
LENNAHAN, CHARLES M	1CWEB	
LEWIS, BILLY M	1CWEB	
LEWIS, FRANK	1DFWS	
LEWIS, THOMAS H IV	1DFWS	
LIEB, HERBERT S	1CWEB	
LIEURANCE, NEWTON A	1CWEB	
LILLY, DOUGLAS K	1CWEB	
LINDSAY, CHARLES V	1CWEB	
LIPPMANN, HAROLD S	1CWEB	
LIVINGSTON, ROBERT L	1DNX	
LOGAN, JAMES H	1DFWS	
LONG, ROBERT F	1DFWS	
LONGACRE, ARTHUR M	1DFWS	
LORIMOR, ELZA G	1CWEB	
LOTT, GEORGE A	1CWEB	
LOVELESS, BURTON F	1CWEB	
LOWRY, DALE A	1CWEB	
LUCAS, EDWIN C	1CWEB	
LUDWIG, CORA G	1CWEB	
MAC DONALD, TORRENCE H	1CWEB	AMRA
MAC DOUGALL, GORDON H	1DNOC	
MAC QUARRIE, R A	1DNBW	
MACHTA, LESTER	1CWEB	
MAKOSKY, FRANK	1CWEB	
MALONE, W F	1DNBW	
MANABE, SYUKURO	1CWEB	
MARCUS, JULIUS	1DNOC	
MARCUS, SIDNEY O JR	1DNOD	AMRA
MARIER, DONALD W	1CWEB	
MARSCHER, JOHN C	1CWEB	
MARTIN, ROBERT H	1DNWS	AMRA
MARTINEZ, CONRAD	1CWEB	
MASON, RALPH B	1CWEB	
MASTERS, CLAUDE B	1DFWS	
MATHERS, JESSE A JR	1CWEB	
MATSON, NORMAN A	1CWEB	
MATTHEWS, MILDRED M	1CWEB	
MAYHEW, WILLIAM A JR	1DFWS	
MAYKUT, E S	1DFWS	
MC BIRNEY, HAROLD R	1CWEB	
MC CARTER, ROY M	1CWEB	
MC CARTY, MIRIAM E	1CWEB	
MC CLAIN, E PAUL	1CWEB	
MC COOK, JOHN W	1CWEB	
MC DONELL, JAMES E	1CWEB	
MC EWEN, ROBERT L	1CWEB	
MC KINLEY, WILLIAM G	1CWEB	
MC NAIRY, JOHN V	1D-X	
MC QUOWN, JOHN R	1DFWS	
MEANS, LYNN L	1CWEB	
MEINTEL, RALPH H	1CWEB	
MILLER, A L	1DNBW	
MILLER, HARRY A	1CWEB	
MILLER, JOHN F	1CWEB	
MILLS, RICHARD H	9CLUN	
MITCHELL, J MURRAY JR	1CWEB	AFRA
MIYAKODA, KIKURO	1CWEB	
MOFFATT, RONALD E	1DNOD	
MOHLER, P I	1DFWS	
MOLANSKY, SIDNEY	1CWEB	
MOLO, WILLIAM L	1DNOD	
MOORE, DONALD F	1DFX	
MORAN, FREDERICK A	8NRNC	AMNA
MORELAND, M B	1DNWS	
MORGAN, DEWITT N	1CWEB	
MORRISON, WILLIAM	1CWEB	
MOSCHELLI, JUDITH A	1CWEB	
MOSKOWITZ, LIONEL I	1DNOC	
MOTTAZ, CONSTANCE E	1CWEB	
MOTTERN, R E	1DNBW	
MOXON, GEORGE W	1DFWS	
MOYER, WILBUR J	1DFWS	
MUNN, RAYMOND O	1CWEB	
MURDOCK, EUGENE A	1DFWS	
MURINO, VINCENT S	1CWEB	
MURPHY, ALVIN D	1CWEB	
MURPHY, LAWRENCE J	1CWEB	
MURPHY, W A JR	1DNWS	
MYERS, VANCE A	1CWEB	
MYERS, WILLIAM H	1XNOD	AMRA
NAGLE, AUSTEN H	1CWEB	
NAGLER, KENNETH M	1CWEB	
NAMIAS, JEROME	1CWEB	AFRA
NASH, WILLIAM P	1CWEB	
NEGELE, JACK H	1DNWS	
NEILON, JAMES R	1CWEB	
NENON, ULMER H	1DFWS	
NESLEY, WILLIAM L	1D-X	
NEWHALL, FRANKLIN	1ASCS	
NICHOLAS, GEORGE W	1XNAS	
NILSESTUEN, ROLF M	1DFWS	
NOEL, JAMES D	1DNOD	
NOFFSINGER, TERRELL L	1CWEB	
NORDENSON, TOR J	1CWEB	
NORQUEST, KENNETH S	1CWEB	
NORWOOD, JAMES P	1DFWS	
NYHAN, JOHN C	1CWEB	
O BRIEN, GERALD F	1CWEB	
O CONNOR, JAMES F	1CWEB	
O HARE, JOSEPH E	1DNOC	
OAKES, WINSLOW B	1DNWS	
OCHINERO, ROBERT V	1DNOD	
ODUM, WILLIAM H III	1DNOD	
OKLAND, HANS R K	1CWEB	
OLIVER, VINCENT J	1CWEB	
OLSON, F G	1DNWS	
OSMUN, J W	1CWEB	AFRA
OSTAPOFF, FEODOR	1CWEB	
OTLIN, SAMUEL	1CWEB	
OTTMAN, PETER L	1CWEB	
PACK, DONALD H	1CWEB	AFRA
PALMER, WAYNE C	1CWEB	
PARRY, H DEAN	1CWEB	
PAULHUS, JOSEPH L	1CWEB	
PAULUS, WILLIAM C	1DNOD	
PAYNE, JAMES O	1DFWS	
PECKHAM, DEAN A	1CWEB	
PEREZ, GEORGE E	1DNOC	
PERIDIER, PAUL H	1CWEB	
PERLROTH, IRVING	1DNOD	
PETERSEN, GERALD A	1CWEB	
PETERSEN, VERNON L	1CWEB	
PETERSON, A DELBERT	1DFWS	
PETERSON, ARTHUR C	1CWEB	
PETERSON, GEORGE W	1DFWS	
PETERSON, KENDALL R	1CWEB	
PETERSON, ROBERT A	1DNOC	
PFEIFFER, EDWARD G	1D-X	
PFEIFFER, ROBERT M	1DFWS	
PHILLIPS, BYRON B	1CWEB	
POLSTON, JAMES A	1DFWS	
PORE, NORMAN A	1CWEB	
PORTER, JOHN M	1CWEB	
PORTER, STANLEY C	1DNOD	
POSEY, JULIAN W	1CWEB	
POTOCSKY, GABRIEL J	1DNOC	
POTTER, THOMAS D	1DFWS	
POURNARAS, STEPHEN W	1DFWS	
PREDOEHL, MARTIN C	1CWEB	
PRESTON, EUGENE R	1DFWS	
PULLEN, WILLIAM T JR	1CWEB	
PULLEY, CHARLES T	1CWEB	
PURDY, DOUGLAS C	1DFX	
PUTNINS, PAUL H	1CWEB	AFRA

PYLE, ROBERT L	1CWEB	
QUIROZ, RODERICK S	1DFWS	
RAGLAND, ADRIAN J	1D-X	
RAHMLOW, H W	1CWEB	
RAMEY, LEWIS H	1CWEB	
RAMMER, WILLIAM A	1CWEB	
RAO, P KRISHNA	1CWEB	
RATNER, BENJAMIN	1CWEB	
REEVES, CHARLES G	1CWEB	
REICHELDERFER, F W	7RETD	AFRA
REIDEL, JOHN T	1CWEB	
REYNOLDS, CLARENCE W	1CWEB	
RHINE, LLOYD R	1CWEB	
RICHARD, OSCAR E	1DFWS	
RICHARDS, LEIFIELD W	1DNOC	
RICHARDS, MARSHALL M	1CWEB	
RICHTER, DONALD A	1CWEB	
RIPPY, HAROLD R	1DFWS	
ROBERTS, CHARLES F	1CWEB	
ROBERTS, KENNETH J	1CWEB	
ROBINSON, CECIL C	1CWEB	
ROCHLIN, BERNARD	1CWEB	
ROCKNEY, VAUGHN D	1CWEB	
RODGERS, LYNDON T	1CWEB	
ROGERS, MARVIN R	1CWEB	
ROPEK, JOHN F	1DNOC	
ROSENBLOOM, ABE	1CWEB	
ROSENDAL, HANS E	1CWEB	
ROSS, ROBERT B	1CWEB	
ROTHENBERG, LEON	1CWEB	
RUBIN, LOUIS	1CWEB	
RUBIN, MORTON J	1CWEB	AFRA
RUFF, IRWIN	1CWEB	
RUSCITTO, PETER A	1CWEB	
RUZECKI, MARY A	1CWEB	
RYALS, JAMES E	1D-X	
RYMER, FRANK P JR	1D-X	
SADOWSKI, ALEXANDER F	1CWEB	
SAIEDY, FUAD	1CWEB	
SANGSTER, LOU A	1CWEB	
SANGSTER, WAYNE E	1CWEB	
SAYLOR, HARLAN K	1CWEB	
SCANLON, JOHN P	1CWEB	
SCHAFER, WOODFORD W	1CWEB	
SCHALLERT, WILLIAM L	1CWEB	
SCHAUSS, CHARLES E	1CWEB	
SCHIESL, JOSEPH W	1CWEB	
SCHLOEMER, ROBERT W	1CWEB	
SCHMIDT, REINHART C	1CWEB	
SCHNURR, RICHARD G	1CWEB	
SCHONER, ROBERT W	1CWEB	
SCHUETZ, JOHN	1CWEB	
SCHULE, JOHN J	1DNOC	
SCHWALB, ARTHUR	1CWEB	
SCHWARZ, FRANCIS K	1CWEB	
SCOTT, HAROLD A	1CWEB	
SCOTTEN, JOHN W	1CWEB	
SEAMON, LILBURN H	1CWEB	
SEEBODE, ALVIN F	1CWEB	
SHANK, MITCHELL K JR	1DNOC	
SHAW, ARCHIE	1CWEB	
SHERRY, EDWIN J	1CWEB	
SHINNERS, WILLARD W	1CWEB	
SHOPE, JOHN I	1CWEB	
SHUMAN, FREDERICK G	1CWEB	
SIK, ALVER E	1CWEB	
SIMMONS, RALPH C	1DFX	
SIMPSON, LLOYD S	1DNOC	
SIMPSON, ROBERT H	1CWEB	
SINGER, S FRED	2HUMD	
SKILES, FRANK L	1DNOC	
SKILLMAN, W C	1DFWS	
SLEATER, JOSEPH K JR	1DFWS	
SLOCUM, GILES	1CWEB	
SMAGORINSKY, JOSEPH	1CWEB	
SMATHERS, EARL E	1DNOD	
SMEDLEY, DAVID	1CWEB	
SMITH, ALVIN L JR	1DFWS	
SMITH, RAYMOND G	1CWEB	AMRA
SMITH, WARREN	1CWEB	
SNIDERO, MIRCO P	1CWEB	
SNYDER, MARLIN H	1DNOC	
SOLLER, RALPH R	1CWEB	
SOLOMON, IRVING	1DFWS	
SOULES, STANLEY D	1CWEB	
SPOWART, D J	1DNWS	
SPREEN, WILLIAM C	1XNAS	
SPRINGER, DONALD P	1CWEB	
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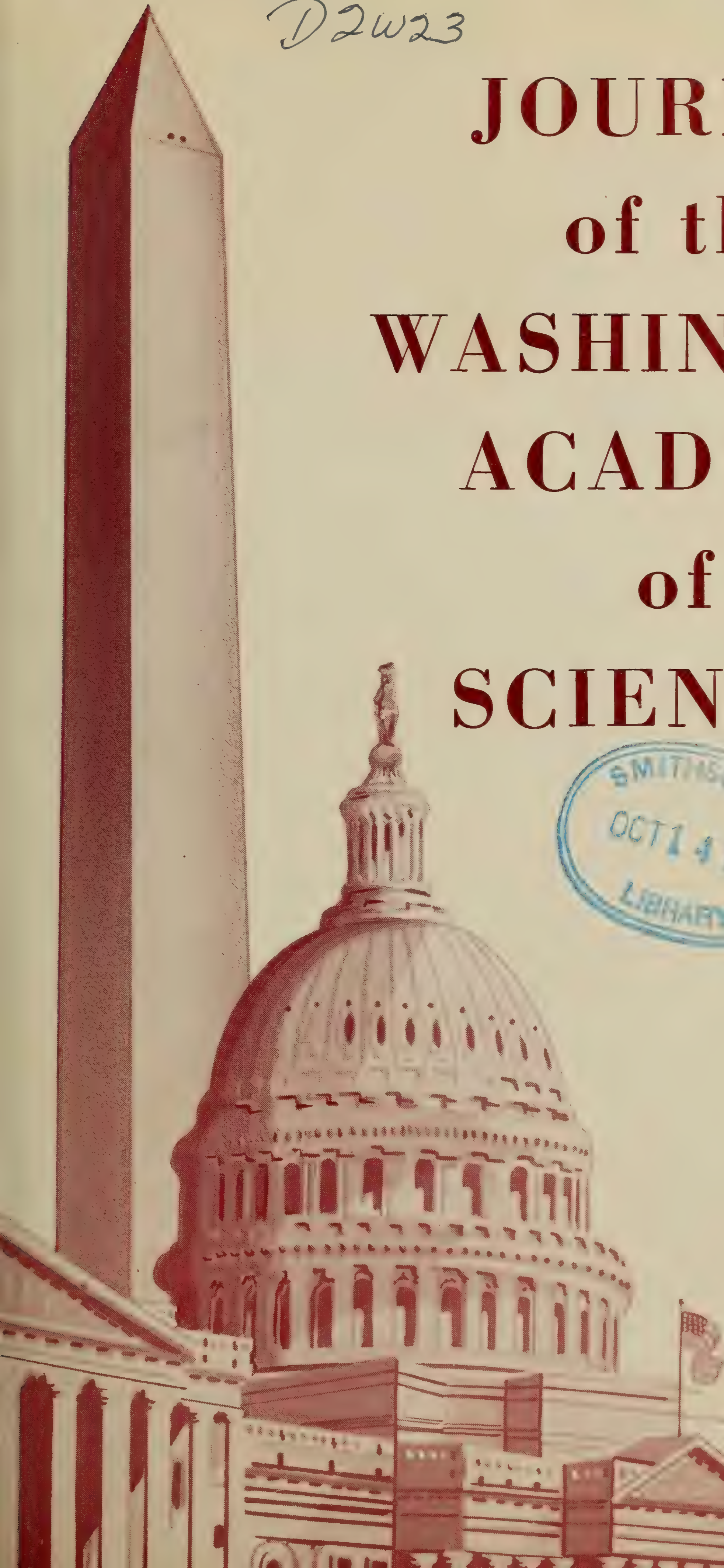

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OCTOBER
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JOURNAL OF THE WASHINGTON ACADEMY OF SCIENCES

This Journal, the official organ of the Washington Academy of Sciences, publishes historical articles, critical reviews, and scholarly scientific articles; notices of meetings and abstract proceedings of meetings of the Academy and its affiliated societies; and regional news items, including personal news, of interest to the entire membership. The Journal appears nine times a year, in January to May and September to December. It is included in the dues of all active members and fellows.

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ACADEMY OFFICERS FOR 1964

Electrochemical Society Holds Semiannual Meeting Here

The Washington-Baltimore Section of the Electrochemical Society will serve as host for the 126th semiannual meeting of the national society to be held at the Sheraton-Park Hotel, October 11 to 15. Some 1500 electrochemists are expected to attend.

A full program consisting of 250 technical papers has been arranged, including both general sessions and symposia. A brief description of the symposia is given below.

Symposia

The Battery and Theoretical Electrochemistry Divisions have scheduled a Joint Symposium on Fuel Cells, all day Monday and Tuesday and on Wednesday morning. All sessions are in the Cotillion Room, South.

The Battery Division has scheduled general sessions Wednesday afternoon and Thursday morning, as well as a special Wednesday evening round-table discussion on Sealed Cells and the Mechanisms of Their Operation, and a session on recent developments relating to fuel cells.

The Corrosion Division has scheduled a Symposium on Metallurgical Factors Affecting the Corrosion Processes, all day Monday and on Tuesday morning. A general session is scheduled for Tuesday afternoon, followed on Wednesday and Thursday morning by a Symposium on Properties of Oxide Corrosion Products. All sessions are in the Delaware Suite.

The Electrodeposition Division has scheduled a Symposium on Precious Metal Plating on Tuesday morning, and a general session on Tuesday afternoon.

The Electrodeposition and Theoretical Electrochemistry Divisions have scheduled a Joint Symposium on Mechanisms of Electrodeposition for Wednesday as well as Thursday morning, in the Maryland Suite.

The Electronics Division, Semiconductor Group, has scheduled the following sessions: Passivation, all day Monday; Epitaxy, Tuesday morning; Compound Semiconductors, Tuesday afternoon; Diffusion, Wednesday morning; and Materials and Processes, Wednesday afternoon. All sessions are in the Park Ballroom.

The Electrothermics & Metallurgy and Corrosion Divisions have scheduled a Joint Symposium on Liquid Metal Corrosion and Phenomena, Monday afternoon through Wednesday afternoon. All sessions are in the Richmond Room, Virginia Suite.

The Electrothermics & Metallurgy Division has scheduled a Symposium on the Electron Microprobe, Monday morning through Thursday afternoon, in Exhibit Hall No. 1.

Other Features

The banquet of the Society, to be held on Tuesday, October 13, will feature the presentation of the Edward Goodrich Acheson Medal and Prize to Earl A. Gulbransen of the Westinghouse Research Laboratories. The award, a gold medal and $1000, is made every two years "for conspicuous contribution to the advancement of the objects, purposes, or activities of the Society."

Dr. Gulbransen is being honored for his contribution to the understanding of gas-solid, and in particular gas-metal, surface interactions, knowledge essential to a better understanding of the corrosion of metals and hence their protection from corrosion. He is the author of more than 125 papers in such areas as oxidation, surface reactions, surface films, stress-corrosion cracking, high-temperature thermodynamics, and related areas of research.

In addition to the technical sessions, laboratory and plant trips have been arranged as follows:

Trip A. Goddard Space Flight Center of the National Aeronautics and Space Administration, Greenbelt, Md. Among the features that will be shown are the Tiros Control Center, satellite exhibits, fabrication facilities, and test and evaluation facilities.

Trip B. Bureau of Engraving and Printing. The Bureau of Engraving and Printing manufactures currency, bonds, and stamps. The tour will include areas not normally open to the public and of particular interest to electrochemists, such as the Electrolytic Section where hand-engraved printing plates are replicated by electroforming.

A Ladies' Program will provide visits to the White House, the public and governmental buildings of Washington, and an embassy tour. The Smithsonian Institution and the National Gallery of Art also will be visited.

A Sunday evening reception and a Monday evening mixer have been planned by the local committee.

Arrangements

Many details of the meeting are the special responsibility of the local committee, under the leadership of David Schlain and Joseph C. White as co-chairmen. Committee members, with their responsibilities, are: Sigmund Schuldiner, secretary; Charles B. Kenahan, treasurer; Clarence M. Shepherd, registration; Vernon A. Lamb, entertainment; Jerome Kruger, arrangements; Gwendolyn B. Wood, ladies' program; Charles P. Wales, printing; and John K. Taylor, publicity.

A Note on Electrochemistry, The Electrochemical Society, and The Washington-Baltimore Section

It is as difficult to define electrochemistry as it is to define any actively growing science. Nevertheless, since electrochemists as a group are among the most recent affiliates of the Washington Academy of Sciences, it is proper to try to indicate how electrochemists came to be and to suggest the bounds within which they work. A definition will not be attempted. Rather, a very brief historical sketch will be presented to show the outlines of the community of interests which electrochemists share as electrochemists.

Looking toward antiquity, one can find suggestive archeological evidence that certain metal workers along the Tigris and Euphrates knew something of the art of electrodeposition, using batteries to generate their currents. However, the evidence is incomplete. Whatever arts those ancients practiced were lost to history and did not figure in the development of the modern science of electrochemistry.

The beginnings of modern electrochemistry can be found in the classic discoveries of Galvani and Volta, who started their work in the eighteenth century. The names of both these investigators have been borrowed for use in electrical and electrochemical terminology. Galvani was actually a physiologist and physician; he is best remembered for the observation that frog muscles twitched when electric currents were passed through them. Volta made two contributions of more direct interest. He accomplished the invention of the electric battery when he observed that he could generate quite substantial "voltages" by assembling piles of elements in the repeating sequence: metal 1, paper soaked with salt solution, metal 2, etc. This invention was an application of the phenomenon of the generation of an electric potential by chemical action. Volta also observed the complementary phenomenon, the induction of a chemical reaction by the passage of electric current. His specific observation was the electrolysis of water to produce gaseous products.

The development of electrochemistry in the early nineteenth century was a part of, and dependent upon, the development of chemistry. In particular, the notions of elements and definite integrally-related combining powers or valences were becoming established. Michael Faraday's investigations, reported in 1833 and 1834, are a landmark in electrochemistry. Faraday showed that, in a large variety of systems, the passage of a definite amount of electric current was associated with a definite amount of chemical action. In addition, he showed that the amounts of chemical action exhibited in various systems were directly related to the combining powers of the substances involved. This was the beginning of the systematic understanding of electrochemical systems. By the close of the nineteenth century, Arrhenius (1883) had developed his theory of electrolytic dissociation. This, with van't Hoff's (1887) treatment of the osmotic pressure of solutions, established the concept of ionic species of definite charge and chemical composition as essential features of electrochemical systems.

The advances in the understanding of electrochemical systems were paralleled by equally valuable practical developments. A practical application of electrochemistry, of major importance to science and technology in general, was the invention of the Daniell cell (1836). This invention resulted in what was for some time the most dependable source of stable electrical power in the practical range of voltages and currents. This was of great importance in places other than the laboratory. For example, the rapid spread of dependable telegraphic service was dependent upon the availability of dependable sources of electric power in all parts of the world, during a period when practically no other use of electricity was made in the world at large. Its use continued into the present century. Electrochemistry received a dividend from the studies of electricity and electromagnetism that stemmed from the invention of the dynamo. The availability of really large amounts of electrical power permitted the development of electrochemical process industries. The wide variety of electroplated articles, and all the aluminum one sees, are familiar products of these developments.

All these various developments meant that by 1900 there had developed a community of interest which could be identified as "electrochemistry." The central feature of this community of interest was an interest in processes involving the transfer of electric charge, where the mechanism of charge transfer involved more than simply electronic conduction in metals or in vacuum. Conduction in the systems of interest usually involved the movement of chemical species and was usually accompanied by chemical transformations.

Late in 1901, six scientists recognized that engineers, scientists, and industrialists interested in electrochemistry were distributed among at least a dozen different societies and had no common medium of communication. Replies to their invitation to form an American Electrochemical Society turned out 337 charter members. Of the charter members, 52 met in founding the Society in Philadelphia on April 3, 1902. The Society grew steadily, and to broaden its scope it was made international in 1930. The name was changed to, simply, The Electrochemical Society. There are members in various parts of the world, including a local section organization in Canada. Experiments with a sectional organization have been carried out by members in India.

There are today over 4000 members of the Society. Most individual members are affiliated with one or more of the Society's nine divisions. The following listing of these divisions shows the breadth of interests of the membership:

Battery
Corrosion
Electronics (including Semi-Conductors and Luminescence)
Electrothermics and Metallurgy
Electric Insulation
Electro-Organic
Electrodeposition
Industrial Electrolytic
Theoretical Electrochemistry

For the membership as a whole the Society maintains media of communication. It holds two general meetings annually, one in the spring and one in the fall. In addition, the Society publishes two periodical journals: the *Journal of the Electrochemical Society* reports Society activities and provides space for the publication of reports of scientific investigations; and *Electrochemical Technology* provides for the publication of material on applied electrochemistry.

The local section organization of the Society provides contact and communication between members in various geographical areas. There are 18 of these local sections. The Washington-Baltimore Section was founded in 1949; its organizational meeting was held on September 15, 1949, and the Section was formally established on October 12, 1949, with Paul L. Howard as chairman, Abner Brenner as vice-chairman, and Joseph C. White as secretary-treasurer.

The Section maintains a regular program of monthly meetings. It attempts to encourage the study of electrochemistry by presenting prizes for the best exhibits in electrochemistry at the major area science fairs. In addition, in alternate years it awards the William F. Blum Award for distinguished publication in electrochemistry. This endowed award was established in 1958; the recipients have been William F. Blum, Sigmund Schuldiner, and D. Norman Craig.

WASHINGTON-BALTIMORE SECTION, ELECTROCHEMICAL SOCIETY

Organization for 1964-65

Chairman	Gilbert W. Castellan	Catholic University
First Vice Chairman	Charles B. Kenahan	Bureau of Mines
Second Vice Chairman	Frederic M. Bowers	Naval Ordnance Laboratory
Secretary	Galen Frysinger	Engineering Research & Development Laboratory
Treasurer	Kurt H. Stern	National Bureau of Standards
Councilors	Joseph C. White	Naval Research Laboratory
	Fielding Ogburn	National Bureau of Standards

Meetings

Regular meetings of the Section are held on the third Thursday of the months of October, November, January, February, March, April, and May. The usual meeting place is Room 252 of the Social Center, Catholic University.

Standards of Electromotive Force

Walter J. Hamer

Electrochemistry Section, Institute of Basic Standards, National Bureau of Standards

Figure 1 is a reproduction of the seal of the Electrochemical Society, a society that is featured in this issue of the *Journal.* Looking at this seal you will note that the Society was founded in Philadelphia in 1902 and was incorporated in 1930. You will also note on the seal a sketch of a standard cell and a symbol for an electric arc. The first may also be considered symbolic of electric batteries, electrolysis, and electrodeposition and the second of electrothermics and electrometallurgy, subjects which cover much that is electrochemistry.

Fig. 1. The seal of the Electrochemical Society, Inc.

It is the purpose of this article to consider the first of these symbols, namely, the standard cell, not only because the author is associated with work on standard cells in the Institute of Basic Standards of the National Bureau of Standards, but also because standard cells are excellent illustrations of the science of electrochemistry. Electrochemistry is defined as that branch of science which deals with the relation of electricity to chemical changes and with the interconversion of chemical and electrical energies. Standard cells are unique chemical systems having a definite and steady electromotive force. They are used primarily in the maintenance of the unit of electromotive force or as d-c reference voltages. They constitute the basic standard (or reference) of electromotive force in the United States. This standard is maintained at the National Bureau of Standards in Washington, D. C.

In 1893 the International Electrical Congress, meeting in Chicago with delegates from Austria, Canada, France, Germany, Great Britain, Italy, Mexico, Sweden, Switzerland, and the United States, chose as a standard of electromotive force (emf), the Clark cell, a voltaic (or galvanic) cell devised by Latimer Clark (1) in Great Britain in 1872. It assigned to this cell a value of 1.434 international volts at 15°C based on the electrical units of resistance and current then accepted. No method was then available, nor is any to this day, for a direct measurement of emf in the electromagnetic system of units. Instead, the unit was obtained through Ohm's law and the measurement of the fall of potential produced in a resistance by a current. Today the values of the resistance and the current are both determined in absolute measure, the first by self or mutual inductors, and the second by current balances or electrodynamometers. By this method the precision or uncertainty in the determination of the volt in absolute measure is about ± 7 parts per million (ppm). The unit of emf may also be determined in electrostatic units using absolute electrometers and thus in electromagnetic units by multiplying the former by the speed of light. However, to date the accuracy of this method is lower than the electromagnetic approach, the uncertainty being of the order of 100 ppm.

The Clark cell and the above value for its emf were legalized on July 12, 1894, as the standard of emf for the United States and its possessions by Public Law No. 105, 53rd Congress, which stated:

> "The unit of electro-motive force shall be what is known as the international volt, which is the electro-motive force that, steadily applied to a conductor whose resistance is one international ohm, will produce a current of an international ampere, and is practically equivalent to one thousand fourteen hundred and thirty-fourths of the electro-motive force between the poles or electrodes of the voltaic cell known as Clark's cell, at a temperature of fifteen degrees centigrade, and prepared in the manner described in the standard specifications."

This law also specified "That it shall be the duty of the National Academy of Sciences to prescribe and publish, as soon as possible after the passage of this Act, such specifications of details as shall be necessary for the practical application of the definitions of the ampere and volt hereinbefore given, and such specifications shall be the standard specifications herein mentioned." A committee of seven, chaired by Henry A. Rowland, of the National Academy of Sciences, issued their specification for making Clark cells on February 9, 1895.

In the years immediately following 1893, the United States, Canada, Great Britain, and France adopted 1.434 V for the emf of the Clark cell at 15°C as their national standard of emf; Germany, Austria, Belgium, and Switzerland adopted a standard defined in terms of the cgs (centimeter-gram-second) definitions of the ohm and ampere. Germany at a later date (1898) adopted 1.4328 V for the emf of the Clark cell at 15°C while retaining their legal definition of the volt in terms of the ohm and ampere. Although the German value was not universally accepted, it was a more nearly correct value as later experiments showed. Work in various laboratories also showed that Clark cells made with specially purified mercurous sulfate had an emf 0.0003 V lower than that specified in 1893 by the Chicago International Electrical Congress.

The responsibility for maintaining the unit of emf in the United States, as specified by Public Law 105, was assigned to the Office of Standards of Weights and Measures under the Coast Survey in the Treasury Department (2), which then had the responsibility for the national standards of length and mass. However, owing to a limited staff and appropriations, practically nothing was done until July 1, 1897, and then progress was delayed by the pressure of routine work. By 1900, however, three dozen or more Clark cells had been made from the purest materials that could then be obtained commercially. The intercomparisons of these cells showed that they could be relied upon to ±0.005 percent (today, the emf standard can be relied upon to ±0.0001 percent). Also a number of Weston Normal cells, a new type of standard cell which had been invented in 1892 by Edward Weston (3), were made and late in 1900 were compared with the Clark cells. The significance of the expression "Weston Normal cell" is discussed later.

In 1901, the first session of the 56th Congress by Public Law 177 created the National Bureau of Standards stating ". . . the Office of Standards of Weights and Measures shall hereafter be known as the National Bureau of Standards." Samuel W. Stratton, who in the previous year had been appointed inspector of weights and measures in the Office of Standards of Weights and Measures, was named director of the new National Bureau of Standards. In his first annual report to the Secretary of the Treasury, March 27, 1903 (NBS was transferred to the Department of Commerce and Labor on July 1, 1903), Dr. Stratton announced that the Bureau was prepared to compare and calibrate either for commercial or scientific purposes a number of standards and measuring instruments including "Standards of emf—Clark, Weston, and other standard cells." Other standard cells must have included Daniell, Leclanché, and other types of primary cells that were then used commercially as rough standards of voltage.

The National Bureau of Standards was initially housed in a modified private house on the site of the present House Office Building, but in 1904 three new buildings became available at the present site on Connecticut Avenue. A temporary standard cell laboratory was set up in one of them, in which F. A. Wolff and H. N. Stokes began an investigation of mercurous sulfate, the oxidizing agent or "depolarizer" used in Clark and Weston cells. As mentioned above, the emf of Clark cells was found to be very sensitive to the purity of the mercurous sulfate used in the cell, and much research was then being done on mercurous sulfate in the various national laboratories. By the end of 1906 these experimenters, with C. E. Waters and M. P. Shoemaker who had been added to the staff, had made 96 new Clark cells and 180 new Weston cells using several different procedures of assembly and several samples of mercurous sulfate prepared and purified in different ways. The cells showing the greatest stability with time were used in the maintenance of the unit of emf and in the dissemination of the unit to the general public.

In 1906 the United States standard of emf was defined by Clark cells made with specially purified mercurous sulfate and by Weston Normal cells, the emf of which was expressed in terms of the difference in emf between Clark and Weston Normal cells. The mean emf of the Clark cells was assigned a value of 1.42110 V at 25°C. This value was based on the value 1.434 V at 15°C adopted by the Chicago International Electrical Congress and legalized by the U. S. Congress, less the correction of 0.0003 V for the use of specially purified mercurous sulfate, and less the temperature correction calculated from the emf-temperature coefficient determined by Callendar and Barnes (4). The mean of the Weston Normal cells made at NBS, and then on hand, was 1.01890 V at 25°C in terms of the Clark standard.

The Weston Normal cell has several advantages over the Clark cell. It has an emf-temperature coefficient about one-thirtieth that of the Clark cell; it tends to gas at the anode at a much smaller rate than the Clark cell and, therefore, has a longer life; and it has an emf which is closer to 1 V than the Clark cell, which makes it a more convenient standard than the latter.

The International Conference on Electrical Units and Standards which met in London in 1908 officially accepted the Weston Normal cell because of the above advantages, as the international standard of emf and adopted provisionally 1.0184 V as its emf at 20°C. The Weston cell supplanted the Clark cell at this time as the standard of emf in the United States. This Conference also recommended the emf-temperature formula of Wolff (5) for the Weston Normal cell. Accordingly, at 25°C the value of the Weston Normal cell was 1.018174 V, or 0.000726 V lower than the value then accepted in the United States. This discrepancy arose from the fact that the United States had accepted 1.4337 V for the Clark cell at 15°C, whereas the German value of 1.4328 V at this temperature had proved to be a more nearly correct value.

The London Conference recommended that a further study be made of the problem. Following this recommendation, additional experiments were conducted at the National Bureau of Standards in 1910 by scientists from England, France, Germany, and the United States. As a result of a large number of experiments with Weston Normal cells and silver coulometers and resistance coils (resistances known in terms of the mercury ohm), they concluded that the emf of the Weston Normal cell at 20°C was 1.0183 V. At NBS values derived from this were taken to be exact to the fifth decimal (6) and later to the sixth and then to the seventh decimal. These delegates retained the adjective "international" for their units. They also realized that their measurements based on silver coulometers and mercury ohms gave only an approximation to the "true" or "absolute" value and that still additional work was necessary in order to attain the theoretical cgs units. Accordingly, the various national laboratories continued their "absolute" experiments on the ohm, ampere, and volt. By 1948, after interruptions caused by the two World Wars and after improvements in techniques, accurate determinations of the electrical quantities in cgs electromagnetic units were achieved and on January 1, 1948, changes from international to absolute units were officially made internationally. The legal status of these new units in the United States is exactly the same as that of the older ones because the law of 1894 mentions both sets of units on an equivalent basis. However, in order to remove the ambiguities of the old act, new legislation was passed by the Congress in 1950. In the new law, Public Law 617, 81st Congress, 2nd Session, July 21, 1950, the unit of emf is defined as follows:

"The unit of electromotive force and of electric potential shall be the volt, which is the electromotive force that, steadily applied to a conductor whose resistance is one ohm, will produce a current of one ampere."

The new law did not include a reference to a physical standard for the unit of emf.

The mean international conversion factors for the ohm and the volt (for which comparisons could be directly made) were:

1 mean international ohm =
1.00049 absolute ohms.
1 mean international volt =
1.00034 absolute volts.

The mean international conversion factor for the ampere was then:

1 mean international ampere=
0.99985 absolute ampere.

The mean international values were the averages of values maintained in the national laboratories of France, Germany, Great Britain, Japan, Russia, and the United States, that took part in international comparisons before the outbreak of World War II. The units maintained in the United States differed from the above averages by a few parts in a million (7) and specifically were:

1 international ohm (USA) =
1.000495 absolute ohms.
1 international volt (USA) =
1.00033 absolute volts.
1 international ampere (USA) =
0.999835 absolute ampere.

In comparisons of literature data, therefore, cognizance must be taken of the fact that the unit of emf in the United States after 1947 differs by 0.033 percent from the unit used prior to 1948. Also for comparisons of data obtained in various countries, cognizance should be taken of the fact that the unit of emf differs somewhat between countries. These differences, however, are quite small and insignificant except for work of the highest accuracy. Although the terms "international" and "absolute" served a useful purpose during the historical development of the electrical units, neither term should be used since now there can be only one kind of volt, ohm, or ampere. When these units are used, it is understood that they are the "absolute" or, as closely as possible, the theoretically correct ones.

The above discussion gives the history and present status of the unit of emf in the United States, on which all emf (or voltage) measurements in the United States are based. Although the electrochemical basis for the standard of emf is old, it is likely to persist for some time to come. *An atomic standard for the volt* would be most desirable, for it would have a permanency not possible in a physical electrochemical system which may be lost or damaged. *The Stark effect* has been proposed (8, 9, 10). This effect pertains to the splitting of spectral lines when an electric field is applied to a material emitting or absorbing the radiation. However, the method gives relative voltages only, as it gives only the product of the applied voltage gradient and the electric dipole moment of the molecule giving rise to the spectral line. In essence, the electric dipole moment can be determined from dielectric constant measurements, but these are of insufficient accuracy, at the present time, to yield a voltage with the desired accuracy. Perhaps sufficient accuracy in the measurements will later be realized, or another atomic method capable of yielding an atomic standard for the volt will be proposed. Until then, reliance must be placed in the electrochemical method.

In this connection it should be stressed that Weston (or cadmium sulfate) cells have shown excellent stability in emf with time and therefore are excellent standards. Between "absolute" measurements of the emf of Weston standard cells the mean emf of a group of cells is assumed to remain constant. It is obvious that all of a group of "identical" cells may increase or decrease in emf with time without departures from an originally assigned mean emf being evident. Therefore, an alternative type of standard cell of approximately the same emf as the Weston Normal cell but of different composition would be most valuable, for if changes in emf with time in the two different systems were to occur, they would not be likely to follow the same pattern. Thus, studies of the ratio of emfs of two different systems over a period of years would give valuable insight into the stability of the standard. This matter is considered below under *Modifications in Weston Cells.*

The units of emf of various nations are now intercompared every third year at the Bureau International des Poids et Mesures (BIPM) at Sèvres (a suburb of Paris) which by international treaty has authority to co-ordinate the standards of measurement in the field of electricity as well as of length and mass. These intercomparisons are effected by standard cells maintained by the participating countries and by BIPM and are conducted at 20°C. As a rule each country submits four to 10 cells to BIPM for intercomparisions; at the present time the cells are carried to BIPM by messenger. When the intercomparisions are completed, BIPM reports its results to the participating countries in terms of the deviations from the BIPM unit. In Table 1, comparisions between the units of emf as maintained in the participating countries and BIPM are listed for comparisons made since 1948 when the "absolute units" were adopted. In 1955

TABLE 1

Relation between the units of emf as maintained by various countries and the Bureau International des Poids et Mesures

(Data are differences in microvolts from BIPM unit)

	1950	1953	1955	1957	1960
Australia	—	—	—	—	+6.3
Canada	—	− 3.1	−2.4	−0.8	−3.4
France	− 0.1	− 1.8	−1.8	−2.1	−3.2
Germany (East)	−10.2	− 2.8	+0.5	+1.1	—
Germany (West)	—	− 2.3	+0.6	+0.2	−0.1
Great Britain	+ 2.2	+ 3.2	+4.5	+5.2	+5.1
Japan	− 3.5	− 1.4	−2.0	−3.4	−2.9
Russia	+23.0	+22.3	+9.3	+8.4	+6.8
United States	+ 0.8	− 3.3	−0.7	−1.3	−1.9
BIPM	0	0	0	0	0

Russia made an adjustment in its unit of 13 microvolts. Otherwise, the various countries have not made adjustments and do not do so unless their unit should deviate by an unusually large amount from that maintained by BIPM and the other countries.

The United States has also provided reference standards for Israel, Sweden, and the Union of South Africa. In 1960 Italy compared its unit with the French unit immediately prior to the international comparisions at BIPM in which France but not Italy took part. Italy, therefore, obtained information indirectly on the relation of its unit of emf to that maintained at BIPM.

Early Voltaic Cells

Although Clark and Weston cells have been selected as standards of emf, they were not the first voltaic cells used in electrical measurements or in electrochemical investigations. The first cell, as is well known, was devised by Alessandro Volta in 1796 and described by him in 1800 (11); it is known today as the voltaic pile. His cell consisted of an alternate series of tin, (or better zinc) and copper (or better silver) separated by discs of pasteboard or hide soaked in water or "humeur" which has been interpreted as meaning vinegar or salt water. He used the sensation of pain as his chief method of measurement. By moistening his fingers he could detect the "electric fluid" from 3 or 4 couples, and as the number of couples was increased the electric shocks became greater. Volta studied many electrode combinations. Although he had no units with which to express his observations, we now know that his cell made with zinc and copper had a voltage of about 1.1 V. The name "volt" for the unit of emf was not accepted until 1862 when Latimer Clark and Sir Charles Bright (12) proposed its use to the British Association for the Advancement of Science. Volta's cells were not suitable as standards of emf for they showed a decrease in emf with time.

Michael Faraday and others of his time made extensive use of Grove and Bunsen cells (or batteries) in their work in electricity. These cells were two-fluid cells, designed in 1839 and 1841, and may be represented by:

Zinc | sulfuric acid (dilute aq) ||
nitric acid (strong aq) | Pt or C

where aq = aqueous solution. Grove used platinum whereas Bunsen used carbon. The cell had to be reassembled each time it was used because of serious local action (corrosion) at the electrodes. Also provisions had to be made to remove the nitrogen oxide formed at the platinum or carbon electrodes. Obviously these cells were not convenient as standards of emf.

Faraday and others also used the cell designed by John F. Daniell (13) in 1836. This cell, in its original form, consisted of a glass jar containing a porous cup of unglazed earthenware in which a zinc plate or rod and a dilute solution of sulfuric acid, zinc sulfate, or zinc sulfate acidified with sulfuric acid were placed. Outside and around the pot a cylindrical sheet of copper and a concentrated solution of copper sulfate were placed. The cell had an emf of 0.00357 to 0.00390 cgs electrostatic units or 1.07×10^8 to 1.14×10^8 cgs electromagnetic units or 1.07 to 1.14 volts, depending on the concentration and acidity of the solutions used in the cell. It did not show a long-term stability in emf but was much more stable than the Grove or Bunsen cell. The solutions diffused into each other, causing local action at the electrodes and a steady decrease in emf. Even so, for over 35 years (from 1836 to 1872) the Daniell cell was used as the standard of emf.

In 1872 Latimer Clark proposed the cell which bears his name and which was discussed above in a general way. This cell was superior to all those that had preceded it. In announcing his cell, he said.

"No material standard of electromotive force has yet been issued. Much difficulty has, in fact, been found in devising such a standard. Mechanical means, such as the rotation of a conductor in a magnetic field of known intensity, are too complicated for ordinary use; thermoelectric couples are extremely variable, and voltaic elements, which would constitute the most convenient form of standard, have been hitherto found singularly inconstant, and therefore inapplicable. The Daniell's element, which has been most frequently used for this purpose, commonly varies five per-cent. or more without apparent cause."

In 1874 he added,

"Practically electricians have been compelled to define electromotive forces by comparison with those of the GROVE'S or DANIELL'S cell, the copper and zinc cell, or other electromotive sources; and it is curious circumstance that among the thousand galvanic combinations known to exist, not one has been hitherto found which could be relied upon to give a definite electromotive force: however pure the materials, and however skilful the manipulation, differences varying from four to five percent. upwards constantly occur without any assignable cause; and different observers using different materials of course meet with still larger discrepancies."

Clark's cell was a one-fluid cell consisting of a saturated solution of zinc sulfate, a cathode of mercury covered with a paste of mercurous sulfate, and an anode of zinc. He constructed the cell in a single tube with the zinc above and extending into the mercurous sulfate paste. By using a sine galvanometer or an electrodynamometer and a British Association resistor he found that his cell had an emf of 1.457 V at 15.5°C. His cell, although much superior to its predecessors, still did not exhibit the steadiness in emf hoped for. The cell tended to gas at the anode and the emf showed large variations mainly because of the concentration gradients that developed, during slight changes in temature, within the mercurous sulfate paste. Rayleigh and Sidgwick (14) overcame these weaknesses of the Clark cell 10 years later by amalgamating the zinc and placing the anode and the cathode in separate compartments of an H-shaped container (see Fig. 2; this figure is for a Weston cell but the modified Clark cells were made in similar containers).

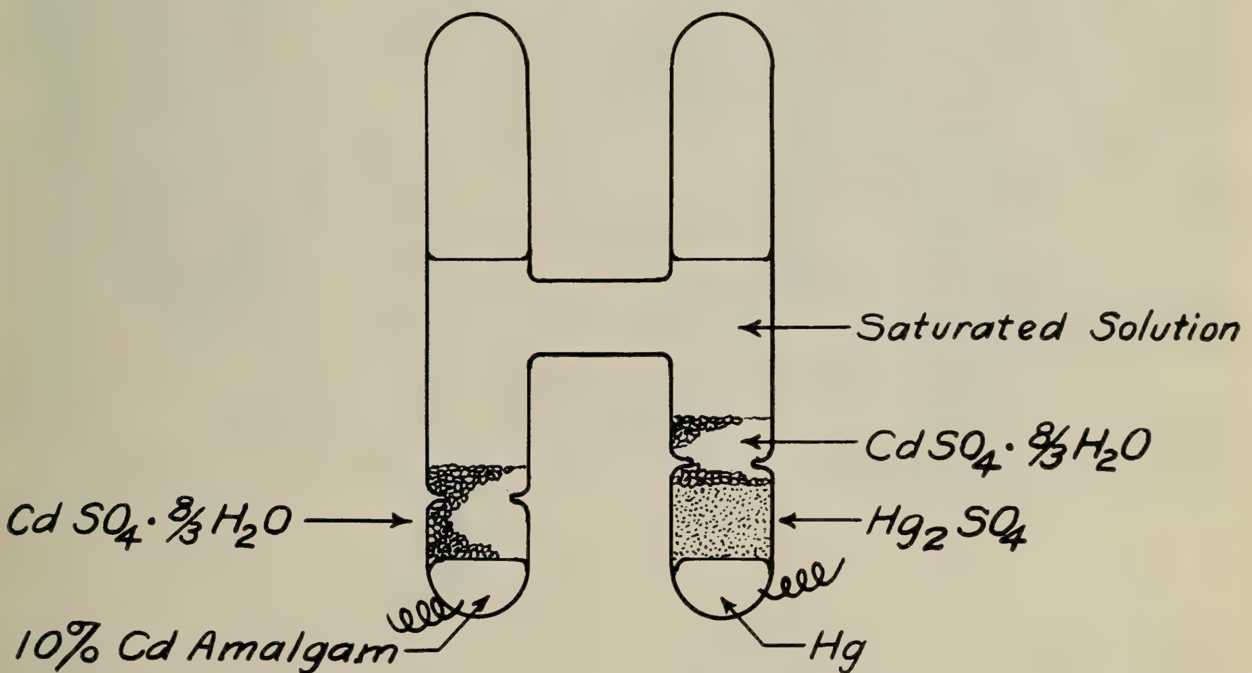

Fig. 2. Cross-section of saturated standard cell of National Bureau of Standards type.

Edward Weston designed a better cell than the Clark cell by the simple expedient of replacing zinc by cadmium, *i.e.*, by using a cadmium amalgam and a solution of cadmium sulfate rather than a zinc amalgam and a solution of zinc sulfate. By so doing, Weston obtained a standard cell that had advantages, mentioned above, over the Clark cell. Today, the standard of emf is exclusively the Weston or cadmium sulfate cell.

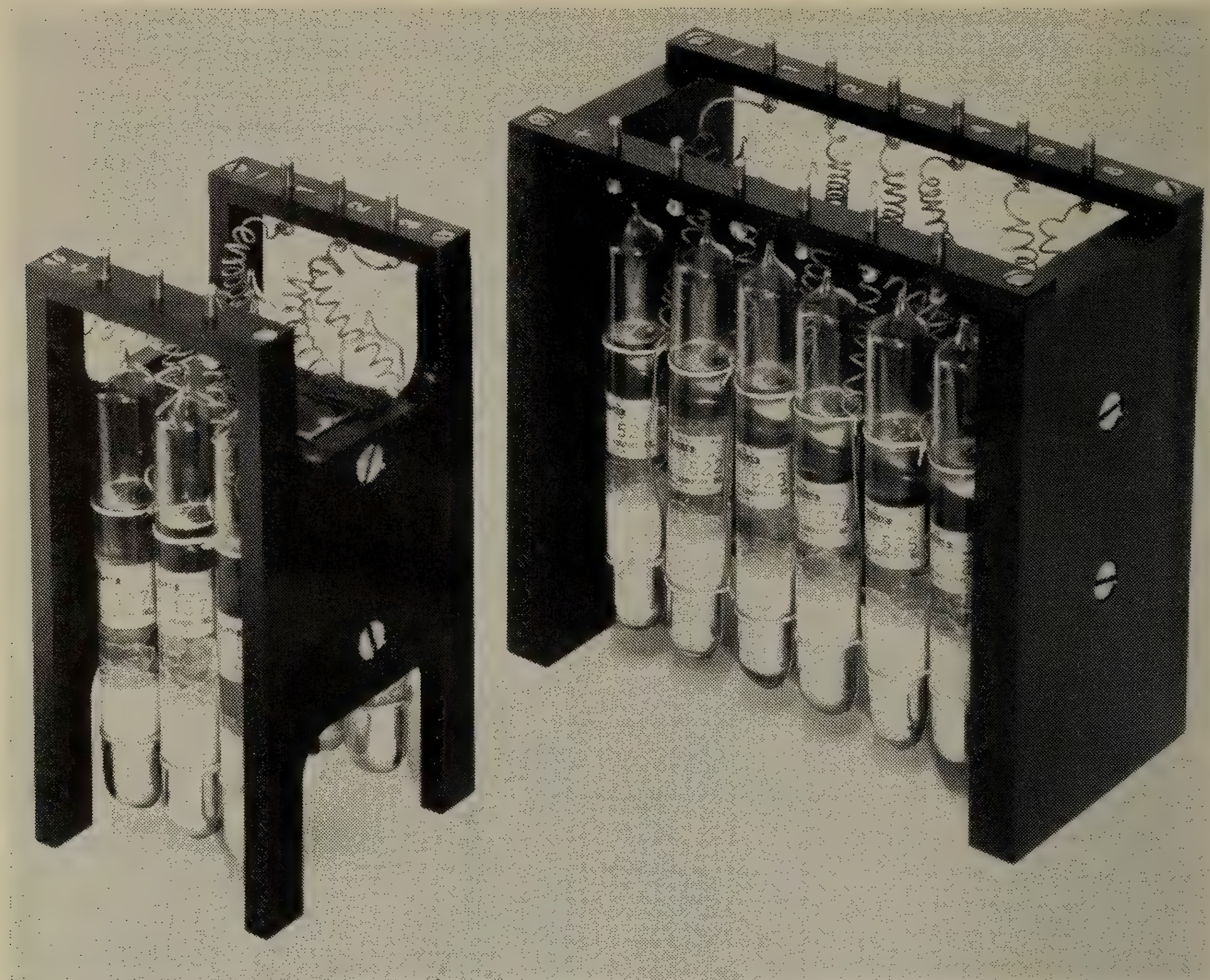

Fig. 3. Racks with commercial saturated standard cells.

The Weston (Cadmium Sulfate) Cell

The Weston or cadmium sulfate cell is made in two general types, unsaturated and saturated, where these terms refer to the state of the electrolyte used in the cell. The first one is the well-known shippable type mounted in a non-transparent copper-shielded case. It is also available unmounted for use in pyrometers, pH meters, recording instruments, etc. It is made shippable by placing a septum over the surface of each electrode, whereby the electrode materials are locked in place. It has an emf-temperature coefficient that is less than ± 4 microvolts per degree C (the actual value depends on the age of the cell), and the unsaturated cell is therefore used widely in ambient room temperatures where an emf reference of 0.005 percent accuracy suffices. However, on the average, unsaturated standard cells show a decrease in emf of 20 to 40 microvolts per year, and they are accordingly unsuitable for maintaining the unit of emf. On the other hand, the saturated cell does not show a decrease in emf with time and is therefore the one used to maintain the unit. It is the precision cell. Figure 2 shows a cross-section of a saturated standard cell as made at the National Bureau of Standards. The figure is largely self-explanatory. Indentations are placed near the bottom of each limb of the cell to lock in some of the crystals of $CdSO_4 \cdot 8/3\ H_2O$. Saturated cells are not mounted in cases because they are intended for immersion in temperature-controlled oil or air baths where cases would be a hindrance. Commercial saturated standard cells are usually mounted in groups of 3, 4, or 6 on special racks for convenience in use. In Fig. 3 are

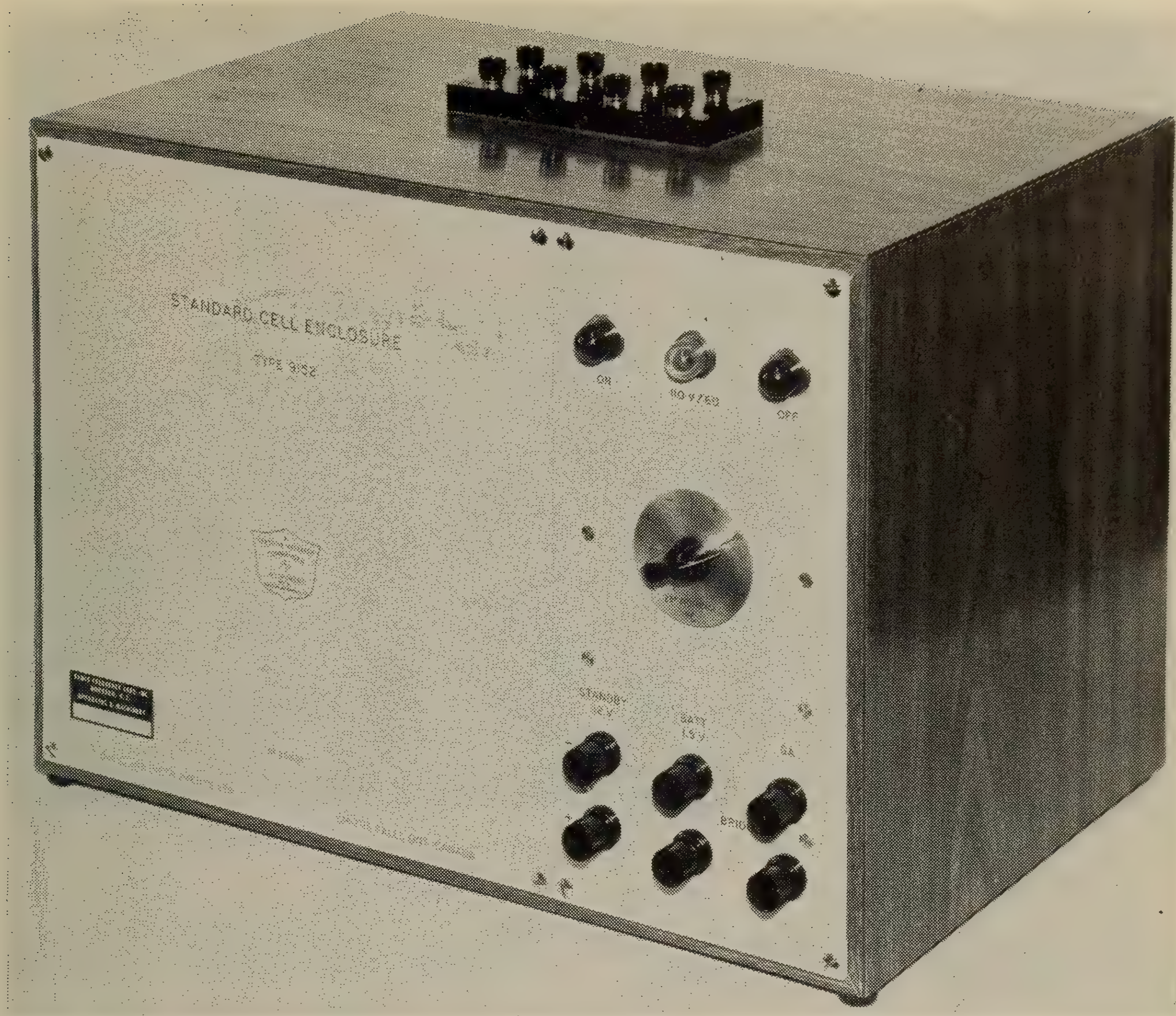

Fig. 4. A constant-temperature controlled box for saturated standard cells.

shown two commercial racks holding commercial saturated standard cells; one rack holds 3 cells, the other one 6 cells. Saturated standard cells must usually be transported by hand, but some recent types are stated to be shippable. Considerable study will be required to ascertain their long-term emf stability.

The saturated type of standard cell has a higher emf-temperature coefficient than the unsaturated type, and for measurements of the highest precision the cell must be maintained at a constant temperature controlled to at least $\pm 0.01\,^{\circ}C$. In practice, saturated standard cells are maintained at a constant temperature in thermostatically-controlled oil baths or in portable thermostatically-controlled air boxes. The latter are generally made after a design first proposed by Mueller and Stimson (15) The cells are housed in a thin-walled aluminum box which rests within a larger thick-walled aluminum box. The temperature of the latter is controlled by a mercury-in-glass thermoregulator. The aluminum boxes are thermally insulated and are enclosed in a wooden box which also contains an a-c relay, a transformer, and a pilot light. The box is operated on the 110 V—60 c/s a-c line. As a rule these boxes are designed to operate at some temperature between 28 and $37\,^{\circ}C$. A commercial box is shown in Fig. 4.

At the National Bureau of Standards oil baths are used to house saturated standard cells. A picture of three of these baths is given in Fig. 5. The two baths to the left are used to house those cells which

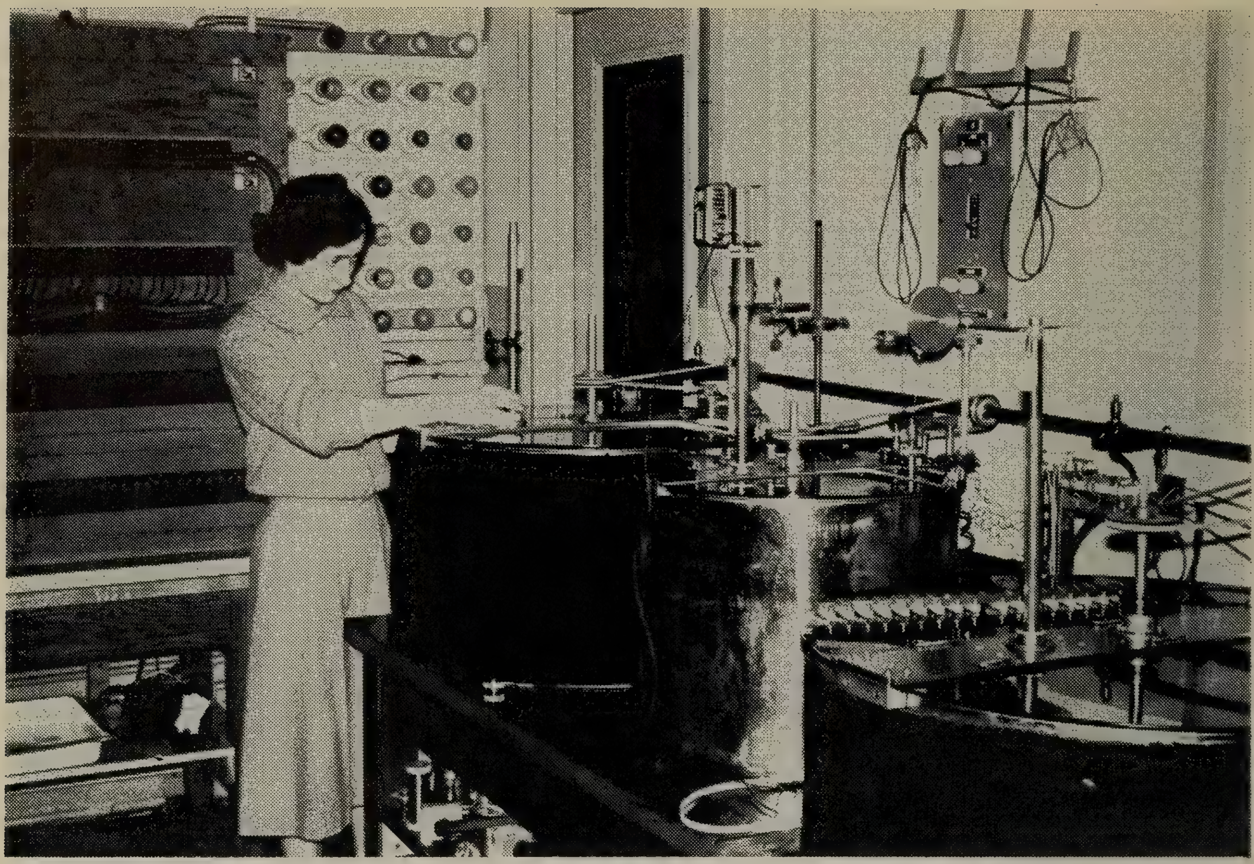

Fig. 5. Oil baths used at the National Bureau of Standards to maintain standard cells at a constant temperature.

maintain the national unit of emf; the bath to the right is used for calibration or testing purposes.

The saturated type of Weston cell consists of a 2-phase cadmium amalgam anode and a mercury-mercurous sulfate cathode in a saturated solution of cadmium sulfate with crystals of $CdSO_4 \cdot 8/3\ H_2O$ over the surface of both electrodes. A 10 percent cadmium amalgam is now generally used; over a temperature range of —8°C to 51°C it consists of a liquid phase and a solid-solution phase. The cell may be represented by

$$(-)\,Cd,Hg(2p)\ |\ CdSO_4 \cdot 8/3\ H_2O(c)\ |\ CdSO_4(sat\ aq)\ |\ CdSO_4 \cdot 8/3\ H_2O(c)\ |\ Hg_2SO_4(s)\ |\ Hg(l)\ (+)$$

$$(xCd),(yHg)\,(2p) + Hg_2SO_4(s) + \frac{8/3}{m-8/3}(CdSO_4 \cdot mH_2O)\,(sat\ aq) =$$

$$\frac{m}{m-8/3}\,(CdSO_4 \cdot 8/3\ H_2O)\,(c) + 2Hg(l) + (x-1)\,Cd,(yHg)\,(2p)$$

where x moles of Cd are associated with y moles of Hg in the amalgam and m is the number of moles of water associated with 1 mole of $CdSO_4$ in the saturated solution. The saturated cell is called the "Weston Normal cell" or the "neutral cell" if no sulfuric acid is added to the solution in the cell. It is called an "acid cell" if a small amount of sulfuric acid, sufficient to make the acid concentration 0.03 to 0.06 N, is added to the solution. The acid is added to prevent the partial hydrolysis of the mercurous sulfate to form a small amount of basic mercurous sulfate. The addition of sulfuric acid decreases slightly the emf of a standard cell. Several different expressions have been proposed relating the change in the emf to the acid concentration, the simplest being that proposed by the National Physical

Laboratory (16), namely ΔE(in microvolts) = —615x where x= the normality of the sulfuric acid before it is saturated with cadmium sulfate.

The emf of the "neutral" cell as a function of temperature between —20°C and 40°C is given by the equation:

$$E(\text{in volts}) = 1.0189860 + (9.453\text{x}10^{-6})t - (16.595 \text{ x } 10^{-7})t^2 + (18.606 \text{ x } 10^{-9})t^3 - (15.005 \text{ x } 10^{-11})t^4.$$

The equation for "acid" cells is the same except for the first term, the value of which depends on the normality of the sulfuric acid in the cell. The changes in Gibbs energy (free energy), enthalpy, entropy, and heat capacity for the cell reaction are given, respectively, by: $\Delta G = -nFE$; $\Delta H = - nFE + nFT\ (dE/dT)$; $\Delta S = nF\ (dE/dT)$; and $\Delta C_p = [d(\Delta H)/dT] = nFT\ (d^2E/dT^2)$, where F is the Faraday and n is the number of equivalents involved in the cell reaction; in the present case $n = 2$. The value of F is 96487 coulombs per gram equivalent on the now accepted ^{12}C scale of atomic weights (17); thus if E is expressed in volts ΔG is given in volt-coulombs per gram equivalent or in joules per gram equivalent.

The unit of energy in the Système International d'Unités (SI) adopted in a resolution of the 11th General Conference on Weights and Measures (Paris, October 1960) is the joule. The above thermodynamic quantities in the SI system are given, respectively, by:

$$\Delta G(\text{in J mole}^{-1}) = -196{,}637.80 - 1.82418t + 0.32024t^2 - (35.9047 \times 10^{-4})t^3 + (28.9557 \times 10^{-6})t^4,$$

$$\Delta H(\text{in J mole}^{-1}) = -196{,}139.53 - 174.9471t + 2.62197t^2 - (24.4561 \times 10^{-3})t^3 - (86.8673 \times 10^{-6})t^4,$$

$$\Delta S\ (\text{in J mole}^{-1} \text{ per degree} = 1.82418 - 0.64048t + (10.7714 \times 10^{-3})t^2 - (11.5823 \times 10^{-5})t^3,$$

$$\Delta C_p\ (\text{in J mole}^{-1} \text{ per degree}) = -174.9471 + 5.24394t - 0.073368t^2 - (34.747 \times 10^{-5})t^3.$$

The mole here is the grammole. The National Academy of Sciences-National Research Council recently recommended that the mole be defined in terms of the gram (18); thus when the term "mole" is used it is implicit that the unit is the gram. In Table 2 values of these quantities at 5° intervals from 0°C to 40°C are listed. These values represent standard data based on the determination of the volt in absolute measure. If these quantities were determined directly by heat measurements we would have an independent check on the internal consistency of heat and electrical measurements. Giauque and his associates (19) have made these checks for Clark cells; a similar check for the Weston cell would be most valuable.

Modifications in Weston Cells

As was pointed out above, in maintaining the unit of emf it is assumed that in the interval between "absolute determinations" of the volt the mean emf of a group of Weston cells remains constant. It was also pointed out that emfs of "identical" cells may show an increase or decrease with time without departures from an originally assigned mean being evident and, therefore, a modified type of Weston cell would serve a most useful purpose in maintaining the volt. At the National Bureau of Standards two such modifications have been made: (1) some cells have been made slightly acidic by adding sulfuric acid to the cell solution, and (2) cells have been made with a solvent of deuterium oxide-normal water (20) instead of normal water alone. In Table 3

TABLE 2

Thermodynamic data for the reaction in Weston saturated standard cells made with 10 percent cadmium amalgam

Temperature °C	*Gibbs energy* ΔG J mole^{-1}	Changes[a] in *Enthalpy* ΔH J mole^{-1}	*Entropy* ΔS J mole^{-1} deg^{-1}	*Heat capacity* ΔC_p J mole^{-1} deg^{-1}
0	− 196,637.8	− 196,139.5	+ 1.824	− 174.95
2.994[b]	− 196,640.4	− 196,640.4	0	− 159.91
3	− 196,640.5	− 196,641.3	− 0.003	− 159.88
5	− 196,639.3	− 196,951.7	− 1.123	− 150.61
10	− 196,627.3	− 197,652.0	− 3.619	− 130.19
15	− 196,603.8	− 198,260.7	− 5,750	− 113.97
20	− 196,570.3	− 198,799.1	− 7.603	− 102.20
25	− 196,528.0	− 199,290.4	− 9.265	− 95.13
30	− 196,477.8	− 199,758.8	− 10.823	− 93.04
35	− 196,419.8	− 200,229.8	− 12.364	− 96.18
40	− 196,354.0	− 200,729.6	− 13.973	− 104.82

[a]—These may be converted to the thermochemical calorie (defined) by the relation 1 thermochemical calorie (defined) = 4.1840 J (18).

[b]—Cell has a maximum emf at this temperature and a zero emf-temperature coefficient.

TABLE 3

Nominal emfs of saturated standard cells at some common temperatures

Temperature °C	Normality of H_2SO_4 in cell solution: *neutral* [a] V	*0.03N* V	*0.05N* V	*0.10N* V
20	1.018636	1.018612	1.018596	1.018556
25	1.018417	1.018393	1.018377	1.018337
28	1.018266	1.018242	1.018226	1.018186
30	1.018157	1.018133	1.018117	1.018077
32	1.018041	1.018017	1.018001	1.017961
35	1.017856	1.017832	1.017816	1.017776
37	1.017725	1.017701	1.017685	1.017645

[a] actually 0.00092*N*.

the nominal emfs of "neutral" and "acid" saturated cells are given for a number of common temperatures. In Table 4 the emfs of saturated cells made with deuterium oxide and normal water are given for a temperature of 20°C. The ratio of the mean emf of a group of cells made with normal water and a group made with heavy water (deuterium oxide) is followed in the course of time in maintaining the unit of emf. Likewise the ratio of the mean emf of a group of "neutral" and "acid" cells is similarily followed. Suffice it to say here that these studies have shown that the unit of emf, as maintained by the National Bureau of Standards, does not change by more than 0.1 ppm per year.

Voltage Ranges

Accurate measurements of emfs or d-c voltages at values below approximately 2 V are made with a null-type d-c potentiometer in which the ratio of emf is compared with ratios of potential drops across a uniform resistance wire, or with the ratio of resistances in a resistance box. One emf in this measurement is that of a standard cell. Accurate measurements of emf or d-c voltages at values above 2 V are nearly always made by the "volt-box" method. In this method use is made of a resistive voltage divider which consists of a high resistance, R_1, in series with a low resistance, R_2. The voltage to be measured is connected across the series combination with R_2 at the ground end. The divider ratio, $(R_1 + R_2)/R_2$ is chosen to give a voltage drop across R_2 which is within the range of the potentiometer. If E_x and E_s represent, respectively, the IR drop across $R_1 + R_2)$ and R_2 then $E_X = E_S(R_1 + R_2)/R_2$. This method may be used without difficulty to measure voltages up to 1,500 V in terms of a standard cell.

In extending the method to higher voltages the high resistor must be designed to keep I^2R heating to a minimum, to prevent current leakage through the volume or over the surface of the resistor insulation, and to prevent corona discharges which may appear at locations of high gradient along the resistor as the voltage is increased. At the National Bureau of Standards a special high-voltage resistor (100 megohms) has been constructed in which these factors are kept at a minimum (21). This resistor serves as a high-voltage standard. It is made up of a large number of individually shielded 1-megohm wire-wound resistors connected in series and arranged to form a vertical helix between a ground plate and a high-voltage electrode at the top. The 1-megohm resistors are made of Karma or Evanohm wire of low temperature coefficents of opposite sign; the effect on the resistance due to I^2R heating is, therefore, kept at a minimum. The pitch of the helix was chosen to prevent any possibility of corona between adjacent turns. Polyethylene was used as insulation. The effective resistance of this high-voltage resistor remains constant to 10 ppm for voltages up to 50 kV, and at 100 kV the maximum error is about 40 ppm under ordinary laboratory conditions.

A-C Voltages

Precise measurements of voltage at power and audio frequencies are made with so-called "transfer instruments" which have the same response, or a known difference in response, to direct and alternating currents. Instruments based on electrodynamometer principles have been developed at the National Bureau of

TABLE 4

Emfs at 20° C of saturated standard cells made with mixed solvent of normal water and deuterium oxide[a].

Percentage of D_2O in water mixture	*Emf, V*
0.02[b]	1.018603
10	1.018567
20	1.018531
30	1.018495
40	1.018459
50	1.018423
60	1.018384
70	1.018344
80	1.018301
90	1.018255
100[c]	1.018204

[a] normality of H_2SO_4 in cell solution was 0.031.
[b] normal water contains 0.02 percent D_2O.
[c] extrapolated from 98 percent.

Standards to measure a-c voltages from 10 to 600 V at frequencies up to about 2,000 hertz (cycles per second) (22), with an accuracy better than 0.01 percent at power frequencies and about 0.1 percent up to 3,000 Hz and above 50 V. Electrostatic voltmeters for the measurement of a-c voltages from 50 to 160 V have been used at the National Physical Laboratory in England for many years (23). Electrostatic instruments are best suited for measurements of voltages above 50 V. The NPL instrument yields ac-dc differences known to better than 0.01 percent at power frequencies and to better than 0.05 percent up to 100,000 Hz.

Electrothermic instruments containing thermal converters are now used at the National Bureau of Standards (24) for measurements of a-c voltages up to 750 volts at frequencies from 25 to 20,000 Hz. A thermal converter is a device that consists of one or more thermojunctions in thermal contact with an electric heater or integral therewith, so that the emf developed at its output terminals by thermoelectric action gives a measure of the input current in its heater. For voltage measurements, the thermal converters are used in series with resistors having taps to give various voltage ranges up to 750 V.

In practice, these converters may be used either directly to measure the ac-dc difference of a voltmeter, or, with a suitable potentiometer, to measure an alternating voltage, as might be indicated on a voltmeter. The first may be called an "ac-dc difference test" and the second an "a-c test"; the accuracy of the second is approximately half that of the first. In the first, an instrument under test and the transfer standard are connected to measure the same quantity (in this case, voltage), first on alternating current and then on direct current, which in each case is adjusted to give the same deflection of the test instrument. From the averaged difference in the response of the transfer standard, the ac-dc difference of the test instrument is computed. In the second, the instrument under test and the transfer standard are connected to measure the same a-c voltage which is adjusted to produce the desired deflection of the test instrument. The response of the transfer standard is observed, and the standard is then transferred to direct current. The d-c voltage is adjusted to give the same response of the transfer standard and after adjustment is measured with a suitable d-c potentiometer, volt box, and standard cell. By these methods ac-dc transfer may be made at voltages of 0.2 to 750 V with an accuracy of 0.01 percent at frequencies of 25 to 20,000 Hz, while "a-c voltages" may be obtained in these voltage and frequency ranges with an accuracy of about 0.02 percent.

Zener Diodes

In recent years solid-state devices known as zener diodes have appeared on the market as d-c reference voltages. They differ fundamentally from standard cells in that they require a source of electric current for operation. Unlike standard cells, which have emfs in the range of about 1.018 to 1.019 V, the zener diodes currently being considered as standards have operating voltages ranging from 5 to 12 V. These require a current ranging from 5 to 15 milliamperes for operation. Zener diodes show a much wider spread in voltage than do saturated standard cells, *i.e.*, their construction has not yet been standardized.

The zener diode is a variant of the silicon junction diode, a solid-state semiconductor formed of two types of silicon (p and n) having different electrical properties. Silicon junction diodes have an extremely high ratio of forward to reverse resistance and therefore are usually used as rectifiers or to block the flow of electricity in one direction. However, if a voltage applied to the diode in the reverse direction is gradually increased, the current will remain extremely small until a critical voltage, known as the breakdown voltage, is reached (see Fig. 6). At this voltage, a nondestructive breakdown of the high reverse resistance will occur and the current will increase rapidly. In the region of breakdown, the voltage drop across the diode will be very nearly independent of the current, depending only on the very small reverse resistance of the diode.

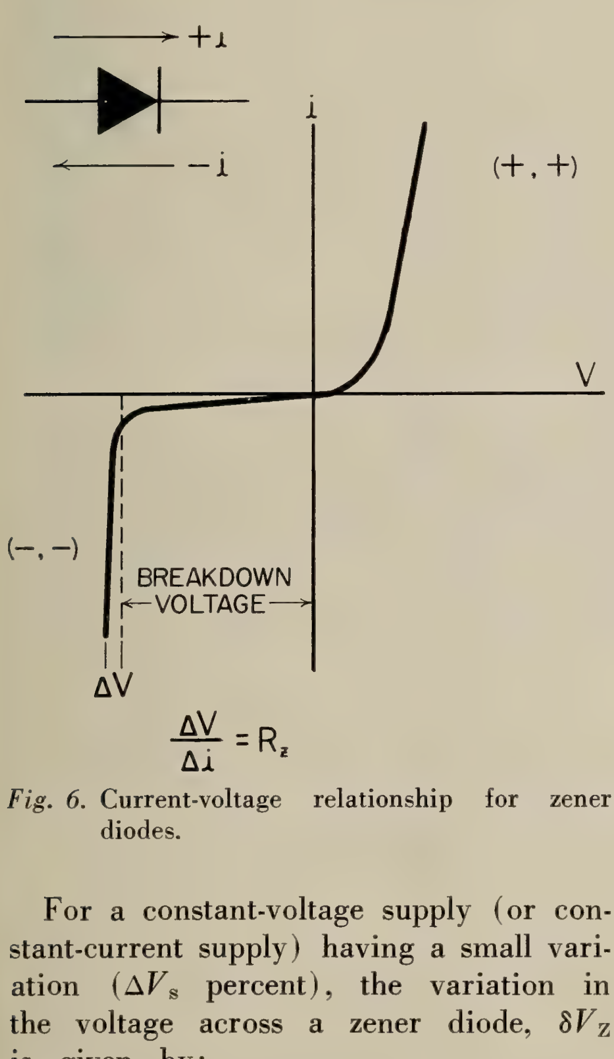

Fig. 6. Current-voltage relationship for zener diodes.

For a constant-voltage supply (or constant-current supply) having a small variation (ΔV_s percent), the variation in the voltage across a zener diode, δV_Z is given by:

$$\frac{\delta V_Z}{V_Z} = \frac{\Delta V_S I R_Z}{100 V_Z (1 - V_Z/V_S)}$$

where I is the current, R_Z is the dynamic resistance of the diode, V_Z is the zener voltage, and V_S is the supply voltage. For a particular diode, IR_Z/V_Z is a constant and, if V_S is made large compared to V_Z we have:

$$\delta V_Z/V_Z = \Delta V_S k/100 = \Delta V_S (IR_Z/V_Z)/100$$

for the variation in zener (or output) voltage in terms of the percentage variation in the supply (or input) voltage. For many reference diodes k (or IR_Z/V_Z) is in the range 0.001 to 0.02.

To serve as an emf standard, a zener diode must have a low emf-temperature coefficient. The usual procedure to achieve this characteristic is to package a zener diode with one or more diodes that operate in the forward direction. The negative temperature coefficients of the added diodes are balanced against the positive coefficient of the zener diode. In addition, many diodes can be made to have a zero temperature coefficient at a specific temperature by proper selection of the operating current. A temperature-compensated zener diode is then connected to a suitable power source in series with a resistor to limit the current (see Fig. 7).

Several types of commercial zener diodes of different packaging are shown in Fig. 8. Their small size is evident.

A basic circuit used to measure the operating voltage of zener diodes is shown in Fig. 7. (This circuit without the standard cells and the resistor R_S represents a basic circuit for the use of zener diodes as voltage references.) The method is based on the opposition principle, in which the unknown voltage to be measured, the zener voltage, is opposed by a known voltage of approximately the same magnitude provided by a group of unsaturated standard cells in series. The small voltage difference is measured with a potentiometer. At the National Bureau of Standards an 80-V lead-acid storage battery is used as the voltage supply, V_S. The current is first set to the desired value by the rheostat shown at the top of Fig. 7 and the magnitude of the current is determined by measuring, with a potentiometer, the IR drop in R_S, a standard resistor. For highly precise and accurate measurements, the zener diodes and unsaturated standard cells are housed in a temperature-controlled oil bath. In practice, several diodes are connected in series in the same circuit and their voltage measured individually in terms of the unsaturated standard cells. In terms of the standard cells, the voltages of zener diodes up to 9 V can be determined to 1 to 2 parts per million (ppm).

The National Bureau of Standards has recently completed a three-year study of zener diodes kept on continuous operation (25, 26, 27). Stability varies widely among diodes of the same type. In Fig. 9, typical stability curves are shown. These diodes were not preconditioned or aged as is now frequently done for diodes for reference use. It may be noted that three distinct behaviors are exhibited: some diodes increase in voltage with time, some decrease, while others remain relatively constant. The reason for these differences in performance is not known, but it is believed to be due to diffusion of impurities across the p-n barrier of the diodes.

These curves show three sections: a stabilization period, a period of linear drift, and a constant period. The latter two periods may be considered as useful periods. During the stabilization period the rate of change of voltage varies with time, while during the useful periods the rate of change is constant or zero. The stabilization period represents the time required for a diode to come to a steady-state condition, while the useful periods represent the time during which a diode operates under a steady-state condition. Diode 1 stabilized in about one week and then showed a drift in voltage of 75 ppm per year for 400 days, after which the

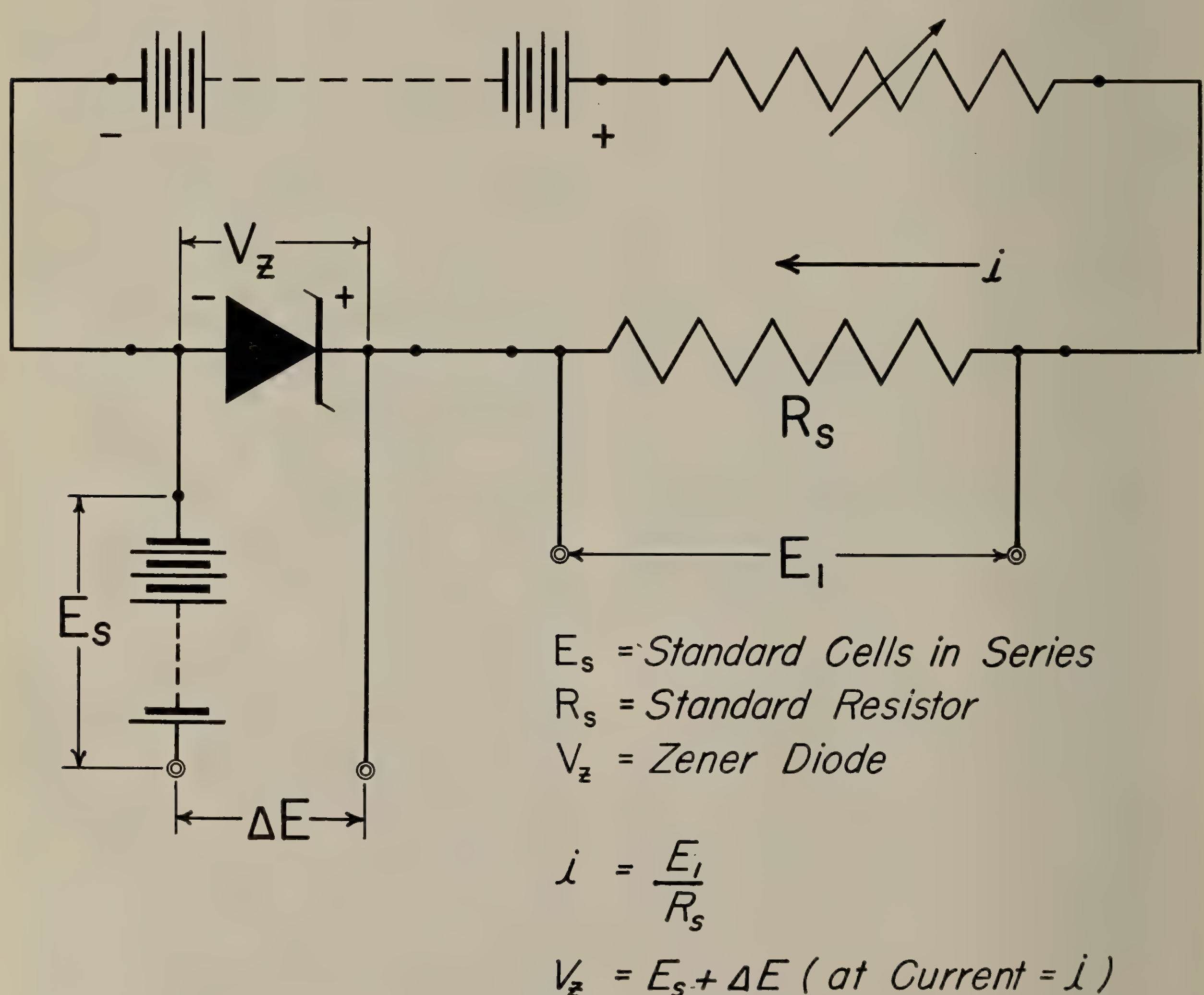

Fig. 7. Basic circuit used to measure the operating voltage of zener diodes.

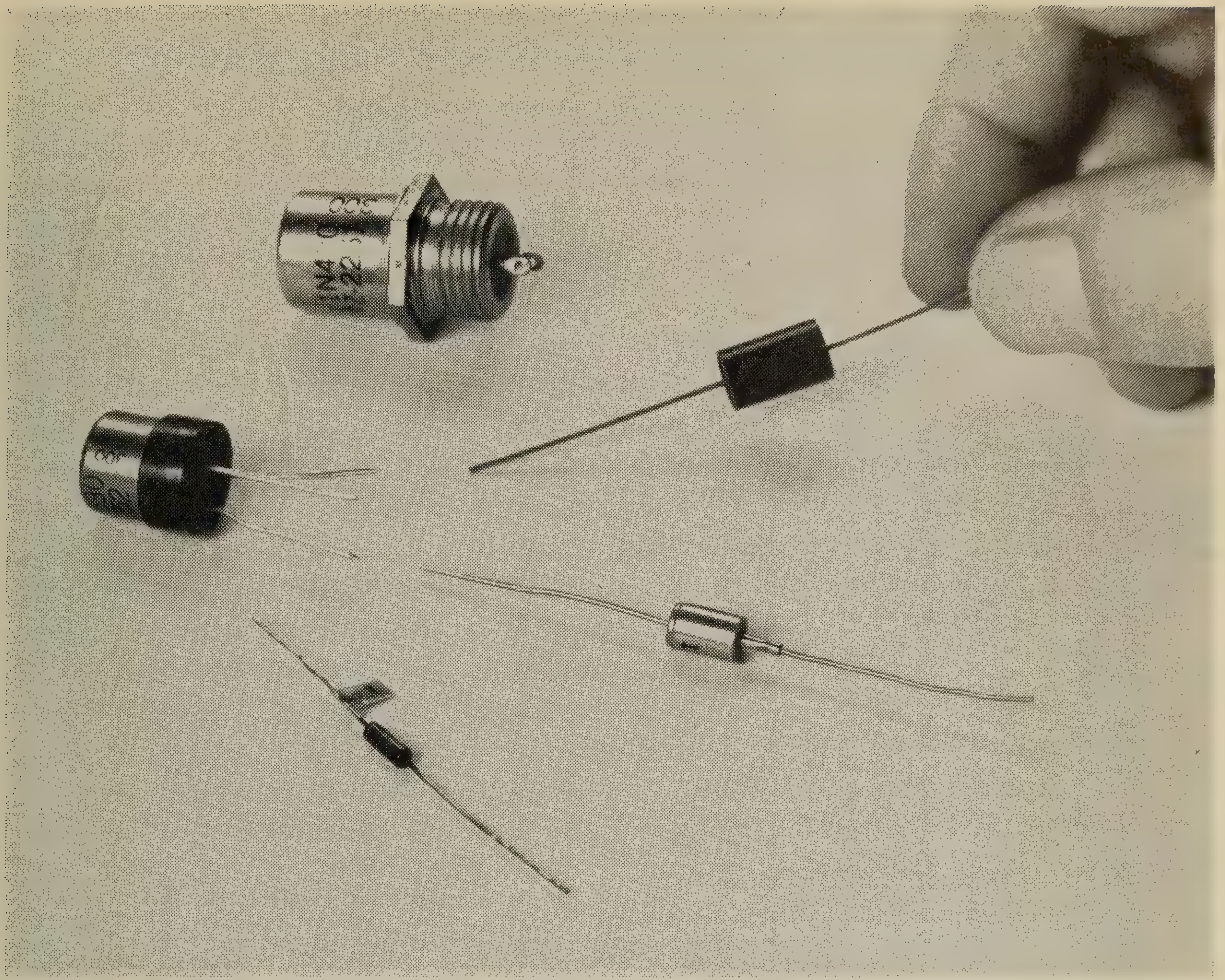

Fig. 8. Zener diodes.

rate decreased sharply to about 10 ppm per year. Diode 2 stabilized in about five days and showed no tendency to drift with time. It did, however, show a sensitivity to changes in operating conditions. The shaded areas in the curves represent changes in voltages caused by changes in environmental temperature. For the last 600 days of operation this diode varied by less than 3 ppm from a mean value. Diode 3 required about 100 days for stabilization, after which it drifted in voltage at a rate of about 75 ppm per year for about 400 days. Its voltage then remained relatively constant showing fluctuations of about 10 ppm from a mean value.

For 25 diodes so far studied, the stability of voltage may be summarized as follows:

Stabilization time

Maximum: 12 months
Minimum: 5 days
Average: 3+ months

Stability
(over 1 to 2 year period)

Maximum: 138 ppm
Minimum: 15 ppm

where the distribution of results is approximately normal and the standard deviation is 20 ppm. Stability is defined as the maximum voltage less the minimum voltage during the period in question. It is to be expected that zener diodes will show even greater stability and reproducibility in the future as improvements are made in design.

Although zener diodes unfortunately require a current source for operation, they have the advantage over standard cells of being rugged and compact and may, therefore, be suitable for use under many

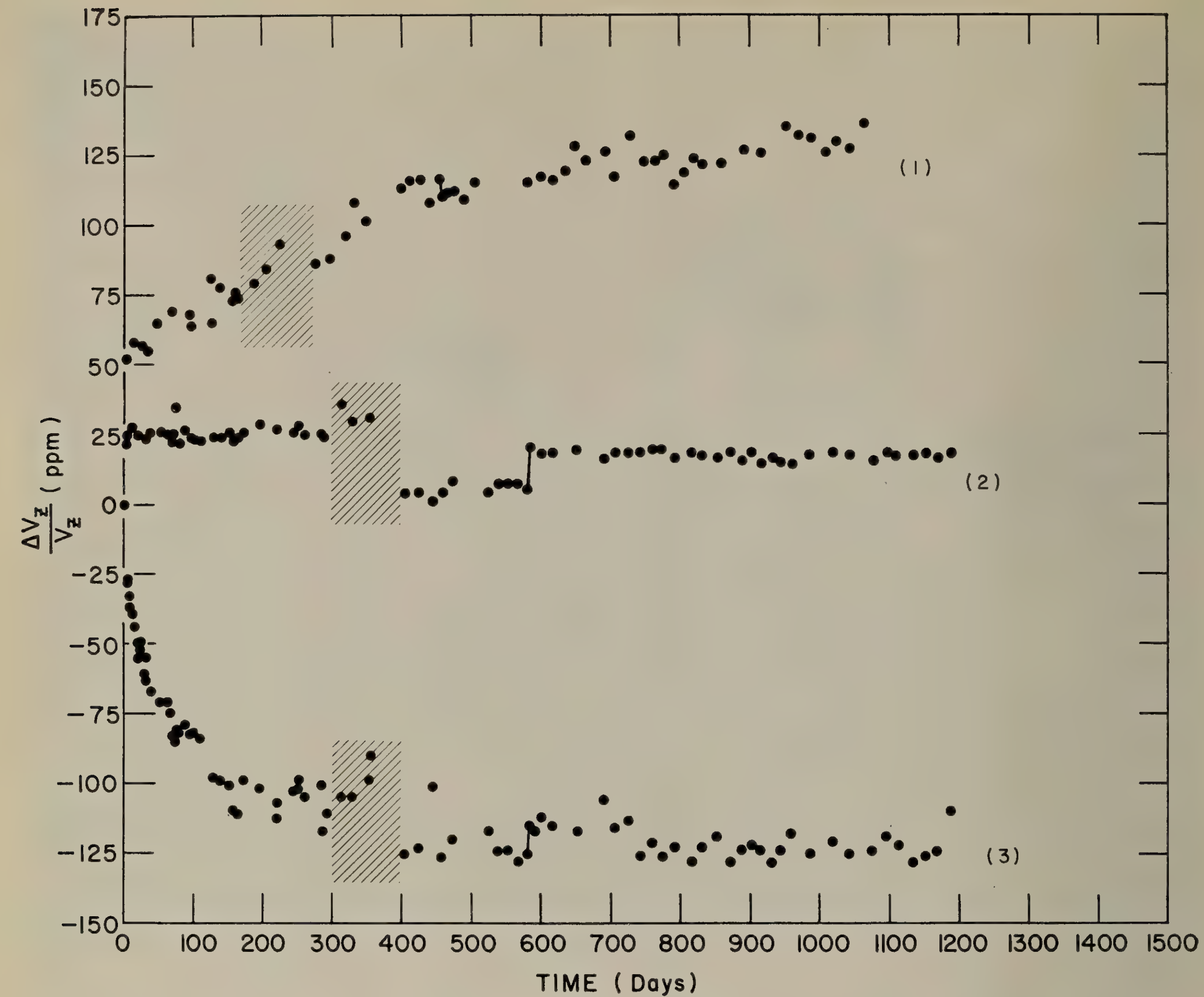

Fig. 9. Stability of the operating voltage of typical zener diodes of the temperature-compensated type.

conditions where standard cells would be unsuitable.

Emf Standard

It should be reiterated, in conclusion, that the Weston (or cadmium sulfate) standard cell is the standard to which all emf or voltage measurements, whether they be d-c or a-c, or whether they be for low or high voltages, are referred. In terms of the present uncertainties in the "absolute" measurements of the ohm and the ampere, the uncertainty in the determination of the volt in absolute measure is ± 7 ppm. The unit, however, may be maintained with a precision of better than 1 ppm.

References

(1) Latimer Clark. On a voltaic standard of electromotive force. Proc. Roy. Soc. (London) *20*, 444 (1872).

(2) Frank A. Wolff, Jr. The facilities afforded by the U. S. Office of Standard Weights and Measures for the verification of electrical standards and electrical measuring apparatus. Electrical World and Engineer *35*, 361 (1900).

(3) Edward Weston. Normal element. German Patent 75,194 (Jan. 5, 1892). Improvements in voltaic cells. British Patent 22,482 (Feb. 6, 1892).

(4) H. L. Callendar and H. T. Barnes. On the variation of the electromotive force of different forms of the Clark standard cell with temperature and strength of solution. Proc. Roy. Soc. (London) *62*, 117 (1897).

(5) Frank A. Wolff. The temperature formula of the Weston standard cell. Natl. Bur. Standards Bull. 5, 309 (1908).

(6) Announcement of a change in the value of the International Volt. Bur. Standards Circular 29 (1910).

(7) Announcement of changes in electrical and photometric units, Natl. Bur. Standards Circular C459 (1947).

(8) J. W. Trischka. Electric resonance voltage standards. U. S. Patent No. 2,959,683 (Nov. 8, 1960).
(9) Y. Beers and G. L. Strine. The measurement of voltage by the use of the Stark effect. IRE Trans. *I-11*, Nos. 3 and 4, 171 (1962).
(10) C. H. Townes and A. L. Schawlow. Microwave spectroscopy, Chap. 10, McGraw-Hill Book Co., Inc., New York, 1955.
(11) Alessandro Volta. On the electricity excited by the mere contact of conducting substances of different kinds. Phil. Trans. Roy. Soc. *90*, 403 (1800).
(12) Latimer Clark and Sir Charles Bright. Report of 1862 of the original British Association Committee on Standards of Electrical Resistance.
(13) John F. Daniell. On voltaic combinations. Phil. Mag. III, *8*, 421 (1836).
(14) Lord Rayleigh and Mrs. H. Sidgwick. On the electro-chemical equivalent of silver, and on the absolute electromotive force of Clark cells. Phil. Trans. *II*, *175*, 411 (1884).
(15) E. F. Mueller and H. F. Stimson. A temperature-control box for saturated standard cells. J. Research NBS *13*, 699 (1933) RP 739.
(16) Report of the National Physical Laboratory, Electrician *75*, 463 (1915).
(17) D. N. Craig, J. I. Hoffman, C. A. Law, and W. J. Hamer. Determination of the faraday with a silver-perchloric acid coulometer. J. Research Natl. Bur. Standards *64A*, 381 (1960).
(18) New Values for the Physical Constants—Recommended by NAS-NRC. Natl. Bur. Standards Tech. News Bull. *47*, No. 10, 175 (1963). Consistent Set of Physical Constants Proposed. Chem. & Eng. News *41*, No. 46, 43, (Nov. 18, 1963).
(19) R. E. Barieau and W. F. Giauque. $ZnSO_4 \cdot 7H_2O$. $ZnSO_4 \cdot 6H_2O$. Heat capacities, entropies and crystal perfection at low temperatures. Heats of solution and transition. J. Am. Chem. So. *72*, 5676 (1950).
W. F. Giauque, R. E. Barieau, and J. E. Kunzler. Crystal perfection of $ZnSO_4 \cdot 7H_2O$. Partial molal heat capacity, heat content and vapor pressure of its aqueous solutions. Thermodynamics of Clark Cell. J. Am. Chem. Soc. *72*, 5685 (1950); *73*, 5927 (1951).
(20) L. H. Brickwedde and G. W. Vinal. Electromotive force of saturated Weston standard cells containing deuterium oxide. J. Research Natl. Bur. Standards *20*, 599 (1938) RP1094. Relation of electromotive force to the concentration of deuterium oxide in saturated standard cells, *ibid*, *27*, 479 (1941) RP1435.
(21) J. H. Park. Special shielded resistor for high-voltage d-c measurements. J. Research Natl. Bur. Standards *66C*, 19 (1962).
(22) F. K. Harris. A suppressed zero electrodynamic voltmeter. J. Research Natl. Bur. Standards *3*, 445 (1929).
(23) R. S. J. Spilsbury and A. Felton. The electrostatic voltmeter as a dc/ac transfer instrument. J. IEE *89*, 129 (1942).
(24) F. L. Hermach. Thermal converters as ac-dc transfer standards for current and voltage measurements at audio frequencies. J. Research Natl. Bur. Standards *48*, 121 (1962) RP2296.
(25) W. G. Eicke, Jr. The operating characteristics of zener reference diodes and their measurements. ISA Trans. *3*, 93 (1964).
(26) W. G. Eicke, Jr. Making precision measurements of zener diode voltages. Conference Paper CP63-416. Presented at the Winter Meeting of the IEEE, Jan. 28-Feb. 1, 1963, New York, N.Y.
(27) Zener diodes as voltage standards. Natl. Bur. Standards Tech. News Bull. *48*, 1 (1964).

Academy Proceedings

482nd Meeting of the Washington Academy of Sciences

SPEAKER: MARSHALL H. STONE
Professor of Mathematics, University of Chicago
SUBJECT: SCIENCE AND SOCIETY
TIME: THURSDAY, OCTOBER 15, 1964
8:15 P.M.
PLACE: JOHN WESLEY POWELL AUDITORIUM, COSMOS CLUB
2170 Florida Avenue, N.W.

Abstract of Address—The growth of science is working a transformation of society with all the characteristics of a cultural revolution. Already, in the initial stages of this revolution, we are acutely aware of the great changes it has wrought. The trends in the different sciences, from mathematics to medicine, lead to potentialities of still more profound changes. Many of these changes must be expected to be ambivalent. Men must be prepared, therefore, to accept major readjustments in their ways of life and to confront new and troublesome problems very difficult to solve. The indications are clear that we shall not be able to escape a revision of social, ethical, and philosophical attitudes in meeting what the future thus seems to hold in store for mankind.

The Speaker—Marshall H. Stone, educator and mathematician, was born in New York City and grew up in Englewood, N. J. He received the A.B., M.A., and Ph.D. (1926) degrees from Harvard University. He also did graduate work at the University of Paris in 1924-1925 and was Guggenheim fellow at the Institute for Advanced Study in 1936-1937. He has received honorary degrees from Kenyon College, Amherst College, Colby College, the University of San Marcos, the University of Buenos Aires, and the University of Athens. He has taught at Harvard, Columbia, Yale, and Stanford Universities and at the University of Washington. He has served as visiting professor at the University of Buenos Aires, the University of Brazil, the Tata Institute of Fundamental Research, and at the Col. de France and as visiting lecturer at Japanese and Australian universities. Since 1946 he has been Andrew MacLeish distinguished service professor of mathematics at the University of Chicago, where he was chairman of the Department of Mathematics until 1952.

He is former vice chairman of the Division of Mathematics and Physical Sciences, National Research Council, and former president of the International Mathematical Union, and has been a member of the panel for elementary school mathematics, School Mathematics Study Group, since 1960.

During World War II he served with the Office of the Vice Chief of Naval Operations, Department of the Navy, and with the Office of the Chief of Staff, War Department, and carried out assignments overseas in the China-Burma-India and European theatres.

Professor Stone is the author of the book, "Linear Transformations in Hilbert Space and Their Applications to Analysis." He has contributed a number of research papers in the areas of general topology, the algebra of logic, and Hilbert space theory to domestic and foreign scientific journals.

ACHIEVEMENT AWARD NOMINATIONS REQUESTED

The Committee on Awards for Scientific Achievement has called attention to the Academy's annual scientific achievement awards program. Nominations for awards will be received at the Washington Academy of Sciences office, 1530 P St., N.W., until November 2.

Each year the Academy gives awards for outstanding achievement in each of five areas—biological sciences, engineering sciences, physical sciences, mathematics, and teaching of science (including mathematics). The 1964 winners of these awards will be honored at the annual dinner meeting of the Academy early in 1965. Academy fellows and members are invited to submit nominations for the awards, in accordance with the following procedures.

Eligibility. Candidates for the first four awards must have been born in 1924 or later; there is no age limit on the teaching of science award. All candidates must reside within a radius of 25 miles from the zero milestone behind the White House. It is not necessary that a candidate be a member of a society affiliated with the Washington Academy of Sciences.

Recommendation. Nomination forms can be obtained from the Academy office. Use of these forms is not mandatory, but the sponsor's recommendation should include the following: (a) General biography of candidate, including date of birth, residence address, academic experience with degrees and dates, and post-academic experience with particular detailed reference to work for which an award is recommended; (b) list of publications with reprints, particularly of that work for which recognition is suggested. If reprints are not available, complete references to publications must be included.

Citation. Particular attention should be given to preparation of a citation (80 typewriter spaces or less) which, in summary, states the candidate's specific accomplishments and which would be used in connection with presentation of award to the successful candidate.

Re-nomination. Former nominees may be re-nominated with or without additional evidence, provided sponsors make known their desires by letter to the general chairman of the Committee.

Early submission of biographical and publications information will facilitate the evaluation of nominations. Further information can be obtained from the various chairmen, as follows:

Edward A. Mason (general chairman), University of Maryland (WA 7-3800, Ext. 212).

Ellis T. Bolton (biological sciences), Department of Terrestrial Magnetism (WO 6-0863).

Martin A. Mason (engineering sciences), George Washington University (FE 8-0250, Ext. 248).

Samuel N. Foner (physical sciences), Applied Physics Laboratory (776-7100).

Harry Polachek (mathematics), David Taylor Model Basin (365-2600, Ext. 350).

Leo Schubert (teaching of science), American University (244-6800, Ext. 265).

ELECTIONS TO FELLOWSHIP

The following persons were elected to fellowship in the Academy at the Board of Managers meeting on June 9:

Benjamin H. Alexander, chief organic chemist, Department of Immunochemistry, Walter Reed Army Institute of Research, "in recognition of his contributions to organic chemistry, and in particular his researches on the relation of chemical constitution to biological activity with special reference to pesticides. (Sponsors: Leo Schubert, G. C. Paffenbarger, L. M. Kushner.)

William Benesch, assistant professor, Institute for Molecular Physics, University of Maryland, "in recognition of his contributions to molecular physics, and in particular his researches on high-resolution molecular spectroscopy in the far infrared." (Sponsors: E. A. Mason, H. W. Schamp, Jr., J. T. Vanderslice.)

George A. Candela, chemical physicist, Magnetic Measurements Section, National Bureau of Standards, "in recognition of his studies in magnetochemistry; in particular, his researches on the magnetic susceptibility of paramagnetic materials." (Sponsors: I. L. Cooter, A. H. Scott.)

Mark Harrison, chairman, Department of Physics, American University, "in recognition of his contributions to acoustics and his contributions to physics education." (Sponsors: Leo Schubert, R. K. Cook.)

Lester F. Hubert, chief, Synoptic Branch, Meteorological Satellite Laboratory, Weather Bureau, "in recognition of his contributions to meteorology, and in particular his original analysis of the structure of weather systems using information from meteorological satellites. (Sponsors: J. M. Mitchell, Jr., H. E. Landsberg.)

William H. Klein, chief, Development and Testing Section, Weather Bureau, "in recognition of his valuable contributions to science through original research (and distinguished authorship) in the fields of extended forecasting and dynamic climatology." (Sponsors: J. M. Mitchell, Jr., Jerome Namias, G. P. Cressman.)

Allan J. Melmed, physicist, National Bureau of Standards, "in recognition of his contributions to field-emission microscopy, particularly on metal whiskers." (Sponsors: L. M. Kushner, G. A. Ellinger, H. P. Frederikse.)

Malcolm W. Oliphant, chairman, Department of Mathematics, Georgetown University, "in recognition of his contributions to higher mathematics education in the District of Columbia and the Nation." (Sponsors: Jacinto Steinhardt, W. J. Thaler.)

Donald H. Pack, chief, Environmental Meteorological Research Project, Weather Bureau, "in recognition of his valuable scientific contributions in the fields of atmospheric pollution, diffusion, and the weather factor in safe operation of nuclear reactors." (Sponsors: J. M. Mitchell, Jr., H. E. Landsberg.)

Arthur W. Ruff, Jr., physicist, Solid State Section, National Bureau of Standards, "in recognition of his contributions to the study of dislocations in metal crystals by the application of electron microscopy techniques." (Sponsors: L. M. Kushner, G. A. Ellinger, H. P. Frederikse.)

John A. Simmons, research physicist, National Bureau of Standards, "in recognition of his contributions to theoretical research on plastic deformation." (Sponsors: L. M. Kushner, G. A. Ellinger, H. P. Frederikse.)

Ralph L. Streever, Jr., solid state physicist, Magnetic Measurements Section, National Bureau of Standards, "in recognition of his studies in nuclear magnetic resonance; in particular, his researches on the hyperfine fields in ferromagnetic metals, alloys, and compounds." (Sponsors: I. L. Cooter, A. H. Scott.)

Sidney Teweles, chief, Stratospheric Meteorology Research Project, Weather Bureau, "in recognition of his major contributions to knowledge concerning the meteorology of the upper atmosphere." (Sponsors: J. M. Mitchell, Jr., H. E. Landsberg.)

An earth-covered trampoline, constructed of one-inch nylon rope woven into a net on a 14-foot steel ring, has shown remarkable resistance to high explosive blasts when used as the roof sector of temporary military shelters. The Fort Belvoir Army laboratories, in tests, have compared this type of command post installation with comparable timber structures weighing ten times as much and found it to be as good or better, with the additional advantage of eliminating all supporting columns. In use, the roof is placed over an approximately 10′ diameter excavation and covered with earth.

Science in Washington

CALENDAR OF EVENTS

October 7—Institute of Electrical and Electronics Engineers

Meeting of George Washington University Student Branch. William W. Eaton, Deputy Assistant Secretary of Commerce for Science and Technology, "Engineering Management."

Room 200, Tompkins Hall of Engineering, GWU, 8:30 p.m.

October 8—Washington Society of Engineers

Ralph I. Cole, management consultant, "Engineering Manpower."

Powell Auditorium, Cosmos Club, 8:00 p.m.

October 8—American Society of Mechanical Engineers

Charles E. Berberick, manager of generating engineering, PEPCO, "Pepco's Chalk Point Plant."

Dinner at O'Donnell's Restaurant, 1221 E St., N.W., 6:00 p.m. Meeting at PEPCO Auditorium, 10th & E Sts., N.W., 8:00 p.m.

October 13-14—Bureau of Naval Weapons

Fifth Annual Symposium on Advanced Techniques for Aircraft Electric Systems.

Departmental Auditorium, Constitution Avenue between 12th & 14th Sts., N.W.

October 14—American Society of Mechanical Engineers

Field Trip to PEPCO's Chalk Point plant.

Buses leave PEPCO Building, 10th & E Sts., N.W., at 10:00 a.m. Transportation and box lunch, $3.00 per person.

October 14—American Society of Heating, Refrigerating, and Air-Conditioning Engineers

Otho E. Ulrich, Armstrong Machine Works, "Humidification—Why and How?"

Cameo Room of Presidential Arms, 1320 G St., N.W. Social hour at 5:15 p.m., meeting at 7:30 p.m.

October 21—Society of American Foresters

Clare W. Hemdee, deputy chief of Forest Service, and Dwight F. Rettie, staff coordinator of Poverty Program Task Force, on "Conservation and the Job Corps in the Poverty Program."

Occidental Restaurant, 1411 Pennsylvania Ave., N.W., noon.

October 21—Paleontological Society of Washington

J. Hazel and D. Massie of the Geological Survey, on subjects to be announced.

Room 43 Natural History Building, 10th St. & Constitution Ave., 8:00 p.m.

SCIENTISTS IN THE NEWS

Contributions to this column may be addressed to Harold T. Cook, Associate Editor, c/o Department of Agriculture, Agricultural Research Service, Federal Center Building, Hyattsville, Maryland.

AGRICULTURE DEPARTMENT

Herbert L. Haller, internationally known for his contributions to control of agricultural pests, retired August 31 after nearly 40 years of service with the Department. He joined USDA in 1919 as a chemist, and remained with the Department thereafter, except for five early years with the Rockefeller Institute for Medical Research. For the past two years he had been an assistant administrator of the Agricultural Research Service, with responsibilities in farm research. One of his most important contributions—made in collaboration with F. B. LaForge and L. E. Smith—was the determination of the chemical structure of rotenone, a naturally-occurring plant insecticide that leaves no toxic residue. For this achievement he received the Hillebrand Prize for 1932 from the Chemical Society of Washington.

AMERICAN UNIVERSITY

Leo Schubert has been appointed to the editorial advisory board of a new quarterly sponsored by AAAS, which will provide definitive and critical evaluations of science books at about the time of publication.

ARMY ENGINEER R&D LABORATORIES

Oscar P. Cleaver, who has received more work performance awards than any other employee at ERDL, recently received a 12th outstanding performance rating certificate

COAST AND GEODETIC SURVEY

B. K. Meade attended an International Association of Geodesy Symposium on the Readjustment of the European Triangulation Networks, held in Stockholm, Sweden, August 10-14.

John S. Rinehart, former director of the Mining Research Laboratory, Colorado School of Mines, has been appointed to direct the Coast and Geodetic Survey's Office of Research and Development. He replaces Christopher E. Barthel, Jr., who has left the Survey to become executive director of the Kansas Research Foundation at Topeka.

DAVID TAYLOR MODEL BASIN

Harry Polachek, head of the Applied Mathematics Laboratory, received the honorary degree of Doctor of Humane Letters at the 33rd annual commencement exercises of Yeshiva University in New York City on June 11. An alumnus of the University, Dr. Polachek was one of six distinguished leaders in the arts, sciences, and public life to receive honorary degrees at the ceremonies

Harvey R. Chaplin, deputy head of the Aerodynamics Laboratory, received the Doctor of Engineering degree on June 7 from Catholic University, as the clumination of his studies under the DTMB advanced training program for engineering, scientific, and professional personnel.

FAO

Roy C. Dawson, of the North American Regional Office, was assigned to FAO headquarters in Rome in the period August 26-September 25. He expected to return by way of Boston, in order to participate in an International Conference on the Wholesomeness of Irradiated Foods, September 27-30.

GEORGETOWN UNIVERSITY

Jacinto Steinhardt, professor of chemistry and science advisor to the president, recently received a five-year grant from the National Institutes of Health for study of the effects of protein interactions on protein stability. Dr. Steinhardt presented a paper, "Oxidation and Acid Denaturation of Ferrohemoglobins" (with F. Moezie), at the April meeting of the American Society of Biological Chemists in Chicago.

HARRIS RESEARCH LABORATORIES

Alfred E. Brown received the 1964 Honor Scroll of the Washington Chapter, American Institute of Chemists, at a dinner held here on May 5. Dr. Brown was cited for his contributions to professional societies and science organizations in the Washington area.

NATIONAL BUREAU OF STANDARDS

Shirleigh Silverman was recently appointed associate director for resources planning. In this position, Dr. Silverman will advise Director Astin on matters pertaining to the planning and management of the Bureau's scientific and technical programs, and in relating the Bureau's research programs to the technological needs of industry and the requirements of the scientific community.

John D. Hoffman has been named chief of the Polymers Division in the NBS Institute for Materials Research. He replaces Gordon M. Kline, who retired in December 1963. Dr. Hoffman will direct polymer research as well as polymer standards work at the Bureau, and will also personally engage in some research.

Arnold H. Scott has been named chief of the Dielectrics Section in the NBS Institute for Basic Standards. A member of the Dielectrics Section since 1924, Dr. Scott's efforts to improve the precision of dielectric measurements have made him internationally famous in his field.

A most enjoyable and festive luncheon was recently given to honor **Don Mittleman,** chief of the Computation Section, who resigned from the Bureau to accept an appointment at the University of Notre Dame, where he will set up a computer center.

John Mandel will be spending the coming academic year as a guest worker at the Technological University of Eindhoven, Netherlands.

NATIONAL INSTITUTES OF HEALTH

James A. Shannon, director of NIH, was the recipient of an honorary M.D. degree on May 29 from the famed Karolinska Institutet in Stockholm, Sweden. In his letter to Dr. Shannon, Dr. Sten Friberg, rector of the Institute, said, "The degree is a modest expression of our deeply felt appreciation of the generous support, given through the years, to Swedish medical research."

Kenneth M. Endicott, director of the National Cancer Institute, received the Distinguished Service Medal, the highest honor awarded by the Department to a member of the PHS Commissioned Corps, at the 13th Annual Honor Awards Ceremony of HEW on April 10. Dr. Endicott was cited "for his outstanding and distinguished leadership in medical research administration and national cancer research programs."

Marshall W. Niremberg, chief of the Section of Biochemical Genetics, Laboratory of Clinical Biochemistry, National Heart Institute, received the Superior Service Award at the same ceremony "for the first experimental verification of the chemical basis of the genetic code."

Koloman Laki has been appointed chief of the newly created Laboratory of Biophysical Chemistry of the National Institute of Arthritis and Metabolic Diseases. The new laboratory will be responsible for conducting research on muscle and blood proteins, the physical and enzymatic properties of contractile muscle proteins, and evolutionary aspects of the fibrinogen-thrombin interaction, among other studies.

Sarah E. Stewart of the Laboratory of Viral Oncology, National Cancer Institute, received the Lucy Wortham James Award on April 22 in New York City. The award is given annually by the James Ewing Society to an outstanding individual in cancer research. Dr. Stewart also was named by Georgetown University as a "Medical Man of Georgetown." She is the first woman graduate to receive this honor, which is bestowed periodically in the Georgetown Medical Bulletin. Dr. Stewart was also the first woman to earn an M.D. degree at the university, in 1949.

Carl J. Witkop, Jr., chief of the Human Genetics Branch, National Institute of Dental Research, attended the Institute of Nutrition for Central America and Panama in Guatemala City, Guatemala, June 22 to September 1, where he took a course in public health nutrition. Dr. Witkop also gave a course in human genetics, and acted as co-instructor in a course on nutrition diseases as they affect the oral cavity. He conducted a study on the relationship of vitamin A absorption and certain hereditary lesions of the tongue, and a study of possible genetic factors as they relate to nutritional requirements and oral disease.

NATIONAL SCIENCE FOUNDATION

Raymond J. Seeger was scheduled to give one of the major addresses at an international symposium on the history, methodology, logic, and philosophy of science, held in Florence, Italy, September 14-16 in honor of the quatercentenary of the birth of Galileo. His subject was, "On Galileo's Philosophy of Science—in Retrospect."

NAVAL RESEARCH LABORATORY

On July 29, the Department of Defense Distinguished Civilian Service Award was presented to **William A Zisman,** superintendent of the NRL Chemistry Division. Dr. Zisman was the only Navy employee receiving the award at this time. The award was presented for his contribution to surface chemistry and lubrication, which has been his particular field of interest since he joined the Laboratory's staff in 1939.

Last May, **Herbert Friedman** and **Richard Tousey** received the 1964 Eddington Medal of the British Royal Astronomical Society "for their pioneering research in ultraviolet astronomy." Dr. S. Friedman and Tousey have been leaders in rocket astronomy since the V-2 rockets first became available at the end of World War II.

Allen L. Alexander, associate superintendent of the Chemistry Division, presented a paper on "Natural Resistance of Woods to Marine Borer and Other Biological Deterioration in Tropical Environments" before the I^{e} Congres International de la Corrosion Marine et des Salissures held at Cannes, France in June. At the conclusion of this conference, Dr. Alexander visited the Institut Francais du Petrole in Paris, the Organization for Industrial Research TNO in Delft, Holland, and a number of British Admiralty laboratories in England.

Horace M. Trent, Applied Mathematics Staff, is chairman of the newest technical committee set up under the International Standards Organization—TC 108, on Mechanical Vibration and Shock. This committee held its first meeting June 1-5 in Aix-les-Bains, France, with representatives from seven countries in attendance.

G. R. Irwin, superintendent of the Mechanics Division, participated in a special conference on fracture of heavy section steel structures held at the Royal Society in London, on May 28.

SMITHSONIAN INSTITUTION

Frank H. H. Roberts, Jr., director of the Bureau of American Ethnology and one of the founders of the Inter-Agency Archeological Salvage Program, retired on July 3 after 37 years and 7 months of service. During the time that Dr. Roberts was with the Institution, he spent many years excavating prehistoric archeological remains in the Southwestern United States and publishing the results of these excavations. He was one of the three or four American archeologists who had the foresight to see the potential destruction to American prehistory by the large-scale program of reservoir construction throughout the nation, and was the leader in organizing the River Basin Surveys to salvage these archeological remains.

NOTES FROM OUR OVERSEAS CORRESPONDENT

Frank L. Campbell reported from Karlsruhe on August 15 that after attendance at the Entomology Congress, he had spent a month in London recovering from pneumonia. Thereafter he had acquired a new Volkswagen, and currently he was being driven by Mrs. Campbell through Germany toward Switzerland and Italy.

DEATHS

Charles O. Appleman, emeritus professor of botany and emeritus dean of the University of Maryland Graduate School, died on July 28 at the age of 85. Dr. Appleman was dean of the Graduate School from 1918 until his retirement in 1948. He started his career as a plant physiologist at the Maryland Agricultural Experiment Station in 1908 and was made professor of plant physiology in 1910. He was distinguished for his research on the respiration of plant tissues. Dr. Appleman served as chairman of the graduate section of the American Association of Land Grant Colleges and Universities, as president of the Society of Plant Physiology, and as president of the Conference of Deans of Southern Graduate Schools.

Peter Hidnert, 72, a physicist at the National Bureau of Standards for more than 40 years, died June 10 after a heart attack. Dr. Hidnert joined the Bureau in 1916, served as a physicist until his retirement in 1957, and was a consultant there from 1957 to this year. He specialized in the linear thermal expansion of solids, and in the instruments and methods used to measure such expansion. He wrote numerous articles for scientific journals throughout the world.

A native of New York, Dr. Hidnert received the B.A. and M.S. degrees from George Washington University, did graduate work at Columbia University, and received the Ph.D. degree in physics from American University. In 1952 he received a medal of merit from the Department of Commerce.

Ross C. MacCardle, 62, of the National Cancer Institute, died June 23 after a heart attack. Dr. MacCardle, a native of Bart, Pa., was a graduate of the University of Michigan and Brown University. Before joining NCI in 1946, he had taught at Temple, Columbia, and Duke Universities, and from 1938 to 1946 had been a research assistant and assistant professor of anatomy at Washington University in St. Louis. During World War II, Dr. MacCardle worked for the Army Air Force, on research that led to the development of high altitude oxygen equipment. From 1947 to 1953 he was scientific editor of the Journal of the National Cancer Institute; and recently he had been named editor-in-chief of the International Journal of Cancer. Also, he was a teacher of physiology and histology, and lectured to classes at Johns Hopkins, George Washington, and American Universities. He was an associate clinical professor of anatomy at the Georgetown University School of Medicine.

SCIENCE AND DEVELOPMENT

If one accepts the current notion, held by some informed geologists, that the earth first evolved as a cold body from a dust cloud about the sun, and then for a period of perhaps a billion years remained relatively quiet while it heated up internally as a result of radioactive decay, it suggests that fragments of the original crust may still remain in certain of the continental rocks. Robert S. Dietz, of the Coast and Geodetic Survey, who argues for this point of view, feels that the search should shift from the granitic rocks, where it has been traditionally pushed and which have been unrewarding, to what are called "ultramafics," dark heavy rocks found embedded in very old sedimentary rocks of the oldest mountain ranges. He suggests that radioactive analysis, indicating exceedingly ancient origins for these possible fragments of the earth's crust, which have hitherto been discounted as unbelievable, may actually be valid. Dr. Dietz feels it highly unlikely that the sea floor, which has undergone repeated renewal during the earth's history, will retain any of the sought after crust fragments; he suggests rather various continental spots such as Manitoba, Northern Rhodesia, and the Russo-Finnish border.

For some time the Geological Survey has conducted studies of heat flow from the earth's interior in old mines, tunnels, and wells in the West as a part of its contribution to the International Upper Mantle Project, a study of the geology of the outer 400 miles of the earth. Augmenting this, the Survey is drilling a 2,000 foot hole in the Sierra Nevada, a young still-building mountain range, at a point 40 miles northeast of Fresno, Calif. At some later time a second boring will be made at a point where radioactivity is much greater, and where the crust is thicker. Comparisons of the heat flow at the two sites, and with others both within and outside the continental United States, will help in determining more precisely the role of radioactivity in the generation of the earth's heat. Actual calculations are made from records of temperature changes within the holes and measurements of thermal conductivity in sample cores.

The contributions of the amateur enthusiast to scientific knowledge, particularly in these days of multimillion dollar research hardware, are too often overlooked, perhaps. It is comforting to note, then, the recent purchase by the Smithsonian Institution of a meteorite collection from the estate of Arthur Allen, a man with little formal education who managed first the family blacksmith shop, and later opened one of the first automobile shops in his Colorado home town. But he had a consuming interest in meteorites, and spent a great deal of time in building his collection of 45, eleven of them not represented in the Smithsonian's present collections, and seven previously unknown to scientists.

And speaking of extraterrestrial materials, evidence is accumulating, according to staff members and colleagues of the Astrophysical Observatory in Cambridge, Mass., that the dust particles recovered from polar ice caps, showing as they do magnetic properties and an iron content usually not found in terrestrial materials, are almost certainly solidified droplets from asteroids, meteors, or comets. Analysis of volcanic deposits indicates that the proportion of these spheroidal forms in volcanic particles is minute, and that most of the volcanic samples contain aluminum while most of the polar ice granules do not.

The more commonly encountered units in the International System of Units recently adopted by the National Bureau of Standards would cause few of us any hesitation—the meter, kilogram, second, ampere, degree Kelvin, and, perhaps, even the candela (for luminous intensity). Others are more intriguing, no doubt, but sound strange to the ear of all but the physical scientists. A few, chosen from a lengthy list just released by the Bureau, show how extensively the names of noted scientists of the past are thus preserved to the future:

hertz—frequency
newton—force
farad—electrical capacitance
weber—magnetic flux
henry—inductance
watt—power
coulomb—electric charge

Units designed for the Army primarily to produce potable water from the sea have proved, in tests, to be encouragingly effective in removing water-soluble chemical warfare agents from contaminated sources. In some cases it was necessary to subject the material to additional treatments with carbon or ion exchange resins, while in others the water leaving the distillation units was drinkable immediately.

Cost and convenience, among other things, govern the utility of reader-printers in microcopy work. The Council on Library Resources has taken one step toward improving this situation by awarding a contract to Documentation Incorporated, which will attempt to build a machine weighing about 20 pounds and selling for perhaps $100 to $200, depending on numbers produced. Prototypes will be tested in area libraries under actual conditions before a decision is reached on final production. Among special features are a paper supply in pack form and a combined developing and clearing tank used in processing the film.

Delegates to the Washington Academy of Sciences, Representing the Local Affiliated Societies*

Philosophical Society of Washington	Urner Liddel
Anthropological Society of Washington	Gordon McGregor
Biological Society of Washington	John L. Paradiso
Chemical Society of Washington	William A. Zisman
Entomological Society of Washington	Harold H. Shepard
National Geographic Society	Alexander Wetmore
Geological Society of Washington	Luna Leopold
Medical Society of the District of Columbia	Thomas M. Brown
Columbia Historical Society	U. S. Grant, III
Botanical Society of Washington	Wilbur D. McClellan
Society of American Foresters	Harry A. Fowells
Washington Society of Engineers	Martin A. Mason
Institute of Electrical and Electronics Engineers	George Abraham
American Society of Mechanical Engineers	William G. Allen
Helminthological Society of Washington	Marion M. Farr
American Society for Microbiology	Frank Hettrick
Society of American Military Engineers	H. P. Demuth
American Society of Civil Engineers	Thorndike Saville, Jr.
Society for Experimental Biology and Medicine	Falconer Smith
American Society for Metals	Hugh L. Logan
International Association for Dental Research	Harold J. Caul
American Institute of Aeronautics and Astronautics	Eugene Ehrlich
American Meteorological Society	J. Murray Mitchell, Jr.
Insecticide Society of Washington	Robert A. Fulton
Acoustical Society of America	Malcolm C. Henderson
American Nuclear Society	George L. Weil
Institute of Food Technologists	Richard P. Farrow
American Ceramic Society	J. J. Diamond
Electrochemical Society	Kurt H. Stern

* Delegates continue in office until new selections are made by the respective affiliated societies.

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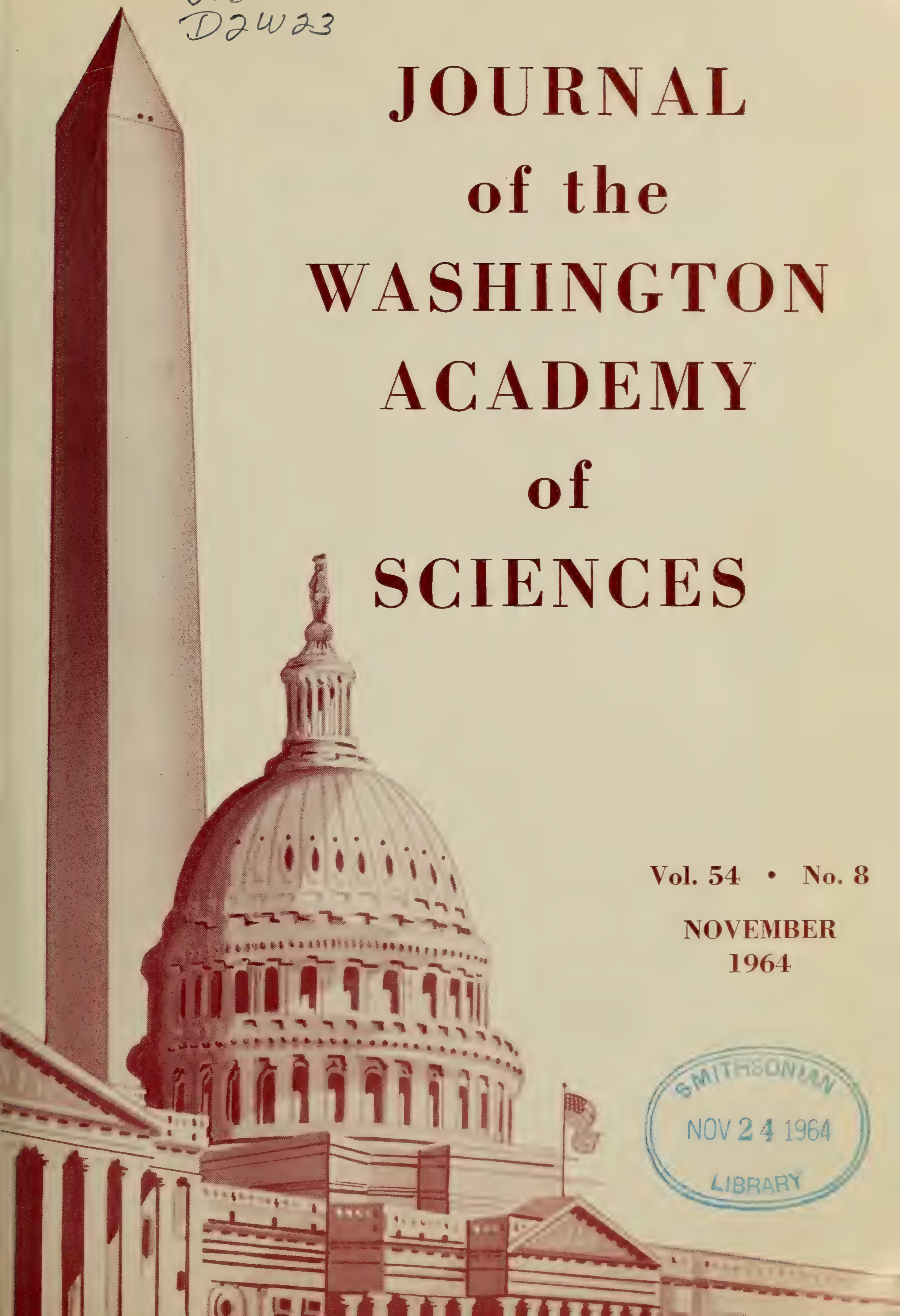

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NOVEMBER
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JOURNAL OF THE WASHINGTON ACADEMY OF SCIENCES

This Journal, the official organ of the Washington Academy of Sciences, publishes historical articles, critical reviews, and scholarly scientific articles; notices of meetings and abstract proceedings of meetings of the Academy and its affiliated societies; and regional news items, including personal news, of interest to the entire membership. The Journal appears nine times a year, in January to May and September to December. It is included in the dues of all active members and fellows.

Subscription rate to non-members: $7.50 per year (U.S.) or $1.00 per copy; foreign postage extra. Subscription orders should be sent to the Washington Academy of Sciences, 1530 P St., N.W., Washington, D.C. Remittances should be made payable to "Washington Academy of Sciences."

Back issues, volumes, and sets of the Journal (Volumes 1-52, 1911-1962) can be purchased direct from Walter J. Johnson, Inc., 111 Fifth Avenue, New York 3, N. Y. This firm also handles the sale of the Proceedings of the Academy (Volumes 1-13, 1898-1910), the Index (to Volumes 1-13 of the Proceedings and Volumes 1-40 of the Journal), and the Academy's monograph, "The Parasitic Cuckoos of Africa."

Current issues of the Journal (past two calendar years) may still be obtained directly from the Academy office at 1530 P Street, N.W., Washington 5, D.C.

Claims for missing numbers will not be allowed if received more than 60 days after date of mailing plus time normally required for postal delivery and claim. No claims will be allowed because of failure to notify the Academy of a change of address.

Changes of address should be sent promptly to the Academy Office, 1530 P St., N.W., Washington, D.C. Such notification should include both old and new addresses and postal zone number, if any.

Second class postage paid at Washington, D.C.

ACADEMY OFFICERS FOR 1964

Albert Einstein, As I Remember Him*

Churchill Eisenhart

Senior Research Fellow, National Bureau of Standards

During the winter of 1933, Albert Einstein joined the newly formed Institute for Advanced Study in Princeton, N.J., and took up residence in Princeton for the rest of his life. Soon after he had settled in his first house, at the corner of Mercer Street and Bayard Lane, he and his second wife, Frau Elsa Einstein Einstein, who was his cousin, came to dinner at my father's house. I, a senior in Princeton University, residing on the campus, went home for the occasion. During dinner Professor Einstein returned again and again to how well his wife took care of him. Finally, my mother interjected: "Professor Einstein, your wife seems to do absolutely everything for you. Just exactly what do *you* do for her?" With a twinkle in his eye he replied at once: "I give her my understanding."

One day not long thereafter, the telephone rang in the office of the Dean of the Graduate School, Princeton University. The voice at the other end inquired: "May I speak with Dean Eisenhart, please." Being advised that my father was not in, the voice continued: "Perhaps then *you* will tell me where Dr. Einstein lives." My father's secretary replied that this she could not do inasmuch as Dr. Einstein wished to have his privacy respected. The voice on the telephone dropped to a near whisper, and continued: "Please do not tell anybody, but I *am* Dr. Einstein. I am on my way home and I have forgotten where my house is."

My father has an anecdote about Dr. Einstein that he enjoys telling because in this case the joke was on my father's long-time friend, the late Thomas J. Watson, president of the International Business Machines Corporation, whose wife (nee Jeannette Kittridge) my father had known in their school days in York, Pennsylvania. By way of background, let me remind you of two technological advances of the 40's: (1) The IBM executive typewriter, which types such clean sharp copy that it looks as if it were printed, was placed on the market in 1940. (2) the world's first truly electronic automatic digital calculator, the ENIAC (acronym for Electronic Numerical Integrator And Calculator), designed and built for the Ballistic Research Laboratories, Aberdeen Proving Ground, was dedicated at the Moore School of Electrical Engineering of the University of Pennsylvania in February, 1946, and was moved to Aberdeen Proving Ground in October of the same year.

In 1948, the IBM Corporation sent out letters to all of the big names in mathematics, science, and industry, inviting them to the forthcoming unveiling of IBM's great new Selective Sequence Electronic Computer at IBM world headquarters on Madison Avenue, New York. One of these invitations went to Dr. Einstein. Several weeks elapsed and they received no reply. A second invitation was sent. Again no reply. My father was reached by telephone from New York and asked to inquire whether Dr. Einstein had received an invitation and whether he would be able to attend. He explained that something must be amiss, because Dr. Einstein was scrupulous about replying to all such invitations. He walked over to Dr. Einstein's house and explained the situation. Dr. Einstein dumped the contents of a very

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*Adapted from the author's commencement address presented on June 15, 1964, to the first class to graduate from the Albert Einstein Senior High School, Newport Mill Road, Kensington, Md.

large wastebasket on the floor and examined an item here and there. Finally his face lighted up. He handed one of the invitational letters to my father, saying, "It looks as if it were printed. I never read printed circulars." Unfortunately, by then Dr. Einstein had already committed himself to another engagement and was unable to attend the unveiling.

In the book review section of the current (June 1964) issue of the *Scientific American*, J. Bronowski remarks:

> From time to time a new branch of science catches the imagination of scientists and public together, so that it comes to express the spirit of a whole generation. The theory of evolution by natural selection did this 100 years ago; it was an idea that laymen as well as naturalists could seize, with the result that they could see its implications and feel themselves personally engaged in them. In our own century the theory of relativity took the same hold on the generation of World War I.

But with this difference in the case of the theory of relativity: laymen lacking the advanced physics and higher mathematics necessary for its appreciation, did not, and could not be expected to comprehend Einstein's theory. In consequence, the lay public seems to have seized upon one particular non-original feature, namely, formulation of the theory in terms of *four-dimensional geometry*, as constituting the new, revolutionary, and far-reaching contribution of the entire theory. And worse, having a misconception of what a mathematician or a mathematical-physicist means by a "four-dimensional space," the public accepted this feature of the theory as the basis of its incomprehensibility to them. This in turn gave rise to the commonly held belief that Einstein's theory was so difficult that only a handful, or at most a dozen men in the entire world were capable of comprehending it; and, finally, to mystical and even fanatical reverence and adulation of Einstein himself. Einstein, notable to all who knew him personally for his extreme shyness and his honest and forthright humility, is said to have commented on all of this with characteristic modesty: "It is an irony of fate that I myself have been the recipient of excessive admiration and reverence from my fellow beings, through no fault and no merit of my own. . .*"

Einstein was deeply disturbed by the popular belief that he had invented the concept of a "four-dimensional space," and took pains in his Autobiographical Notes (see below) to correct the "widespread error that the special theory of relativity is supposed to have, to a certain extent, first discovered, or at any rate, newly introduced, the four-dimensionality of the physical continuum." He was particularly impatient with the commonly held belief that his theory was so difficult that only six, ten, or at most a dozen people in the entire world were able to comprehend it, and especially with the fact that such estimates were often attributed to Einstein himself. Consequently, he was very receptive to a manuscript by Joseph B. Nichols entitled, "You have one chance in a hundred to understand Einstein" that I brought to him on behalf of the *Scientific American* late in 1933. (In those days I was a so-called "contributing editor" of the *Scientific American*, my "contribution" consisting principally of replying to correspondence received on mathematical and physical topics.)

In this article Mr. Nichols emphasized that in order to answer the question of how many people can understand Einstein "we must first define just what we mean by 'understanding Einstein.' "

> If, by an understanding of relativity, we mean such a complete knowledge of the subject that all its implications and effect are explicitly in mind, [then] we may anticipate the answer to be—none. I am sure that Professor Einstein would be the first to agree with this conclusion.

Professor Einstein concurred. Mr. Nichols continued:

> Suppose we . . . estimate, if we can, how many may perhaps understand almost as much of rela-

*William Cahn, *Einstein: A Pictorial Biography*, The Citadel Press, New York, 1955; paperback reprint, 1960, page 40.

tivity as Einstein himself. The number of men included in this group would be very small; perhaps, at the lowest, the mighty six, or at the most liberal estimate not more than two or three dozen. They would be men of surpassing ability, who have given a lifetime to the study of mathematical physics . . . Though an illuminating idea may wait for generations for some genius to discover it; after that genius has once announced it, it appears to those who are prepared as very understandable.

Mr. Nichols then went on to expound his general thesis that at birth one child in a hundred has the mental capacity to understand Einstein, *provided* that he receives sufficient training in mathematics and physics; and that in the case of any particular child his chances improve steadily as he grows older, *if* he embarks upon the necessary program of training in mathematics and physics, or decrease steadily if he shuns these subjects and pursues a course of study leading to some other profession. In other words, in the senior class here tonight there are very likely a dozen or so whose chances of understanding Einstein's theory of relativity are very good, and many many more whose chances are very slim—they are already headed in other directions.

Professor Einstein enthusiastically endorsed the proposed publication of this article, and wrote to Mr. Nicsols: "What you say against the legend of the unattainableness of the theory of relativity is as correct as it is useful. I believe that your figures give a good idea and contribute towards removing that detrimental and false faith in authority against which I have always fought to the best of my ability." Needless to say, the article was published, in the February 1934 issue of the *Scientific American.*

My fear of the great man being reduced to manageable proportions by this experience, I took to him a term paper on "The Ether" as viewed through the "spectacles" of the special and the general theories of relativity, a paper that I had written a year or so earlier in a course on relativity. (Actually, as I was to learn, Professor Einstein was ever ready, and even eager, to give time and attention to those who really needed it, especially to young people. To these, who would sometimes hesitate to bother Einstein with their problems, he would say: "I shall always be able to receive you. If you have a problem, come to me with it. You will never disturb me, since I can interrupt my own work at any moment." * And so it came to pass that Professor Einstein obligingly helped me fix up my manuscript, saying to me charitably that its publication might save him the necessity of answering so many inquiries on the subject. It appeared in the November 1934 issue of the *Scientific American,* with a flashy title devised by the editors, "The Ether: Riddle of the Ages."

During the brief two-year period (1933-1935) before I left Princeton for the University of London in August 1935, I heard Dr. Einstein present only one scientific paper. It was a memorable occasion. I do not recall the subject of his talk at this great distance. I do recall that he spoke slowly and gave an exceptionally clear account of what he had to say. When he had finished, one of the other mathematicians present proceeded to deduce Professor Einstein's principal result in short order from certain results of other authors in the then available scientific literature. The audience waited breathlessly for Professor Einstein's response. He rose, thanked his colleague for this very concise and elegant derivation of his own principal result, reminded all present that the assumptions underlying the results upon which the discussant's short proof had been based were somewhat different from those from which he himself had started, and concluded by thanking his colleague for thus revealing that his result had a somewhat broader base of validity than he himself had appreciated. The approving buzz of the audience testified to the fact that Albert Einstein had clearly not lost but gained from

*Ibid., p. 76.

the intended criticism.

From Albert Einstein's pen came over 300 articles, books, essays, etc., on scientific topics. His non-scientific publications came to nearly 150; and almost as many interviews, letters, and speeches by Einstein were quoted in the *New York Times,* not counting items published more completely elsewhere.* One of the letters quoted in the *Times,* dated February 10, 1929, was addressed "to a 13-year Los Angeles boy who had written on relativity for a Los Angeles paper"; another, dated July 26, 1934, praised Phillip H. Phenix, my classmate at Princeton, for his senior thesis on "The absolute significance of rotation."

Professor A. M. Low, president of the British Institute of Engineering Technology, said on learning of Einstein's death: "No tribute can be adequate. His death is a great loss to science, and a greater loss to the world of a good and kindly man."* Although Professor Einstein found it necessary to escape from publicity seekers, he never shut the door to those who needed his advice and counsel. As I have already said, he was especially found of helping children. The stories on this score are legion in Princeton. I wish that I could tell some of these here, plus more anecdotes based on my own or my family's experience. But the time alloted to my "appetizer" has run out, and I had best sit down soon and let you turn to the "main course."

You, the first class to graduate from Albert Einstein Senior High School have an unusual opportunity to keep alive by your words and deeds the living memory of "a good and kindly man" whom Senator Herbert Lehman termed "a great citizen of the world and one of the greats of our age." *

*Annotated lists of all of these various publications of Dr. Einstein through 1949 may be found in *Albert Einstein: Philosopher-Scientist,* edited by Paul Arthur Schilpp, The Library of Living Philosophers, Inc., Evanston, Illinois, 1949; which also contains Einstein's "Autobiographical Notes" in his original German and in English translation, on facing pages (pp. 2-95).

* Ibid., p. 122.

Academy Proceedings

483rd Meeting of the Washington Academy of Sciences

SPEAKER: CHRISTOPHER TIETZE
Director of Research, National Committee on Maternal Health, Inc., New York City

SUBJECT: EFFECTIVENESS OF METHODS OF POPULATION CONTROL

TIME: THURSDAY, NOVEMBER 19, 1964
8:15 P. M.

PLACE: JOHN WESLEY POWELL AUDITORIUM, COSMOS CLUB
2170 Florida Avenue, N.W.

Abstract of Address—Adoption of official policies of population control aimed at achieving a balance between rate of population growth and socio-economic development in many countries of Asia and Africa is a truly twentieth-century phenomenon. National programs underway or under serious discussion have the primary objective of reducing birth rates, which have remained high while death rates have been dramatically reduced by modern medical achievements. To appraise these policies realistically in terms of attainment of objectives, we must understand the relationship between contraceptive methods and birth rates.

The following specific methods and techniques of birth control are compared for their effectiveness and suitability under the conditions prevailing in the emerging areas of the world: (1) "Traditional" methods—diaphragm, condom, jellies, etc.; (2) "modern techniques"—the oral "pill" and intro-uterine devices; and (3) surgical sterilization and induced abortion.

Levels of contraceptive effectiveness of different methods of birth control, in terms of pregnancy rates during periods of contraceptive practice, are compared with crude birth rates per 1,000 population. The objectives of population control programs require both highly effective contraceptive methods and their adoption at an early stage of the reproductive cycle by all couples exposed to the risk of pregnancy.

The Speaker—Born in Vienna, Christopher Tietze graduated from the University of Vienna Medical School in 1932. He served his medical internship at Municipal Hospital, Vienna, and before coming to the United States in 1938, had a general medical practice in his native city. From 1938 to 1943 he was research associate at the Johns Hopkins University School of Hygiene and Public Health and he also served as medical statistician of the Mental Hygiene Study of the Eastern Health District in Baltimore. From 1943 to 1949 he was research associate of the National Committee on Maternal Health. Dr. Tietze became a United States citizen in 1944. For 19 months, from 1944 to 1946, he served as battalion surgeon with combat engineers in New Guinea, the Philippines, and Japan. He was director of Italian Statistical Studies at the Johns Hopkins University School of Hygiene and Public Health, 1947 and 1948. From 1949 to 1957 he served with the Division of Functional Intelligence, Department of State, as intelligence research specialist (demography) and as chief of the Population and Labor Staff. Since 1958 he has been director of research for the National Committee on Maternal Health.

Dr. Tietze has been advisor to the U.S. delegation to the 8th and 9th sessions of the United Nations Population Commission (1955 and 1957); advisor to the U.S. delegation to the 4th session of the Committee on the Improvement of National Statistics of the Inter-American Statistical Institute (1956); statistician for family planning, United Nations Technical Assistance Administration, in Barbados, W. I. (1956 and 1958); and U.S. delegate to the Conference on Demographic Problems of the Area Served by the Caribbean Commission, Port-of-Spain, Trinidad (1957).

DIRECTORY CORRECTIONS

Foresters

In preparations for the September 1964 directory, one sheet of the master list for the Washington Section, Society of American Foresters (Code 2L) was overlooked; hence over three dozen foresters of the Washington area were not included. Your editor shares responsibility for this oversight by failing to realize that when Page 3 of a list follows Page 1, something must be wrong.

The following persons should be added to the list of foresters on pages 277-279 of the directory:

ALEXANDER, PETER P	4CONS
CASTLES, JOHN R	1AFOR
CHANDLER, CRAIG C	1AFOR
CHESTER, CHARLES E	1IBIA
CHURCHILL, E DICK	4CONS
CHURCHILL, GILBERT B	9CLUN
CLAPP, CECIL E	1AFOR
CLAPP, E H	7RETD
CLARKE, E H	1AFOR
CLAUSEN, MELVIN D	8NRNC
CLAYTON, JOSEPH E	1DAX
CLEMENTS, PAUL H	9CLUN
CLEPPER, ALBERT L	4CONS
CLEPPER, HENRY E	3ASAF
CLIFF, EDWARD P	1AFOR
CLIFF, OLIVER	1AFOR
CLOCKER, EVERETT H	1AFOR
CLONINGER, RUSSELL T	1AFOR
CONNOLLY, FRANK A	9CLUN
COOK, LAWRENCE F	1INPS
COSTLEY, RICHARD J	1AFOR
COWGER, ROLAND D	1CBPR*
CRAFT, ARCHIE D	1IBLM
CRAFTS, EDWARD C	1IBOR
CRAIG, JAMES B	3AAFA
CRAVENS, JAY H	1AFOR
CUMMINGS, LAURENCE J	1SAID
CUMMINGS, WILLIAM H	1ACSR
CURTIS, ROBERT L	1DNBY
DAHLEN, WADE A	1AFOR
DAVIS, ARTHUR A	9CLUN
DAVIS, CLINTON L	1AFOR
DEAN, ANTHONY P	7RETD
DE GROAT, RUSSELL E	1DFX
DE NIO, REGINALD M	1AFOR
DIEHL, JAMES N	7RETD
DILLER, JESSE D	7RETD
DIMMICK, ROBERT S	1AFOR
DONALDSON, HAROLD B	1AFOR
HORNADAY, FRED E	9CLUN
HORSMAN, LEWILL E	1DAEC
HOWARD, HARRY E	1AFOR
HUCKENPAHLER, B J	1AFOR
HUPPUCH, MATTHIAS C	1DAEC
HUSMAN, DONALD L	1DAX
INCE, GORDON A	1AFOR
JACKSON, SETH	1AFOR
JACQUEMIN, FRANCIS P	1IBLM
JANZEN, DANIEL H	1IFWS
JAY, JAMES W	1AFOR
STEINHOFF, ROBERT G	1AFOR

NRL

On page 250, under 1DNRL, Naval Research Laboratory, B. F. Brown and Floyd Brown are the same person.

*1CBPR—Bur. Public Roads

OCEANOGRAPHERS

Under the agency classification, the National Oceanographic Data Center appears twice—on page 249 as 1DNOD, and on page 254 as 1XNOD. The first of these is the correct code.

ELECTIONS TO FELLOWSHIP

The following persons were elected to fellowship in the Academy at the Board of Managers meeting on October 13:

Alden B. Bestul, physicist, Inorganic Materials Division, National Bureau of Standards, "in recognition of his contributions to the understanding of the rheology of concentrated high polymer solutions especially in the non-Newtonian regime and at critical energy inputs; and of the vitreous conditions of matter, especially as it occurs in diverse types of substances." (Sponsors: C. M. Tchen, G. B. Schubauer, R. E. Ferguson.)

Stanley Block, crystallographer, Crystallography Section, National Bureau of Standards, "in recognition of his contributions in crystallography, particularly in determination of structure of borates, phosphates, and glasses, and in the application of modern computer methods to such studies." (Sponsors: H. F. McMurdie, H. C. Allen, Jr., J. J. Diamond.)

George B. Chapman, professor and chairman of Department of Biology, Georgetown University, "in recognition of his researches conducted with the electron microscope in the field of cytology, ranging from bacteria to man." (Sponsors: J. Steinhardt, W. J. Thaler.)

Thomas D. Coyle, chief, Inorganic Chemistry Section, National Bureau of Standards, "in recognition of his contributions to inorganic chemistry and in particular his researches on the synthesis and characterization of new compounds." (Sponsors: H. C. Allen, Jr., J. J. Diamond, H. F. McMurdie.)

Richard D. Deslattes, Jr., physicist, Crystal Chemistry Section, National Bureau of Standards, "in recognition of his contributions to soft X-ray spectroscopy and crystal defect studies by X-ray diffraction microscopy." (Sponsors: H. S. Peiser, J. L. Torgesen, J. J. Diamond.)

Eduard Farber, research professor of chemistry, American University, "in recognition of his pioneer and prolific work in the history of chemistry and his laboratory work in wood chemistry." (Sponsors: L. Schubert, B. W. Sitterly.)

Wolfgang Haller, physical chemist, Glass Section, National Bureau of Standards, "in recognition of his contributions to physical chemistry, and in particular his researches on the structure of glass." (Sponsors: J. J. Diamond, H. C. Allen, Jr., H. F. McMurdie.)

Louis S. Hansen, head, Officer Education Department, Naval Dental School, National Naval Medical Center, "in recognition of his extensive investigations of the pathological conditions in the mouth and of diagnostic problems in oral pathology as well as distinguished administration of research in the field of oral pathology." Sponsors: G. M. Brauer, G. Dickson, W. T. Sweeney.)

Martin Jacobson, chemist, Agricultural Research Service, "in recognition of his contributions to our knowledge of the chemistry of natural products and in particular for his leading role in the elucidation of the chemistry of sex attractants isolated from insects and in the synthesis of new compounds useful in attracting injurious insects." (Sponsors: F. L. Campbell, G. W. Irving, Jr., S. B. Detwiler, Jr.)

Philip S. Klebanoff, physicist, Fluid Mechanics Section, National Bureau of Standards, "in recognition of his contributions to fluid dynamics, particularly his researches on the transition from a laminar to a turbulent flow and the hydrodynamic stability of waves developed in a boundary layer." (Sponsors: C. M. Tchen, G. B. Schubauer, R. E. Ferguson.)

Ernest M. Levin, physical chemist, National Bureau of Standards, "in recognition of his contributions to the study of the phase relations of inorganic oxides, and for his service in the compilation of data on such solids." (Sponsors: H. F. McMurdie, H. C. Allen, Jr., J. J. Diamond.)

Robert J. List, chief, Atmospheric Radioactivity Research Project, Weather Bureau, "in recognition of his contributions to meteorology and the public welfare, and in particular of his researches on atmospheric radioactive fallout." (Sponsors: J. M. Mitchell, Jr., H. E. Landsberg, H. C. S. Thom.)

William M. MacDonald, professor of physics, University of Maryland, "in recognition of his contributions to the field of nuclear physics, particularly to the theory of nuclear reactions and to Coulomb corrections of the isotopic spin approximations." (Sponsors: J. S. Toll, R. D. Myers, H. D. Holmgren.)

Gertrude D. Maengwyn-Davies, professor of pharmacology, Georgetown University, "in recognition of her contribution to pharmacology, and in particular of her researches on enzyme kinetics and on the effects of atropine, including its reaction with amino acids." (Sponsors: M. L. Robbins, T. Koppanyi, B. R. Bhussry.)

Millard Maienthal, chemist, Bureau of Scientific Research, Food and Drug Administration, "in recognition of his contributions to organic chemistry, and in particular his researches on amines and nitriles." (Sponsors: J. K. Taylor, R. S. Tipson, R. Schaffer.)

Terrell L. Noffsinger, agricultural program leader, Weather Bureau, "in recognition of his contribution to biometeorology, and in particular of his wide-ranging and significant research on the relation of weather to crops and farm animals." (Sponsors: J. M. Mitchell, Jr., H. E. Landsberg, H. C. S. Thom.)

Vincent J. Oliver, chief, Requirement and Application Branch, National Weather Satellite Center, Weather Bureau, "in recognition of his broad contributions to meteorology, including valuable research in weather forecasting, and of his valuable and effective leadership in meteorological training and education." (Sponsors: J. M. Mitchell, Jr., H. E. Landsberg, H. S. C. Thom.)

Fred D. Ordway, Jr., consultant, Inorganic Materials Division, National Bureau of Standards, "in recognition of his contributions to crystal chemistry, particularly in determinations of crystal structures, the phase problem, and studies on the nature of glass." (Sponsors: H. F. McMurdie, J. J. Diamond, J. B. Wachtman, Jr.)

Elizabeth J. Oswald, research microbiologist, Bureau of Scientific Research, Food and Drug Administration, "in recognition of her contributions to microbiology and in particular her research on antibiotic-resistant staphylococci, including studies on the effects of combinations of antibiotic drugs." (Sponsors: M. L. Robbins, H. Reynolds, R. C. Dawson.)

William T. Pecora, geologist, U.S. Geological Survey, "in recognition of his meritorious original contributions on the geochemical mineralogy of nickel and phosphate minerals, on the petrology of alkalic igneous rocks, and on the petrogenesis of carbonatites." (Sponsors: J. J. Fahey, S. B. Detwiler, Jr., C. R. Naeser.)

Frederick A. H. Rice, professor of chemistry, American University, "in recognition of his outstanding work in the isolation and characterization of compounds of biological importance and his systematic study of the acid degradation products of monosaccharides." (Sponsors: L. Schubert, B. W. Sitterly.)

Ralph G. H. Siu, director, Research Division, U.S. Army Materiel Command, "in recognition of his contributions to terpene chemistry, embryo growth factors, cellulolytic enzymes, tropical deterioration of material, radiation preservation of foods, melt-spinning of ultrafine filaments, and especially research management." (Sponsors: F. L. Campbell, G. W. Irving, Jr., S. B. Detwiler, Jr.)

Lendell E. Steele, head, Radiation Operations Section, Naval Research Laboratory, "in recognition of his scientific achievements in the study of radiation effects on the properties of reactor pressure vessel materials." (Sponsors: A. L. Alexander, L. B. Lockhart, Jr., W. A. Zisman.)

Dean I. Walter, head, Analytical Chemistry Branch, Naval Research Laboratory, "in recognition of his contributions to analytical chemistry, and in particular his original research on analysis of gases in refractory and conventional metals and alloys, and his development of vacuum fusion analytical methods, and equipment. (Sponsors: L. A. DePue, B. F. Brown, G. Sandoz.)

ELECTIONS TO MEMBERSHIP

John A. Waring, consultant, qualified as a member on March 15, but was inadvertently omitted from previous membership announcements.

The following persons were elected to membership in the Academy by action of the Committee on Membership at its meeting on April 27:

Collins Arsem, research electronic engineer, Harry Diamond Laboratories.

Francis E. Butler, project engineer, Naval Ordnance Laboratory.

Edwin Dyke, director of communications engineering, Howard Research Corporation.

Donald P. Easter, staff scientist, National Aeronautics and Space Administration.

Matthew H. Fusillo, research microbiologist, Mt. Alto Veterans Administration Hospital.

James L. Gargus, research manager, Toxicology Department, Hazleton Laboratories.

Clifford A. Hewitt, analytical chemist, National Cancer Institute.

Fritz G. Hochwald, patent agent.

W. Haward Hunt, grain technologist, Agricultural Marketing Service.

Martin Jacobson, chemist, Agricultural Research Service.

William D. Jenkins, research metallurgist, National Bureau of Standards.

J. A. Morris, chief, Section on Respiratory Viruses, National Institutes of Health.

Arthur J. Pallotta, director of research, Bionetics Research Laboratories.

Irena Z. Roberts, associate professor of chemistry, Trinity College.

Elaine G. Shafrin, physical chemist, Naval Research Laboratory.

Leon Shmukler, M.D., on staff of New England Medical Center and City Hospital, Boston, Mass.

Daniel A. Sullivan, Jr., mathematics teacher, McKinley Senior High School.

Robert W. Van Evera, editor, *Mining Congress Journal.*

Mario G. Vangeli (captain, USN Ret.), research associate and assistant to the director of the Engineering Experiment Station, Ohio State University.

Stanley P. Wasik, research chemist, National Bureau of Standards.

DeForrest E. Weaver, chemist, Geological Survey.

The following persons were elected to membership in the Academy by action of the Committee on Membership at its meeting on May 25:

Don R. Boyle, electronic computer engineer, National Bureau of Standards.

Andrew F. Freeman, physical science administrator, Agricultural Research Service.

Peter H. Haas, chief, Nuclear Vulnerability Branch, Harry Diamond Laboratories.

Grady T. Hicks, physicist, Naval Research Laboratory.

Robert H. Martin, meteorologist, Navy Yard Annex.

Elizabeth M. O'Hern, assistant professor of microbiology, George Washington University.

Kenneth J. Vigue, manager of special projects and director, Export Licensing and Control Office, ITT Corporation.

The following persons were elected to membership in the Academy by action of the Committee on Membership at its meeting on September 21:

Lewis F. Affronti, assistant professor of microbiology, George Washington University.

Eugene Ehrlich, program manager, National Aeronautics and Space Administration.

Oscar Felsenfeld, research pathologist, Walter Reed Army Institute of Research.

Earl M. Hildebrand, plant pathologist, Agricultural Research Service.

William J. McCabe, supervising geologist, Federal Power Commission.

Lewis T. Milliken, chemist, National Bureau of Standards.

Louis R. Perkins, science instructor, School of Nursing, D.C. General Hospital.

Warren A. Robinson, veterinarian, Food and Drug Administration.

Lloyd L. Salisbury, physicist, Harry Diamond Laboratories.

James P. San Antonio, plant pathologist, Agricultural Research Service.

Grover C. Sherlin, hydraulic engineer, National Bureau of Standards.

Harvey G. Talmadge, Jr., electronics engineer, Naval Research Laboratory.

William L. West, associate professor, Department of Pharmacology, Howard University.

Warren F. Witzig, senior vice president and technical director, Nuclear Utility Services, Inc.

BOARD OF MANAGERS MEETING NOTES

March Meeting

The Board of Managers held its 563rd meeting on March 19, 1964 at the Cosmos Club, with President Frenkiel presiding.

The minutes of the 562nd meeting were approved as previously distributed, with minor corrections.

Announcements. Dr. Frenkiel advised the Board that the order of business prescribed in the revised Standing Rules (approved in principle at the 562nd meeting on February 28) would henceforth be followed.

Dr. Frenkiel announced the following committee appointments: To the Executive Committee, Allen L. Alexander and Francis Reichelderfer; to the Committee on Public Information, Francis E. Carey and Thomas R. Henry. He pointed out the desirability of having full committee rosters on the record, and asked all committee chairmen to provide him with complete lists of members at or before the next Board meeting.

Dean Van Evera announced that he had just come from Georgetown University's 175th Anniversary Convocation, at which Rev. Francis J. Heyden, S.J., Academy member and chairman of the Committee on Encouragement of Science Talent, had received an honorary Doctor of Science degree.

Treasurer. Dr. Henderson presented the following budget for 1964:

Estimated Receipts — Dues, $10,000; Journal subscriptions and sales, $3,000; dividends and interest, $2,300; committees, dinners, etc., $750; services to Joint Board on Science Education, $200; publication sales by Johnson Reprint Corp., $50; total, $16,300.

Estimated expenditures—Journal (9 issues), $8,000; grants, $1,000; meetings and committees, $3,500; secretary, $700; treasurer and headquarters expenses, $1,000; headquarters salaries and taxes, $3,750; miscellaneous, including Joint Board salaries, $1,500; total, $19,450.

Deficit—$3,150.

This budget had been examined by the Executive Committee as a preliminary to consideration at the present meeting. It evoked considerable discussion, centering largely around the question of capital gains and whether they should be converted into cash or new stocks, treasury notes, etc.

Editor Detwiler pointed out that the budget item for the Journal—$8,000—was the same in 1964 as in 1963, although over several months past he had had discussions with Dr. Frenkiel concerning the desirability of expanding the content of the magazine; that pursuant to these discussions he had already expanded the March issue of the Journal; that he had made definite commitments for even further expansion in the April and May issues; and that the year's expenses could well come closer to $10,000 than to $8,000. The costs of the April and May issues would be further increased by plans to provide free sample copies to members of certain affiliated societies.

Mr. Detwiler further indicated that he had no immediate need for an allotment of more than $8,000. He proposed therefore that the Journal item should stand *pro tem.* at that figure; and that after the May bills were in, he would cast up accounts, extrapolate the results to the end of the year, and discuss with the Board whether to retrench or to request a supplemental allotment. These stipulations were agreeable to the Board, and the budget was approved as presented by Dr. Henderson.

Membership. Chairman Cook reminded the Board that on March 5 he had mailed out the nominations of the following three persons proposed for fellowship in the Academy: Norman H. C. Griffiths of Howard University, Louis C. W. Baker of Georgetown University, and Gale W. Cleven of the Department of Defense; and that such prior notification met the requirements of Article II, Section 5 of the Bylaws. On his motion, Messrs. Griffiths, Baker, and Cleven were elected to fellowship.

Dr. Cook announced that on February 24 the Committee on Membership had elected two persons to membership in the Academy, as follows: Gerald J. Franz of the David Taylor Model Basin, and William T. Kabisch of the AAAS.

Policy Planning. Chairman Van Evera reported that the Committee had begun discussions concerning ways in which the Academy could make its imprint on the Washington scientific scene. He also announced that, as retiring president of the Academy, he had sent letters to 240 members of the Joint Board, thanking them for their services during his tenure, and providing each one with a membership application form.

Meetings. Chairman Robbins discussed final arrangements for the "Conversazione" to be held at the general meeting of the Academy, after the Board meeting. Responses to the invitation to attend the "Conversazione" had been enthusiastic, over 180 acceptances having been received; and many who could not accept wrote to commend the idea. Twelve tables had been provided—six with 10 seats and six with 20 seats. Each table would have a *provocateur* and a suggested topic of conversation. Among the topics were such subjects as, "Can scientific ability be tested?" "Are Government in-house laboratories effective?" and "Are we being computerized into automata?"

Dr. Robbins reminded the Board that at the meeting of April 16, Alvin M. Liberman, professor of psychology at the University of Connecticut, would give a lecture demonstration on "The Perception of Speech"; this would be a joint meeting with the Washington Junior Academy of Sciences.

Dr. Robbins also announced that the meeting of May 21, to be held at the Howard County building of the Applied Physics Laboratory, would in part commemorate the 400th anniversary of the birth of Galileo. APL Director Ralph E. Gibson was scheduled to give a pre-dinner talk, "What Has Become of Galileo's Ideas Today?" The principal event would be a lecture demonstration on "Satellite Navigation" by R. B. Kerschner.

Grants-in-Aid. On motion of Chairman McPherson, the Board approved grants-in-aid to two high school students, as follows:

(1) To Robyn King of Fairmont High School (Prince Georges County), $100 for purchase of electronic components for use in a research project, "Digital Computer Using Neon Bulb Flip-Flop Circuits."

(2) To Robert S. Brown of Bethesda-Chevy Chase High School, $30 for purchase

of biological material for use in a research project, "Enzymatic Correction of Hereditary Diseases in *Drosophila melanogaster* and *Mormoniella vitripennis*."

Bylaws and Standing Rules. Chairman Wood discussed sundry minor changes proposed for its Bylaws by the Junior Academy. On his recommendation, they were accepted by the Board.

Dr. Wood also discussed the matter of editing the revised version of the Standing Rules, which had been approved in principle by the Board at its previous meeting. He distributed a final draft of Section 6, concerning the Committee on Membership, which evoked considerable discussion. Noting that Membership Panels were to consist of only five members each, Dr. Schubert indicated that he was in favor of enlarging the size of committees so as to give more Academy members an opportunity for service. Dr. Wood responded that while the number of Membership Panels is flexible (there are currently nine of them), he favored limiting each panel to five members; in this connection, he felt that the panels properly have a judicial function and should not become concerned with the stimulation of membership.

Dr. Wood recommended that the Board consider the revised draft of Section 6 at the present time, without waiting to act on the complete Standing Rules at a later time. The Board thereupon approved the new language for Section 6.

Science Education. In the absence of Chairman Taylor, Dr. Frenkiel distributed a printed six-page circular constituting a "Summary Report 1963" of the Joint Board on Science Education.

Editor. The editor having reported during consideration of the budget, he made no further comments.

April Meeting

The Board of Managers held its 564th meeting on April 16, 1964 at the Cosmos Club, with President Frenkiel presiding.

The minutes of the 563rd meeting were approved as previously distributed.

Announcements. Dr. Frenkiel introduced Jacinto Steinhardt as incoming chairman of the Committee on Meetings, effective July 1.

Dr. Frenkiel announced tentative appointments to the Committee on Grants-in-Aid for Research, as follows: through 1964, Don R. Boyle; through 1965, Ralph I. Cole and Elizabeth D. Peacock; through 1966, Ashley B. Gurney and Clifford Hewitt. This roster was in accordance with Chairman McPherson's recommendation that in future the committee should consist of six persons including the chairman, with two persons appointed each year for a three-year term.

Chairman Cook of the Membership Committee distributed a tentative roster of the eight panels of the Membership Committee (see organization page, September Journal). Chairmen of the panels are as follows: agricultural sciences, vacancy; chemistry, Robert B. Hobbs; earth sciences, Raymond L. Nace; general biology, Harold E. Finley; mathematical sciences, vacancy; medical sciences, Bernice E. Eddy; physics and astronomy, R. K. Cook (acting); engineering, William G. Allen.

Dr. Frenkiel announced that Eugene Ehrlich was the new delegate to the Academy from the American Institute of Aeronautics and Astronautics; that Raymond J. Seeger had written to suggest that the Chesapeake Section of the American Association of Physics Teachers should be affiliated with the Academy; and that Eduard Farber had similarly written to suggest affiliation of the Washington History of Science Club.

Treasurer. Dr. Henderson reported the following balances: Academy checking account, \$1,053.45; Junior Academy checking account, \$237.37; Junior Academy savings account, \$2,704.00; Joint Board checking account, \$6,500.00. He also indicated that the Academy had contributed \$300 to the summer program for training high school science students; and that the Junior Academy had contributed \$300 to the same fund as well as $1,000 to the Joint Board.

Membership. Chairman Cook reminded the Board that on April 9 he had mailed out nominations of the following nine persons proposed for fellowship in the Academy: Albert J. Herz of the Naval Research Laboratory, Irvin E. Wallen of the Smithsonian Institution, Freeman H. Quimby of NASA, David C. Rife of the National Institute of General Medical Science, Gregory K. Hartmann of the Naval Ordnance Laboratory, Charles S. Tidball of George Washington University, George Abraham of the Naval Research Laboratory, Irving Gray of Georgetown University, and Aaron Seamster of NASA. On his motion, these nine candidates were elected to fellowship.

Dr. Cook announced that on March 23 the Committee on Membership had elected 13 persons to membership in the Academy as follows: Suzanne F. Bershad, William H. Myers, and Sidney O. Marcus, Jr., all of the National Oceanographic Data Center; Vannie E. Gray of the National Bureau of Standards; Frank Hetrick of the University of Maryland; Frank D. Allan and John C. Bartone, both of George Washington University; Wade M. Edmunds of the Joint Board on Science Education; George W. Cry, Torrence H. MacDonald, Augustine Y. M. Yao, and Nina S. Zikeev, all of the Weather Bureau; and Frederick A. Moran of the Valley Forge Space Technology Center.

Dr. Cook stated that new membership application forms had been issued and were available at the Academy office.

Policy Planning. In the absence of Chairman Van Evera, Dr. Frenkiel announced that the previously-mentioned letters from the Chesapeake Section of the American Association of Physics Teachers and the Washington History of Science Club had been referred to the Policy Planning Committee for consideration and appropriate action.

Ways and Means. In the absence of Chairman Scribner, Dr. Frenkiel briefly mentioned that the committee had met on March 26 to consider its objectives and proposed activities for 1964, and that the discussions had been summarized in Mr. Scribner's memorandum of April 13 (see Secretary's file). For lack of time, the memorandum was not discussed by the Board.

Meetings. Referring to her report at the previous Board meeting, Dr. Robbins again reminded the Board that at the general meeting later on April 16, Alvin M. Liberman, professor of psychology at the University of Connecticut, would give a lecture demonstration on "The Perception of Speech"; and that at the general meeting of May 21 (to be held at the Howard County building of the Applied Physics Laboratory), R. B. Kerschner would give a lecture demonstration on "Satellite Navigation," while APL Director Ralph E. Gibson would give a predinner talk on, "What Has Become of Galileo's Ideas Today?"

Grants-in-Aid. Dr. McPherson discussed a committee recommendation of long standing, to the effect that the Board should encourage grants in aid of family-style research projects, as exemplified by the survey of the Dismal Swamp conducted several years ago by Ashley B. Gurney and his son. (See Journal for March 1963, pages 57-63). He indicated that the committee is on the lookout for other projects of this nature, which the Academy might subsidize with modest grants.

Encouragement of Science Talent. In the absence of Chairman Heyden, Dr. Frenkiel announced that since the April 16 general meeting was being held jointly with the Washington Junior Academy of Sciences, the officers of the Junior Academy would be guests at the dinner just following the Board meeting.

Bylaws and Standing Rules. Chairman Wood reminded the Board that at the behest of the Internal Revenue Service, the American Chemical Society desires the Academy to carry a "protective" clause in its Bylaws, to protect the interests of Academy affiliates, particularly the Chemical Society of Washington (the local section of ACS). Dr. Wood moved that the Board approve the following amendment to the Bylaws (as a new section in Article VIII) and have it submitted to the membership for ratification by mail ballot:

"No affiliated society shall be committed by the Academy to any action in conflict with the charter, constitution, or bylaws of said society, or of its parent society."

The motion was passed.

Mr. Detwiler raised the question as to whether the Academy should have a "dissolution" clause in its Bylaws. (A "dissolution" clause stipulates that if the organization is ever disbanded, its remaining assets should be used to further the cause of science, and not for the benefit of individuals.) Dr. Henderson recommended that the question be left in abeyance pending clarification of the Academy's pending request to IRS for tax-exempt status.

Special Events. Dr. Forziati discussed the "Conversazione" held at the general meeting on March 19, and indicated that he had received many enthusiastic comments on the affair. He reported that similar "conversaziones" might be held at future Academy meetings.

Journal. Dr. Detwiler reported that he was about to begin work on the May issue of the Journal, which would be an expanded issue addressed primarily to the geologists of Washington.

Archivist. Dr. Frenkiel reported that an archivist had not yet been appointed, although he was hopeful that a suitable candidate would soon be found.

Joint Board. Dr. Schubert reported that Board President Churchill Eisenhart was in course of developing a new organizational and financial structure for the Board.

New Business. Dr. Mitchell advised that while stimulating interest in Academy membership among Weather Bureau staff members, he had had occasion to review the Bylaws as they concern the privileges of *members* (as distinguished from *fellows*). He suggested that while the Bylaws imply that members have the franchise in the election of officers, they might better say so explicitly. Dr. Frenkiel commended the suggestion and referred it to the Committee on Bylaws and Standing Rules for study.

Dr. Frenkiel mentioned that he was considering the feasibility of holding an annual meeting of the Academy that would be concerned with matters of national policy.

Dr. Diamond suggested that the Membership Committee consider means of advising the scientific public as to how one becomes a member of the Academy. Mr. Detwiler responded that he had anticipated the suggestion in part by publishing in the April Journal (of which some 400 free copies were sent to local members of the American Society for Microbiology) a page discussing the Academy's objectives and activities, the classes of membership, and how one applies for membership; and that he expected to publish the same page in the May issue, of which some 650 copies were to be distributed free to local members of the Geological Society of Washington. Dr. Cook mentioned his suggestion at a previous Board meeting, that a special committee be appointed to bring the desirability of Academy membership to the attention of members of affiliated societies. After some further discussion, it was left that the Board would further explore the idea of setting up either a special committee, or a special unit of the Membership Committee, especially charged with soliciting new members of the Academy.

June Meeting

The Board of Managers held its 565th meeting on June 9, 1964 at the AAAS

Building, with President Frenkiel presiding.

The minutes of the 564th meeting were approved as previously distributed.

Announcements. Dr. Frenkiel announced that Margaret Pittman had resigned as chairman of the Committee on Awards for Scientific Achievement, because of the press of other duties, and would be succeeded by Edward A. Mason of the University of Maryland. The following subcommittee chairmen have been appointed: biological science, Ellis T. Bolton; engineering science, Martin Mason; physical science, Samuel Foner; mathematics, Harry Polachek; teaching of science, Leo Schubert.

Executive Committee. Dr. Frenkiel and Secretary Irving summarized the Committee's discussions at its meeting of June 9, when it was proposed to amend the Academy's Act of Incorporation (November 1963 Journal, page 212) as follows:

(1) Amend Article 3 to read: "3. That the Society is organized and shall be operated exclusively for charitable, educational, and scientific purposes, and in furtherance of these and no other purposes shall have power:" (continue with Paragraphs (a) through (g), without change).

(2) Add new Paragraph 3(h) as follows: "To maintain an office and staff to aid in the carrying out of the purposes of the society. Notwithstanding the enumerated powers, the society shall not engage in activities, other than as an insubstantial part thereof, which are not in themselves in furtherance of the charitable, educational and scientific purposes of the society."

(3) Add a new Article 5: "In the event of dissolution of the corporation, all assets remaining after payment of all debts and obligations shall be distributed for charitable, educational, and/or scientific purposes."

The foregoing changes were approved by the Board. It was concluded that inclusion of the "dissolution clause" in the Act of Incorporation would obviate the need for including it in the Bylaws.

The Committee recommended, and the Board approved, the following changes in the 1964 budget as previously approved on March 19 (see also May 1964 Journal, page 197): (1) Take capital gains in 1964 as cash, thus adding about $1,000 to "receipts." (2) Increase expenditures by $2,000, including $1,000 additional for Journal; $500 as a special contribution to the Academy directory (September Journal); $150 additional for secretary; $250 for a new Membership Promotion Committee; and $100 for a new Interdisciplinary Activities Committee.

The revised budget follows:

Estimated Receipts — Dues, $10,000; Journal subscriptions and sales, $3,000; dividends and interest, $3,300; committees, dinners, etc., $750; services to Joint Board, $200; publication sales by Johnson Reprint Corp., $50; total, $17,300.

Estimated expenditures — Journal (9 issues), $9,500 including the $500 special contribution to directory; grants, $1,000; meetings and committees, $3,500; secretary, $850; treasurer and headquarters expenses, $1,000; headquarters salaries and taxes, $3,750; miscellaneous, including Joint Board subvention, $1,500; membership promotion, $250; interdisciplinary activities, $100; total, $21,450.

Deficit — $4,150.

In discussion of the revised budget, it was pointed out that estimated receipts for 1964 do not include increased income expected from dues; that application will be made to the National Science Foundation by an ad hoc committee to be appointed, for support of the directory, which may obviate the need for the "special contribution" included in the budget above; and that J. M. Mitchell, Jr., has been appointed chairman of the new Membership Promotion Committee.

Membership. Chairman Cook reminded the Board that on May 27 he had mailed out nominations of the following 13 persons proposed for fellowship in the Academy: Mark Harrison, Benjamin H. Alexander, Malcolm W. Oliphant, William Benesch, Ralph L. Streever, Jr., George A. Candela, John A. Simmons, Allan J. Melmed, Arthur W. Ruff Jr., Lester F. Hubert, William H. Klein, Donald H. Pack, and Sidney Teweles. On motion of Dr. Robbins, these 13 candidates were elected to fellowship.

Dr. Cook announced that the Committee had elected 21 persons to membership in the Academy on April 27, and an additional seven persons to membership on May 25, as follows: DeForrest E. Weaver, Collins Arsem, Irena Z. Roberts, Clifford A. Hewitt, Robert W. Van Evera, Marion G. Vangeli, Fritz G. Hochwald, Leon Schmukler, Daniel A. Sullivan, Jr., Francis E. Butler, Matthew H. Fusillo, Elaine G. Shafrin, Arthur J. Pallotta, Donald P. Easter, W. Haward Hunt, Stanley P. Wasik, Martin Jacobson, James L. Gargus, J. A. Morris, William D. Jenkins, Edwin Dyke, Grady T. Hicks, Elizabeth M. O'Hern, Don R. Boyle, Peter H. Haas, Robert H. Martin, Andrew F. Freeman, Kenneth J. Vigue.

Policy Planning. Chairman Van Evera moved that the application of the Washington History of Science Club for affiliation with the Academy be approved by the Board and referred to the Academy membership for ratification. The motion was passed.

Affiliation of the Chesapeake Section of the American Association of Physics Teachers was tentatively approved pending successful outcome of negotiations between the Policy Planning Committee and the Association, and subject to ratification by the Academy membership.

Ways and Means. Chairman Scribner reported that while the Committee had not yet held a formal meeting, informal consideration had been given to the question of how the Academy could grow and assume its proper place in the science activities of the Capital area. The Committee has available records of the deliberations of the Committee for the past several years, and will make appropriate use of them in formulating recommendations for the Board. In discussion, Dr. Eisenhart suggested consideration of establishing "institutional" memberships with free journals distributed to young staff members of institutional members; Mr. Detwiler suggested that the Cosmos Club's Endowment Fund might wish to contribute to the welfare of the Academy; and Dr. Schubert suggested that Academy awards might be underwritten by area companies, with the award being identified with the donor company.

Meetings. Dr. Robbins announced that this meeting represented her last appearance as chairman of the Committee, since Dr. Steinhardt would assume the chairmanship on July 1. The Board extended a vote of thanks to Dr. Robbins for the stimulating series of meetings that she had arranged for the Academy during her incumbency.

Awards for Scientific Achievement. Chairman Mason reported that the Committee had prepared a letter which would be mailed in the near future to university, government, and industry administrators, to solicit nominations for Academy awards. It was expected that solicitation of the Academy membership would be made later, probably in September, also, that notices would appear in the Journal and publications of the affiliates.

Encouragement of Science Talent. In the absence of Chairman Heyden, Dr. Taylor reported that a very successful awards dinner program had been held at Georgetown University, to present certificates of merit in science to 40 high school seniors.

Bylaws and Standing Rules. After an explanation by Chairman Wood of several proposed changes in the Standing Rules, the Board took the following actions:

(1) Approved a revision of Section 17, to increase the Academy contingent of the Joint Board on Science Education

from six to nine, on condition that similar action be taken by the D. C. Council of Engineering and Architectural Societies. (Concurrently, the Board approved changes in the bylaws of the Joint Board, to conform with the foregoing action.)

(2) Approved revision of Rule 4, Section C, to permit *members* of the Academy to serve on the committees, and to increase the membership of the Committee on Grants-in-Aid to six members or fellows—two to be appointed each year for three-year terms.

(3) Approved revision of Rule 9 to delete the number limitation on the size of the Committee.

(4) Approved revision of Rule 18(a), on interdisciplinary panels, to read "no more than nine fellows or members."

(5) Approved revision of Rule 4 to indicate that membership on only three committees—Policy Planning, Membership, and Awards—should be limited to fellows of the Academy.

Dr. Wood reviewed language changes in other Standing Rules, previously approved in principle by the Board. The Board approved the wording of the changes.

Journal. Editor Detwiler reported in detail on the size and cost of the five Journal issues from January through May, 1964. The augmented April issue (76 pages) and May issue (52 pages) cost $2200 and $1300 respectively, compared to $600-800 each for previous issues this year. Mr. Detwiler estimated that the total Journal cost for 1964 might well approximate $11,000. He indicated that rosters for the following affiliates, not covered in last year's directory, would probably be included in the forthcoming directory: Philosophical Society, American Society for Microbiologists, American Meteorological Society, Electrochemical Society, and Society of American Foresters.

Joint Board. Dr. Taylor reported that the National Science Foundation grant, formerly made to the Academy, would this year be made direct to the Joint Board. He reported that the first Collegiate Science Conference was held in May at Georgetown University, when 26 papers were presented by undergraduates in a very successful all-day meeting. Dr. Taylor announced that a proposal is being discussed, to have collegiate sections of the Academy.

BYLAWS OF THE WASHINGTON ACADEMY OF SCIENCES

(Last Revised in September 1963)

Article I—Purposes

Section 1. The purposes of the Washington Academy of Sciences shall be: (a) to stimulate interest in the sciences, both pure and applied, and (b) to promote their advancement and the development of their philosophical aspects by the Academy membership and through cooperative action by the affiliated societies.

Section 2. These objectives may be attained by, but are not limited to:

(a) Publication of a periodical and of occasional scientific monographs and such other publications as may be deemed desirable.
(b) Public lectures of broad scope and interest in the fields of science.
(c) Sponsoring a Washington Junior Academy of Sciences.
(d) Promoting science education and a professional interest in science among people of high school and college age.
(e) Accepting or making grants of funds to aid special research projects.
(f) Symposia, both formal and small informal, on any aspects of science.
(g) Scientific conferences.
(h) Organization of, or assistance in, scientific expeditions.

(i) Cooperation with other Academies and scientific organizations.
(j) Awards of prizes and citations for special merit in science.
(k) Maintaining an office and staff to aid in carrying out the purposes of the Academy.

Article II—Membership

Section 1. The membership shall consist of three general classes: members, fellows and patrons.

Section 2. Members shall be persons who are interested in and will support the objectives of the Academy and who are otherwise acceptable to at least two thirds of the Committee on Membership. A letter or application form requesting membership and signed by the applicant may suffice for action by the Committee; approval by the Committee constitutes election to membership.

Section 3. Fellows shall be persons who by reason of original research or other outstanding service to the sciences, mathematics, or engineering are deemed worthy of the honor of election to Academy fellowship, which may be attained only through nomination as provided in Section 4.

Section 4. Nominations of fellows shall be presented to the Committee on Membership on a form approved by the Committee. The form shall be signed by the sponsor, a fellow who has knowledge of the nominee's field, and shall be endorsed by at least one other fellow. An explanatory letter from the sponsor and a bibliography of the nominee's publications shall accompany the completed nomination form.

Section 5. Election to fellowship shall be by vote of the Board of Managers upon recommendation of the Committee on Membership. Final action on nominations shall be deferred at least one week after presentation to the Board, and two-thirds of the vote cast shall be necessary to elect.

Section 6. Persons who have given to the Academy not less than one thousand (1,000) dollars or its equivalent in property shall be eligible for election by the Board of Managers as patrons (for life) of the Academy.

Section 7. Life members or fellows shall be those individuals who have made a single payment in accordance with Article III, Section 2, in lieu of annual dues.

Section 8. Members or fellows in good standing who have attained the age of 65 and are retired, or are retired before the age of 65 because of disability, may become emeritus. Upon request to the treasurer for transfer to this status, they shall be relieved of the further payment of dues, beginning with the following January first; shall receive notices of meetings without charge; and, at their request, shall be entitled to receive the Academy periodical at cost.

Section 9. Members or fellows living more than 50 miles from the White House, Washington, D. C., shall be classed as nonresident members or fellows.

Section 10. An election to any dues-paying class of membership shall be void if the candidate does not within three months thereafter pay his dues or satisfactorily explain his failure to do so.

Section 11. Former members or fellows who resigned in good standing may be reinstated upon application to the Secretary and approval by the Board of Managers. No reconsideration of the applicant's qualifications need be made by the Membership Committee in these cases.

Article III—Dues

Section 1. The annual dues of resident fellows shall be $10.00 per year. The annual dues of members and of nonresident fellows shall be $7.50 per year. Dues for fractional parts of the year shall be at the monthly rate of one-twelfth the annual rate. No dues shall be paid by emeritus members and fellows, life members and fellows, and patrons.

Section 2. Members and fellows in good standing may be relieved of further payment of dues by making a single payment to provide an annuity equal to their annual dues. (See Article II, Section 7). The amount of the single payment shall be computed on the basis of an interest rate to be determined by the Board of Managers.

Section 3. Members or fellows whose dues are in arrears for one year shall not be entitled to receive Academy publications.

Section 4. Members or fellows whose dues are in arrears for more than two years shall be dropped from the rolls of the Academy, upon notice to the Board of Managers, unless the Board shall otherwise direct. Persons who have been dropped from membership for nonpayment of dues may be reinstated upon approval of the Board and upon payment of back dues for two years together with dues for the year of reinstatement.

Article IV—Officers

Section 1. The officers of the Academy shall be a President, a President-elect, a Secretary, and a Treasurer. All shall be chosen from resident fellows of the Academy.

Section 2. The President shall appoint all committees and such non-elective officers as are needed unless otherwise directed by the Board of Managers or provided in the Bylaws. He (or his substitute—the President-elect, the Secretary, or the Treasurer, in that order) shall preside at all meetings of the Academy and of the Board of Managers.

Section 3. The Secretary shall act as secretary to the Board of Managers and to the Academy at large. He shall conduct all correspondence relating thereto, except as otherwise provided, and shall be the custodian of the corporate seal of the Academy. He shall arrange for the publication in the Academy periodical of the names and professional connections of new members, and also of such proceedings of the Academy, including meetings of the Board of Managers, as may appropriately be of interest to the membership He shall be responsible for keeping a register of the membership, showing such information as qualifications, elections, acceptances, changes of residence, lapses of membership, resignations and deaths, and for informing the Treasurer of changes affecting the status of members. He shall act as secretary to the Nominating Committee (see Art. VI, Sect. 2).

Section 4. The Treasurer shall be responsible for keeping an accurate account of all receipts and disbursements, shall select a suitable depository for current funds which shall be approved by the Executive Committee, and shall invest the permanent funds of the Academy as directed by that Committee. He shall prepare a budget at the beginning of each year which shall be reviewed by the Executive Committee for presentation to and acceptance by the Board of Managers. He shall notify the Secretary of the date when each new member qualifies by payment of dues. He shall act as business adviser to the Editor and shall keep necessary records pertaining to the subscription list. In view of his position as Treasurer, however, he shall not be required to sign contracts. He shall pay no bill until it has been approved in writing by the chairman of the committee or other persons authorized to incur it. The fiscal year of the Academy shall be the same as the calendar year.

Section 5. The President and the Treasurer, as directed by the Board of Managers, shall jointly assign securities belonging to the Academy and indorse financial and legal papers necessary for the uses of the Academy, except those relating to current expenditures authorized by the Board. In case of disability or absence of the President or Treasurer, the Board of Managers may designate the President-elect or a qualified Delegate as Acting President or an officer of the Academy as Acting Treasurer, who shall perform the duties of these officers during such disability or absence.

Section 6. An Editor shall be in charge of all activities connected with the Academy's publications. He shall be nominated by the Executive Committee and appointed by the President for an indefinite term subject to annual review by the Board of Managers. The Editor shall serve as a member of the Board.

Section 7. An Archivist may be appointed by the President. If appointed, he shall maintain the permanent records of the Academy, including important records which are no longer in current use by the Secretary, Treasurer, or other officer, and such other documents and material as the Board of Managers may direct.

Section 8. All officers and chairmen of standing committees shall submit annual reports at the January meeting of the Board of Managers.

Section 9. Prior to November 1 of each year the Nominating Committee (Art. VI, Sect. 2), having been notified by the Secretary, shall meet and nominate by preferential ballot, in the manner prescribed by the Board of Managers, one person for each of the offices of President-elect, of Secretary and of Treasurer, and four persons for the two Managers-at-large whose terms expire each year. It shall, at the same time and in like manner, make nominations to fill any vacancy in the foregoing. Not later than November 15, the Secretary shall forward to each Academy member a printed notice of these nominations, with a list of incumbents. Independent nominations may be made in writing by any ten active members. In order to be considered, such nominations must be received by the Secretary before December 1.

Section 10. Not later than December 15, the Secretary shall prepare and mail ballots to members and fellows. Independent nominations shall be included on the ballot, and the names of the nominees shall be arranged in alphabetical order. When more than two candidates are nominated for the same office the voting shall be by preferential ballot in the manner prescribed by the Board of Managers. The ballot shall contain also a notice to the effect that votes not received by the Secretary before the first Thursday of January, and votes of individuals whose dues are in arrears for one year or more, will not be counted. The Committee of Tellers shall count the votes and report the results at the annual meeting of the Academy.

Section 11. The newly elected officers shall take office at the close of the annual meeting, the President-elect of the previous year automatically becoming President.

Article V—Board of Managers

Section 1. The activities of the Academy shall be guided by the Board of Managers, consisting of the President, the President-elect, one Delegate from each of the affiliated societies, the Secretary, the Treasurer, six elected Managers-at-large, and the Editor. The elected officers of the Academy shall hold like offices on the Board of Managers.

Section 2. One Delegate shall be selected by each affiliated society (see Art. VIII, Sect. 3). He shall serve until replaced by his society. Each Delegate is expected to participate in the meetings of the Board of Managers and vote on behalf of his society.

Section 3. The Board of Managers shall transact all business of the Academy not otherwise provided for. A quorum of the Board shall be nine of its members.

Section 4. The Board of Managers may provide for such standing and special committees as it deems necessary.

Section 5. The Board shall have power to fill vacancies in its own membership until the next annual election. This does not apply to the offices of President and Treasurer (see Art. IV, Sect. 5), nor to Delegates (see Art. V, Sect. 2).

Article VI—Committees

Section 1. An Executive Committee shall have general supervision of Academy finances, approve the selection of a depository for the current funds, and direct the investment of the permanent funds. At the beginning of the year it shall present to the Board of Managers an itemized statement of receipts and expenditures of the preceding year and a budget based on the estimated receipts and disbursements of the coming year, with such recommendations as may seem desirable. It shall be charged with the duty of considering all activities of the Academy which may tend to maintain and promote relations with the affiliated societies, and with any other business which may be assigned to it by the Board. The Executive Committee shall consist of the President, the President-elect, the Secretary and the Treasurer (or Acting Treasurer) ex officio, as well as two members appointed annually by the President from the membership of the Board.

Section 2. The Delegates shall constitute a Nominating Committee (see Art. IV, Sect. 9). The Delegate from the Philosophical Society shall be chairman of the Committee, or, in his absence, the Delegate from another society in the order of seniority as given in Article VIII, Section 1.

Section 3. The President shall appoint in advance of the annual meeting an Auditing Committee consisting of three persons, none of whom is an officer, to audit the accounts of the Treasurer (Art. VII, Sect. 1).

Section 4. On or before the last Thursday of each year the President shall appoint a committee of three Tellers whose duty it shall be to canvass the ballots (Art. IV, Sect. 10, Art. VII, Sect. 1).

Section 5. The President shall appoint from the Academy membership such committees as are authorized by the Board of Managers and such special committees as necessary to carry out his functions. Committee appointments shall be staggered as to term whenever it is determined by the Board to be in the interest of continuity of committee affairs.

Article VII—Meetings

Section 1. The annual meeting shall be held each year in January. It shall be held on the third Thursday of the month unless otherwise directed by the Board of Managers. At this meeting the reports of the Secretary, Treasurer, Auditing Committee (see Art. VI, Sect. 3), and Committee of Tellers shall be presented.

Section 2. Other metings may be held at such time and place as the Board of Managers may determine.

Section 3. The rules contained in "Robert's Rules of Order Revised" shall govern the Academy in all cases to which they are applicable, and in which they are not inconsistent with the bylaws or the special rules of order of the Academy.

Article VIII—Cooperation

Section 1. The term "affiliated societies" in their order of seniority (see Art. VI, Sect. 2) shall be held to cover the:

Philosophical Society of Washington
Anthropological Society of Washington
Biological Society of Washington
Chemical Society of Washington
Entomological Society of Washington

National Geographic Society
Geological Society of Washington
Medical Society of the District of Columbia
Columbia Historical Society
Botanical Society of Washington
Washington Section of Society of American Foresters
Washington Society of Engineers
Washington Section of Institute of Electrical and Electronics Engineers
Washington Section of American Society of Mechanical Engineers
Helminthological Society of Washington
Washington Branch of American Society for Microbiology
Washington Post of Society of American Military Engineers
National Capital Section of American Society of Civil Engineers
District of Columbia Section of Society for Experimental Biology and Medicine
Washington Chapter of American Society for Metals
Washington Section of the International Association for Dental Research
Washington Section of American Institute of Aeronautics and Astronautics
D. C. Branch of American Meteorological Society
Insecticide Society of Washington
Washington Chapter of the Acoustical Society of America
Washington Section of the American Nuclear Society
Washington Section of Institute of Food Technologists
Baltimore-Washington Section of the American Ceramic Society
Washington-Baltimore Section of the Electrochemical Society

and such others as may be hereafter recommended by the Board and elected by two-thirds of the members of the Academy voting, the vote being taken by correspondence. A society may be released from affiliation on recommendation of the Board of Managers, and the concurrence of two-thirds of the members of the Academy voting.

Section 2. The Academy may assist the affiliated scientific societies of Washington in any matter of common interest, as in joint meetings, or the publication of a joint directory: Provided, it shall not have power to incur for or in the name of one or more of these societies any expense or liability not previously authorized by said society or societies, nor shall it without action of the Board of Managers be responsible for any expenses incurred by one or more of the affiliated societies.

Section 3. Each affiliated society shall select one of its members as Delegate to the Academy who is a resident member or fellow of the Academy.

Section 4. The Academy may establish and assist a Washington Junior Academy of Sciences for the encouragement of interest in science among students in the Washington area of high school and college age.

Article IX—Awards and Grants-in-aid

Section 1. The Academy may award medals and prizes, or otherwise express its recognition and commendation of scientific work of high merit and distinction in the Washington area. Such recognition shall be given only on approval by the Board of Managers of a recommendation by a committee on awards for scientific achievement.

Section 2. The Academy may receive or make grants to aid scientific research in the Washington area. Grants shall be received or made only on approval by the Board of Managers of a recommendation by a committee on grants-in-aid for scientific research.

Article X—Amendments

Section 1. Amendments to these bylaws shall be proposed by the Board of Managers and submitted to the members of the Academy in the form of a mail ballot acompanied by a statement of the reasons for the proposed amendment. A two-thirds majority of those members voting is required for adoption. At least two weeks shall be allowed for the ballots to be returned.

Section 2. Any affiliated society or any group of ten or more members may propose an amendment to the Board of Managers in writing. The action of the Board in accepting or rejecting this proposal to amend the bylaws shall be by a vote on roll call, and the complete roll call shall be entered in the minutes of the meeting.

Science in Washington

CALENDAR OF EVENTS

November 11—Zoology Colloquium, University of Maryland

Larry S. Roberts, University of Massachusetts, "Growth Physiology of Castodes."

Room L-405, General Library, University of Maryland, 3:45 p.m.

November 12—Chemical Society of Washington

Main speaker: Herbert A. Laitinen, University of Illinois, "Electroanalytical Chemistry in Molten Salts."

NEA Auditorium, 16th & M Sts., N.W., 8:15 p.m.

Topical groups:

Ernest Freese, National Institutes of Health, "Lethal and Mutagenic Effects of Transforming DNA."

Ralph Wilkins, State University of New York, "Rapid Reactions of Metal Complexes in Aqueous Solution."

Percy L. Julian, Julian Institute of Research, "Some Observations on the Relationship Between Structure and Physiological Action in Steroids."

C. G. Overberger, Polytechnic Institute of Brooklyn, "Catalytic Action of Polymers with Imidazole Side Chains."

NEA Building, 5:00 p.m. Social hour and dinner, NEA Cafeteria, 6:00 p.m.

November 12—Washington Operations Research Council

Panel: Stuart Rice, Surveys & Research (*Chairman*); J. Moshman, CEIR; R. Scammon, Census Bureau; "Models of Voter Behavior."

Red Cross Auditorium, 2025 E St., N.W., 8:15 p.m.

November 17-18—Office of Naval Research

Symposia: Microelectronics and Large Systems.

Department of Interior Auditorium.

November 19—American Society of Mechanical Engineers

D. G. Adler, Babcock & Wilcox Co., "The Nuclear Fuel Cost Problem."

PEPCO Auditorium, 10th & E Sts., N.W., 8:00 p.m. Pre-meeting dinner at O'Donnell's Restaurant, 6:30 p.m.

SCIENTISTS IN THE NEWS

Contributions to this column may be addressed to Harold T. Cook, Associate Editor, c/o Department of Agriculture, Agricultural Research Service, Federal Center Building, Hyattsville, Md.

AGRICULTURE DEPARTMENT

James H. Turner, formerly a principal research parasitologist at the Beltsville Parasitological Laboratory, has accepted the position of executive secretary of the Allergy and Immunology Study Section, Division of Research Grants, National Institutes of Health. This change was made in October after 16 years with USDA.

Edward H. Graham has retired from government service and is now a consulting ecologist. He has established his professional headquarters and office in his residence at Vienna, Va.

Joseph R. Spies, Allergens Laboratory, Agricultural Research Service, gave a lecture entitled "Oilseed Allergens" at the Gordon Research Conference on Food and Nutrition at Colby Junior College, New London, N. H., August 14.

W. T. Pentzer, ARS, received the Distinguished Service Award from the American Society of Heating, Refrigerating and Air Conditioning Engineers at the June meeting of the Society in Cleveland, Ohio.

Ashley B. Gurney, Entomology Research Division, ARS, has returned from a one-month trip to California where he collected grasshopper specimens and studied grasshopper habitats. He worked in northern California and made his headquarters in Sacramento. A highlight of the trip was a week of camping and collecting in the Trinity Alps north of Weaverville, in association with entomologists of the California Department of Agriculture and the Plant

Pest Control Division, USDA. His trip was supported in part by a grant from the American Philosophical Society. Grasshoppers and other orthopterous insects of localized distribution are richly represented in California.

R. A. Fulton, entomologist, retired from USDA on August 29. He now resides at 530 Merrie Drive, Corvallis, Ore.

Stanley A. Hall gave a talk on current developments in the Pesticide Chemicals Research Branch, ARS, at the Conference of Military Entomologists, Walter Reed Army Medical Center, October 5-9.

Victor R. Boswell has been appointed program chairman of the Vegetable Section, XVII International Horticultural Congress, to be held at the University of Maryland in August 1966. Dr. Boswell will welcome proposals regarding symposia and papers for that section of the Congress.

Kenneth G. Clark retired from government service on August 9, after 40 years of productive service. Author of some 60 publications, he contributed substantially to developments in fertilizer technology, especially in the nitrogen and potassium industries. Dr. Clark has been a member of American Chemical Society, American Association for the Advancement of Science, American Society of Agronomy, the Fertilizer Society (London), Washington Academy of Sciences, and Association of Official Agricultural Chemists.

Paul R. Miller, Crops Research Division, Plant Industry Station, is presently in Castelar, Argentina, where he is participating in a 5-week international course in plant pathology, sponsored by the National Institute of Agricultural Technology (INTA). Dr. Miller is giving a series of lectures on the epidemiology of plant diseases, plant disease forecasting, and the appraisal of plant disease losses to postgraduate students in plant pathology from Argentina and Chile.

A. M. Pommer has been promoted to clinical assistant professor of pediatrics (nutrition) by Georgetown University. He attended the Gordon Research Conference on Dissolution and Crystallization of Calcium Phosphates, Meriden, N. H., August 10-14, and presented a paper entitled "Calcium Electrodes"; he also attended the Gordon Research Conference on Ionic Movements and Interactions in Biological, Chemical, and Physical Phenomena, Tilton, N. H., August 31-September 4. Dr. Pommer has been appointed program chairman of the Washington Section, Instrument Society of America.

C. R. Benjamin was elected vice-president of the Mycological Society of America at its recent annual meeting in Boulder, Colo. Dr. Benjamin also was elected to the Committee for Fungi by the Nomenclature Section of the X International Botanical Congress held at Edinburgh, Scotland, and also was recently appointed chairman of the U.S. panel on toxic microorganisms of the Joint U.S.-Japan Cooperation on Development of Natural Resources.

Warren L. Butler resigned from the Agricultural Research Service at the end of August to accept a position with the Johnson Research Foundation, University of Pennsylvania, Philadelphia.

R. A. St. George retired from government service on September 30, after 46 years with USDA. Dr. St. George's entire career has been devoted to problems associated with forest insects. He is a recognized national and international authority on insects attacking woods and wood products.

C. H. Hoffman, assistant director of the Entomology Research Division, was guest speaker at the 13th Annual Health Conference, Pennsylvania State University, University Park, August 19. He spoke on "Insecticides and Other Approaches to Control Agricultural and Forest Insects." Dr. Hoffman also was guest speaker at the Awards Dinner of the 19th American Horticultural Congress, held October 1 in New York. He spoke on Biological Control of Garden Insect Pests.

E. L. Little is serving as consultant and teaching a course in dendrology for FAO at the Interamerican Institute of Agricultural Sciences, Turrialba, Costa Rica. Dr. Little's appointment began September 27 and will last 5 months. He will also do research on the forest trees of Costa Rica.

HARRIS RESEARCH LABORATORIES

Anthony M. Schwartz attended the Fourth International Congress on Detergency in Brussels, September 7-12, and presented a paper, co-authored by Charles A. Rader, entitled "Micro-scale Surface Energy Measurements of Repellent Finishes on Fibers."

Lyman Fourt gave a talk on "Textile Evaluation: Aesthetics and Instruments" before the Washington Section of the Instrument Society of America on September 28.

Harris Research Laboratories again was host to ten high school science teachers under the National Science Foundation program for six weeks during the summer.

NATIONAL BUREAU OF STANDARDS

The Science and Technology Fellowship Program, a unique plan for the exchange of scientists within the technical bureaus of the Department of Commerce, became effective on September 9. Secretary of Commerce Luther H. Hodges announced the program and named 17 senior Commerce Department scientists as first participants. Eight of the 17 are staff members of the National Bureau of Standards, including the following members and fellows of WAS: **Ralph Klein,** chief, Surface Chemistry Section, assigned to Weather Bureau as meteorologist concerned with research and development planning and establishment of a Weather Bureau atmospheric chemistry laboratory; and **Lawrence M. Kushner,** chief, Metallurgy Division, assigned to Office of Assistant Secretary for Science and Technology as a technical assistant. Dr. Kushner will undertake special studies for the Assistant Secretary relating to scientific and technical activities of the Department.

John K. Taylor received an award for 35 years of service, as well as an incentive award for superior accomplishment.

National Bureau of Standards personnel participated in recent overseas meetings as follows: **G. M. Kline** at the European Plastics Congress, Milano, Italy, September 20-23; **D. P. Johnson** at the Centre National de la Recherche Scientific de Bellevue, France, October 9; **K. H. Stern,** at the Academy of the Rumanian People's Republic, Bucharest, Rumania, September 14; **W. A. Wildhack** at the Third International Measurement Conference, Stockholm, Sweden, September 14; **J. Mandel** at a meeting of the International Association of Statistics in Physical Sciences, Berne, Switzerland, September 17.

Papers were presented at other meetings as follows: **H. L. Logan** at Baltimore-Washington Section, National Association of Corrosion Engineers, Baltimore, September 22; **T. W. Lashof** at TAPPI Testing Conference, Boston, October 1; **H. J. Kostkowski** and **R. Stair** at the Optical Society of America, New York; **A. T. McPherson,** Dairy and Food Industries Supply Association, Chicago, October 8-9; **G. C. Paffenbarger** at the University of Pittsburgh School of Dentistry, Pittsburgh, October 7; **R. Zwanzig,** Chemistry Department, Massachusetts Institute of Technology, Cambridge, September 29.

NAVAL RESEARCH LABORATORY

Kenneth Dunning, head of the Van de Graaff Branch of the Nucleonics Division, is undertaking a one-year study program at Catholic University under the newly established Sabbatical Study Program at NRL. Eligius A. Wolicki has been appointed acting head of the Van de Graaff Branch during Mr. Dunning's absence.

Delegates to the Washington Academy of Sciences, Representing the Local Affiliated Societies*

Philosophical Society of Washington	Urner Liddel
Anthropological Society of Washington	Gordon McGregor
Biological Society of Washington	John L. Paradiso
Chemical Society of Washington	William A. Zisman
Entomological Society of Washington	Harold H. Shepard
National Geographic Society	Alexander Wetmore
Geological Society of Washington	Luna Leopold
Medical Society of the District of Columbia	Thomas M. Brown
Columbia Historical Society	U. S. Grant, III
Botanical Society of Washington	Wilbur D. McClellan
Society of American Foresters	Harry A. Fowells
Washington Society of Engineers	Martin A. Mason
Institute of Electrical and Electronics Engineers	George Abraham
American Society of Mechanical Engineers	William G. Allen
Helminthological Society of Washington	Marion M. Farr
American Society for Microbiology	Frank Hettrick
Society of American Military Engineers	H. P. Demuth
American Society of Civil Engineers	Thorndike Saville, Jr.
Society for Experimental Biology and Medicine	Falconer Smith
American Society for Metals	Hugh L. Logan
International Association for Dental Research	Harold J. Caul
American Institute of Aeronautics and Astronautics	Eugene Ehrlich
American Meteorological Society	J. Murray Mitchell, Jr.
Insecticide Society of Washington	Robert A. Fulton
Acoustical Society of America	Malcolm C. Henderson
American Nuclear Society	George L. Weil
Institute of Food Technologists	Richard P. Farrow
American Ceramic Society	J. J. Diamond
Electrochemical Society	Kurt H. Stern

* Delegates continue in office until new selections are made by the respective affiliated societies.

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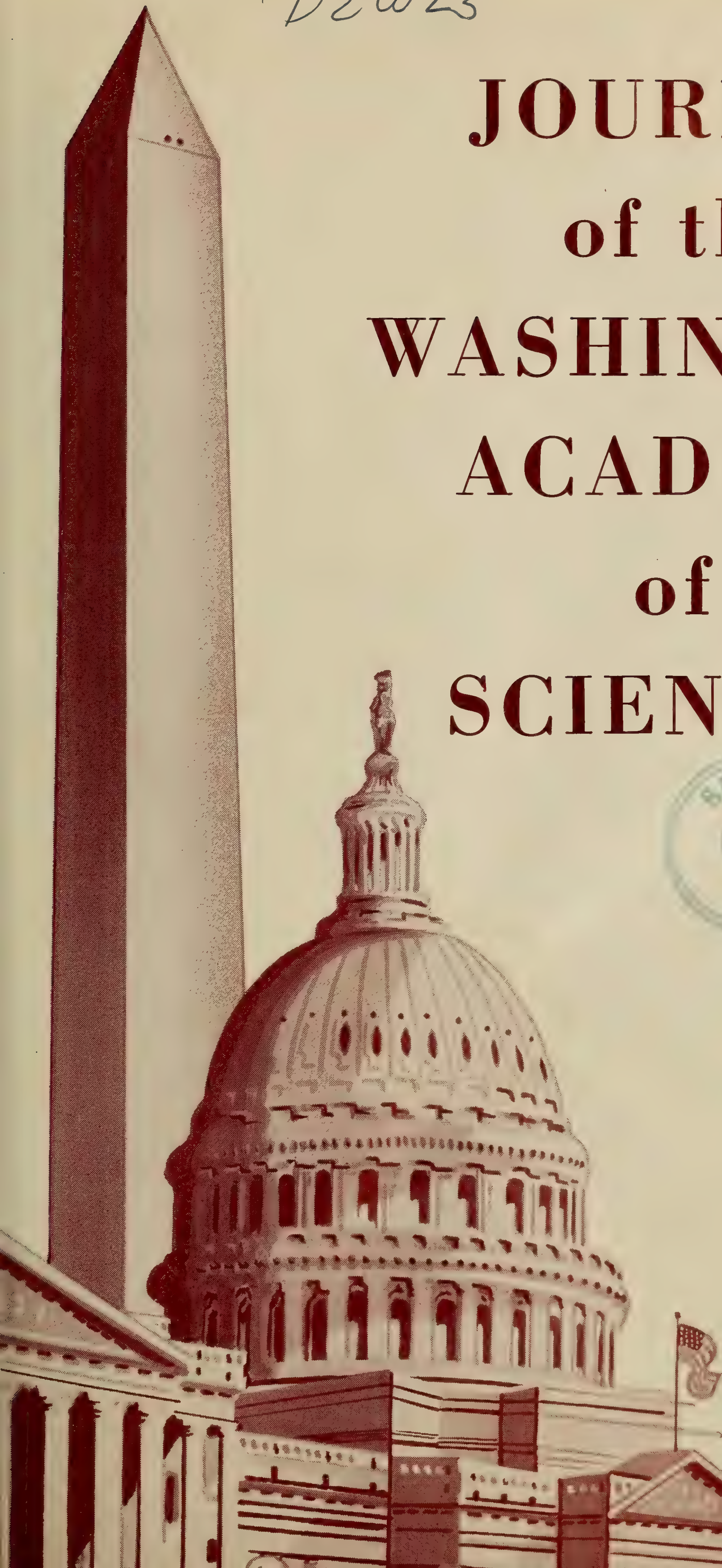

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DECEMBER
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JOURNAL OF THE WASHINGTON ACADEMY OF SCIENCES

This Journal, the official organ of the Washington Academy of Sciences, publishes historical articles, critical reviews, and scholarly scientific articles; notices of meetings and abstract proceedings of meetings of the Academy and its affiliated societies; and regional news items, including personal news, of interest to the entire membership. The Journal appears nine times a year, in January to May and September to December. It is included in the dues of all active members and fellows.

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ACADEMY OFFICERS FOR 1964

Theories of Types in the History of Science

Eduard Farber

Research Professor, Department of Chemistry, American University

The time from about 1760 to 1860 can be called the period of type theories in the history of several sciences. Such theories are not entirely limited to this period; predecessors extend far back of it, and successors appear decades later. Yet, the accumulation of independently developed theories of types in sciences and their predominance are particularly characteristic during this period. Almost every branch of science went through this phase. Anthropology was first, and chemistry was —preliminarily—last. To review these several developments together will bring out what they had in common and what distinguished their separate origins and applications. Perhaps we can thus contribute to a future comparative history of the sciences while providing some stimulation for the methods of teaching science. These are the practical aims of the following study; they are supported by the general importance of the concept, which is here described by its fruitful use rather than by its philosophical implications.

Anthropology

In 1775 Kant published his book "On the various races of man." Ten years later, he followed it with a "Definition of the concept of a human race." Kant defined four typical races as follows:

1. Very blond	North-European climate	damp-cold
2. Copper-red	America	dry-cold
3. Black	Segambia	damp-hot
4. Olive-yellow	India	dry-hot

This selection of four races, and their connection with four complex qualities to characterize their climates, raises the suspicion that they were derived from the four elements of Aristotle and their definition by four qualities. This suspicion should not go so far as to reject the whole scheme for being that of a mere philosopher. We have to remember that Aristotle has stimulated many a scientist, even in the late 18th century. And besides, Kant was not only and exclusively a philosopher. His first publication, in 1754, was concerned with "The Question, whether the Earth ages, considered from the standpoint of physics" ("Die Frage, ob die Erde veralte, physikalisch erwogen"). In his affirmative answer he referred to "a volatile acid that is expanded everywhere in the air," a "subtile, but universally acting matter," as being more suitable, materialistic explanations than "products of a bold imagination" ("Geschöpfe der kühnen Einbildungskraft"). In the same year, Kant gave his "Natural history and theory of the skies," made famous by LaPlace in 1796. He also developed a theory of wind directions (1756) which Buys Ballot later (1850) extended.

The idea of "types" persisted in anthropology long after Kant. Jean Louis Rodolphe Agassiz (born 1807 in Switzerland, professor at Harvard from 1846 on, died 1873) was not satisfied with the three principal types of Cuvier: European, Mongolian, Negro. Agassiz postulated first

(1850) six, then (1853) eight geographical types. In their book on "Types of Mankind" (Philadelphia, 1854), Mott and Gliddon quoted these types with approval. Andreas Adolf Retzius (1796, Lund—1860, Stockholm) distinguished four "gentes" which he characterized as follows:

(1) dolichocephalae orthognatae,
(2) brachycephalae orthognatae,
(3) dolichocephalae prognatae,
(4) brachycephalae prognatae.

Thus, in 1855, we find another modification of the Aristotelian scheme, the pairing of two pairs of opposites to characterize four classes.

In his "Kritik der Urteilskraft" (1790) Kant spoke of a primordial image (*Urbild*) of all organic forms in a philosophical way, which, in all its caution, bordered on the mystical:

> This analogy of forms, insofar as they seem to be created according to a common *Urbild*—in spite of all the difference between them—strengthens the supposition of their real relationship as emerging from a common maternal origin (*Urmutter*) (p. 364 f. of the first edition).

The idea of an *Urbild* was present already in his book of 1775, and he expected its real definition from the further advance of science.

Botany and Zoology

This idea found more specific expressions in the work of another man whose fame as a poet often overshadows his scientific endeavors, Goethe. He had been deeply interested in trends towards a comparative anatomy, such as Johann Friedrich Blumenbach's *Handbuch der vergleichenden Anatomie* (Handbook of Comparative Anatomy) and Petrus Camper's lecture before the Amsterdam Academy of Design on the analogy in structure between man and other vertebrate animals (1778). Thus, when Goethe chanced on a broken ram's head in 1790, he found in it only a confirmation of his theory that the cranium is a modified vertebra. Five years later, Goethe published his essay in comparative anatomy ("Erster Entwurf einer allgemeinen Einleitung in die vergleichende Anatomie", 1795) in which he developed a program, a "proposal" as he called it:

> Because they (the plants) can be summarized under a concept, it gradually became clear and clearer to me that perception (*Anschauung*) might be enlivened in a still higher manner—a requirement which, at that time, hovered before my mind under the physical form of a metaphysical primordial plant (*"Urpflanze"*). Therefore, I here present a proposal for an anatomical type, a general picture, in which the shapes of all animals would be contained potentially, and according to which every animal would be described in a certain order. This type would have to be constructed, as far as possible, in physiological respect. From the mere general idea of a type it follows that, here, none of the specific single animals could be postulated as such a rule for comparisons; no one singular item can be pattern of the whole entity.

Goethe elaborated these thoughts, in his "Lectures" of 1796, with analogies taken from mineralogy, with references to Camper and Buffon, and with specific examples from the metamorphosis of insects. Although this remained fragmentary, the theory of types was always close to his heart. We can see that in an amusing story told by his faithful assistant, Eckermann. He visited Goethe on Monday, August 2, 1830, when the news of the July revolution in France had just reached Weimar.

> "Well," he exclaimed, "what do you think of this great event? The volcano has started to erupt; everything is in flames, and it is no longer a negotiation behind closed doors!"
>
> "A terrible story," I replied. "However, under the known circumstances, and with such a government, what else was to be expected than that it would end with the expulsion of the present royal family?"
>
> "We don't seem to understand each other, my dearest fellow," replied Goethe. "I am not talking about those people at all; I am concerned with entirely different things. I am talking about the scientifically most important controversy between Cuvier and Geoffroy de Saint-Hilaire which has publicly erupted in the Académie!" (Johann Peter Eckermann's *Gespräche mit Goethe*. Dritter Teil, 1847.)

He saw in Saint-Hilaire his ally, because he went much further than Cuvier. The difference between the two French anatomists was more in the application than in the basic concept of types. Cuvier divided the animals into four types: vertebrata, mollusca, articulata, and radiata. All the different classes of animals within these four groups follow the ground-plan of their group of which they are characteristically modified realizations. Saint-Hilaire had to retract some of the wild analogies which he had constructed. His main viewpoint, however, emerged the more clearly. He saw in all animals one general animality, "an abstract entity which yet is tangible to our senses in diverse forms." This is what attracted Goethe, who, decades before, had seen his *Urpflanze* not only in his imagination, but had discovered it in a real plant.

Plan and type were foremost in the thought of botanists and zoologists of this time. To Carl Linné, Pyrame de Candolle, or Ernst von Baer, the concept of type was not something tentatively abstracted from observations, but an active reality. Thus, Linné wrote: "It is not the character (the marks used to characterize the genus) which makes the genus, but the genus which makes the character." The parenthesis was added by Julius von Sachs when he quoted this passage in his *History of Botany* of 1875.* And further on, Julius von Sachs describes Linné's position according to the 6th edition of the "*Genera Plantarum*," 1764, as follows:

> At the creation of plants (in ipse creatione) one species was made as the representative of each natural order, and these plants so corresponding to the natural orders were distinct from one another in habit and fructification, that is, absolutely distinct.

In the communication of 1764, the following words occur:

> 1. Creator O. T. in primordio vestiit vegetabile medullare principiis constitutivis diversi corticulis, nude tot difformis individua, quod ordines naturales, prognata" (P. 105/6).

> Where Linnaeus had spoken of a class-plant or genetic plant, the expression: plan of symmetry, or type, was used, meaning an ideal original form, from which numerous related forms might be derived. It was left undecided, whether the ideal form ever really existed, or whether it was merely the result of intellectual abstraction; and thus the forms of thought of the old philosophy began to reappear . . . (p. 111)

In his *Théorie élémentaire de la Botanique* (1813), Augustin Pyrame de Candolle "gave to the science of comparative morphology its first principles in his theory of symmetry, ... the doctrine that the nature of an organism is expressed in the plan by which the positional relations of all its parts is manifested. The uncovering of this plan from beneath the effects of abortion, degeneration, and adhesion which obscure it, he conceived to be the rule for the determination of true affinities." * Karl Ernst von Baer said in his Scholion V of *Entwicklungsgeschichte der Tiere* (1828) "on the relationship of the forms through which the individual goes in the several stages of its development:"

> I call type the positional relationship of the organic elements and the organs. This positional relationship is the expression of certain fundamental relationships in the direction of the single interconnections of life, e.g. the absorbing and the excreting poles. The type is entirely different from the stage of development, so that the same type can persist in several stages of the development, and vice versa, the same stage of development is reached in several types (p. 208).
>
> I believe that 4 principal types are clearly to be proved: the peripheric or radial type, the articulated or length-type, the massive or mollusk type, and the type of the vertebrates (p. 209).

Similarly, although perhaps more metaphysically, Carl Gustav Carus spoke of fundamental forms and schemes in his *Grundzüge der vergleichenden Anatomie* of 1828. Richard Owen relied heavily on Oken and Carus when he wrote *On the Archetype and homologies of the vertebrate skeleton* in 1848.

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*Translated by E. F. Garnsey, revised by I. B. Balfour, Oxford, Clarendon Press, 2nd ed., 1906, p. 9.

*R. C. McLean and W. R. Ivimey-Cook, *Textbook of theoretical botany*, vol. 2, p. 2159. Longmans Green and Co., London, 1956.

I have indicated above that the number four in Kant's scheme was selected under the influence of Aristotle. Richard Owen refers to the "Platonic idea" underlying his construction of an archetype.

The Platonic idea, or specific organizing principle or force, would seem to be in antagonism with the general polarizing force, and to subdue and mould it in subserviency to the exigencies of the resulting specific forms (p. 172).

Mineralogy

It was a little late to develop such ideas in 1848. They had been quite fruitful, with all their vagueness and vastness, about half a century earlier. Due to such general concepts and feelings for the unity of nature, Linné's work on the classification of plants, animals, and minerals enlightened René Juste Haüy and Romé de L'Isle in a new approach to mineralogy, particularly crystallography. They discovered types and fundamental plans of crystal forms. Haüy's "integrant molecule" was the mineralogical corollary to Goethe's *Urpflanze* and Cuvier's types. Deodat G. S. T. Gratet de Dolomieu confirmed Haüy's statement that "the integrant molecule is one by composition as well as form." * Claude Louis Berthollet objected:

"In order to establish that the integrant molecule is the type of a group and that this group is constant in its composition, Haüy has to consider as heterogeneous substances all the differences which our analysis finds in the minerals that nevertheless have one and the same form *(Essai de Statique chimique,* vol. 1, p. 438).

Berthollet was justified later by Mitscherlich's discoveries.

A relationship between crystal form and chemical composition became recognized (Haüy, 1809). It had to be modified in later studies, but that is the usual fate of our general theories, particularly those of such an origin in philosophy. The "integrant molecule" recurred in Avogadro's work of 1814 and was not understood by contemporary chemists.

**Sur la philosophie minéralogique et sur l'es*pèce minéralogique, 1801.

Meteorology

A rather unphilosophical system of types was developed by Luke Howard for describing clouds, and we still use it today. It was published in 1830 under the title: "On the modifications of clouds and the principles of their production, suspension, and destruction, being the substance of an Essay read before the Askesian Society in the Session of 1802-3" (London, Printed by I. Taylor). Howard did not use the word type, he spoke of modifications. "The simple modifications" were thus named and defined:

1. Cirrus. Definition—Nubes cirrata, tenuissima, qua undique crescat. Parallel, flexuous, or diverging fibers, extensible in all directions.
2. Cumulus. Definition—Nubes cumulata, densa, sursum crescens. Cones, or conical heaps, increasing upward from a horizontal base.
3. Stratus. Definition—Nubes strata, aquae modo expansa, deosum crascens. A widely extended, continuous, horizontal sheet, increasing from below.

To these three, he added "the intermediate modifications"

4. Cirro-cumulus and
5. Cirro-stratus,

and "the compound modifications"

6. Cumulo-stratus and
7. Cumulo-cirro-stratus vel Nimbus, the rain cloud.

He devised a simple system of signs, derived from a feather for cirrus, a convex half-circle for cumulus, and a horizontal line for stratus. These signs could be combined in order to represent the "compound" forms.

The first sharp distinction between three typical forms had to be softened by intermediaries and compounds. A philosopher taking a comparative view of type theories would have recognized a process that is not restricted to the study of clouds. However, philosophy at the beginning of the 19th century was concerned only with its own history and did not realize how much material was to be found in the history of science. Chemistry would have offered many splendid subjects for philosophical evaluation, first in the developments which started from the early theories of the elements, and later in the specific formulation of type theories.

Chemistry

Although the Aristotelian elements assumed the character of types in the long development of this concept, actual and outspoken chemical theories of types came relatively late. They originated from specific new experiments, not from a search for broad analogies. Nevertheless, these experiments did not speak for themselves, they had to be interpreted, and that required decisions which left room for controversy. In 1839, G. B. André Dumas interpreted the action of chlorine on acetic acid as occurring by substitution. He considered the properties of the chlorinated acids to be fundamentally the same as those of the parent acid. Therefore, he saw a common "type chimique" maintained in this chemical change of composition. Substances which contain the same "number of equivalents," yet differ in fundamental properties, are combinations on the basis of the same "type méchanique."

After much debate, the theory of types was enlarged by Adolphe Wurtz when he found simple "organic alkalies," and by A. W. Hofmann, whose discoveries of diethylamine and triethylamine completed the first series of the type, ammonia.

$$\begin{array}{cc} \begin{array}{c} \mathrm{H} \\ \mathrm{NH} \\ \mathrm{H} \end{array} & \begin{array}{c} \mathrm{C_2H_5} \\ \mathrm{NH} \\ \mathrm{H} \end{array} \\ \text{ammonia} & \text{ethylamine} \\ \begin{array}{c} \mathrm{C_2H_5} \\ \mathrm{NC_2H_5} \\ \mathrm{H} \end{array} & \begin{array}{c} \mathrm{C_2H_5} \\ \mathrm{NC_2H_5} \\ \mathrm{C_2H_5} \end{array} \\ \text{diethylamine} & \text{triethylamine} \end{array}$$

In 1851, Alexander William Williamson added the water-type to explain his findings about ethers, esters, and anhydrides of acids:

$$\begin{array}{cc} \begin{array}{ll} \mathrm{H} & \\ & \mathrm{O} \\ \mathrm{H} & \end{array} & \begin{array}{ll} \mathrm{C_2H_3O} & \\ & \mathrm{O} \\ \mathrm{H} & \end{array} \\ \text{water} & \text{acetic acid} \end{array}$$

$$\begin{array}{c} \begin{array}{ll} \mathrm{C_2H_3O} & \\ & \mathrm{O} \\ \mathrm{C_2H_3O} & \end{array} \\ \text{"anhydrous acetic acid"} \end{array}$$

Gerhardt, who had predicted the water-type in 1842, added "double types" of water, furthermore H_2 and HCl, so that the number of types was now four (1853). Edward Frankland found it very convenient to derive the constitution of his new metal-organic compounds from inorganic types:

$$\begin{array}{lcl} \begin{array}{ccc} & \mathrm{S} & \\ \mathrm{As} & & \mathrm{As} \\ & \mathrm{S} & \end{array} & \begin{array}{c} \mathrm{C_2H_5} \\ \\ \mathrm{C_2H_5} \end{array} & \text{cacodyl} \\ \begin{array}{ccc} & \mathrm{O} & \\ \mathrm{As} & \mathrm{O} & \mathrm{As} \\ & \mathrm{O} & \end{array} & \begin{array}{c} \mathrm{C_2H_5} \\ \\ \mathrm{C_2H_5} \\ \mathrm{O} \end{array} & \text{cacodyl oxide} \end{array}$$

Neither Gerhardt nor Williams Odling considered the types as "real"; they are "only formal—based upon illusions" (Gerhardt), only relative, not really constitutive (Odling). For Dumas, they had appeared real enough, at least, to argue against Lavoisier's dualism, and they guided Wurtz in his work on glycols (1856). Kekulé accepted the "idea of types" in 1857, a year before he developed the concept of tetravalency for carbon which reduced the type theory to a historical stage in the development of organic chemistry. However, Kekulé himself continued to use type formulas. Adolf Baeyer represented the relationship of malonic and mesoxalic acids to their urea compounds by formulas based on the types of doubled water and ammonia:*

$$\begin{array}{cc} \begin{array}{ll} \mathrm{C_3O_2H_2} & \\ & \mathrm{O_2} \\ \mathrm{H_2} & \end{array} & \begin{array}{ll} & \mathrm{CO} \\ \mathrm{N_2} & \mathrm{C_3O_2H_2} \\ & \mathrm{H_2} \end{array} \\ \text{malonic acid} & \text{barbituric acid} \end{array}$$

*A. Baeyer, *Liebig's Ann. 130*, 129 (1864).

$\begin{array}{l} C_3O_3 \\ \qquad O_2 \\ \; H_2 \end{array}$	$\begin{array}{l} \qquad CO \\ N_2\ C_3O_2 \\ \qquad H_2 \end{array}$
mesoxalic acid	alloxan

August Wilhelm Hofmann proposed a triple ammonia type in the new formulas for aniline red, blue, and violet in 1864 (*Ann. 132*, 297).

These formulas provided a good orientation in the maze of newly separated substances. The theory of types became an order of arrangement for symbols, and both possessed the same degree of reality or abstractness.

The first chemical types were rejected as ridiculous by Berzelius, Liebig, and Wöhler. They maintained the dualistic conception of chemical affinity, and they emphasized the differences between acetic acid and the product produced from it by chlorine. If it was a bold view that saw the "typical" equality between these acids, it was shortsighted to consider only what happened to the acetic acid. When this is chlorinated, part of the chlorine combines with hydrogen out of the methyl group of acetic acid, and if this had been emphasized as the "driving" reaction, the old dualism would have been saved. Actually, Dumas himself had talked of the "dehydrogenating action" of chlorine and the other halogens:

> Chlorine possesses the specific power *(le pouvoir singulier)* to take hold of the hydrogen in certain substances and to replace it atom for atom (13 January, 1834).

Two years later, Laurent added nitric acid to the dehydrogenating agents. Adolphe Wurtz considered these views so important that he cited them in the historical introduction of his *Dictionnaire de Chimie* (vol. 1, Paris, 1869, p. XXXLL). Nevertheless, the emphasis was on the resulting organic product, the inorganic hydrogen compound was neglected. To discover the same "type" in water and acetic anhydride required something of this kind of thinking that prevailed in the unifying concepts of old alchemistic times!

Use and Abuse of Type Theories

This ended the period in which type theories were prominent in the history of the sciences. Nevertheless, theories of types remained fruitful. We use them successfully in teaching chemistry. Textbooks on zoology, like that by Claude E. Villee *et al*, (Philadelphia, 1958) relate the multitude of animals to representative types. The same is true in psychology and anthropology. For such use, we do not have to consider types as real in nature, but we cannot deny that they have their reality in "thought." This kind of reality should not be discounted.

In the foreword of his book on Greek Cultural History (1898-1902), Jacob Burkhardt pleaded the cause of typical presentations in history:

> The singularity of the source, the so-called single event may be heard only as a witness for the generality, not for its own sake; the reason is that the facts we seek are the modes of thinking which themselves naturally also are facts. Even if an event did not actually take place, or not precisely so, the thought about it would retain its value through the typical presentation . . . Perhaps the really true content of ancient history is the constant which emerges from such a typical presentation. We come to know the eternal Greek, a general type instead of a single factor. . . . The typical gives us a picture of history which is, as a whole, always true and yet was never true at any single time. . . . Philosophers of history consider the past as contradiction and preliminary to us in our further development. We consider that which repeats itself, that which is constant and typical, as something similar and understandable to ourselves.

With this translation I have tried to be true to the text, and yet I have not quite reproduced the "spirit" of Burkhardt's words. Some of the ambiguities of his abstract nouns disappear when transformed into English verbs.

In history, "the so-called single event" corresponds to the single example in science as being "a witness for the generality." When an observed fact is proclaimed to be an example, it becomes a representative for more than itself and gains in importance. The gain is achieved by depriving the fact of its individuality. We have to pay for the gain by a loss. Though only an interpretation, not an exchange of energy is involved, the law of conservation is valid here. For itself, the fact retains its individuality and remains more than a mere example. We are not only willing to pay for the gain, we make special efforts in this direction, because it leads us to a view of unity in diversity. In all these respects, examples are like types. When we read Burkhardt's words about the eternal Greek, we remember the typical Englishman we knew, the exemplary Italian we met, with some surprise that what he had in mind really exists, and with the conviction that, in order to exist, they also have to be individuals.

Types are constructions from ideas, abstractions from experiences. They are "on the one hand intellectual, on the other hand sensual," a "monogram of the pure intuition a priori," to use the words of the great thinker with whom I started this survey. In his "Critique of pure reason,"* Kant introduced this monogram, this schema, as the "mediator" between mind and nature. This mediator took on different forms in anthropology, botany, zoology, meteorology, mineralogy and chemistry. They are as real, and not more so, as the "lines of force" which Faraday, as Maxwell put it, saw "in his mind's eyes."

What the mind sees depends on the accumulation of experiences. Kant derived his four anthropological types from the same simple and direct impressions as Aristotle; Retzius used measurements on skulls in formulating his four basic characteristics which he then combined according to the Aristotelian pattern. In other fields, the development consisted in multiplying the number of types, from Goethe's single Urpflanze to a number of plant types, and from the one typical "animality" of Saint-Hilaire to many types of animals. More recently, and on a stronger experimental foundation, we have seen the original (1901) first three, later four bloodtypes of Landsteiner increased by subdivisions and additions of main types.

Type theories have been powerful tools for the advancement of science. They were created with enthusiasm, and they needed it to withstand severe criticism.

So deeply rooted are theories of types that sometimes even complete nonsense has been accepted under their name. During the period of type-theories in science, Joh. Gottfried Rademacher (1772-1850) developed a new system for the healing arts. All maladies, according to him, can be reduced to three types, depending upon whether they can be healed by iron, by copper, or by saltpeter. A reference to this great example can be found in a book published in 1868 by the somewhat neglected chemist Friedrich Mohr under the title: "Mechanische Theorie der chemischen Affinität und die Neuere Chemie" (Mechanical Theory of Chemical Affinity and the New Chemistry, p. 168). And Mohr stated that this type-theory found many strong believers.

Type and Time

Considered as a complex of construction from ideas and abstraction from experiences, types represent the general process by which we build science. Therefore, it is not surprising that type theories were elaborated in so many sciences. What causes surprise is that type theories flourished almost together at a specific period in the development of science, so that the question arises whether this was due to direct influences. Some influences of this kind are known. Romé de L'Isle and Haüy had been inspired by Linné, biological typologists followed Carl Gustav Carus. Other questions are still open. Did Gerhardt study Cuvier's types of animals and then expand them to chemistry? Did Burckhardt purposely or subconsciously transfer types in chemistry to types in political history?

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* I 182 ff. in the first edition, 1781.

These questions are directed to the process by which theories of types were created in time. Another problem is concerned with the product of this process. Does the concept of type mean an entity that is essentially constant, or can it comprise change and evolution? For mineralogy or chemistry, the questions do not arise. Here, types meant forms that are either fundamental or convenient, structural or exploratory, but in no way evolutionary. In the life sciences, types have a distinguishing additional feature. "Urpflanze" can mean the oldest in time and the most invariable in history. Biological type as the constant reality corresponding to eternal idea has no room for evolution. "Many of the basic concepts of the synthetic theory, such as that of natural selection and that of population, are meaningless for the typologist."*

For types as "the mediators between mind and experience" (Kant) there is no danger of becoming petrified, although it is the danger common to all our general concepts. This is true in science as well as in other human activities, it has been noticed in art and architecture, and it can become ominous in the form of rigid policies to the detriment of sound administration in business and research.

*Ernst Mayr, *Animal species and evolution,* Cambridge, 1963, p. 6.

Dating on the Banks of the Potomac*

Meyer Rubin

U. S. Geological Survey, Washington, D. C.

One would think that the combination of a long-established radiocarbon laboratory in Washington and the large concentration of working and picnicking geologists here (largest in the world, I'm told) would produce a great number of radiocarbon-dated samples from the Washington area. However, the geologic history of the region has determined otherwise. Actually, except for some Coastal Plain sediments of Cretaceous, Eocene, and Miocene age, the area is essentially dominated by the geologically ancient (Precambrian) schists and gneisses, as at Great Falls, overlaid by the partly eroded Pliocene blanket of Brandywine Gravel seen in the Ward Circle and Washington Cathedral areas.

Not only have few carbon-14 samples been analyzed (eight published analyses, to my knowledge), but also most of them have been outside the range of the dating method. Carbon dating has an effective maximum limit of about 40,000-50,000 years, depending on the optimism of the laboratory operator. This limit is quite good, considering that it is about eight half-lives of a practically nonexistent commodity (10^{-12} concentration compared to normal C^{12}) to begin with. (To avoid confusion, the new half-life of carbon-14, 5730 years instead of 5568 years, is not used in age computations, although it is considered to be a better approximation.) No wood

* Publication authorized by the Director, U. S. Geological Survey.

has ever been found in the Brandywine Gravel, and it would have had little chance of preservation in the iron-stained, oxidized, coarse phase anyway; but even if it were found in the silts, it would probably be too old to date.

The younger terraces of the Potomac were therefore the natural choice for a dating project. But the pleasant prospect of canoeing down the river, collecting samples idyllically, was quickly dispelled by the dates we obtained on two samples from the lowest level terrace (i.e., the youngest) on the Potomac River. These samples, W-252* (shells) and W-253 (wood), came from a well-known fossil-collecting locality at Wailes Bluff, Md., near Cornfield Harbor, about three miles above the river mouth. They were given a minimum date of greater than 35,000 years. Another wood sample (W-1389) from the lowermost terrace, obtained from an excavation at the eastern approach of the Roosevelt Island Bridge near Virginia Avenue, again proved the futility of dating the terraces by this method: its age was greater than 38,000 years.

Buried cypress swamps on top of many of the terrace gravels here have been known for a long time, and wood from one of them, from the original excavation for the Mayflower Hotel, was described years ago. The age of this peaty deposit is believed to be Pleistocene, but exactly when in the Pleistocene age is not known. When the site for the new annex to the Mayflower was excavated in 1955, a sample of cypress (W-302) was collected and dated as older than 38,000 years. Many of the new excavations in that part of town turn up peat of the same or similar deposits. A piece of wood from another peat deposit (W-817) was collected from an excavation for the relocation of Wheeler Road, near the southeast boundary line of the District of Columbia. This also proved disappointing, in that it was more than 38,000 years old.

The only sample that gave a finite age was an archeological one—charcoal dug from a firepit near the mouth of Seneca Creek, where the Creek enters the Potomac. Hundreds of points, scrapers, and pieces of pottery have been unearthed by the Southwestern Chapter of the Archeology Society of Maryland, the excavators of the site. The sample (W-798) showed that woodland Indians inhabited what was then an island in the Seneca Creek delta, about 1,960 years ago. I was told that an older culture lies beneath these layers but that no datable material was found. If some day some carbon is found with which to date these earliest of suburban Washingtonians, the sample would most probably be dated by the radiocarbon laboratory of the Smithsonian Institution, a recent and excellent facility specializing in archeological samples.

A few years ago, samples of peat (W-1064) and of wood (W-1065) were collected from the flood plain silt and the underlying gravel in Watts Branch near Rockville, Md., to determine whether the gravel was deposited much earlier than the silt. Here again, the method was not suitable because the ages determined for both were less than 250 years.

In spite of the great interest in local geologic samples, and in spite of our willingness to analyze them, very few carbon samples from the Washington area are likely to be analyzed—unless, of course, we want to know the source of river and atmospheric organic pollution, a task for which C^{14} is admirably suited. But that's another story.

* Laboratories denote their samples by the prefix to the laboratory number: W indicates the U.S. Geological Survey laboratory, Washington, D.C., and SI indicates the new Smithsonian Institution laboratory on the Mall.

Academy Proceedings

484th Meeting of the Washington Academy of Sciences

SPEAKER: RICHARD BROOKE ROBERTS
Carnegie Institution of Washington,
Department of Terrestrial Magnetism
SUBJECT: PROSPECTS FOR ACTION IN ARMS CONTROL

SPEAKER: EDWARD N. PARKER
USN (Ret.)
SUBJECT: TO CONTROL THE THREAT

TIME: THURSDAY, DECEMBER 17, 1964
8:15 P.M.
PLACE: JOHN WESLEY POWELL AUDITORIUM, COSMOS CLUB
2170 Florida Avenue, N. W.

Abstract of Dr. Roberts' Talk—The recent election gave strong support to President Johnson's policies for dealing with the USSR and China. Further action toward arms control measures should therefore be expected. The Chinese nuclear test emphasizes the need for measures to prevent proliferation of nuclear weapons. Proposals already made by the United States and USSR are likely to become the subject of serious negotiations. The status of the multilateral forces (MLF) will require re-examination. These proposals and other possible action will be discussed in the contexts of the military needs of the United States and USSR.

The Speaker—Richard Brooke Roberts was born in Titusville, Pa. He received the A.B. degree from Princeton in 1932, the A.M. degree in 1933, and the Ph.D. degree in physics in 1937. He was a fellow with the Carnegie Institution from 1937 to 1939, an associate physicist there from 1939 to 1943, and a physicist with the Johns Hopkins Applied Physics Laboratory from 1943 to 1946. In 1947 he joined the staff of the Department of Terrestrial Magnetism, Carnegie Institution, and became chairman of the Biophysics Section in 1953. He served as consultant to the Weapons Systems Evaluation Group in 1950, and was a member of the Committee on Biological Warfare Research and Development Board from 1948 to 1951. He was awarded the Medal for Merit in 1947.

Dr. Roberts is a member of the Physics Society, the Biophysics Society, the Bacteriology Society, the Biochemistry Society of Great Britain, and the British Society for

General Microbiology. His field is nuclear physics, with special emphasis on reactions, scattering, fission, weapons developement, the proximity fuse, fire control, guided missiles, biosynthesis of small and large molecules, and microbiology.

Abstract of Vice Admiral Parker's Talk—The current emphasis on arms control and disarmament is strongly motivated by the threat of total destruction to whole societies in a general nuclear war. In this world of violence, hatreds, and open aggression, the goal of general and complete disarmament is but a dream. To remove the "Sword of Damocles" from above our heads, while maintaining our national objective of remaining a nation of free men, there are two possible courses:

(1) To establish some measure of control over nuclear armaments, either to reduce the direct threat or to limit the situations in which we are threatened;

(2) To develop and install the capability to limit the damage which nuclear weapons can inflict on our people should deterrence—or arms control—fail.

These two possible courses are not mutually exclusive; both aim to control the threat; they can be pursued in parallel and are mutually supporting. Some measure of arms control will assist the defense; some defense—rather than none—should promote agreement on arms control.

Among the many contributions which science can make toward controlling the nuclear threat, two are considered of special importance:

(1) To develop means of proving that an arms control agreement (of whatever kind) is, in fact, being carried out. To be useful, the means must cause the least possible disruption of the societies and maintain the freedom of the individual normal in the society.

(2) To assist the development of the capability to limit the damage to our society and the casualties to our population, should we be attacked by nuclear weapons, by these means: (a) stop saying defense is impossible; (b) start helping to make it possible and effective, so that our people cease being hostages to the capability and intentions of those who have promised to bury us and those who are working hard to develop that capability.

The Speaker—Edward N. Parker, vice admiral, U. S. Navy (Retired) was born in Avalon, Pa. He graduated from the United States Naval Academy in June 1925, served with Ordnance Engineering from 1932 to 1935, and became assistant director of the Research Division of the Bureau of Ordnance in 1945. He was associated with Fleet Training and Readiness, Naval Operations, 1948–1950; with the Armed Forces Special Weapons Project, 1952–1954; with Plans and Policy, Naval Operations, 1956–1957; and with Chief Defense Atomic Support Agency, 1957–1960. He was deputy director of Joint Strategic Target Planning Staff, 1960–1962, and assistant director of the Arms Control and Disarmament Agency, 1962 and 1963.

Admiral Parker retired from active duty with the U. S. Navy in November 1963. He is now a consultant to several firms, and makes his home in Annapolis, Md.

STANDING RULES OF THE BOARD OF MANAGERS

Approved June 9, 1964

1(a). MEETINGS of the Board of Managers shall be held as called by the President, or in his absence by the Secretary, or within one week after written request of three members of the Board. Generally, regular meetings are scheduled to be held on the third Thursday immediately before the Regular Meeting each month except July, August, and September.

1(b). A Delegate of an Affiliated Society may, in an emergency, be represented by a substitute from his society who shall also be a Resident Fellow or Resident Member of the Academy except that the authority to vote cannot be delegated to the substitute. Because of the latter restriction a delegate cannot be represented on the NOMINATING COMMITTEE by another person. One week before the October meeting of the Board of Managers, the Secretary shall inform each member of the Nominating Committee of the date and place of the Committee meeting to be held before November 1. In the case of an Affiliated Society that has not been represented at a substantial number of the Board meetings, the Secretary shall also inquire whether the scheduled dates of the Board meetings or any other causes are responsible for the inability of the Society to be represented and shall report his findings to the Executive Committee for possible consideration of a remedial action.

2. The regular ORDER OF BUSINESS shall be:
   - (a) Approval of the minutes of the last meeting.
   - (b) Announcements, such as committee appointments.
   - (c) Report of the Secretary.
   - (d) Report of the Treasurer.
   - (e) Reports of standing committees as follows:
     - i. Executive Committee
     - ii. Committee on Membership
     - iii. Committee on Policy Planning
     - iv. Committee on Ways and Means
     - v. Committee on Meetings
     - vi. Committee on Awards for Scientific Achievement
     - vii. Committee on Grants-in-aid for Research
     - viii. Committee on Encouragement of Science Talent
     - ix. Committee on Public Information
   - (f) Reports of special committees.
   - (g) Report of the Editor.
   - (h) Report of the Archivist.
   - (i) Report from the Joint Board on Science Education.
   - (j) Unfinished business.
   - (k) New business.
   - (l) Adjournment.

3. MOTIONS should be presented to the Board in written form when possible. Committee Reports should be presented in written form with copies for distribution if possible.

4(a). There shall be ten STANDING COMMITTEES: nine as listed in Rule 2 and the Academy members of the Joint Board on Science Education referred to in Rule 17.

4(b). Appointment to standing committees should be announced at the first Board Meeting following the Annual Meeting of the Academy, unless another time is prescribed for that purpose.

4(c). The Committees on Policy Planning, on Encouragement of Science Talent, the Academy members of the Joint Board on Science Education, Committee on Grants-in-Aid For Research, and the Subcommittees on Awards shall each consist of six Resident Fellows appointed for three-year terms at the rate of two members each year. Each Membership Committee Panel shall consist of 5 Resident Fellows, serving staggered 3-year terms (See Standing Rule 6). Appointment to noncompleted terms shall be made whenever necessary. Members of other standing committees shall be Fellows or Members of the Academy and their term of office, as well as the terms of the chairmen of all standing committees, panels and subcommittees, shall be one year. The terms of members of the Committees on Meetings, on Public Information, of the Joint Board on Science Education, and of the Membership Panels shall terminate at the end of June. The terms of members of other standing committees shall end at the conclusion of an Annual Meeting. Chairmen of all standing committees shall receive from the secretary all communications addressed to the Board of Managers and shall be expected to attend all meetings of the Board. When unable to attend a meeting, a Chairman shall either designate a member of his Committee to replace him or submit in advance a written report to the Secretary, whenever the proper conduct of the Committee's activity requires it.

4(d). The incoming President may appoint an AD HOC COMMITTEE ON COMMITTEES or use any other appropriate assistance to select candidates for membership on committees, panels, and for other appointments.

5(a). The EXECUTIVE COMMITTEE shall consist of the President, the President-Elect, the Secretary, and the Treasurer (or Acting Treasurer) ex officio, as well as two members appointed annually by the President from the membership of the Board. It shall have general supervision of the finances of the Academy, approve the selection of a depository for the current funds, direct the investment of the permanent funds, and shall prepare for the Board at the beginning of each year an itemized statement of the receipts and expenditures of the preceding year (or review such a statement already prepared by the Treasurer) and a budget based on the estimated receipts and disbursements of the coming year, with such recommendations as may seem desirable.

It shall be charged with the duty of considering all of those activities of the Academy that may tend to maintain and promote the relations with the affiliated societies, and with any other business which may be assigned to it by the Board.

5(b). The office of the Academy shall be under the general supervision of the Executive Committee. The functions of the office are as follows: to be the repository for files of the officers, especially those of the Secretary, and of the Treasurer; to relieve these officers of routine bookkeeping and filing activities; to receive subscriptions and be a sales office for Academy publications; to provide office assistance in the preparation of material for publication; and to function as a center for such other activities of the Academy as can be appropriately accommodated there.

6(a). The Committee on Membership shall consist of its Chairman and the Chairmen of the Membership Panels. The normal terms of appointment to each Panel shall be three years. Shorter-term appointments may be made when necessary to maintain a staggered system. Only Resident Fellows of the Academy shall be eligible for appointment to the Committee and its Panels, and no person shall be appointed to more than two consecutive terms.

6(b). The Committee shall recommend to the Board of Managers the scope of the Membership Panels. Each Panel shall consist of five members, not more than two of whom have the same institutional affiliation.

6(c). Nominations for Fellowship shall be referred to the Committee on Membership, which shall carefully examine the qualifications of each nominee and within a reasonable time report its findings to the Board. No rejected candidate shall be eligible for renomination within one year from the date of rejection.

6(d). The names of those approved for Membership by the Committee on Membership shall be reported to the Board. The Committee shall review at least once a year the current list of Members to consider their eligibility for elevation to Fllowship.

7(a). The COMMITTEE ON POLICY PLANNING shall periodically assess the status of the Academy from the viewpoint of long-term objectives. It shall recommend to the Board of Managers any new policy or changes in policy designed to make the Academy more effective in the scientific life of the Washington area.

7(b). All requests or consideration for AFFILIATION of a Society will be examined by the Committee on Policy Planning which will make its recommendations to the Executive Committee after giving proper consideration to the scholarly nature and purposes of the Society, the number of fellows of the Academy who are members of the Society, the extent to which its membership overlaps with the membership of Affiliated Societies, and the Society's affiliations with other bodies. Consideration of requests for release from affiliation shall be examined by the Committee on Policy Planning which will make its recommendations to the Executive Committee.

8. The COMMITTEE ON WAYS AND MEANS shall consider and advise the Board of Managers on the maintenance of a sound financial structure and such other matters as are intended to strengthen the Academy.

9. The COMMITTEE ON MEETINGS shall make all arrangements for the Regular Meetings of the Academy and such Special Meetings as may be of interest to the members of the Academy, the Affiliated Societies, and the general public interested in science. The Committee may also be

requested to participate with other committees of the Academy in making appropriate arrangements for specialized symposia and scientific conferences.

The retiring Chairman shall serve ex officio. Appointments should be made annually before the end of April for a one-year term starting in July and terminating when a new Committee on Meetings is appointed. If unable to attend a regular meeting of the Board, the Chairman of the Committee shall designate a member of his Committee as a substitute.

10(a). The COMMITTEE ON AWARDS FOR SCIENTIFIC ACHIEVEMENT shall recommend one or more candidates for each of the following awards: Biological Sciences, the Engineering Sciences, the Physical Sciences, Mathematics, and the Teaching of Science. A candidate must reside within 25 miles of the White House, Washington, D. C., and, except for an award for the Teaching of Science, shall not have passed the 40th anniversary of his birth by the end of the calendar year for which the award is made. Recommendations by the Committee must reach the Board of Managers not later than the meeting immediately preceding the annual meeting of the Academy in January. Each recommendation to the Board must be accompanied by a written supporting statement concerning the candidate, together with a citation covering not over 80 spaces, as . . . "In recognition of his distinguished service. . . ."

10(b). The Committee on Awards for Scientific Achievement shall examine from time to time the procedures used for the selection of awardees and recommend such changes as it deems appropriate; the Committee may also consider the desirability of establishing such other awards, prizes, or medals as may help in expressing the recognition and commendation of work of high merit and distinction in science, mathematics, engineering, and teaching in the Washington area, and may make appropriate recommendations to the Board.

10(c). The Committee on Awards for Scientific Achievement shall be responsible for obtaining a sponsor and verifying the presentation to the Membership Committee of the nomination for Fellowship of each recipient of an Academy Award for Scientific Achievement who is not already a Fellow.

11. The COMMITTEE ON GRANTS-IN-AID FOR RESEARCH shall review applications for grants from such funds as may be at the disposal of the Board of Managers for this purpose.

12. THE COMMITTEE ON ENCOURAGEMENT OF SCIENCE TALENT shall consider and arrange for participation of the Academy in activities promoting a professional interest in science among people of high school and college age. A member of this committee shall be designated by the President each year to serve as Chairman of the Governing Council of the Washington Junior Academy of Sciences.

13. THE COMMITTEE ON PUBLIC INFORMATION shall be concerned with publicizing the activities and functions of the Academy and shall maintain appropriate liaison with information services or organizations of special interest to the Academy.

14. SPECIAL COMMITTEES shall continue until the assigned duties are accomplished, unless sooner discharged.

15(a). The JOURNAL OF THE WASHINGTON ACADEMY OF SCIENCES shall consist of two parts published under separate or same cover: *Part A* will be of *scholarly* nature and may include: review papers, surveys devoted to interdisciplinary research, articles on the history of science, other scholarly articles and abstracted proceedings of the meetings of the Board of Managers. The selection of papers accepted for publication will be made by the Editor after appropriate review. *Part B* will be of the nature of a *newsletter* and may include: notices of major activities of the Academy, the Joint Board on Science Education, the Affiliated Societies, and the Junior Academy of Sciences; regional news items of scientific interest; personal news of changes in affiliations and major appointments and awards received by Academy members; reports on the activities of the Interdisciplinary Panels of the Academy; and such other items as may be of general interest to the members of the Academy and of the Affiliated Societies, to science teachers, science administrators, and to executives and legislators concerned with scientific research and its interrelation with public policy. News items and personal news submitted for publication shall be edited to retain an appropriate standard and eliminate news of lesser significance to the readers.

15(b). The editorial activities of the Academy shall be directed by the EDITOR with the assistance of such ASSOCIATE EDITORS as may be needed and the advice of an ADVISORY EDITORIAL BOARD. The Associate Editors will be elected annually by the Board of Managers on nomination by the Editor, and vacancies may be filled in a like manner. The Advisory Editorial Board shall include the Editor, the Chairmen of the Committees on Meetings, and of the Committee on Interdisciplinary Cooperation, and no more than fifteen fellows appointed by the President after consultation with the Editor. The Advisory Editorial Board shall meet at least twice a year under the President's chairmanship to examine the editorial policies of the Academy and to make appropriate recommendations.

16. An ARCHIVIST shall be appointed for a one-year term starting in July and shall continue to serve until his successor is appointed. In case of disability or absence of the Archivist his duties will be performed by the Secretary.

17. The JOINT BOARD ON SCIENCE EDUCATION of the Washington Academy of Sciences and the D. C. Council of Engineering and Architectural Societies consists of nine members appointed by each of the two bodies and the President of the Academy and the Chairman of the D. C. Council serving ex officio. The members representing the Academy shall be selected in a manner to provide (on the Joint Board) a good representation in the sciences, mathematics, and engineering and to insure a good contact with the local school systems. One of these members shall be appointed as Chairman of the Academy contingent on the Joint Board, and report on the activities of the Joint Board to the Board of Managers.

The Academy members of the Joint Board shall be ex officio members of the INTERDISCIPLINARY PANEL ON SCIENCE EDUCATION.

18(a). With the view to stimulating interest in the sciences, to promoting their advancement, and to developing their philosophical aspects, he Board may institute INTERDISCIPLINARY PANELS which shall explore, discuss, and review such interdisciplinary fields as may best be advanced through direct cooperation between individual scientists. Following upon the authorization by the Board of a panel with a defined scope of activities, the President shall appoint no more than nine Resident Fellows or Members including a convener and no more than two members of the Board who shall be ex officio members of the Panel. By a majority vote of at least five votes, the Panel may coopt six additional members who must be Fellows or Members of the Academy. Each panel shall review its activities and its scope and report to the Board before the end of November, including recommendations in regard to the continuance of the Panel. Unless renewed, the Board's authorization shall expire at the end of the Annual Meeting following the initiation of the panel. If continued, the membership of the panel shall elect a Chairman and a Secretary for the ensuing year.

The result of the deliberations of these panels shall from time to time be brought to the attention of the general membership of the Academy through formal symposia or meeting sessions arranged by the Academy, publication of reports or review articles regarding the interdisciplinary fields under study or such other means as may be appropriate, provided that the Academy responsibility or approval of the conclusion shall not be engaged except when specifically approved by the Board of Managers.

18(b). AN ADVISORY BOARD ON INTERDISCIPLINARY COOPERATION may be created to assist the Executive Committee in the coordination of the activities of the Interdisciplinary Panels, and in such other matters related to interdisciplinary cooperation as may be assigned to this Board.

19. Each Officer and each Chairman of a standing committee will be entrusted by the Archivist with the REGISTER of his office which shall include the following documents to be inserted by each holder of the office:

I. Name of the Officer or names of Committee members.
II. Annual reports.
III. Information concerning the location of other reports and files.
IV. Outline of procedures used in the conduct of the office.
V. Short statement prepared at the end of the Officer's (or Chairman's) term with recommendations to be noted by his successors.

The Registers will be maintained by the Archivist who will retain in his files a copy of each document inserted in each Register.

20. All routine ALLOTMENTS (including allotments for expenses of the Secretary, Treasurer, Committee on Meetings, and the Academy periodical) are considered to be renewed pro rata for the period from December 31 until a budget for the following year has been adopted by the Board.

21. DEFICITS or liabilities in excess of any allotment shall not be incurred in the name of the Academy without first obtaining authority from the Board. All requests for such authority, with reasons therefor, shall first be referred to the Executive Committee for consideration, in the same manner as items of the regular budget.

22. PUBLICATIONS shall be sent to Members, Fellows, and Patrons for the year for which their dues are paid. Sending of publications to members whose dues have not been paid shall be discontinued after six months.

23. NEW MEMBERS may receive the complete volume of the Academy periodical for the year of acceptance of membership upon payment of dues for the entire year.

24. Dues for the fractional part of a year for an ACTIVE MEMBER RESIGNING from the Academy shall be at the monthly rate of one-twelfth the annual rate. For the purpose of this rule, the first of the month which falls nearest the intended date indicated in the letter of resignation shall be considered the date of resignation. Sending of publications shall be discontinued upon resignation.

25. Amendments to the constitution and bylaws of the WASHINGTON JUNIOR ACADEMY OF SCIENCES and the expenditure of funds by the Junior Academy must have the approval of the Board of Managers of the senior Academy.

26. SUSPENSION OF RULES. By unanimous consent of the Board members present any standing rule of the Board may be temporarily suspended.

27. AMENDMENTS. These standing rules may be added to or amended by a majority of the members of the Board present, provided one week's notice of a proposed new rule or amendment has been given and provided such new rule or amendment is not in conflict with the Bylaws.

BOARD OF MANAGERS MEETING NOTES

October Meeting

The Board of Managers held its 566th meeting on October 13 in the Conference Room of the American Association for the Advancement of Science, with President Frenkiel presiding.

The minutes of the 565th meeting were approved as corrected to indicate the date of the meeting.

Announcements. Dr. Frenkiel announced that the new committees of the Board are listed in the Directory (September) issue of the Journal.

Treasurer. Dr. Henderson reported as follows: The Academy is a tax exempt organization. In support of this position, an amendment to the Academy's certificate of incorporation has been executed and filed with the District of Columbia. It is likely that the Internal Revenue Service will ultimately certify the Academy's tax exempt status.

Three statements were distributed for the information of the Board: (a) list of membership changes during 1964; (b) roster of the Board of Managers and committee chairmen, 1964; (c) list of Academy members whose dues have been delinquent since 1962.

By January 1, 1965, it is estimated, the Academy will have a cash operating deficit of about $2700. Investments of the Academy have appreciated in the past year by approximately $16,000. The Treasurer was authorized and directed to sell 67 shares of State Street Investment Trust stock and deposit the proceeds (approximately $2900) in the Academy's operating account.

The treasurer expects to establish a category of members who receive the Journal but do not receive Secretary's notices, to increase the efficiency of the business office.

Raymond Morgan, University of Maryland, was approved by the Board as fellow emeritus. John S. Coleman, NAS-NRC, was reinstated as a fellow of the Academy.

Membership. On motion of Chairman Cook, the following 24 persons were elected to fellowship in the Academy: A. B. Bestul, S. Block, G. B. Chapman, T. D. Coyle, R. D. Deslattes, Jr., E. Farber, W. Haller, L. S. Hansen, M. Jacobson, P. S. Klebanoff, E. M. Levin, R. J. List, W. M. MacDonald, G. D. Maengwyn-Davis, M. Maienthal, T. L. Noffsinger, V. J. Oliver, F. D. Ordway, Jr., E. J. Oswald, W. T. Pecora, F. A. H. Rice, R. G. H. Siu, L. E. Steele, D. L. Walter. President Frenkiel announced the appointment of Fellow Eduard Farber, American University, as Archivist of the Academy.

Dr. Cook reported that the following 14 persons had been elected to membership by the Committee: L. F. Affronti, L. R. Perkins, L. T. Milliken, G. C. Sherlin, Oscar Felsenfeld, Eugene Ehrlich, L. L. Salisbury, E. M. Hildebrand, H. G. Talmadge, Jr., W. A. Robinson, J. P. San Antonio, W. J. McCabe, W. F. Witzig, W. L. West.

Meetings. Chairman Steinhardt reported on programs for the year's meetings: *October,* Dr. Marshall Stone, University of Chicago, "Science and Society"; *November,* Dr. Christopher Tietze, National Committee on Maternal Health, Inc., New York Academy of Sciences, "Effectiveness of Methods of Population Control"; *December,* discussion between Dr. Richard Roberts, Department of Terrestrial Magnetism, Carnegie Institution of Washington, and Vice Admiral Edwin N. Parker, USN (Ret.), "Contribution of Science to Arms Control"; *January,* a subject concerned with the history of science (speaker to be selected); *February,* address of the retiring president; *April,* "Conversazione."

Dr. Steinhardt expressed the view that better means should be sought for publicizing Academy meetings.

Awards for Scientific Achievement. In the absence of Chairman Mason, Dr. Frenkiel outlined the steps that have been taken to request nominations from industry, universities, and government agencies for the Academy's awards for 1964.

Grants-in-Aid. In the absence of Chairman McPherson, Dr. Boyle presented a recommendation of the Committee that Clayton Curtis, Jr., who had been granted $200 in 1962 to construct a digital computor, be granted an additional $100 to liquidate indebtedness incurred in completing the project. The case was deferred, pending review by the Committee.

Editor. Editor Detwiler reported that the September issue of the Journal (Directory) and the October issue were both in the mail. The directory lists 1200 Academy members and the complete rosters of nine of the Academy affiliates. Eight of these affiliates are contributing to the cost of the Directory, of which 3900 copies were printed. The October issue is devoted to the interests of the electrochemists, who will be meeting in Washington. The November and December issues will be small.

Joint Board on Science Education. Chairman Taylor reported that two publications are available at the Academy office: "Summary Report, Washington Academy of Sciences to the National Science Foundation, 1963–64," and "Directory of the Joint Board on Science Information for the Greater Washington Area, 1964–65."

A fair in 1970 has been proposed to display the unique science features of the Greater Washington area. The President was authorized to inform Mr. Cole that the Academy endorses the proposal.

Another science conference for college students is being organized for the spring of 1965. Members of the Academy are urged to attend.

Unfinished Business. The Secretary reminded the chairman of the Nominating Committee (Dr. Liddel, delegate of the Philosophical Society) that the Committee's list of nominees must be available in time to reach the membership by mail on November 15. The Committee will meet November 9, 8 p.m., at the Cosmos Club.

New Business. Dr. Boyle of the Grants-in-Aid Committee asked for guidance on the merit of proposals to the Committee and inquired whether science teachers might be considered eligible for grants. President Frenkiel requested the Committee to bring its own recommendations to the Board for consideration.

DIRECTORY CORRECTION

On page 221, Peter H. Haas should be coded 1DAHD instead of 9CLUN.

Science in Washington

CALENDAR OF EVENTS

December 7—Instrument Society of America

C. Edward Chapman, Bureau of International Commerce, "Foreign Demand for American Instruments."

Lecture Room, Materials Testing Laboratory, National Bureau of Standards, 8:00 p.m. Pre-meeting dinner at Burgundy Cafe, 6:00 p.m.

December 10—Chemical Society of Washington

Donald F. Hornig, Science Advisor to the President, "Scientific Progress and the Federal Government."

Knights of Columbus Activity Hall, Arlington, Va., 8:15 p.m. Dinner at 6:00 p.m.

December 10—American Society of Mechanical Engineers

Phillip A. Stender, Goddard Space Flight Center, "Drive Systems for Space Application." Edward J. Devine, Goddard Space Flight Center, "Rolling Element Contacts in Vacuum."

PEPCO Auditorium, 10th & E Sts., N.W., 8:00 p.m. Pre-meeting dinner at O'Donnell's Restaurant, 6:30 p.m.

December 10—Entomological Society of Washington

John C. Downey, Southern Illinois University, "Talking Pupae—A Study in the Biology of Lycaenidae."

Symons Hall, Agriculture Auditorium, University of Maryland, 8:00 p.m.

December 11—Science Bureau Lecture Series

G. Bentley Glass, Johns Hopkins University, "Human Heredity, Today and Tomorrow." William R. Menyhert, Drug Detection & Development Organization, Inc., response.

Glover Hall, American University, 8:00 p.m.

December 11—Howard University, Department of Architecture Lecture Series

Carl Feiss, F.A.I.A., A.I.P., Planning and Urban Renewal Consultant, Washington, D.C.

Auditorium, School of Engineering and Architecture, Howard University, 4:00 p.m.

December 11—Computer Science Center, University of Maryland

David Fox, Johns Hopkins Applied Physics Laboratory, "Comparison Operators Constructions Based on Truncations II."

Room 315, Mathematics Building (on Campus Drive), University of Maryland, 11:00 a.m. Open to the scientific public.

December 15—George Washington University Lecture Series on Regional and Urban Development

Martin Anderson, Columbia University, and Edmund N. Bacon, executive director of the Philadelphia City Planning Commission, "Examination of Past Regional and Urban Development Approaches, Not to Uncover Community or Regional Archeology But to Identify the Nature and Potential of Such Approaches."

Lisner Auditorium, 730 21st St., N.W., 8:30 p.m.

January 8—Georgetown University Seminar

Lt. Col. Kenneth R. Dirks, MC, U.S. Army Medical Unit, Walter Reed Army Medical Center, Frederick, Md., "Medical Aspects of Biological Warfare."

Room 103, Reiss Science Building, Georgetown University, 4:00 p.m.

January 15—Georgetown University Seminar

D. J. Kushner, National Research Council, Ottawa, Canada, "Life in Salt: The Physiology of the Halophilic Bacteria."

Room 103, Reiss Science Building, Georgetown University, 4:00 p.m.

SCIENTISTS IN THE NEWS

Contributions to this column may be addressed to Harold T. Cook, Associate Editor c/o Department of Agriculture, Agricultural Research Service, Federal Center Building, Hyattsville, Md.

AGRICULTURE DEPARTMENT

The 1964 Distinguished Achievement Award of the Instrument Society of America was awarded to **Dorothy Nickerson** on October 13, in recognition of her contribution to the advancement of optical and color instrumentation for agricultural applications. This award, consisting of a plaque, framed certificate, and $500 honorarium, is offered annually to an individual in recognition of an outstanding technical, educational, or philosophical contribution to the science and technology of instrumentation. Miss Nickerson, an active member of several national and international technical and scientific groups dealing with color and illumination, is leader of the Color Research Laboratory, Agricultural Research Service.

Justus C. Ward served on a panel on pesticides at the American Public Health Association meeting in New York, October 5, and on a similar panel in the Public Health Service's Training Course on Safe Use of Pesticides, held October 30 in Atlanta. On October 22 Mr. Ward gave a talk, "Residues of Pesticides in Milk, Meat, and Eggs," before the U.S. Livestock Sanitary Association at Memphis, Tenn.

George W. Irving, Jr., became associate administrator of the Agricultural Research Service in July, upon the retirement of M. R. Clarkson. Dr. Irving addressed the 100th anniversary celebration of the discovery of white burley tobacco, at Ripley, Ohio, in August; and in November he addressed the 19th annual meeting of the Armed Forces Chemical Association, held in Washington, on "Agricultural Preparedness for the Future."

Marion M. Farr attended the First International Congress of Parasitology, held in Rome September 20-26. She presented a paper entitled, "Survival of Oocysts of Chicken and Turkey Coccidia Under Various Conditions."

N. R. Ellis, associate director of the Animal Husbandry Research Division, Agricultural Research Service, retired on August 30. Mr. Ellis completed 44 years of service in animal husbandry research in the Department at Beltsville, Md.

Alfred H. Yeomans was appointed head of investigations on aerosols in the Pesticide Chemicals Research Branch, ARS, following the retirement of Robert A. Fulton on August 29. This unit is responsible for research on liquefied gas and other aerosols, as well as for testing respiratory devices for pesticides. It is the only laboratory which issues lists of respirators suitable for pesticides.

AMERICAN UNIVERSITY

Eduard Farber, research professor in the Department of Chemistry, was awarded the Dexter Award in the History of Chemistry at the American Chemical Society convention held in early September. This is one of the important national awards of ACS.

Leo Schubert has accepted a one-year appointment to the advisory board of *Chemistry*, published by the American Chemical Society. The term, beginning January 1, 1965, is Dr. Schubert's second appointment. Dr. Schubert has been advised that the National Science Foundation has granted American University the sum of $49,610 for support of the seventh consecutive Summer Institute in the History and Philosophy of Science and Mathematics. Dr. Schubert is director of the program.

GEORGE WASHINGTON UNIVERSITY

William F. Sager, professor of chemistry, has resigned from the University, effective at the end of the current semester, to assume the chairmanship of the Department of Chemistry at the new Chicago campus of the University of Illinois, which is scheduled to be completed by 1970. The undergraduate and graduate student body is expected to reach 20,000 by that date.

HARRIS RESEARCH LABORATORIES

Arnold Sookne, Norman Hollies, and **John Krasny** attended the Fiber Society meeting in Montreal, October 20-23, where Dr. Hollies presented a talk, "The Nature of a Fabric Surface: Interaction of the Surface Fibers."

Lyman Fourt attended the ASTM Committee D-13 meeting in New York, October 12-15. He presided over Subcommittee B-1 on Chemical and Performance Tests of Textiles.

Alfred E. Brown attended the recent 19th annual meeting of the Armed Forces Chemical Association at the Mayflower Hotel. He spoke on "R & D Preparedness Through Encouragement of Creativity."

HOWARD UNIVERSITY

Lloyd N. Ferguson served as a visiting lecturer for the week of July 6 in the National Science Foundation summer institute for high school teachers of the second year and advanced placement chemistry, held at Hope College, Mich.

Moddie D. Taylor is listed as one of the consulting editors of *Introductory Physical Science,* a recent publication of Educational Services, Inc. Dr. Taylor served full-time with ESI at Watertown, Mass., during the past summer.

James W. Wheeler, Jr., has been appointed assistant professor of chemistry. He has done postdoctoral research under Professor Vladimir Prelog at the Swiss Federal Institute of Technology, Zurich, Switzerland, and Professor Jerrold Meinwald at Cornell University.

NATIONAL BUREAU OF STANDARDS

In recent foreign presentations, **D. R. Boyle** presented a paper, "Incremental Magnetic Tape Data Logger," at Aldermaston, England; **S. Silverman** presented a talk entitled, "Some Aspects of Federal Support of Science in the United States," before the Canadian Association of Physicists, meeting in Ottawa; and **J. C. Smith** addressed the Fiber Society at Montreal on "The Strain Distribution in a Textile Yarn Subject to Rifle Bullet Impact."

SMITHSONIAN INSTITUTION

John C. Ewers, one of the Nation's leading ethnologists and historians, has been appointed director of the new Museum of History and Technology. Mr. Ewers began his service with the Smithsonian in 1946, and for the past six years has been assistant director of the Museum of History and Technology. He is an authority on the American Indian and history of the American West.

WEATHER BUREAU

Milton L. Blanc, research climatologist at Tempe, Ariz., traveled to Italy and Israel during September. In Italy he visited the Rome headquarters of FAO to discuss current studies in northern Africa on arid zone climatology. In Israel he conferred with the directors of the Israel Meteorological Service and the National and University Institute of Agriculture, concerning the establishment of a soil moisture study at the Desert Experimental Station near Gilat. He also visited other points of interest in arid zone research near Gilat, Avdat, and Eilat.

Delegates to the Washington Academy of Sciences, Representing the Local Affiliated Societies*

Philosophical Society of Washington	Urner Liddel
Anthropological Society of Washington	Gordon McGregor
Biological Society of Washington	John L. Paradiso
Chemical Society of Washington	William A. Zisman
Entomological Society of Washington	Harold H. Shepard
National Geographic Society	Alexander Wetmore
Geological Society of Washington	Luna Leopold
Medical Society of the District of Columbia	Thomas M. Brown
Columbia Historical Society	U. S. Grant, III
Botanical Society of Washington	Wilbur D. McClellan
Society of American Foresters	Harry A. Fowells
Washington Society of Engineers	Martin A. Mason
Institute of Electrical and Electronics Engineers	George Abraham
American Society of Mechanical Engineers	William G. Allen
Helminthological Society of Washington	Marion M. Farr
American Society for Microbiology	Frank Hettrick
Society of American Military Engineers	H. P. Demuth
American Society of Civil Engineers	Thorndike Saville, Jr.
Society for Experimental Biology and Medicine	Falconer Smith
American Society for Metals	Hugh L. Logan
International Association for Dental Research	Harold J. Caul
American Institute of Aeronautics and Astronautics	Eugene Ehrlich
American Meteorological Society	J. Murray Mitchell, Jr.
Insecticide Society of Washington	Delegate not appointed
Acoustical Society of America	Malcolm C. Henderson
American Nuclear Society	George L. Weil
Institute of Food Technologists	Richard P. Farrow
American Ceramic Society	J. J. Diamond
Electrochemical Society	Kurt H. Stern

* Delegates continue in office until new selections are made by the respective affiliated societies.

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VOLUME 55 NUMBER 1

Journal of the WASHINGTON ACADEMY OF SCIENCES

JANUARY 1965

JOURNAL OF THE WASHINGTON ACADEMY OF SCIENCES

Editor: SAMUEL B. DETWILER, JR., Department of Agriculture

This Journal, the official organ of the Washington Academy of Sciences, publishes historical articles, critical reviews, and scholarly scientific articles; notices of meetings and abstract proceedings of meetings of the Academy and its affiliated societies; and regional news items, including personal news, of interest to the entire membership. The Journal appears nine times a year, in January to May and September to December. It is included in the dues of all active members and fellows.

Subscription rate to non-members: $7.50 per year (U.S.) or $1.00 per copy; foreign postage extra. Subscription orders should be sent to the Washington Academy of Sciences, 1530 P St., N.W., Washington, D.C. Remittances should be made payable to "Washington Academy of Sciences."

Back issues, volumes, and sets of the Journal (Volumes 1-52, 1911-1962) can be purchased direct from Walter J. Johnson, Inc., 111 Fifth Avenue, New York 3, N. Y. This firm also handles the sale of the Proceedings of the Academy (Volumes 1-13, 1898-1910), the Index (to Volumes 1-13 of the Proceedings and Volumes 1-40 of the Journal), and the Academy's monograph, "The Parasitic Cuckoos of Africa."

Current issues of the Journal (past two calendar years) may still be obtained directly from the Academy office at 1530 P Street, N.W., Washington 5, D.C.

Claims for missing numbers will not be allowed if received more than 60 days after date of mailing plus time normally required for postal delivery and claim. No claims will be allowed because of failure to notify the Academy of a change of address.

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Second class postage paid at Washington, D.C.

ACADEMY OFFICERS FOR 1964

Entomological Axiomatization—From Abbott's Formula to Zawarzin's Network*

William E. Bickley

Department of Entomology, University of Maryland

Axiomatization means establishment or creation of an axiom. An axiom is defined as an established principle in some art or science, which, though not a necessary truth, is universally received. There are at least 12 synonyms for axiom, *viz:* adage, aphorism, apothegm, dictum, epigram, maxim, motto, precept, principle, proverb, rule, and saying.

I contend that sometimes the expression of an idea may transcend the idea itself. The manner in which the fact is stated may be a most valuable contribution to science —even a more valuable contribution than the actual discovery of the fact.

There is the well-known story of a young lady who became thoroughly disenchanted with Shakespeare when she saw a live production of "Hamlet" for the first time. She said that there was really nothing to "Hamlet." It was just a lot of quotations.

I invite you now to consider a number of quotations. Not all of them are purely entomological, but each one of them can certainly be used by entomologists in some way.

Here is Abbott's Formula:

$$\frac{x - y}{x} \times 100 = \text{percent control}$$

Where $x =$ percent living in check
$y =$ percent living in treated plot

This formula was set forth by W. S. Abbott (1925) and has been widely used to compute "percent control," taking into consideration mortality in the check plot or untreated group of insects. It is a means of ascertaining the proportion of insects actually affected by a treatment without regard to deaths in the check (untreated) group which cannot be explained. For example, if 40 percent of a group of insects survive a treatment and all untreated insects survive, 60 percent control would result:

$$\frac{100 - 40}{100} \times 100 = 60 \text{ percent (control)}$$

But if there were a mortality of 20 percent in the check, only 50 percent control could be claimed:

$$\frac{80 - 40}{80} \times 100 = 50 \text{ percent}$$

Next I give you Abelson's Apothegm.

> A man of any stature, according to the current vogue, must have at least one nonprofessional assistant and, if he is a person of real consequence, a battery of assorted flunkeys.

Philip H. Abelson, the distinguished editor of *Science* and a past president of the Washington Academy of Sciences, in one of his penetrating editorials argues that those who are doing fundamental research, if they are not old-fashioned, must spend a disproportionate amount of their time serving as straw bosses directing the work of their flunkeys, with the result that they exist in a sterile atmosphere. Without the nonprofessional aides the environment is intellectually stimulating and more conducive to creativity.

The next author is Anonymous.

> Question: Are you working on the solution—or are you part of the problem?
> Answer: Perversity is the mother of strife.

For your delectation I now present my definition of education.

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* Condensation and modification of the address of the retiring president, Entomological Society of Washington, presented February 6, 1964. Miscellaneous Article No. 525, Contribution No. 3599 of the Maryland Agricultural Experiment Station.

Education is training the mind and the will and the body to do the thing that has to be done whether you want to do it or not.

This has been referred to as regressive education.

We come now to Carey's Law.

Scientists can bring pressure on their political representatives in their behalf.

This law was proposed by Jerome B. Wiesner. W. B. Carey is a high official in the Budget Bureau.

Being a frustrated taxonomist, I am doing things systematically, and you may have noticed that I am working my way down the alphabet. We are still in the C's. Rachel Carson, who was a pro with prose, was quoted by the Baltimore *Sun* as follows:

My vocation and my avocation coincide.

I have termed this little gem "Carson's Precept." Margaret Mead expressed the same idea in a Washington *Post* interview —Mead's Maxim:

Luckily I do not distinguish between work and pleasure, and I seldom have to do anything I don't want to do.

We come now to something a little more germane, Dyar's Law:

An observational rule which shows that among lepidopterous larvae the increase in the width of the head shows a regular geometrical progression in successive instars.

Dyar (1890) gave measurements of the width of the head of the different instars of 28 species. The number of stages varied from four through 10. Dyar's Law has been used to calculate the total number of instars as well as to identify various instars by comparison of measurements.

A. B. Gahan (1923), in his address as retiring president of the Entomological Society of Washington, discussed problems of taxonomists. Forty-one years later, taxonomists are confronted with the same problems, the major one being a burden of routine identification which reduces the time available for research. One of Gahan's statements has often been quoted and used by taxonomists to console each other:

Objects without names cannot well be talked of or written about; without descriptions they cannot be identified, and such knowledge as may have accumulated regarding them is sealed; unclassified their relationships are unknown and the possibilities of deduction are destroyed.

Let us examine next Gause's Competitive Exclusion Principle (1934), also referred to as Gause's Contention or Gause's Hypothesis.

Two species with similar ecology cannot live together in the same place.

or

Complete competitors cannot coexist.

or

Ecological differentiation is the necessary condition for coexistence.

This was recently discussed by Garrett Hardin (1960), who reported that Gause did not actually set forth the idea, but that the ornithologist Lock, in his book "Darwin's Finches," made the proposal. Hardin said that the "principle" is admittedly unclear and that it can be proved only by theory. To prove it empirically one would have to be certain that two sympatric, non-interbreeding populations were present in the same niche. This is an impossibility. When species A multiplies a little faster than species B, then B will be displaced.

Graham's Law of Natural Compensations (1956) is a sort of corollary of the Competitive Exclusion Principle.

If any species . . . tends to dominate the locality in which it lives . . . environmental forces will ultimately reduce it to a lower position . . . Compensating forces tend to keep each species in its appropriate proportion to others.

It seems to me that here we have a statement that is very difficult to analyze. I call your attention to the word *appropriate.* Do the ecologists feel qualified to decide just what is the appropriate proportion for each species? Graham describes cases in which insects have reduced populations of trees to a more appropriate position relative to associated species. It would appear that the insects are helping the ecologists in their decision-making. At any rate, we must agree with Graham that complexity contributes to stability.

One of the best examples of entomological axiomatization is Hopkins' Bioclimatic Law (1919):

> Other conditions being equal, the variation in time of occurrence of a given periodic event in life activity in temperate North America is at the general average rate of 4 days to each degree of latitude, 5 degrees longitude, and 400 feet altitude; later northward, eastward, and upward in spring and the reverse in autumn.

This is familiar to most entomologists, and we can be proud that an entomologist has been credited by other biologists with providing us with a useful axiom. Students frequently have difficulty in understanding the reasons why 5 degrees longitude eastward has an effect on bark beetles and other forms of life. This is explained by the Japan current.

Another significant statement by Hopkins was the Host Selection Principle (Craighead, 1921):

> The female of an insect breeding on two or more hosts will prefer to lay eggs on the host on which such female was reared.

Here we are dealing with behavior patterns. There are many opportunities in research on host selection activities of insects and the applicability of Hopkins' Host Selection Principle.

Huff's Classification of Arthropod Transmission (1931) is a most convenient dictum, especially for teachers of medical entomology and parasitology:

1. Cyclopropagative
2. Cyclodevelopmental
3. Propagative
4. Mechanical

I am sure that one of the most overworked examination questions is one calling for illustrations or examples of the different types of transmission. Heredity transmission ought to be included.

The Lincoln Index can be stated as follows:

Mark: Release: Recapture

$$\frac{\text{Marked spms in sample}}{\text{Unmarked spms in sample}} = \frac{\text{Total marked spms}}{\text{Total spms in area}}$$

E.g.: 500 marked flies are released; 10 percent of those captured later are marked; then the total number of flies is 5,000.

The Lincoln Index was discovered independently by F. C. Lincoln (1930), who was studying ducks in North America, and by C. H. N. Jackson (1933), who was studying tsetse flies in Africa. Buxton (1955) has commented that there is an advantage in working on tsetse; one may recover a marked fly, give it a second mark, release it, and perhaps capture it again. Any information about the recovery of ducks comes from those which are shot.

The mark-release-recapture technique does furnish an index of the absolute population. This has had far-reaching effects on ecologists and others concerned with population density. It has been used effectively in studies of migrations of insects and in evaluating control measures.

Incidentally, ecology has been defined as that phase of biology primarily abandoned to terminology.

Here is Nuttal and Shipley's Epigram:

> The salivary duct of *Anopheles* has played a large part in human history, for along it has passed the cause of disease and death that has ruined cities, devastated countries, . . . conquered armies, and brought about the downfall of nations.

This dramatic statement was quoted by Snodgrass (1944) in a paper on the feeding apparatus of biting and sucking insects affecting man and animals. Next we have one of the witticisms of our late honorary president from the same paper:

> The bed bug appears to be specially adapted by its flat form for getting into the crevices of beds, but of course it existed long before beds were invented, and it might as well be said that beds were made to accommodate the bugs.

This always gives a teacher a chance to ask students if they have ever heard of Darwin. And what is Lamarckianism?

Leaving entomology momentarily, I present Parkinson's Law (1957) to make us all feel glad that we are entomologists and not social scientists.

> Work expands so as to fill the time available for its completion.
>
> The thing to be done swells in importance and complexity in a direct ratio with the time to be spent.
>
> The number of the officials and the quantity of the work are not related to each other at all.

Roubaud proposed a number of descriptive terms. One that is frequently attributed to him is "anophelism without malaria." Roubaud's Theory of Anopheline Zootropy (1920) is briefly as follows:

> In northern Europe there is a biological race of *Anopheles maculipennis* which prefers cattle and other domestic animals rather than man.

He deserves much credit for suggesting the idea of biological differentiation among populations of malaria mosquitoes in Europe. Wesenberg-Lund (1921) proposed the Stabular Deviation Theory concerning *Anopheles maculipennis* populations in Denmark:

> A change in agricultural practices in Denmark led to the construction of cow stables and pigsties which provided attractive resting places for malaria mosquitoes. The mosquitoes became stable-haunting rather than house-haunting, and the transmission cycle was broken.

A good many years later the *maculipennis* complex became thoroughly understood. My point is that the forthright presentation of these ideas and perhaps the labeling of the ideas as theories was an important step in bringing about the solution of a problem.

My last example of an entomological axiom is Uvarov's Phase Theory.

> Phases are temporary conditions of a polymorphic species. The swarming and solitary phases can be characterized, but there are intermediate forms. The swarming or migratory phase develops in response to crowding.

Uvarov (1928) further stated:

> The problem of the causes which induce hoppers of gregarious species to undertake mass wanderings has been much more discussed in the literature than it has been actually studied.

Uvarov himself studied and discussed extensively. He has said:

> Simple observations reveal that to explain the migrations on the basis of hunger is absurd . . . *Acrididae* react to a rise in temperature by making movements. And there is a mutual excitation . . . Dark pigmentation causes an increase in absorption of heat rays . . . The swarming phase develops as a result of crowding of a large number of individuals in a limited space. This follows favorable breeding conditions.

It is possible that the appearance of the black pigment may be due to movement; the pigment may be an oxidation product. The black color increases susceptibility to temperature, and this results in more movement. As emigrating swarms reach new places the populations are reduced by parasites and predators. Evolution into the solitary phase proceeds rapidly.

This brings us to Zarwarzin's Network (1912). Zawarzin's Network consists of large and small nerve branches distributed over the entire inner surface of the insect body wall. This of course has nothing to do with axioms or axiomatization, but it makes it possible for me to go from A to Z. Zawarzin was a German who traced out the fine sensory nerves in the larva of *Melolontha*. He demonstrated great patience, such as that demonstrated by readers of this article.

Literature Cited

Abbott, W. S. A method of computing the effectiveness of an insecticide. J. Econ. Ent. *18*, 265-267 (1925).

Buxton, P. A. The natural history of tsetse flies. London School of Hyg. and Trop. Med. Mem. *10*, 1-816 (1955).

Craighead, F. C. Hopkins' host-selection principle as related to certain cerambycid beetles. J. Agric. Res. *30*, 541-555 (1921).

Dyar, H. G. The number of molts of lepidopterous larvae. Psyche *5*, 420-422 (1890).

Gahan, A. B. The role of the taxonomist in present day entomology. Proc. Ent. Soc. Wash. *25*, 68-78 (1923).

Gause, G. F. The struggle for existence. Baltimore: Williams and Wilkins, pp. 1-163 (1934).

Graham, S. L. Forest insects and the law of natural compensations. Canad. Ent. *78*. 45-55 (1956).

Hardin, Garrett. The competitive exclusion principle. Science *131*, 1292-1297 (1960).

Hopkins, A. D. The bioclimatic law as applied to entomological research and farm practice. Sci. Monthly, 496-513 (1919).

Huff, C. G. A proposed classification of disease transmission by arthropods. Science *74*, 456-457 (1931).

Jackson, C. H. N. On the true density of tsetse flies. J. Animal Ecology *2*, 204-209 (1933) (Original not seen).

Lincoln, F. C. Calculating wildfowl abundance on the bases of banding returns. U. S. Dept. Agric. Circ. 118 (1930) (Original not seen).

Parkinson, C. N. Parkinson's law and other studies in administration. Boston: Houghton Mifflin, pp. 1-112 (1957).

Roubaud, E. Les conditions de nutrition des *Anopheles* en France et le rule de betail dans la prophylaxie du poludisme. Ann. Inst. Pasteur *34*, 181-228 (1920).

Snodgrass, R. E. The feeding apparatus of biting and sucking insects affecting man and animals. Smithsonian Misc. Coll. *104* (7), 1-113 (1944).

Uvarov, B. P. Locusts and grasshoppers. London: Imperial Bureau of Entomology, pp. 1-352 (1928).

Wesenberg-Lund, C. Contribution to the biology of the Danish Culicidae. Mem. Acad. Roy. Sci. and Letters (Copenhagen), Sec. Sci. 8th Ser. 7(1), 1-210 (1921) (Original not seen).

Zawarzin, A. Über das sensible Nervensystem der Larven von *Melolontha vulgaris*. Zeit. Wiss. Zool. *100*, 447-458 (1912).

A Unique Year in Baghdad

Daniel B. Lloyd

Professor of Mathematics, D. C. Teachers College

During the academic year 1962-63 the author had the unusual experience of teaching mathematics at the Al-Hikma University in Baghdad, as one of three *fahrende Scholaren* under the exchange program of the Department of State. The observations described herein were made during his visits en route and during this round-the-world journey. If mathematics were conceived of as a "mountain," the author's contribution in teaching the young Arabs might be considered a modern (and modest) fulfillment of that ancient directive of "carrying the mountain to Mohammed." In view of the scientific and mathematical gifts from this area from primeval history, it may well be claimed that such tardy repayment after 6,000 years is somewhat overdue.

Having taught the history of mathematics in this country for many years, one of the author's intentions in traveling to the Middle East was to visit personally some of the sites where archaeological field work is currently being pursued. The Mediterranean route traveled on the way to Baghdad also provided an opportunity to stop at the Universities of Paris, Boulogne, Pisa, Geneva, Milan, Rome, and Florence, the latter the site of the famous Museo di Storia Della Scienza, directed by Curator Dottissa Maria Luisa Bonelli. Other stopovers included the University of Athens, University of Ankara, and the American University at Beirut, the latter probably the best school of the history of mathematics outside of the United States. It is directed by Professor E. S. Kennedy.

Once settled in Baghdad for the academic year, it became feasible to visit a number of famous sites where diggings were currently in progress. A British party was working at Nimrud in northern Iraq; an American party at Nippur, some 100 miles southeast of Baghdad; and a German party at Babylon 70 miles south. The numerous Moslem holidays to which one falls heir over there permitted frequent visits to these archaeological sites. "Telling" trips of a day or so to some of the tells allowed amateurs to become unofficial participants in the diggings and informal collectors of many ancient though useless fragments—items more interesting than valuable.

At Nippur, center of Sumerian culture 5,000 years ago, one can stand on the ruins of 22 successive civiliations that have risen and fallen upon that very spot. The many strata which have been excavated bear mute evidence of the societies that prospered and crumbled amidst the onrush of the intervening years, centuries and millenia.

The scientist's interest in Baghdad is further heightened by a visit to the Museum of Antiquities. This is now being moved to a new plant across the Tigris in the outlying Mansour section of the city. In the past, a succession of able archaeologists have directed this institution, the present incumbent being Dr. Taha Bakir. Following the Iraqi revolution in February 1963, Bakir was suspended and put under arrest for investigation. This is in line with Iraqi custom—just a routine check, nothing personal! Possible Communist connections were to be investigated and it was expected that he would be reinstated in due time. He is an able Sumerologist of long experience and considerable training and ability. It may be recalled that Dr. Gertrude Bell, a visiting English scientist, was a former prominent director of the work there and is credited with much of the early scientific success of the Department of Antiquities.

Some 30,000 tablets have been found and examined in Mesopotamia (land between the rivers) in the last 30 years. They have revealed the remarkable variety of craftsmanship and scientific knowledge in the civilizations of Sumerians, Babylonians, and their successors some 2,000 years before the Christian era. The reader can consult the scientific magazine *Sumer* for primary sources of this information. Part of this journal is written in English and part in Arabic.

A few of these tablets have been helpful in tracing the earliest history of scientific endeavor. For instance, in 1958 a tablet was found at Tel Harmal, five miles east of Baghdad, which portrayed a problem in Euclidean geometry using principles of similar right triangles. As recently as 1962 a tablet was found at Tel D'hibayi near Baghdad showing an unusual problem relating the diagonal of a rectangle to its area. Within the last 20 years it has been learned that these primeval peoples, as early as 2000 B.C., had knowledge of the famous right-triangle theorem which has been erroneously credited to Pythagoras who lived 1500 years later.

In spite of an increasing emphasis on "nationalism" among many of the emerging nations of Africa, the Middle East, and the Far East, the traditional imprint of western patterns of education is still widely evident. In the universities at Baghdad, Istanbul, Ankara, Beirut, and elsewhere throughout Africa and Southern Asia, class-room instruction is in English. Exceptions are Teheran University, where Farsi, the national Pakistan tongue, is used; in Cairo, where Arabic is used in the first two undergraduate years only; and in various smaller institutions where the enrollment is mainly intra-national. Whereas English is now recognized as a "second language" in most of these emerging countries, the time may soon come when their own native tongue will be their "only language." Such is the decision of India, beginning in 1975, and other countries are likely to follow suit.

For the Bachelor of Science degree in science, 90 to 100 semester hours are commonly required in pure and applied sciences. The areas covered are similar to those of the English universities and are somewhat traditional. The Master's degree may require 20 additional hours plus a thesis, as, for example, in the universities at Baghdad and Teheran. One foreign language is required, usually *not* Russian. Much reference material from Russian sources is available but generally in English translations only. The textbooks are usually those used in British universities or other Western institutions. Typical of Asian universities (Calcutta, Rangoon, Delhi, Lahore) is the requirement of four-hour final examinations in the major branches of science for the Master of Science degree.

Many of the best staff members have had training in Western universities in England, or on the Continent, or occasionally in the United States. A typical professor would be pursuing research and would teach only six hours; a reader would teach 9 to 12 hours, and a lecturer 12 to 15 hours. A university might have only one or two professors on its staff in each branch of science.

Admission of students to college is highly selective, with a rigid entrance examination including mathematics and science. Less than one-fourth of those applying are accepted. There is some variation among institutions, each reflecting the predilections of the local staff, as is true elsewhere.

When one recalls that mathematics and science claim these lands as their birthplace, and grew and prospered for thousands of years while Western man was still roaming the forests and fields, there is little wonder that the modern descendants of the Babylonian, Hindoo, and Egyptian pioneers are presently striving with determination to maintain and advance the achievements of their famous forebears.

D.C. Chapter of Sigma Xi Marks 50th Anniversary

The District of Columbia chapter of the Society of the Sigma Xi recognized its 50th anniversary with a special meeting held at the Freer Gallery auditorium of the Smithsonian Institution on Monday evening, October 26. The meeting was opened by the chapter president, Harriet Frush of the National Bureau of Standards. Wallace R. Brode, member of the chapter and past president of the national society, discussed briefly the historical background of the District of Columbia chapter and recent changes in the society which have confirmed the judgment made 50 years ago in the creation of this chapter.

The District of Columbia chapter is the only one which is not directly associated with an academic, degree-granting institution. When the chapter was founded in 1914, graduate research at nearby academic institutions had not reached the level that Sigma Xi usually requires for chapter status, whereas the research work of Government agencies such as the Smithsonian Institution, the Geological Survey, the National Bureau of Standards, the Department of Agriculture, and others was of a recognized academic quality. The creation of a chapter without an academic sponsor was not easily effected. Over the past 50 years, there have been repeated efforts within the Society to extinguish the sole example of this type of chapter. Much of the success of the District of Columbia chapter and its resistance to attack has been due to its recognition of a special situation and the fact that it has not abused its special privilege. Its elections to membership have been limited to three or four a year, and each person elected has been carefully chosen for outstanding scientific achievement. Within the Government and research institutions in Washington there are always distinguished contributors to scientific knowledge who, because of foreign education, graduation from schools without Sigma Xi chapters, or other good reasons have not been elected to Sigma Xi. It is from this group that the District of Columbia chapter elects its members.

In recent years, members of Sigma Xi have shown an increasing interest in the welfare of science and a need to keep in touch with new developments. The national society has met this need in several ways. In an annual lecture series, each of eight distinguished scientists gives about 20 broad scientific lectures to Sigma Xi and RESA groups in one of eight geographical regions. The establishment and conduct of the Grants-in-Aid of Research program, in which nearly $100,000 is awarded annually in small grants averaging about $200, has captured the interest of many alumni. The RESA organization (Scientific Research Society of America), created in 1947, has also attracted and held the interest of Sigma Xi members in industry and research. The official magazine of the Society, *American Scientist*, is sent to all members in good standing. This journal is recognized as one of the nation's leading platforms for the presentation of major reviews of new developments in science.

All of these activities have promoted the interest of members-at-large who were not associated with an active chapter. Effective this year, there has been initiated a chapter-at-large concept, to do for those outside the academic area (and outside the District of Columbia) that which the District of Columbia chapter has been doing for scientists within the District. This move by the national society to establish a chapter-at-large essentially confirms the good judgment of the executive committee and the founding group at the time the District of Columbia charter was granted 50 years ago.

Among those present at the 50th anniversary celebration was C. G. Abbot, emeritus secretary of the Smithsonian Institution and one of the first three persons to be initiated by the District of Columbia chapter.

The speaker of the evening was the newly appointed secretary of the Smithsonian Institution, S. Dillon Ripley II, whose address marked his first appearance before a Washington scientific group since he assumed his new duties at the Smithsonian. He was introduced by John A. Pope, director of the Freer Gallery and a distinguished Sinologist.

Dr. Ripley noted that "one of the charter members of the District of Columbia chapter was Edmund Heller, a naturalist and explorer who accompanied President Theodore Roosevelt in 1909 on his expedition for the Smithsonian to study and collect mammals in East Africa, the expedition which evoked that succinct and descriptive phrase from the former president as he took the train from Mombasa to Nairobi riding on the cow-catcher of the engine, 'on a railroad through the Pleistocene Age.' Fifty years later, scientists concerned with the great animals of our planet are highly pessimistic about the unique Pleistocene fauna of Africa, much of it reduced to remnants in a semi-zoo status."

In his presentation, Dr. Ripley mentioned that an organizing committee for the District of Columbia chapter in 1914 included ten government scientists and Professor Marcus Lyon of George Washington University. Among this group, scientists from the Smithsonian Institution played a prominent role, particularly Marcus Benjamin. The first officers of the chapter and their scientific institutions were: Dr. Benjamin, president (U.S. National Museum of the Smithsonian), Isaac K. Phelps, vice president (Bureau of Chemistry), Marcus W. Lyon, secretary (George Washington University), and Daniel R. Harper, treasurer (Bureau of Standards).

Much of Dr. Ripley's address dealt with the role of the Smithsonian Institution in the nation's efforts to record and promote the advancement of science. Because of its broad interest and close ties with the Society of the Sigma Xi, his talk is being printed in the current (Spring 1965) issue of the *American Scientist.*

Following the paper by Dr. Ripley, there was a social hour which included refreshments and a special tour of the Freer Gallery for chapter members and their guests. It was most fitting that the Smithsonian Institution should be host on this occasion in view of the leading role which Smithsonian Institution members played in the founding of the chapter and its maintenance over the first 50 years.

Academy Proceedings

485th Meeting of the Washington Academy of Sciences

SPEAKER: **REV. WILLIAM A. WALLACE, O.P.**
Catholic University of America

SUBJECT: **SOME MORAL AND RELIGIOUS IMPLICATIONS OF NUCLEAR TECHNOLOGY**

TIME: **THURSDAY, JANUARY 21, 1965**
8:15 P.M.

PLACE: **JOHN WESLEY POWELL AUDITORIUM, COSMOS CLUB**
2170 Florida Avenue, N. W.

Abstract of Address—An interdisciplinary conference on radiation and social ethics, held at the University of Chicago in 1963, was attended by some 20 scientists and theologians from different parts of the world. The scientists represented chiefly the fields of radiation and nuclear medicine, the theologians the major Judaeo-Christian religions. A marked divergence of opinion developed among the participating theologians as to the morality of further developments in nuclear technology. An attempt is made in the talk (1) to analyze the reasons for this divergence, (2) to propose a solution that may justify the continued expansion of nuclear industry in accordance with accepted principles of morality and religion, and (3) to make a further proposal concerning the way in which science and religion may be led into closer cooperation as a result of developments in technology, particularly cybernetics and nuclear energy.

The Speaker—Born in New York City, Father Wallace received the B.E.E. degree at Manhattan College in 1940, and the M.Sc. degree in physics at Catholic University in 1952. He was awarded the S.T.L. and S.T.Lr. degrees in 1954 by the Dominican House of Studies, Washington, D.C., and earned the Ph.D. degree in 1959 and S.T.D. in 1961 at the University of Fribourg, Switzerland.

A naval officer in the Pacific during World War II, Father Wallace became interested in the priesthood through contact with Father Walter Farrell, O.P., while aboard the USS Yorktown. Stationed later on Tinian with the aircraft that dropped the first atom bombs, he became convinced that science and technology alone were powerless to solve the problems of man in the 20th century. Since ordination he has continued his interest in philosophical and theological problems of the atomic age. His specialties are science in the Middle Ages and Thomism as related to modern science.

Father Wallace has taught at the Dominican House of Philosophy, Springfield, Ky., 1954-1956; the Dominican House of Philosophy, Dover, Mass., 1959-1962; Catholic University of America, 1963 to date; and at various summer institutes at St. Xavier College, Chicago; American University; Catholic University; and Asheville, N.C. He has lectured extensively on the philosophy of science and on science and religion at many leading universities and colleges.

His publications include *The Scientific Methodology of Theodoric of Freiberg; The Role of Demonstration in Moral Theology; Einstein, Galileo, and Aquinas; From Physics to God* (in preparation); articles in *The Thomist, New Scholasticism, Homiletic and Pastoral Review, America;* staff editor (philosophy), *The New Catholic Encyclopedia,* 1962 to date; associate editor, *The Thomist,* 1962 to date.

Father Wallace is also a member of Sigma Xi, History of Science Society, Philosophy of Science Association, American Catholic Philosophical Association (Executive Council, 1962-1964), Washington Colloquium on Science and Society (Executive Committee), and Albertus Magnus Lyceum.

COLLEGIATE SCIENCE CONFERENCE SCHEDULED

The Joint Board on Science Education will sponsor a collegiate science conference on March 6 at Trinity College. Like the first collegiate scientific conference held in May 1964, the second conference will receive the support of the National Science Foundation. The program will consist of papers by undergraduate students describing research they have performed. The areas to which the conference will be devoted include astronomy, biological sciences, chemistry, engineering, physics, and psychology. Further information can be obtained from Leopold May of the Department of Chemistry, Catholic University, Washington, D. C. 20017.

The proceedings of the first conference have been published, and copies are obtainable from the Academy office. The booklet contains abstracts of 27 papers presented by youthful scientists from local universities.

ACADEMY ANNOUNCES AWARD WINNERS

Recipients of the 1964 Awards for Scientific Achievement, sponsored annually by the Academy, have been announced. They are as follows:

Biological Sciences: Bruce N. Ames, National Institutes of Health, "for outstanding contributions to molecular genetics."

Engineering Sciences: Thorndike Saville, Jr., Army Coastal Engineering Research Center, "for research in coastal engineering, particularly studies of wave run-up and overtopping."

Physical Sciences: James W. Butler, Naval Research Laboratory, "for contributions to our knowledge of energy levels and properties of atomic nuclei."

Mathematics: David W. Fox, Johns Hopkins University Applied Physics Laboratory, "for research in estimating lower bounds to eigenvalues and related studies."

Teaching of Science: A joint award will be made, to Donald F. Brandewie, Swanson Junior High School of Arlington, Va., "for generating contagious enthusiasm for science through inspirational teaching," and to Herman R. Branson, Department of Physics, Howard University, "for contribution to science education and an outstanding role as physics teacher."

The selections were made by the Academy's Committee on Awards for Scientific Achievement and were approved by the Board of Managers on December 17. The awards will be presented at the meeting of the Academy to be held on January 21.

ELECTIONS TO FELLOWSHIP

The following persons were elected to fellowship in the Academy at the Board of Managers meeting on December 17:

STEPHEN D. BRUCK, senior scientist, Johns Hopkins University Applied Physics Laboratory, "in recognition of his contributions to the field of chemical cross-linking of synthetic fibers, his invention of the chemical crimping of nylon-6 fibers, and his development of polyoxamidation catalysts." (Sponsors: F. T. McClure, M. E. Berl, L. Monchick, J. C. Smith.)

FRANCIS B. GORDON, director, Department of Microbiology, Naval Medical Research Institute, "in recognition of his contributions to microbiology and in particular (1) his researches on neurotrophic viruses and on drug susceptibilities of the trachoma agent and related microorganisms, and (2) his 22 years of editorial service for microbiological publications." (Sponsors: M. L. Robbins, B. E. Eddy, R. C. Parlett.)

RUDOLPH HUGH, associate professor of microbiology, George Washington University School of Medicine, "in recognition of his contributions to microbiology, in particular his studies of bacterial taxonomy with special emphasis on the Pseudomonadales." (Sponsors: M. L. Robbins, R. C. Parlett, C. R. Treadwell.)

HERMAN A. RODENHISER, deputy administrator, Agricultural Research Service, Department of Agriculture, "in recognition of his contributions to an understanding of diseases in cereal crops and the control of such diseases through the development of resistant varieties of crops, and of his effective administration of agricultural research." (Sponsors: R. B. Stevens, S. B. Detwiler, Jr., H. L. Haller.)

WILLIAM L. SULZBACHER, chief, Meat Laboratory, Agricultural Research Service, "in recognition of his furtherance of agriculture through the application of scientific principles to the improvement of meat processing and technology, and his research in the microbiology of meat and meat products." (Sponsors: G. W. Irving, Jr., H. Reynolds, M. L. Robbins.)

ELECTIONS TO MEMBERSHIP

The following persons were elected to membership in the Academy by action of the Committee on Membership at its meeting on November 24:

WILLIAM E. BRADLEY, assistant vice president, Institute for Defense Analyses.

STEPHEN S. DAVIS, dean, School of Engineering and Architecture, and professor of mechanical engineering, Howard University.

JOHN E. duPONT, director, Delaware Museum of Natural History, Newtown Square, Pa.

EMIL E. FOWLER, acting director, Division of Isotope Development, Atomic Energy Commission.

MARSHALL C. HARRINGTON, physicist, Air Force Office of Scientific Research.

DAGMAR HENNEY, instructor in mathematics, University of Maryland.

GEORGE M. KOEHL, professor of physics and associate dean, Columbian College, George Washington University.

DANIEL B. LLOYD, professor of mathematics and director of in-service teaching, D.C. Teachers College.

J. DAVID LOCKARD, associate professor of botany and science education, University of Maryland.

URA M. MEANS, soil bacteriologist, Department of Agriculture.

JOHN D. MORTON, senior scientist, Melpar, Inc.

CMDR. BOBBY L. POTTS, weapons analyst, Department of the Navy.

LUIS A. VEGUILLA-BERDECIA, assistant professor of chemistry, American University.

TRANSFERS TO EMERITUS

W. G. Brombacher
R. A. Fulton
L. C. Graton
G. F. Gravatt
A. L. Shalowitz
H. R. Snoke
E. C. Stakman
Olga Taussky
W. G. Workman

RESIGNATIONS

R. J. Barker
Julian Eisenstein
Alice C. Evans
Sidney Geltman
George Hottle
T. J. Killian
C. J. Lapp
H. M. O'Bryan
Page Truesdell

DIRECTORY CORRECTION

On page 216, Andrew R. Chi should be coded 1XNAS instead of 9CLUN, with affiliations 2B and 2N.

BOARD OF MANAGERS MEETING NOTES

November Meeting

The Board of Managers held its 567th meeting on November 19 at the Cosmos Club, with President Frenkiel presiding.

The minutes of the 566th meeting were approved as previously distributed.

Announcements. Secretary Irving announced the following nominees for office in 1965: John K. Taylor for president-elect; Alphonse F. Forziati for secretary; Roman R. Miller for treasurer; and Malcolm C. Henderson, George W. Irving, Jr., W. D. McClellan, and Harold H. Shepard for managers (two to be elected for full 3-year terms and one to fill the remaining year of Dr. Taylor's term).

Treasurer. Treasurer Henderson reported that the Academy is operating in the black, and that H. Cecil Spicer and L. C. Graton have been granted emeritus status.

Executive Committee. President Frenkiel reported that the Executive Committee took the following actions at its November 17 meeting: (1) Reviewed and approved the nominations for officers, 1965; (2) reviewed and approved the suggestion of the Philosophical Society that the Academy sponsor the annual Christman lectures beginning in 1965. A standing committee will be established to plan and execute this annual affair.

Policy Planning. In the absence of Chairman Van Evera, Dr. Frenkiel announced that the applications for affiliation of the Washington History of Science Club and the Chesapeake Section of the American Association of Physics Teachers with the Academy will be presented to the membership on the December ballot. He also announced that an inquiry about affiliation had been received from the National Capital Section of the Optical Society of America and referred to the Committee for recommendation to the Board.

Meetings. Chairman Steinhardt announced the following plans: *January*, annual awards dinner; Father William Wallace, Catholic University, will speak. *February*, address of the retiring president. *March*, unscheduled. *April*, Conversazione headed by Wallace Brode on the subject, "What is a Scientist?" *May*. Henry Fagin, Department of Urban and Regional Planning, University of Wisconsin, "Problems of Mass Transportation."

Awards for Scientific Achievement. Chairman Mason gave a preliminary report on the selections of the Committee to date, as follows: Engineering, Thorndike Saville; Teaching of science (high school), Don F. Brandewie, Swanson Junior High School, Arlington; Teaching of science (college), Herman R. Branson, Howard University; Mathematics, David Fox, Applied Physics Laboratory.

Grants-in-Aid. Chairman McPherson and Committee member Don R. Boyle again presented the request for grant by Clayton Curtis, Jr., tabled at the last Board meeting. About $3,000 including a $200 grant from the Academy and parts given by industry, has been invested so far in Mr. Curtis's computer project, and a small additional fund is needed to complete it. The Committee recommended that the Academy make the grant, and the Board voted an additional grant of $75.00, provided the Committee is assured that the equipment will be used in an appropriate and responsible way when the project is completed.

Membership Promotion. Chairman Mitchell reported formation of his committee. It will meet soon to develop a plan of operation and to consider such possibilities as letters to prominent scientists, an information "kit," and an appropriate Journal insert.

Editor. In the absence of Editor Detwiler, the Secretary reported that the November issue of the Journal was mailed on November 12, and copy for the December issue had been sent to the printer. Both issues will be small.

Archivist. President Frenkiel introduced

Eduard Farber, the newly appointed Archivist.

December Meeting

The Board of Managers held its 568th meeting on December 17 at the Cosmos Club, with President Frenkiel presiding.

The minutes of the 567th meeting were approved with a minor correction.

Treasurer. Dr. Henderson presented the treasurer's annual report, as follows: Ordinary receipts, $18,539.46; receipts by sale of stock, $2,908.10; expenditures, $25,902.-95; deficit, $4,455.39. Assets: $725.73 cash in bank; market value of stock, $85,481.75; total assets, $86,207.48.

The books for the Junior Academy (for checking and savings accounts combined) showed: Brought forward from 1963, $2,344.72; received, $5,748.97; spent, $7,-662.45; carried forward to 1965, $431.24.

Dr. Henderson announced that the District of Columbia had granted the Academy's request for exemption from income taxes.

On Dr. Henderson's recommendation, the Board approved the following changes in status: *Transfer from active to emeritus,* W. G. Workman, H. R. Snoke, G. F. Gravatt, R. A. Fulton, A. L. Shalowitz, L. C. Graton, W. G. Brombacher, Olga Taussky, and E. C. Stakman; *resignations,* T. J. Killian, R. B. Barker, J. Eisenstein, C. J. Lapp, H. M. O'Bryan, Alice C. Evans, S. Geltman, P. Truesdell, and G. Hottle.

Membership. On the motion of Chairman Cook, the following persons were elected to fellowship in the Academy: Stephen D. Bruck, Rudolph Hugh, Francis B. Gordon, Herman A. Rodenhiser, and William L. Sulzbacher.

Dr. Cook reported that the following 13 persons had been elected to membership by the Committee on November 24: Ura M. Means, John E. duPont, J. David Lockard, Marshall C. Harrington, Daniel B. Lloyd, Emil E. Fowler, Stephen S. Davis, William E. Bradley, Cmdr. Bobby L. Potts, George M. Koehl, Luis A. Veguilla-Berdecia, Dagmar Henney, and John D. Morton.

Meetings. Chairman Steinhardt announced that the speaker at the March meeting would be Kenneth Boulding, University of Michigan, on "Social and Economic Dislocations Incident to Increasing Life Expectancy." This completes the schedule of meetings for the spring semester.

Awards for Scientific Achievement. Chairman Mason nominated the following persons to receive the Academy's 1964 awards of merit, in addition to those reported at the November Board meeting: Biological Sciences, Bruce N. Ames; Physical Sciences, James W. Butler.

Encouragment of Science Talent. President Glenn Smoak and Treasurer Fred Leonberger of the Washington Junior Academy of Sciences appeared before the Board to present a detailed account of WJAS finances. The Junior Academy is currently in straitened circumstances, primarily because (a) a rebate from the Pennsylvania Railroad, pursuant to the last science trip sponsored by the group, will not be received until mid-January; and (b) bills have been presented for several non-routine obligations incurred during the previous fiscal year. The Board approved a loan of $500 to the Junior Academy, to tide it over the emergency.

Membership Promotion. Chairman Mitchell discussed the possibility of Academy sponsorship of a science radio program, such as the successful program sponsored in Baltimore by the Maryland Academy. Dr. Frenkiel recommended that the idea be discussed with the Committee on Public Information. Dr. Schubert mentioned the possibility of presenting a program on American University's Station WAMU.

Editor. Editor Detwiler announced that the December Journal had been mailed, and that work on the January Journal would begin shortly. He mentioned that the printer's bills for the October, November, and December issues had not been received yet and were thus not carried in the treasurer's annual report, but reminded the Board that they would need to be considered when the 1965 budget was prepared.

Archivist. Dr. Farber announced that he was sorting and evaluating several boxes of material. He expressed the need for a centralized location where records of the Academy and other local scientific bodies could be made available.

Joint Board on Science Education. Dr. Taylor reported that the Board had planned to hold several science education conferences during the spring semester, on physics, biology, and chemistry, with outstanding speakers; that a career guidance conference would be held at Catholic University in January; and that the second annual Collegiate Science Conference would be held at Trinity College March 6.

Dr. Frenkiel announced that he planned to write to the Academy's affiliated societies to solicit financial support for the Joint Board in 1965.

Unfinished Business. Dr. Frenkiel announced that the executive board of the Philosophical Society had approved the idea of transferring sponsorship of its annual Christmas Lectures to the Academy beginning in 1965. The matter will be presented to the Society for ratification at its forthcoming annual meeting.

New Business. Dr. Stevens asked whether persons elected to membership were periodically evaluated to determine their suitability for election to fellowship. Dr. Cook replied affirmatively, and discussed the current procedures.

Dr. Schubert briefly discussed a plan being considered by the Chemical Society of Washington to obtain from the Government a building to serve as a headquarters for the scientific societies of Washington. Preferably this building would be one of those located on the present campus of the National Bureau of Standards.

Dr. Schubert moved that the Academy make its customary annual $300 contribution to the program for summer training of high school students in local scientific institutions. The matter was tabled pending consideration of the 1965 budget at a subsequent Board meeting.

Science in Washington

CALENDAR OF EVENTS

January 9—National Capital Astronomers

Marjorie Gardner, University of Maryland, "Progress Report on a Major Planetarium for Washington, D.C."

Department of Commerce Auditorium, 8:15 p.m. Open to the public.

January 12—George Washington University

Robert C. Weaver, administrator, House & Home Finance Agency, and advisor to the President of the United States on Urban Planning; Bernard Hillenbrand, executive director, National Association of Counties; and Senator Harrison A. Williams, Jr. (New Jersey), "Examination of Technical and Political Opportunities and Capacities for Action That Exist or Might Be Developed in the Future."

January 12-14—Office of Naval Research

12th National Infrared Information Symposium.

Army Engineer Research and Development Laboratory, Ft. Belvoir, Va.

January 14—Chemical Society of Washington

Main Speaker: George A. Jeffry, University of Pittsburgh, "Applications of X-

Ray Structure Analysis to the Study of Hydrated Crystals."
Georgetown University, 8:15 p.m.

Topical groups:

David M. Mercules, Massachusetts Institute of Technology, "Luminescence Techniques for Trace Analysis."

Earl Stadtman, National Institutes of Health, "The End Product Regulation of Divergent Biosynthetic Pathways."

Dieter Gruen, Argonne National Laboratory, "Spectra of Molten Salts."

Robert E. Lyle, University of New Hampshire, "The Chemistry of the Pyridium Ion."

Science Center, Georgetown University, 5:00 p.m. Social hour and dinner, 6:00 p.m.

January 18—Washington Operations Research Council

Martin Ernst, past president, Operations Research Society of America, "Simulations of Large Scale Operations as Aids to Policy Decisions in Business."

Charcoal Hearth Restaurant, 2001 Wisconsin Ave., N.W., 8:00 p.m. Social hour, 6:00 p.m.; dinner, 7:00 p.m.

January 19—Anthropological Society of Washington

Conrad Arensberg, Columbia University, "Metropolitan Culture and Classes."

Room 43 (ground floor), Natural History Building, Smithsonian Institution. 8:15 p.m.

January 21—American Society of Mechanical Engineers

Charles P. Howard, Bureau of Ships. John J. Ford, Jr., Solar Division, International Harvester Co., and James Zimmerman, Air-Research Corp., "Gas Turbine Total Energy Concepts."

PEPCO Auditorium, 10th & E Sts., N.W., 8:00 p.m. Pre-meeting dinner at O'Donnell's Restaurant, 6:30 p.m.

January 26—Washington Colloquium on Science and Society

David Hawkins, University of Colorado, "Epistemology of Prediction."

Connecting Lounge, Hughes & McDowell Halls, American University, 8:00 p.m.

January 27—Georgetown University

Paul M. Frye, director, Woods Hole Oceanographic Institution, "Oceanography."

Gaston Hall, 8:00 p.m.

SCIENTISTS IN THE NEWS

Contributions to this column may be addressed to Harold T. Cook, Associate Editor, c/o Department of Agriculture, Agricultural Research Service, Federal Center Building, Hyattsville, Md.

AGRICULTURE DEPARTMENT

KENNETH A. HAINES, Agricultural Research Service, was U. S. representative to the Seventh FAO Regional Conference for Asia and the Far East, held November 7-21 in Manila. The United States is a member of this conference because of its trust island responsibilities. All countries of the region except Cambodia were represented at the meeting.

JOHN T. PRESLEY presented an invited paper at the Second International Kenaf Conference, held December 8-12 in Palm Beach. He spoke on "The Anthracnose Disease of Kenaf from Outbreak to Control."

FRANK P. CULLINAN, associate director of the Crops Research Division, Agricultural Research Service, retired on December 30 after 47 years of service.

ERWIN L. LeCLERG, director of Biometrical Services, ARS, retired on December 30 after 36 years of service.

GEOLOGICAL SURVEY

V. T. STRINGFIELD and *H. E. LeGRAND* presented a paper on limestone rock formations in the southeastern states at the annual meeting of the Geological Society of America, on November 20 at Miami Beach, Fla. At the same meeting, *EDWIN ROEDDER* and *R. L. SMITH* described a new method of geological dating applicable to time spans up to 10 million years, by study of tiny water bubbles trapped in pumice.

HARRIS RESEARCH LABORATORIES

JOHN MENKART gave a talk on "Careers in Chemistry" at Bethesda-Chevy Chase High School on November 17.

EDMUND M. BURAS, JR., was elected chairman of the Washington Section, American Association of Textile Chemists and Colorists, at its meeting of December 4. *JOHN MENKART* was elected secretary, and *LOUIS R. MIZELL* was reelected to another term as councilor.

LYMAN FOURT presented a paper, "Making Subjective Judgment Quantitative in the Textile Field," at the December 4 meeting of the AATCC Washington Section, which was held at Harris Research Laboratories.

ALFRED E. BROWN spoke on "The Washington Scientific Community" at the scientific staff meeting of the National Bureau of Standards on December 11.

NATIONAL BUREAU OF STANDARDS

LAURISTON S. TAYLOR, associate director for technical support, retired from the Bureau on December 18. A dinner was held in his honor at the Sheraton Park Hotel.

An international radiation measurements laboratory was dedicated September 29 on the outskirts of Paris, France. The new facility, one of the finest of its kind in the world, is a significant addition to the International Bureau of Weights and Measures. NBS Director *ALLEN V. ASTIN* participated in the dedication. Dr. Astin had been instrumental in both the planning and realization of the new laboratory. He is the U. S. representative on the international committee that governs the International Bureau. He also headed the original Consultative Committee for the Measurement of Ionizing Radiations, which had the responsibility for international control of radiation standards and measurement.

Also present at the dedication were *LAURISTON S. TAYLOR*, NBS associate director for technical support and chairman of the International Commission on Radiological Units and Measurements, and *HAROLD O. WYCKOFF*, who was chairman of the original Consultative Committee's working group on X-ray standards, and made major contributions to the establishment of the laboratory. Another NBS scientist who made contributions is *WILFRID MANN*, a member of the Committee's working group on radionuclide standards.

NATIONAL INSTITUTES OF HEALTH

MARSHALL W. NIRENBERG, head of the Section on Biochemical Genetics of the National Heart Institute, received the Harrison Howe Award from the Rochester Section of the American Chemical Society on November 9. Recently, also, Dr. Nirenberg was named by President Johnson as one of 11 winners of the 1964 Medals of Science, for his contributions to analysis of the genetic code.

EVERETTE L. MAY, chief of the Section on Medicinal Chemistry of the Laboratory of Chemistry, National Institute of Arthritis and Metabolic Diseases, has been appointed to the World Health Organization's Expert Advisory Panel on Addiction-Producing Drugs.

ELIZABETH G. FRAME has been appointed assistant chief of the Research Fellowship Branch, National Institute of General Medical Sciences.

JAMES A. SHANNON, director of NIH, was one of five Federal career officers named to receive a Rockefeller Public Service Award for 1964.

NAVAL RESEARCH LABORATORY

BERTRAM STILLER, Nucleonics Division, is serving as scientific coordinator of a projected Cosmic Ray Balloon Expedition to Hyderabad, India, during the

International Quiet Sun Year (IQSY). The expedition is a joint Indian and American IQSY activity, with U.S. support financed by the National Science Foundation. Sixteen balloons, designed to float at an altitude above 120,000 feet for at least eight hours, will be launched during March and April, 1965. The objectives are to obtain cosmic ray data near the earth's geomagnetic equator at higher altitudes than had been reached previously. Such data can be used to study astro-physical problems related to the origin of cosmic rays and stellar evolution.

ROBERT G. GLASSER, NATHAN SEEMAN, and *BERTRAM STILLER*, Nucleonics Division, received the Meritorious Civilian Service Award on November 30 for outstanding achievement in the measurement of the lifetime of the neutral pi meson.

Effective November 1, *JAMES H. SCHULMAN*, head of the Dielectrics Branch, was appointed to the first Chair of Science position—that of Chair of Materials Sciences. Chair of Science positions have been established to confer special recognition on the incumbent as a distinguished scientist of exceptional accomplishment.

GEORGE T. RADO, head of the Magnetism Branch, presented an invited paper on "Magnetoelectric Effects in a Ferromagnet" at the International Conference on Magnetism held in Nottingham, England, last September. Following this conferece, Dr. Rado visited several laboratories coducting magnetism research in England and France.

SCIENCE AND DEVELOPMENT

Georgetown University has announced the founding of an annual Louis Pasteur science lectureship, designed to bring to the Washington academic community outstanding, timely expositions of broadly significant work at the frontiers of science. The new series, named in honor of the chemist whose work laid the foundations of bacteriology, will consist of several lectures each spring on a topic of fundamental scientific importance. The lectures will appear annually in expanded form, as a book.

The 1965 Pasteur lecturer will be Tracy M. Sonneborn, distinguished service professor of zoology at Indiana University. His subject, "Cell Differentiation," has broad significance in the development of biological, chemical, and philosophical concepts. The lectures will be given at Georgetown University in April; the public is invited.

It will surprise few, but is none the less gratifying, to read the figures on attendance at the various museums of the Smithsonian during its first month of evening hours' visiting. In July, for example, more than 10,000 persons, tourists from out of town and local visitors, enjoyed the new privilege of access to the exhibits after normal closing hours. Indeed, so successful has the venture proven that it will be reinstituted on April 1 of next year.

That the Alaskan earthquake of last March was of major proportions, all are well aware. When one translates this into specific instances, and hears of "12,000 square miles uplifted," of "strips of sea floor as much as 1,350 feet wide exposed," or of "Alaskan island uplifted 30 feet," it becomes far more vivid. One of the intriguing highlights of this event and its subsequent study by geologists of the Geological Survey is the plan to use existing lakes, some 18 of them in Southern Alaska, as a sort of gigantic spirit level to determine the amount of tilt which has taken place. Just as with the carpenter's and brick mason's level, these lakes can, by periodic checks on the distance between special markers and the water surface, clearly indicate changes which have taken place or which are in progress.

How to tell whether the polar ice on the Antarctic continent is moving, and if so, which way and at what rate? The Geological Survey's attempt to answer this question relies on the erection of a 60-mile "fence" consisting of two parallel rows of 16-foot, 4 x 4 wooden posts, spaced nearly two miles apart on the two-mile-thick ice sheet of Marie Byrd Land. During the next Antarctic summer, an additional 60 miles of posts is planned, to extend to a divide where the ice cap flows west to the Ross Ice Shelf and east to the Filchner Shelf. Measurements would then be made, in about four years, to determine quantitatively both direction and rate of flow. Progress in mapping the geology of this huge continent, one and one-half times the combined area of the 50 United States, goes on apace as an impressive example of international cooperative effort.

Anyone interested in the ecology of natural communities, who has seen first-hand the result of strip mining removal of coal or other mineral resource, does not need to be told of the devastations that occur. But studies, published a month or so ago by the Geological Survey, of the situation in eastern Kentucky, make excellent ammunition for persuading others, and puts the problem in tangible terms. A five-year study of the effects on water, soils, forest, and aquatic life of the Cane Branch Basin in Kentucky's McCreary County produces such striking quotations as these:

"Amounts of sediments carried in the streams due to breakdown of rock fragments in a two-year test period averaged approximately 40 tons per square mile in parts of the basin unaffected by mining, and 380 tons per square mile in parts affected."

"Materials in solution averaged less than 30 ppm in unaffected areas as contrasted to 310 in mining areas."

"Stream acidity, caused by runoff from spoil banks, eliminated fish life and destroyed much of the stream bottom flora and fauna."

"Large areas of land were denuded and left with toxic materials that impede reforestation."

Formation of a National Academy of Engineering was announced on December 11. The National Academy of Sciences has approved articles of organization which bring the new group into being as part of its own structure, operating on an autonomous and parallel, but coordinated, basis. The new Academy will share in the responsibility given the National Academy of Sciences under its enabling act to advise the Federal Government, upon request, in all areas of science and engineering.

Development of practical electronic "image tubes" capable of materially extending the range and usefulness of astronomical telescopes, giving a gain in the rate of recording "information" by a factor of 10 over the best photographic emulsions, has been announced by Merle T. Tuve, chairman of the Carnegie Image Tube Committee and director of the Carnegie Institution's Department of Terrestrial Magnetism.

Use of these image tubes can triple the effective light-recording power of a photographic telescope, making it the equivalent of an unaided telescope of three times the diameter. A 60-inch reflector would thus be capable of photographing star images or recording the spectra of faint objects now obtainable only with telescopes of 180 inches diameter.

At present the world's largest telescope is the 200-inch-diameter reflector at Palomar Observatory, but a number of excellent smaller ones are in operation at various observatories in both the northern and southern hemispheres. Aided by image tubes, these smaller telescopes could rival the unaided capability of the world's largest instruments, giving astronomers markedly increased power to explore the universe, from numerous vantage points all over the world.

Some unexpected results of the largest and most elaborate research project to date in the current world-wide study of the upper mantle of the earth were disclosed recently in a paper given before the Seismological Society of America by John S. Steinhart of the Carnegie Institution's Department of Terrestrial Magnetism.

Lake Superior was chosen as the site for this intensive international project because it lies in the Canadian Shield, an ancient geological area thought to be of rather uniform age and composition. One purpose of the project was to compare the seismic methods of different institutions and national groups, and evaluate results as a means of establishing better overall methods of interpreting seismic studies. Another was to make a detailed calibration of a relatively uniform section of the earth's crust for later use as a standard of comparison in analyzing data from other places.

Beneath Lake Superior was found a large section of extremely dense rock that proved very different from the more or less uniform Shield areas of Wisconsin, Minnesota, and southern Canada adjacent to the lake. This unanticipated discovery has led to further intensive explorations by the University of Wisconsin and the Geological Survey.

The earth waves sent out by a series of one-ton explosions in the bottom of Lake Superior were detected by sensitive instruments in Arizona, Oregon, and other locations at very long distances—some as great as 1600 miles—indicating that underwater explosions above some types of rock formations can be detected at astonishing distances. Such waves in other types of terrain are known to be damped out more quickly, and do not carry nearly as far.

The Army Engineers are using an orbiting artificial satellite to pinpoint exact locations of land bodies separated by large expanses of ocean. Use of the satellite and overseas ground stations is enabling them for the first time to get data with an all-weather electronic system that measures distances of up to a thousand miles to an accuracy within 30 meters. The system, known as SECOR (Sequential Collation of Range), is contributing to the scientific knowledge and military capabilities of the United States and is helping also to determine the exact size and shape of the earth. Operations are being conducted at three ground stations at precisely known points in Japan and the Ryukyus and at one unknown site on Iwo Jima, whose geodetic location is being determined. Two other stations are being located at other points in the Pacific. Plans call for leap-frogging from island to island; nine unknown points are expected to be located in the Pacific during the first year of operations. By a contiguous series of measurements, the Army Map Service will be able to create a network on which to establish a common base for locating points on the earth's surface.

An atomic definition of the second was authorized October 8 by the Twelfth General Conference of Weights and Measures, meeting in Paris. The International Committee on Weights and Measures, acting for the Conference, temporarily based the definition on an invariant transition of the cesium atom in expectation of a more exact definition in future. The new definition replaces the definition of a second based on the annual orbit of the earth around the sun.

This action was recommended by the American delegation to the Conference, Director A. V. Astin and A. G. McNish of the National Bureau of Standards. It increases the accuracy of time measurements to a part in 100 billion, an accuracy 200 times greater than that formerly achieved by astronomical means. More, the measurements can be accurately determined in a few minutes, as compared to the many years required to achieve an accuracy only a hundredth as good by astronomical means.

A 70-mm micromap camera, the basis of a system designed to eliminate problems in printing, storing, and displaying military maps, is being developed by the Army Engineers at Fort Belvoir. Designed for transport and use in standard Army mobile map reproduction vans, the extremely rigid and precise camera produces 70-mm micromaps from standard military maps. Two thousand of these micromaps can be stored in the target map locator, the system's second major component, and projected at will for individual viewing. Those maps required in quantity can then be reproduced from micromap color separations by the electrostatic printer which rounds out the system. In this way maps can be printed, stored, and displayed at the point of demand, thus eliminating the reproduction and storage of large quantities of maps made in advance in anticipation of requirement.

American University has been granted $64,190 by the National Science Foundation for support of a "Summer Institute in Recent Advances in Chemistry and Physics for Secondary School Teachers" during 1965. This program, conducted by Leo Schubert, the Academy's president-elect, is in its tenth year of operation. It is one of the oldest institutes for high school teachers in the country, and is unique in that the teachers are involved not only in lecture and laboratory work on campus, but also in research both on and off campus.

The Army Engineers have awarded a contract for production of image intensifier tubes to be used in night viewing systems developed by their laboratories at Ft. Belvoir. The special tubes intensify the natural low level of night illumination to present a bright image, thus providing the soldier with firepower and mobility at night comparable to daylight activities.

Measurement of length with a laser has been successfully accomplished by the National Bureau of Standards. Using a laser beam as an interferometric light source, K. D. Mielenz, H. D. Cook, K. E. Gillilland, and R. B. Stephens measured the length of a meter bar with an accuracy better than a part in 10 million. This accomplishment means that the laser—which up to now has had only limited practical application—has become a scientific tool for achieving dimensional accuracy of a high order.

The Weather Bureau has ordered a Control Data 6600 computer to speed the processing of large volumes of data on weather conditions around the world. When installed at the Bureau's facilities in Suitland, Md., the new computer, said to be the world's largest, fastest, and most powerful, will be used by the National Weather Satellite Center to process meteorological satellite data; by the National Meteorological Center in day-to-day forecasting; and by the Geophysical Fluid Dynamics Laboratory for atmospheric research studies.

Initial tests of a prototype Airscrew Swamp Vehicle have been begun by the Army Engineers at Fort Belvoir. Designed to further the Army's mobility in swamp areas, the swamp vehicle skims water surfaces having heavy swamp vegetation; it would be used as a troop carrier and to move heavy loads through marshy areas. Although similar to the sports vehicles used in the Florida Everglades, it will be the largest and most powerful boat ever built especially for swamp work. It will be powered by a 400-hp aircraft engine with a specially designed four-blade propellor mounted on a 20-foot hull.

Delegates to the Washington Academy of Sciences, Representing the Local Affiliated Societies*

Philosophical Society of Washington	Urner Liddel
Anthropological Society of Washington	Gordon McGregor
Biological Society of Washington	John L. Paradiso
Chemical Society of Washington	William A. Zisman
Entomological Society of Washington	Harold H. Shepard
National Geographic Society	Alexander Wetmore
Geological Society of Washington	Luna Leopold
Medical Society of the District of Columbia	Thomas M. Brown
Columbia Historical Society	U. S. Grant, III
Botanical Society of Washington	Wilbur D. McClellan
Society of American Foresters	Harry A. Fowells
Washington Society of Engineers	Martin A. Mason
Institute of Electrical and Electronics Engineers	George Abraham
American Society of Mechanical Engineers	William G. Allen
Helminthological Society of Washington	Marion M. Farr
American Society for Microbiology	Frank Hettrick
Society of American Military Engineers	H. P. Demuth
American Society of Civil Engineers	Thorndike Saville, Jr.
Society for Experimental Biology and Medicine	Falconer Smith
American Society for Metals	Hugh L. Logan
International Association for Dental Research	Harold J. Caul
American Institute of Aeronautics and Astronautics	Eugene Ehrlich
American Meteorological Society	J. Murray Mitchell, Jr.
Insecticide Society of Washington	Delegate not appointed
Acoustical Society of America	Malcolm C. Henderson
American Nuclear Society	George L. Weil
Institute of Food Technologists	Richard P. Farrow
American Ceramic Society	J. J. Diamond
Electrochemical Society	Kurt H. Stern

* Delegates continue in office until new selections are made by the respective affiliated societies.

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VOLUME 55 NUMBER 2

Journal of the WASHINGTON ACADEMY OF SCIENCES

WASHINGTON ACADEMY OF SCIENCES 1898

FEBRUARY 1965

JOURNAL OF THE WASHINGTON ACADEMY OF SCIENCES

This Journal, the official organ of the Washington Academy of Sciences, publishes historical articles, critical reviews, and scholarly scientific articles; notices of meetings and abstract proceedings of meetings of the Academy and its affiliated societies; and regional news items, including personal news, of interest to the entire membership. The Journal appears nine times a year, in January to May and September to December. It is included in the dues of all active members and fellows.

Subscription rate to non-members: $7.50 per year (U.S.) or $1.00 per copy; foreign postage extra. Subscription orders should be sent to the Washington Academy of Sciences, 1530 P St., N.W., Washington, D.C., 20005. Remittances should be made payable to "Washington Academy of Sciences."

Back issues, volumes, and sets of the Journal (Volumes 1-52, 1911-1962) can be purchased direct from Walter J. Johnson, Inc., 111 Fifth Avenue, New York 3, N. Y. This firm also handles the sale of the Proceedings of the Academy (Volumes 1-13, 1898-1910), the Index (to Volumes 1-13 of the Proceedings and Volumes 1-40 of the Journal), and the Academy's monograph, "The Parasitic Cuckoos of Africa."

Current issues of the Journal (past two calendar years) may still be obtained directly from the Academy office at 1530 P Street, N.W., Washington, D.C., 20005.

Claims for missing numbers will not be allowed if received more than 60 days after date of mailing plus time normally required for postal delivery and claim. No claims will be allowed because of failure to notify the Academy of a change of address.

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Six Scientists Receive Academy's Annual Awards

Awards for outstanding scientific achievement were conferred upon four research scientists and two science teachers at the Washington Academy's 67th Annual Dinner Meeting on January 21 at the Cosmos Club.

The research investigators honored were Bruce N. Ames of the National Institutes of Health, in the biological sciences; James W. Butler of the Naval Research Laboratory, in the physical sciences; Thorndike Saville, Jr., of the Army Coastal Engineering Research Center, in the engineering sciences; and David W. Fox of the Johns Hopkins University Applied Physics Laboratory, in mathematics.

The science teachers were Donald F. Brandewie of Claude A. Swanson Junior High School in Arlington, and Herman R. Branson of Howard University.

Award winners were introduced by Marshall W. Nirenberg of the National Institutes of Health; H. William Koch of the National Bureau of Standards; J. M. Caldwell of the Coastal Engineering Research Center; R. E. Gibson, director of the Applied Physics Laboratory; Phoebe H. Knipling, science supervisor of Arlington County Schools; and James M. Nabritt, president of Howard University.

The Academy's awards program was initiated in 1939 to recognize young scientists of the area for "noteworthy discovery, accomplishment, or publication" in the biological, physical, and engineering sciences. An award for outstanding teaching was added in 1955 and another for mathematics in 1959. Except in teaching, where no age limit is set, candidates for awards must not be over 40.

Biological Sciences

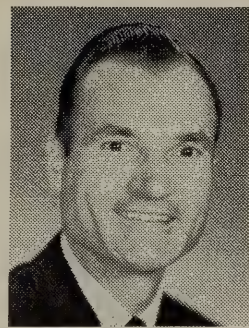
Cited "for outstanding contributions to molecular genetics" was Bruce N. Ames, of the National Institutes of Health. He has been studying the pathway of histidine and has discovered the enzymes and intermediates in the synthesis of this amino acid. While this work in its own right represents a major accomplishment in biochemistry, Dr. Ames has further developed the histidine enzyme complex into a genetic tool as well. The enzymes in this complex or "operon" have been mapped by transduction of their genes in over a thousand different histidine-deficient mutants. Many areas of biology have been enriched by his studies, which relate to mechanisms of protein synthesis, genetic mapping, enzyme regulation and regulatory functioning, and amino acid synthesis.

Born December 16, 1928, in New York City, Dr. Ames received the B.A. degree from Cornell in 1950 and the Ph.D. degree from California Institute of Technology in 1953. He has been at NIH since then, first as a Public Health Service postdoctoral fellow, and later as a staff member. Since 1962 he has been chief of the Section of Microbial Genetics.

Physical Sciences

James W. Butler of the Naval Research Laboratory was cited "for contributions to our knowledge of energy levels and properties of atomic nuclei." He initiated and actively participated in a long series of experiments with the 2-million and 5-million volt Van de Graaff accelerators at

B. N. Ames

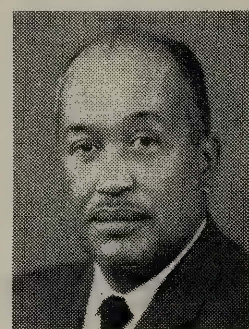


J. W. Butler

T. Saville, Jr.

D. W. Fox

D. F. Brandewie



H. R. Branson

NRL to measure various properties of energy levels of atomic nuclei. Just as the study of optical spectra of atoms some decades ago led to the Bohr model of the atom and modern quantum mechanics, so today the study of nuclear spectra (*i.e.*, nuclear energy levels) is laying the groundwork for the theory of nuclear structure and nuclear forces.

Dr. Butler was born on November 5, 1924, in Dublin, Ga., and received the B.S. degree from Georgia Institute of Technology in 1944 and the M.S. and Ph.D. degrees from Rice Institute in 1949 and 1951, respectively. He was at NRL from 1951 to 1961, when he became professor of physics at Michigan State University. He returned to NRL in 1964 on a full-time basis.

Engineering Sciences

Chief of the Research Division of the Army Coastal Engineering Research Center, Thorndike Saville, Jr., was recognized "for research in coastal engineering, particularly studies of wave run-up and overtopping." Before he entered this field of research, there were essentially no understanding of these phenomena and no guides for the practicing engineer. Yet all work on protective shore structures such as seawalls, bulkheads, breakwaters, and dunes requires information on the height to which wave action will run up on the shore structure, or a reliable estimate of the quantity of water which passes over the top of the structure in case it is overtopped by the wave. His work has provided a sound and useful basis for making the needed computations.

Born in Baltimore on August 1, 1925, Mr. Saville received the A.B. degree from Harvard in 1947 and the M.S. degree from California (Berkeley) in 1949. He has been at the Coastal Engineering Research Center since then, and chief of the Research Division since 1964.

Mathematics

Cited "for research in estimating lower bounds to eigenvalues and related studies" was David W. Fox of the Applied Physics Laboratory. Various eigenvalues of mathematical operators in Hilbert space are of great importance in mathematical physics. The classical method of Rayleigh and Ritz provides a convenient means for setting upper bounds to such eigenvalues, but methods for lower bounds have required auxiliary analyses that were often as inaccessible as the exact solution of the original problem. One of the major uses of eigenvalue bounds is to furnish guides for numerical computations. The techniques developed by Dr. Fox and his collaborators have provided the mathematical foundation for machine computation programs that have been successfully applied to a variety of problems in quantum mechanics.

Born November 21, 1928, in Dubuque, Iowa, Dr. Fox received the A.B. and M.S. degrees from the University of Michigan in 1951 and 1952, respectively, and the Ph.D. degree from the University of Maryland in 1958. He was a member of the Institute for Fluid Dynamics and Applied Mathematics of the University of Maryland in 1958-1960, and has been a project leader at APL since 1960.

Teaching of Science

Recognized "for generating contagious enthusiasm for science through inspirational teaching" was Donald F. Brandewie of Claude A. Swanson Junior High School in Arlington, whose major training has been in geology. Praised by students, colleagues, and administrators alike for his teaching, Mr. Brandewie came to Swanson Junior High School in 1962, after receiving the M.A. degree from the University of West Virginia. Prior to that he was a science teacher at New Bremen, Ohio, High School in 1958-1961. He was born on September 24, 1934, in Fort Laramie, Ohio, and received the B.S. degree from the University of Dayton in 1959.

A member of the Howard University faculty since 1941, Herman R. Branson was cited "for contribution to science education and an outstanding role as physics teacher." Born on August 14, 1914, in Pocahontas, Va., he received the B.S. degree in 1936 from Virginia State College, and the Ph.D. degree in 1939 from the University of Cincinnati. He has been head of the Department of Physics at Howard since 1955, and a member of the Commission on College Physics since 1964. He spent 1948-1949 at California Institute of Technology as a senior fellow of the National Research Council, and 1962-1963 at the University of Hamburg (Germany) and the French Atomic Energy Commission establishment at Saclay, as a faculty fellow of the National Science Foundation. In addition to his teaching, for which he has been particularly recognized by this award, Dr. Branson has published a number of research papers in biophysics and chemical physics.

The Society of American Foresters And Its Washington Section

Arthur B. Meyer

Editor, Journal of Forestry

The Washington Section of the Society of American Foresters, as of June 1964, had a membership of 343 professional foresters. It is one of 23 geographical sections of the 15,000-member Society, spread from Maine to Hawaii.

The Washington Section is unique in the SAF. The average age of its members is probably 10 years greater than the national average of the organization. Many of the members are in high administrative positions in Federal service and have a background of extensive field experience. Because of its location in the Nation's Capital and its frequent meetings during the winter months, the Section draws many "visiting firemen" from across the country, and indeed from foreign posts, who are in Washington on business. As one visiting speaker put it, "You foresters in this Section have been everywhere and seen everything." But beyond the cosmopolitan atmosphere and the professional maturity of its membership, the Section is unique in the degree to which its history is that of early American forestry. In fact, in the sense that people make history, the Section helped write a lot of history.

American literature from earliest Colonial times contains evidence of sporadic concern with various isolated aspects of the importance of forest resources. Yet there is little evidence of any concept of the *universal* importance of forest resources. The first may well be found in the writings of George P. Marsh in his *Man and Nature*, published in 1864. Marsh dealt with man's actions as detrimental to his own environment, and gave considerable attention to forest influences. In 1873, Franklin B. Hough wrote in the proceedings of the American Association for the Advancement of Science "On the Duty of Governments in the Preservation of Forests." By the latter part of the 19th century, public interest in forestry had been awakened to a considerable degree, as demonstrated by the creation of the forest reserves out of the public domain and the work of the small Division of Forestry under Bernhard E. Fernow in the U.S. Department of Agriculture.

A Profession Emerges

The scene was set by 1900 for the emergence of a new profession in America. Gifford Pinchot, the first American-born forester, who was trained in Europe, had just become the new head of the Division of Forestry. In this country, professional education in forestry had just started. The College of Forestry at Cornell was in its third year and the Yale Forest School, established under endowment from the Pinchot family, had opened its doors that autumn.

In the words of Ralph S. Hosmer, writing in the *Journal of Forestry* on the golden anniversary of the Society of American Foresters in 1950, "The problem was how to bring to pass what a few men saw needed to be done. As a member of the committee of the National Academy of Sciences set up to study the forest lands of the public domain, Mr. Pinchot had seen clearly the necessity of a broad national program of forestry. . . . He realized that to carry such a program forward successfully, men trained in forestry were required. Enthusiasm and teamwork were essential. Even more so were high standards and the establishment of forestry on a firm foundation, on a level of dignity equal to that of the other professions. It was from Mr. Pinchot's concept of what forestry should be and how its work should be administered that the Society of American Foresters sprang. His associates were actuated by his zeal and inspired by his dynamic personality."

On November 30, 1900, Mr. Pinchot called a meeting in his office in the Department of Agriculture to discuss the feasibility of organizing a Society of American Foresters. Present, in addition to Pinchot, were Henry S. Graves, Overton W. Price, Edward T. Allen, William L. Hall, Ralph S. Hosmer, and Thomas H. Sherrard. Thus the SAF came into existence with Pinchot as its first chairman.

At a later meeting in December, eight more foresters, some not residents of Washington, were elected to membership under the rules of the newly adopted Constitution that "Active members shall be professional foresters of achievement."

The purpose of the Society was summed up in its Constitution: "The object of this Society shall be to further the cause of forestry in America by fostering a spirit of comradeship among foresters; by creating opportunities for a free interchange of views upon forestry and allied subjects; and by disseminating a knowledge of the purpose and achievements of forestry." Although expressed in broader terms, these objectives stand today as guiding principles.

In a final action for the year 1900, the Society elected 13 associate members whose names represented most of the leaders of the forestry movement in the country. Among them were Secretary of Agriculture James Wilson and the Governor of New York, Theodore Roosevelt.

"The Baked Apple Club"

The activities of the Society in its first years centered around weekly meetings from autumn to spring. Most men entitled to be called foresters were in the employ of the Federal government and for the most part headquartered in Washington. During the winter months there was also a considerable group of young college men working for the Division of Forestry who the previous summer had been student assistants on field surveys. Although not eligible for membership, these men were always welcome at the weekly open meetings. Many of them subsequently graduated from forestry schools.

Mr. Pinchot opened his home at 1615 Rhode Island Avenue to these meetings and thus inaugurated what came to be known as "The Baked Apple Club." Following the presentation of carefully prepared papers on such subjects as "The Disposal of Public Lands" and "Why Prairies Are Treeless," the group would retire from the spacious Pinchot library to the walnut paneled dining room for baked apples, gingerbread, and milk. (One can hardly question that these foresters must have been hungry people, considering the amount of activity in which they engaged on and off the job.)

Many people of prominence in the scientific and other branches of government were guests and speakers at the meetings. High-ranking officials from the Biological Survey, the Geological Survey, and the Department of Agriculture were on the list.

Naturally in these early years the Society was closely bound up with the Division and then Bureau of Forestry—after 1905 the Forest Service.

A Visitor of Note

On the evening of March 26, 1903, Theodore Roosevelt broke a tradition that the President of the United States does not speak in private homes and visited the house on Rhode Island Avenue. He said in part: "I have felt that the meeting this evening was of such a character as not merely to warrant but to require that I should break through my custom of not going out to make speeches of this sort, for I believe that there is no body of men who have it in their power today to do a greater service to the country than those engaged in the scientific study of, and practical application of approved methods of forestry for the preservation of the woods of the United States." His address to the group of foresters and guests is the initial article in Volume 1, Number 1, of the *Proceedings* of the Society published in May 1905.

Once the Society became firmly established, it was natural to assume that the knowledge and ideas expressed at the meetings should be preserved, starting with the *Proceedings* in 1905. In 1902 the forestry students at Cornell had begun to publish the *Forestry Quarterly*, later carried on under private auspices. These two publications were combined in 1917 as the *Journal of Forestry*, now the most widely distributed professional forestry publication in the world.

Foresters Move

In 1905 the Bureau of Forestry became the Forest Service in the Department of Agriculture. It was fast emerging as a full-fledged Government agency responsible for 56 million acres of national forest, carved from the public domain as forest reserves. To carry on its work the Forest Service employed at least 90 percent of the professional foresters in the country, so developments in the Service affected the structure of the Society. Until 1908 the center of Federal government forestry activity was in Washington, but it had become apparent that decentralization of the work was necessary. Headquarters were set up in places far from the Potomac, in Montana, California, Oregon, and even Alaska. As foresters spread to the far corners of the country, some came to question the value of a professional organization located in Washington, D. C. In 1911 the Society had 213 active members. To solve the problem of the profession, it was suggested that local sections be established. This would allow foresters far afield to maintain their professional ties.

An amendment to the Constitution of the Society in 1912 provided for the establishment of regional sections. The first was formed that year in Missoula, Mont., the second in 1913 in St. Paul, Minn., and the third in 1915 at Portland, Ore.

Washington Section Formed

In the autumn of 1916, apparently but not surely on November 6, 26 members of the Society residing in the District of Columbia petitioned for the formation of the Washington Section. The Bylaws provided that eligible foresters residing outside the District could become actively affiliated upon written application.

Allen S. Peck was the first chairman of the Section, with Francis Kiefer as secretary, and W. W. Ashe as third member (of the executive committee).

Although gatherings of the Washington foresters could no longer be considered meetings of the "parent" Society, section "status" seems to have had little or no effect on the activities of the group. Meeting programs continued to be of a high scientific caliber, with members and outside guests discussing a wide array of subjects pertinent to forestry and the profession. The frequency with which the Baked Apple Club met, however, had given way to bimonthly and monthly meetings held at the homes of members, including occasional invitations from Mr. Pinchot, or at the University Club, the New National Museum, and later the Cosmos Club.

By 1917 Washington was immersed in the problems of war. In February the Section appointed a committee to investigate ways and means whereby foresters could assist in national defense. The principle of universal military training was endorsed and it was suggested that all professional foresters be classified as to their skill for meeting military needs.

During the war period, meetings concentrated on subjects relating forestry to defense of the nation and to the post-war future. The agenda for open meetings to be held during 1918 included the following:

February 14: "With the Forest Regiments in France"—Lt. Col. Henry S. Graves.

February 28: "Forestry and the Fuel Problem"—A. F. Hawes.

March 14: "Forest Products and the War"—E. H. Clapp, H. S. Betts, and Rolf Thelen.

The Section became affiliated with the Washington Academy of Sciences in 1904. (See seventh annual report of the Academy's secretary, covering the period January 21, 1904 to January 19, 1905, as recorded in the Academy's Proceedings *6*, 450–2 (1904).) In the Academy's roster of officers for 1904 (*ibid.*, page viii), Gifford Pinchot is listed as representative of the Society of American Foresters; additionally, he is named as one of nine managers of the Academy. (Since he was of the "class of 1907," and the managers served for three-year terms, he presumably began his duties in January 1905.)

Following World War I, developments in forestry were rapid. The Washington Section, not so much as a section of the Society, but as the home grounds of forestry leaders and the seat of government, continued to form the backdrop of history. From 1905 until the war, the main job of the Forest Service had been to establish and maintain the national forest system. War's demand for timber made the time ripe to start giving attention to private timberlands. Regulation by the Government was proposed as a solution and for two years arguments *pro* and *con* filled forestry publications and lumber trade journals. Society President Frederick E. Olmsted appointed a Committee for the Application of Forestry early in 1919; Gifford Pinchot was chairman. The report of "The Pinchot Committee," as it became known, was submitted at the annual meeting of the Society held in New York City in January 1920. The gist of the recommendations was that "the national timber supply must be secured (a) by forbidding the devastation of private forest lands, and (b) by the production of forest crops on public forests." The report outlined suggested legislation to be enacted by Congress to provide strict mandatory regulations to be enforced by the Federal government through the Forest Service.

Heated discussion ensued. A large group in the Society opposed this method of approach. While acknowledging that some regulation was probably desirable, they urged that it be obtained through cooperation, preferably with individual States.

Opposing groups were formed among foresters, led respectively by Mr. Pinchot and William B. Greeley, who had become chief of the Forest Service in April 1920. The Capper Bill and the Snell Bill were introduced in Congress, representing respectively the proposals and ideas of the two groups. Twice during 1920, Society members were polled by letter ballots on the subject of Federal regulation, but many refrained from voting and the results were inconclusive.

Then in 1920 came the appointment of the Senate Committee on Reforestation to study the whole matter. Hearings were held around the country and much testimony was submitted. The final recommendation of the Committee left out controversial issues and stressed other matters on which practically all foresters were in agreement. The result was passage of the Clarke-McNary Act of 1924 which, through cooperative measures among Federal, State, and private groups, has been responsible for much of the progress made in this country in State and private forestry work.

But not all was controversy in the turbulent twenties. A lecture given by William B. Greeley in 1924 resulted in the National Academy of Sciences' setting up a special committee to make "a critical inquiry into the status and needs of research in the sciences basic to Forestry." A grant from the General Education Board made possible a survey of forest research organizations, by I. W. Bailey and H. A. Spoehr. Their report, "The Role of Research in the Development of Forestry in North America," was published by the Academy in 1929. Thus was launched a continuing emphasis on the role of research (and education) in forestry.

The Section and the Society

As the Society grew in numbers—982 in December 1923—its annual meetings grew in importance. From 1921 to 1924 they were held in affiliation with the American Association for the Advancement of Science in Toronto, Boston, Baltimore, and Washington, and again in 1927 at San Francisco. The success of the latter meeting started the custom now in effect of distributing annual meetings of the Society about the country. They return once each decade to Washington, D. C., however, on the anniversary of the 1900 gathering in Gifford Pinchot's office.

The Society has maintained its ties with AAAS since 1913 and currently has two representatives on its council. It is also affiliated in cooperative undertakings with numerous other professional and technical organizations, including the National Research Council, the Natural Resources Council of America, and the American Institute of Biological Sciences.

Since its founding 64 years ago, the Society of American Foresters has achieved general recognition as the national body which represents the profession of forestry in the United States, and as such is acknowledged as its spokesman.

Its 23 sections meet at least once each year, but usually more often. Field trips are taken, technical reports are made, and current issues are discussed. Sections frequently undertake special projects such as studies of forestry operations, special forest resource uses, the compilation of local forest practice rules, forest products marketing, and the publication of bulletins.

Eleven subject-matter divisions are concerned with technical fields of specialization: silviculture; recreation; forest fire; economics; watershed, wildlife, range, and forest management; mensuration; forest products; and education. They conduct special studies and develop technical programs for the national annual meetings.

In 1948 the Society adopted a Code of Ethics, now recognized as a standard for professional conduct.

Committees of the Society function in such varied activities as international relations, research, and civil service. Other committees of the divisions operate in fields of primary interest to them. Standing committees on ethics and the advancement of forestry education ensure the maintenance of professional standards.

Forestry has become an accepted part of American life. It is doubtful that it would have done so to the extent it has were it not for the Society of American Foresters, which has adhered to its original objectives—"the advancement of the science, practice and standards of forestry in America." The members of the Washington Section of the Society, present and past, in their daily labors, in their professional affiliation, in the wealth of experience they bring with them, have done much to make this possible.

WASHINGTON SECTION, SOCIETY OF AMERICAN FORESTERS

During the fall and winter, the Washington Section of the Society of American Foresters has three luncheon meetings, one evening meeting (ladies' night), and one all-day meeting.

At the luncheon meetings, held the third Wednesday of the month at the Occidental Restaurant, the Program Committee usually obtains as the speaker a member of Congress, visiting dignitary, or other important person from industry, education, or government.

The evening meeting, with a social hour, dinner, and dancing, features a prominent woman as a dinner speaker.

At the all-day meeting, held at the Presidential Arms, nationally-known speakers discuss a controversial topic. Normally the meeting concludes with a luncheon speech, for which the Program Committee has been especially successful in obtaining an eminent speaker.

The current issue of *The Journal* is devoted to the Washington Section of SAF, and provides a background for the annual all-day meeting of the Section to be held on March 17 next.

ANNUAL ALL-DAY MEETING

THEME: Pests, Pesticides, and People

PLACE: Presidential Arms, 1320 G Street, N.W.

DATE: Wednesday, March 17, 1965

TIME: Registration—9:00 A.M. (a 50-cent charge)
Luncheon—12:55 P.M.
Adjournment—About 2:30 P.M.

SPEAKERS: Hon. Jamie L. Whitten, Member of Congress, Charleston, Miss.; Chairman, House Subcommittee for Agricultural Appropriations
Austin H. Wilkins, President, National Association of State Foresters, Augusta, Maine
Carl W. Buchheister, President, National Audubon Society, New York City
Parke C. Brinkley, Executive Director, National Agricultural Chemicals Association, Washington, D. C.
(Luncheon speaker and another prominent speaker to be announced later)

Program Chairman: Milton M. Bryan, Forest Service, U.S.D.A.

Arrangements Chairman: Robert A. Smart, Forest Service, U.S.D.A.
For luncheon reservations (price probably $3.50) call 296-7820, Society of American Foresters

Officers of the Washington Section, Society of American Foresters

Chairman: Edwin Zaidlicz, Bureau of Land Management, USDI

Vice-Chairman: Wilson B. Sayers, American Forest Products Industries, Inc.

Treasurer: Dennis A. Rapp, Bureau of the Budget

Secretary: Mark M. Johannesen, Forest Service, USDA

The Control of Pests in Our Forests

W. V. Benedict

Director, Division of Forest Pest Control, Forest Service, Department of Agriculture

Of the total land area of the United States, about one third, or 758 million acres, is forest land. The job of protecting these forests from a host of insect and disease pests requires all the skills of foresters, entomologists, pathologists, and other scientists. In recent years with the availability of effective pesticides, we believe we have been successful in containing or controlling most major insect epidemics that might have destroyed billions of board feet of timber. But in our use of pesticides, we have incurred some public criticism. Thus we think it appropriate to outline our method of determining how, or if, an epidemic might be prevented or controlled.

Forest fires—always dramatic—are considered by many to be the forest's most damaging enemy. This is not true. Diseases and insects take a far greater toll. For example, in an average year they kill an estimated 7.3 billion board feet of valuable sawtimber. Growth impact, or losses in growth of surviving trees, is estimated at 21.2 billion board feet. These enormous losses occur despite efforts made each year to check damage by action programs in prevention and suppression. The chestnut blight has virtually eliminated American chestnut trees. Dutch elm disease has a fair chance of doing the same to the American elm as a forest species. Another disease potentially serious to our hardwood forests is oak wilt. Control is being practiced in some areas, and much research is in progress to determine the real significance of the oak wilt threat and to improve our methods of control.

Among the softwoods, the prized white pines can be grown only on selected sites—and at considerable cost—because of blister rust and the white pine weevil. An attempt is being made to control blister rust on about 11 million acres of white pines. The balsam woolly aphid hangs like a threatening dark cloud over our extensive stands of fir. Bark beetles destroy about 5.5 billion board feet of pine, fir, and spruce timber annually; they are our worst insect pest. We spray about one million acres a year to control various defoliators, which have the power to lay waste entire drainages of susceptible forests.

Dwarf mistletoe, another serious disease, is generally prevalent in our western and northern coniferous forests. We attempt to control it primarily during timber harvest or in timber stand improvement work. We practice some direct control by cutting out heavily infected trees and removing infected branches from lightly infected trees.

Over the past five-year period, average annual Federal expenditures for forest insect and disease control have been $8.2 million and non-Federal expenditures are estimated at $1.3 million annually. During this same period, nearly 500 million acres of commercial forest lands have been surveyed annually to detect insect outbreaks and disease infections. Annually, 1.4 million infested trees and stumps have been treated to control bark beetles; 700,000 acres have been aerially treated for control of defoliating insects; and 291,000 acres have been treated to control diseases.

Combatting Forest Pests

The steps for controlling forest pests are prevention, detection, evaluation, suppression, and eradication. Each is important and all are closely interwoven.

Prevention. Prevention is the first line of defense against damaging diseases and insects. The objective is to incorporate into the management of the National Forests those practices we know to be effective in minimizing pest damage, and to urge other forest landowners to do likewise. Where possible, diseased or insect-infested stands are harvested. Also, high-risk trees and high-hazard stands likely to be attacked are harvested. But some susceptible stands are not now accessible. Some are without current market value. Others are set aside for recreation or single-use where timber cutting is prohibited or limited. And, of course, many pest problems cannot be solved by timber harvest or cultural measures. When preventive measures are inadequate or cannot be used, direct action against a destructive pest must be taken. First however, a troublesome pest must be detected and identified.

Detection. Prompt and thorough detection is the key to quick and effective action in dealing with pests. We now inspect all forest lands in the United States for evidence of abnormal pest activity. We do this in two ways: (1) by utilizing the observations of the foresters in the woods, and (2) by planned and systematic inspections of forest lands from the air or on the ground by trained pest control officers. Not all abnormal disease or insect activity in the forest requires control action. Many diseases and insects are harmless. Some are beneficial, and even the potentially harmful ones often subside without causing serious economic damage. The significance of each pest situation must be evaluated to determine whether control should be undertaken.

Evaluation. There are two steps to our evaluations. The first is an assessment of the biological factors to determine possible losses with and without control, the measures available for control, and their costs. The second is an estimate of the resources threatened, to estimate the cost-benefit relationships to be expected from control. This second step is taken only after the biological assessment indicates that a pest will persist and seriously damage the forest. This analysis shows the impact of the pest upon each forest value—timber, wildlife, recreation, water, forage, scenery—and upon the forest environment as a whole. The objective is to weigh all costs and losses to determine whether the control can be justified.

Suppression. When suppression is considered necessary, direct action must be taken against a pest. The aim here is to reduce its abundance to sufficiently low levels that natural controls can hold the pest at low endemic levels. There are several ways of doing this.

To the extent possible, parasites, predators, and pathogens are relied on to keep pests in check and, in a few cases, are used to suppress an epidemic. Unfortunately, biological controls often fail to prevent pests from becoming epidemic and only in rare instances have effective biological controls been developed to aid in checking an epidemic. Where other methods are not adequate, or where there are no other methods, pesticides are used.

Generally, pesticides have been used more widely against defoliating insects. Such defoliators as the spruce budworm, the loopers, tussock moths, and sawflies are effectively and economically controlled by aerial sprays with modern insecticides. Unfortunately, some of the most effective insecticides are those which, because of their persistence, also have the most impact on fish and game animals. For example, one pound of DDT per acre has reduced the population of spruce budworm by as much as 99 percent. This intensity of control usually puts an end to an epidemic. But DDT is long-lived and it accumulates in the fatty tissue of animals, with unknown consequences. The short-lived malathion reduced the budworm population by 85 percent when sprayed at the rate of 3/4 pound per acre. It was estimated, however, that control would be effective for only 2–3 years.

Eradication. On occasion, a forest pest must be eradicated. Usually we are concerned with native diseases or insects, or firmly established foreign pests, and we make no effort to do more than suppress them to harmless levels. Eradication of the last disease spore or insect specimen is considered highly desirable in situations where an introduced pest is still confined to a small area, and still in its incipient stages of development.

Prompt detection of incipient infestations of newly-invading pests, and rigid Federal and State quarantines to prevent spread while eradication programs are underway, are prerequisites for the success of eradication.

Guidelines in Conducting Forest Pest Control

Before suppression against a pest outbreak is undertaken, we make certain that control action is essential and will be effectively applied with minimal disruption to people, wildlife, and the forest community in general. We determine that

1. The pest in question poses a serious threat to important forest values.

2. Effective measures are available for direct or indirect control.

3. The cost-benefit relationship is favorable.

4. Effective safeguards will be used.

5. Control measures will be thorough and complete.

6. The public is adequately informed.

In conclusion, the rate at which losses from destructive forest diseases and insects in the United States will be reduced in the coming years will depend upon these factors: (1) progress in research; (2) extent to which old-growth timber is harvested; (3) new developments in utilizing pest-infested and infected material; (4) rate of conversion of the wild forest to managed forests; and (5) the success in coordinating cooperative controls among Federal, State, and private forest landowners. Of these five actions, the most important is rate of progress in research. Control can advance only as fast as research provides the means for control to move forward.

Wildlife and Chemical Pesticides

Lansing A. Parker

Associate Director, Bureau of Sport Fisheries and Wildlife, Fish and Wildlife Service, Department of the Interior

In my opinion, very few subjects have stirred up such long and, at times, acrimonious discussions as the problem of pesticide-wildlife relations. Those who favor chemical control have centered much of their fire on Rachel Carson's presentation on the subject in her book, "Silent Spring." The anti-chemical group points to reports of fish kills in the Mississippi River and elsewhere with an "I told you so."

Usually the debates discuss pesticides in general without a scientific basis for the extrapolations offered either *pro* or *con*. A vast amount of research must be conducted before we will have the hard facts from which to make final judgments. In the meantime, we must recognize that problems can and do result from the application of large-scale chemical control measures.

Most of the early organic pesticides were broad spectrum, nonselective, persistent chemicals. DDT, the great-grandfather of the clan, has been used for only about 20 years in agricultural and forest insect control. The background of early tests to determine the effects of DDT serves as a splendid example of cooperation between research entomologists and wildlife biologists. Their joint efforts resulted in setting maximum levels that were considered safe for fish and wildlife. The only hitch, unforeseen at the time, was the long life of DDT in the environment; the half-life is roughly 10 years. That characteristic, together with its tendency to concentrate in the food chain and thereby cause sublethal chronic effects on fish and wildlife such as lowered reproduction, reduced numbers of normal offspring, and sudden death of the organism under stress, has caused the biologists to reassess this commonly used insecticide (6).

Unfortunately, many of the earlier disagreements on the subject were concerned with how much, if any, fish and wildlife were immediately destroyed following a spray operation. There have been sufficient surveys documented which have proved losses, even drastic at times (3, 4, 8, 9, 10). Much of the difficulty results from the fact that too often the subject is discussed in the broad context of all pesticidal chemicals without consideration of their individual characteristics. Then the attempted conclusions are stated in terms of "black or white," while actually they are more likely to be "some shade of gray."

Much debate centers around relative values of the wild animal resources versus the need to control some agricultural pest or potential health hazard. What are some of the fish and wildlife values that should be weighed?

Let's consider some of the dollar values of the fish and wildlife resources. In 1960 a national economic survey of hunting and fishing revealed that 50 million of the then 130 million people over 12 years of age in the United States went fishing, hunting, or both that year (5). Of each five persons, approximately two participated in these sports. How many more people were out-of-doors, motivated wholly or in part by interest in these resources, is not known. Bird watching, nature study, and photography no doubt attract many more millions. The survey also indicated over 650 million recreation days and expenditures of \$3.9 billion annually for hunting and fishing. In many states tourism ranks among the top three or four dollar businesses. Much of the tourist industry's foundation rests on the fish and wildlife resources,

Also, we must take into account the commercial value of fish and shellfish, for these resources are in potentially grave danger, especially those species that use the large rivers and estuaries. In practice, too many rivers are sewers that deliver many kinds of chemical runoff to the oceans.

Estuaries and coastal waters are of great importance to salt water fish and shellfish. They serve as the production areas for many species and as the permanent habitat of such important commercial resources as clams, oysters, and crabs. Menhaden and shrimp, which are the two most valuable commercial species, spend a large part of their life cycle in the estuaries. These two species, plus the oysters and clams, account for about 50 percent of the total United States fishery landings and for about one-third of the value.

At one time or another most of us have probably read of the prodigious numbers of insects and weed seeds consumed by birds. In a sense birds probably are the chief insect control in an undisturbed environment. Even in the monotype habitat of modern agriculture they serve as important biological checks against nuisance insects and weeds.

Another set of values, although impossible to evaluate economically, is recognized by most people: the aesthetic worth of these resources. What is the dollar value of one whooping crane? Judging by the news interest of the 42 wild remnants of this species, many million people must derive satisfaction in just knowing they still exist and in learning of the birds' welfare.

Then, too, we have just begun to understand the significance of each component part of an ectosystem. The violence of suddenly removing a segment of the life of a community has hardly been appraised. Actually, fish and wildlife may serve as the "miner's canary" for interpreting the effects of chemical pesticides on man. The President's Science Advisory Committee in its report on "Use of Pesticides" (14) noted: "The study of wildlife presents a unique opportunity to discover the effects on the food chain of which each animal is a part, and to determine possible pathways through which accumulated and, in some cases, magnified pesticide residues can find their way directly or indirectly to wildlife and to man."

But the arguments advanced thus far beg the question of relative values of a resource belonging to all of the people compared to potential economic loss to the individual or to a public health hazard, or to the destruction of sizable areas of forests which, in themselves, are essential to many forms of fish and wildlife. Obviously each pest situation must be appraised individually.

Frequently the question is raised concerning how many or what part of a fish or wildlife population can be sacrificed in order to protect other values. Some people say "none," which is easy for one who has no responsibility for the results. I would not view with great alarm the sometimes drastic immediate losses of fish, birds, or mammals if I could be sure that these were the total impact. Obviously there are instances every year where because of storms, droughts, or other natural calamities, segments of fish and wildlife are wiped out or annual production fails. Most organisms have the ability to bounce back when favorable conditions return.

The immediate losses due to chemical control programs are often indicators of something more insidious and serious. This is particularly true with several of the persistent chlorinated hydrocarbon insecticides. Many of the misunderstandings have developed about this point. The foresters point to insect control programs which require chemical treatment once every 3 to 5 years. The most commonly used material is DDT which, as already stated persists in the environment for long periods. Theoretically, that habitat is never completely free of DDT under those circumstances. Then consider some of the agricultural croplands where as many as 3 to 8 applications of one or more pounds per acre of persistent chemicals are applied each year. It is not unusual for large quantities to accumulate in the soil as the years pass. A recent survey revealed accumulations from 1.5 to 176 pounds per acre in heavily treated areas, most of it in the top few inches of soil. Investigators have reported that DDT is the most persistent of these followed, in order of decreasing persistency, by toxaphene, lindane, chlordane, heptachlor, dieldrin, and aldrin (7).

The chlorinated hydrocarbons also are the most toxic to salt water fish and shellfish. Aldrin, dieldrin, and endrin cause the most severe reactions. Shrimp, a close relative of the insects, can be killed by concentrations as low as 0.6 parts per *billion* within 24 hours. Mullet die at 2.6 parts per *billion.* Growth of oysters is retarded at 25 parts ber *billion.* (To illustrate what small amounts these are, someone has defined 1 part per billion as equivalent to 1 ounce of vermouth in 1,000 tank cars of gin.) Also, there is the indirect effect on the metabolism of phytoplankton, the base of the food chain of the oceans.

Another aspect that evades recognition is the characteristic of drift during applications, particularly from aerial spraying. Available figures indicate that only a small fraction of the land area is treated with the bulk of the chemicals that are used (11). This leads to the assumption that the rest of the country goes "scot-free." Studies have shown that some of these chemicals drift widely and probably occur over the entire country. Even under carefully controlled spraying conditions, a test with radioactive DDT showed that only one-fourth landed on the intended target area (13).

Scientists of the Bureau of Sport Fisheries and Wildlife have recovered DDT and its degradation products from water, soils, eggs, and ducklings taken in the Northwest Territory of Canada, hundreds of miles from any known application. Traces were even recovered from air samples collected in the Far North. Except for isolated instances, no one knows the magnitude of the present pesticide load or whether it is increasing or decreasing. However, the extent of contamination of fish and wildlife can be judged by the fact that approximately three-fourths of the specimens analyzed at our laboratories in recent years contained detectable amounts of pesticides.

There are other characteristics of this new element of the environment. Specimens of fish and wildlife have been analyzed which contained residue levels well above those considered lethal under laboratory tests. Presumably by ingesting only sublethal amounts for long periods, they were able to store the chemicals in their body fat. During periods of stress, as the fat is rapidly converted, they may succumb. But what of their ability to produce normal offspring? Laboratory experiments have shown that certain sublethal dosages result in fewer eggs and few surviving young. It has been well established that some of the pesticides are transmitted from the hen to the egg.

In this connection, ornithologists the world over are much concerned by the decline of all of the raptors. Strong circumstantial evidence points to pesticides as the probable cause of low hatchability of the eggs of osprey (1) and the bald eagle of the East Coast.

Another cause for concern is biological magnification in the food chain. Earthworms feeding on material contaminated with DDT as a result of spraying against Dutch elm disease in Michigan were able to concentrate the chemical in their bodies. Subsequently the demise of birds was caused by the combined load of many earthworms they fed upon. Brain tissue of robins contained as much as 120 p.p.m. (2). A very clear example (12) is the DDD spraying for gnat control that passed from the plankton to the fishes to the fish-eating birds, with disastrous consequences to the latter.

The problems of migratory birds that twice annually encounter the results of several pesticide control programs along their migration routes are obvious, and could very well account for the decline of some of the formerly common species, including the eastern bluebird, house wren, and purple martin. But an additional hazard has been detected, that is, the synergistic effects of some of these compounds when they are applied together. Laboratory tests have shown that DDT combined with 2, 4–D had a much more lethal effect on mallard ducks than when each compound was fed separately.

What are the solutions or alternatives to resolve the problem?

Generally it is accepted that pesticidal chemicals are essential to the modern production of food and fiber and to public health. It is a matter of taking into account all facets of interest in seeking a solution. Then, as is so frequently the case, a final hard decision must be made.

Some members of the chemical industry offer a simple, direct solution. They suggest a definition of what constitutes wildlife habitat. They would not urge spraying lakes, streams, marshes, and woodlands, which they class as wildlife habitat. They propose that environments such as cultivated lands, pastures, haylands, suburbs, and arteries of transportation should be considered as "man habitat" where wildlife does not belong and is not welcome. While this may offer a direct solution to the problem, ecologists cannot endorse this idea and even the agricultural pesticide users generally would not agree with it. Most farmers welcome the presence of the robin, the cottontail rabbit, a covey of bobwhite quail, and other wildlife. Obviously the hunting fraternity would oppose such a classification, for about three-fourths of the game is produced on farmland.

Biological control has been urged as the answer. The entomologists have done remarkable work in the control and, in some cases, the eradication of some serious insect pests. All will agree that the principle holds considerable additional promise, but much research remains to be done and, in many situations, this approach is not likely to be the answer.

Thus, most fish and wildlife scientists recognize chemical control as the best answer to the majority of man's pest problems, particularly because the environment has been so altered that planned monotypes of agricultural crops and forests often do and will prevail. We also believe that better safeguards are needed to protect the fish and wildlife resources and to minimize the effects of chemical control programs on them. A number of steps have been taken during the past few years to accomplish this. They include both administrative and legislative action.

Within the Federal government there is general recognition of the problems and the need for cooperative efforts to solve them. By administrative action, the Secretaries of Agriculture, Defense, Interior, and Health, Education, and Welfare signed an agreement which reconstituted the Federal Pest Control Review Board into the Federal Committee on Pest Control. The Committee's functions have been broadened to include not only its earlier task of reviewing operational control programs of the Federal Government, but also review and coordination of the research, monitoring, and public information programs dealing with this subject.

By agreement between the Secretaries of Agriculture, Interior, and Health, Education, and Welfare, a system of review of the applications for registration of pesticides has been initiated. The final decisions remain those of the Department of Agriculture, but the other two Departments study the background data supporting the registration application and recommend actions to protect the resources for which they are responsible.

Insofar as the Department of the Interior's chemical control programs are concerned, Secretary Udall has issued a clear directive. It provides that all bureaus must have their programs reviewed by a team composed of representatives from the Geological Survey, the Bureau of Commercial Fisheries, and the Bureau of Sport Fisheries and Wildlife prior to submission to the Federal Committee on Pest Control. The Secretary of the Interior wants this Department to serve as a model in carrying out its programs to control noxious weeds, insects, and other pests.

Cooperative efforts with the chemical industry have resulted in the preparation of a guide for testing new compounds on representative species of fish and wildlife. This will enable the manufacturers and formulators to conduct fish and wildlife screening tests prior to presenting their applications for registration. The results of these tests should give good indications of the effects of their chemicals on fish, shellfish, and wildlife.

The Bureau of Sport Fisheries and Wildlife is cooperating with the Forest Service's insecticide laboratory at Berkeley, California, to assist in the appraisal of potential pesticides for the control of forest insects by testing them on representative forms in the laboratory and by surveillance of field tests.

The heated debates of the past, plus the large die-off of fishes in the Lower Mississippi, have caused Congress to look at the problem too. Committees in both the Senate and the House have held extensive hearings. Some revisions in the laws governing registration of chemicals have been enacted by Congress in recent sessions.

Within the past few years many of the states and Canadian provinces have, by executive direction or legislative act, established state boards or committees which have responsibilities to regulate or control the use of pesticides within their borders. Fish and wildlife representatives usually are members of these boards or serve on technical advisory committees.

In spite of the actions of all governments, the final determination will be that of the users, who have the responsibility of using these tools wisely.

As shown above, the persistent chemicals are of most concern because of their relatively long life and subsequent accumulation if applied frequently. The others, while rapidly degrading, do have some serious consequences. Therefore, all applications of pesticides should be at the minimum rates to control the target organism. The most selective chemical should be used. If the time of the year is of no great consequence, treatments should be avoided during periods of bird migrations and time of nestlings. Large blocks of land should not be sprayed at one time. Direct spraying of lakes, streams, or other waters should be avoided. Thought should go into the planning of a control program to recognize and prevent adverse side effects. Biologists of Federal and state fish and wildlife agencies are available for consultation concerning locations of important fish and wildlife habitats.

In other words, it is not a proposition of "either or," but rather one of moderation so that control can be achieved with minimum damage to fish and wildlife values.

References

(1) Ames, Peter L., and Mersereau, G. S. Some factors in the decline of the osprey in Connecticut. Auk *81* (2), 173-185 (1964).

(2) Bernard, Richard F. Studies on the effects of DDT on birds. Publications of the Museum, Michigan State University, Biological Series *2* (3), 155-192 (1963).

(3) Burdick, G. D., Harris, E. J., Dean, H. J., Walker, T. M., Skea, J., and Colby, D. The accumulation of DDT in lake trout and the effects on reproduction. Trans. Am. Fish Soc. *93* (2), 127-136 (1964).

(4) Bureau of Sport Fisheries and Wildlife. Pesticide-Wildlife Review, 1959, Bur. of Sport Fish. and Wildl. Cir. 84, 1960, 36 pp.

(5) Bureau of Sport Fisheries and Wildlife. 1960 National Survey of Fishing and Hunting. Bur. of Sport Fish. and Wildl. Cir. 120, 1961, 73 pp.

(6) Dewitt, James B. Chronic toxicity to quail

and pheasants of some chlorinated insecticides. J. Agr. Food Chem. *4*, 863-866 (1956).
(7) Edwards, C. A. Persistence of insecticides in the soil. New Scientist *19*, 351 (August 1963).
(8) Fish and Wildlife Service. Effects of pesticides on fish and wildlife, 1960. U. S. Fish and Wildl. Ser. Cir. 143, 1962, 52 pp.
(9) Fish and Wildlife Service. Pesticide-Wildlife Studies, 1961 and 1962. U.S. Fish and Wildl. Ser. Cir. 167, 1963, 109 pp.
(10) Fish and Wildlife Service. Pesticide-Wildlife Studies, 1963. U.S. Fish and Wildl. Ser. Cir. 199, 1964, 130 pp.
(11) Hall, D. G. Use of insecticides in the United States. Entomol. Soc. Am. release, May 20, 1962, pp. 5-11.
(12) Hunt, E. G., and Biscoff, A. I. Inimical effects on wildlife of periodic DDD applications to Clear Lake. Calif. Fish and Game *46*, 91-106 (1960).
(13) Peterle, Tony J., and Giles, Robert H., Jr. New tracer techniques for evaluating the effects of an insecticide on the ecology of a forest fauna. RF Project 1207, Report 3, The Ohio State University, 1964.
(14) President's Science Advisory Committee. Use of Pesticides. The White House Report, 1963, 22 pp.

Forest Insect Control By Biological Methods

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Concern with some of the undesirable aspects of controlling insect pests by chemical means has focused interest on other methods of insect control. Biological control is one of the most popular of these other methods. Not only is it safe, but it has shown spectacular success in some cases. The term "biological control" is sometimes used very broadly to cover all methods of encouraging the action of biotic factors, but in this paper it refers specifically to the use of parasites, pathogens, and predators. These biological control factors are active at all times, to some degree, among the populations of native forest insect pests. Without them and other natural controls, the forests we know today probably would not exist.

The basis of biological control depends on the existence of a natural enemy or complex of enemies that are more or less host specific; that have good searching capacity, adequate rates of increase, and dispersal; that react to environmental conditions favoring the host; and whose effectiveness increases with host density, with little or no time lag. With these attributes, the introduced natural enemy by itself or in conjunction with other mortality factors is expected to prevent outbreaks of the pest species, or at least to hold down major population fluctuations (Prebble, 1960).

The objective, then, in biological control of forest insects is to manipulate predators, parasites, and diseases so that they will exert an even greater influence in keeping pest insects below economic damage levels. The goal is prevention, rather than direct control of outbreaks. When populations of a pest species become epidemic and damage is severe and widespread, it is usually necessary to resort to more direct methods such as chemical control. Biological control methods have not advanced to the stage where they can be used as rapid and direct measures for suppression of epidemics. One possible exception is the aerial application of a disease organism to control an outbreak of a forest pest such as a defoliator.

Although many are enthusiastic about the possibilities of biological control of insect pests, others do not share this enthusiasm. For example, Taylor (1955) believes that the prospective use of the method on a continental basis is not encouraging. Also, Milne (1957) is not convinced that the available evidence supports belief that an enemy species by itself, or indeed, several kinds of enemies acting in concert, can control a pest species at an economic or any other stated level; and Elton (1958) notes that proof that parasites and predators have done the job without assistance from unknown causes or events is usually inadequate or totally lacking.

Regardless of opposing views, we should not overlook the fact that the forest offers special opportunity for biological control. For example, certain characteristics of the forest environment, a high degree of tolerance of some kinds of trees, and a willingness to accept something less than eradication or 100 percent control increase the possibilities of biological control of some forest insects. The forest is ecologically diverse in flora and fauna and occupies varied topographic sites. It is free from annual upheavals in the form of cultivating and cropping practices, and the long time required to grow a timber crop provides security for continuous prolonged efforts. Its tolerance of repeated defoliation provides sound biological grounds for withholding chemical control in many instances. This tolerance of moderate injury also provides a basis for less exacting standards in biological control than would be acceptable to producers of many annual crops (Prebble, 1960).

In short, biological control of many forest insects might well be judged successful, if through the use of counterpests the intensity or duration of outbreaks is reduced to less than tree-killing proportions.

In the past, most efforts toward biological control in North America have been aimed at the introduction and colonization of parasites and predators of introduced pests. Control has been attempted against some 15 or 16 important introduced forest and shade tree pests. Worthwhile results are judged to have been produced against 10 of them. Only a few of these more successful introductions are discussed here.

The larch casebearer has been successfully held in check in the East and Lake States by the introduction of its native European parasites. Attempts are now being made to colonize one of the more important of these in the western United States, where the casebearer has recently become established.

The European spruce sawfly in Canada and northeastern United States is being effectively controlled during low populations by introduced parasites. At higher populations, an introduced virus disease takes over and becomes equally effective. Together, these biological controls have prevented epidemics of this once very destructive pest of spruce.

The European pine sawfly in both Canada and the United States is being controlled in infested plantations largely by the aerial application of a host-specific virus. This disease organism has been quite persistent in some areas where it was applied only once.

Biological control of native forest insects has received relatively little attention in the past because it has been reasoned that indigenous pests already have their full complement of native enemies that are exerting their influence against their respective host species. It has also been reasoned that the introduction of foreign parasites and predators into an ecosystem where they would be in competition with native species would be ecologically unsound. In addition, there has been a general feeling in the past that little could be done to increase the effectiveness of parasites, predators, and diseases against native pests. Under favorable conditions, they would be reasonably effective, and under adverse conditions, efforts to increase their effectiveness were likely to be futile.

Fortunately, this generally negative attitude toward the natural biotic control agents is now less widely accepted than formerly. Today many able scientists are confident that research can provide the knowledge that will enable us to make more effective use of parasites, predators, and diseases in preventing outbreaks of native forest insect pests. This is reflected in the forest insect research program of the Forest Service.

Observations of outbreaks of many native forest pests have often revealed sudden drastic population reductions that have effectively terminated the outbreak. Sometimes it has not been possible to explain these population declines, but at other times the evidence has pointed strongly to parasites, predators, or disease as the primary controlling factor. For example, a recent sudden termination of the elm spanworm epidemic in the Southeast was attributed to the effects of an egg parasite. Also the pine tortoise scale in the Lake States and the East is often controlled by predaceous ladybird beetles and parasites.

Nematodes were largely responsible for bringing to an end a recent fir engraver beetle outbreak in New Mexico, and mites and parasites played a major role in stopping an outbreak of the southern pine beetle in Texas. Native viruses and bacterial diseases have also terminated outbreaks of some defoliators, such as the Douglas-fir tussock moth, the pandora moth, the gypsy moth, and certain sawflies. These are only a few examples of biological control in action.

Although we recognize the importance of biological control factors as well as something of their impact on pest populations under natural conditions, we have not progressed very far in our ability to manipulate them to our advantage. We can, of course, transport parasites and predators into areas where they do not occur naturally, but we cannot force them to do the job we have in mind. Neither can we mass-produce them in numbers great enough to overwhelm an outbreak. A few pathogens, principally viruses and bacteria, have been identified and reproduced as aerial sprays for control of a small number of defoliating insects. Since these are for the most part highly specific, *i.e.*, effective against a single species, and since they are living organisms dependent for their survival, multiplication, and spread on a restrictive range of climatic and biological conditions, literally hundreds of different pathogens are required to replace a single broad-spectrum insecticide. Their identification, isolation, mode of action, culture, and formulation for field use offer both challenges and opportunities for insect pathologists.

In view of all these problems, it appears quite unlikely that biological methods will, in the near future, play a major role in the direct control of forest insect outbreaks. This is not to imply that research will not find ways and means to use parasites, pathogens, and predators more effectively against forest insects. This, however, will require greatly increased research effort. It is encouraging to note that the country-wide trend is already toward more research on biological control as well as toward more basic research.

However, there is little likelihood that we can suppress insect epidemics quickly by direct application of biological methods. Eventually, enough can be learned about the manipulation of biological control factors that they can be made to exert a stronger influence toward prevention of outbreaks. It seems reasonable to expect that one day it may be possible to dampen the effects of outbreaks, to lengthen the time between epidemic peaks, and even to decrease the magnitude of those peaks through the application of biological control methods.

Biological control alone probably will not give our forests the full protection needed. It should be used with silvicultural and chemical control, all of which need much more research aimed at their integrated use.

References

Elton, C. S. The ecology of invasions by animals and plants. John Wiley & Sons, Inc., New York, 1958.

Taylor, T. H. C. Biological control of insects. Ann. Appl. Biol. *42* (1955).

Milne, A. Theories of natural control of insect populations. Cold Spring Harbor Symposium on Quantitative Biology *22* (1957).

Prebble, M. L. Biological control in forest entomology. Bull. Entomol. Soc. Am. (March 1960).

Biological Control Of Forest Tree Diseases

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America's forests are one of her greatest renewable natural resources. Unlike mineral resources, forests can be utilized, and then, under good management and with adequate protection, they can be regenerated again and again on the same site. During this cycle, they provide lumber and other products, protect the soil from erosion, contribute to water conservation, offer food and cover for wild and domestic animals, and are an important element in human enjoyment of outdoor recreational activities. Maximum use of forests for the greatest public benefit requires constant vigilance to reduce preventable losses from destructive agencies, of which diseases are currently highest on the list.

The several hundred species of trees comprising American forests are vulnerable to the attack of innumerable diseases. Some are caused by pathogens such as fungi, bacteria, nematodes, viruses, and parasitic flowering plants; others by unfavorable environmental influences such as moisture and temperature extremes, nutritional imbalances, and noxious fumes in the atmosphere. Reduction of disease losses is sought through many and diverse measures: (1) quarantines to exclude dangerous foreign pathogens from this continent, (2) special fungicidal, sanitation, or eradication applications to reduce inoculum or to prevent infection, (3) selection and breeding for genetic host resistance, (4) timely application of beneficial silvicultural practices, and (5) stimulation of biotic factors in the forest environment that prevent infection, retard disease spread and intensification, or increase tree vigor.

Quarantines are the first line of defense. Plants and plant parts capable of introducing known potentially damaging forest pathogens are excluded, and incoming shipments of other plant materials are carefully inspected to insure freedom from disease. Quarantine efficiency is steadily improving through research on all continents to identify and characterize forest pathogens and to keep inspection techniques up to date through a continuing training program.

Special direct disease control measures are seldom employed unless all other methods of reducing losses to a tolerable level have failed. Examples of such measures now in practice are fungicidal seedling sprays and soil fumigation in forest nurseries, destruction of currants and gooseberries (the alternative hosts) to protect white pines from blister rust infections and antibiotic applications to cure those already infected, chemical stump treatments to prevent the establishment of root rot infections in forest soils, and sanitation pruning of western conifers to remove dwarf mistletoe infections.

The development of genetically resistant stock for planting in areas of high disease hazard is one of the most promising approaches to permanent reduction of losses from specific diseases. Outstanding progress has been made in producing white pines resistant to the introduced blister rust fungus, elms resistant to the phloem necrosis virus and the Dutch elm disease, shortleaf pines resistant to the littleleaf disease, longleaf pines resistant to brown spot needle blight, and southern pines resistant to fusiform rust.

Biological control of forest diseases, the major theme of this paper, may be defined in two ways. In the broad sense it includes all biotic measures that favor tree growth and health or are unfavorable to pathogens; in a much more restricted sense, it includes only the action of parasitic or predaceous organisms on the pathogens that cause forest diseases. Each of these concepts will be examined separately, beginning with the application of beneficial silvicultural practices.

Many forest pathogens, including most of those native to this continent, depend upon reduced tree vigor or upon injuries to provide an opportunity for successful attack. Losses from all such diseases may be reduced by applying measures to maintain or increase tree vigor or to prevent injuries. In essence, this amounts to growing the right tree on the right site, providing it with adequate growing room, and protecting it from natural and man-made injuries. Practice of this kind of forest management involves consideration of site selection, species mixtures, stocking, rotation age, stand regeneration, cultural treatments, and prevention of wounds that serve as infection courts for pathogens.

Trees growing on good sites for the species are more vigorous and in general are less susceptible to disease attacks than those on poor sites, indicating the need for better appreciation of the site requirements of important species. For example, research has shown that the littleleaf disease of shortleaf pine occurs only on heavy soils with poor internal drainage, a situation favorable to the causal fungus. This disease may be controlled by converting to other species on high hazard sites, particularly to hardwoods that are known for their soil building capacity.

In most instances, trees growing in mixtures are more vigorous than those in pure stands, indicating the need for more information on the effects of stand composition on disease incidence. A good rule of thumb is to follow nature. If a tree species occurs naturally in mixture with other species, the same mixtures should be encouraged under management. If it occurs naturally in pure stands (*i.e.*, Douglas fir), it may be assumed that disease hazards are not emphasized by stand purity alone.

Trees growing under ideal stocking according to age and size are more vigorous than those in over-dense or wide open stands, indicating the need for research on the relationships between spacing and disease attacks. For example, Hypoxylon canker of aspen is more abundant in open stands and on exposed trees at the edges of stands than in the interior of closed stands. Proper spacing affords some biological control of this disease.

Trees from sapling to physiological maturity are more vigorous than those that are overmature, indicating the need for recognition of the age at which different species reach maturity. In all species that have been studied, the incidence of heart rot is directly related to age. The rotation age should not exceed that age at which heart rot losses become excessive.

Naturally regenerated stands are usually more thrifty than planted ones, presumably for two reasons: they are better suited to the sites and root formation, and distribution in the soil is not adversely affected by planting techniques. If planting must be resorted to, great care should be exercised to assure that the species and the provenance of seed are appropriate for the site. Incidentally, native species are almost universally more vigorous than exotics, indicating the need for caution in establishing tree species in areas or on sites where they do not occur naturally. For example, Scots pine plantations in North America have seldom reached maturity without excessive pest attacks, often resulting in complete loss. Even more striking is the fact that Tympanis canker of red pine occurs almost entirely in plantations south of the natural range of the species; it has never been observed in naturally regenerated stands and is of no consequence in plantations in areas where red pine occurs naturally.

Cultural treatments such as thinning to optimium spacing, pruning lower or diseased branches, reducing sprout clump, harvesting without site degradation, or even correcting nutritional imbalances by artificial fertilization can be carried out so as to reduce disease incidence or to prevent new infections. All cultural measures should be considered in relation to disease occurrence and should be properly timed for maximum utility in disease suppression. For example, dwarf mistletoe in western conifers can be controlled by sanitation to remove infected trees or parts of trees, thereby preventing infection of understory reproduction, which is the nucleus of the next generation. In all cultural operations, diseased trees should be removed to leave the residual stand in the best possible condition.

Uninjured trees are more vigorous than those that have had to undergo or withstand any deteriorating or injurious influence. Fire and logging scars are the most frequent kinds of wounds that provide entry for heart rot fungi and other pathogens. Fire prevention and careful logging to avoid injuries to residual trees are effective means of reducing disease losses.

It is obvious that many biological factors contribute to disease incidence in forest trees; it is equally obvious that through the use of good management practices they can be made more or less innocuous. Many diseases have erupted to epidemic proportions not because the pathogen has suddenly become more virulent, but rather because forest management, or mismanagement, has created an environment favorable to the pathogen. The real challenged, therefore, is to determine how to reverse this trend: how to establish a balance between trees and pathogens that will prevent catastrophic disease epidemics.

The possibility of preventing or controlling forest diseases through the action of organisms parasitic to or predaceous on pathogens has a strong appeal to the imagination but little basis in fact. There are many examples of fungi parasitic on forest pathogens and a few examples of insect predators, but there are no known instances of the reduction of a forest disease outbreak to tolerable levels through the action of such organisms. Conversely, there is ample evidence that parasites and predators of forest pathogens really thrive only when and after the pathogen is widespread and damaging. Under such circumstances they undoubtedly do reduce inoculum production but not sufficiently to suppress the epidemic. Most important of all, however, they failed to prevent the epidemic in the first place.

A few case histories illustrate the situation. There are several native fungi parasitic on the stem rusts of American conifers, of which the most widely distributed is the purple mold, *Tuberculina maxima.* When the white pine blister rust fungus was introduced into this continent about 60 years ago, this mold found it a more congenial host than any of our native rusts. In spite of this, it has been incapable of preventing the spread and intensification of blister rust throughout the range of the white pine species in the United States and Canada. Currently, there is evidence that it may be reducing damage from the rust on western white pine in the northern Rocky Mountain region but it most certainly has not controlled the disease there or elsewhere.

American beech in eastern Canada and northeastern United States has been severely damaged during the past 35 years by successive attacks of an introduced scale insect and a native but secondary fungus. After the pathogen is well established in the bark of trees previously infested by the insect, it in turn is commonly parasitized by a brown mold, *Gonatorhodiella highlei,* which eventually kills the pathogen, but not before it has spread to many more trees and, in most cases, has killed the tree on which it was established.

Dwarf mistletoes are parasitic flowering plants that attack, deform, and kill many western and northern conifers. There are numerous fungi parasitic on the dwarf mistletoes and several insects that feed on them, but in no instance is such action early and common enough to prevent further spread of the parasites. Artificial attempts to increase their effectiveness have failed to date.

In the case of *Fomes annosus* root rot of pines, particularly common and damaging in eastern and southern United States, the outlook for biological control is more promising. The action, however, will be through antagonism rather than parasitism. The causal fungus is native and widespread but is incapable of causing severe losses of naturally regenerated pines on undisturbed forest soil. On the other hand, it spreads rapidly and causes catastrophic losses in pine plantations on land previously under agricultural cultivation. It is thought that the use of land for the production of agricultural crops changes the soil flora and fauna and thereby eliminates those organisms that exert an antibiotic influence on the pathogen in forest soils. Research is underway to determine what microorganisms have been eliminated from forest soils by agricultural practices (cultivation, rotation, nutrient depletion, soil erosion, etc.), which of them are antagonistic to the root pathogen, and how to reintroduce them to land reverting to forest production. It is hoped that this may be accomplished by inoculation of nursery soil in which seedlings are grown before outplanting, thereby providing each seedling with its full complement of protective organisms.

In conclusion, there are tremendous opportunities to improve forest disease control by applying biotic measures of all kinds that favor tree growth or are detrimental to the spread and intensification of pathogens. In most cases, these will not be special measures over and above what is required for maximum tree growth, but they must be applied consistently and at appropriate times in the life of the forest to be fully effective. Biological disease control must be practiced from stand regeneration to maturity and harvest, must be preventive rather than palliative, and must be based on sound ecological concepts of the forest as a community of plants rather than as simply a stand of trees.

Breeding Forest Trees For Pest Resistance

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Success in the development of pest resistant forest trees holds out promise that tree breeding may alleviate at least part of the pressures from disease organisms and insects. Forest tree breeding is a relatively new art. The first formalized research in this country took place only about 40 years ago. In the past 10 years, research in forest genetics has increased many-fold and breeding for pest resistance is a major objective in many programs.

Tree-Breeding Procedures

The development of improved forest trees is a difficult, often frustrating, and time-consuming undertaking. The selection of resistant trees requires extensive examination of forests to search for the rare tree which may carry the genetic tendency for resistance. Then only by controlled breeding and progeny testing can it be established that the resistance is in fact inherited, and that the healthy tree had not escaped attack.

The process of creating hybrids, in conifers, requires many trips up and down trees to protect the immature female strobili from stray pollen, to collect the desired pollen, to pollinate the female strobili, to remove the pollination bags, and finally to collect the cones (Cumming and Righter, 1948).

In the pines, in which most research is being conducted, this procedure lasts for about a year and a half. The female strobili mature during the period from February or March until May, depending on the latitude, altitude, and species, and are receptive for pollination for only a few days. Fertilization occurs after 12 to 14 months, in the year following pollination, and cones and seeds mature several months later.

Seeds are usually sown in the nursery in spring, and seedlings emerge in a few weeks. Seedlings can be tested for resistance to fungi or insects in one to several years under artificial or natural conditions, although it may take many years to test for some pests. Ten to twenty years or more must pass before a second generation can be produced in some species. But these difficulties have been overcome and pest-resistant trees have been developed.

Breeding for Disease Resistance

Many of the disastrous diseases of forest trees in the United States resulted from organisms brought in from other continents. Our native species had no opportunity to evolve to this new part of the environment by natural selection. Thus the organisms causing white pine blister rust, chestnut blight, and Dutch elm disease found highly susceptible hosts here. Other native diseases, endemic normally, flair up under changed environmental conditions of intensive management for wood production or when a favored host is moved out of its natural range.

Forest geneticists are developing resistant trees by two procedures. Selecting the rare individual which, through some genetic change, is resistant to the disease organism has been most productive. Producing interspecific hybrids between the susceptible native species and immune or resistant exotic or native species has also shown promise.

Western white pine (*Pinus monticola*) is extremely susceptible to the organism causing white pine blister rust (*Cronartium ribicola*). In the millions of acres of infected trees in Idaho, a few hundred scattered trees were found in epidemic areas which bore no disease cankers (Bingham, Squillace, and Duffield, 1953). Controlled breeding among these resistant candidates has shown that about one quarter of the selections are able to transmit their resistance to their offspring. Narrow-sense heritability was found to be high, and the genetic gain in survival was estimated to be about 20 percent per breeding generation (Bingham, 1960). The results of this research are so encouraging that seed orchards are being established to produce seed for trees with substantially greater resistance to the blister rust fungi. Similar research is underway for sugar pine *(P. lambertiana)* and eastern white pine *(P. strobus)*, the two other important native white pines.

Some exotic white pines are highly resistant to the blister rust fungus. They have been used in interspecific hybridization in an attempt to incorporate resistance factors in the hybrid. Himalayan white pine *(P. griffithii)*, has been crossed with eastern white pine and the progeny are more resistant than the American parental species (Callaham, 1962).

Even better prospects exist for developing trees resistant to a native rust, *Cronartium fusiforme*, which severely attacks two important southern pines—loblolly (*P. taeda*) and slash (*P. elliottii*). Rust-free trees have been located in heavily infected stands. Progeny of rust-free parents had markedly fewer infections under heavy artificial inoculation with the fungus than did progeny from infected parents (Jewell, 1961).

Also, the possibility exists for mass production of interspecific hybrids between these two susceptible pines and the resistant shortleaf pine (*P. echinata*). Shortleaf pine x loblolly pine hybrids showed no rust cankers after five years in an area of heavy infection on slash pine (Henry and Bercaw, 1956). In subsequent trials under forced inoculation, cankers did develop on both this hybrid and the hybrid between shortleaf and slash pines (Jewell, 1961). But infection was not nearly as severe as on the slash or loblolly pine seedlings.

Progress is being made in breeding forest trees which are resistant to *Endothia parasitica*, the causal agent of chestnut blight. This imported disease has practically destroyed the American chestnut (*Castanea dentata*). A few trees apparently have survived attack and may constitute the basis for developing a resistant strain (Anderson, 1960). Some hybrids between the American chestnut and the Japanese chestnut (*C. crenata*) and the Chinese

Figure 1. A forest geneticist squirts pollen over the female strobili, which are protected from stray pollen.

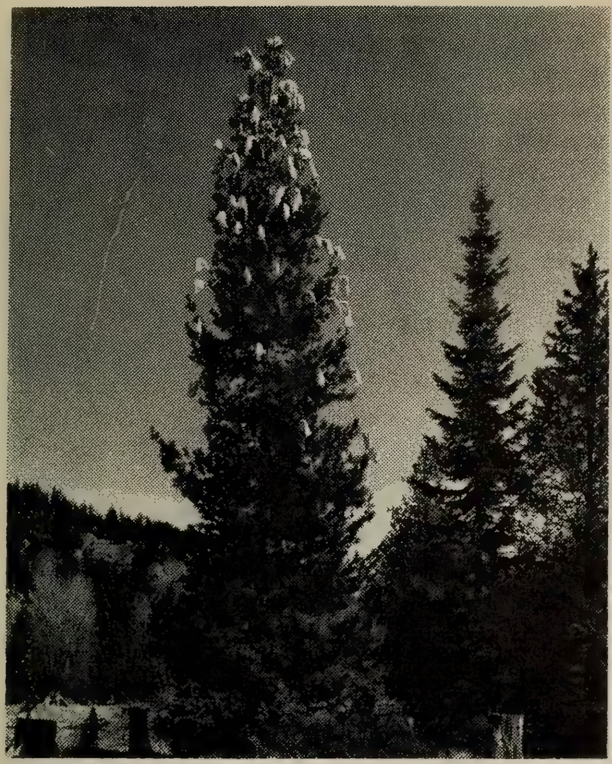

Figure 2. A western white pine tree which has been control-pollinated to produce blister-rust-resistant trees.

chestnut (*C. mollissima*), the most resistant species, are resistant to the fungus. However, most of these hybrids have relatively poor form for timber trees and need a better site than did the native chestnut (Gravatt et al., 1953).

Although the poplars are not particularly important now as timber trees in this country, they have great potential for rapid growth. They also are beset by many diseases. In Europe, poplar culture is often very intensive and breeding for disease resistance has long been a part of growing poplar. As a result, a number of clonal lines have been developed to resist many of the disease organisms (Schreiner, 1959). Poplars are easily propagated by cuttings and perpetuation of resistant strains is easy.

Less progress has been made in breeding other trees to withstand disease organisms. For example, little progress todate has been made in breeding against the organisms causing Dutch elm disease (*Ceratocistis ulmi*) or oak wilt (*Ceratocystis fagacearum*). Breeding against any of the multitude of heart rots, which cause damage in the billions of board feet annually, has not yet started. But these endeavors are not impossible even though success may be a long time off.

Breeding for Insect Resistance

Natural variation exists within many tree species with respect to susceptibility to insect attack. Immunity of some tree species to attack by a given insect also provides the basis for developing strains of hybrids resistant to insect pests. In the Northeastern and Lake States, eastern white pine is so severely damaged by the white pine weevil (*Pissodes strobi*) that profitable management of white pine is uncertain. This insect repeatedly attacks the terminal of saplings, causing trees of very poor form. Enough trees have resisted attack to justify a breeding program (Wright and Gabriel, 1959).

In California, plantations of ponderosa pine (*Pinus ponderosa*) and Jeffrey pine (*P. jeffreyi*) have suffered severely from killing by the pine reproduction weevil (*Cylindrocopturus eatonii*). Coulter pine (*P. coulteri*), native to California, is immune to the insect. Hybrids between Jeffrey pine and Coulter pine were attacked by the insect but not killed under conditions in which all Jeffrey pine trees were killed (Miller, 1950; Callaham, 1960). Planting results with these hybrids in California have been successful enough that the Forest Service has started a program to produce hybrid seed.

The valuable red pine (*P. resinosa*) of the Lake States is considered to be extremely susceptible to the European shoot moth (*Rhyacionia buoliana*). A closely related species, Austrian pine (*P. nigra* var *austriaca*) is the least susceptible (Holst, 1963). All attempts to hybridize red pine with other pines in its group (*Lariciones*) failed until recently. In 1962 the red pine x Austrian pine was created (Critchfield, 1962). One might expect that these hybrids will be intermediate between the parents in their susceptibility to the shoot moth.

In the South, loblolly and shortleaf pines are attacked by the Nantucket tip moth (*Rhyacionia frustrana*), but longleaf and slash pines are quite resistant species. Interspecific hybridization provides opportunities for improvement.

Recent research shows that we should be able to produce pines which are resistant to the very destructive bark beetles. The susceptibility of pines to bark beetles varies greatly among species and even within a host species. Because bark beetles attack relatively mature trees, the determination of resistance could be a longtime procedure. To shorten this testing period, forestry scientists looked for the causes of resistance. They now believe that resistance is due to the composition of the terpenes of the gum which exudes into the gallery made by the attacking beetles. Terpenes vary in kind and relative amounts in the pines. Some bark beetles are very sensitive to certain terpenes but can tolerate large amounts of others (Smith, 1961). With the toxic terpenes known, resistant young trees or even seedlings can be identified quickly by gas chromotography from even a drop of gum.

Literature Cited

Anderson, G. W. The search for resistance to chestnut blight in the Lake States. U. S. Forest Service, Lake States For. Expt. Sta., Tech. Note No. 578. 1 p. (1960).

Bingham, R. T., Squillace, A. E., and Duffield, J. W. Breeding blister-rust-resistant western white pine. Jour. of Forestry *51,* 163-168. (1953).

Bingham, R. T., Squillace, A. E., and Wright, J. W. Breeding blister-rust-resistant western white pine. II. First results of progeny tests including preliminary estimates of heritability and rate of improvement. Silvae Genetica *9,* 33-41 (1960).

Callaham, R. Z. Observations on pine susceptibility to weevils. U. S. Forest Service, Pac. Southwest Forest and Range Expt. Sta., Tech. Paper 151, 12 p. (1960).

Callaham, R. Z. Resistance of three interspecific white pine hybrids to blister rust. Jour. of Forestry *60,* 409-410 (1962).

Critchfield, W. B. The Austrian x red pine hybrid. Silvae Genetica *12,* 187-192. (1963).

Cumming, W. C., and Righter, F. I. Methods used to control pollination of pines in the Sierra Nevada of California. U. S. Dept. Agr. Circ. 792. 18 p. (1948).

Gravatt, G. F., Diller, J. D., Berry, F. H., Graves, A. H., and Nienstaedt, H. Breeding timber chestnuts for blight resistance. Proc. First Northeastern Forest Tree Improvement Conference, 70-75 (1953).

Henry, B. W., and Bercaw, T. E. Shortleaf-loblolly hybrid pines free from fusiform rust after five years' exposure. Jour. of Forestry *54,* 779 (1956).

Holst, Mark. Breeding resistance in pines to *Rhyacionia* moths. Proc. World Consultation on Forest Genetics and Tree Improvement, Vol. II, 6b/3, 15 p. (1963).

Jewell, F. F. Infection of artificially inoculated shortleaf pine hybrids with fusiform rust. Plant Disease Rptr. *45,* (639-640 (1961).

Miller, J. M. Resistance of pine hybrids to the pine reproduction weevil. U.S. Forest Service, Calif. Range and For. Expt. Sta. Research Note 68, 17 p. (1950).

Schreiner, E. J. Production of poplar timber in Europe and its significance and application in the U. S. U.S. Dept. Agr. Handbook 150, 124 p. (1959).

Smith, R. H. The fumigant toxicity of three pine resins to *Dendroctonus brevicomus* and *D. jeffreyi.* Jour. Econ. Ent. *54,* 365-369 (1961).

Academy Proceedings

486th Meeting of the Washington Academy of Sciences
(Address of the Retiring President)

SPEAKER: **FRANCOIS N. FRENKIEL**
David Taylor Model Basin

SUBJECT: **HIGH SPEED COMPUTER ANALYSES OF RANDOM PROCESSES**

DATE: **THURSDAY, FEBRUARY 18, 1965**
8:15 P.M.

PLACE: **JOHN WESLEY POWELL AUDITORIUM, COSMOS CLUB**
2170 Florida Avenue, N.W.

Abstract of Address—Random processes of physical origin are being considered in many fields of science, both physical and biological, as well as in games and elections. In problems of communications, the random noise obscures the transmitted signal and thus is a hindrance. In many other processes the random fluctuations are of particular interest and the signal is of secondary importance. The characteristics of such processes as accoustic noise, fluid dynamic turbulence, hydrospheric fluctuations, and randomness of sea waves and encephalographs and many geophysical, biological, and astrophysical processes are now the subject of extensive studies.

High speed computer techniques are being applied to the analysis of such random processes and to the determination of their statistical description. The results of these studies provide information on high order correlations, probability distributions, spectra, and many other characteristics of such processes which should lead to the interpretation of their physical significance. Some of the results and the methods used to study such processes will be presented.

The difference between such processes and the outcome of an idealized game of chance also is discussed.

The Speaker—Dr. Frenkiel received a degree in mechanical engineering at the Royal University of Ghent, Belgium, in 1933, and a degree in aeronautics at the same institution in 1937; he received the Ph.D. degree in physics at the University of Lille, France, in 1946. He was a research engineer at the Technical Service of Aeronautics in Belgium in 1938, and a research associate at the Institute of Fluid Mechanics of the University of Lille, 1939-40. From 1940 to 1943 he was with the French Group of Aeronautical Research in Toulouse; and after the War he returned to the Aerodynamics Research Center in the same city.

In 1947 Dr. Frenkiel joined the research staff of the Graduate School of Aeronautical Engineering at Cornell University; and from 1948 to 1950 he was a senior research associate at the Naval Ordnance Laboratory. From 1950 to 1960 he was employed at the Applied Physics Laboratory of Johns Hopkins University; and since 1960 he has been a consultant at the David Taylor Model Basin.

Dr. Frenkiel was associated on a part-time basis, in 1962-63, with the Courant Institute of Mathematical Sciences at New York University. More recently he held a professorship at the University of Minnesota, where he gave a course on turbulence and atmospheric fluid dynamics.

He is a fellow of the American Physics Society, American Geophysical Union, and the American Association for the Advancement of Science. He is also a member of the AAAS Air Conservation Commission. He has served several times as chairman of the American Physics Society's Division of Fluid Dynamics; and he is editor of the journal, *The Physics of Fluids.* He was president of the Philosophical Society of Washington in 1963; and he was recently elected chairman of the U. S. National Committee on Theoretical and Applied Mechanics.

Science in Washington

CALENDAR OF EVENTS

February 5—Catholic University of America

Sigurdur Helgason, Institute for Advanced Study, Princeton University, "Applications of the Radon Transform on Symmetric Spaces."

Auditorium A, Caldwell Hall, Catholic University, 3:30 p.m.

February 6—National Capital Astronomers

Mrs. Winifred S. Cameron, National Aeronautics and Space Administration, "Interpretation of the Moon Photos." (Slides of Ranger photos of the moon will be shown.)

Department of Commerce Auditorium, 8:15 p.m.

February 9—American Institute of Industrial Engineers

Donald Schon, director, Institute of Applied Technology, National Bureau of Standards, "The Engineer's Response to Technological Change."

Howard Johnson Restaurant, 2601 Virginia Ave., N.W., 8:00 p.m. Cocktails at 6 o'clock, dinner at 7 o'clock.

February 16—Anthropological Society of Washington

Jean Bock, University of Maryland, "Ethnic Minorities in American Schools."

Room 43 Natural History Building, 10th St. and Constitution Ave., N.W., 8:15 p.m.

February 17—Howard University

Science Bureau Lecture Series. Nicholas M. Smith, Jr., chief, Advanced Research Division, Research Analysis Corp., "Foundations of the Prescriptive Sciences."

Biology Auditorium, Howard University, 8:00 p.m.

February 18—American Society of Mechanical Engineers

Tour of National Geographic Society Building. Tour begins at NGS, 17th and M Sts., N.W., at 11:00 a.m. Luncheon at noon, University Club, 1135 16th St., N.W.

February 18—Electrochemical Society

J. P. Carter and Walter Ackerman, Bureau of Mines, "Chemical and Galvanic Corrosion Properties of Vanadium."

Room 252 Social Center, Catholic University, 8:00 p.m.

February 19—Howard University

Albert Mayer, F.A.I.A., A.I.P., architect and planner. Topic to be announced.

Auditorium, School of Engineering and Architecture, 2300 6th St., N.W., 4:00 p.m.

March 1—Instrument Society of America

Marie U. Nylen, D.D.S., "Electron Microscopy Today." (A talk for non-electron microscopists, discussing powers and limitations of the method, what to do with samples to preserve their structure, what not to do to avoid artifacts, and the kind of samples suitable for selection.)

Conference Room 3, Building 31, National Institutes of Health, 8:00 p.m. Dinner at 6 o'clock at O'Donnell's in Bethesda.

SCIENTISTS IN THE NEWS

Contributions to this column may be addressed to Harold T. Cook, Associate Editor c/o Department of Agriculture, Agricultural Research Service, Federal Center Building, Hyattsville, Md.

COAST AND GEODETIC SURVEY

AARON L. SHALOWITZ, special assistant to the director, recently retired after 48 years of continuous service with C&GS. He is the author of a two-volume treatise on the legal and engineering aspects of water boundaries, Volume Two of which was recently released by the Government Printing Office. He was technical adviser to the Department of Justice on the boundary aspects of the Supreme Court's "tidelands" decision. In 1952 he was awarded the Department of Commerce Exceptional Service Gold Medal for "outstanding contributions to science and technology in the fields of hydrographic and cartographic engineering."

HARRIS RESEARCH LABORATORIES

MILTON HARRIS has been appointed by the president of Yale University to the Board. Dr. Harris, who received the Ph.D. degree at Yale in 1929, also has been elected to the Yale University Council for a term of five years, and re-elected president of the Yale Chemists Association for four years.

NATIONAL BUREAU OF STANDARDS

EMMA J. MacDONALD retired on July 31 after 35 years of service with the Bureau.

I. C. SCHOONOVER, deputy director, has been named acting associate director for technical support.

C. EISENHART spoke on "The Rise and Fall of the Principle of Arithmetic Means," at the annual meeting of the American Association for the Advancement of Science, held last December in Montreal.

IRVIN H. FULLMER and ARCHIBALD T. McPHERSON have received the Edward Bennett Rosa award, consisting of a plaque and $1500 cash to each recipient. Dr. Fullmer's plaque was inscribed, "in recognition of leadership in the development and promulgation of screw thread standards, both nationally and internationally." Dr. McPherson's plaque was inscribed, "in recognition of significant educational and organizational achievement in standardization, both nationally and internationally."

NATIONAL INSTITUTES OF HEALTH

BERNICE E. EDDY participated in a Conference on Antiviral Substances, sponsored by the New York Academy of Sciences December 9-11.

CARL R. BREWER, chief of the Research Grants Branch of the National Institute of General Medical Sciences, has accepted an associate deanship at the University of Texas Graduate School of Biomedical Sciences at Houston.

KOLOMAN LAKI has been appointed head of the Section on Physical Biochemistry of the Laboratory of Biophysical Chemistry, National Institute of Arthritis and Metabolic Diseases.

EDWIN D. BECKER,chief of the Section on Molecular Biophysics, Laboratory of Physical Biology, NIAMD, spoke on "Recent Nuclear Magnetic Resonance Studies of Hydrogen Bonding" at the Montreal meeting of the American Association for the Advancement of Science in December.

MARGARET PITTMAN, chief of the Laboratory of Bacterial Products, Division of Biologics Standards, attended a Symposium on Cholera Research held in Honolulu, January 24-29, and presented a paper, "Potency Assay of Cholera Vaccine." After the symposium, in her capacity as consultant to the Pakistan-SEATO Cholera Research Laboratory, she expected to visit laboratories in Dacca (East Pakistan) and other Far Eastern countries.

WEATHER BUREAU

L. F. HUBERT, V. Oliver and L. Whitney, of the National Weather Satellite Center, presented a workshop for the use of weather satellite data to meteorologists from Japan, Eastern Asia, India, New Zealand, and Australia, meeting in Tokyo. The workshop, which ended the first week of December, was sponsored by the World Meteorological Organization.

ELECTION RESULTS ANNOUNCED

Returns from the annual mail ballot of the membership, sent out in mid-December, were tallied by a Committee of Tellers on January 8 and reported at the Academy's annual meeting on January 21.

This year's balloting covered the election of officers and managers, affiliation of two new local scientific groups, and a Bylaws change. About 440 ballots were cast, as compared with 340 returns in January 1964, 278 returns in 1963, and 468 returns in 1962.

The voters chose John K. Taylor of the National Bureau of Standards to be president-elect; Alphonse F. Forziati of the Advanced Research Projects Agency to be secretary; and Roman R. Miller of the Naval Research Laboratory to be treasurer. For managers-at-large, Malcolm C. Henderson of Catholic University and George W. Irving, Jr., of USDA were elected for the three-year term 1965-1967, while W. D. McClellan of USDA was elected to fill the final year (1965) of the position vacated by Dr. Taylor.

The Washington History of Science Club and the Chesapeake Section of the American Association of Physics Teachers were approved as affiliated societies. The membership also voted to amend Article VIII of the Bylaws by adding a new Section 3, as follows: "No affiliated society shall be committed by the Academy to any action in conflict with the charter, constitution, or bylaws of said society, or of its parent society."

These new officers were installed at the close of the annual meeting on January 21. At the same time, Leo Schubert, last year's president-elect, automatically assumed the presidency.

A complete roster of officers, managers, and committee chairmen will be published in an early issue of the Journal.

Delegates to the Washington Academy of Sciences, Representing the Local Affiliated Societies*

Philosophical Society of Washington	Urner Liddel
Anthropological Society of Washington	Gordon McGregor
Biological Society of Washington	John L. Paradiso
Chemical Society of Washington	William A. Zisman
Entomological Society of Washington	Harold H. Shepard
National Geographic Society	Alexander Wetmore
Geological Society of Washington	Luna Leopold
Medical Society of the District of Columbia	Thomas M. Brown
Columbia Historical Society	U. S. Grant, III
Botanical Society of Washington	Wilbur D. McClellan
Society of American Foresters	Harry A. Fowells
Washington Society of Engineers	Martin A. Mason
Institute of Electrical and Electronics Engineers	George Abraham
American Society of Mechanical Engineers	William G. Allen
Helminthological Society of Washington	Marion M. Farr
American Society for Microbiology	Frank Hettrick
Society of American Military Engineers	H. P. Demuth
American Society of Civil Engineers	Thorndike Saville, Jr.
Society for Experimental Biology and Medicine	Falconer Smith
American Society for Metals	Hugh L. Logan
International Association for Dental Research	Harold J. Caul
American Institute of Aeronautics and Astronautics	Eugene Ehrlich
American Meteorological Society	J. Murray Mitchell, Jr.
Insecticide Society of Washington	Delegate not appointed
Acoustical Society of America	Malcolm C. Henderson
American Nuclear Society	George L. Weil
Institute of Food Technologists	Richard P. Farrow
American Ceramic Society	J. J. Diamond
Electrochemical Society	Kurt H. Stern
Washington History of Science Club	Delegate not appointed
American Association of Physics Teachers	Delegate not appointed

* Delegates continue in office until new selections are made by the respective affiliated societies.

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VOLUME 55 NUMBER 3

Journal of the WASHINGTON ACADEMY OF SCIENCES

MARCH 1965

JOURNAL OF THE WASHINGTON ACADEMY OF SCIENCES

This Journal, the official organ of the Washington Academy of Sciences, publishes historical articles, critical reviews, and scholarly scientific articles; notices of meetings and abstract proceedings of meetings of the Academy and its affiliated societies; and regional news items, including personal news, of interest to the entire membership. The Journal appears nine times a year, in January to May and September to December. It is included in the dues of all active members and fellows.

Subscription rate to non-members: $7.50 per year (U.S.) or $1.00 per copy; foreign postage extra. Subscription orders should be sent to the Washington Academy of Sciences, 1530 P St., N.W., Washington, D.C., 20005. Remittances should be made payable to "Washington Academy of Sciences."

Back issues, volumes, and sets of the Journal (Volumes 1-52, 1911-1962) can be purchased direct from Walter J. Johnson, Inc., 111 Fifth Avenue, New York 3, N. Y. This firm also handles the sale of the Proceedings of the Academy (Volumes 1-13, 1898-1910), the Index (to Volumes 1-13 of the Proceedings and Volumes 1-40 of the Journal), and the Academy's monograph, "The Parasitic Cuckoos of Africa."

Current issues of the Journal (past two calendar years) may still be obtained directly from the Academy office at 1530 P Street, N.W., Washington, D.C., 20005.

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Poisonous Animals and Their Venoms

Bernhard Witkop

National Institutes of Health, Bethesda, Md.

The etymologists tell us that the word for *venom* is derived from the Latin *venenum, i.e.,* drug, poison, magic charm (related to *venus,* love), and use of this word should be restricted to poisonous matter secreted by animals, such as snakes, scorpions, and bees. While *venom* denotes origin, *poison* refers to effect and includes any substance that on entering living organisms in small quantities has harmful or fatal properties. The term *toxin,** as we use it nowadays, refers to poisonous proteins elaborated during metabolism of living organisms, especially of bacteria. As a defense against toxins, living organisms prepare *antitoxins.* Venoms are sometimes referred to as *biotoxins,* a term which should be reserved for *proteinaceous* venoms (1). Some of these active agents are listed in Table I, which gives approximate minimal lethal doses per microgram (0.000001 g.) of compound for a few representatives from plants and animals (2-7).

While the cobra *(Crotalus terrificus)* makes *active* use of its neurotoxin, the puffer fish *(Spheroides rubripes),* the Colombian poison arrow frog *(Phyllobates bicolor),* toad, and salamander contain *passive* venoms which act only when these animals are eaten or their extracts enter the blood stream. Interestingly enough, salamanders will die of their own venom when, as a result of some lesion, it penetrates from the skin glands into the blood.

Since antiquity the ingredients of plants and animals have been used as arrow poisons for hunting. In Guam the natives poison the pools among the coral reefs with the juices pressed from sea cucumber *(Holothuria argus)* as an aid in catching fish for food. The active principles in the Bahamian sea cucumber *(Actinopyga agassizi)* are concentrated in the Cuvierian tubules, which are reddish, branching filaments containing granules and which are attached to the common stem of the respiratory organs near the region where the intestinal tract enters the cloaca. When the sea cucumber is disturbed, it may react by a vigorous contraction of the body wall, followed by a slow extension of the Cuvierian tubules through a rupture in the cloacal wall, and finally by an explosive expulsion of the intestinal tract and genital glands out through the anus. Autotomy occurs when these organs break off from the rest of the body. The structures remaining within the animal are remnants of mesenteric tissue, the cloaca respiratory organs, the anterior tentacles, and all parts of the water vascular system. As time progresses, the eviscerated and autotomized parts are regenerated (8).

The exact relationship of the poison-laden Cuvierian tubules to the phenomenon of evisceration is not definitely known, although the available facts intimate a close association. Injection of holothurin solutions made from fresh tubules will induce evisceration as will the introduction

* *Taxus* = yew, probably furnished wood for *toxon* = bow, which gave rise to *toxicon* (pharmakon) = (arrow) poison; the Greek word for arrow is *ia,* which in *iatros* = *physician,* German: Arzt, entered into the therapeutic application of poisons in medicine.

Table I. *Toxicity of the Most Active Naturally-occurring Poisons*

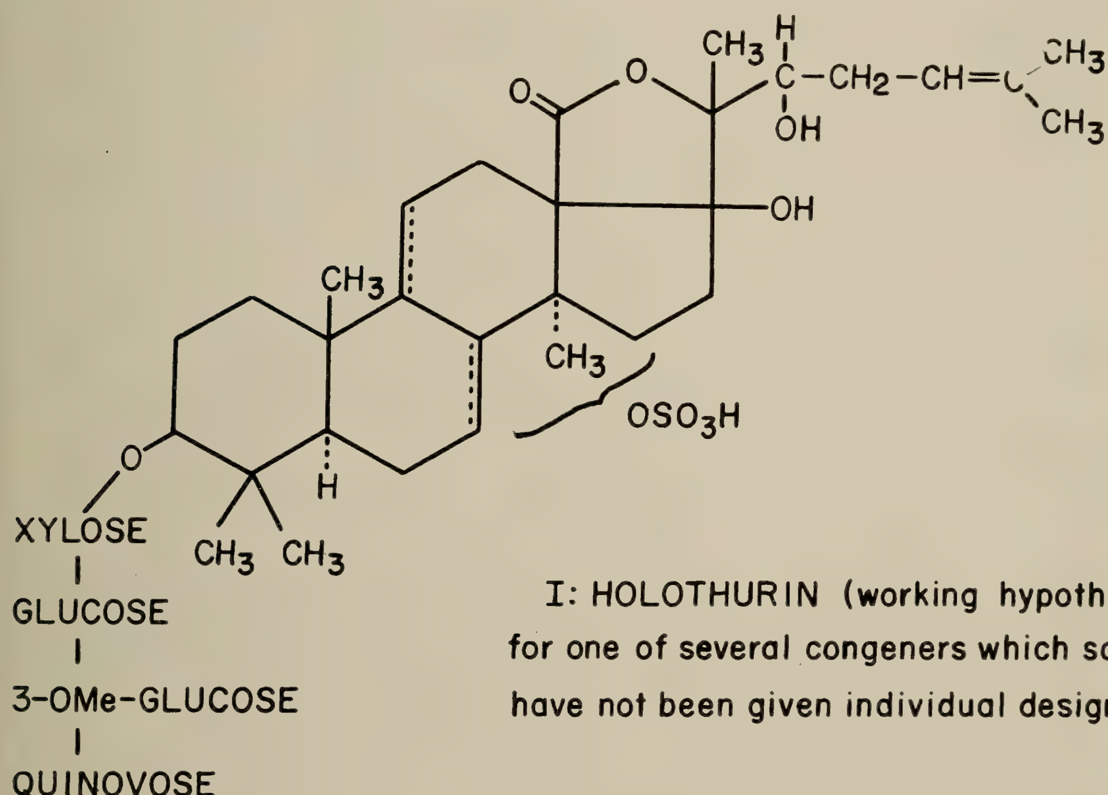
Venom, toxin, or poison	Class of compound	Toxicity MLD/μg of cpd.	Animal	Reference
Botulinus toxin, crystalline type A	Protein, MW 900,000-1,130,000	1,200 30,000	Guinea-pig Mouse	C. Lamanna et al., Science **103**, 613 (1946).
Tetanus toxin	Protein, MW 67,000	1,200 12,000	Guinea-pig Mouse	W. van Heyningen, *Bacterial Toxins* (Thomas, Ill. 1950), p. 6.
Diphtheria toxin	Protein, MW 72,000	3.5	Guinea-pig	
Batrachotoxin from the Colombian poison arrow frog, *Phyllobates bicolor*	Nitrogenous steroid, MW 399 (*cf.* X).	50-100	Mouse	F. Märki and B. Witkop, Experientia **19**, 329 (1963); J. Daly, B. Witkop, P. Bommer and K. Biemann, J. Am. Chem. Soc. **87**, 124 (1965).
Calabash curare alkaloid E Calabash curare alkaloid G	Dimeric indole alkaloids related to strychinine	0.95-8 0.7-12	Mouse Mouse	J. Kebrle, H. Schmid, P. Waser, and P. Karrer, Helv. chim. Acta **36**, 116 (1953).
Paralytic shell fish poison (mytilotoxin)	Guanidine derivative, MW 372	5-6	Mouse	E. J. Schantz et al., J. Am. Chem. Soc. **79**, 5230 (1957).
Tarichatoxin (eggs of California newt)	Identical guanidine derivatives (II, III, IV)	7	Mouse	M. S. Brown and H. S. Mosher, Science **140**, 295 (1963); **144**, 1100 (1964).
Tetrodotoxin (poison from toxic puffer or globe fish)	$C_{11}H_{17}N_3O_8$, MW 319	3-5	Mouse	E. F. Murta, Ann. N.Y. Acad. Sci. **90**, 821 (1960).
Gonyaulax catenella poison (purif.)		5	Mouse	E. J. Schantz et al., Am. Chem. Soc. Meeting (Sept. 1962).
Coral poison ("palytoxin")	Weak base, MW 650 (?)	2	Mouse	P. Scheuer, Univ. of Hawaii (unpublished)
Samandarine from fire salamander (*Salamandra maculosa*)	Modified nitrogenous steroid, MW 305, $C_{19}H_{31}NO_2$ (VI)		Mouse	O. Gessner and P. Möllenhoff, Arch. exptl. Pathol. Pharmakol. **167**, 638 (1932).
Cobra venom neurotoxin	Protein, MW 30,000	0.9	Mouse	*Venoms*, edited by E. E. Buckley and N. Porges, Amer. Assoc. Adv. of Science (Washington, D. C., 1956).
Sea cucumber venom (holothurin)	Steroidal sapogenin, glycoside, MW-1200 (Structure I)	0.1	Mouse	S. L. Friess et al., N. Y. Acad. Sci. **90**, 893 (1960).

of this solution or of the tubules into the water in which intact animals are kept. The higher the dose of the venom, the quicker is the reaction.

Crude holothurin has cancerostatic properties. Even 0.1 mg. of such a preparation, injected intraperitoneally into ascites-bearing mice, leads to a remarkable increase in survival time.

Holothurin consists of two fractions: the A-fraction resembles the plant sapogenin digitonin, and forms an insoluble

500 persons died in Japan during 1956–1958 as a result of poisoning from eating *shashimi* (raw portions) of *fugu, i.e.,* puffer fish *(Spheroides rubripes* and *porphyreus). Ichthyosarcotoxism* is the high-sounding term for this syndrome which also punishes eaters of other fish, such as certain morays *(Gymnothorax)*, mackerels *(Scombroidei)*, and *Ciguatera*. Only licensed operators in Japan are allowed to serve the dangerous delicacy to gourmet customers. The venom is localized in the



I: HOLOTHURIN (working hypothesis for one of several congeners which so far have not been given individual designations).

complex with cholesterol. The aglycon is the sulfuric ester of a steroid lactone I to which is attached the following sequence of four monosaccharides: quinovosyl (3-0-methyl-glucosyl)-glucosylxylose. This is the first instance of the isolation of a steroidal sapogenin from animals (9). Only plants have been known to contain this class of compounds. Even more exceptional is the triterpenoid sapogenin which recently was reported to occur in *Holothuria vagabunda* (10).

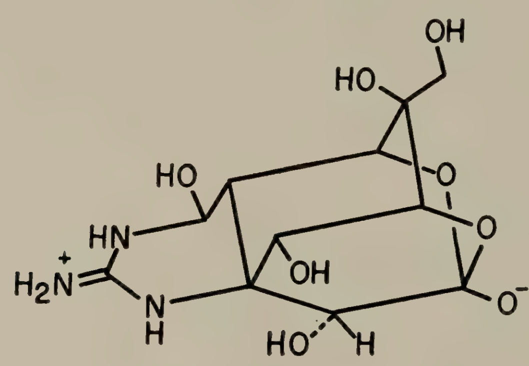
Whereas utilitarian principles led to the discovery of venoms and arrow poisons for hunting purposes, gourmandism detected the most dreaded marine venom. Nearly

livers and ovaries of the puffer fish, whose excision is mandatory for the purpose of consumption. The venom was isolated, crystallized, and named tetrodotoxin in 1950. Tsuda determined its toxicity as 0.01 γ/g. in mice. It required the most modern methods for two Japanese teams (Tsuda and Hirata) and one group at Harvard (R. B. Woodward) to arrive at the correct empirical formula and three-dimensional structure of textrodotoxin. The difficulty of this elucidation is easily seen from the formula, $C_{11}H_{17}N_3O_8$, in which the number of hetero-atoms matches the number of carbon atoms, nine of which are asymmetric. The free tetrodotoxin base is a zwitterion II which on protonation becomes the hemilactal III, which is in equilibrium with the hydroxylactone IV (11).

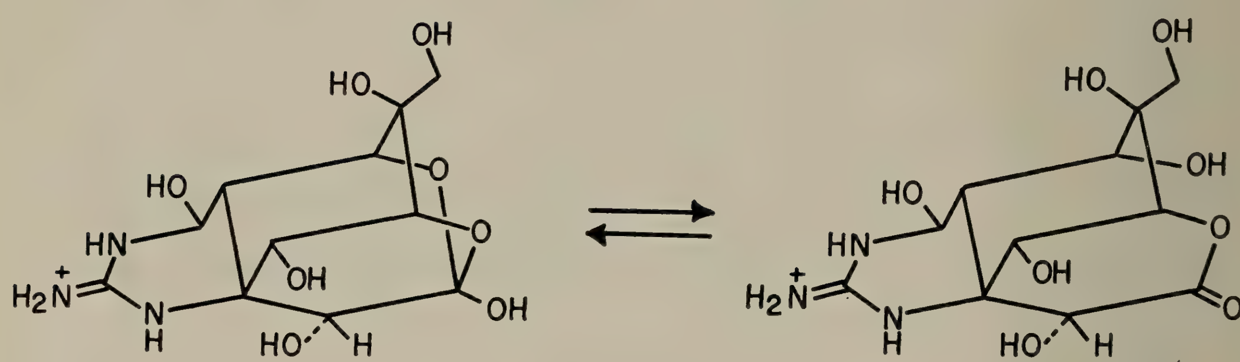
The dimeric ether structure V, a serious alternative suggestion for I, could only be ruled out on the basis of a careful determination of the unit cell and the molecular weight of tetrodotoxin by X-ray crystallography (12).

If we now turn our attention from marine to amphibian venoms, we notice some interesting relationships. The classical work in this area begins with the toad venoms (H. Weiland, 1920-1943 (13)), continues with the salamander (C. Schöpf, 1930-1961 (14)), and leads to crystallization of the frog venom, the most potent venom known, in 1964 (15) (Table II). As the toxicity of these venoms goes up, their quantity goes down. Several hundred grams of crystalline starting material were available for structural work on the toad venoms and samandarin.

A comparison of the collection procedure is instructive: A ten-day collection in the environs of Freiburg (Black Forest) netted a quarry of 33,000 toads *(Bufo bufo bufo)* which were "milked" by placing under an inverted bowl and expressing the venom out of the parotid glands (located behind the eyes) with flat forceps. The stream of milky fluid is caught on the walls of the bowl and in cotton. The animal is set free at the place of capture with no injurious consequence. From 33,000 toads, 36 g. of crystalline bufotalin VI and 29 g. of companion venoms were obtained.



II. Tetrodotoxin Zwitterion (free base)



III. Hemilactal (salt)

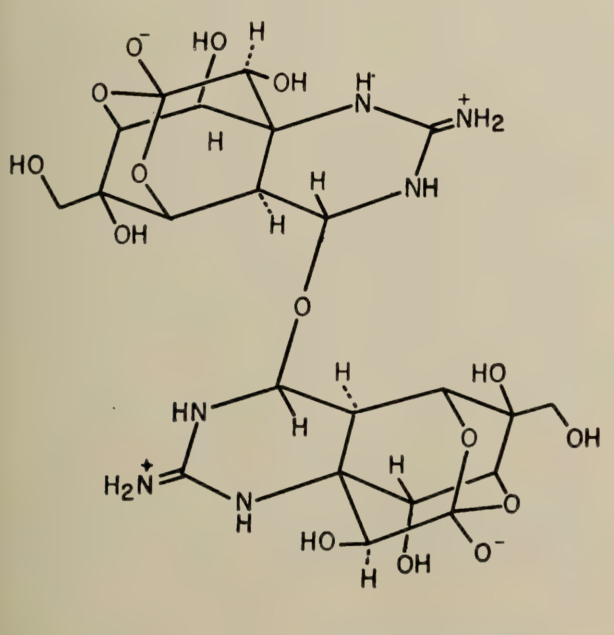
IV. Hydroxylactone (salt)

By contrast, the first expedition into the Choco jungle of Western Colombia (annual rainfall over 11 yards), under the courageous leadership of Mrs. Martè Latham, within 8 weeks yielded only 330 of the tiny and elusive poison arrow frogs, whose capture is infinitely more difficult than that of the clumsy and heavy European toad. Our Indian helpers used a little trick: they skillfully imitated the frog's peeping which sounds like fiú-fiú-fiú, by whistling and at the same time tapping

Table II. Comparative Tabulation of Venoms from Amphibians: Toads, Salamanders, and Frogs

Amphibian	Average Weight of Single Animal	Amount of Venom per Animal	Individual Components of Venom
Bufo alvarius (North America)	284 g	0.44 g	Bufotalin Bufotalinin
Bufo marinus (South America)	230 g	0.58 g	Marinobufagin Telocinobufagin
Bufo bufo bufo (Europe)	27 g	0.016-0.027 g	Bufotoxin
Salamandra maculosa taeniata (Fire salamander, Belgium, Spain)	14-18 g	0.042 g	Samandarine Samandarone Samandaridine Cycloneosamandione
Salamandra maculosa maculosa (Balcan subspecies)	18-24 g	0.05 g	O-Acetylsamandarine Samandarone Samandaridine Cycloneosamandione
Salamandra atra (Alpine salamander, Tyrol)	6.2 g	0.032-0.035 g	Samandarine Samandarone Samandaridine
Phyllobates bicolor (Poison arrow frog of Western Colombia)	1 g	0.001 g	Batrachotoxin Batrachotoxinin A Batrachotoxinin B Batrachotoxinin C

their cheek with their fingers. Their imitation is so perfect that a frog not too far away usually answers the call and thus can be located. Trying to find these small frogs which live well-hidden under the



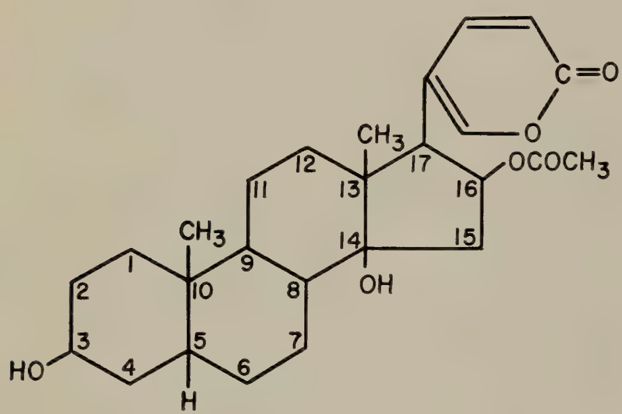
V

tropical ground cover, by any other means, would seem hopeless.

The kokoi frog, as the Cholo Indians call it, is 2-3 cm. long and averages only one gram in weight. Frogs have no parotid glands and the venom is located in the skins, from which it is extracted by aqueous methanol. The skin is black, with either two small yellow stripes along the back or two broad bands of a deep reddish yellow, with dots of the same color sprinkled in between these bands. This bicolorism reminds one of the similar but much stronger black-yellow skin pattern of the fire salamander, where the yellow color, a warning signal to other animals, consists of riboflavin which may be either bound to protein, or form an occlusion complex with guanin in the guanophorous cells of the epiderm (16).

Salamanders (15-18 g.) contain up to 40 mg. of crystalline alkaloids. If one extrapolates these figures to human conditions, a man of 80 kg. body weight would carry in his skin 150-180 g. of samandarin and congeners, *i.e.*, a poison with one-third the toxicity of strychnine. Although normally salamanders make no active use of their venom, they may force the venom out of their skin glands at the last extremity.

Although there was no dearth of salamander alkaloids and a wealth of chemical information, the interesting and novel steroidal systems of samandarine (VII) and cycloneosamandione (VIII) had to be established by roentgenographic analysis.



VI. BUFOTALIN

Like bufotalin (VI), samandarin (VII) has an oxygen function in the C_{16}-position, and in the venom of *Salamandra maculosa maculosa* this hydroxyl is also acetylated (17). The related ketone, samandarone, shows a rotatory dispersion curve with a negative Cotton effect, whose interpretation leads to the relative and absolute configurational assignments as expressed in VII. Cycloneosamandione (VIII) contains the unusual α-aldehyde group at C-10, which becomes free on reaction with methyl iodide to form N-methyl-neosamanonol methiodide (IX) whose Cotton effect is opposite to that of carotoxigenin (5α, 10β); VIII is the first natural steroid with the anomalous α-C-10 configuration (18).

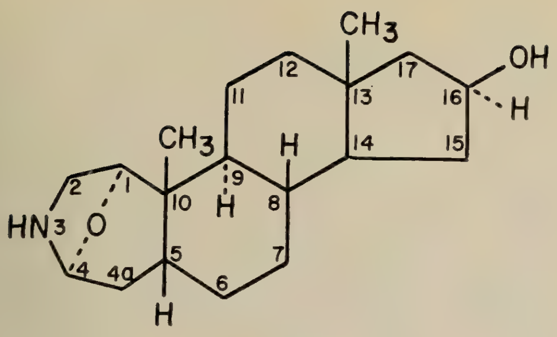
The empirical formula of batrachotoxin was first established with 50 micrograms of amorphous material. The advent of the double-focusing mass spectrophotometer made possible this more-than-hundredfold increase in analytical sensitivity. Without this advance, structural elucidations on a microgram scale would not be possible. All chemical reactions were carried out with less than 50 γ of batrachotoxin. The products of these reactions were purified by thin-layer chromatography and then injected into the mass spectrometer. To judge from the available "cracking patterns" and the new method of "element mapping", batrachotoxin should possess a steroid-type carbon skeleton X, to one terminus of which (ring A or D) is attached the $C_4H_{8-10}NO$ grouping which in turn should have another oxygen atom within three additional carbon atoms. Although the steroidal skeleton is common to the venoms of sea cucumber, toad, salamander, and kokoi frog, there are unique and novel chemical features in each structure. Batrachotoxin does not have the unusual 3-aza-A-homo-5β-androstan structure of samandarin. Its most unusual feature is the weakly basic nitrogen and its particular environment which are currently the subject of detailed investigation on the microgram level. In that respect a new dimension has been added to the structural elucidation of natural products (19).

However, structural elucidation *per se* is no longer a primary aim, but only a prerequisite for entering into the dynamic aspects of cell components. Poisonous animals have given us the first clues on the occurrence, biosynthesis, and interrelationships of endogenous amines, such as serotonin, octopamine etc., which were later discovered in human metabolism. Conversely, enzymes involved in the biosynthesis and breakdown of catechol- and indole-alkyl-amines in mammalian organisms have later been located and identified in the toad (20).

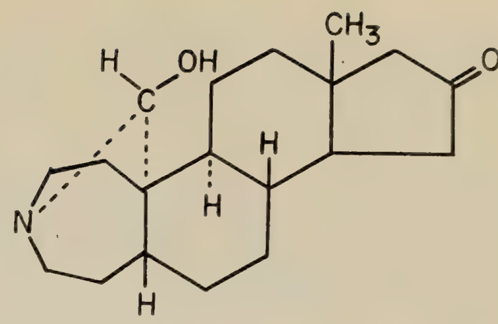
Literature Cited

(1) van Heyningen, W. E., in The Proteins, edited by H. Neurath and K. Bailey: Toxic Proteins, Academic Press, New York, 1954, pp. 345-387.

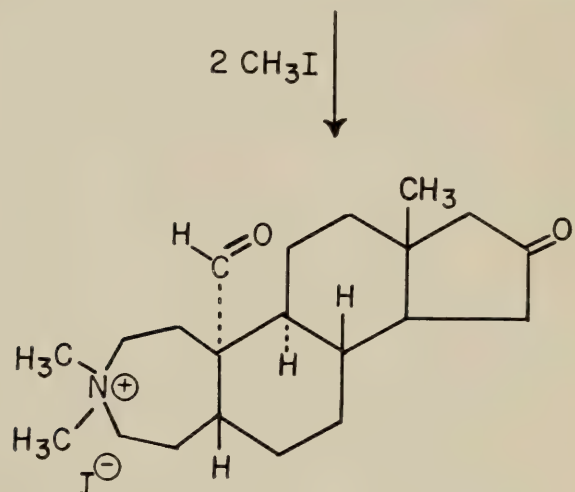
(2) Phisalix, M. Animaux venimieux et venins. Masson, Paris, 1922.



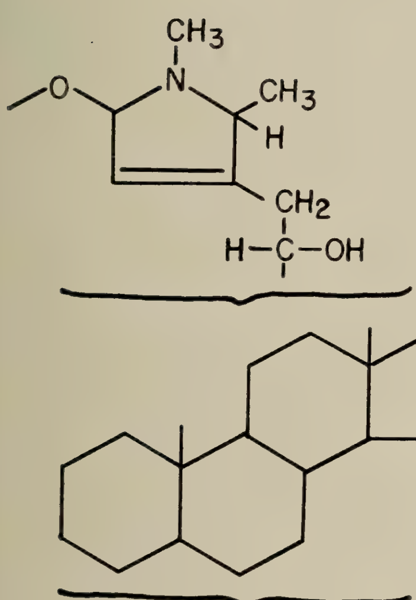
VII. SAMANDARINE



VIII. CYCLONEOSAMANDIONE



IX



C=C
OH
O<

X

(3) Pawlowsky, E. M. Gifttiere und ihre Giftigkeit. G. Fischer, Jena, 1927.

(4) Kaiser, E., and Michl, H. Die Biochemie der tierischen Gifte. F. Deuticke, Wien, 1958.

(5) Halstead, V. W., in E. E. Buckley and N. Porges: Venoms. American Assoc. for the Advancement of Science, Washington, 1956.

(6) Crescitelli, F., and Geissman, J. A. Annual Rev. Pharmacol. **2**, 143 (1962).

(7) Ghiretti, F. Biochemie der Giftstoffe von Meerestieren. Angewandte Chemie **76**, 982 (1964).

(8) Mosher, C. Observations on evisceration and visceral regeneration of the sea cucumber, *Actinopyga agassizi* Selenka. Zoologica **41**, 17 (1956).

(9) Chanley, J. D., Ledeen, R., Wax, J., Nigrelli, R. F., and Sobotka, H. Holothurin. I. The isolation, properties and sugar components of holothurin A. J. Am. Chem. Soc. **81**, 5180 (1959); Sobotka, H., Friess, S. L., and Chanley, J. D. Comparative neuro-chemistry; Proceedings of the 5th International Neurochemical Symposium, Austria, 10-15 June, 1962; Chanley, J. D., personal communication.

(10) Matsuno, T., and Yamonouchi, T. A new triterpenoid sapogenin of animal origin (sea cucumber). Nature **191**, 75 (1961).

(11) Woodward, R. B. The structure of tetrodotoxin. Third International Symposium on the Chemistry of Natural Products, April 12-18, 1964, Kyoto. Butterworths, London, 1964, pp. 49-74.

(12) Woodward, R. B., and Gougoutas, J. Z. J. Am. Chem. Soc. **86**, 5030 (1964).

(13) *Cf.* Behringer, H. Angew. Chem. **56**, 83, 105 (1943).

(14) Schöpf, C. Die Konstitution der Salamander-Alkaloide. Experienta **17**, 285 (1961).

(15) Märki, F., and Witkop, B. Experientia **19**, 329 (1963).

(16) Kaufmann, Th., and Vogt, Karl. Isolierung von D-Lactoflavin und Isoxanthopterin aus der Haut des Feuersalamanders (*Salamandra maculosa* Laur.). Chem. Ber. **92**, 2855 (1959).

(17) Habermehl, G. O-Acetylsamandarin im Gift von Salamandra maculosa. Ann. **679**, 164 (1964).

(18) Habermehl, G., and Göttlicher, S. Konstitution and Konfiguration des Cycloneosamandions, Angew, Chemie **76**, 790 (1964); Chem. Berichte **98**, 1 (1965).

(19) Biemann, K. High resolution mass spectrometry of natural products. Third International Symposium on the Chemistry of Natural Products, Kyoto, April 12-18, 1964, Kyoto. Butterworths, London, 1964, pp. 95-118.

(20) Märki, F., Axelrod, J., and Witkop, B. Biochem. Biophys. Acta **58**, 367 (1962).

A CONTRIBUTION FROM THE ARCHIVIST

A Forester's Thoughts in the Journal of 1915

Forestry, to which the February issue of the Journal was dedicated, was discussed in a previous issue 50 years ago, in a long article, "The Place of Forestry Among the Natural Sciences" (Journal 5, 41-57 (1915)). It was the text of an address delivered before the Academy on December 3, 1914, by Henry Solon Graves (May 3, 1871-March 7, 1951), chief of the U. S. Forest Service from 1910 to 1920. His main objective was to define forestry as "tree sociology" into which anatomy and physiology enter "only as one of the essential parts without which it is impossible to grasp the processes that take place in the forest." He used this opportunity to mention proudly that the Forest Service "is now spending nearly $300,000 annually for research work." In the Annual Report of the Department of Agriculture for the year ended June 30, 1915, Graves gave some results of this research (page 187), which led to improvements in hardwood distillation, turpentining, and the utilization of sawdust by hydrolysis and subsequent alcoholic fermentation.

Graves was a lieutenant colonel in the Corps of Engineers, 1917-19, and Sterling professor of forestry at Yale, 1922-39. In 1947 he was decorated by the French government with the Cross of Officier du Mérite Agricole. His book on forest mensuration first appeared in 1906.

Here is the heart of his story from the 1915 Journal, pages 44-5:

> Forestry as a natural science, therefore, deals with the forest as a community in which the individual trees influence one another and also influence the character and life of the community itself. As a community the forest has individual character and form. It has a definite life history; it grows, develops, matures, and propagates itself. Its form, development and final total product may be modified by external influences. By abuse it may be greatly injured and the forest as a living entity may even be destroyed. It responds equally to care and may be so molded by skillful treatment as to produce a high quality of product, and in greater amount and in a shorter time than if left to nature. The life history of this forest community varies according to the species composing it, the density of the stand, the manner in which the trees of different ages are grouped, the climatic and soil factors which affect the vigor and growth of the individual trees. The simplest form of a forest community is that composed of trees of one species and all of the same age. When several species and trees of different ages occupy the same ground, the form is more complex, the crowns overlapping and the roots occupying different layers of the soil. Thus, for instance, when the ground is occupied with a mixed stand of Douglas fir and hemlock, the former requiring more light, occupies the upper story, and because of its deeper root system extends to the lower lying strata of the soil. The hemlock, on the other hand, which is capable of growing under shade, occupies the under story, and having shallow roots utilizes largely the top soil.
>
> These are forest communities, such for instance as those typical of northwestern Idaho, where western larch, Douglas fir, western white pine, white fir, western red cedar, and hemlock all grow together. Such a forest is evidently a very complex organism, the stability of which is based on a very nice adjustment between the different classes and groups occupying the same ground. Any change in one of these classes or groups must necessarily affect the other. If, for instance, in the Douglas fir-hemlock forest, the Douglas fir is cut out, the remaining hemlock trees are likely to die out because their shallow roots are left exposed to the drying effect of the sun and wind. It is only by a thorough understanding of

such mutual adjustments that the forester is capable of intelligently handling the forest. With the great number of species that are found in this country, with the great variety in climatic and other physical factors which influence the form of the forest, it is self-evident that there are many forest communities, each with distinctive biological characteristics, which offer a wide field for scientific inquiry. Amid the great volume of administrative phases of the work in the Forest Service this main objective has never been lost sight of in handling the National Forests. The Forest Service is now spending nearly $300,000 annually for research work; it maintains eight forest experiment stations and one thoroughly equipped forest products laboratory, and is doing this work solely to study the fundamental laws governing the life of the forest and their effect upon the final product—wood.

Forestry may be called tree sociology and occupies among natural sciences the same position as sociology among humanistic sciences. Sociology may be based upon the physiological functions of man as a biological individual. A physician, however, is not a sociologist, and social phenomena can be understood and interpreted only in the light of sociological knowledge. So also with forestry. Forestry depends upon the anatomy and physiology of plants, but it is not applied anatomy and physiology of plants. With foresters, anatomy and physiology of plants is not the immediate end but enters only as one of the essential parts without which it is impossible to grasp the processes that take place in the forest.

—*Eduard Farber*

Academy Proceedings

March Meeting

487th Meeting of the Washington Academy of Sciences

SPEAKER: KENNETH E. BOULDING
Professor of Economics, University of Michigan
SUBJECT: THE MENACE OF METHUSELAH! POSSIBLE CONSEQUENCES OF INCREASED LIFE EXPECTANCY
DATE: THURSDAY, MARCH 18, 1965
8:15 p.m.
PLACE: JOHN WESLEY POWELL AUDITORIUM, COSMOS CLUB
2170 Florida Avenue, N.W.

Abstract of Address—Is the Fountain of Youth just around the corner? Aging is one of the major unsolved problems in biology; with the present explosion in biological knowledge it is at least conceivable that this problem will be solved in the next few decades. This would open up the prospect of substantial, perhaps indefinite, increase in the human life span. No human institution would emerge unscathed from such a development.

The essential problem is that society has an age-specific role structure, and if the age distribution does not correspond to the role structure serious tensions arise. We see this even in the dislocations due to net birth changes, such as are shaking the whole tropical world now, and threaten major disaster in the next ten years. This age-role structure has developed through history to accommodate a definite age distribution; even the increasing number of old people today create disproportion between the traditional age-role structure, adapted to early mortality, and the present age structure. Ages in the hundreds even (100-200) would create wholly unprecedented problems, not only for the old but for the young, for it is the *relative* age structure which matters.

Among these may be listed: (1) impact on organizations in general (absence of promotion); (2) impact on the family (long years of childlessness); (3) impact on education; (4) impact on insurance, both social and private; (5) impact on pension plans; (6) political impact (who gets the *longevity*, if this is costly); (7) impact on the level of human wisdom and adaptability (is Bernard Shaw right, or Swift, with his Struldbrugs?).

The Speaker: Kenneth Ewart Boulding was born in Liverpool and was educated at New College at Oxford, where he received the B.A. degree with first class honors, in 1931, and later the M.A. degree. He first visited the United States in 1932, when he was a Commonwealth fellow at the University of Chicago. Afterwards he returned to the United Kingdom as a fellow at the University of Edinburgh. Then followed years of teaching in the United States and Canada—at Colgate, Iowa State, and McGill, and since 1949 at the University of Michigan, where he is professor of economics. He became an American citizen in 1948.

He has been awarded the John B. Clark Medal by the Economic Association, and a prize by the American Council of Learned Societies. He has been an advisor to the League of Nations, and has worked with a group doing advanced studies in the behavioural sciences at Palo Alto.

He is a member of the American Academy of Arts and Sciences, the International Institute of Arts and Letters, and the American Philosophical Society.

In addition to contributions to the literature of economics and the arts, he is the author of *Economic Analysis, The Economics of Peace, A Reconstruction of Economics, The Organizational Revolution, Principles of Economic Policy, Disarmament and the Economy, The Meaning of the 20th Century,* and, jointly, of *Conflict and Defense* and *Linear Programming and the Theory of the Firm.*

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See inside rear cover.

Summary Annual Report of Secretary for 1964

The following brief statement summarizes activities, more extensively reported by the committee chairmen of the Academy, during 1964.

Membership. During calendar year 1964, the Committee on Membership (Richard K. Cook, chairman) approved the applications of 73 men and women for membership in the Academy and recommended to the Board, which approved them, 67 men and women for fellowship in the Academy. The Committee also has developed a procedure for periodically evaluating those elected to membership, to determine their eligibility for election to fellowship. Several members have already been elevated under the procedure.

The Academy's rolls now number 94 members, 970 fellows, and 134 emeriti, for a total of 198.

The Board approved the resignations, for various reasons, of 57 persons and authorized a change from active to emeritus status of 31 persons.

The following deaths were reported to the Academy in 1964: H. A. Allard, Charles C. Applebaum, E. B. Behrend, E. S. Belote, H. B. Brooks, Agnes Chase, F. M. Defandorf, H. Dorn, Graham DuShane, J. Franck, H. Fuller, W. A. Geyger, Peter Hidnert, J. I. Hoffman, F. L. Howard, B. Johnson, R. C. MacCardle, T. F. McIlwraith, H. Morrison, H. C. Oberholser, W. J. V. Osterout, W. F. Roeser, L. H. Rumbaugh.

Meetings. Eight monthly meetings were developed by the Committee on Meetings (Mary L. Robbins, chairman for spring semester; Jacinto Steinhardt, chairman for fall semester). With one exception, meetings were held in the John Wesley Powell Auditorium of the Cosmos Club.

The 478th meeting of the Academy was held on February 20. The speaker of the evening was B. D. Van Evera, retiring after two years as president of the Academy. He spoke of some of the pressures now confronting science teachers.

As a departure from the usual lecture-type meetings of the Academy, a "Conversazione" was arranged for the 479th meeting, on March 19. Tables were arranged in the auditorium, about which small groups could gather to discuss subjects of mutual interest. Participants were free to go from table to table, and snacks, coffee, soft drinks, and cocktails were provided. Reaction to this type of meeting was very favorable, and the Meetings Committee is making plans for a similar informal meeting in the spring of 1965.

The 480th meeting of the Academy, on April 16, was sponsored jointly with the Junior Academy. The speaker on this occasion was A. M. Liberman of the University of Connecticut, whose subject, "The Perception of Speech," dealt with the work of the Haskins Laboratory directed at finding why the sounds of speech are so highly efficient in the transmission of information.

The 481st meeting on May 21, commemorating the 400th anniversary of Galileo's birth, was held at the Howard County building of the Johns Hopkins Applied Physics Laboratory, with both before- and after-dinner programs. Ralph E. Gibson, director of the Laboratory, spoke before dinner on the subject, "What Has Become of Galileo's Ideas Today?" After dinner, R. B. Kershner, also of the Laboratory, talked about "Navigation by Satellites."

Following the summer recess, the Academy returned to the John Wesley Powell Auditorium for its 482nd meeting on October 15. Marshall H. Stone of the University of Chicago spoke to the members and their guests on the subject, "Science and Society," reminding his audience that the growth of science is effecting a transformation of society with all the characteristics of a cultural revolution.

Christopher Tietze of the National Committee on Maternal Health, New York

City, addressed the Academy at its 483rd meeting, November 19, on the subject, "Effectiveness of Methods of Population Control." His address concerned the adoption of official policies of population control aimed at achieving a balance between rate of population growth and socio-economic development, particularly in Asia and Africa.

In view of the ever-present threat of nuclear war, the 484th meeting of the Academy, on December 17, consisted of a discussion of the *pros* and *cons* of arms control. R. B. Roberts of Carnegie Institution's Department of Terrestrial Magnetism discussed "Prospects for Action in Arms Control," while Vice Admiral E. N. Parker (Retd.) spoke on the subject, "To Control the Threat."

At the 67th annual dinner meeting, on January 21, 1965, winners of the Academy's 1964 awards for scientific achievement were honored. They are: Bruce Ames, National Institutes of Health (biological sciences); Thorndike Saville, Jr., Army Coastal Engineering Research Center (engineering sciences); James W. Butler, Naval Research Laboratory (physical sciences); David W. Fox, John Hopkins Applied Physics Laboratory (mathematics); Donald F. Brandewie, Swanson Junior High School (teaching of science); Herman R. Branson, Howard University (teaching of science).

Miscellany. The Academy's annual student awards dinner meeting was held at Georgetown University on May 13 under the auspices of the Committee on Encouragement of Science Talent (Father F. J. Heyden, chairman), aided by the Special Events Committee (Alphonse Forziati, chairman). Gale Cleven of the Advanced Research Projects Agency (now with Hughes Aircraft at Los Angeles, in charge of the data reduction center) was guest speaker, with Academy President-elect Leo Shubert presiding at the head table. Dr. Cleven spoke generally on the desirability of obtaining a good academic education. Thirty-three awards were actually presented at this meeting, since it was discovered that seven of the 40 award winners approved were high school juniors.

The Board of Managers approved the requests submitted by the Committee on Policy Planning (B. D. Van Evera, chairman) for affiliation of the Washington History of Science Club and the Chesapeake Section of the American Association of Physics Teachers. These actions were ratified by the necessary two-thirds of the Academy's membership by mail ballots in December.

During 1964, the Standing Rules of the Board of Managers were completely revised by the Committee on Bylaws and Standing Rules (Lawrence A. Wood, chairman) and approved by the Board of Managers. The new Standing Rules were published in the Journal for December 1964. The Committee also presented an amendment to Article 8, Section 3, of the Bylaws, to protect the interests of the affiliated societies. This amendment was approved by the Board and ratified by the Academy membership in December.

Four grants-in-aid to young scientists of the Washington area, totaling $237.50, were recommended by the Committee on Grants-in-Aid of Research (A. T. McPherson, chairman) and approved by the Board. The recipients were John Fournelle ($32.-50 for supplies for biology investigations); Robyn King ($100 for parts for building a computer); Robert Brown ($30 to purchase biological specimens); and Clayton Curtis ($75 for electronic components to complete a computer. These grants were made from a balance of the 1963 allotment of $400.68; a sum of $163.18 reverted to the American Association for the Advancement of Science. Available for grants in 1965 is an allotment for 1964 of $457.00 and an allotment for 1965 of $457.00, or a total of $914.00. There were fewer demands for funds during the year, since schools now have more money for science projects . The Committee has before it requests for three grants, totaling $210.00.

Volume 54 of the Academy's Journal (S. B. Detwiler, Jr., editor), was published in 1964 with a total of 368 pages. Eight of the issues contained a variety of articles by leading area scientists, reviewing the status of research in a number of important fields; special reports of science education and other major Academy programs; and news concerning the Academy's organization, plans, and accomplishments. The April, May, and October issues were addressed to the special interests of particular affiliated groups — the microbiologists, geologists, and electrochemists, respectively; free copies of these issues were distributed to members of the affiliates concerned. The September issue contained a directory of the membership, classified alphabetically, by place of employment, and by membership in affiliated societies. It included also the complete rosters of nine of the Academy's affiliates—Philosophical Society, Entomological Society, Botanical Society, Society of American Foresters, American Society for Microbiology, International Association for Dental Research, American Meteorological Society, Institute of Food Technologists, and Electrochemical Society.

A new Special Committee on Membership Promotion (J. Murray Mitchell, Jr., chairman) is actively pursuing means for stimulating new memberships—both fellows and members—in the Academy.

Other active committees include: Public Information (Watson Davis, chairman); Ways and Means (Bourdon F. Scribner, chairman); Awards for Scientific Achievemen (Edward A. Mason, chairman); Auditing (Bourdon F. Scribner, chairman); and Tellers (Harry A. Fowells, chairman).

—*George W. Irving, Jr., Secretary*

Annual Report of the Treasurer for 1964

Washington Academy of Sciences

Statement of Income and Expenses

Receipts

Dues	$10,159.50
Journal income—	
Subscriptions	1,855.66
Sale of reprints	635.40
Sale of single copies	121.23
Affiliate contributions to 1963 directory	139.25
Affiliate contributions to 1964 directory	297.00
Certificates of membership	15.00
Committee receipts	778.30
Dividends—	
Regular	2,301.69
Capital gains	43.53
Interest	42.97
Joint Board [1]—	
Reimbursement for taxes, etc.	1,678.06
Reimbursement for office expenses	210.67
Reimbursement for grants-in-aid of research	162.50
Miscellaneous refunds	62.39
Miscellaneous (including Science Calendar)	36.31
Sale of stocks (67 shares State Street)	2,908.10
Total receipts	$21,447.56

[1] All responsibility for Joint Board operations ceased on July 1, 1964.

Disbursements

Secretary	$ 490.17
Treasurer	294.73
Headquarters expenses—	
Salaries	2,610.30
Supplies, etc.	1,281.86
Taxes and FICA withheld and paid [2]	2,524.57
Science Calendar	269.91
Committees—	
Meetings	3,807.78
Other	743.10
Journal—	
Printing, mailing, postage, etc. (9 issues of 1963 and 1964)	11,126.61
Reprints	0.00
Grants—	
Reimbursable	130.00
Outright	1,332.50
Refunds and debit memos	18.00
Miscellaneous, including Joint Board salary [1]	1,273.42
Total disbursements	$25,902.95

[2] The Academy has no liability for corporate income tax.

Cash Account Reconciled With Bank

Bank balance 12/15/63	$ 5,181.42	Balance	726.03
Plus receipts in 1964	21,447.56	Less petty cash at hand	0.30
Total	26,628.98	Balance	725.73
Less disbursements in 1964	25,902.95	Bank balance 12/7/64	$ 725.73

Capital Assets

(Market values as of 12/7/64)

2951 shares Massachusetts Investors' Trust @ 17.07	$50,373.57
(58 shares capital gain dividend in 1964 + $12.33)	
1202 shares Investment Company of America @ 11.52	13,847.04
(53 shares capital gain dividend in 1964 + $5.40)	
1811 shares Washington Mutual Investment Co. @ 11.74	21,261.14
(66 shares capital gain dividend in 1964 + $10.20)	
67 shares State Street Investment Co. (sold in 1964)	0.00
(3 shares capital gain dividend in 1964 + $15.60)	
Total market value of stocks	$85,481.75
Cash in bank, 12/7/64	725.73
Total	$86,207.48

Income from Investments

Dividends: Massachusetts Investors' Trust	$1,291.48
Investment Company of America	295.89
Plus 1963 dividend received late	68.94
Washington Mutual Investment Co.	605.18
State Street Investment Co.	40.20
Interest earned on Treasury notes	42.97
Total	$2,344.66

Comparison

	12/31/63	12/7/64
Stocks at market value	$78,079.44	$85,481.75
Cash	5,182.42	725.73
Net worth	$83,261.86	$86,207.48

Membership

(as of 12/7/64)

Active fellows—	
Good standing (includes 6 life and 3 honorary)	928
Delinquent for 1964	30
Delinquent for 1963 and 1964	12
Active members—	
Good standing	93
Delinquent for 1964	1
Emeriti receiving notices, bulletins, and Journal—	
Paid subscription to Journal through 1964	40
Owing for 1964	2
"Retired of long standing," no payments	22
Emeriti receiving only notices and bulletins	70
Total membership	1,198

Changes in 1964

New members	+89
New fellows	+60
Changed from active to emeritus status	15
Resigned	−37
Reported deceased	−20
Dropped (delinquent or "lost")	−20
Net change	+72

Washington Junior Academy of Sciences

Checking Account

Balance, 1/1/64	$ 751.20
Plus receipts in 1964	4,054.01
Plus transfer from savings account	3,150.00
Total	7,955.21
Less disbursements in 1964	7,662.45
Balance, 12/7/64	$ 292.76

Savings Account

Balance, 1/1/64	$1,593.52
Plus receipts in 1964	1,694.96
Total	3,288.48
Less transfer to checking account	3,150.00
Balance, 12/7/64	$ 138.48

JOINT BOARD ON SCIENCE EDUCATION

The National Science Foundation has awarded the Joint Board on Science Education a $17,000 grant to support a second summer program for area high school biology teachers at Montgomery Junior College. Robert B. Nicodemus is the organizer and director of the program.

The month-long program, beginning June 21, will consist of intensive laboratory work and lectures by 12 area scientists relating to new developments in biology and teaching techniques. Speakers will include Ellis T. Bolton, Carnegie Institution of Washington; Howard E. Finley, Howard University; William O. Negherbon, Hazleton Laboratories; and Charles S. Tidball, George Washington University School of Medicine. Topics to be covered include cell ultra-structure and organelles, diffusion and active transport, radioisotope tracers and techniques, cell biochemistry, microbiology, population dynamics, plant growth and regulation, dichotomous keys, embryology, genetics, and ecology.

The 24 teachers selected to participate will receive stipends provided by the grant. Last year 26 local teachers attended the first summer program; of these, 18 were from three Maryland counties, four from two Virginia counties, one from Washington public schools, and three from private schools. An informal academic year follow-up program is presently being conducted for this group. So far, three meetings have been held, at which talks were given by Charles A. Hufnagel, Georgetown University research surgeon, and Vera Remsburg, Virginia state consultant for BSCS. For the February meeting, a lecture by A. J. Tousimis, professor of biophysics at George Washington University, is scheduled.

The summer course is part of a cooperative effort by local school systems, scientists, and educators supporting what is called "a revolution in science teaching." In the past five years, new curricula have been produced in mathematics, physics, chemistry, and biology for grades K to 12. They share the philosophy that science is effectively taught through investigation by the student in a laboratory situation. One of the most successful of the new curricula is the high school biology course produced by the Biological Sciences Curriculum Study. It is rapidly gaining acceptance in the Metropolitan area, with adoptions ranging from 50 to over 90 percent in the local school systems. Acceptance is being encouraged by local teacher in-service programs, college courses that emphasize BSCS methods, and the cooperative program sponsored by the Joint Board on Science Education.

Interested persons should contact John K. Taylor, director of science projects for the Joint Board on Science Education, or Robert B. Nicodemus, director of the CCSS Program, Department of Biology, Montgomery Junior College.

COMMITTEE REPORTS

The following summary statements of activity in 1964 have been prepared from committee reports presented at the Board of Managers meeting on January 21.

Committee on Membership

During 1964 the Committee consisted of Richard K. Cook, chairman (physics and astronomy); William E. Bickley (agricultural sciences); Robert B. Hobbs (chemistry); Raymond L. Nace (earth sciences); Harold E. Finley (general biology); Solomon Kullback (mathematical sciences); Bernice E. Eddy (medical sciences); and William G. Allen (engineering).

The nominations of 67 persons for fellowship in the Academy were studied by the Committee. All of the persons nominated were recommended for fellowship, and were subsequently elected by the Board of Managers. Most of the new fellows work in the area of the physical sciences.

The Committee received the applications of 73 persons for membership in the Academy. All who applied were elected to membership. The Committee took note of the fact that many of those so applying apparently qualify for fellowship as well. The question of how to find sponsors and endorsers for such potential fellows in currently being worked out in cooperation with the Committee on Membership Promotion.

The work of evaluating nominations for fellowship is carried on by means of panels established in the scientific areas mentioned above. The evaluation is done with respect to criteria set forth in the Bylaws, as interpreted by the Committee over the last several years.

—*Richard K. Cook, Chairman*

Committee on Policy Planning

The Committee presents the following four recommendations:

1. The Committee strongly recommends a review of the publishing policy of the Academy's Journal. From listening to a number of comments, and from its own reactions, the Committee feels that something valuable was lost when the Journal ceased being a journal of scientific record. Accordingly, a review of present policies is recommended.

It is also suggested that articles on the history of science and more particularly the history of science in Washington is a currently neglected field into which it might be profitable to move.

2. Another field of activity into which the Academy may move with profit to all is the sponsoring of symposia covering multi-disciplinary approaches to timely scientific topics. Publishing the proceedings of such symposia, either as monographs or as special issues of the Journal, would be a real service to the scientific community.

3. In an effort to promote the international aspects of science, it is suggested that the Academy start a program of inviting distinguished foreign visitors to address the Academy, either at regular meetings or at special meetings. Cooperation with the science attaches of the various embassies should enable us to get a priority on the time of these individuals.

4. In view of the growing concern about the humanities and arts, the Committee recommends that the Academy consider in what ways it can contribute to the understanding of the humanistic and cultural aspects of science.

The chairman has not discussed one last point with the Committee, and makes the recommendation on his own. This is to suggest that the Academy consider whether the procedure by which societies affiliate with the Academy cannot be simplified.

—*B. D. Van Evera, Chairman*

Committee on Meetings

The Meetings Committee as presently constituted did not come into existence until the spring of 1964. Its membership comprises Paul H. Oehser, Arnold M. Sookne, David Rosenblatt, Edwin Roedder, Mary L. Robbins, Ernest Gray, John M. Coleman, Shirleigh Silverman, and Jacinto Steinhardt (chairman).

The Committee held two informal dinner meetings, one just before the beginning of the summer and the other in late September, to formulate the program speakers and other events at the monthly meetings commencing in October. There has been a fine division of labor among the members of the Committee in initiating and following through topics and speakers for each of the meetings.

One more meeting will be held, at the end of January 1965, to formulate proposals for the meetings next fall, in order that the new Committee, which will take over before summer, will have a backlog to start with.

The programs scheduled by the present committee are as follows:

October 1964: Marshall Stone, University of Chicago, "Science and Society."

November 1964: Christopher Tietze, National Committee on Maternal Health, "Effectiveness of Methods of Population Control."

December 1964: Richard B. Roberts, Carnegie Institution, "Prospects for Action in Arms Control," and Vice Admiral Edward N. Parker (USN Retd.), "To Control the Threat."

January 1965: Awards dinner: Rev. William A. Wallace, Catholic University, "Some Moral and Religious Implications of Nuclear Technology."

February 1965: Francois N. Frenkiel, David Taylor Model Basin, "High Speed Computor Analyses of Random Processes" (address of retiring president of the Academy).

March 1965: Kenneth Boulding, University of Michigan, "Social and Economic Dislocations Incident to Increased Life Expectancy."

April 1965: "Conversazione" on topic, "What Is a Scientist?"

May 1965: Henry Fagin, University of Wisconsin, "Mass Transportation."

Attendance at the first three meetings of the current Academy year has been somewhat above the average of preceding years, but is still far smaller than the quality of the speakers merits.

An informal dinner, sometimes combined with the Board of Managers dinner, has preceded each of the first three occasions. I have invited a small number of people from outside the Academy, who were known to me to be interested in the topic at each of these dinners. About half of them have accepted.

—*Jacinto Steinhardt, Chairman*

Committee on Grants-in-Aid of Research

Funds Available for Calendar Year 1964

Carryover from 1963	$400.68
Allotted by AAAS for 1964	457.00
Total	857.68

Grants Approved by the Board in 1964

January 16. John Fournelle. Supplies for project production of ultraviolet-induced pigment mutants in Chlorella	32.50
March 19. Robyn King. Electronic components for project on digital computer using neon bulb flip-flop circuits	100.00
March 19. Robert S. Brown. Biological material project on enzymatic correction of hereditary diseases in *Drosophila melanogaster* and *Mormoniella vitrapennis*	30.00
November 19. Clayton Curtis. Power supply to complete computer	75.00
Total	237.50

Funds Canceled by AAAS

Unobligated funds allotted for 1963	163.18

Funds Available for Calendar Year 1965

Unobligated allotment for 1964	457.00
Allotment for 1965	457.00
Total	914.00

Applications Pending

Since January 1, 1965, two applications have been filed and a third is in preparation. The total amount requested is about $210.

Applications Not Approved

One application for a grant for travel to Europe was turned down by the Committee. Two applications recommended by the committee were approved only in part by the Board.

Alternative Sources of Support for Research Projects

The Grants-in-Aid Program of the Academy is only one source of support for original investigations in the Washington area. Other sources are as follows:

Schools. Many schools in the area are receiving support for their science programs that enable them to provide supplies and equipment for many original projects.

Research laboratories. Summer programs now under way afford many students the opportunity to work in government and institutional laboratories. Some students continue to work in these laboratories outside of school hours during the year. Others secure the loan of equipment for use in laboratories at school or at home.

Industry. Local representatives of manufacturers of electronic and other equipment have been generous in securing gifts of obsolescent but usable items needed for specific investigations.

Publicity about Grants

A statement on grants-in-aid of research which was approved by the Policy Planning Committee in 1962 has been distributed to members of the Board and given other circulation as opportunities arose. Science supervisors have also been alerted to the availability of grants.

—*A. T. McPherson, Chairman*

Committee on Encouragement of Science Talent

The Committee has had no formal meeting during the year because of pressures from various agenda that began in September 1964.

The Committee members are John K. Taylor (1962), Alfred Weissler (1962), Lloyd Ferguson (1963), Howard Owens (1963), Nate Haseltine (1964), and Francis Heyden (1964) (chairman). The date after the names indicates the year in which the member joined the Committee. Some preliminary discussions with Academy President Frenkiel indicated a preference for a term of three years, but no final decision has been made.

Activities

Science Awards Dinner

This dinner was held May 13, 1964 at Georgetown University, with Gale Cleven of the Advanced Research Projects Agency as guest speaker and Leo Schubert as representative of the senior Academy. Awards were presented to 33 high school students of the Washington area, comprising 25 students who had competed in the Westinghouse Science Talent Search, four students who had competed in area Science Fairs, and four students selected by the Washington Junior Academy of Sciences. The prizewinners were:

Westinghouse Talent Search entrants: Joseph W. Bell, Jr., Margaret P. Brook, Marcia C. Cleveland, David B. Coomber, Richard E. Coukouma, Leona M. Dryden, Marc S. Durand, Robert L. Epstein, Gerald W. Ferguson, Jeffrey E. Fookson, Mark A. Goldstein, William F. Hermach, Henry M. Jaffin, Peter M. Kogge, Douglas A. Lind, Tessa D. Orellana, Arnold L. Polinger, Thomas L. Rothstein, Madeleine S. Reines, Stanley J. Shapiro, James D. Steakley, Natalie A. Weiss, Stephen M. Winters, Douglas L. Will, Randall C. Zisler.

Science Fair entrants: David L. Abel, Marshall Curtis, Ingrid Hougland, David Matthews.

Junior Academy selections: Patricia Evans, Virginia Fano, John Jelen, Robert Sproull.

Science Fairs

Most of the Committee members served as judges in Science Fairs of the Washington area. The District of Columbia Fair was held in Hangar No. 2 at Bolling Air Force Base, through arrangements made by Gale Cleven. The hangar proved to be very satisfactory for display of science projects and parking, and in convenience was considered second only to the Georgetown University gymnasium. The D.C. Fair was better attended in 1964 than in 1963.

Junior Science and Humanities Symposia

Several members of the Committee assisted in organizing two symposia, sponsored by the Army Office of Research and held November 27-28, 1964 at Georgetown University. Co-sponsors of the event were the Harry Diamond Laboratories, the

Washington Post, and the Washington Junior Academy of Sciences. The 60 papers submitted were judged by a group comprising the Committee, Phoebe Knipling of the Arlington County Schools, B. Lamberton of Visitation High School, and Israel Rotkin of the Harry Diamond Laboratories. The six best papers were selected for presentation at the symposium, as follows:

Howard Ozer, Jr., Fairfax High School, "Pesticide Cross Resistance in Bluegill Sunfish."

Clayton Curtis, Bethesda-Chevy Chase High School, "The Development of a Solid-State Automatic Digital Computer."

Steven Hadler, Walt Whitman High School, "Division by Zero."

William Pala, Jr., George Marshall High School, "The Nature and Cause of Lunar Luminescence."

Richard Fitch, Albert Einstein High School, "An Experiment in Suspended Animation of Leopard Frogs."

These six students will be rewarded by membership in the Junior Academy, by selection for the forthcoming awards dinner, if seniors, and by a three-day trip to West Point next spring, as guests of the Army.

More than 400 students and teachers from 78 local high schools attended the two-day sessions. Alfred Friendly, business editor of the Washington Post, was the guest speaker. The entire symposium was tape-recorded for future reference.

Junior Academy

This affiliate of the senior Academy was established in 1951 under the Committee for the Encouragement of Science Talent. Funds for the Junior Academy at that time were derived from a benefit showing of the *Kon Tiki* travelogue in a Washington theater. Mrs. Truman was one of the sponsors, together with the presidents of the Washington area universities.

The Junior Academy has continued successfully for the past 14 years, with help and guidance from adult advisors of the senior Academy. It has contributed generously to the Joint Board on Science Education to help defray the cost of sending Science Fair winners to the National Science Fair. The funds have been raised by the Junior Academy by sponsoring trips for high school students to New York and Philadelphia, on the Pennsylvania Railroad. Howard Owens has given generously of his time in organizing these trips.

The governing council of the Junior Academy meets monthly at the cottage near Georgetown University to discuss matters of business and policy. These meetings, which continue through the summer months, have been attended regularly by the chairman of the Committee for Encouragement of Science Talent.

The third volume of the Proceedings of the Junior Academy has been published and is being sold to members for $1.00. Previous issues of the Proceedings were given away, at a serious loss to the Junior Academy.

The Junior Academy's annual convention was held December 29 at Georgetown University, with an unusually large attendance. Glenn Seaborg of the Atomic Energy Commission delivered the invited lecture, "Transuranium Elements," to more than 300 academy members.

The only expenses for this convention were $350 for the luncheon. The lecture and meeting rooms at Georgetown were made available without charge to the Academy. The use of such facilities instead of hotel meeting rooms has reduced the cost of the annual convention by more than 50 percent.

Contributed Efforts of Individual Members

The Committee seldom acts as a unit; but all the individual members have contributed their time to the goal to which the Committee is dedicated. Most of them serve as judges of local Science Fairs, and several are volunteer lecturers for schools. The chairman gave more than 50 lectures to schools and other groups during the academic year 1963-64.

—*Francis J. Heyden, S.J., Chairman*

ELECTIONS TO FELLOWSHIP

The following persons were elected to fellowship in the Academy at the Board of Managers meeting on February 18:

MORTON BEROZA, investigations leader in charge of synthesis investigations, Department of Agriculture, "in recognition of his work on insect control agents, especially for synthesis of insect attractants." (Sponsors: B. D. Van Evera, C. R. Naeser, T. Perros.)

GLENN W. BRIER, head, Meteorological Statistics, Weather Bureau, "in recognition of his pioneering contributions to meteorological statistics, and his design of statistical methods leading to important discoveries of lunar and solar relationships to weather." (Sponsors: J. M. Mitchell, Jr., H. E. Landsberg, H. C. S. Thom.)

JAMES W. BUTLER, consultant, Van de Graaff Branch, Naval Research Laboratory, "in recognition of his contributions to our knowledge of energy levels and other properties of atomic nuclei." (Sponsors: E. A. Mason, S. N. Foner.)

DAVID W. FOX, project leader, Aeroelasticity Project, Johns Hopkins University Applied Physics Laboratory, "in recognition of his research in estimating lower bounds to eigenvalues and related studies." (Sponsors: E. A. Mason, Harry Polachek.)

MAX A. KOHLER, chief hydrologist, Weather Bureau, "in recognition of his wide-ranging contributions to research and education in the field of hydrology, many having been of exceptional value to water conservation programs in the U.S.A. and abroad." (Sponsors: H. E. Landsberg, J. M. Mitchell, Jr.)

ROBERT LADO, dean, Institute of Languages and Linguistics, Georgetown University, "in recognition of his outstanding contributions to the scientific study of linguistics, and to the establishment of advanced education in the science of linguistics." (Sponsors: J. Steinhardt, W. J. Thaler, F. Heyden, S.J.)

LESTER MACHTA, research meteorologist, Weather Bureau, "in recognition of his highly significant contributions to, and direction of, broad research programs in meteorology, most especially in the area of atmospheric radioactivity and atomic fallout." (Sponsors: M. J. Rubin, R. H. Simpson, J. M. Mitchell, Jr.)

CLIFFORD J. MALONEY, chief, Biometrics Section, National Institutes of Health, "in recognition of his application of statistical and computer techniques to biology and to Army research and development problems." (Sponsors: Margaret Pittman, Jerome Cornfield, C. W. Hiatt.)

ALBERT V. H. MASKET, research physicist, Naval Research Laboratory, "in recognition of his pioneering studies of penetration ballistics, his valuable contributions to data analysis in nuclear radiation measurements, and his clarifying treatments of interior-value problems of mathematical physics." (Sponsors: G. R. Irwin, W. C. Hall, R. L. Dolecek.)

ELIO PASSAGLIA, chief, Polymer Physics Section, National Bureau of Standards, "in recognition of his contributions to the physics of high polymers and in particular his researches on the thermodynamic and mechanical properties of semi-crystalline hydrocarbon polymers." (Sponsors: L. A. Wood, J. D. Hoffman, N. Bekkedahl.)

JOHN S. RINEHART, assistant director for research and development, Coast and Geodetic Survey, "in recognition of his work in the field of ballistics and astrophysics, particularly dynamics of explosions, fragmentation, and hypervelocity flight and impact." (Sponsors: D. S. Carder, C. A. White, J. B. Small.)

RICHARD C. ROBERTS, chief, Mathematics Department, Naval Ordnance Laboratory, "in recognition of his outstanding leadership in devising, advancing, and directing his laboratory's mathematics effort in support of Navy research and engineering programs." (Sponsors: H. Polachek, E. A. Mason.)

RYSZARD SYSKI, associate professor, Department of Mathematics, University of Maryland, "in recognition of his contributions in the field of probability theory and stochastic processes and in particular for applications to congestion theory and queueing theory as evidenced in his book, 'Introduction to Congestion Theory in Telephone Systems'." (Sponsors: H. Polachek, E. A. Mason.)

ELECTIONS TO MEMBERSHIP

The following persons were elected to membership in the Academy by action of the Committee on Membership at its meeting on February 2:

ELVIRA A. EULER, teacher of physics and earth-space science, George Mason High School, Falls Church.

JOHN H. HONIG, chief, Naval Warfare Technology, Honeywell, Inc.

GARY B. JORDAN, member of the technical staff, Bunker-Ramo Corporation, Canoga Park, Calif.

ERNEST E. SAULMON, associate director, Animal Disease Eradication Division, Department of Agriculture.

BOARD OF MANAGERS MEETING NOTES

January Meeting

The Board of Managers held its 569th meeting on January 21 at the Cosmos Club, with President Frenkiel presiding.

The minutes of the 568th meeting were approved as previously distributed.

Announcements. Dr. Frenkiel announced the appointment of an Auditing Committee consisting of Bourdon F. Scribner (chairman), John L. Torgesen, and Michael Goldberg. He also reported that the Philosophical Society had decided to continue its sponsorship of the annual Christmas Lectures, and that it would therefore be unnecessary for the Academy to assume such sponsorship.

Secretary and Treasurer. The annual reports of secretary and treasurer were deferred for presentation at the general meeting of the Academy, following the Board meeting. (They appear elsewhere in this issue.)

Executive Committee. President-elect Schubert reported that the Committee has approved payment of $10 annual dues to the American Association for the Advancement of Science, for the Academy representative on the AAAS Council; also, that Dr. Schubert had been appointed Academy representative to the Council for 1965.

Annual Committee Reports. Annual reports were submitted for the Committees on Membership, Policy Planning, Meetings, Grants-in-Aid of Research, Encouragement of Science Talent, and Awards for Scientific Achievement. (Summaries of the first five of these reports appear elsewhere in this issue. The activities of the Committee on Awards for Scientific Achievement are summarized in the article, "Six Scientists Receive Academy's Annual Awards," appearing on page 21 of the February issue.)

Membership. No new applications were presented to the Board at this meeting. Chairman Cook reported that the problem of finding sponsors for members qualified for fellowship status is being worked out in cooperation with the Committee on Membership Promotion.

Awards for Scientific Achievement. Chairman Mason indicated that the Committee was screening the runners-up in the recent selection of the Academy's annual award winners, to determine their eligibility for fellowship in the Academy.

Grants-in-Aid of Research. On motion of Chairman McPherson, the Board approved a grant of $80 to Howard Katz of Springbrook High School, for the completion of a complete television station for use in the school's program; and a grant of $65 to Glen Urquhart as part of a three-year program in the field of optics.

Special Events. Chairman Forziati reported that he had received 113 reservations for the annual dinner just following the Board meeting.

Editor. Editor Detwiler reported that the February issue of the Journal, currently in press, was directed primarily to the interests of the foresters of Washington. In response to a suggestion from Dr. Schubert, he agreed that additional Journal articles on the history of science in Washington would be desirable.

Archivist. Archivist Farber reported that he had had little opportunity to come to grips with the Academy files, but had been perusing old issues of the Journal. He was impressed with some of the older material, particularly illustrations, and suggested that it might be worth while to republish some of them. The editor was agreeable to the idea.

Joint Board. In the absence of Dr. Taylor, Dr. Schubert reminded the Board of the annual Architects, Engineers, and Scientists Day, to be held this year on February 16 at the Presidential Arms.

Science in Washington

CALENDAR OF EVENTS

March 9—Weather Bureau

Charles E. Anderson, manager, Supporting Research Division, Office of Federal Coordinator for Meteorological Services and Supporting Research, "Numerical Simulation of the Growth of Cumulus Towers."

Room B-04, 615 Pennsylvania Ave., N.W., 2:15 p.m.

March 10 — American Society of Heating, Refrigeration, and Air Conditioning Engineers

William P. Chapman, Johnson Service Company, "Management by Exception."

Cameo Room, Presidential Arms, 1320 G. St., N.W., 7:30 p.m. Social hour at 5:15, dinner at 6:15.

March 11 — Chemical Society of Washington

Hillebrand Award dinner. Award of 1964 prize to Ellis R. Lippincott, University of Maryland.

Knights of Columbus Activities Hall, 5115 Little Falls Rd., Arlington, Va. Social period at 7:00 p.m., dinner at 7:30. (For reservations call Guido Cammisa, KI 9-1622.)

March 16—Anthropological Society of Washington

William Madsen, Purdue University, "Mexican-American Acculturation—Anxiety and Witchcraft."

Rm. 43, Natural History Building, 10th & Constitution Ave., N.W., 8:15 p.m.

March 17 — Society of American Foresters

Annual all-day meeting, on topic, "Pests, Pesticides, and People." Speakers: Hon. Stewart L. Udall, Secretary of the Interior; Hon. Jamie L. Whitten, Congressman from Mississippi; Austin H. Wilkins, president, National Association of State Foresters; Carl W. Buchheister, president, National Audubon Society; Parke C. Brinkley, president, National Agricultural Chemicals Association; Robert J. Anderson, assistant surgeon general, Public Health Service.

Presidential Arms, 1320 G St., N.W. Registration at 9:00 a.m.; luncheon at 12:50 p.m.; adjournment about 2:30 p.m. (Reservations needed before noon on March 15; call SAF office, 296-7820.)

March 19—Howard University Architecture Department

John C. Warecke, F.A.A., on topic to be announced.

Auditorium, School of Engineering and Architecture, 2300 6th St., N.W., 4:00 p.m.

SCIENTISTS IN THE NEWS

Contributions to this column may be addressed to Harold T. Cook, Associate Editor, c/o Department of Agriculture, Agricultural Research Service, Federal Center Building, Hyattsville, Md.

AGRICULTURE DEPARTMENT

W. B. ENNIS, JR., participated in a panel on pesticides at the annual meeting of the Range Society of America in Las Vegas, Nev., on February 11. He discussed "The New Research in Pesticides."

KENNETH W. PARKER attended the Ninth International Grassland Congress at Sao Paulo, Brazil, January 7-20, and gave a paper, "Progress in Range Management in the United States." From January 21 to 29 he made a tour of range research work in Argentina.

ELBERT L. LITTLE, JR., Forest Service dendrologist, spent five months recently on an FAO assignment as consultant in dendrology at the Interamerican Institute of Agricultural Sciences at Turrialba, Costa Rica. He returned to Washington March 1.

NATIONAL BUREAU OF STANDARDS

H. J. KOSTKOWSKI participated in a panel discussion on Terminology, Definitions, and Units of Solar Simulation at the First International Symposium on Solar and Planet Radiation Simulation, Los Angeles, Calif.

J. K. TAYLOR presented a paper on "High-Precision Coulometric Analysis with Special Reference to the Determination of Uranium," at the Euratom, Bureau Central de Measures Nuclaires, Brussels, Belgium.

NORMAN BEKKEDAHL, formerly chief of the Polymer Characterization Section, has been designated deputy chief of the Polymers Division.

JOHN R. MANNING was named chief of the Metal Physics Section on January 1.

G. K. TEAL, vice president and international technical director for Texas Instruments, Inc., has accepted appointment as director of the Institute for Materials Research for a period of approximately two years. Dr. Teal is internationally known in connection with the physics and chemistry of materials, and for his work on the development of transistors.

FRANK R. CALDWELL, supervisory physicist, retired on December 30 after 45 years of government service.

CHARLES L. GORDON, analytical chemist, retired on January 4 after 36 years of government service.

NAVAL RESEARCH LABORATORY

RICHARD TOUSEY, head of the Rocket Spectroscopy Branch of the Atmosphere and Astrophysics Division, has accepted an invitation to serve as a member of the Board of Visitors to the Department of Chemistry at Tufts University.

HOMER W. CARHART was presented the Navy Superior Civilian Award by Admiral J. K. Leydon, chief of naval research, on January 26. This award was presented in recognition of Dr. Carhart's contributions in the field of fuels. His studies have led to a more lucid understanding of combustion mechanisms, and these in turn have been used to eliminate hazards associated with fuel handling. Dr. Carhart has been associated with fuels and related programs at NRL for 22 years

DEATHS

HORACE M. TRENT, head of the Naval Research Laboratory's Applied Mathematics Staff, died December 16 following an illness complicated by pneumonia. He would have been 57 years old on December 20. Dr. Trent was a nationally recognized authority in the field of graph theory. He attracted world-wide attention in 1958 by a paper in the Journal of the American Acoustical Society, in which he showed that the loud report when a bull whip is cracked is produced because the tip exceeds the speed of sound. He demonstrated this by means of a theatrical whip-cracking team and high speed photography.

BERNARD FRANK, visiting professor of watershed management at Colorado State University, died November 15, 1964 at Fort Collins, Colo. He had been elected to the Academy on January 13, 1959.

SCIENCE AND DEVELOPMENT

In 1928 George Ellery Hale, first director of the Mount Wilson Observatory, wrote an article entitled "The Possibilities of Large Telescopes." Now, 15 years after the installation of the 200-inch instrument which bears his name, his predictions have been more than fulfilled. The observable universe is now known to be many times larger than hitherto estimated, and the "nearby" Andromeda nebula is now set at the order of 2 billion light years. Ira Bowen, present director of the Mount Wilson and Palomar Observatories, goes so far as to suggest that the observation of so large a fraction of the radius of the universe as is permitted by the 200-inch Hale instrument, makes possible observational differentiation between the various cosmological models: the exploding universe, the pulsating universe, and the steady-state universe. Add to the data from the giant telescope the information now being derived from radio astronomy, and one moves into a whole new realm of understanding and inquiry. It now appears, for example, that a substantial fraction of the several thousands of known radio sources are galaxies exploding with a force causing energy emissions as much as 100 times the normal radiation from all the stars of a large galaxy like Anromeda. When one considers that the lifetime of the explosion is perhaps a few million years only, the events cannot be regarded as rare and must play a major role in the evolution of many galaxies. Dr. Bowen summarizes one theory of the development of stars as follows:

"The gas clouds from which the star condenses are made up chiefly of hydrogen. As the mass of hydrogen condenses into the star the core is heated to a temperature of the order of 10 million degrees centigrade. At this temperature hydrogen is slowly transformed into helium, each pound producing an amount of energy equivalent to the combustion of about 10,000 tons of the best coal.

"When the hydrogen fuel in the core approaches exhaustion, the core heats to some hundred million degrees, at which temperature the helium atoms, now the chief constituent of the core, can react to form carbon, nitrogen, oxygen, and neon. These reactions liberate a number of neutrons which can combine with the atoms presnt to form the heavier elements, such as iron.

"As the reactions continue, the core temperature may eventually increase to a few billion degrees, and in the more massive stars the reaction may eventually proceed explosively. This is presumably the cause of the supernovae, in which for a few weeks after the explosion the star emits as much light as all the normal stars in a whole galaxy. During the explosion a considerable fraction of the mass of the star is thrown off into space with a velocity of thousands of miles per second."

War and preparations for possible war continue. The Army laboratories at Fort Belvoir are now testing an extremely lightweight and compact glide angle light for night landings in remote areas. Weighing about 25 pounds, it can be dropped by parachute, assembled, and put into operation by one man in five minutes; it provides a high intensity three-colored beam. Aircraft coming in on the green can be assured of a good approach; on the red they will be warned that they are too low, and on the yellow that they are too high. The projected beams are separated by two minutes of arc, eliminating blind spots at three miles. The unit operates either on its own nickel cadmium battery or from the jeep DC power supply.

And most veterans of World War II will be wryly amused at the development of a one-pound cylindrical device which enables the combat soldier to dig a foxhole in much less time than formerly necessary. It consists of two delay-type fuses, a spike or stability rod, and a cratering charge. The container itself detonates to produce a pilot hole, and the cratering charge loosens the earth for the foxhole proper. The final effort devolves upon the soldier and his intrenching tool.

The Ames Research Center, NASA, hopes to provide moon dust for subsequent analysis by sweeping the outer atmosphere with a sounding rocket launched from the White Sands, New Mexico, site. Michael Carr of the Geological Survey points out that when meteoritic material strikes the surface of the moon, it causes a spray ejection of extremely fine dust, much of which escapes the moon's gravity. Some, in turn, enters the earth's atmosphere within 75 miles of the earth's surface, and it is this that the Aerobee rocket is to pick up for subsequent study by electron probe and electron microscopy.

Water cannot longer be taken for granted in most of the industrialized portions of the United States, as indicated by a recent city-by-city inventory of "Public Water Supplies of the 100 Largest Cities in the United States," published by the Geological Survey. This survey provides information on the ownership of the systems, population, daily use, treatment methods, and storage. Some 34 percent of our population are served by these supplies. As for sources, 66 of the cities tap surface supplies, 20 use ground water, and 14 a combination of the two. Ten pump water from the Great Lakes.

Nor can its quality be ignored. Of the total population noted above, 56 percent receive filtered water, 98 percent water that has been chlorinated. Twenty seven cities soften the water, and 34 add fluorine. As for properties of hardness, dissolved solids, and other chemical characteristics, the Survey has just released an atlas of the public water supplies of the United States, including Puerto Rico, based on 1,596 supplies serving 103 million people.

To those of us who marvel that far-flung points on the earth's surface are locatable at all, it comes as a reassuring surprise to learn that the Bermuda Islands have, by use of the two Echo satellites, been pinpointed on the map with an accuracy greater than ever before possible. The precision of this effort by the Coast and Geodetic Survey, which used the satellites as space targets against star backgrounds and employed the most advanced camera designs, is underscored by the results, which showed that the islands are 220 feet further north and 105 feet further west than had been previously recorded. For those who plan to travel in that direction, the news release points out that the islands are thus nearer to New York than ever before.

The islands were first visited by the Spanish about 450 years ago, their location charted in the late 1800's and again in 1937 by the British Admiralty. During the last war, a still more accurate survey was made in order to establish military and naval bases. Submarine gravity and astronomic surveys resulted in a still different determination in 1957. In 1959, simultaneous observation of high-altitude flares in Massachusetts, Virginia, and Bermuda permitted a two-dimensional triangulation. This remained until the present three-dimensional effort just reported.

In the wake of the well-known "IGY" or International Geophysical Year has come an increasing succession of somewhat comparable international scientific efforts. Each seems to strive for its own identity, and each must of course have its unique problems and its distinct approach. And so we see the "International Years of the Quiet Sun," the "International Hydrological Decade," and the "International Biological Programme." Raymond L. Nace of the Geological Survey heads the U.S. National Committee for the IHD, and Roger Revelle, of Harvard University, the comparable committee for the IBP. Inherent in the enormous efforts necessary to establish and prosecute the great international undertakings are two basic needs: to bring into focus the diverse and often unplanned research undertakings of the several countries involved, and to accomplish by international effort what no single country can possibly manage alone. There is almost certainly an ancillary dividend of international goodwill among scientists involved to be had from the programs.

By means of controlled chemical explosions, geophysicists of the Geological Survey have probed further into the nature of the earth's crust and upper mantle. With the assistance of the Coast Guard cutter Woodrush and Navy demolition teams, explosives were placed at depths of several hundred feet in Lake Superior, and the resulting shock waves studied in a series of three listening lines radiating out to the south and west. The Lake Superior area seems to be particularly efficient in transferring shockwaves and thus is a better-than-average research site. At the depths selected, damage to fish is negligible.

The slow process of trying to uncover the mystery of the "biological clock" mechanisms in living things goes on. Recently, Solomon H. Snyder, Mark Zweig, and Julius Axelrod of the National Institutes of Health have reported that one of the more striking 24-hour rhythms, the serotinin content of the rat pineal gland, is mediated by a central nervous system clock from which the information is relayed to the gland itself through the sympathetic nervous system. Blinded rats continue to show the rhythm, whereas those with certain sympathetic nerve fibers removed do not, indicating the pathway of transmission. The most vexing question, however, is not yet solved, i.e., whether the basic mechanism is endogenous or exogenous, for there still remains the possibility that there are photoreceptors of the external light stimuli other than the eyes.

Although silver production continues to rise, a trend expected to last at least until 1970, the consumption increase far outdistances it. One of the interesting sidelights on this issue is the fact that the bulk of the metal is recovered not from mines that produce silver alone, but from workings which include lead, zinc, copper, or gold. This situation is true also of mines in Canada, Mexico, and Peru, from which we normally import silver; and in all such cases the overproduction of the other metals engenders complex market situations. One likely outcome is intensified prospecting throughout the U.S. West, using the modern gadgetry of the geologist, in the hope of finding additional sources of straight silver ores and, possibly, the exploitation of low-grade sandstone deposits which have hitherto received scant attention.

The atomic age has its atomic garbage disposal problem, and the search for a satisfactory solution is many-sided. It now appears that the crystalline rock some 1500 feet beneath the surface of the Savannah River plant near Aikin, South Carolina, would be an extraordinarily safe repository for some hundreds of years. In the first place, water movement would be at a maximum of perhaps 7 feet per year, depending on degree of fracturing. Secondly, a virtually impermeable layer of clay lies between the rock and the unconsolidated materials above; and thirdly, chemical reactions can be depended upon to tie up the strontium and cesium components of any seepage that might develop. Any one of these barriers, according to Wendell Marine of the Geological Survey, would confine the wastes to the plant area for a time much greater than the 600 years necessary to render them innocuous.

Systematics, the oldest and too often the most maligned discipline in the biological sciences, refuses to die. Rather, it reappears again and again in a new context, the classic example of the old saw to the effect that "if you can't beat 'em, join 'em." The Biophysics Group of the Carnegie Institution's Department of Terrestrial Magnetism, for example, has turned this most fashionable kind of biology into a new approach to the basic taxonomic relationships in vertebrate. For this they utilize a technique whereby fragments of single-stranded DNA from one species are allowed to attach themselves to homologous segments of single-stranded DNA from other species. The extent of this recombination is taken to indicate the degree of homology in the species compared, on the now almost universally held assumption that the polynucleotide sequences held in common between species are indicative of similar genes.

Such is the complexity of the natural environment that man's activities too often bring on undesired results. Where as in the East, removal of vegetation often leads to increased erosion and loss of water from surface runoff, in the more arid West it is becoming necessary to remove plants from as much as 16 million acres of land as a water conservation measure. The so-called saltcedar (Tamarix), introduced from the Mediterranean about 100 years ago, is a prime example of an undesirable phreatophyte, or water-stealing species. Water moving into these plants from the soil is lost at a rate much greater than that from uncovered soil, and may amount in the aggregate to 25-30 million acre-feet per year. Studies are now underway to determine the best method, or combination of methods, to remove the unwanted vegetation and thus save the water for irrigation or to support the growth of desirable forage grasses sown in the cleared areas.

The Sudbury Basin in Ontario, Canada, may well be at once one of the most desolate looking sites and the location of the richest ore deposits in this continent, its nickel supply being valued at a half billion dollars annually. It now appears to Robert S. Dietz that it is the equivalent of a lunar mare, or sea-like depression on the moon. In his opinion, an asteriod or large meteorite impacted about 1.7 billion years ago, resulting in what was probably the greatest explosion in the earth's existence, producing energy comparable to the explosion of seven million megatons of TNT (the largest H-bomb exploded with energy of less than 100 megatons). Unlike other such depressions studied in a ten-year program of research and exploration, the Sudbury basin impact was so great as to melt the underlying rocks, creating a lava which welled up into the crater and congealed into a saucer-shaped body. Earth movement and erosion produced the present contours. Lesser impacts on the earth have produced the Lonar Crater in India, the Ashanti Crater in Ghana, the Vredefort Ring Structure in South Africa, the Crooked Creek Structure in Missouri, and the Wells Creek Basin in Tennessee. These, like the craters on the moon, did not produce a subsequent lava flow.

A recent exhibit in the Smithsonian's Museum of History and Technology has once more underscored the critical importance to the historian and archeologist of primary evidence, this time in the form of the Reifenberg collection of coins. Far more than just an assembly of coins, this collection has been gathered over many years to document the history of Israel, starting with two exceedingly rare copper pieces struck in Judaea under Persian rule, and including the first coins of the Maccabean rulers, those of the Herodian dynasty, and so on. It reflects not only the political changes that repeatedly swept the Jewish peoples, but also their military conflicts with Roman legionnaires.

—*Russell B. Stevens*

Delegates to the Washington Academy of Sciences, Representing the Local Affiliated Societies*

Philosophical Society of Washington	Urner Liddel
Anthropological Society of Washington	Gordon McGregor
Biological Society of Washington	John L. Paradiso
Chemical Society of Washington	Florence H. Forziati
Entomological Society of Washington	Harold H. Shepard
National Geographic Society	Alexander Wetmore
Geological Society of Washington	Luna Leopold
Medical Society of the District of Columbia	Thomas M. Brown
Columbia Historical Society	U. S. Grant, III
Botanical Society of Washington	Peter H. Heinze
Society of American Foresters	Harry A. Fowells
Washington Society of Engineers	Martin A. Mason
Institute of Electrical and Electronics Engineers	George Abraham
American Society of Mechanical Engineers	William G. Allen
Helminthological Society of Washington	Marion M. Farr
American Society for Microbiology	Frank Hettrick
Society of American Military Engineers	H. P. Demuth
American Society of Civil Engineers	Thorndike Saville, Jr.
Society for Experimental Biology and Medicine	Falconer Smith
American Society for Metals	Hugh L. Logan
International Association for Dental Research	Harold J. Caul
American Institute of Aeronautics and Astronautics	Eugene Ehrlich
American Meteorological Society	J. Murray Mitchell, Jr.
Insecticide Society of Washington	Delegate not appointed
Acoustical Society of America	Malcolm C. Henderson
American Nuclear Society	George L. Weil
Institute of Food Technologists	Richard P. Farrow
American Ceramic Society	J. J. Diamond
Electrochemical Society	Kurt H. Stern
Washington History of Science Club	Delegate not appointed
American Association of Physics Teachers	Delegate not appointed

* Delegates continue in office until new selections are made by the respective affiliated societies.

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APRIL 1965

JOURNAL OF THE WASHINGTON ACADEMY OF SCIENCES

This Journal, the official organ of the Washington Academy of Sciences, publishes historical articles, critical reviews, and scholarly scientific articles; notices of meetings and abstract proceedings of meetings of the Academy and its affiliated societies; and regional news items, including personal news, of interest to the entire membership. The Journal appears nine times a year, in January to May and September to December. It is included in the dues of all active members and fellows.

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Back issues, volumes, and sets of the Journal (Volumes 1-52, 1911-1962) can be purchased direct from Walter J. Johnson, Inc., 111 Fifth Avenue, New York 3, N. Y. This firm also handles the sale of the Proceedings of the Academy (Volumes 1-13, 1898-1910), the Index (to Volumes 1-13 of the Proceedings and Volumes 1-40 of the Journal), and the Academy's monograph, "The Parasitic Cuckoos of Africa."

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ACADEMY OFFICERS FOR 1965

Some Moral and Religious Implications Of Nuclear Technology*

William A. Wallace, O.P.

Catholic University of America

As a basis for discussing the actual state of relations between science and religion in the 1960's, I should like to report briefly on an interdisciplinary conference held at the University of Chicago two years ago (1). Its purpose was to discuss social ethics in the context of problems raised by radiation effects of nuclear technology. The conference was attended by some 20 scientists and theologians from different parts of the world. The scientists were mainly physicists and specialists in nuclear medicine, and the theologians represented the major Judeo-Christian religions. A marked divergence of opinion developed among the participating theologians as to the morality of further developments in nuclear technology. I shall sketch this divergence for you by first summarizing some remarks of those who were against this development, and then presenting a more abbreviated conspectus of the opinions in its favor.

Arguments Pro And Con

One of the most articulate spokesmen against nuclear technology was the Orthodox Jewish spokesman, Rabbi Abraham Heschel, of the Jewish Theological Seminary of America. His main emphasis was on a proper hierarchy of values; for him, man and life are far superior to any material needs. Life, he observed, is sacred, and must be treated with reverence by the scientist; he wondered whether this was the case. In his view, material benefits of nuclear energy must always remain secondary to the preservation of life. Modern man must sacrifice many of his conveniences if he is to work out his divine destiny.

Along similar lines was the criticism of a Greek Orthodox spokesman for the World Council of Churches, Nicos Nissiotis. He saw the materialism associated with science and the pragmatism of its technology as anti-theistic movements that base their philosophy on man's possibilities alone. The radiation problem, in his view, highlights the dilemma in which modern man finds himself because he is trying to create an anthropocentric paradise. As he put it, nuclear energy is the culminating achievement of an age of science that can now lead Almighty Man to suicide, with the accompanying destruction of his self-centered universe. He castigated religious leaders for having permitted this materialistic attitude to dominate our culture, for being afraid to point out that man is a divine creature. The churches, in his view, must give up their present luxuries, abandon their secular methods and their cooperation with governments, and wholly preach the message of God to a world enslaved by science.

Less castigating in his attitude, but nonetheless concerned over the development of technology, was the Indian theologian, Joshua Chandran of the United Theological College in Bangalore. In the abstract, as he saw it, man finds liberation and freedom by subduing nature and exploiting her resources. But he was definitely concerned over the effects of nuclear and other

* An address before the Washington Academy of Sciences on January 21, 1965.

modern technologies on the dignity of the human person, which he felt was not always safeguarded in each nation's concern for its own security and well-being.

The French spokesmen, George Casalis of the Protestant Theological Faculty of Paris and Dominic Dubarle of the Catholic Institute of Paris, while not opposed to the development of nuclear technology, expressed concern over its tendency to increase still further the gap between the advanced and the backward nations. One of the basic causes for group tensions and wars seems to be the unjust and unequal distribution of wealth and resources among the peoples of the world. If nuclear technology is part of God's gift to man, the wealth it develops cannot be merely for the benefit of one particular group or nation, but must be used for the good of all. They expressed grave doubts whether such an equitable policy will govern the growth and application of nuclear technology. Father Dubarle also brought up the case of the malformed infants born because of a too hasty use of thalidomide, and called for very great prudence in evaluating the potential risks society will face from increased radiation hazard.

As opposed to these somewhat negative attitudes, more favorable evaluations of nuclear technology were forthcoming from a number of representatives. Among these was the foremost theologian present, Paul Tillich. In reflecting on the "philosophy of risk" proposed by a number of the scientists present, Dr. Tillich developed the point that faith itself involves risk. While conceding that risk is basically human, he was willing to argue that it is found even in the divine. When God created man, he said, God took a risk Himself. The very existence in Paradise of the tree of knowledge of good and evil introduced an element of risk into man's eternal destiny. He felt that the notion of risk is intimately connected with man's freedom and his efforts to realize his God-given potentialities. And he stressed, in opposition to other spokesmen, that any attempt on the part of religious leaders to suppress scientific research and technology would be a sin against truth and against freedom.

More rational in their approach to the moral and religious problems raised by nuclear technology were a number of theologians who had previous backgrounds in the physical sciences. Among these were the Catholic theologians, both Anglican and Roman: myself, who had previously been an electrical engineer and physicist; Father Dubarle, who had done work in cosmic radiation; William Pollard, the Episcopalian minister in charge of the nuclear institute at Oak Ridge; and Robert Cecil Mortimer, Lord Bishop of Exeter, England, who had worked with the British scientists at Harwell. Their efforts were directed toward investigating the proportionality between the good done to mankind through the use of nuclear energy and the evil concomitantly or subsequently produced. They distinguished between physical and moral evils, and questioned whether radiation is completely different from other physical evils to which man is exposed, whether it produces unique harm, and whether the genetic and carcinogenic effects can bring the human race to a catastrophic end.

Another sympathetic analysis was that provided by Joseph Sittler of the Chicago Divinity School, who used the concept of nature to good effect in his arguments. He stated that man is not opposed to nature, but is a part of it himself, and must learn to live in and control its environment by every technological means possible.

The remaining theologians present were more neutral than pro or con; much of their indecision seemed to come from a lack of knowledge of the present state of the nuclear art. They represented all denominations: Rabbi Ralph Simon of Chicago; Father Felix Morlion, the Papal representative from Vatican City; a Japanese theologian, Masao Takenaka; and others. They wished to reserve judgment, but urged serious study of the moral and religious problems facing mankind collectively in the 20th century. Foremost in their minds was the development of social, legal, and political instruments that will make it extremely difficult (if not impossible) for one group or nation to kill off other groups or nations by their technological advance. In this way, they felt, it might be possible for all men to realize material and spiritaul freedom through the medium of technology.

Reasons for the Divergent Opinions

Although some basic unanimity manifested itself, the theologians present, even those of the same denomination and background, were divided on the moral and religious issues raised by nuclear technology. The reasons for this divergence of opinion are difficult to analyze. I shall attempt now to give some thoughts of my own on the subject, while incorporating some explanations that have been proposed by others in discussions of the conference (2).

First, and most obvious, was the difference of opinion that could be traced to the degree of technical information or scientific background possessed by the theologians present. Those who had a scientific formation prior to their entrance into the ministry seemed more open to, and more favorably disposed toward, proposals for technological advance. Perhaps one could generalize and say that theologians, like everyone else, have a fear and distrust of the unknown. Their reaction is liable to be negative toward any advance that they do not fully understand. By the same token, however, the ignorance of mankind in general, including scientists, concerning the long-range effects of radiation prompts everyone to have a sober attitude when evaluating its potential hazards.

Second, somewhat related to differences in background, a difference of attitude could be discerned in theologians recognized as "liberal" and others recognized as "conservative." The liberal group, more open to change and adjustment and pragmatic solutions, were not noticeably disturbed by the problems of nuclear technology. The conservative group, on the other hand, more attached to tradition and perhaps more aware of the wide gulf between God's way of thought and man's way of thought, were not so willing to rationalize the problems away. It should be observed, however, that all agreed that radiation presented a problem in social ethics of a different order of magnitude from that presented by other noxious effects of technology. The theologians, as a group, were certainly more concerned over the sacredness of life and man's unique personal dignity in creation than were members of other professions who attended the Conference.

Third, related to this concern for the sacredness of life, there seemed to be a resistance on the part of a number of theologians present to any attempt to quantify life as a value, and subject it to the same type of minimax calculation as other variables. Those more acquainted with mathematical techniques were amenable to the extension of these methods in the social sciences, but wondered whether such sciences should or could be normative, and how the problem of value, particularly where questions of life are concerned, could ever be solved to everyone's satisfaction.

Fourth, the influence of political and socioeconomic pressures clearly manifested itself in the thinking of theologians. The opposition of the French theologians, both Protestant and Catholic, to the extension of nuclear technology seemed to be rooted in their concern over a continued imbalance in political and economic power among the nations of the earth. The same type of concern was voiced by the Indian and Japanese representatives. In the Catholic tradition (and here I include both Anglicans and Romans), the continental view (i.e., French and Italian) was negatively influenced by political and economic considerations, whereas the Anglo-American view was optimistic, based at least partly on the confidence of the participants in the ability of Anglo-Saxon methods and technology ultimately to solve man's pressing problems.

Fifth, part of the diversity seemed traceable to a difference in doctrinal commitments on the part of the theologians present. In the thinking of some, there was an implicit affirmation of a complete dichotomy between the divine and the human, between the order of grace or supernature and that of nature itself. Those committed to this view felt that man could achieve his supernatural destiny only by rejecting the things of this world and, along with them, the products of an enlightened technology. They viewed nuclear developments negatively, but would probably have viewed similarly any advance along technological lines. Theologians, on the other hand, who felt that the order of nature could be subsumed under that of supernature, or that material progress need not be incompatible with spiritual progress, or that material goods are necessary for spiritual life, were more disposed to see good, rather than evil, in the promise of nuclear technology.

Although not immediately relevant to divergence of theological opinion, I should note that there was also a difference of opinion, or perhaps I should say concern, manifested by the scientists who were present at the Conference. In general, those who professed no religious commitment themselves were patently annoyed by the adverse criticism of theologians; apparently, they had regarded their own work as eminently reasonable and had expected the theologians merely to rubberstamp their conclusions with approval. Scientists who professed a religious commitment, on the other hand, seemed to have a deeper appreciation of the values at stake, and sought more energetically to define the areas of controversy and come to some type of compatible understanding.

A Proposed Solution

From the foregoing, it may perhaps be clear that it will be difficult ever to attain complete agreement on the moral and religious aspects of nuclear technology. Some measure of agreement, however, appears to me possible, particularly if scientists and theologians can be encouraged to cooperate, in interdisciplinary discussion, with the aim of clarifying issues and exploring the alternative solutions that are open to us. For such discussions to initiate, the desideratum would seem to be a nucleus of theologians with previous training in science and of scientists who themselves are sympathetic to the religious commitments that characterize our Judeo-Christian culture. Exploratory attempts, moreover, should be initiated with those who are liberal-minded, *i.e.*, more open to discussion and to a consideration of alternative hypotheses; only then should the enterprise be opened to the more conservative and hidebound variety of thinker. Again, since the problem is a "reasonable" one, I think that a rational and objective approach should be attempted, granted that many religious values are highly subjective and not open to the universal consensus given to scientific data. This would entail a view of the supernatural as distinct from the natural, as in some way above it, but as not being irrevocably opposed to the order of nature. Even within the order of nature, moreover, an implicit recognition of a hierarchy of values would seem to be a necessary prerequisite to the type of discussion I have in mind. Regardless of how men feel toward God and their obligations to Him, there must be some type of recognition of man's primacy in the universe, and in general of the superiority of the living to the nonliving. Again, it seems to me that this problem can be discussed only in the context of man's situation on earth, which seems to have necessarily associated with its evils as well as good. In other words, without a frank recognition of the inevitability of evil and suffering in the world, it may never be possible to come to a solution to this problem—at least one that proposes a course of action designed to yield the lesser of two evils (3).

The evils that result from increased nuclear technology seem to be associated, in one way or another, with the deleterious genetic effects associated with increased radiation. My personal evaluation is that present knowledge of such genetic effects does not substantiate the almost hysterical fears that have been voiced by some. General studies of gene mutations show that these can be divided into two classes: (1) those that proceed spontaneously, and (2) those produced by known external agents such as artificial activity and chemicals. Present data reveal that only 10 percent of so-called "spontaneous" mutations are produced by the cosmic and solar radiation to which terrestrial organisms are subjected. The remaining 90 percent must be attributed to unknown causes, possibly due to chemical influences localized within individual cells(4). If this information is correct, then radiation due to nuclear energy sources causes no effects that are absolutely unique in human experience. Present indications are that chemicals found in aspirin and caffein can produce genetic mutations comparable to those of radioactive sources. Because radiation is so easily measured, it is true that we now have clearer knowledge of the extent of genetic damage produced by this source. But future scientific research will make comparable data available on other factors, and there is no reason to suspect that those due to radiation will be found to be greater than ordinary.

Some thinkers will object to such a solution because they regard all radiation to which man is subjected as evil. They defend such a position on the ground that no detectable threshold exists below which man is free from the danger of increased genetic mutations. This presents an interesting problem for the theologian, because, according to this view, even the natural radiation in which man lives is an evil. The theologian who regards nature as God's handiwork, and therefore as a good that can be elevated to the order of supernature by God's grace, will disagree with this. He regards natural radiation as part of man's God-given environment. For him, man's natural habitat was intended by God and as such is good. His approach consists rather in accepting the order of nature and then ascertaining how much man can justifiably disturb that order, in this case by adding to, or filtering out, radiation.

If the normal background of radiation is not an evil, it should follow as a corollary that any background of radiation comparable to the natural background cannot itself be regarded as seriously evil. If this be accepted, it becomes possible to apply quantification techniques that can yield results acceptable to scientists and theologians alike. For example, if the normal background owing to natural causes in a particular area is 0.19 rem per year, an increase of this background to 0.11 rem per year through nuclear technology, *i.e.*, an increase of 10 percent, could hardly be regarded as seriously evil. Again, if the area where a nuclear power plant is built has a lower natural background than another area, it would seem permissible to increase the background by industrial radiation provided the background in the area of the plant remains lower than the natural background in another locality. This type of analysis would give considerable freedom to nuclear technologists, it might be noted, since natural backgrounds vary widely over the face of the earth. In some localities of India, for instance, the normal background is ten times the mean value for other parts of the world. A permissible increase of ten times the mean background would give nuclear engineers ample room not only for power-plant development but for a host of other industrial devices. And even though this might increase danger to the human race, it might also be morally justifiable from the good effects to be expected from the peaceful use of nuclear energy, particularly by way of equalizing the fuel resources of the nations of the world (5).

Science, Religion, and the Future

A solution along lines such as these may suggest how one can justify the continued expansion of nuclear industry in accordance with the accepted principles of morality and religion. I propose this only as exploratory and tentative and welcome your discussion and criticism of any of the points mentioned. In conclusion, I should like to suggest that a closer cooperation between scientists and theologians may well be in the offing as technology becomes more and more sophisticated. Apart from the uses of nuclear energy, the most striking innovation in our time is that of automation, or, to use the newer term, cybernation—the replacement of the working man by the machine. Sociologists tell us that we are only at the beginning of the cybernation process. Only one percent of the heavy industry that can be automated in the United States has thus far been adapted to the new equipment. We have yet to see what a fully automated business office or a fully automated bank will look like, but we have every reason to expect that they will be far more efficient than our present facilities and that they will be run by only a small fraction of the people they now employ.

If this process works—and it seems only a matter of time that it will—we are faced with the prospect of cybernation's putting a major portion of our work force out of work permanently. This could result in a breakdown of the economic system as we now know it. Now some have proposed, somewhat unrealistically, that we should put a stop to automation right now, just as others have urged that we abandon the use of nuclear energy. In my mind, the argument against the one is just as ineffective as that against the other. We cannot prevent men from thinking or from using their ingenuity to get the most work done with the least effort. We cannot place arbitrary limitations on free enterprise and still exist as the democratic nation we now are.

There is one other possibility, one suggested to me by Donald M. Michaels (6) and others who have participated in the Washington Colloquium on Science and Society (7). In this possibility, religious values and motivation might assume a transcendent importance. It could happen that machines would not put most people out of "work" permanently, because "work" may begin to take on a new aspect in the twenty-first century. Machines will take over the work people have been doing up to now—yes, that is true—but they will leave men free to do types of work they have never attempted before on a large scale. What kind of work could this be? Creative and intellectual work would be one answer, and this as opposed to manual labor, what man does "by the sweat of his brow." But a more significant answer, from the viewpoint of religious values, would be a type of work that all could do, regardless of their intellectual ability. We might characterize it as *work in the service of others*—the Peace Corps illustrates the concept very well. Not all work need be in production, in competition with a machine. The rendering of personal service is something that a machine can never do, but oddly enough we have not yet scratched the surface on the ways in which service to others can assume a prominent role in our society.

If ever we have to come to the guaranteed annual income for everyone—and I enjoy it right now, it seems—if we wish to avoid a decadent society, we must generate motives in society for doing things apart from making money or attaining the conventional status symbols. Such work (and it *can* be work, I assure you) will not follow the present economic pattern. It will not be profit motivated; it will not be advertising oriented; it will not be competitive; it need not be efficiently oriented. To educate people for this work will require a complete change of educational concepts. It will mean the abandonment of training—and that is what most of our "education" now is—and a substitution of values that I would characterize as predominantly religious and spiritual. In a word, it will open the way for the closest possible cooperation between science, technology, and religion. And it will put a greater emphasis and a greater burden on religious institutions than has ever been experienced in human culture, at least since the close of the thirteenth century.

Jacques Maritain once remarked that spirit never seems to keep pace with the rate of development of matter. This may have been the story of civilization to the present. To see that it does not remain the story is the challenge facing every religious-minded scientist as he looks forward to the beginning of the twenty-first century.

Notes

(1) The conference was held at the University's Center for Continuing Education from January 16 to 18, 1963. It was convoked jointly by Jerald Brauer, dean of the Divinity School, and by John H. Rust, head of the Section of Nuclear Medicine, and was supported by a grant from the Rockefeller Foundation.

(2) A rough draft of this paper was presented at a meeting of the Washington Colloquium on Science and Society at American University on December 17, 1963. The author wishes to thank the discussants for the many helpful comments he has been able to incorporate into the paper as it now appears.

(3) As a further point, because so much of our technological civilization is bound up with the socio-economic structure of Western society, it would seem well to prescind from immediate problems of a political and economic nature when discussing the absolute morality of nuclear technology.

(4) These figures, admittedly rough estimates, were furnished to the conference by Dr. Buzzati-Traverso, director of the International Laboratory of Genetics at the University of Naples.

(5) For a fuller explanation of the arguments that could justify increased nuclear technology through an application of the "principle of the double effect," see the author's article, "Radiation and Social Ethics," in *America*, Vol. 108, No. 25 (June 22, 1963), pp. 880-883.

(6) Institute of Policy Research, Washington, D.C. See Dr. Michael's paper, "Cybernation and Social Change," condensed transcript of a Seminar on Manpower Policy and Program, U. S. Department of Labor, Washington, D.C., April 23, 1964.

(7) Particularly E. G. Mesthene, executive director of the Program on Technology and Society, Harvard University, and W. H. Ferry, vice president, The Fund for the Republic, Inc., Center for the Study of Democratic Institutions.

A Role for Science In Controlling the Nuclear Threat*

Edward N. Parker

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In approaching the subject of possible contributions of science to arms control, I believe it worthwhile to quickly survey the essential desires of the people of the United States. What *do* we want and what are the problems involved in satisfying these wants?

Two desires of overriding importance can be identified:

To remain free; and

To survive.

These two are interdependent; we do not want either to be free but dead, or to survive as puppets of Russian or Chinese masters.

Two others also are important:

To live in a peaceful world; and

To improve our lot—and, as an almost revolutionary concept on a national scale, to improve the lot of others.

These fundamental wants of ours are simple and seem reasonable, but as we look around the real world in which we live, it is obvious that the actions necessary to satisfy them are far from simple, and at this time, it is not reasonable to expect to satisfy them simultaneously.

To remain free, we must keep the Communists from expanding their system over the rest of the world and eventually over ourselves.

To survive, we must put an end to the threat of total destruction of our people and society posed by the modern weapons of mass destruction in the hands of those hostile to our interests.

Today these imperatives require that we maintain strong and costly military forces equipped with the most powerful weapons available to us, even though we recognize that the security gained is by no means complete.

However, to live in a peaceful world requires more than just the absence of active war. Three hundred years ago, Spinoza said: "Peace . . . is a virtue, a state of mind, a disposition for benevolence, confidence, justice." It is obvious that we humans have not yet arrived at that point in our development and that, for the time being, we will have to settle for the absence of war which impinges actively on us. Again, this requires that we remain militarily strong.

To improve our lot and the lot of those around us, we would like to be able to use more of our resources for the programs important for these purposes. A most attractive method would be to reduce the requirements for the military forces needed to satisfy the first three wants. Yet our commitments and involvement, and their costs, are increasing.

Thus we face a dilemma:

We need to be militarily strong all over the world, but we would like to reduce military expenditures; we want to live in peace, but we need to prepare for war.

We do not want to be threatened by weapons of mass destruction, but we threaten others to deter the possibility that they will use such weapons against us.

In this situation it is only natural that people turn their thoughts to arms control and disarmament as offering hope for a solution.

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*An address before the Washington Academy of Sciences on December 17, 1964. $R

Ideas for arms control and disarmament are not new, but the current emphasis is strongly motivated by the threat of total destruction to whole nations and people posed by modern weapons, particularly the ballistic missile with its thermonuclear warhead.

The term "disarmament" covers a spectrum of possible actions, but serious, realistic consideration of it has been hindered by the fact that the discussion between the United States and the Soviet Union has been principally in terms of general and complete disarmament, either Russian style —"under strict international control"—or U.S. style—"in a peaceful world." Yet Communists will not permit strict international control of any kind, and therefore the discussion has become little more than propaganda. Too often ideas that are within the realm of possibility are dismissed as inconsistent with our general and complete position on disarmament.

However, arms control has possibilities, as events have proved. Some arms control measures and possibly some minor reductions in armaments would be mutually acceptable and beneficial.

Unfortunately, the recent entry of Red China into the "nuclear club" and its subsequent increase in hostility to the United States and to peaceful co-existence with the West present threats to both the Soviet Union and ourselves. Therefore the prospects are quite long-term, and currently we are in a period where further agreements are unlikely to be reached soon. This period provides an opportunity to develop a modest program for arms control and disarmament.

I have supported this course, which I call "the gradual approach," and I believe that meaningful progress can be made only by such methods.

A different kind of arms control involves establishing a defense against the threat to our people and society that is capable of reducing the damage below that which would occur under present conditions, should our deterrence fail for any reason. The Pentagon calls this a "damage limiting posture."

Secretary of Defense McNamara, in his speech at Ann Arbor in June 1962, described a counterforce strategy as an option which might possibly coerce an adversary into adopting counterforce himself, thus avoiding the mutual holocaust of a "cities only" strategy.

In his annual statement to the Congress on the 1965 defense budget, Mr. McNamara sought to clarify "the basic fundamentals of the strategic problem confronting our nation in the nuclear age." He described in considerable detail his concept of military strategy and introduced the term "damage limiting strategy."

Mr. McNamara described and commented on two other theories or strategies. One he termed the "overkill theory"—a "deterrence only" strategy—namely, that the U.S. already has enough nuclear weapons to destroy all the major cities of the Soviet Union several times over and thus needs no more. The second he termed the "full first strike theory," which he described as the belief "that we should build a strategic force that would enable us, if we struck first, to so reduce Soviet retaliatory power that the damage it could then do to the U.S. population and industry would be brought down to an 'acceptable level,' whatever that might be."

He concluded that "while a 'cities only' strategic retaliatory force would, in our judgment, be dangerously inadequate, a 'full first strike' force, as I defined it earlier, is, on the basis of our estimates of the Soviet nuclear strike forces in the fiscal year 1967-69 period, simply unattainable. Moreover, I know of no responsible Pentagon official, certainly none of the Joint Chiefs of Staff, who proposes such a force . . ." Thus, a 'damaging limiting' strategy appears to be the most practical and effective course for us to follow. Such a strategy requires a force considerably larger than would be needed for a limited 'cities only' strategy. While there are still some differences of judgment on just how large such a force should be, there is general agreement that it should be large enough to ensure the destruction, singly or in combination, of the Soviet Union, Communist China, and the Communist satellites as national societies, under the worst possible circumstances of war outbreak that can reasonably be postulated, and, in addition, to destroy their war-making capability *so as to limit, to the extent practicable, damage to this country and to our allies*" (italics added).

Thus in January 1964 the damage limiting strategy was essentially a survivable counterforce capability composed of protected Minutemen and Polaris missiles, presumably (and this is my presumption) because a reasonably effective defense against Soviet intercontinental systems was not available.

Study of the problems of a counterforce strategy, over the range of possible situations in which our strategic capabilities might have to be employed, makes it obvious that a damage limiting capability based solely on counterforce places a high premium on a U.S. first strike, a course of action that our leadership has abjured.

Therefore, if a damage limiting strategy is to be adopted and implemented, we must provide damage limiting measures other than counterforce. However, a full damage limiting posture makes a great deal of sense, and study of its possible effectiveness indicates immense potential strategic significance.

The elements of a damage limiting posture depend, of course, on how our survival is directly threatened, and in the short term would consist of coordinated programs for shelters, air defense, ballistic missile defense, national recuperation, and, possibly, anti-submarine warfare.

These, added to our strategic offensive capability, could to a large extent remove our population from their present positions as complete hostages to the intentions and actions of our avowed enemies and would greatly improve the chances that our nation would both survive and remain free.

The establishment of a reasonably effective defense to thermonuclear attack on our cities and people offers us a number of other advantages:

1. It could reduce the concern over accidental or inadvertent launch of missiles against us.

2. It might permit a somewhat lower level of readiness on the part of our national civilian and military leaders and thus reduce the tensions inherent in the present situation.

3. It would reduce the threat inherent in the proliferation of nuclear weapons now underway, and make the catalytic action of foreign flareups of lesser import.

Moreover, should deterrence fail, the loss of people, industry, services, and recovery capability could be greatly decreased, probably to the point where the nation, though grievously hurt, would still survive.

Arms control and defense as an arms control measure are not mutually exclusive. Some measures of arms control and disarmament could assist the defense; some defense could promote the possibility of agreements on arms control measures and reduce some of the hazards. Pursued in parallel and mutually supporting, they both aim to control the threat to us as a people and a nation and make it more likely that war, if it could not be prevented, would not be a complete holocaust.

Adding a damage limiting posture to our current capabilities will not reduce military expenditures—it will increase them. However, a combination of a reasonable arms control and disarmament program and a damage limiting posture can provide us with a relatively sound basis on which to face the future.

What contributions can science and scientists make to arms control and to defense as an arms control measure?

The gradual approach—a program of small actions or measures of arms control and disarmament consistently followed—provides some possibility of advancing toward the goal. Furthermore, such a program would, in time, test the sincerity of those involved and serve as a trial of the procedures that must precede meaningful actions or agreements.

One of the major obstacles in all discussions with the Communists is that of "verification," as we call it, or "control," as they label it. With the "closed society," it is meaningless for us to enter into an agreement unless we can determine whether the agreement is, in fact, being carried out. The question is not whether the Communists will abrogate an agreement that has ceased to be in their interest; of course they will. What we need to know is whether, and when, they will take action contrary to the agreement. Each step of a gradual approach depends on the previous steps—on the experience gained and the faithful discharge of the commitments made.

Verification of arms control agreements involves many problems, and they are by no means one-sided. Effective inspection in the closed societies would, under almost any circumstances, provide a greater exchange of information than the Communists will agree to at this time. But effective inspection of a substantial disarmament agreement would also pose very considerable problems in a Western society. This is an additional and important reason for the small beginnings of the gradual approach.

To summarize the position:

1. We cannot expect rapid progress.
2. Large measures are unrealistic, and concentration on them is positively harmful.
3. A program of small beginnings makes sense.
4. An ability to verify is an element of all actions.
5. Procedures for verification must be tried and found to be satisfactory before we depend on them.
6. At this time the Communists refuse inspection that provides the exchange of substantial amounts of information.

Therefore the arms control and disarmament measures that we pursue are those which lay the foundation for future progress which will come about when the conflict that causes the arms race declines in intensity and moves to the point where major changes are possible without jeopardizing the essential desires of our people.

In consequence, one of the more important contributions that science can make to arms control is to assist in the development of the types of arms control actions or agreements, and their tested means of verification, which can lay the foundation for future progress. To be useful, the means of verification must cause a minimum of disruption of the respective societies and permit the maintenance of that freedom of the individual normal in the society.

Science, scientists, and engineers can make major contributions to the goal of controlling the threat by limiting the probable damage to our people and society, should we be attacked.

Members of the scientific community seem to be leaders in the cry that defense against ballistic missiles is impossible, too expensive, or whatever is the popular argument of the moment.

What are some of the arguments used against a ballistic missile defense?

1. *The offense is always ahead of the defense.* This is not strictly true, but it certainly approaches being true if all resources are concentrated on offense.

2. *It's a "Fortress America" concept.* On the contrary, it would permit us greater freedom in the use of our national power and capabilities in support of our worldwide objectives and commitments by reducing the value of "rocket rattling."

3. *It's too expensive.* Careful study should show that the cost exchange ratio is not nearly as one-sided as has been supposed.

4. *It would de-stabilize the present "balance of terror," so called.* Nothing in the present world situation would provide greater stability of the type we want than a reasonably effective defense for a large part of the people and industry of the U.S.

5. *A completely effective defense is im-*

possible and a less than completely effective one is of little value. President Johnson and others have stated that, with no defense, our casualties in nuclear war would exceed half our population. The defense provided by a damage limiting posture will reduce casualties and save some of the industry and services which support our people.

How much will a defense save? It depends on how much we put into it of scientific and engineering skill and of our resources.

A defense adds another deterrence to nuclear attack. At present the planning factors in the enemy's calculations of his offensive effectiveness are known to him. The existence of a defense would add an unkown factor to complicate his planning and to limit the assurance of political decision makers when they consider general war as a possible course of action.

This is a really major contribution that science and scientists can make to fulfill the fundamental desires of our people to control the threat which confronts both our freedom and our survival: by thinking of ways to defend us against this threat, rather than of why it is impossible or why we shouldn't do it.

During the last war, when I was in the Navy's Bureau of Ordnance, a letter came in from the head of one of the Maritime Academies, enclosing a suggestion by one of his faculty for improving the terrible ordnance equipment we were providing the armed guards in merchant ships. The letter went something like this:

"As a longtime engineer I am doubtful of the value of the enclosed suggestion, but I have lived long enough to know that I am not capable of saying there is absolutely no merit in another man's idea; therefore I forward the suggestion to you."

I have lived long enough in this wonderful period of scientific and technical progress to believe that just about any problem in engineering or technology can be solved if we put our minds to it.

There are major contributions which science and scientists can make, but the biggest one I can see is to work positively to satisfy the essential wants of our people and those of like mind.

Academy Proceedings

April Meeting

(488th Meeting of the Washington Academy of Sciences)

SUBJECT: **CONVERSAZIONE**

DATE: **THURSDAY, APRIL 15, 1965**
Beginning at 8:15 p.m.

PLACE: **JOHN WESLEY POWELL AUDITORIUM, COSMOS CLUB**
2170 Florida Avenue, N.W.

Fellows and members of the Washington Academy of Sciences are invited to an informal interdisciplinary *Conversazione*, a social evening for discussion of ideas and problems with cup or glass in hand. A few special guests also have been invited.

Participants may move from table to table to discuss any subjects of mutual interest. Some of the suggested subjects are:

What is a scientist? Who speaks for science?

How to achieve excellence in government in-house scientific institutions?

What limits should be set to federal support of scientific education and research?

Is science significantly lengthening the life of persons already past 20?

How should the Civil Service select scientists?

How to balance support of research in the most competent institutions with the improvement of other institutions on a basis of geographic distribution?

Is automation destroying or increasing the good life? Is privacy obsolete?

What is the impact of federal research grants on teaching?

How to develop at least one great university in the capital of the United States?

Should the Washington Academy of Sciences continue the type of lectures it has sponsored since last October?

Is the Citation Index sufficiently useful to scientists to justify its cost?

Cocktails, coffee, soft drinks, and snacks will be complimentary. Advance reservations are required. Reservation cards have been mailed to Academy members.

BOARD OF MANAGERS MEETING NOTES

February Meeting

The Board of Managers held its 570th meeting on February 18, 1965 at the Cosmos Club, with incoming President Leo Schubert in the chair.

The minutes of the 569th meeting, previously distributed, were approved with a minor correction.

Announcements. Dr. Schubert distributed a list of current officers, managers, delegates, and committee chairmen. He noted that since incoming Treasurer Miller had a broken ankle, Dr. Henderson would continue to function as treasurer until Mr. Miller had recovered.

Dr. Schubert asked for comments on the desirability of establishing a new panel in the Committee on Membership, to be concerned with the behavioral sciences. There was considerable discussion as to which social sciences qualified for membership in the Academy. It was left that a trial panel in the behavioral science area would be considered.

Secretary. Secretary Forziati reported that the annual dinner on January 21 had cost the Academy $357.26, of which $132.00 was for complimentary dinners and $88.50 was due to a 75-cent subsidy on 118 paid dinners; also, that the Cosmos Club had a 10 percent surcharge on dinners and beverages and a charge for extra help, amounting to $88.56. He suggested that, in planning future dinners, the Academy should consider raising the price or finding another meeting place.

Membership. On the motion of Chairman Cook, the following persons were elected to fellowship in the Academy: Morton Beroza, Max A. Kohler, Lester Machta, David W. Fox, Ryszard Syski, Clifford J. Maloney, Elio Passaglia, John S. Rinehart, James W. Butler, Glenn W. Brier, Albert V. H. Masket, Richard C. Roberts, and Robert Lado. Dr. Cook reminded the Secretary to inform those new fellows who had received Academy awards, that they would not be required to pay dues for the first year of fellowship.

Dr. Cook reported that at its meeting of February 2, the Committee had elected the following persons to membership: Elvira A. Euler, John G. Honig, Gary B. Jordan, and Ernest E. Saulmon.

There followed a discussion on procedures for promoting members to fellows, and for submitting the names of Academy award winners to the Board for election to fellowship. It was pointed out that it is the responsibility of the Awards Committee to assure that award winners are elected to fellowship, but that the nominations must go through the Membership Committee; further, that the Membership Committee should review the member list for potential fellow candidates. Dr. Cook suggested that the Committee on Membership Promotion should flag the names of candidates for membership, who might be eligible for fellowship status in a year or two.

Meetings. In the absence of Chairman Steinhardt, Dr. Schubert reported that the Committee had firmed up the 1965 meetings through June, and was working on the program for next fall and winter.

Awards. Chairman Mason asked the delegates of the affiliated societies to publicize WAS award winners in their society journals so as to generate greater interest in the awards and thereby increase the number of nominees.

Grants-in-Aid. On recommendation of Dr. McPherson, the Board approved a grant of $80 to Alan Gillespie, a student at McLean High School, to aid in his spectroscopic studies of the Martian atmosphere. It was noted that the recommendation had been endorsed by Father Hayden of Georgetown Observatory, under whose guidance the work was being done, and by Charlotte Sitterly of NBS.

Encouragement of Science Talent. Outgoing Chairman Heyden reviewed the Committee's activities over the previous year. As advisor to the Washington Junior Acaemy of Sciences, he had attended all meetings of the WJAS governing council, held at Georgetown Observatory. One recurring activity of WJAS is an annual convention during the Christmas holidays. The 1964 convention was addressed by Glenn Seaborg on the subject, "Post-uranium Atoms." Four hundred students attended, and many student papers were presented. Abstracts of these papers have been printed, and are included in the proceedings of the Junior Academy, which are available at a dollar per copy. The convention was held at Georgetown University, with dinner at the Georgetown cafeteria and showed a profit of $175; by contrast, the conventions of previous years, held at hotels, resulted in deficits.

The Junior Academy also made a profit of $2,000 on its field trips to New York and Philadelphia. Father Heyden wondered whether the customary annual WJAS donation to the Joint Board of Science Education should be discontinued; he felt that this donation, used to finance teachers and student science fair winners attending national science fairs, benefitted relatively few people, whereas a donation of, say, $500, contributed to the summer school program, would secure jobs for many students. Dr. Schubert felt that a decision in this matter should be made by the Junior Academy itself, rather than by the senior Academy. In response to a question from Dr. Leikind, Father Heyden stated that membership in the Junior Academy was based on a system of credit points, earned by recommendation of a science teacher, by giving a paper at a WJAS convention, or by winning a science fair prize. Ten points are required for membership; there is no age limit.

Public Information. Outgoing Chairman Davis reminded the Board that there would be a display of science fair projects on February 27; about 40 displays were expected to be exhibited.

Archivist. Dr. Farber noted that the Academy was no longer exchanging journals with other scientific organizations. However, a large amount of diverse literature had accumulated from previous exchanges; he planned to tabulate this material in some orderly manner.

Journal. Editor Detwiler reported that the February issue of the Journal had been put in the mails a week previously, in time to publicize the general meeting of February 18, and that copy for the March issue had just gone to the printer.

New Business. Dr. Schubert announced that some time previously, Academy members A. T. McPherson and Ralph Siu had addressed a convention of the Dairy and Food Industries Supply Association; that they had been offered, and had declined, honoraria amounting to $300; that the Association had therefore offered a $300 check to the Academy, to be used for objectives of the Committee on Grants-in-Aid of Research; and that the check would be presented by Messrs. Cunningham and Williams, on behalf of the Association, at the general meeting on February 18.

BOARD OF MANAGERS MEETING NOTES INDEX

Condensed minutes of the Academy's Board of Managers meetings have been published in the Journal for 1960 and subsequent years, as follows:

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Science in Washington

CALENDAR OF EVENTS

April 12-13—Georgetown University, First Annual Louis Pasteur Science Lectures

Tracy M. Sonneborn, Distinguished Service professor of zoology, Indiana University, "Cell Differentiation." (Second and third lectures in a series; the first was delivered on April 9.)

Gaston Hall, Healy Building, Georgetown, University, 4:00 p.m.

April 14—American Society of Heating, Refrigeration & Air Conditioning Engineers

Nash M. Love, consulting engineer, Washington, D.C., "Economic Study Justifies All-Electric Heating."

Presidential Arms, 1320 G St., N.W. Social hour, 5:15 p.m.; dinner, 6:15 p.m.; meeting, 7:30 p.m.

April 20—Anthropological Society of Washington

Walter Miller, Boston University, "Culture of Lower-class Americans."

Room 43 (ground floor), Natural History Building, 10th St. and Constitution Ave., N.W., 8:15 p.m.

April 28—Trinity College, Science Bureau Lecture Series

Mary I. Bunting, commissioner, Atomic Energy Commission, "The Education of Women in Science, Let's Experiment." Response by Michael Markels, Jr., Atlantic Research Corp.

Notre Dame Auditorium, Trinity College, 8:00 p.m.

April 30—Howard University, Department of Architecture

Karel Yasko, assistant commissioner for design and construction, General Services Administration, Washington, D.C. Topic to be announced.

Auditorium, School of Engineering and Architecture, 2300 Sixth St., N.W., 4:00 p.m.

May 7—Chemical Society of Washington and Maryland Section, ACS Meeting-in-miniature

Maryland University, 2:00 to 10:00 p.m. For details of the program, call Calvin F. Stuntz, 927-3800, Ext. 535.

SCIENTISTS IN THE NEWS

Contributions to this column may be addressed to Harold T. Cook, Associate Editor, c/o Department of Agriculture, Agricultural Research Service, Federal Center Building, Hyattsville, Maryland.

AGRICULTURE DEPARTMENT

C. H. HOFFMANN, associate director of the Entomology Research Division, presented the keynote address on "New Horizons in Insect Control" at the 16th Annual Western Forest Insect Work Conference and Central International Forest Insect and Disease Work Conference, held March 1 at Denver.

AMERICAN UNIVERSITY

FREDERICK A. H. RICE, Chemistry Department, has been awarded an Army research contract concerned with the distribution of water-soluble pyrogenic metabolites between the mycelium and medium of a species of *Penicillium.*

LEO SCHUBERT has accepted appointment to the Teaching Aids Panel of the Advisory Council on College Chemistry. He has also been asked to serve on a study funded by the U.S. Office of Education, through the Board of Education of the City of New York, whose objective is to prepare a science course of study at the junior high school level, for culturally-deprived children.

COAST AND GEODETIC SURVEY

DEAN S. CARDER participated in the Third World Conference on Earthquake Engineering at Auckland and Wellington, New Zealand, January 23-30.

DEFENSE DEPARTMENT

CARL LAMANNA, Army Research Office, recently returned from a trip to Japan and the Philippines, where he reviewed Army-supported research. On November 18 he lectured before the Japan Bacteriology Society, meeting at Keio University, Tokyo.

GEORGE WASHINGTON UNIVERSITY

RUDULPH HUGH, associate professor of microbiology, School of Medicine, attended a Symposium on Cholera Research held in Honolulu January 24-29, and presented a paper, "Nomenclature and Taxonomy of *Vibrio comma*, Pancini 1854 and *Vibrio eltor* Pribram 1933."

ROBERT C. PARLETT, chairman and professor of the Department of Microbiology, School of Medicine, has returned from an inspection of laboratory facilities of Vargas Hospital, Caracas, Venezuela, for the National Institutes of Health.

NATIONAL BUREAU OF STANDARDS

Three members of the Academy were awarded the Gold Medal of the Department of Commerce on February 15, and four others were awarded the Silver Medal. The Department of Commerce Gold Medal Award, the highest given by the Department, is granted for rare and outstanding contributions of major significance to the Department, such as major contributions to science, technology, or administration. The Silver Medal Award, the second highest given by the Department, is granted for contributions of unusual value to the Department, such as very valuable contributions to science, technology, or administration.

Gold Medal winners were:

MELVILLE S. GREEN, chief of the Statistical Physics Section, Heat Division, "for outstanding contributions to the development of physical theory in the quantum mechanical treatment of cooperative phenomena, and in studies on transport properties of gases at high temperature."

WALTER J. HAMER, chief of the Electrochemistry Section, Metrology Division, "for continued distinguished service to government and industry, exemplified by authorship and leadership in the field of electrochemistry."

JOHN D. HOFFMAN, chief of the Polymers Division, "for distinguished contributions to polymer research and for vigorous leadership of research groups conducting significant and fundamental programs of research in dielectrics and macromolecules."

Silver Medal winners were:

ROLAND E. FLORIN, chemist, Polymer Chemistry Section, Polymers Division, "for distinguished contributions in elucidating the mechanisms whereby structural changes occur in polymers upon exposure to high energy radiations."

DAVID R. LIDE, JR., chief of the Infrared and Microwave Spectroscopy Section, Atomic Physics Division, "for pioneering research on the determination of the structure of complex molecules by microwave spectroscopy."

H. STEFFEN PEISER, chief of the Crystal Chemistry Section, Inorganic Materials Division, "for actively developing a program in crystal chemistry and for forward looking leadership on general crystallographic problems."

ROBERT W. ZWANZIG, chemist, Theoretical Chemistry Section, Physical Chemistry Division, "for meritorious authorship, in particular for a very distinguished series of contributions to science in the field of statistical physics."

ARCHIBALD T. McPHERSON retired on February 28 after 43 years of government service.

NATIONAL INSTITUTES OF HEALTH

HOWARD L. ANDREWS, radiation safety officer and chief of the Clinical Center's Department of Radiation Safety has been awarded the Public Health Service Medal and Certificate for Meritorious Service in recognition of "his belief in, and untiring efforts toward the advancement of the mission of the Public Health Service."

HEINZ SPECHT, who has been chief of the Pacific Area Office of the NIH Office of International Research, with headquarters in Tokyo, will return to the United States in May.

SARAH E. STEWART, head of the Human Virus Studies Section, Laboratory of Viral Carcinogenesis, National Cancer Institute, was one of six women in Government service selected to receive the 1965 Federal Woman's Award. Dr. Stewart was cited for her "extraordinary accomplishments and discoveries in virology which have changed the course of cancer virus research."

NAVAL RESEARCH LABORATORY

L. S. BIRKS, head of the X-Ray Optics Branch, received the Spectroscopy Society Award at the Analytical Chemistry and Applied Spectroscopy meeting held in Pittsburgh, on March 2. The award was made for his work in X-ray spectrochemical analysis and electron probe microanalysis. His award address was entitled, "X-ray Spectrochemical Analysis—Where Do We Go From Here?"

WEATHER BUREAU

Two Academy members were among five Weather Bureau employees who received the Commerce Department's Gold Medal for Exceptional Service on February 15. They are *JEROME NAMIAS*, assistant director for extended forecasting at the National Meteorological Center, "for major contributions to science through original research, highly distinguished authorship, and expert direction of programs in the field of extended weather forecasting"; and *HERBERT C. S. THOM*, meteorologist in the Office of Climatology, "for outstanding scientific contributions to statistical climatology, their industrial and agricultural applications, and highly distinguished authorship."

SCIENCE AND DEVELOPMENT

One of the more interesting stories in the development of man's civilization is the way in which he has returned, time and again, to the natural products of plant and animal species for substances of medical or industrial importance, but each time at a markedly higher level of sophistication. Witness the current interest of the pharmaceutical companies, for example, in the concoctions of the primitive witch doctors as possible sources of information leading to important steroids of botanical origin. Our attention is directed, in a recent news item from the National Institutes of Health, to work being done on the chemical structure of the most potent known venom, that of the kokoi frogs of the Colombian jungles, work which shows the material to be related to steroid hormones and structurally similar to the secretions of the adrenal gland. This venom, derived from the skin of the frog, has been used as an arrow poison for centuries by the Cholo Indians of Colombia, and produces in the victim a number of effects, including an irreversible block of motor nerve transmission, causing death within minutes. Skin extracts from 2,400 animals yielded a total of 30 milligrams of a crystalline active ingredient, which is being examined with the aid of modern analytic techniques to determine its composition and structure. Obviously, the investigators hope thereby to make possible synthesis and, with larger amounts available, to study pharmaceutical effects which may be turned to the benefit of man.

Anyone old or impecunious enough to have experienced a non-air-conditioned existence in Washington will have nothing but sympathy for the situation in England, where summer temperatures do not usually warrant these modern comforts and where conferences, lectures, and just plain living are repeatedly bothered by the noise of passing aircraft. It is therefore interesting to note a trial, in the Building Research Station of the DSIR, near London, of a motorized window which can be opened or shut in about three seconds and which is controlled by the outside noise level. Sheer noise has been by some considered a major hazard of our modern society, and we cannot but rejoice any move to combat it. What will be the fate of a motorized window confronted by the sonic boom is another matter.

We are seldom more poignantly reminded of the ineffectiveness of man to cope with the hazards of the natural environment than when the headlines scream the news of a mine disaster, and carry us day by day through the too often unsuccessful attempts to recover the victims of that accident while they still live. It will come as some comfort, then, to learn that careful monitoring of seismic activity, over a period of years, has made it possible in considerable measure to forecast the spontaneous rock bursts and falls in mine workings. Most impressive, probably, were forecasts in early fall of last year, in certain Utah coal mines, where a series of violent "bumps" were correctly foreseen. Safety precautions applied as a result of these warnings were such as to avoid any injuries to personnel, despite considerable structural damage.

As our industrialized society presses ever harder on the natural resources upon which it depends, the problems of how best to manage and conserve those resources become more acute. Two releases from the Geological Survey point up, again, the crucial role of water in the welfare of man. and the need to act only on the basis of dependable data. On Long Island, for example, we find one of many instances where depletion of the fresh water supplies has endangered the safety and convenience of some two millions of people in Nassua and Suffolk Counties alone, as salty water from the Atlantic moves into the groundwater system. In other areas of the Island, for that matter, aquifers are now completely permeated with salt water and the water entirely unusable. Present plans call for an experimental effort to operate an injection well and several observation wells at Bay Park, where 400 gallons per minute will be pumped *into* the ground. Eventually, by using purified waste waters for this purpose, it is hoped that the salt can be flushed out and the balance of discharge and recharge reestablished.

Meanwhile, aerial airborne photodetection, with infrared equipment, is being carried out in Puerto Rico and the Virgin Islands, areas where fresh water is among the more precious commodities, to detect major points of leakage from underground sources into the oceans. Slight differences in temperature are sufficient to register on the film and pinpoint these points of outflow, possibly down to discharges as little as one million gallons a day. A point thus located would indicate where additional fresh water could be pumped from the ground without danger of salt water contamination of the aquifers.

The recovery of drinking water from engine exhaust gases is being studied by the Engineer Research & Development Laboratories at Fort Belvoir. The combustion of one pound of gasoline releases about a pound of water, which normally would be lost to the atmosphere in a gaseous state. If it can be reclaimed and purified, this water would provide a limited emergency supply in arid or other water shortage areas. The laboratory study, to date, has included the investigation of heat transfer or gas condensing characteristics for obtaining water from engine exhaust gases, the physical and chemical properties of the water produced, and the treatment processes required to render the water potable.

For some years now, our scientific journals have repeatedly talked of the Mohole Project, that intriguing effort to drill through to the earth's mantle, initiated by that society with the equally intriguing name, the American Miscellaneous Society. Perhaps, after all, it will not be necessary to work that hard at it, if measurements currently being made at the Carnegie Institution's Department of Terrestrial Magnetism turn out favorably. More specifically, samples taken from St. Paul's Rocks, a tiny group of mid-Atlantic islands near the equator, seem quite possibly to be of direct mantle origin, presumably forced up through the ocean floor at that point. The crux of the matter lies in the correspondence between the age of these samples and that of meteorites, long considered to have been formed at the same time as the earth, perhaps 4.7 billion years ago. Age, in this particular context, is determined by measuring the ratio of strontium 86 and strontium, the latter having been formed by radioactive decay of rubidium 87.

Frederick Seitz, president of the National Academy of Sciences since 1962, has been re-elected for a six-year term beginning July 1. Dr. Seitz's re-election took place under bylaws recently adopted by the Academy, that provide henceforth for a full-time, salaried president. Although previous presidents have devoted large portions of their time to Academy affairs, they have customarily maintained a primary affiliation elsewhere. Dr. Seitz, who had been named as vice-president for research and dean of the graduate college at the University of Illinois, has resigned those positions, effective July 1.

—*Russell B. Stevens*

Delegates to the Washington Academy of Sciences, Representing the Local Affiliated Societies*

Philosophical Society of Washington	Urner Liddel
Anthropological Society of Washington	Gordon McGregor
Biological Society of Washington	John L. Paradiso
Chemical Society of Washington	Florence H. Forziati
Entomological Society of Washington	Harold H. Shepard
National Geographic Society	Alexander Wetmore
Geological Society of Washington	Luna Leopold
Medical Society of the District of Columbia	Thomas M. Brown
Columbia Historical Society	U. S. Grant, III
Botanical Society of Washington	Peter H. Heinze
Society of American Foresters	Harry A. Fowells
Washington Society of Engineers	Martin A. Mason
Institute of Electrical and Electronics Engineers	George Abraham
American Society of Mechanical Engineers	William G. Allen
Helminthological Society of Washington	Marion M. Farr
American Society for Microbiology	Frank Hettrick
Society of American Military Engineers	H. P. Demuth
American Society of Civil Engineers	Thorndike Saville, Jr.
Society for Experimental Biology and Medicine	Falconer Smith
American Society for Metals	Hugh L. Logan
International Association for Dental Research	Harold J. Caul
American Institute of Aeronautics and Astronautics	Eugene Ehrlich
American Meteorological Society	J. Murray Mitchell, Jr.
Insecticide Society of Washington	Delegate not appointed
Acoustical Society of America	Malcolm C. Henderson
American Nuclear Society	George L. Weil
Institute of Food Technologists	Richard P. Farrow
American Ceramic Society	J. J. Diamond
Electrochemical Society	Kurt H. Stern
Washington History of Science Club	Delegate not appointed
American Association of Physics Teachers	Delegate not appointed

* Delegates continue in office until new selections are made by the respective affiliated societies.

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MAY 1965

JOURNAL OF THE WASHINGTON ACADEMY OF SCIENCES

This Journal, the official organ of the Washington Academy of Sciences, publishes historical articles, critical reviews, and scholarly scientific articles; notices of meetings and abstract proceedings of meetings of the Academy and its affiliated societies; and regional news items, including personal news, of interest to the entire membership. The Journal appears nine times a year, in January to May and September to December. It is included in the dues of all active members and fellows.

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An Exercise in Probability*

E. R. Weaver

Washington, D. C.

There is a familiar story to the effect that the invention of the game of chess so pleased an oriental ruler that the inventor was offered any reward he might choose. He chose one grain of wheat for the first square of the chess board, two for the second, four for the third, and so on, doubling the number each time to the 64th square. This modest-seeming demand delighted the king until he undertook to fill the order. I never heard what happened after that, but I suspect that the inventor was shot with a poisoned arrow at the next sunrise.

The amount of wheat is easily calculated if you know how plump the grains were. I counted some rather small wheat grains in a measured volume, and came up with a total volume, for the chess board, of 150 cubic miles, probably more wheat than has ever grown and about seven thousand times as much as is now stored in this country.

The subject I shall discuss in this paper similarly involves a power series. Some years ago someone remarked that if a monkey should punch the keys of a typewriter at random for a long enough time he would eventually, by sheer chance, type out the works of Shakespeare. This striking and easily understandable figure of speech seems to have appealed to popular imagination, for it has been repeated so often that it has come to resemble an anonymous proverb. It is generally used as a background for a partial attempt to explain nature, and particularly organic life, as the result of physical and chemical action without guidance other than pure chance. The reasoning connecting Shakespeare and natural history seems to be that, since the sequence of events that results in the accidental edition of Shakespeare is readily imagined, there is no reason to suppose that the sequence of unguided events necessary to produce and evolve life to its present stage of development should be any less understandable. Usually it is asserted that the two or three billion years believed to have elapsed since the first appearance of life on earth is "ample time" for the operation of chance to accomplish everything. Oddly enough, it is always Shakespeare that is compared to nature, not Charles Dickens or Erle Stanley Gardner.

The Shakespeare side of the picture is easily drawn. After that, it will remain to compare the significant order and the complexity of the works of Shakespeare with those of organic nature.

Suppose we strike at random one of the letters of the typewriter. There is one chance in 26 that the letter will be A. If we strike two letters there is the same chance that the second letter will be B

* Author's note: This paper was prepared for the entertainment of and discussion by a small group of retired scientists—self-called "Fossils"—on April 5, 1963. It was not intended for publication, and would not have been submitted to the *Journal* except for the kind interest of a friendly chemist and an eminent biologist. It does not contain any new information. None of the scientific facts stated or implied originated with the author by discovery or invention. Their sources can be covered by a single reference: "They say." They are not necessarily accurate, and small errors, such as underestimating by a factor of a hundred the size of the universe or the duration of geologic time, can probably be ignored. If the reader has more accurate data, he is invited to substitute them and see what difference they make.

and one chance in 26 times 26 that the combination will be AB. The chance that the first three letters will be ABC is one in 26 times 26 times 26, which is 10,816. And so on.

A typewriter usually has 40 keys or a few more for letters, numerals, punctuation marks, etc., but I am willing to settle for the 26 letter keys and the space bar. I insist on the space bar because Shakespeare will be so much easier to read if there are spaces between the words.

I counted the letters and spaces on what I decided, from inspection, to be a nearly average page of a certain edition of Shakespeare and multiplied by the number of pages. The product was about five million, of which something less than a million were spaces. For brevity, from now on I shall refer to both letters and spaces as letters; in this sense, punching any of the 27 keys results in a letter, and all the letters must be in correct sequence to accomplish the job assigned to the monkey.

We now have to deal with a probability represented by 27 with the exponent 5 million instead of two to the 64th power minus one, the number of grains on the checker board. In more familiar terms, the larger number is equal to ten with the exponent 7,150,000.

It is common practice to refer to a small probability as a chance in a million. To make it emphatic, we are likely to say a chance in a million million. To express the probability that the first random typing of five million letters will produce a perfect copy of Shakespeare, we will have to say a chance in a million and repeat the last word 1,150,000 times. This would be monotonous.

I will try a different aid to the imagination. Suppose we could mark for identification a single molecule, then mix up all of the molecules there are and choose one at random like a ticket in a lottery. According to the astronomers, there are something like one billion galaxies and something like a billion stars per average galaxy. Our sun is believed to be a nearly average star. Its weight, plus that of its attendant planetary system, is about 10^{33} grams; and one gram of hydrogen, the lightest and most abundant element, contains 10^{23} molecules. These factors multiplied together give 10 to the 74th power. We then have one chance in 10^{74} of drawing the marked molecule in a well-conducted lottery. For comparison, we have one chance in 10^{73} that an electric typewriter in a hail storm will immediately type the couplet,

> Mary had a little lamb
> Its fleece was white as snow,

and one in 10^{84} that it will write,

> All that glitters is not gold
> Often have you heard that told.

The chance of drawing a designated molecule three times in succession is the same as the chance that if one hundred typewriters are exposed to the pelting hail one of them will write,

> The time has come the Walrus said
> To talk of many things,
> Of shoes and ships and sealing wax
> And cabbages and kings,
> And why the sea is boiling hot
> And whether pigs have wings.

As for a complete Shakespeare, the chances that it will be produced the first time a typewriter is exposed to a monkey or a hailstorm is equal to the chance of drawing the same molecule from the universe every day for 250 years.

The next-to-last user of the Shakespeare analogy whose work I read remarked that "several" nearly perfect copies of Shakespeare would probably be produced before one that was entirely errorless. In fact, it was this statement that goaded me to this discussion. How many is several?

Assuming that a perfect copy of Shakespeare has been produced up to but not including the last letter, there is one chance in 27 that the next stroke will be the right one and 26 that it will not. But there is as much chance of an error in each of the five million strokes that precede it as in the last stroke, hence we can expect 26 times five million or 130 million copies with a mistake of only one letter for every correct copy, roughly three copies for every American family. There is the same chance that one billion copies will be perfect except for the last word, which in my edition happens to be "prayer."

As my son Bob immediately pointed out, by the time we get a perfect Shakespeare we should have vast numbers of almost every possible combination of much less than five million letters, and these might be expected to include not only everything of minor length that was ever published, but also many creations that might be as much superior to Shakespeare as Shakespeare is to Mother Goose.

Now let us turn to the biological side of the picture. Living organisms are made up of tissues of many more kinds than there are letters in the alphabet, all arranged in certain definite relation to one another. There are tissues that form bones, muscles, blood vessels, skin, hair, toenails, and an impressive variety of glands and other specialized organs each with a different or several different kinds of cells. There are light-sensitive cells in the eye but nowhere else. Outside the mammals, in the firefly and hundreds of deep-sea species there are cells that emit light under conditions that we have never been able to duplicate or even to understand. In the electric eel there are the components of a generator of static electricity and a powerful condenser, the discharges of which are under voluntary control although everything has been made in, and is used while immersed in, a highly conducting solution.

Each tissue is built of cells of the right kind in the right place. Every cell is made up of chemical structures, the extreme complexity of which will be discussed later.

How are these chemical structures produced? An ordinary building is constructed of bricks, boards, nails, etc., made for the purpose in separate and special factories in the outside world and merely fitted together. In a living organism, not one cell—and it is probably not much of an exaggeration to say not one substance—is obtained ready-made in a physical form or a chemical combination that is directly usable. Everything has to be made on the job from a miscellaneous and ever-varying mixture of raw materials most of which are useless or worse. A small fraction of useful material must be extracted, incorporated into a single fluid, and transported in true or colloidal solution to every point at which a particular material is required; and there the wanted chemical is synthesized from the common supply to meet the need.

Every cell in the complex structure is alive; and to remain alive it must be continuously supplied with structural and energy-producing material by a fluid in contact with at least a portion of the cell wall. If the cell is not located directly on a main, its supplies must be received and its garbage emptied through a neighbor's back yard.

How would you like to be an engineer charged with building a system to supply water or other liquid to, and remove waste from, several thousand times as many customers as there are people on earth under the following conditions? The system is to start with a supply for one customer (one cell). The conduits are to be made on the job from substances carried by the fluid to be confined. Unwanted materials in the fluid are to be separated and flushed away together with wastes added by the customers themselves. New customers are to be served without delay. While the community is developing at its maximum rate, you must be prepared to connect a million new customers per second. During the building and connecting of conduits the system is never to be opened, no part of its operation is to be interrupted, it must remain in continuous use without leakage, and it must be completed in nine months. Thereafter it must be self-expanding and self-repairing, with all structural materials replaced every few years.

The electrician who would build and install the communication (nervous) system has almost as complex a job. A recent article in one of the official journals of the American Medical Association stated in effect that there are "several *trillion*" nerve connections in the human brain alone. There are only several billion people in the world. Approximately, then, the discrete channels of communication in one brain would, with a change in size, location, and material, provide every person in the world with a thousand telephone lines. Several thousand of what may be regarded as long-distance lines are to be run through a thread-sized cable called the optic nerve without cross leakage, and the whole job is to be done without getting a wrong number.

As a former chemist, I am as much impressed with the chemical operation of this self-built chemical factory as with its construction. Its products include not only the structural materials of cells and tissues, but also a vast category of such things as hormones, enzymes, milk, vaccines, and antibiotics. When the organism is attacked by any one of many diseases, something within its diagnoses the attack, prescribes a specific chemical remedy, and promptly begins its manufacture from whatever raw materials happen to be available.

The remedy is usually extremely complicated; it may even be itself a living organism such as a white blood corpuscle; and it is different for almost every disease. According to a recent article, it may be different for more than 30 varieties of colds and influenza, the effects of which cannot be consciously distinguished by ourselves or our physicians until the manufacture of the appropriate antigen has been automatically begun by our alert diagnostic apparatus. Some of these complex chemical remedies have been isolated after years of careful work by skilled scientists using elaborate equipment, but very few if any of them have been synthesized. They are obtained for study or for use in one organism only by taking them from another that has previously made them for itself.

There are several million known varieties of living organisms, plants and animals, and each is complex in its structure and perfect in its functioning beyond anything that I can more than vaguely suggest. As a whole, their development seems to me much more nearly analagous to the writing of the Library of Congress than to the works of Shakespeare only.

Professor Edwin Conklin expressed substantially the same thought more briefly: "The probability of life originating from accident is comparable to the probability of the unabridged dictionary resulting from an explosion in a printing shop."

To get even the most inadequate idea of this comparison we should start with the completely sterile world that undoubtedly once existed. Prof. Francis O. Rice has described a *possible* process by which certain essential combinations of matter that are usually found only in living cells could be synthesized from primordial constituents that *might* have occurred in sufficient concentration in the path of a lightning flash or a volcanic eruption.

That anything with the properties of living matter, properties required for growth and reproduction for example, would result if the chemical composition of a living cell could be exactly duplicated, must be assumed if we are to discuss the problem at all. It has not thus far been demonstrated that this is true.

In any case, the formation of the first bit of living matter is an event of such high improbability that it is commonly assumed to have occurred only once in geologic time. What would be the chance of survival of the first tiny blob of living matter? A seemingly insurmountable difficulty appears in the lack of a food supply. Additions to its carbon chain could not be made from elementary carbon or from carbon dioxide or the methane possibly present under any conditions we now recognize until an elaborate system of operating chemical machinery had already come into existence, either as a protein with powers of both photosynthesis and reproduction, or as chlorophyl.

When the first chlorophyl molecule happened to put itself together in association with the protein complexes as necessary to its functioning as it was to theirs, it was quite an event. It provided possibly the only means, certainly the only common means, by which carbon is made available in a combination that can be used by terrestrial organisms or by most of those in the oceans.

Professor Rice, a leader in trying to make *credible* the spontaneous occurences of the chemicals indispensable to any life, has called the chlorophyl molecule "*incredibly*" complicated. It is hardy more so than the equally necessary protein. The accidental occurence together of the first molecule of each type seems vastly less probable than the spontaneous appearance on a typewriter in a hail storm of "Mary had a little lamb, its fleece was white as snow." It may or may not be less probable than the appearance of Shakespeare's works under similar circumstances; but several generations of chemists have devoted their best efforts and best equipment to making a chlorophyl molecule, until very recently without success. It still does not appear why the compound should be so hard to prepare in the laboratory and so easy to produce outside.

Don't let me suggest that life has anything to do with it, for that would be vitalism, and vitalism is a bad word that has been deleted from the vocabulary of all good biologists. Life is understood to be merely a term popularly applied to certain chemical phenomena not yet fully investigated.

If this appears to be sarcasm, I hope you will not misunderstand my attitude. I admire, even envy, the accomplishments of scientists who look at life in substantially this way, and I admit that their point of view may have contributed to their success. One form of vitalism certainly retarded the development of chemistry until about a hundred years ago, when the idea that "organic" compounds could not be produced except through the operation of a life process had to be abandoned.

We will now assume that we have life, in the form of a living cell, and a food supply to make growth and reproduction possible. The cells begin to divide, maintaining linkages among themselves to form vast complex structures called tissues. As we should expect, the cells of a tissue are very much alike up to a certain point. Then suddenly they are different and a different kind of tissue develops. In another direction other tissues grow.

Amazingly, the point at which one tissue stops growing and another begins is just right to produce a structure, of the complexity previously suggested rather than described, that will function successfully in a usually difficult environment. Any wrongly placed junction among millions will be disastrous. Suppose, for example, that the bony tissue of a vertebra should expand across the spinal canal or that light-sensitive cells should develop behind the bone of an eye socket instead of behind a beautifully transparent lens. Or even suppose that all red-sensitive cells should occur on one side of the retina and all blue sensitive cells on the other instead of being uniformly distributed over the area.

But this is only the beginning of mystery. Surprising as are the aspects of structure and chemical functioning of living creatures, far more amazing to me are their instincts. Every little mammal, if he is not of the genus homo, knows without being told at which end of his mother the commissary is located and how to make practical use of the knowledge.

Countless examples of instinct could be given that would be completely incredible without direct evidence that they exist. I shall confine myself to one case.

As winter approaches, a certain species of wasp constructs a two-room apartment. She then seeks out a certain species of spider which she stings. The stinging act is not a crude assault like a blow from a lion's paw, but a skillful injection of just the right amount of a prepared anesthetic into a certain nerve center of the spider to immobilize it. Too much would kill it, and random placing would be ineffective. The act is closely comparable in several respects to the application of spinal anesthesia by a surgeon. The anesthetized spider is put into one compartment of the prepared structure. I have read divergent accounts of what happens at this point. According to one source, only one spider is placed in one cell and eventually serves as food for a single young wasp. If this is correct, each wasp must repeat the building and foraging process several times, for the race of wasps could not survive if there were only a single off-spring from each mother. According to another source other spiders, as many as a hundred, are put into one storage cell. Perhaps different species of wasp have different practices. In any case, when the supply of anesthetized spiders is thought adequate, their cell is sealed. In the other compartment the wasp lays an egg or a clutch of eggs and seals them up too strongly for the seal to be broken open by the wasp larvae when the eggs hatch. The baby wasps have to get out by breaking the relatively frail paper septum into the food warehouse where they eat the helpless but still living spiders until they are strong enough to break out and make their own way in the world.

The act of capturing the spiders was described to me by W. H. Bradley who has watched it closely. The wasp approaches a spider's web, carefully avoiding entanglement, reaches out, grasps a radial thread of the web and shakes it to simulate a struggling captive insect. The spider hurries out to investigate and is lost.

Consider what would be an analagous action by a woman. She would have to acquire somehow a knowledge of the arts of masonry and paper making and select and transport a fairly large bulk, in proportion to her size, of raw materials. If proportionality is to be maintained in both weights and distances, it will be necessary for the woman to carry as much as two or three tons to the top of the Empire State building. There she must build a well-designed structure exactly suited to its future use. She would have to acquire a knowledge of natural history in order to recognize among thousands of species of animals of appropriate size the one suitable for her purpose. She would have to be a hunter of considerable skill to find and secure a sufficient number of unwilling victims. In accomplishing this she must not only recognize the homes of her prey but understand their structural arrangement and mechanical properties and appreciate and avoid their built-in hazards. She must even understand what, for lack of a better term, I must call the psychology of the prospective items of living baby food.

She must be supplied in advance with an injecting needle and a suitable chemical anesthetic. She would need some of the training of an anesthesiologist including an accurate knowledge of the anatomy of her subject. She would have to store the prepared meat supply, recognize when it was adequate in amount, and seal it up, not to be seen again in her lifetime. She would then go to the right delivery room to give birth to her progeny and follow up that event by making certain provisions that her babies would not enter a hostile world except through the cookie jar. She would have to be clairvoyant, for each step of her extended sequence of operations is meaningless except as preparation for future events that she will not witness, and each step has to be taken at just the right time. No mother or neighborhood gossip has told her that she is about to become a mother herself. She must have a strong motivation to perform her labors, yet for thousands of generations her ancestors have been doing the same things and not one of them has lived to see a desirable result. From a human viewpoint, motivation is the strangest thing of all.

Of course, no one believes that the growth of an organism from germ cell to adulthood is a random process. It takes place according to a detailed pattern of chemical and physical structure, sequence, and time. The same pattern is followed with only slight variation in endless reption. Some organisms now living are almost identical with fossilized ancestors after many millions of generations.

I sometimes amuse myself by trying to imagine what an intelligent being, well informed with respect to most natural phenomena, would think of something that we take for granted if he should encounter it for the first time. In this case, suppose that someone from outer space should become acquainted with everything human beings have ever known of physics, chemistry, and even of anatomy and physiology; suppose, however, that his knowledge was confined to one individual of each organic species and then suddenly he should encounter the facts of heredity. If he was at all intelligent I feel sure that he would be as incredulous as the boy that saw his first giraffe and declared "There ain't no such animal."

What is the pattern that determines the development of similar organisms generation after generation? Its study is, of course, the science of genetics on which a vast amount of work has been and is being done with amazing success. The science has its own language, and to avoid misusing such terms as chromosomes, genes, codons, and deoxyribonucleic acid or even giving the impression that I know what they mean, I am going to call the pattern a blueprint, meaning anything that determines in detail the procedure and final result of a building process.

It seems now to be generally accepted that the blueprint of not only structure and physiology but also of instinct is embodied in long material structures, frequently referred to as molecules and sometimes described as coded tapes. The tapes appear to be infinitely varied arrangements of vast numbers of simpler but still highly complicated chemical groups, of about as many recognized kinds as there are letters in the alphabet. If this is correct, our heredity is spelled out with about the same number of basic symbols that Shakespeare used.

Let me explain, in just a few words, a theory of encyclopedic complexity that I do not understand. Suppose we want to transmit Shakespeare's works by telegraph. We will use the Morse code of three symbols, dot, dash and space. The arrangement of these symbols will determine the appearance of 26, or 27 if we include spaces, more complex symbols called letters. The arrangement of the letters gives us another series of aggregates called words, and an arrangement of words conveys the thoughts of the author. They might transmit, clumsily, the information needed to make a blueprint; and eventually a building would arise that would be determined by the blueprint and ultimately by a sequence of dots, dashes and spaces, themselves produced by the intermittent flow of electrons in a wire.

Heredity seems to correspond to this pattern of successive arrangements surprisingly. Instead of the three symbols of the Morse code there are said to be four kinds of DNA groups whose arrangements in some way determine the development of a number of amino acids nearly equal to the number of letters in the alphabet; and the arrangement of amino acids determines the structure of cells that may be considered to play a part in the creation of a work of nature roughly analagous to the part words play in a literary work.

If my vague picture of prevalent theory is correct, the coded tapes are coiled into microscopic bundles in the nuclei of cells, and each tape in a fully developed cell has bilateral symmetry or at least two conforming parts that can be separated. When the cell divides, each part forms half the nucleus of a new cell, and growth soon restores the other half and reproduces the original cell accurately before division again takes place. Something of the sort has long been suspected as the simplest explanation of heredity, but until recently the blueprint, or most of it, was thought to be confined to the germ cell. Now is it alleged that every cell of the organism except a few special types has a copy of the blueprint.

When two germ cells combine in fertilization, a new blueprint is formed embodying the parts that are identical in the parent prints, but discarding one or another of the parts that do not match. The new individual thus started has some minor features that seem peculiar to himself, but almost all important characteristics accurately copy one or the other of his immediate ancestors. Significant differences between the blueprint of the new individual and those from which it is copied are called mutations, and are ascribed to displacements or substitutions among the atoms comprising it.

When we graft the axiom that the individual that survives is the only one that leaves progeny onto the observed fact that descendants closely resemble their parents except when accidental mutations interfere, we have a complete explanation for everything—or do we?

A vast amount of work has been given to the study of mutations in a few species, such as the fruit fly and the Jimson weed. Although a large number of mutations such as the shape and coloring of leaves have been produced under controlled conditions, and although the combinations of "DNA molecules" of nearly all organisms superficially resemble one another as closely as do two rolls of an architect's blueprints, the results of single mutations seldom amount to more than minor corrections. The blueprints for the Empire State building are not likely to be accidentally converted into blueprints for an airplane carrier, and it has not been reported that a fruit fly has given birth to a Jimson weed.

I believe that the popular concept of evolution from the first living cell to men or oak trees has been simplified out of any close resemblance to reality by easily accepted and often repeated analogies and examples such as the monkey typing Shakespeare and the lengthening legs and neck of the giraffe, which enable a taller individual to survive by eating leaves out of reach of a short one. I have the greatest difficulty in fitting into such a simple picture the fact that the first lightning-generated molecule of some derivative of deoxyribonucleic acid must have accidentally discovered and transmitted to some of its descendants as a family secret the most important industrial process of all time, how to make chlorophyll. Here we have something hidden from the most prudent members of the species that is called by the Latin words for wise man, and revealed unto every miscroscopic flake of algae in a pond scum.

I have equal difficulty in fitting into a sequence of small changes by mutation the genesis of the combination of structural, chemical, and physical phenomena, recognitions, skills, motives, and apparent extrasensory perceptions involved in the instinctive actions of a wasp that stores spider meat for its young. It is almost inconceivable that such a group of phenomena, all exquisitely related to accomplish a single purpose, could have occurred as the result of a single accidental rearrangement or substitution of an atom or any group of atoms in a molecule, by an impact of a fast neutron or other unusual circumstances; and because one change would have been useless without all the others, it is equally hard to believe that all of the seemingly necessary changes could have occurred one at a time. Certainly the accidental writing of "The Walrus and the Carpenter" seems probable by comparison. If this were the only case of highly involved phenomena by instinct, it would be relatively easy to accept it as a coincidence; but almost equally improbable instinctive behavior can be found in all sorts of species from ants to elephants.

We are about ready for the question of time, usually dismissed so easily by the assertion that geologic ages have provided ample opportunity for everything. But first, the most important point in this whole discussion must be made clear.

No blueprint can provide directions for a greater number of details than are represented by the significant details of the print. If Shakespeare is translated into code or microfilmed, or spoken into an audio recorder, the number of things—

whether we call them letters, symbols, sounds, or events—that must be recorded in sequence is not appreciably, if at all, reduced. And if we have in a giant chemical molecule complete directions for the construction, physiology, and instinctive behavoir of an organism, there must be in that molecule at least as many possibly variable details of chemical composition and structure as there are directions to be followed. The fact that it is all contained in a microscopic speck of what we used to call protoplasm, and the fact that billions of faithful copies have been made of it, do not alter the fact that each detail had to be put into the record at some time. They only add to the wonder of it all.

If all life has evolved from the first living molecule through a succession of accidental mutations, then each mutation bears the same relation to a genetic blueprint that the typing of a single letter does to a manuscript. Each is an event that makes something that did not exist before. We should like to know how the number of events, of the kind needed to convert a sheaf of blank paper into Shakespeare's works, compares with the number of events of the kind needed to evolve, from a single cell, the most advanced beings that have lived. It would be helpful if we had the answers to some of the simpler questions into which the problem as a whole might be divided.

For example, a hair is made by an organ called a follicle, that is similar in complexity and in the chemical nature and physical form of its product to a nylon factory. A feather is chemically about like a hair and is produced by a similar organ. The most primitive beings did not have hairs. There must have come a time when the first hair factory appeared. How many mutations did it take to produce a follicle where none existed before? How many were involved in causing the differences between a cat's whisker and a peacock's tail feather? After we have one nylon factory the building of an additional one is a separate event requiring either accident or intelligent action relating to construction, product, and location. Does each new hair similarly require a new act or a new mutation? This is a question to which the activities of the geneticists have supplied an answer of a sort. Coloration of both plants and animals has been a principal guide in the development of evolutionary theory, and next to the length of the giraffe's neck, protective coloring and the use of color for sex appeal are among the most familiar items in the popular understanding of evolution. Protective coloring, in the zebra for example, involves only the placement of the machines that turn out hairs of different colors; but if the placement of some hairs depends on mutations and survival, why not the placement of all hairs? Then how many mutations did it take to properly clothe a sheep?

When we consider time, it doesn't matter how fast our monkey typist works, or how many other monkeys he might have to help him. If he strikes keys, night and day, at the rate for projecting moving picture frames (16 per second) at which flicker begins to fade, his manuscript in one year will equal in length a hundred Shakespeares.

It is generally stated that the origin of life occurred between two and four billion years ago. Several lines of evidence, including the time since, on the theory of the expanding universe, everything existed in the form of a single blob of 10^{74} molecules, point to the life of the universe as about ten billion years. I shall use only the larger figure and call it geologic time. It would take one monkey, typing one hundred manuscripts per year, $10^{7,149,988}$ geologic times to have an even chance of producing a perfect copy of Shakespeare. If a million monkeys worked on the job, we can subtract six from this exponent and leave it a mere 7,149,982.

With many dropped stitches, I believe I have followed to completion the pattern proposed in the original analogy to Shakespeare. It is doubtful that this is the pattern the proponent actually had in mind, for he had, no doubt, studied high school algebra "up to logarithms" and could have figured out the situation essentially in five minutes had it occurred to him to do so. But the pattern was simple and simply plausible to those who are accustomed to think in terms only of the decimal system and the odds of the local bingo game, and that includes most of us. We know about an exponential system but do not use it much. The king who promised the inventor of chess what he probably believed to be only a few bushels of wheat made the same mistake, and this is the reason I started with the old story.

We need not complicate the pattern of the monkey typist much to make a more plausible one. We will add to one monkey a duplicating machine and a proof-reader. Each time the monkey strikes a key the proof-reader looks at the result, and if it does not make sense, the paper is thrown away, and the monkey is allowed to try again on an available duplicate. This is repeated as often as necessary to get something that will pass the proof-reader, and when he is satisfied a new lot of duplicates is made with which to continue operations.

This system will result in a copy of Shakespeare in a relatively short time and, if manuscripts with promising deviations are assigned to other monkeys, it will account for the rest of the Library of Congress as well. It will also represent the course of nature somewhat better than the first pattern. Each letter typed by the monkey is a mutation, there are lots of duplicates, and the name of the proof-reader is "natural selection."

Two difficulties apear to me to be involved in explaining nature by this pattern. The first again involves time. The number of mutations needed to develop an advanced form of life from a single cell must be so enormous that the adequacy of a minor correction per generation to accomplish it even in several billion years might well be questioned. How many hairs has a sheep? The second and more fundamental difficulty does not seem to involve time particularly; it does involve the probability of the accidental occurrence and perpetuation of such things as chlorophyl, DNA, and protein structures, and a wasp's instincts.

A third pattern that might also be worth considering would result if not all events are accidental, but, like the spots of paint on so many recent works or art, only appear to be so.

I began this exercise with a very old story. I am going to end it with one so new that it does not occur until a billion years after all terrestrial life was destroyed by an atomic explosion, in which marine life was almost unaffected. Among the survivors was the dolphin which, according to the investigators who knew it best before the explosion, had a mental development nearly equal to that of the most advanced land animal, called human. From the dolphin a new race had evolved which again peopled the land and whose intellectual attainments had developed at an ever increasing rate.

At the time this story opens, the Professor of Ultimate Knowledge was just completing his explanation of the last remaining mystery of the universe when somebody broke open the three shells of a remarkable geode and disclosed a perfectly preserved typewritten copy of Shakespeare. This was brought to the professor who identified it at once as a remarkable fossil of the foliage of the pre-explosion vegetable known as a paper plant. It was unfortunate that the beautiful fossil was badly marred by stains, identified as fly speck left by a diminutive and very remote ancestor of the flying fish.

Because of the form and distribution of these stains, one of the students questioned this identification, but the professor pointed out that in the purely accidental distribution of small spots of stain one arrangement was as probable as any other and should cause no surprise. The student had to admit the truth of this; but still he was not entirely satisfied and, to tell the truth, neither was the professor.

Then they found the typewriter, and a little observation of its operation explained everything except one minor point, certain to be cleared up soon. What accident produced the typewriter?

Scholarship and Civilization*

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In "A Grammarian's Funeral" (1855) Robert Browning made an apotheosis of a scholar. The students at the funeral are not weeping, but singing, "This is our master, famous, calm and dead, borne on our shoulders." It is a poem of paradox. The hero is not a noble character, not even a splendid scoundrel like Milton's Satan; he is merely a pedant, a bookworm. His field, moreover, is not an exciting one like literature or science; it is simply Greek grammar. And yet, he himself, has been an inspiration to all humanity. He could have done anything he liked. "He was a man born with thy face and throat, Lyric Apollo." He died like a true hero. Just as a dying officer might not take precious time to commend his soul to God, nor even to send his love to his wife, but rather pants hopefully, "Did we win?" so, too ,this dedicated grammarian gasping his last breath dictates Greek grammar. Gazing upon this man, we ponder, "Of what use is the apparently useless work of a scholar?"

This question is old! In Plato's "Republic," actually the first treatise on education, Glaucon, his youthful brother, when asked about the study of astronomy, admits that it is "as essential to the general as it is to the farmer or sailor." Socrates counters, "I am amused at your fear of the world, which makes you guard against the appearance of insisting upon useless studies." In "A Mathematician's Apology" (1940) G. H. Hardy of Cambridge University sounds a challenging echo; he boasts, "The 'real' mathematics of the 'real' mathematician is almost wholly useless . . . I have never done anything useful."

The persistent, perennial question is: "To what extent has scholarship ever contributed to civilization?" May I pose my own answer: If a scholar reviews the current scene from the perspective of the past, with relevancy to the present, toward universality in the future, then I believe the useless may become useful. As evidence of this thesis, I would like to cite some examples from philosophy and theology, from history and literature, from art and science. In each case we shall see how a particular scholar has determined to a large extent the direction of civilization.

First of all, let us consider philosophy, undoubtedly the greatest intellectual contribution of the Greeks. In his "Protrepticus" (the persuader), addressed to Themison a prince of Cyprus, Aristotle (4th century B.C.) ponders the choice of pleasure and gain, of action, and of studies for the pursuit of happiness. He is attracted by studies, which seemingly enable man to fulfill his higher nature. You may recall the well-known statement in his "Metaphysics," "All men by nature desire to know." In his later Nicomachean "Ethics" he concedes that the average man may have to be content with practical wisdom as a sort of golden mean, but he still regards happiness as the goal of a higher theoretical life. In this connection, we find the word *theoretical* defined in Webster's Dictionary as follows: "not expected to produce a practical result, as an academic discussion." The practical, the mere doing, however, will necessarily be blind without uplifted viewing. The theoretical, the mere viewing, in turn, will inevitably be empty without any

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associated doing. The practical and the theoretical are intrinsically complementary, as the left hand and the right hand jointly enable one to make a single grasp. I wish to call your attention particularly to Aristotle's "Organon" (instrument). Here he proposes logic as an instrument of investigation. The resulting abstraction can well be regarded as the beginning of analytical science. Out of such considerations Aristotle himself later organized the Lyceum which was a research center, devoted especially to historical matters. Out of Aristotle's thinking we find forged a chain of thought extending across the ages: Boethius (5th century), Abelard (12th), Roger Bacon (13th), William of Ockham (14th), and even Francis Bacon (17th). Although the latter stresses a "Novum Organum," he relies still upon the same Aristotelian causes. If Aristotle's followers had only been as progressive as their master, Aristotelianism would probably not have become a drag on civilization.

More recently, Ludwig Wittgenstein (1889-1951), trained in science and in the British empirical tradition, taught at Cambridge University and exerted a great influence on current philosophy. He became one of the outstanding leaders of the English school of linguistic analysis, which concentrates upon the meaning of words as ascertainable from everyday experience. Using logic with respect to context and intentions of words, one soon becomes involved in major philosophical issues. Words in themselves are not quite meaningful except with reference to their usage. Sentences, indeed may be more important than terms, and propositions, i.e., the meaning of sentences, more significant even than concepts. Otherwise, one is embarrassed by such puzzling questions as, "What kind of a chisel is a screw driver?" The rearranging of analytical units (propositions) in an imaginative way like a tinker toy enables one to understand why something works with respect to the nature of the world both as it is, or as it could be. This approach has led to a modern revolution in philosophy.

Let us look now at theology. Thomas Aquinas (13th) was familiarly called the "dumb ox" at Padua. His teacher, Albertus Magnus, once remarked, "I tell you this 'dumb ox' shall bellow so loud that his bellowings will fill the world." We still hear the echoes of scholasticism. In his age men were enamored with Plato, who believed the real to be literally out of this world. Even as late 1523, Paolo Veronese was criticized by the Inquisition for portraying the actual world in a sacred picture. Aquinas, however, preferred to re-view life from the standpoint of Aristotle. He urged the application of reason to the empirical. Thus, from the five sense windows, one would seek reasonably a natural theology, involving possible proofs (5 ways) of the very existence of God. Faith then becomes the handmaid to revealed theology. Thus light from within complements light from without and makes contradiction theoretically impossible. Neo-Thomism is prima facie evidence of current interest in the ideas of Aquinas, primarily from the viewpoint of Roman Catholics, as in the papal encyclicals of Leo XIII (1879) and of Benedict XV (1921), but also from some Protestant outlooks. Neo-Thomism seems to be the middle of the road between unbounded rationalism and extreme anti-intellectualism!

A more recent scholar, Karl Barth (b. 1886), professor of theology at Basle since 1935, who began his impact upon modern theological thinking with the publication of a "Commentary of Romans" (1919), has insisted upon a return to the ideas of the Reformation. He is not content with the natural theology of Roman Catholicism, nor, on the other hand, with the Protestant experientialism of a Schleiermacher. He prefers the tradition of the Reformers: revelation (for example, Biblical prophecy), judgment, and grace. Neo-orthodoxy, as it is called, is not just reactionary; it is very much concerned with present relevancy.

Accepting science for a human description of this life, such theologians look beyond it toward God through symbolic interpretations of the Scriptures, creeds and the Church; furthermore, they insist upon social relevance. The Neo-orthodox movement (not a school) has influenced almost every contemporary theologian.

Turning to the history of history, we meet the pioneer Augustine (5th), the Platonic Bishop of Hippo. He was much exercised when after eleven hundred years the eternal city Rome was captured in 410 by the Visigoth Alaric. Why did God permit the established center of Christendom to be seized by the heathens? Perhaps, as some pagans claimed, the indigenous religions had been wrongfully displaced by foreign Christianity! Augustine's own answer was the "City of God" (twenty-two books) which he wrote in the thirteen years from 413 to 426. He visualized actually two cities existing side by side, an earthly Rome with its worldly principles and selfish citizens, and a heavenly city comprised of the righteous, following God's will and ever looking toward the future life. Of particular importance was Augustine's use of the perspective of Christian faith to produce a common history involving both sacred and secular aspects, the first philosophy of history. Its theology, to be sure, was not altogether insignificant. As someone once remarked, many later theologians merely added footnotes to Augustine's writings; for instance, Anselm (11th) and Aquinas (13th) in Roman Catholicism, and in Protestantism Luther (16th) and Calvin (16th), as well as Tillich (20th). The "City of God" has had tremendous influence; from 1467-1500 alone it went through twenty editions. It virtually molded medieval civilization; it was read, for example, at dinner to Charlemagne (8th). Its perennial interest is due in part to its concern with continuing problems, such as a mixed society consisting of Church and State. Even today it is widely studied by those who are troubled about the potential shattering of Western Civilization by the ever-threatening explosions of atomic bombs or of Communistic ideas.

The thinking historian has always watched current events from the vantage point of the past, as well as vice versa. Thus Frederick Jackson Turner (1861-1932), professor of history at Harvard, noting in the 1890 census the increasing unavailability of free land, perceived the significance of the rapidly disappearing frontier in the development of U.S.A. In his address, "The Significance of the Frontier in American History," at the American Historical Association meeting in Chicago (1893), he emphasized the primary importance of the frontier, not merely its secondary influences. The frontier, indeed, could be said in a large degree to have molded American character by shaping its concern for material things and its energy for the practical and the inventive, by cultivating individualism growing out of freedom. The influence of the frontier is still with us. We still have new frontiers, only they now take less tangible forms, such as science, which has been called the "endless frontier," and social relations with their international, interracial, and interreligious connections. We need to review continually present problems with our eyes upon the frontier horizons about us.

For a literary outlook let us focus our attention upon Dante Alighieri (13th). Last summer I visited his sadly neglected tomb in Ravenna, where he finally found rest after having been a Florence exile from the age of forty-six. The "Divine Comedy" has a message for each of us still today. Dante begins, "Midway on the road of our life I found myself in a dark wood whose direct way was blurred," *i.e.*, lost. He recalls his personal experience beginning with his exile, which was practically an inferno, in which the damned are neither submissively stupified nor happily reformed, but are merely bound by their earthly desires without any personal satisfaction. His own studies, including philosophy, loom up as a veritable Purgatory, in which the spirit is cleansed and hope shines ahead. All-embracing love becomes an eternal Paradise, a state in which "His will is our own." In reading Dante, however, one must regard the whole pattern, which for the first time affords a subjective scale of human emotions, from the superficially sensuous to the intellectually mystical, all in a philosophical objective framework that reveals more clearly the emotions themselves. The permeating influence of this literary endeavor throughout the ages has been largely owing to its universality. The allegory still speaks intimately to our own condition, as Quakers are wont to say. Whether it is an individual or a civilization, each must choose basically a similar plan for salvation. Fulfillment will be made possible only through faith and hope. People can no longer be content with the illusory adage, "Better to travel hopefully than to arrive."

The need for such a general overall viewpoint is clearly outlined in the kaleidoscopic reflections from our own intense specialization. The modern poet Thomas Stearns Eliot (b. 1888) follows Dante; he prefers living exhibits to dead analyses for interpreting the present scene. "The Love Song of Alfred J. Proofrock" (1917) has an epigraph about the eternal symbolism of the poem itself. Eliot looks upon the decadence associated with our modern sterile society. All about A. J. Proofrock is passion, but he himself cannot even be roused to it. This is truly hell! In the "Ash Wednesday" (1927) Eliot, disclosing his new royalist and Anglo-Catholic yearnings, confronts us now with repentance as an inherent hope—like a purgatory experience. This poem closes significantly with a vision of earthly paradise. Throughout his works Eliot seeks the understanding of history from the meaning of life—not vice versa.

In meditating next upon art, we are fascinated by Leonardo da Vinci (15th), who becoming an apprentice to Andrea Verocchio (15th) at the age of 15 developed into "the fullest man of the Renaissance." Being naturally curious, he studied life and light diligently; adept at detailed observation, he concentrated upon anatomy and perspective. Leonardo searched far and wide for suggestive models for Jesus and Judas in his celebrated Last Supper. He is said to have occasionally spent hours merely contemplating this picture without making a single stroke. In this way he learned to represent successfully movements and attitudes. The "Virgin of the Rocks," which required the longest period of gestation and which illustrates well the human figure as part of its environment, exhibits his other primary interest, namely, unity. Leonardo, indeed, was the first artist to sketch completely before actually painting. In no mean sense, he was a genius linking science and art. In the latter, he was fascinated by the transiency of the real, by the glimpse of the ideal. Nature, particularly nature at sunset, evoked in him a sensitivity that was more significant than reason alone, an insight as to spiritual grace, superior to physical beauty. Accordingly, taking light and shade as prime values he experimented with nuances of shadows. By the use of the remoteness latent in a hazy atmosphere he added an additional factor to perspective (not color, however, which was to be the domain of Il Tintoretto). No wonder that he was able to simulate strange sensations by his nebulous images; for example, the melancholy that becomes accentuated with the smile of a woman like Mona Lisa. The expression of the universal created his masterpieces.

There is no present counterpart to Leonardo. Perhaps the abstractness of modern art is not unrelated to the abstractness of modern science.

Let us finally examine science itself. We consider first Nicholas Copernicus (16th), educated at Cracow, Bologna, and Rome, later a canon at Frauenburg. In the 2nd century Ptolemy had cleverly utilized a model of 80 rotating celestial spheres to fit the planetary data of Hipparchus (2nd century B.C.). On the basis of the information available in his day, he reasonably rejected the heliocentric hypothesis. Over the centuries, however, an increasing discrepancy evolved between the theoretical predictions of Ptolemy and the observational data, the perennial problem being still "to save the appearances" both theoretically and practically. What Copernicus succeeded later in doing was not to make a new discovery, nor even to create a new idea, but rather to select a different point of view, which resulted in a wholly new view. His reduced model of thirty-four spheres checked the observational data as well as that of the Ptolemaic theory. That such an equivalent theory was possible became increasingly significant. It upset all medieval philosophy involving planets, which were associated with metals, astrology, theology, *et al.* A commentary of his work appeared in 1540, but final publication did not occur until 1543. This date, therefore, marked a whole new outlook of man, the consequence of a changed viewpoint.

In 1905, Albert Einstein (1879-1955), while working for a living in the government patent office at Zurich, meditated on the relativity of mechanics, which had been first glimpsed by Galileo, namely, the equivalence of descriptions of mechanical phenomena for systems moving with constant velocity with respect to each other. The velocity of light had been observed to be constant independent of the observer. No longer was the earth a unique or even adequate reference point; invariance had to be sought in the phenomena themselves. Einstein conceived a new relativity principle—for all electromagnetic phenomena, including light. The new outlook revealed an intimate relationship between experimental space and time. The foundation of mechanics was shaken by a different association of mass and force; the relativistic mass of a body with its velocity was found to be proportional to energy ($m = E/c^2$). Thus was unveiled the unseen universe of atomic energy.

Another inspiring scientist was Michael Faraday (19th), whose basic training consisted of only the four R's—readin' 'ritin', 'rithmetic, and religion. Motivated by a relentless urge to understand phenomena, he kept searching for the unity of the universe through experimentation. As Hans C. Oersted had observed the magnetic effect produced by electricity, so Faraday discovered that magnetic effects can reciprocally produce electricity. He detected also a relationship between magnetism and light. The mathematical formulation of his ideas, however, was due to Clerk Maxwell, who was thus able to predict the existence of an electromagnetic wave, observed twenty years later by Heinrich Hertz. It so happens that any electrically charged body, when accelerated, will produce an electromagnetic disturbance that travels with the speed of light. This discovery was the cumulative climax of evidence for the electromagnetic nature of matter.

In order to explain microcosmic electrical phenomena, Ernest Rutherford (1871-1937) subsequently conceived an atomic model (1911) in which electrons revolved about a nucleus, somewhat like a planetary system. Such accelerated motion of electrically charged particles would necessarily be unstable because of the energy radiated. Niels Bohr (1885-1963), therefore, postulated selective orbits for which no radiation would be emitted. Certain conditions were set down for their existence; these turned out later to be interpretable on the uncertainty principle (1927) of Werner Heisenberg (b. 1901). Here physicists were accosted for the first time by a limit to the usability of a causality principle in describing nature, and hence an unexpected barrier to ever-increasing scientific knowledge. The whole development of civilization became suddenly confronted by a not quite knowable universe.

Thus scholars in all fields of learning, of philosophy and theology, of history and literature, of art and science, by re-viewing the current scene with past perspective, present relevancy, and future universality, continually have redirected the course of civilization.

There is a current problem that I should like to discuss in its relationship to scholarship. Werner Jaeger (1888-1961), the Harvard classicist, wrote in the preface to the first edition of "Paideia" (1933), "Even today it is impossible to have any educational purpose or knowledge without a thorough and comprehensive knowledge of Greek culture." He discerns two distinct features of the Greeks. The first is their devotion to culture itself, the "paideia." The Greeks considered it not simply an anthropological characteristic of all groups, but rather a peculiar trait inherent only in the pursuit of a social ideal. In their case, the ideal was communal humanism—not individualism except as persons are themselves members of a community. The Greek mind was thus rooted in a common life. Cultural education, to them, meant the molding of character with a respect to a community ideal. Individuals, however, were always elements of the living whole, every one of whom had to be related and subordinate to the group. The Greeks, in short, had an organic outlook. These two aspects have given them a unique position in the history of education. We, who are interested in American education with the objective of an American ideal, an American way of life, can profit by looking back at the Greek example. If there are nowadays two essentially distinctive intellectual cultures in many places in the world, is it not because our man-made academic blinders force us to study in the artificial light of subject-tight compartments?

Erwin Schrödinger (1887-1961), the Nobel physicist at the Dublin Institute for Advanced Studies, stresses that we moderns all think the "Greek way." As Theodore Gomperz emphasized long ago (1911), most intellectual education of today is derived from the Greeks. John Burnet, indeed, reminds us that modern science has developed only with people who have been under Greek influence. Do we think the "Greek way" even in science? If we look at current scientific crises, like the wave-like and corpuscle-like characteristics of particles, we recognize at once that the very foundations of particles have been shaken. Modern physics foundations, however, are themselves based on older ones of philosophy and of mathematics. Are there any extant ruins of those early materials, any preconceived Greek ideas, any unwarranted classical assumptions implicit in today's thinking? Schrödinger emphasizes that the detection of such residues is much easier in their primitive, ingenuous forms, where present bias is less likely. For example, although most of us accept Euclid's fifth (parallel) postulate, in our everyday lives, we become more aware of its postulational character by examining it geometrically at the time of Euclid. Schrödinger, therefore, urges that we return to the Greeks to liberate human thought from the present bondage due to the past and to apply our newly-found freedom to current crises—not just for general knowledge, but, indeed, for scientific progress.

In summary, we note that the relationship of scholarship to civilization is not purely an academic matter. Over and over again, yesterday and today, we find that the viewing of the theoretical combined with the doing of the practical inevitably makes unexpected progress—the same optimism of cumulative experience. We are better able to solve our problems by grasping them with the left hand of theory and the right hand of practice simultaneously. In many instances, the apparently useless has thus become significantly useful.

Geological Society of Washington: Proceedings for 1964

854th Meeting

The 845th meeting of the Society was held in the John Wesley Powell Auditorium on January 8 with President William T. Pecora presiding. The president announced the deaths of Paul B. Bunton and J. T. Singewald, Jr.

Informal Communication. Brian Skinner reported on the finding of a new mineral, composition Fe_3S_4, in a bore hole near Kramer, San Bernardino County, Calif., that he has named Greigite. Thomas Wright reported on a technique for the X-ray identification of minute amounts of K feldspars in perthites.

Program

F. E. Senftle: "Magnetic Properties of Tectites." Discussed by Lindsley, Roedder, Skinner, and Pecora.

Robert Reeves: Film: "Geology Education in Brazil." Discussed by Gabelman, Skinner, Doerr, and Pecora.

Edward Chao: "Petrographic Evidence of Impact Metamorphism." Discussed by Gabelman, Neuman, Dietz, Roedder, Senftle, Toulmin, and Pecora.

855th Meeting

The 855th meeting of the Society was held in the John Wesley Powell Auditorium on January 22 with President William T. Pecora presiding.

Informal Communication. Rudy Steiger reported on "K-feldspars I have known."

Program

Thomas P. Thayer: "The Ophiolite Concept vs. the Alpine Mafic Magma Stem." Discussed by Jackson, Hopson, and Pecora.

Robert O. Fournier: "The Effect of Supersaturated Silica Solutions During the Hydrothermal Alteration of Feldspars." Discussed by White, Stewart, Zen, Wones, and Altschuler.

Jack E. Schoellhamer: "The Los Angeles Basin, its Basement Floor and Sedimentary Fill." Discussed by Pecora, Cohee, Anderson, Conant, Stewart, Davis, Zen, and Neuman.

856th Meeting

The 856th meeting of the Society was held in the John Wesley Powell Auditorium on February 12 with President William T. Pecora presiding.

Program

Isidore Zietz: "Mid-continent Gravity High—a Geophysical Study." Discussed by Hearn, Pavlides, Hadley, Altschuler, and Lill.

Gerald M. Richmond: "Status of Quaternary Glacial Chronology in the Rocky Mountains." Discussed by Rubin, Altschuler, McKelvey, Denny, and Krinsley.

Charles R. Warren: "Dusty Ice Moon?" Discussed by Rubin, Sohn, and Toulmin.

857th Meeting

The 857th meeting of the Society was held in the John Wesley Powell Auditorium on February 26 with President William T. Pecora presiding.

Informal Communication. Charles Milton reported on "Martini Stones." Discussed by White and Pecora.

Program

Mackenzie Gordon, Jr.: "Goniatite Evolution Applied to Carboniferous Problems." Discussed by Barton, Cohee, and Pecora.

Robert Dietz: "The Sudbury Complex—An Astrobleme?" Discussed by Rubin, McKelvey, Barton, Goldich, Hubbert, Stewart, Brown, Dietz, Lindsley, Guild, Jones and Zen.

Brian J. Skinner: "Sulfides of the Niland Well, a Modern Ore Deposit?" Discussed by Rubin, McKelvey, Barton, Goldich, Hubbert, Stewart, Brown, Dietz, Lindsley, Guild, Jones, and Zen.

858th Meeting

The 858th meeting of the Society was held in the John Wesley Powell Auditorium on March 11 with President William T. Pecora presiding. The president announced the death of Samuel Lasky.

Informal Communication. Ken Lohman reported on the solubility of $Ca_2Mg_5Si_8O_{22}(OH)_2$ in C_2H_5OH. Paul Jones reported on the maximum rate of sedimentation on the Gulf Coast and suggested a rate of about 70 years per foot.

Program

Gordon Davis: "Effect of Contact Metamorphism on Zircon Ages." Discussed by Godfried, Hadley, Roedder, Milton, Harrison, White, Zartmann, and Anderson.

W. J. Schneider: "Variability of Low Flows in an Area of Diverse Geologic Units." Discussed by LeGrand, McKelvey, and Denny.

Abraham Lerman: "Paleoecological Problems of Mg and Sr in Biogenic Calcites in Light of Recent Thermodynamic Data." Discussed by Blair Jones, Henbest, Altschuler, and Hanshaw.

859th Meeting

The 859th meeting of the Society was held in the John Wesley Powell Auditorium on March 25 with President William T. Pecora presiding.

Informal Communication. Douglas Rankin reported on optically positive potassic feldspar. Discussed by Pecora and Milton.

Program

Michael B. Duke: "The Basaltic Meteorites, just Breaking the Skin of a Meteoric Parent Body." Discussed by Warren, Pecora, Stewart, Skinner, and Zartmann.

Steacy M. Hicks: "Secular Sea Level Variations along U.S. Coasts." Discussed by Pecora, Zen, McKelvey, Rasmussen, Rucker, Hanshaw, Fournier, and Ericson.

Frank C. Frischknecht: "Mapping Conductive Strata by Electromagnetic Methods." Discussed by Wright, Stewart, Martin, Neuman, and Leo.

860th Meeting

The 860th meeting of the Society was held in the John Wesley Powell Auditorium on April 8 with President William T. Pecora presiding.

Informal Communication. Frank Forrester reported on the Survey's exhibit at the World's Fair in New York, and on the Fair in general. William Leo reported on chromium-bearing mica from Brazil; discussed by Guild, Milton, Pecora, Kinkle, and Fleischer. George Gates reported on the Alaskan Earthquake. James Clark reported on his new hypothesis "that evolution is accelerated during periods of reversal of the earth's magnetic field"; discussed by Yochelson, Pakieser, Lerman, and Shoemaker.

Program

Edwin Roedder: "Great Swan Island Glass Bubbles—An Enigma." Discussed by Pecora, Tracey, and Taulman Bayley.

Erle G. Kauffman: "Biostratigraphic Revision of the Lower Colorado Group, Western Kansas and Eastern Colorado." Discussed by Cohee, Kinney, Gordon, Tweto and Pecora.

Y. K. Bentor: "The African Rift Valley System."

861st Meeting

The 861st meeting of the Society was held in the John Wesley Powell Auditorium on October 14 with President William T. Pecora presiding. The president announced the deaths of Andrew Brown and N. H. Hawkins.

Informal Communication. The American Institute of Professional Geologists held a meeting prior to the regular meeting of the GSW.

Program

W. P. Woodring: "A First Field Season with the U.S. Geological Survey." Discussed by Duncan.

I. W. Marine: "Technical Feasibility of Storing Radioactive Waste in Bedrock at the Savannah River Plant near Aiken, S.C." Discussed by Roedder, Proctor, Hanshaw, Sohn, Pecora, and Fary.

Charles Milton, Blanche Ingram, Joan R. Clark, and Edward J. Dwornik: "McKelveyite, a New Hydrous Sodium Barium Rare-earth Uranium Carbonate Mineral from the Green River Formation, Wyoming."

862nd Meeting

The 862nd meeting of the Society was held in the John Wesley Powell Auditorium on October 28 with President William T. Pecora presiding.

Informal Communication. Cornelia C. Cameron, U.S.G.S. reported on an environmental approach to mapping continental glacial drifts. Discussed by Warren and Woodring.

Program

K. O. Emery: "Marine Geology of the Atlantic Continental Shelf—a Progress Report." Discussed by Cohee, Newman, Zen, Rhodehamel, and Rupkin.

Lloyd G. Henbest: "Diagenetic Phenomena in Colitic Limestones of Morrow Series, Pennsylvanian, Northwest Arkansas and Northeast Oklahoma." Discussed by Lowman, McKnight, Pecora, and Hanshaw.

B. C. Hearn, Jr.: "Diatremes Southeast of the Bearpaw Mountains, Montana." Discussed by Ericson, Roedder, Milton, Pecora, Killsgaard, McKnight, and Martin.

863rd Meeting

The 863rd meeting of the Society was held in the John Wesley Powell Auditorium on November 25 with President William T. Pecora presiding.

Program

A. R. Kinkel, Jr., U.S.G.S.: "Metamorphism of a Massive Sulfide Ore." Discussed by Wones, Toulmin, Barton, Burns, Skinner, Hertz, and Pecora.

B. F. Grossling, U.S.G.S.: "Mathematical Formulation of Geologic Concepts." Discussed by McKelvey and Pecora.

Thomas E. Krogh: "Carnegie Institution —Geologic History of Greenville Province Rocks in Ontario: a Geochronology Approach."

864th Meeting

The 864th meeting of the Society was held in the John Wesley Powell Auditorium on December 9 with President William T. Pecora presiding.

Program

Presidential address by William T. Pecora: "Dual Concept of Time in Geologic Sciences."

72nd Annual Meeting

The 72nd Annual Meeting was held immediately following the 864th regular meeting. The reports of the secretaries, treasurer, and Auditing Committee were read and approved. The award for the best paper of the year went to Carter Hearn for his paper, "Diatremes Southeast of the Bearpaw Mountains, Montana." Robert Fournier was awarded second prize; honorable mention went to Arthur Kinkel, Thomas Thayer, and Edwin Roedder. The Great Dane Award for the best informal communication was presented to Thomas Wright for his note on "X-ray Identification of Alkali Feldspar and Perthites." The Sleeping Bear Award was presented to Thomas Thayer. Officers for the year 1965 were then elected as follows:

President	George V. Cohee
First Vice-President	Philip W. Guild
Second Vice-President	Douglas M. Kinney
Secretary (two year term)	C. Erwin Brown
Treasurer	Jane H. Wallace
Council (two year term)	Emmett Finley
	Earle Kauffman
	John Snyder

The Society nominated Wiliam T. Pecora to be delegate to the Washington Academy of Sciences for the year 1965.

—*Bruce B. Hanshaw, Secretary*

GEOLOGICAL SOCIETY OF WASHINGTON

Officers for 1965

President	George V. Cohee
First Vice-President	Philip W. Guild
Second Vice-President	Douglas M. Kinney
Secretaries	Bruce B. Hanshaw
	C. Erwin Brown
Treasurer	Jane H. Wallace
Members-at-large of the Council	Wenonah E. Bergquist
	George E. Ericksen
	Donald H. Lindsley
	Emmett Finley
	Earle Kauffman
	John Snyder

Committee on Communications

Philip M. Bethke, *Chairman*
Harry E. LeGrand
Jerry Meyer
George Phair
Isadore Zeitz
James R. Randolph
Edwin Roedder
Thomas P. Thayer
Frank C. Whitmore, Jr.

Committee on Finance

Preistley Toulmin, *Chairman*
Carle H. Dane
Lloyd G. Henberst
Charles L. McGuinness
Philip M. Bethke
Malcolm Ross
Jane H. Wallace

Committee on Awards

W. S. White, *Chairman*

Meetings

Meetings of the Society are held on the second and fourth Wednesdays of each month, October through April, from 8 to 10 p.m. in the John Wesley Powell Auditorium.

Irving Named to Head Agricultural Research Service

George W. Irving, Jr., was named administrator of USDA's Agricultural Research Service in an announcement on March 19 by Secretary of Agriculture Orville L. Freeman. He succeeded Byron T. Shaw, administrator since 1952, who was transferred to a research position in ARS at his own request.

Concurrently with this action, Marion W. Parker, a USDA career scientist and research administrator, was appointed associate administrator of ARS.

Dr. Irving is a native of Caribou, Maine, although a long-time resident of the Washington area. He began his professional career in 1927 as a laboratory assistant at the National Bureau of Standards, but transferred in 1928 to a similar post in USDA's Bureau of Chemistry, under Charles Thom. In 1935 he became a junior chemist in the Bureau of Entomology and Plant Quarantine.

Also in 1927, Dr. Irving became a part-time student in George Washington University's night school. After receiving the B.S. degree in chemistry in 1933, he took up graduate studies in the GWU School of Medicine, and received the M.S. degree in biochemistry in 1935. At that time he left the Department of Agriculture to undertake full-time doctoral studies under Vincent duVigneaud, then head of the GWU Biochemistry Department. He continued his research with duVigneaud in 1938-39 at Cornell University College of Medicine, in New York City; and in the latter year GWU awarded him the Ph.D. degree in biochemistry. In 1939-42 he served as an assistant in chemistry under Bergmann at the Rockefeller Institute for Medical Research.

Dr. Irving returned to the Department of Agriculture in 1942, as head of oilseed protein research at the Southern Utilization Research Laboratory, New Orleans. In 1945 he was transferred to Beltsville, to do research on biologically-active plant constituents. In 1947 he became an assistant chief of the Bureau of Agricultural and Industrial Chemistry.

In January 1954, Dr. Irving became chief of the Biological Sciences Branch of the Agricultural Marketing Service. The following October he was named a deputy administrator of the Agricultural Research Service; in this post he was primarily concerned with administration of the four Utilization Research & Development Divisions and related activities in the Nutrition, Consumer, and Industrial Use Research group. On July 19, 1964, Dr. Irving became associate administrator of ARS following the retirement of M. R. Clarkson.

Dr. Irving has been active in affairs of the Washington Academy of Sciences, having served as its secretary in 1962-64. He is currently an elected member of the Academy's Board of Managers.

Dr. Parker, a native of Salisbury, Md., received the B.S. degree from Hampton-Sidney College in 1928. He received the M.S. and PhD. degrees in plant physiology from the University of Maryland, in 1930 and 1932, respectively. He remained with the University as assistant professor of plant physiology until June 1936.

He joined USDA in 1936 as associate plant physiologist in the Bureau of Plant Industry; with H. A. Borthwick, he made several basic discoveries concerned with photoperiodism and controlled environment of plants.

After holding several administrative positions in the Bureau of Plant Industry, Dr. Parker in 1957 was appointed director of the Crops Research Division of ARS. Since October 1964 he has headed a Research Development and Evaluation Staff reporting to Nyle C. Brady, the Department's Director of Science and Education. He is a member of many national and international scientific societies and the author or co-author of some 50 scientific publications.

A CONTRIBUTION FROM THE ARCHIVIST

Report on a Stony Meteorite

The Proceedings of the Washington Academy of Sciences for 1900 contained a brochure entitled, "A New Stony Meteorite from Allegan, Michigan, and a New Iron Meteorite from Mart, Texas," by George P. Merrill and H. N. Stokes.

George Perkins Merrill (d. 1929) of the National Museum was an original member of the Academy; he was president of the Geological Society of Washington in 1906 and again in 1915. Our files do not state whether he was related to Maj. J. C. Merrill (d. 1902) of the Army Medical Museum, who had been elected to membership in May 1898; or to Oscar Charles Merrill (b. 1874), forester in the Department of Agriculture, a member from April 1916 to 1938; or to Elmer Drew Merrill (b. 1876, d. 1956), director of the New York Botanical Garden, a member from June 1931; or to Melvin Clarence Merrill (b. 1884, d. 1952) of the Department of Agriculture, a member from May 1938. George Merrill's book, "The First One Hundred Years of American Geology," first published in 1924, has recently been reprinted.

Merrill's report on the Allegan meteorite opens as follows:

"A little after eight o'clock on the morning of July 10, 1899, there fell on what is locally known as Thomas Hill, on the Saugatuck Road, in Allegan, Michigan, a stony meteorite, the total weight of which cannot have been far from seventy pounds, although, unfortunately, it was badly shattered in striking the ground, and its exact weight can never be known." The 16 pages of text are followed by six plates, of which the first is reproduced here. According to a footnote, "the general and petrographic description are by G. P. Merrill, and the chemical examination is by Dr. H. N. Stokes."

Interest in the meteorite has continued to be active in the Geological Survey. I am grateful to Michael B. Duke for the following comments:

"The Allegan (Michigan) Meteorite, an olivine-bronzite chondrite (Mason, 1962) . . . was observed to fall and is remarkably free of terrestrial oxidation. It is one of the most friable chondritic meteorites, the individual chondrules being easily broken free and separated from the fine-grained matrix.

"As in other chondritic meteorites, the principal silicate minerals are olivine, pyroxene, and plagioclase feldspar, mixed with metallic iron, troilite (FeS), and other minor minerals. The numerous varieties of chondrule textures were described in several later works by Merrill (1920, 1921, 1930).

"Recently much attention has been focused on chemical analyses of meteorites, especially those parameters that appear to be significant in the problems of the origin of the solar system and the Earth. A very careful study of the concentrations of rare earth elements in the Allegan Meteorite has been made by neutron activation analysis by Schmitt and his coworkers (Schmitt *et al.*, 1960). The concentrations of rare earth elements in this meteorite were found to be similar to other chondrites, but different from terrestrial rocks derived from the upper mantle. Further analytical work on meteorites of this type will help decide the question of the chondritic composition of the Earth's mantle."

References

Mason, Brian. Meteorites. John Wiley & Sons, New York, 1962. 274 pp.

Merrill, George P. On chondrules and chondritic strucure in meteorites. Proc. Nat. Acad. Sci. *6*, 449-472 (1920).

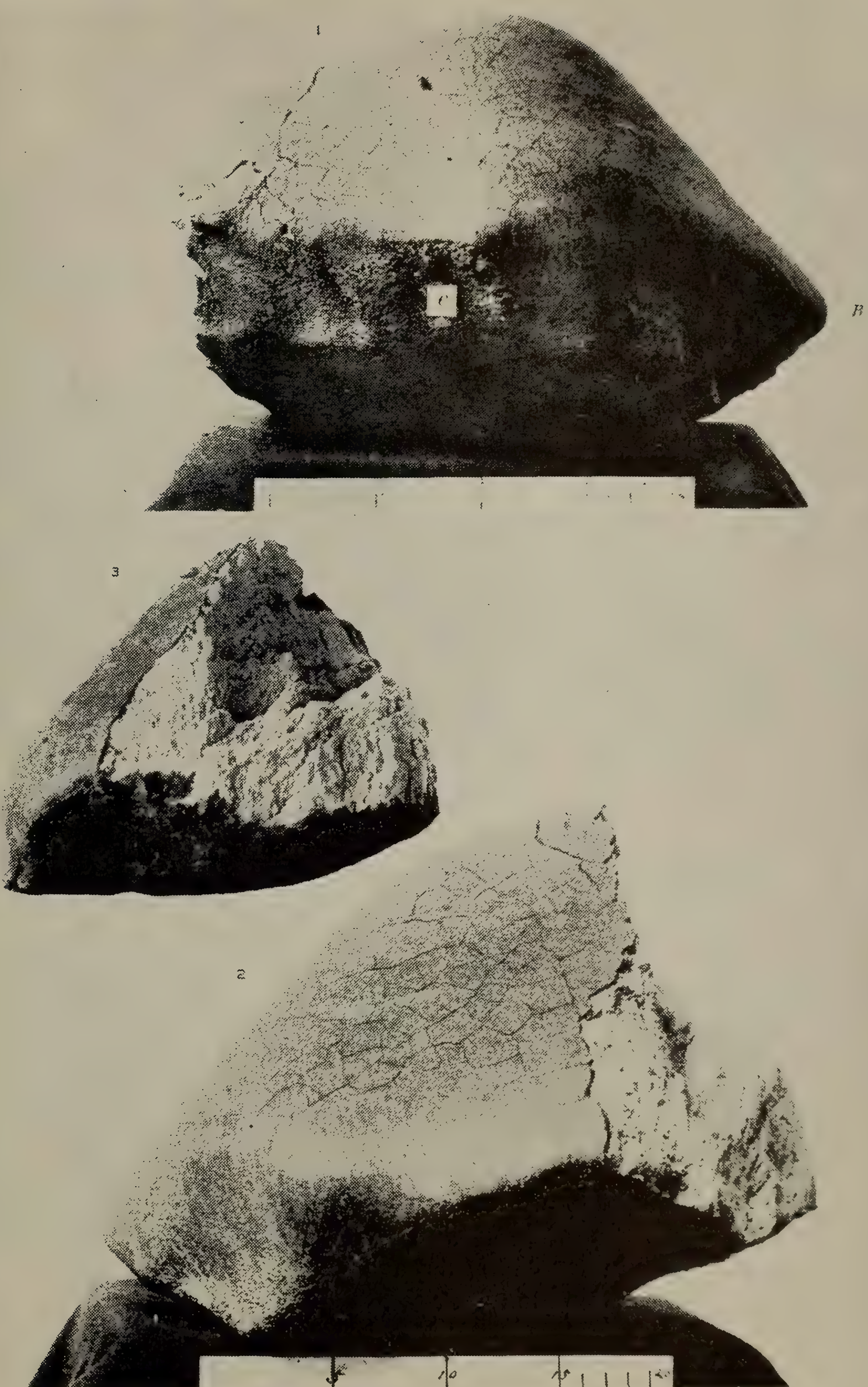
Merrill, George P. On metamorphism in meteorites. Geol. Soc. Am. Bull. *32*, 395-416 (1921).

Merrill, George P. Composition and structure of meteorites. U. S. Nat. Mus. Bull. *149*, 1930, 62 pp.

Schmitt, R. A., Mosen, A. W., Suffrendini, C. S., Lasch, J. E., Sharp, R. A., and Olehy, D. A. Abundances of the rare earth elements, lanthanum to lutetium, in chondritic meteorites. Nature *186*, 863-866 (1960).

—*Eduard Farber*

PROC. WASH. ACAD. SCI. VOL. II. PLATE I.



THE ALLEGAN METEORITE.

Academy Proceedings

489th Meeting of the Washington Academy of Sciences

SPEAKER: HENRY FAGIN
Professor of Urban and Regional Planning
University of Wisconsin

PANELISTS: C. DARWIN STOLZENBACH
Administrator, National Capital Transportation Agency
E. H. HOLMES
Director of Planning, Bureau of Public Roads, Department of Commerce

SUBJECT: MASS TRANSPORTATION
DATE: THURSDAY, MAY 20, 1965
8:15 P.M.
PLACE: LECTURE ROOM, NATIONAL ACADEMY OF SCIENCES
2101 Constitution Avenue, N.W.

Abstract of Address—The urban-suburban transportation problem is a national problem for which there are two extreme solutions—that is, the solution of Los Angeles, which involves a freeway system that is very expensive, and the solution of New York, which involves a subway system, a train system, and a freeway system, all very expensive. The solution of the problem in Washington, which up to the present has a freeway system, depends on whether the authorities choose to expand this system, or supplement it with a subway system. Both of these solutions present certain difficulties of execution, partly because of the several distinct political entities involved. The speaker will refer to a study made for the State of New Jersey, and the panelists will attempt to relate the conclusion to the Washington context.

The Speaker—Henry Fagin is professor of planning in the Department of Urban and Regional Planning, University of Wisconsin, and an architectural and planning consultant. From its launching in June 1959 through August 1962, he was executive director of the Penn Jersey Transportation Study. Prior to this, for seven years he served as planning director and then as executive director of New York's Regional Plan Association, Inc. In 1958 he was Ford rotating research professor in governmental affairs in the Department of Political Science, University of California at Berkeley. Earlier, he had practiced as an architect and planner in association with several architectural and planning consultant firms, after graduating from Coumbia University (B. Arch. 1937 and M.S. Planning 1938).

JOINT BOARD ON SCIENCE EDUCATION

The Joint Board sponsored the Second Collegiate Science Conference for the Greater Washington Area on March 6, with the support of the National Science Foundation. Undergraduate students from the Washington area presented 21 papers, covering topics in astronomy, biology, chemistry, engineering, and physics. Representative George P. Miller spoke to the students on the relationship between scientists and Congress.

District Education Association Honors JBSE and J. K. Taylor

The District Education Association presented School Bell Awards to the Joint Board on Education for Science, Engineering and Technology of the Greater Washington Area, and to John K. Taylor, at its annual Spring Conference held at the Mayflower Hotel on March 20. The annual award, consisting of an appropriate scroll, is made to organizations and individuals in recognition of their contributions to public education in the District of Columbia.

The Joint Board was cited for its programs of assistance to science education in the area. The school contacts program, teacher-recognition awards, sponsorship of science fairs, and the program in which scientists substitute for classroom teachers to permit their attendance at professional meetings, were singled out for particular praise. Lowell E. Campbell, chairman of the Joint Board, accepted the award for his organization.

Dr. Taylor was cited for his individual activities in advancing science education. His long and untiring efforts were noted both as an individual participant and as director of science projects for the Joint Board under grants from the National Science Foundation. These include the series of annual curriculum conferences for teachers, and the Visiting Scientists and Engineers Program which provides the assistance of scientists and engineers to students, teachers, and science clubs.

Science in Washington

SCIENTISTS IN THE NEWS

Contributions to this column may be addressed to Harold T. Cook, Associate Editor, c/o Department of Agriculture, Agriculture Research Service, Federal Center Building, Hyattsville, Maryland.

AGRICULTURE DEPARTMENT

JUSTUS C. WARD was appointed one of the United States delegates to a U.S.-Japan research planning conference on pesticides at the East-West Center, University of Hawaii, Honolulu, April 7-9. His part of the program was to inform the Japanese research directors about pesticide tests required to obtain registration and commercial distribution under U.S. law.

K. A. HAINES attended the Board of Directors Meeting of the Inter-American Institute of Agricultural Sciences held at Antigua, Guatemala, March 1-6.

ROBERT W. WEBB, research cotton technologist in the Market Quality Research Division, Agricultural Research Service, retired on March 31 after 44 years of service. Dr. Webb's first 6 years of work had to do with research on certain fungus and virus diseases of winter wheat; his last 38 years were devoted to research, testing, and evaluation with respect to cotton quality. Dr. Webb plans to continue living at the Cosmos Club, where he will be glad to see his friends and former professional associates at any time.

CHINGIZ KADYROV of the Institute of Chemistry of Plant Substances at Tashkent, U.S.S.R., is visiting scientists at Plant Industry Station, and working in the Plant Hormone and Regulator Pioneering Research Laboratory under the direction of *JOHN W. MITCHELL.* Dr. Kadyrov will spend some of his time traveling in this country to become acquainted with scientific effort in the U.S.A.

LAWRENCE ZELENY, as the official United States delegate, attended the second meeting of the Joint FAO/WHO Codex Alimentarius Commission Expert Committee on Oils and Fats in London, April 6-8. The purpose of the committee is to establish international standards for vegetable and animal oils and fats used for food purposes.

EDWARD H. GRAHAM has retired from the Soil Conservation Service and is now a consulting ecologist with professional headquarters and residence at Box 233, Route 2, Vienna, Va.

DEFENSE DEPARTMENT

GEORGE W. HOWARD of the Engineer R&D Laboratories, Army Materiel Command, has been cited for outstanding performance as technical director of the laboratories.

FOOD AND DRUG ADMINISTRATION

CLEM O. MILLER, coordinator of scientific committees in the Office of the Commissioner, will be awarded the honor scroll of the Washington Chapter, American Institute of Chemists, at its annual dinner meeting on May 18.

HELEN L. REYNOLDS, technical editor in the Bureau of Scientific Research, has been named a recipient of the FDA Merit Award for 1965.

HOWARD UNVERSITY

LLOYD N. FERGUSON was guest speaker at ceremonies dedicating the Louis N. Cassett Lecture Auditorium in the newly-completed chemistry building, Beury Hall, of Temple University, Philadelphia, on March 2. Dr. Ferguson was a member of the team of visiting scientists for the Division of Chemical Education of the American Chemical Society, that spent March 25-26 on the campus of Fort Hays Kansas State College, Hays, Kansas. At that time he held organic chemistry classes, gave a banquet address, and discussed chemical education and research with the faculty and students.

MODDIE D. TAYLOR has been reappointed to the Education Advisory Board of Chemistry for 1964-65. He served as visiting scientist for students of Lima High School, Shawnee High School, Elida High School, and Ohio Extension University at Lima, Ohio, on January 25-27. Dr. Taylor also lectured to the Graduate Colloquium at the City Colleges of New York on February 26, served as visiting scientist at Simmons College, Boston, Mass., March 15 and 16, and served as visiting scientist at Winona College, Winona, Minn., April 12 and 13. He has been invited by Columbia University and the Indian Government to serve as a consultant in teacher education this summer in New Delhi, India.

KELSO B. MORRIS, professor of chemistry, gave three lectures recently before the participants of the NSF-sponsored Academic Year Institute at Atlanta University, Atlanta, Ga.

NATIONAL BUREAU OF STANDARDS

ABNER BRENNER, chief of the Electrolysis and Metal Deposition Section, has received the William Blum Award of the Electrochemical Society for outstanding contributions to the field of electrodeposition.

NATIONAL INSTITUTES OF HEALTH

JEROME CORNFIELD has been appointed chief of the Biometrics Research Branch of the National Heart Institutes.

NAVAL OCEANOGRAPHIC OFFICE

PAUL D. THOMAS, scientific staff assistant in the Marine Sciences Department, attended the Seventh Conference of Senior Navy Mathematicians at the Naval Postgraduate School, Monterey, Calif., on February 24-26. He presented a paper, "The Second Order Term in the Andoyer-Lambert Approximation to Geodesics on the Reference Ellipsoid."

NAVAL RESEARCH LABORATORY

By arrangement through the Office of Naval Research office in London, *G. R. IRWIN*, superintendent of the Mechanics Division, will spend approximately three months, beginning in May, in Freiburg, Germany, at the Ernst Mach Institut in collaboration with Frank Kerkhof on problems of fracture mechanics. Dr. Irwin will give a Physics Colloquium lecture at the University of Freiburg, and a series of seminar lectures to students and members of the Institut. Following this tour of duty, Dr. Kerkhof will be at NRL during 1966 for a similar three-month stay.

JAMES H. SCHULMAN was presented the Superior Civilian Service Award on February 19. This is the second highest recognition available to a civilian employee of the Navy. It was awarded to Dr. Schulman for his "brilliant insight, originality, and intellectual scientific acumen" as evidenced by his work in solid state physics.

CURTIS R. SINGLETERRY and *WILLIAM A. ZISMAN* recently shared, with two other chemists, a $5,000 award for their development of a technique to salvage damaged electronic equipment. It is estimated that the development may save up to $20 million worth of water-damaged equipment.

OFFICE OF NAVAL RESEARCH

I. ESTERMANN has retired from ONR and accepted a position as Lidow professor of solid state physics at Israel Institute of Technology (Technion), Haifa.

UNCLASSIFIED

FREDERICK D. ROSSINI, dean of the College of Science at the University of Notre Dame, has been given the University's highest honor, the Laetare Medal, conferred annually on an outstanding American Catholic layman; he is the second scientist to receive the award. Dr. Rossini was with the National Bureau of Standards from 1928 to 1950.

SCIENCE AND DEVELOPMENT

The 175th anniversary of the United States patent system was commemorated on April 8 by an all-day meeting at the Sheraton-Park Hotel. In addition to a plenary session on overall aspects of the patent system, seven seminars were conducted on mechanical, electrical, chemical, pharmaceutical, and metallurgical invention; independent and small-business inventors; and employee inventors. The meeting was climaxed by a dinner at which Commissioner of Patents Edward S. Brenner presided, and Secretary of Commerce John T. Connor spoke on "The Challenges to the Patent System."

More than 700 prominent scholars, scientists, and representatives of universities, museums, and learned societies from at least 90 countries are expected to join in a two-day celebration on September 17 and 18, marking the 200th anniversary of the birth of James Smithson, founder of the Smithsonian Institution. Smithson, an English scholar and scientist, at one time a prominent member of the Royal Society of London, left his entire estate to the United States "to found at Washington, under the name of the Smithsonian Institution, an establishment for the increase and diffusion of knowledge among men." He died in Genoa, Italy, in 1829 at the age of 64.

Fortunately, to the trained radiologist, X-rays are not the bits of blurred confusion they appear to the uninitiated. Even so, for clear pictures of deep lying tissues, it has been necessary in the past to employ very expensive and elaborate instrumentation. New technology, developed by J. M. Morel and others at the Clinical Center of the National Institutes of Health, permits very considerable savings in cost and effort. In principle, the X-ray emission tube and film remain fixed, and the patient is rotated during actual exposure in such a position that the axis of rotation is precisely at the point where the desired picture is to be taken. As a result, that portion of the tissues produce a clear image, while masses either in front or behind the plane of the area of interest are continually displaced on the film and thereby blurred. Moving the film simultaneously and parallel to the patient's body results in a straight plane, and the width of the cross-section pictured can be controlled by the amount of turning done by the body. Among other advantages, the time of exposure is considerably shorter than with conventional equipment for achieving the same general result. A final note on cost: estimates suggest the device could be produced and sold at perhaps $1,500—about as much as to move conventional equipment for "tomography" from one room to another!

A science news reporting these days is hardly complete without an item on nucleic acids. In this vein we note the determination, by a team of USDA and Cornell University biochemists, of the molecular structure of alanine transfer RNA, one of the smallest of the known biologically active nucleic acids. By two sets of enzymatic splitting series, by determining the structures of the pieces derived therefrom, and by comparing these pieces with each other, and by manipulating temperature and time of contact so as to control enzyme action, the full structure was eventually unravelled, and a total of 77 nucleotides identified and located. This is the first instance where this has been accomplished. It remains now by discover just which of these 77 form the three crucial elements of the "anticodon," the genetic code word determining the sequence of alignment at the protein-building site.

The southern visitor to a city such as Minneapolis is at first greatly puzzled by the deplorable condition of even relatively new model automobiles, until he asks the first year-round resident. The answer? "Salt!" And by this, of course, is meant the practice of putting calcium and sodium chloride on city streets and rural highways as a snow removal measure in northern winters. R. G. Petersen, of the Geological Survey, notes that in the winter of 1965, more than 100,000 tons of salt were dumped on Massachuetts highways. So much, in fact, that concern is mounting over the possible effect on ground water. Preliminary analysis at the water table in several points of eastern Massachusetts show a current chloride content of nearly 250 ppm, the limit recommended by the Public Health Service for public water supplies. Further studies will be made to determine vertical and lateral movement, the differences attributable to different kinds of soils, and so on. Like so very many of man's activities, the answers are neither white nor black; one must balance the good of increased safety against the destructive effects on automobiles and the contamination of the drinking water.

—*Russell B. Stevens*

Delegates to the Washington Academy of Sciences, Representing the Local Affiliated Societies*

Philosophical Society of Washington	Urner Liddel
Anthropological Society of Washington	Gordon McGregor
Biological Society of Washington	John L. Paradiso
Chemical Society of Washington	Florence H. Forziati
Entomological Society of Washington	Harold H. Shepard
National Geographic Society	Alexander Wetmore
Geological Society of Washington	Luna Leopold
Medical Society of the District of Columbia	Thomas M. Brown
Columbia Historical Society	U. S. Grant, III
Botanical Society of Washington	Peter H. Heinze
Society of American Foresters	Harry A. Fowells
Washington Society of Engineers	Martin A. Mason
Institute of Electrical and Electronics Engineers	George Abraham
American Society of Mechanical Engineers	William G. Allen
Helminthological Society of Washington	Marion M. Farr
American Society for Microbiology	Frank Hettrick
Society of American Military Engineers	H. P. Demuth
American Society of Civil Engineers	Thorndike Saville, Jr.
Society for Experimental Biology and Medicine	Falconer Smith
American Society for Metals	Hugh L. Logan
International Association for Dental Research	Harold J. Caul
American Institute of Aeronautics and Astronautics	Eugene Ehrlich
American Meteorological Society	J. Murray Mitchell, Jr.
Insecticide Society of Washington	Delegate not appointed
Acoustical Society of America	Malcolm C. Henderson
American Nuclear Society	George L. Weil
Institute of Food Technologists	Richard P. Farrow
American Ceramic Society	J. J. Diamond
Electrochemical Society	Kurt H. Stern
Washington History of Science Club	Delegate not appointed
American Association of Physics Teachers	Delegate not appointed

* Delegates continue in office until new selections are made by the respective affiliated societies.

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VOLUME 55 NUMBER 6

Journal of the WASHINGTON ACADEMY OF SCIENCES

Directory Issue

SEPTEMBER 1965

JOURNAL OF THE WASHINGTON ACADEMY OF SCIENCES

This Journal, the official organ of the Washington Academy of Sciences, publishes historical articles, critical reviews, and scholarly scientific articles; notices of meetings and abstract proceedings of meetings of the Academy and its affiliated societies; and regional news items, including personal news, of interest to the entire membership. The Journal appears nine times a year, in January to May and September to December. It is included in the dues of all active members and fellows.

Subscription rate to non-members: $7.50 per year (U.S.) or $1.00 per copy; foreign postage extra. Subscription orders should be sent to the Washington Academy of Sciences, 1530 P St., N.W., Washington, D.C., 20005. Remittances should be made payable to "Washington Academy of Sciences."

Back issues, volumes, and sets of the Journal (Volumes 1-52, 1911-1962) can be purchased direct from Walter J. Johnson, Inc., 111 Fifth Avenue, New York 3, N. Y. This firm also handles the sale of the Proceedings of the Academy (Volumes 1-13, 1898-1910), the Index (to Volumes 1-13 of the Proceedings and Volumes 1-40 of the Journal), and the Academy's monograph, "The Parasitic Cuckoos of Africa."

Current issues of the Journal (past two calendar years) may still be obtained directly from the Academy office at 1530 P Street, N.W., Washington, D.C., 20005.

Claims for missing numbers will not be allowed if received more than 60 days after date of mailing plus time normally required for postal delivery and claim. No claims will be allowed because of failure to notify the Academy of a change of address.

Changes of address should be sent promptly to the Academy Office, 1530 P St., N.W., Washington, D.C., 20005. Such notification should include both old and new addresses and postal zone number, if any.

Second class postage paid at Washington, D.C.

Postmasters: Send Form 3579 to Washington Academy of Sciences, 1530 P St., N.W., Washington, D.C., 20005.

Washington Academy of Sciences
1965 Directory

Foreword

The present, 40th issue of the Academy's directory is again this year issued as the September issue of the Journal.

As was the case last year, we have attempted to produce an up-to-date listing of the membership at minimum cost to the Academy. Between the classified listing and the Washington area telephone books, there should be little difficulty in getting in touch with local members; hence we have not given the addresses of members. Also, the Academy office at 1530 P Street N.W. (AD 4-5323) is in a position to supply addresses for all members, whether local or nonresident, upon request.

Again this year, members are classified by three listings—alphabetically, by place of employment, and by membership in local societies affiliated with the Academy. Thus, the directory attempts to answer the basic questions that arise when the name of a scientist is mentioned: Where does he work? and What does he do? The knowledge that John Jones works in the Agricultural Research Service and that he belongs to the Entomological Society is the key to whether we have anything in common with him, and if so, how to seek him out.

With a few exceptions, we have not indicated places of employment for nonresident members, since this would lead to a very complex coding system; and such codes would scarcely be a reliable guide for written contacts. Nor, generally, have we classified emeritus members by place of employment, since most of them, presumably, have retired from gainful employment.

Assignment of codes for place of employment and membership in affiliated societies is based upon results of a postcard questionnaire sent to the Academy membership. Where the questionnaire was not answered, the coding was made on the basis of other available information. Corrections should be called to the attention of the Academy office.

In 1963, as an innovation, the directory included complete membership rosters for four of the Academy's affiliated societies, whether or not the persons listed were members of the Academy; in return for their cooperation, the four affiliates were provided with a supply of copies of the directory at nominal cost. In 1964, the practice was extended to nine of the affiliates.

After consideration of comparative costs, the Academy's Board of Managers has concluded that whatever the merits of joint directories, they are presently beyond the Academy's means and should be discontinued. Accordingly, the 1965 directory has been confined to Academy members only.

Explanation of Listings

The alphabetical listing purports to include all fellows and members on the Academy rolls as of July 1, 1965, whether resident or nonresident (i.e., living more than 50 miles from the White House), and whether active (dues-paying) or emeritus (retired).

Employment.—The first column of code symbols after the name is a semi-mnemonic cross-reference to place of employment, as shown in the first classified listing. In the employment code, 1 refers to Government agencies (and 1A to Agriculture, 1C to Commerce, etc.; and ICNBS refers to the National Bureau of Standards in the Department of Commerce); 2 refers to educational institutions, both higher (2H) and secondary (2S) (2HUMD is the University of Maryland); 3A refers to associations and 3I to private institutions; 4 refers to consultants, physicians, and other self-employed persons; 5 refers to business concerns (5HARE is the Harris Research Laboratories, for example); 6 refers to foreign and international groups (embassies, UN organizations, etc.); 7 refers to retired persons; and 8 and 9 refer to persons whose places of employment, if any, are not known or not coded.

Places of employment are given primarily for resident active fellows and members, with few exceptions.

Affiliation.—The second column of code symbols refers to the person's membership in one or more of the societies affiliated with the academy, as given in the following list, which includes also the year of the societies' affiliation with the Academy:

Code	
2B	Philosophical Society of Washington (1898)
2C	Anthropological Society of Washington (1898)
2D	Biological Society of Washington (1898)
2E	Chemical Society of Washington (1898)
2F	Entomological Society of Washington (1898)
2G	National Geographic Society (1898)
2H	Geological Society of Washington (1898)
2I	Medical Society of the District of Columbia (1898)
2J	Columbia Historical Society (1899)
2K	Botanical Society of Washington (1902)
2L	Society of American Foresters, Washington Section (1904)
2M	Washington Society of Engineers (1907)
2N	Institute of Electrical and Electronics Engineers, Washington Section (1912)[1]
2O	American Society of Mechanical Engineers, Washington Section (1923)
2P	Helminthological Society of Washington (1923)
2Q	American Society for Microbiology, Washington Branch (1923)
2R	Society of American Military Engineers, Washington Post (1927)
2S	American Society of Civil Engineers, National Capital Section (1942)
2T	Society for Experimental Biology and Medicine, D. C. Section (1952)
2U	American Society for Metals, Washington Chapter (1953)
2V	International Association for Dental Research, Washington Section (1953)
2W	American Institute of Aeronautics and Astronautics, Washington Section (1953)[2]
2X	American Meteorological Society, D. C. Branch (1954)
2Y	Insecticide Society of Washington (1959)
2Z	Acoustical Society of America, Washington Chapter (1959)
3B	American Nuclear Society, Washington Section (1960)
3C	Institute of Food Technologists, Washington Section (1961)
3D	American Ceramic Society, Baltimore-Washington Section (1962)
3E	Electrochemical Society, Washington-Baltimore Section (1963)
3F	Washington History of Science Club (1965)
3G	American Association of Physics Teachers, Chesapeake Section (1965)

Academy Status.—The third column of symbols refers to membership status in

[1] In 1963 the American Institute of Electrical Engineers (affiliated 1912) was merged with the Institute of Radio Engineers (affiliated 1933) to become the Institute of Electrical and Electronics Engineers. IEEE has been assigned the same seniority as the elder of the two merged societies.

[2] In 1963 the Institute of the Aerospace Sciences (affiliated 1953) absorbed the American Rocket Society and assumed the new name, American Institute of Aeronautics and Astronautics.

the Academy. AF refers to a *fellow* of the Academy, and AM to an Academy *member*. RA refers to a resident active fellow or member; NA refers to a nonresident active fellow or member (living more than 50 miles from the White House); and RE and NE refer respectively to resident and nonresident emeritus fellows.

Organization, Objectives, and Activities

The Washington Academy of Sciences had its origin in the Philosophical Society of Washington. The latter, organized in 1871, was for a few years the only scientific society of Washington. As other more specialized local scientific societies were formed, need was felt for federation of all such societies under an academy of sciences. Therefore 14 local scientific leaders moved to establish the Washington Academy of Sciences, which was incorporated on February 18, 1898. In that year the first eight societies listed above became affiliated with the Academy. The Philosophical Society heads the list because of its key position in the establishment of the Academy; the other seven are listed in alphabetical order, and the remaining 23 in chronological order of affiliation. Some of these 31 societies are local, without other affiliation; most are local sections or branches of national societies; one, the National Geographic Society, became a popular national society, whose present affiliation with the Academy is only of historical significance.

It should be noted that the Academy has had a total of 32 affiliations, but that two societies—the electrical engineers and the radio engineers—were merged in 1963 as mentioned above.

The primary purpose of the Academy is the promotion of science in various ways through cooperation among natural scientists and engineers of the Washington metropolitan area. Except during the summer, the Academy holds monthly meetings, stressing subjects of general scientific interest. It publishes a monthly journal, which is intended to facilitate and report the organized scientific activity of the Washington area. It may sponsor conferences or symposia and publish their proceedings, or it may publish suitable scientific monographs. In many ways, the Academy encourages excellence in scientific research and education, e.g., by sponsoring the Washington Junior Academy of Sciences; by sponsoring through the Joint Board on Science Education, experiments in and services to secondary scientific education in the public and private schools of the area; by making annual awards to promising high school students and to a few outstanding young professional scientists for their achievements in research or teaching; and by making small grants-in-aid for support of research. The Academy also may aid public understanding of important scientific developments through sponsored conferences and teacher training. It may make recommendations on public policy involving scientific matters.

The Academy acts as the federal head of its affiliated societies, each of which is represented on the Board of Managers by a delegate appointed by his society. Annual elections are by mail ballot.

The membership consists of three general classes: members, fellows, and patrons. At present the membership is composed principally of resident active fellows who by reason of scientific attainment are deemed eligible. Nominations for fellowship, endorsed by at least two fellows of the Academy, and changes in the status of members, are acted upon by the Board of Managers upon recommendation of the Committee on Memberhip. The new category, "member," is open, upon application, to any interested person who is approved by the Committee on Membership.

Further information on membership in the Academy is given in a statement elsewhere in this issue.

As of July 1, 1965, the Academy had a membership of 1263, including 1146 fellows and 117 members.

Organization for 1965

Officers

President	Leo Schubert	American University
President-Elect	John K. Taylor	National Bureau of Standards
Secretary	Alphonse F. Forziati	Department of Defense
Treasurer	Roman R. Miller	Naval Research Laboratory

Managers-at-Large

1963-65	Mary Louise Robbins	George Washington University
1963-65	Wilbur D. McClellan	Department of Agriculture
1964-66	Allen L. Alexander	Naval Research Laboratory
1964-66	Francis W. Reichelderfer	Retired
1965-67	Malcolm C. Henderson	Catholic University of America
1965-67	George W. Irving, Jr.	Department of Agriculture

Standing Committees

Executive	Leo Schubert, *Chairman*	American University
Membership	Malcolm W. Oliphant, *Chairman*	Georgetown University
Policy Planning	Dean Cowie, *Chairman*	Department of Terrestrial Magnetism, CIW
Ways and Means	Francois N. Frenkiel, *Chairman*	David Taylor Model Basin
Meetings	Jacinto Steinhardt, *Chairman*	Georgetown University
Awards for Scientific Achievement	Edward A. Mason, *Chairman*	University of Maryland
Grants-in-Aid for Research	Ralph I. Cole, *Chairman*	American University
Encouragement of Science Talent	Z. V. Harvalik, *Chairman*	Engineer Research & Development Laboratories
Public Information	Charles deVore, *Chairman*	Office of Naval Research
*Science Education**	John K. Taylor, *Chairman*	National Bureau of Standards

* The Academy contingent of the Joint Board on Science Education, which is sponsored by the Academy and the D.C. Council of Engineering and Architectural Societies.

Special Committees

Bylaws and Standing Rules	LAWRENCE A. WOOD, *Chairman*	National Bureau of Standards
Membership Promotion	JACOB J. DIAMOND, *Chairman*	National Bureau of Standards
Meetings Arrangements	JOHN H. MENKART, *Chairman*	Harris Research Laboratories
Archives	EDUARD FARBER, *Chairman*	American University
History of Science in Washington	MORRIS C. LEIKIND, *Chairman*	National Institutes of Health

The Journal

Editor	SAMUEL B. DETWILER, JR.	Department of Agriculture
Associate Editors	HAROLD T. COOK	Department of Agriculture
	RICHARD P. FARROW	National Canners Association
	HARRY A. FOWELLS	Department of Agriculture
	HELEN L. REYNOLDS	Food & Drug Adm.
	RALPH G. H. SIU	Department of Defense
	RUSSELL B. STEVENS	George Washington University

Delegates of Affiliated Societies

See inside rear cover.

Past Presidents

1898	John R. Eastman	1927	Alexander Wetmore	1946	Hugh L. Dryden
1899-		1928	Robert B. Sosman	1947	Waldo L. Schmitt
1910	Charles D. Walcott	1929	Ales Hrdlicka	1948	Frederick D. Rossini
1911	Frank W. Clarke	1930	William Bowie	1949	F. H. H. Roberts, Jr.
1912	Frederick V. Coville	1931	Nathan Cobb	1950	Francis B. Silsbee
1913	Otto H. Tittmann	1932	Leason H. Adams	1951	Nathan R. Smith
1914	David White	1933	Robert F. Griggs	1952	Walter Ramberg
1915	Robert S. Woodward	1934	Louis B. Tuckerman	1953	Frank M. Setzler
1916	Leland O. Howard	1935	George W. McCoy	1954	Francis M. Defandorf
1917	William H. Holmes	1936	Oscar E. Meinzer	1955	Margaret Pittman
1918	Lyman J. Briggs	1937	Charles Thom	1956	Ralph E. Gibson
1919	Frederick L. Ransome	1938	Paul E. Howe	1957	William M. Rubey
1920	Carl L. Alsberg	1939	Charles E. Chambliss	1958	Archibald T. McPherson
1921	Alfred H. Brooks	1940	Eugene C. Crittenden	1959	Frank L. Campbell
1922	William J. Humphreys	1941	Austin H. Clark	1960	Lawrence A. Wood
1923	Thomas W. Vaughan	1942	Harvey L. Curtis	1961	Philip H. Abelson
1924	Arthur L. Day	1943	Leland W. Parr	1962	Benjamin D. Van Evera
1925	Vernon Kellogg	1944	Clement L. Garner	1963	Benjamin D. Van Evera
1926	George K. Burgess	1945	John E. Graf	1964	Francois N. Frenkiel

Bylaws and Standing Rules

The Bylaws of the Academy, as last amended in September 1963, appear in the November 1964 issue of the Journal, pages 341-345. They will be reprinted in the near future.

The Standing Rules of the Board of Managers appear in the December 1964 issue of the Journal, pages 360-364.

THE WASHINGTON ACADEMY OF SCIENCES

Objectives

The objectives of the Washington Academy of Sciences are (a) to stimulate interest in the sciences, both pure and applied, and (b) to promote their advancement and the development of their philosophical aspects by the Academy membership and through cooperative action by the affiliated societies.

Activities

The Academy pursues its objectives through such activities as (a) publication of a periodical and of occasional scientific monographs; (b) holding of public lectures on scientific subjects; (c) sponsorship of a Washington Junior Academy of Sciences; (d) promotion of science education and a professional interest in science among people of high school and college age; (e) accepting or making grants of funds to aid special research projects; (f) sponsorship of scientific symposia and conferences; (g) assistance in scientific expeditions; (h) cooperation with other academies and scientific organizations; and (i) award of prizes and citations for special merit in science.

Membership

The membership consists of two major classes—**members** and **fellows.**

Members are persons who are interested in science and are willing to support the Academy's objectives as described above. A letter or form initiated by the applicant and requesting membership may suffice for action by the Academy's Committee on Membership; approval by the Committee constitutes election to membership.

Dues for members are $7.50 a year.

Fellows are persons who have performed original research or have made other outstanding contributions to the sciences, mathematics, or engineering. Candidates for fellowship must be nominated by at least two fellows, recommended by the Committee on Membership, and elected by the Board of Managers.

Dues are $10.00 a year for resident fellows (living within 50 miles of the White House) and $7.50 a year for nonresident fellows.

Persons who join the Academy as members may later be considered for fellowship.

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ALEXANDER, SAMUEL N	1CNBS	2B2N	AFRA
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ANDERSON, WENDELL L	1DNRL	2E	AFRA
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ANDREWS, JOHN S	1ARFR	2P	AFRA
ANDREWS, T G	2HUMD		AFRA
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ARSEM, COLLINS	1DAHD	2G2N	AMRA
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BAKER, LOUIS C W	2HGEU	2E	AFRA
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BARNHART, CLYDE S	1DAX	2F	AFNA
BARON, LOUIS S	1DAWR	2Q	AFRA
BARRETT, MARGARET D	1HNIH	2G2T	AFRA
BARRETT, MORRIS K	7RETD	2T	AFRA
BARSS, HOWARD P	7RETD	2K	AFNE
BARTONE, JOHN C	2HGWU	2T	AMRA
BASS, ARNOLD M	1CNBS	2B	AFRA
BATEMAN, ALAN M	4CONS	2H	AFNE
BATES, PHAON H	7RETD		AFNE
BATES, ROGER G	1CNBS	2E3E	AFRA
BAUER, HUGO	7RETD	2E	AFRA
BEACH, LOUIS A	1DNRL	2B2G3G	AFRA
BEACH, PRISCILLA A	4CONS		AMRA
BEAN, HOWARD S	4CONS	2G2O	AFRA
BEARCE, HENRY W	7RETD	2B	AFNE
BECKER, EDWIN D	1HNIH	2E	AFRA
BECKETT, CHARLES W	1CNBS	2B2E	AFRA
BECKMANN, ROBERT B	2HUMD	2E	AFRA
BEIJ, K HILDING	7RETD	2B	AFNA

BEKKEDAHL, NORMAN	1CNBS	2B2E2G	AFRA
BELKIN, MORRIS	1HNIH		AFRA
BELSHE'M, ROBERT O	1DNRL	2B2G2M2O	AFRA
BENDER, MAURICE	8NRNC	2E3C	AFNA
BENEDICT, WILLIAM S	2HJHU		AFRA
BENESCH, WILLIAM	2HUMD	2B	AFRA
BENJAMIN, CHESTER R	1ARFR	2D2G2K	AFRA
BENNETT, JOHN A	1CNBS	2U	AFRA
BENNETT, LAWRENCE H	1CNBS	2U	AFRA
BENNETT, MARTIN T	4CONS	2E	AFRA
BENNETT, ROBERT R	1IGES	2H	AFRA
BENNETT, WILLARD H	8NRNC	2B	AFNA
BERCH, JULIAN	5HARE	2E	AMRA
BERKNER, L V	8NRNC	2G	AFNA
BERL, WALTER G	3IAPL	2B2E2W	AFRA
BERLINER, ROBERT W	1HNIH	2B2T	AFRA
BERNTON, HARRY S	4PHYS	2I	AFRA
BEROZA, MORTON S	1ARFR	2E2T2Y	AFRA
BESTUL, ALDEN B	1CNBS	2B2E2G	AFRA
BIBERSTEIN, FRANK A JR	2HCUA	2B2M2S	AFRA
BICKLEY, WILLIAM E	2HUMD	2F2Y	AFRA
BIRCKNER, VICTOR	7RETD		AFRE
BIRD, H R	8NRNC	2G	AFNA
BIRKS, LAVERNE S	1DNRL		AFRA
BISHOPP, FRED C	7RETD	2C2D2F	AFRE
BLACK, RICHARD B	1DNOR	2G	AFRA
BLAKE, DORIS H	1XSMI	2F	AFRE
BLANC, MILTON L	1CWEB	2G2X	AFNA
BLOCK, STANLEY	1CNBS	2E	AFRA
BLOOM, MORTIMER C	1DNRL	2B2E3E	AFRA
BLUM, WILLIAM	4CONS	2E2G3E	AFRE
BLUNT, ROBERT F	1CNBS		AFRA
BOGLE, ROBERT W	5DERE	2B2G	AFNA
BOLTON, ELLIS T	3ICIW	2G	AFRA
BOND, HOWARD W	1HPHS	2E	AFRA
BONDELID, ROLLON O	1DNRL		AFRA
BORTHWICK, HARRY A	1ARFR	2D2G2K	AFRA
BOSWELL, VICTOR R	1ARFR	2G	AFRA
BOUTWELL, JOHN M	4CONS	2G2H	AFNA
BOWER, VINCENT E	1CNBS		AFRA
BOWLES, ROMALD E	5BOEN	2G2W	AFRA
BOWMAN, PAUL W	1HNIH	2D2K	AFRA
BOWMAN, THOMAS E	1XSMI	2D	AFRA
BOYLE, DON R	1CNBS	2N	AMRA
BOZEMAN, F MARILYN	1DAWR	2Q2T	AFRA
BRAATEN, NORMAN F	1CCGS	2B2M2R	AFRA
BRADLEY, WILLIAM E	3IIDA	2N	AMRA
BRANSON, HERMAN	2HHOU	2B2G3G	AFRA
BRAUER, GERHARD M	1CNBS	2E2V	AFRA
BRECKENRIDGE, F C	4CONS	2B	AFRA
BRECKENRIDGE, ROBERT G	8NRNC		AFNA
BREEDLOVE, C H JR	2HMJC		AMRA
BREIT, GREGORY	8NRNC		AFNA
BRENNER, ABNER	1CNBS	2E2G3E	AFRA
BREWER, A KEITH	1DNNO	2B2E2G	AFRA
BREWER, CARL R	8NRNC	2Q	AFNA
BRICKWEDDE, F G	8NRNC	2B	AFNE
BRIER, GLENN W	1CWEB	2G2X	AFRA
BRODIE, BERNARD B	1HNIH	2T	AFRA
BROMBACHER, W G	7RETD	2B	AFRE
BROWN, ALFRED E	5HARE	2B2E2G	AFRA
BROWN, B F	1DNRL	2U3E	AFRA
BROWN, EDGAR	7RETD	2D2K	AFRE
BROWN, JOSHUA R C	2HUMD		AFRA
BROWN, RUSSELL G	2HUMD	2K	AFRA
BROWN, THOMAS M	2HGWU	2I	AFRA
BRUCK, STEPHEN D	3IAPL	2E2G	AFRA
BUHRER, EDNA M	7RETD	2P	AFRA
BUNN, RALPH W	3AESA	2F2Y	AFRA
BURAS, EDMUND M JR	5HARE	2E	AFRA
BURGERS, J M	2HUMD	2B	AFRA

BURINGTON, RICHARD S	1DNBW 2B2G	AFRA
BURK, DEAN	1HNIH 2E2T	AFRA
BURKE, BERNARD F	3ICIW	AFRA
BURKE, FREDERIC G	4PHYS 2I	AFRA
BURKEY, LLOYD A	7RETD 2Q	AFRE
BURNETT, HARRY C	1CNBS 2G2U	AFRA
BUTLER, FRANCIS E	1DNOL 2G20	AMRA
BYERLY, PERRY	7RETD	AFNA
BYERLY, THEODORE C	1ACSR 2T	AFRA
BYRNE, ROBERT J	1HNIH 2Q	AFRA
CALDWELL, FRANK R	1CNBS 2B2G	AFRA
CALDWELL, JOSEPH M	1DACE 2S	AFRA
CALLEN, EARL R	8NRNC 2B	AFNA
CAMPAIGNE, HOWARD H	1D-X	AFRA
CAMPBELL, FRANK L	7RETD 2F2Y	AFNA
CANDELA, GEORGE A	1CNBS	AFRA
CANNON, EDWARD W	1CNBS 2B	AFRA
CARDER, DEAN S	1CCGS 2B2H	AFNA
CAREY, FRANCIS E	5ASPR	AFRA
CARHART, HOMER W	1DNRL 2E2G	AFRA
CARMICHAEL, LEONARD	3INGS 2B2G2J2T	AFRA
CARRINGTON, TUCKER	1CNBS 2B2E	AFRA
CARROLL, THOMAS J	5BERA 2B	AFRA
CARROLL, WILLIAM R	1HNIH 2E	AFRA
CARRON, MAXWELL K	1IGES 2E2H	AFRA
CARTER, HUGH	1HPHS	AFRA
CASH, EDITH K	7RETD 2K	AFRE
CASSEL, JAMES M	1CNBS 2E2G	AFRA
CAUL, HAROLD J	1CNBS 2E2G2U2V	AFRA
CHALKLEY, HAROLD W	7RETD 2T	AFRE
CHAPIN, EDWARD A	7RETD	AFNE
CHAPIN, EDWARD J	1DNRL 2G2U	AFRA
CHAPLIN, HARVEY R JR	1DNDT 2W	AFRA
CHAPLINE, W R	7RETD 2G2K2L	AFRE
CHAPMAN, GEORGE B	2HGEU	AFRA
CHEEK, CONRAD H	1DNRL 2E	AFRA
CHITWOOD, BENJAMIN G	8NRNC	AFNA
CHRISTENSON, LEROY D	1ARFR 2F2G2Y	AFRA
CLAIRE, CHARLES N	7RETD 2B2M	AFRA
CLARK, FRANCIS E	1AX	AFNA
CLARK, GEORGE E JR	5ARCO	AFRA
CLARK, KENNETH G	7RETD 2E2G	AFRE
CLAUSEN, CURTIS P	7RETD 2F	AFNE
CLEAVER, OSCAR P	1DAER 2M2N2R	AFRA
CLEMENT, J REID JR	1DNRL	AFRA
CLEVEN, GALE W	8NRNC 2B2W	AFNA
COCHRAN, DORIS M	1XSMI 2G	AFRA
COHN, ERNST M	1XNAS 2E3E	AMRA
COHN, ROBERT	1DNHS 2B	AFRA
COLE, HOWARD I	7RETD 2G	AFNE
COLE, KENNETH S	1HNIH 2B	AFRA
COLEMAN, JOHN S	3INAS 2Z	AFRA
COLLINS, HENRY B	1XSMI 2C	AFRA
COMPTON, W DALE	8NRNC	AFNA
CONGER, PAUL S	1XSMI	AFRA
CONTEE, CARL T	2SDCP	AMRA
COOK, HAROLD T	1ARMR 2B2K3C	AFRA
COOK, RICHARD K	1CNBS 2B2Z	AFRA
COOK, ROBERT C	5PORB 2K	AFRA
COOKE, C WYTHE	7RETD 2H	AFRE
COOLIDGE, HAROLD J	3INAS 2G	AFRA
COOLIDGE, WILLIAM D	7RETD	AFNA
COONS, GEORGE H	7RETD 2K	AFRE
COOPER, G ARTHUR	1XSMI 2H	AFRA
COOPER, STEWART R	7RETD	AFRE
COOTER, IRVIN L	1CNBS 2B2N	AFRA
CORNFIELD, JEROME	1HNIH	AFRA
CORY, ERNEST N	7RETD 2F2G2Y	AFRE
COSTRELL, LOUIS	1CNBS 2B2N	AFRA
COTTAM, CLARENCE	8NRNC 2D	AFNA
COULSON, E JACK	1ARNI 2E2T	AFRA
COWIE, DEAN B	3ICIW	AFRA
COYLE, THOMAS D	1CNBS 2E2G	AFRA
CRAFT, CHARLES C	1AX	AFNA
CRAFTON, PAUL A	2HGWU 2G2N2O2W	AFRA
CRAGOE, CARL S	7RETD 2B2G	AFRE
CRANE, LANGDON T JR	1XNSF 2B	AFRA
CRAVEN, JOHN P	1DNSP 2B2Z	AFRA
CREITZ, E CARROLL	1CNBS 2E	AFRA
CRESSMAN, GEORGE P	1CWEB 2X	AFRA
CRY, GEORGE W	1CWEB 2X	AMRA
CULLINAN, FRANK P	7RETD 2K	AFRE
CURRAN, HAROLD R	7RETD 2Q	AFRA
CURRIER, LOUIS W	4CONS 2H	AFRE
CURTIS, ROGER W	5WEEL 2B2G2N	AFRA
CURTISS, LEON F	7RETD 2B	AFNE
CUTHILL, JOHN R	9CLUN	AFRA
CUTTITTA, FRANK	1IGES 2E2G2H	AFRA
DAFT, FLOYD S	7RETD 2E2T	AFRA
DALZELL, R CARSON	1XAEC 2O2U3B	AFRA
DANE, CARLE H	1IGES 2H	AFRA
DARWENT, BASIL DE B	2HCUA 2B2E	AFRA
DAUER, CARL C	7RETD	AFRA
DAVIS, CHARLES M JR	9CLUN	AMRA
DAVIS, MARION M	1CNBS 2E2G	AFRA
DAVIS, PHILIP J	8NRNC	AFNA
DAVIS, R F	2HUMD 2T	AFRA
DAVIS, RAYMOND	7RETD 2B2E	AFRE
DAVIS, STEPHEN S	2HHOU 2O	AMRA
DAVIS, WATSON	3ISCS 2B2H2M	AFRA
DAVISSON, JAMES W	1DNRL 2B	AFRA
DAWSON, PAUL R	7RETD	AFNE
DAWSON, ROY C	6FAOR 2Q	AFRA
DE CARLO, MICHAEL	3INAS 2G	AMRA
DE FERIET, J KAMPE	8NRNC	AFNA
DE LAUNAY, JULES R	1DNRL	AFRA
DE PACKH, DAVID C	1DNRL 2B	AFRA
DE PUE, LELAND A	1DNRL 2G2U	AFRA
DE VORE, CHARLES	1DNOR 2B2M2N3B	AMRA
DE WIT, ROLAND	1CNBS	AFRA
DEBORD, GEORGE G	7RETD 2Q	AFNE
DEITZ, VICTOR R	1DNRL 2E	AFRA
DEMUTH, HAL P	1CCGS 2N2R	AMRA
DERMEN, HAIG E	1ARFR 2K	AFRA
DESLATTES, RICHARD D	1CNBS	AFRA
DETWILER, SAMUEL B	7RETD 2G2K2L	AFRA
DETWILER, SAMUEL B JR	1ARNI 2E	AFRA
DIAMOND, JACOB J	1CNBS 2E3D	AFRA
DIAMOND, PAULINE	2SMOC	AFRA
DICKSON, GEORGE	1CNBS 2G2V	AFRA
DIEHL, WALTER S	4CONS 2W	AFRA
DIEHL, WILLIAM W	7RETD 2D2K	AFRE
DIGGES, THOMAS G	7RETD 2U	AFRE
DOCTOR, NORMAN J	1DAHD 2N	AFRA
DOETSCH, RAYMOND N	2HUMD 2Q	AFRA
DOLECEK, RICHARD L	1DNRL 2B2G3G	AFRA
DOSS, MILDRED A	2HUMD 2P	AFRA
DOUGLAS, CHARLES A	1CNBS 2B2G	AFRA
DOUGLAS, THOMAS B	1CNBS 2E	AFRA
DOWNING, LEWIS K	2HHOU 2S	AFRA
DRAEGER, R HAROLD	4PHYS	AFNE
DRECHSLER, CHARLES	1ARFR 2G2K	AFRA
DRUMMETER, LOUIS F JR	1DNRL	AFRA
DRYDEN, HUGH L	1XNAS 2B2G2O2W	AFRA
DU PONT, JOHN E	8NRNC	AMNA
DUERKSEN, JACOB A	7RETD 2B2G	AFRE
DUNCAN, HELEN M	1IGES 2H	AFRA
DUNNING, KENNETH L	1DNRL 2B	AFRA
DUPONT, JEAN R	8NRNC	AFNA
DURBIN, CHARLES G	1HFDA 2G2P	AFRA
DUTILLY, ARTHEME	2HCUA 2K	AFRA
DYKE, EDWIN	5HOWR 2N	AMRA
EASTER, DONALD	1XNAS 2E	AMRA
ECKERT, W J	8NRNC	AFNA
ECKHARDT, E A	7RETD	AFNE
EDDY, BERNICE E	1HNIH 2G2Q2T	AFRA
EDDY, NATHAN B	4CONS 2G2T	AFRA
EDMUNDS, LAFE R	1XNSF 2F	AFRA
EDMUNDS, WADE M	3IJBS 2M2N3B	AMRA
EDWARDS, H KENNETH	1SX 2E	AMRA

EGLI, PAUL H	1DNRL	2B2E	AFRA
EGOLF, DONALD R	1ARFR	2K	AFRA
EISENHART, CHURCHILL	1CNBS	2B	AFRA
ELBOURN, ROBERT D	1CNBS	2B2N	AFRA
ELLINGER, GEORGE A	1CNBS	2G2U3E	AFRA
ELLIOTT, CHARLOTTE	7RETD	2G2K	AFNE
ELLIOTT, FRANCIS E	5GEEL		AFRA
ELLIS, NED R	7RETD	2E2T	AFRE
EMERSON, W B	9CLUN		AFRE
EMERY, ALDEN H	3AACS	2E2G	AFRA
EMMART, EMILY W	1HNIH	2Q2T	AFRA
EMSWELLER, SAMUEL L	1ARFR	2K	AFRA
ENDICOTT, KENNETH M	1HNIH	2T	AFRA
ENNIS, WILLIAM B JR	1ARFR		AFRA
ESTERMANN, IMMANUEL	1DNX	2B	AFNA
ETZEL, HOWARD W	1XNSF	2G	AFRA
EULER, ELVIRA A	9CLUN		AMRA
EVANS, W DUANE	8NRNC		AFNA
EWERS, JOHN C	1XSMI	2C2G	AFRA
FABER, JOHN E	2HUMD	2Q	AFRA
FAHEY, JOSEPH J	1IGES	2E2G2H	AFRA
FALLON, ROBERT J	5MELP	2B2E	AFRA
FARBER, EDUARD	2HAMU	2E2G3F	AFRA
FARR, MARION M	2HUMD	2P	AFRA
FARROW, RICHARD P	3ANCA	2E2G3C	AFRA
FAULKNER, JOSEPH A	1DNOL	2G	AMRA
FAUST, GEORGE T	1IGES	2H3D	AFRA
FAUST, WILLIAM R	1DNRL	2B2G	AFRA
FELSENFELD, OSCAR	8NRNC	2G2T	AMNA
FERGUSON, HENRY G	7RETD		AFRE
FERGUSON, LLOYD N	2HHOU	2E	AFRA
FERGUSON, ROBERT E	1CNBS	2E	AFRA
FERRELL, RICHARD A	2HUMD	2G3G	AFRA
FIELD, WILLIAM D	1XSMI		AFRA
FIELDNER, ARNO C	7RETD	2E2G2M	AFRA
FINAN, JOHN L	2HGWU		AMRA
FINLEY, HAROLD E	2HHOU	2D	AFRA
FISK, BERT	1DNRL	2G	AFRA
FIVAZ, ALFRED E	7RETD	2L	AFRE
FLETCHER, DONALD G	1CNBS	2E	AMRA
FLETCHER, HEWITT G JR	1HNIH	2E	AFRA
FLORIN, ROLAND E	1CNBS	2E2G	AFRA
FONER, SAMUEL N	3IAPL	2B	AFRA
FOOTE, PAUL D	3INAS	2B	AFRA
FORD, T FOSTER	1DNRL	2E	AFRA
FORZIATI, ALPHONSE F	1D-S	2E2V3E	AFRA
FORZIATI, FLORENCE H	1ARNI	2E	AFRA
FOSTER, AUREL O	1ARFR	2P2Y	AFRA
FOURNIER, ROBERT O	8NRNC	2H	AFNA
FOURT, LYMAN	5HARE	2E2W	AFRA
FOWELLS, HARRY A	1AFOR	2L	AFRA
FOWLER, EMIL E	1XAEC	3B	AMRA
FOX, DAVID W	9CLUN		AFRA
FOX, M R SPIVEY	1HFDA	2E2G2T	AFRA
FOX, ROBERT B	1DNRL	2E2G	AFRA
FRAME, ELIZABETH G	1HNIH	2E	AFRA
FRANK, KARL	1HNIH		AFRA
FRANKLIN, PHILIP J	1CNBS	2E2N	AFRA
FRANKLIN, TEMPIE R	2SARC		AFRA
FRANZ, GERALD J	1DNDT	2G2Z	AMRA
FRAPS, RICHARD M	1ARFR	2B2T	AFRA
FREDERIKSE, H P R	1CNBS		AFRA
FREEMAN, ANDREW F	1ARNI	2E	AMRA
FREEMAN, MONROE E	1XSMI	2E	AFRA
FRENKIEL, FRANCOIS N	1DNDT	2B2W2X	AFRA
FRIEDMAN, LEO	8NRNC	2G2T	AFNA
FRIESS, SEYMOUR L	1DNMR	2E	AFRA
FRUSH, HARRIET L	1CNBS	2E	AFRA
FULLMER, IRVIN H	1CNBS	2B2G2O	AFRA
FULTON, ROBERT A	7RETD	2E2Y	AFNE
FURUKAWA, GEORGE T	1CNBS	2B2E2G	AFRA
FUSILLO, MATTHEW H	1XVET	2Q	AMRA
GABRIELSON, IRA N	3IWMI		AFRA
GAFAFER, WILLIAM M	7RETD		AFNE
GALLOWAY, RAYMOND A	2HUMD	2K	AFRA
GALTSOFF, PAUL S	7RETD	2D	AFNE
GAMOW, GEORGE	8NRNC	2B	AFNA
GANT, JAMES Q JR	4PHYS	2G212X	AMRA
GARDNER, IRVINE C	7RETD	2B2G	AFRE
GARGUS, JAMES L	5HALA		AMRA
GARNER, CLEMENT L	7RETD	2B2G2M2R	AFRE
GARSTENS, HELEN L	2HUMD		AFRA
GARVIN, DAVID	1CNBS	2E	AFRA
GARY, ROBERT	1CNBS		AFRA
GATES, G E	8NRNC	2D	AFNA
GAZIN, CHARLES L	1XSMI	2D2H	AFRA
GEIL, GLENN W	1CNBS	2G2U	AFRA
GELLER, ROMAN F	7RETD	2B2G3D	AFRA
GHAFFARI, ABOLGHASSEM	1XNAS	2B	AFRA
GIBSON, JOHN E	1DNRL	2N	AFRA
GIBSON, KASSON S	7RETD	2B2G	AFRE
GIBSON, RALPH E	3IAPL	2B2E2W	AFRA
GILLMAN, JOSEPH L JR	4CONS	2E2M2O2U	AFRA
GINNINGS, DEFOE C	1CNBS	2E2G	AFRA
GINTHER, ROBERT J	1DNRL	3E	AFRA
GISH, OLIVER H	7RETD	2B	AFNE
GLASGOW, AUGUSTUS R JR	1HFDA	2E2G	AFRA
GLASS, JEWELL J	1IGES	2G2H	AFRA
GLASSER, ROBERT G	2HUMD	2B	AFRA
GODFREY, THEODORE B	1DAHD		AFRA
GOLDBERG, MICHAEL	7RETD	2B	AFRA
GOLUMBIC, CALVIN	1ARMR	2E3C	AFRA
GONET, FRANK	1XUST	2E	AFRA
GORDON, CHARLES L	7RETD	2B2E2G	AFRA
GORDON, FRANCIS B	1DNMR	2G2Q2T	AFRA
GORDON, RUTH E	8NRNC	2Q	AFNA
GOULD, IRA A	8NRNC		AFNA
GRAF, JOHN E	7RETD	2F2G	AFRA
GRAHAM, EDWARD H	4CONS		AFRA
GRANT, ULYSSES S III	7RETD	2G2J2R2S	AFRA
GRASSL, CARL O	1ARFR		AFNA
GRATON, LOUIS C	8NRNC		AFNE
GRAVATT, G FLIPPO	7RETD	2K2L	AFRE
GRAY, ERNEST P	3IAPL	2B	AMRA
GRAY, IRVING	2HGEU	2G2T	AFRA
GRAY, VANNIE E	1CNBS	2E	AMRA
GREEN, MELVILLE S	1CNBS	2B	AFRA
GREENOUGH, M L	1CNBS		AFRA
GREENSPAN, MARTIN	1CNBS	2B2Z	AFRA
GRIFFITHS, NORMAN H C	2HHOU	2V	AFRA
GRISAMORE, NELSON T	2HGWU	2B2G2N	AFRA
GROSVENOR, GILBERT H	7RETD	2G2J	AFRA
GUARINO, P A	1DAHD	2N	AFRA
GUILDNER, LESLIE A	1CNBS	2B2G	AFRA
GURNEY, ASHLEY B	1ARFR	2D2F2G	AFRA
HAAS, PETER H	1D-X		AMRA
HACSKAYLO, EDWARD	1AFOR	2G2K2L	AFRA
HAGUE, JOHN L	1CNBS	2E2G	AFRA
HAHN, FRED E	1DAWR	2Q	AFRA
HAINES, KENNETH A	1ARAO	2F2G2Y	AFRA
HAKALA, REINO W	8NRNC		AFNA
HALL, E RAYMOND	8NRNC	2D2G	AFNA
HALL, R CLIFFORD	7RETD	2G2L	AFRE
HALL, STANLEY A	1ARFR	2E2Y	AFRA
HALL, WAYNE C	1DNRL	2B2G2N3G	AFRA
HALLER, HERBERT L	7RETD	2E2F2G2Y	AFRA
HALLER, WOLFGANG	1CNBS	2E2G3D	AFRA
HALSTEAD, BRUCE W	8NRNC	2T	AFNA
HAMBLETON, EDSON J	7RETD	2D2F2G	AFRA
HAMBLETON, JAMES I	7RETD	2F	AFRA
HAMER, WALTER J	1CNBS	2E2G2N3E	AFRA
HAMMERSCHMIDT, WM W	1D-S	2B	AMRA
HAMMOND, H DAVID	2HHOU	2K	AMRA
HAMPP, EDWARD G	1HNIH	2Q2V	AFRA
HAND, CADET H JR	8NRNC	2G	AFNA
HANSBOROUGH, LOUIS A	2HHOU		AMRA
HANSEN, IRA B	2HGWU	2D2G	AFRA
HANSEN, LOUIS S	1DNMC	2V	AFRA
HANSEN, MORRIS H	1CBUC		AFRA
HARDENBURG, ROBERT E	1ARMR		AFRA

HARDER, E C	8NRNC	AFNA
HARRINGTON, MARSHALL C	1DFOS 2B2N2W3G	AMRA
HARRIS, FOREST K	1CNBS 2N	AFRA
HARRIS, MILTON	5GICO 2E	AFRA
HARRISON, MARK	2HAMU 2B3G	AFRA
HARRISON, WILLIAM N	7RETD 2B2G2U3D	AFRA
HARTMANN, GREGORY K	1DNOL 2B2Z	AFRA
HARVALIK, Z V	1DAER 2E2G3G	AFRA
HARWOOD, PAUL D	8NRNC 2D2G2P	AFNA
HASELTINE, NATE	5WAPO 2X	AFRA
HASKINS, CARYL P	3ICIW 2F2G2R	AFRA
HASS, GEORG H	1DAER	AFRA
HAUPTMAN, HERBERT	1DNRL 2B2G	AFRA
HAWTHORNE, EDWARD W	2HHOU	AFRA
HAZLETON, LLOYD W	5HALA 2E2G2T	AFRA
HEINZE, PETER H	1ARMR 2E2G2K3C	AFRA
HELLER, ISIDORE	2HCUA	AFRA
HENDERSON, E P	1XSMI 2H	AFRA
HENDERSON, MALCOLM C	2HCUA 2B2Z3B3G	AFRA
HENLEY, ROBERT R	7RETD 2G	AFRE
HENNEBERRY, THOMAS J	1ARFR 2F2Y	AFNA
HENNEY, DAGMAR	2HGWU 2B	AMRA
HENRY, THOMAS R	4X 2B	AFRA
HERMAN, CARLTON M	1IFWS 2G2P2T	AFRA
HERMAN, ROBERT C	8NRNC	AFNA
HERSCHMAN, HARRY K	1CBDS 2U	AFRA
HERSEY, MAYO D	8NRNC 2B	AFNA
HERZ, ALBERT J	8NRNC 2B	AFNA
HERZFELD, CHARLES M	1D-S 2B	AFRA
HERZFELD, KARL F	2HCUA 2B	AFRA
HERZFELD, REGINA F	2HCUA 2C	AFRA
HESS, WALTER C	9CLUN 2V	AFRE
HETRICK, FRANK	2HUMD 2Q	AMRA
HEWITT, CLIFFORD A	1HNIH 2E	AMRA
HEYDEN, FRANCIS J	2HGEU 2B2G3G	AFRA
HIATT, CASPAR W	1HNIH 2E2G2Q2T	AFRA
HICKLEY, THOMAS J	1CCGS 2S2Z	AFRA
HICKOX, GEORGE H	8NRNC 2G	AFNA
HICKS, GRADY T	1DNRL 2G	AMRA
HICKS, VICTOR	8NRNC	AFNA
HILDEBRAND, EARL M	1ARFR 2G2K2Q	AMRA
HILL, FREEMAN K	3IAPL 2G2W	AFRA
HILTON, JAMES L	1ARFR	AFRA
HINMAN, WILBUR S JR	4CONS 2S	AFRA
HOBBS, ROBERT B	1CNBS 2B2E2G	AFRA
HOCHWALD, FRITZ G	9CLUN 2K	AMRA
HOERING, THOMAS C	3IGEL 2E2G2H	AFRA
HOFFMAN, JOHN D	1CNBS 2B2F2L2Y	AFRA
HOFFMANN, CLARENCE H	1ARFR 2F2Y	AFRA
HOFFMASTER, EDMUND S	9CLUN	AMRA
HOGE, HAROLD J	1DAX 2B	AFNA
HOLLIES, NORMAN R S	5HARE 2E	AFRA
HOLLINGSHEAD, ROBERT S	7RETD	AFRE
HOLMES, FRANK H	7RETD 2G2U	AMRA
HOLMGREN, HARRY D	2HUMD 2B	AFRA
HOLSHOUSER, WILLIAM L	1XCAB 2G2U	AFRA
HONIG, JOHN G	5HONE	AMRA
HOOKER, MARJORIE	1IGES 2H	AFRA
HOOVER, JOHN I	1DNRL 2B2G	AFRA
HOOVER, THOMAS B	1CNBS 2E	AFRA
HOPP, HENRY	1AFAS 2L	AFNA
HORTON, BILLY M	1DAHD 2B2G2N	AFRA
HOSTETTER, J C	8NRNC	AFNE
HOUGH, FLOYD W	7RETD 2G	AFNA
HOWARD, GEORGE W	1DAER 2S	AFRA
HOWARD, ROBERT E	1CNBS	AFRA
HOWE, PAUL E	4CONS 2E2T	AFRA
HUBBARD, DONALD	7RETD 2E2G	AFRA
HUBERT, LESTER F	1CWEB 2X	AFNA
HUGH, RUDOLPH	2HGWU 2Q2T	AFRA
HUMPHREYS, CURTIS J	1DNOL 2B	AFNA
HUNDLEY, JAMES M	1HPHS	AFRA
HUNT, W HAWARD	1AMRP 2G	AMRA
HUNTER, GEORGE W III	8NRNC 2P	AFNE
HUNTER, RICHARD S	5HUAS 2G	AFRA
HUNTER, WILLIAM R	1DNRL 2B2G	AFRA
HUNTOON, ROBERT D	1CNBS 2B2N	AFRA
HUTCHINS, LEE M	8NRNC 2K2L	AFNA
HUTTON, GEORGE L	1DNBY 2F2G	AFRA
IMAI, ISAO	8NRNC	AFNA
INSLEY, HERBERT	4CONS 2B2G2H3D	AFRA
IRVING, GEORGE W JR	1ARAO 2E3C	AFRA
IRWIN, GEORGE R	1DNRL 2B2G	AFRA
ISBELL, HORACE S	1CNBS 2E	AFRA
JACKSON, HARTLEY H T	7RETD 2D	AFRE
JACKSON, JULIUS L	2HHOU 2B	AFRA
JACOB, KENNETH D	4CONS 2E	AFRA
JACOBS, WALTER W	1D-X 2B	AFRA
JACOBS, WOODROW C	1XNOD 2X	AFRA
JACOBSON, MARTIN	1ARFR 2E2Y	AFRA
JAMES, L H	8NRNC	AFNE
JAMES, MAURICE T	8NRNC 2F	AFNA
JAY, GEORGE E JR	5MIAS 2G	AFRA
JEN, CHIH K	3IAPL 2B	AFRA
JENKINS, ANNA E	7RETD 2D2G2K3F	AFNE
JENKINS, WILLIAM D	1CNBS 2U	AMRA
JESSUP, RALPH S	7RETD 2B2G	AFRA
JOHANNESEN, ROLF B	1CNBS 2E2G	AFRA
JOHNSON, DANIEL P	1CNBS 2B	AFRA
JOHNSON, KEITH C	2SDCP 2B3G	AFRA
JOHNSON, PHYLLIS T	8NRNC 2F2G	AFNA
JOHNSTON, FRANCIS E	7RETD 2B	AFRE
JONES, HENRY A	8NRNC	AFNA
JORDAN, GARY B	8NRNC 2N	AMNA
JOYCE, J WALLACE	1SX 2B2G	AFRA
JUDD, DEANE B	1CNBS 2B	AFRA
JUDD, NEIL M	7RETD 2C	AFRE
JUDSON, LEWIS V	7RETD 2B2G	AFNE
JUHN, MARY	7RETD 2T	AFRA
KABISCH, WILLIAM T	3AAAS 2G	AMRA
KAGARISE, RONALD E	1DNRL	AFRA
KAHN, ARNOLD H	1CNBS	AFRA
KALMUS, HENRY P	1DAHD 2N	AFRA
KANAGY, JOSEPH R	1CNBS 2E	AFRA
KANE, EDWARD A	1ARFR 2E	AFRA
KARKENNY, MOSES	5MIPI 2E	AMRA
KARLE, ISABELLA	1DNRL 2E2G	AFRA
KARLE, JEROME	1DNRL 2B2E	AFRA
KARR, PHILIP R	8NRNC	AFNA
KARRER, ANNIE M H	7RETD	AFRE
KARRER, SEBASTIAN	7RETD 2B2E2G3G	AFRA
KAUFMAN, H PAUL	4CONS 2M	AFRA
KEEGAN, HARRY J	1CNBS 2E2G	AFRA
KEGELES, GERSON	8NRNC	AFNA
KELLUM, LEWIS B	8NRNC 2G	AFNA
KENK, ROMAN	1XLIC 2G	AFRA
KENNARD, RALPH B	7RETD 2B2G3G	AFRE
KENNEDY, E R	2HCUA 2G2Q	AFRA
KENNEY, ARTHUR W	1XNSF 2B	AFRA
KERESZTESY, JOHN C	1HNIH 2E	AFRA
KESSLER, KARL G	1CNBS 2B	AFRA
KEULEGAN, GARBIS H	1DAX 2B	AFNA
KIES, JOSEPH A	1DNRL 2B2G2U	AFRA
KIESS, CARL C	2HGEU 2G	AFRA
KING, PETER	1DNOR 2B2E	AFNA
KINNEY, JAY P	7RETD 2L	AFNE
KLEBANOFF, PHILIP S	1CNBS 2B2W	AFRA
KLEIN, WILLIAM H	1CWEB 2X	AFRA
KLUTE, CHARLES H	1DAHD 2B2E	AFRA
KNAPP, DAVID G	1CCGS 2G	AFRA
KNIPLING, EDWARD F	1ARFR 2F	AFRA
KNIPLING, PHOEBE H	2SARC 3G	AFRA
KNOBLOCK, EDWARD C	1DAWR 2E2T	AFRA
KNOPF, ELEANORA B	8NRNC 2H	AFNE
KNOWLTON, KATHRYN	7RETD 2E2T	AFRA
KOEHL, GEORGE M	2HGWU 3G	AMRA
KOHLER, HANS W	1DAHD 2G2N3G	AFRA
KOHLER, MAX A	1CWEB 2S2X	AFRA
KOLB, ALAN C	1DNRL 2B	AFRA
KOPPANYI, THEODORE	2HGEU 2T	AFRA

KOSTKOWSKI, HENRY J	1CNBS	2B	AFRA
KOTTER, F RALPH	1CNBS	2G2N	AFRA
KRASNY, JOHN F	5HARE		AFRA
KRAUSS, ROBERT W	2HUMD	2K	AFRA
KREITLOW, KERMIT W	1ARFR	2G	AFRA
KRUGER, JEROME	1CNBS	2E3E	AFRA
KULLBACK, SOLOMON	2HGWU	2N	AFRA
KULLERUD, GUNNAR	3IGEL	2G	AFRA
KURTZ, FLOYD E	1ARNI	2E	AFRA
KURZWEG, HERMAN H	1XNAS	2B2W	AFRA
KUSHNER, LAWRENCE M	1CNBS	2U	AFRA
LADO, ROBERT	2HGEU		AFRA
LAKI, KOLOMAN	1HNIH	2E	AFRA
LAKIN, HUBERT W	1IGES	2H	AFNA
LAMANNA, CARL	1DARO	2Q2T	AFRA
LAMB, FRANK W	8NRNC		AFNA
LAMBERT, EDMUND B	1ARFR	2G2K	AFRA
LAMBERT, WALTER D	7RETD	2B	AFNE
LAMBERTON, BERENICE	2HGEU		AMRA
LANDIS, PAUL E	1DAHD	2N	AFRA
LANDSBERG, HELMUT E	1CWEB	2X	AFRA
LANG, WALTER B	7RETD		AFRE
LANGFORD, GEORGE S	2HUMD	2F2Y	AFRA
LAPHAM, EVAN G	7RETD	2B	AFNA
LAPP, RALPH E	4X	2B	AFRA
LARRIMER, WALTER H	3INAS	2G2L2Y	AFRA
LASHOF, THEODORE W	1CNBS	2B2G3G	AFRA
LASTER, HOWARD J	2HUMD	2B3G	AFRA
LATTA, RANDALL	6FAOR	2F	AFNE
LE CLERG, ERWIN L	7RETD	2K	AFRA
LEE, RICHARD H	2SMSA	3G	AFRA
LEIGHTY, CLYDE E	7RETD	2G2K	AFRE
LEIKIND, MORRIS C	1HNIH	3F	AFRA
LEINER, ALAN L	8NRNC		AFNA
LEONARD, LORRAINE I	2SMOC		AMRA
LEVERTON, RUTH M	1ARNI		AFRA
LEVIN, ERNEST M	1CNBS	2E3D	AFRA
LEVY, SAMUEL	8NRNC		AFNA
LEY, HERBERT L JR	8NRNC	2Q	AFNA
LI, HUI-LIN	8NRNC		AFNA
LICKLIDER, JOSEPH C R	8NRNC		AFNA
LIDDEL, URNER	1XNAS	2B2N2W	AFRA
LIDE, DAVID R JR	1CNBS		AFRA
LIEBERMAN, MORRIS	1ARMR	2E	AFRA
LIEBSON, SIDNEY H	8NRNC		AFNA
LIKINS, ROBERT C	1HNIH	2V	AFRA
LILLY, JOHN C	8NRNC		AFNA
LINDQUIST, ARTHUR W	7RETD	2F	AFNA
LING, LEE	6FAOR		AFNA
LINNENBOM, VICTOR J	1DNRL	2E2G2N	AFRA
LIPPINCOTT, ELLIS R	2HUMD	2B2E	AFRA
LIST, ROBERT J	1CWEB	2X	AFRA
LITOVITZ, THEODORE A	2HCUA	2B2Z	AFRA
LITTLE, ELBERT L JR	1AFOR	2K2L	AFRA
LLOYD, DANIEL B	2HDCT		AMRA
LOCKARD, J DAVID	2HUMD		AMRA
LOCKHART, LUTHER B JR	1DNRL	2E	AFRA
LOGAN, HUGH L	1CNBS	2U3E	AFRA
LORING, BLAKE M	4CONS	2U	AFRA
LOTHROP, S K	8NRNC		AFNA
LOVE, S KENNETH	1IGES	2E2H	AFRA
LUDFORD, GEOFFREY S S	8NRNC		AFNA
LUTZ, JACOB M	1ARMR	2K3C	AFRA
LYMAN, JOHN	1IFWS	2E	AFRA
LYNN, W GARDNER	2HCUA	2B	AFRA
MAC DONALD, TORRENCE H	1CWEB	2X	AMRA
MAC DONALD, WILLIAM M	2HUMD	2B2G3G	AFRA
MACHTA, LESTER	1CWEB	2X	AFRA
MADORSKY, SAMUEL L	7RETD	2E	AFRA
MAENGWYN-DAVIES, G D	2HGEU	2B2E2G2T	AFRA
MAGIN, GEORGE B JR	1XAEC	2E2H3B	AFRA
MAHAN, ARCHIE I	3IAPL	2B	AFRA
MAIENTHAL, MILLARD	1HFDA	2E	AFRA
MALONEY, CLIFFORD J	1HNIH		AFRA
MANDEL, H GEORGE	2HGWU	2E2T	AFRA
MANDEL, JOHN	1CNBS	2B2E	AFRA
MANN, DAVID E	1CNBS	2E	AFRA
MANNING, JOHN R	1CNBS	2G	AFRA
MARCUS, MARVIN	8NRNC		AFNA
MARCUS, SIDNEY O JR	1DNOD	2X	AMRA
MARSHALL, LOUISE H	1HNIH		AFRA
MARSHALL, WADE H	1HNIH	2B	AFRA
MARTIN, GEORGE W	8NRNC		AFNE
MARTIN, JOHN H	7RETD	2G2K	AFRA
MARTIN, MONROE H	2HUMD		AFRA
MARTIN, ROBERT H	1DNWS	2X	AMRA
MARTON, L L	1CNBS	2B	AFRA
MARVIN, ROBERT S	1CNBS	2B2E2G	AFRA
MARYOTT, ARTHUR A	1CNBS	2E2G	AFRA
MARZKE, OSCAR T	8NRNC		AFNA
MASKET, ALBERT V H	1DNRL		AFRA
MASON, EDWARD A	2HUMD	2B2E3F3G	AFRA
MASON, MARTIN A	2HGWU	2M2O2S	AFRA
MASSEY, JOSEPH T	3IAPL	2B2N	AFRA
MATHERS, ALEX P	1TIRS	2E	AFRA
MATLACK, MARION B	7RETD	2E2G	AFRE
MATOSSI, FRANK	8NRNC		AFNA
MAUSS, BESSE D	7RETD		AFRA
MAXWELL, LOUIS R	1DNOL	2B	AFRA
MAY, DONALD C JR	1DNBW	2B	AFRA
MAY, IRVING	1IGES	2E2G2H	AFRA
MAYER, CORNELL H	1DNRL	2B2N	AFRA
MAYOR, JOHN R	3AAAS	2G	AFRA
MAZUR, JACOB	1CNBS	2B2G	AFRA
MC BRIDE, GORDON W	8NRNC	2E3C	AFNA
MC CABE, LOUIS C	5RERS	2E2G	AFRA
MC CABE, WILLIAM J	1XFPC	2H	AMRA
MC CLAIN, EDWARD F JR	1DNRL	2B2N	AFRA
MC CLELLAN, WILBUR D	1ARFR	2G2K	AFRA
MC CLURE, FRANK J	1HNIH	2N2T	AFRA
MC CLURE, FRANK T	3IAPL	2B2E	AFRA
MC CULLOUGH, NORMAN B	1HNIH	2G2I2Q	AFRA
MC DONALD, EMMA J	8NRNC	2E	AFNA
MC ELHINNEY, JOHN	1DNRL	2B2G	AFRA
MC INTOSH, ALLEN	7RETD	2G2P	AFRA
MC KEE, SAMUEL A	7RETD		AFRA
MC KELVEY, VINCENT E	1IGES	2H	AFRA
MC KENZIE, LAWSON M	8NRNC	2B	AFNA
MC KINNEY, HAROLD H	7RETD	2G2K2Q	AFRE
MC KNIGHT, EDWIN T	1IGES	2H	AFRA
MC KOWN, BARRETT L	2SPGC	2G	AMRA
MC MILLEN, J HOWARD	1XNSF	2B3G	AFRA
MC MULLEN, DONALD B	1DAWR	2P	AFRA
MC MURDIE, HOWARD F	1CNBS	3D	AFRA
MC NESBY, JAMES R	1CNBS		AFRA
MC PHEE, HUGH C	7RETD	2G	AFRE
MC PHERSON, ARCHIBALD	4X	2B2E2G3C	AFRA
MC WHORTER, FRANK P	8NRNC		AFNE
MEADE, BUFORD K	1CCGS	2R	AFRA
MEANS, URA MAE	1ARFR	2Q	AMRA
MEARS, ATHERTON H	7RETD		AFRE
MEARS, FLORENCE M	2HGWU		AFRA
MEBS, RUSSELL W	1CNBS	2M2U	AFRA
MEGGERS, WILLIAM F	4CONS	2B2G	AFRA
MEINKE, W WAYNE	1CNBS	2E	AFRA
MELMED, ALLAN J	1CNBS		AFRA
MENDLOWITZ, HAROLD	1CNBS		AFRA
MENKART, JOHN H	5HARE	2E	AFRA
MERRIAM, CARROLL F	7RETD	2G	AFNA
MERZ, ALBERT R	7RETD		AFRE
MEYERHOFF, HOWARD A	8NRNC	2G2H	AFNA
MEYERSON, MELVIN R	1CNBS	2U	AFRA
MEYROWITZ, ROBERT	1IGES	2E	AFRA
MIDDLETON, HOWARD E	7RETD		AFNE
MIDER, G BURROUGHS	1HNIH	2G	AFRA
MILLER, CARL F	1XSMI	2C2G	AFRA
MILLER, CLEM O	1HFDA	2E	AFRA
MILLER, J CHARLES	7RETD	2H	AFNA
MILLER, PAUL R	1ARFR	2K	AFRA
MILLER, ROMAN R	1DNRL	2E2G3D	AFRA
MILLIKEN, LEWIS T	1CNBS	2B2E2G2H	AMRA
MINARD, DAVID	8NRNC		AFNA

MISER, HUGH D	1IGES	2H	AFRE
MISNER, CHARLES W	2HUMD		AFRA
MITCHELL, J MURRAY JR	1CWEB	2G2X	AFRA
MITCHELL, JOHN W	1ARFR		AFRA
MITTLEMAN, DON	8NRNC	2B	AFNA
MIZELL, LOUIS R	5HARE	2E	AFRA
MOHLER, FRED L	7RETD	2B	AFRE
MOLLARI, MARIO	7RETD	2Q	AFRE
MONCHICK, LOUIS	3IAPL	2B2E	AFRA
MONTROLL, ELLIOTT W	3IIDA	2B	AFRA
MOORE, GEORGE A	1CNBS	2G2U3E	AFRA
MOORE, HARVEY C	2HAMU	2C	AFRA
MORAN, FREDERICK A	1XMDG	2G2X	AMRA
MORGAN, RAYMOND	2HUMD	2B	AFRE
MORRIS, J A	1HNIH	2E2P2Q	AMRA
MORRIS, JOSEPH B	2HHOU	2E	AFRA
MORRIS, KELSO B	2HHOU	2E	AFRA
MORRISON, BENJAMIN Y	7RETD		AFNE
MORRISON, JOSEPH P	1XSMI	2D	AFRA
MORRISS, DONALD J	1AFOR	2L	AFRA
MORTON, JOHN D	5MELP	2X	AFRA
MOSHMAN, JACK	5CEIR		AMRA
MOSTOFI, F K	1D-IP	2T3B	AFRA
MUEHLHAUSE, CARL O	1CNBS	2B3B	AFRA
MUESEBECK, CARL F W	7RETD	2D2F	AFRE
MURPHY, LEONARD M	1CCGS	2B	AFRA
MYERS, ALFRED T	1IGES	2E2G	AFNA
MYERS, RALPH D	2HUMD	2B	AFRA
MYERS, WILLIAM H	1DNOD	2G2X	AMRA
NAESER, CHARLES R	2HGWU	2E2H	AFRA
NAMIAS, JEROME	1CWEB	2X	AFRA
NELSON, R H	3AESA	2F2G2Y	AFRA
NEUENDORFFER, J A	1DNX	2G	AFRA
NEWMAN, MORRIS	1CNBS		AFRA
NEWMAN, SANFORD B	1CNBS		AFRA
NEWTON, CLARENCE J	1CNBS		AFRA
NICKERSON, DOROTHY	4CONS	2G	AFRA
NIKIFOROFF, C C	7RETD	2G2H	AFRE
NIRENBERG, MARSHALL W	1HNIH	2E	AFRA
NOFFSINGER, TERRELL L	1CWEB	2X	AFRA
NOLLA, JOSE A B	8NRNC		AFNA
NORRIS, KARL H	1ARMR	3C	AFRA
NOYES, HOWARD E	1DAWR	2Q2T	AFNA
O BRIEN, JOHN A	2HCUA	2K	AFRA
O DAY, RICHARD	1XDCG		AMRA
O HERN, ELIZABETH M	2HGWU	2Q	AMRA
O KEEFE, JOHN A	1XNAS	2B	AFRA
O NEILL, HUGH T	7RETD		AFRE
OBOURN, ELLSWORTH S	1HOED	2B3G	AFRA
OEHSER, PAUL H	1XSMI	2B2D3F	AFRA
OKABE, HIDEO	1CNBS		AFRA
OLIPHANT, MALCOLM W	2HGEU		AFRA
OLIVER, VINCENT J	1CWEB	2X	AFRA
OLSON, BYRON J JR	8NRNC		AFNA
OLSON, HENRY W	2HDCT		AFRA
ORDWAY, FRED D JR	5MELP	2E2G3D	AFRA
OREM, THEODORE H	1CNBS	2U	AFRA
OSGOOD, WILLIAM R	2HCUA	2O	AFRA
OSMUN, J W	1CWEB	2X	AFNA
OSTEN, EDWARD J	1XLIC	2B2W	AMRA
OSWALD, ELIZABETH J	9CLUN		AFRA
OVERTON, WILLIAM C JR	8NRNC	2B2G	AFNA
OWENS, HOWARD B	2SPGC	2D2F2G	AFRA
OWENS, JAMES P	1IGES	2G2H	AFRA
PACK, DONALD H	1CWEB	2X	AFRA
PAFFENBARGER, GEORGE C	1CNBS	2V	AFRA
PAGE, BENJAMIN L	7RETD	2B2G	AFRE
PAGE, CHESTER H	1CNBS	2B2G2N	AFRA
PAGE, ROBERT M	1DNRL	2N	AFRA
PALLOTTA, ARTHUR J	5BIRE		AMRA
PALMER, ALLISON R	1IGES		AFRA
PARK, HELEN D	1HNIH		AFRA
PARK, J HOWARD	8NRNC	2N	AFNA
PARKER, KENNETH W	1AFOR	2D2K2L	AFRA
PARKER, MARION W	1ARAO	2D2K	AFRA
PARKER, ROBERT L	1CNBS		AFRA
PARLETT, ROBERT C	2HGWU	2Q	AFRA
PARR, LELAND W	7RETD	2Q	AFRE
PARSONS, DOUGLAS E	4CONS	2B2G2S	AFRE
PASSAGLIA, ELIO	1CNBS		AFRA
PATTERSON, MARGARET E	3IFOF		AFRA
PATTERSON, WILBUR I	1ARNI	2E2G2T3C	AFRA
PAYNE, LAWRENCE E	8NRNC		AFNA
PEACOCK, ELIZABETH D	9NCOC		AMRA
PECORA, WILLIAM T	1IGES	2H	AFRA
PEISER, H STEFFEN	1CNBS	2B2E3D	AFRA
PELCZAR, MICHAEL J JR	2HUMD	2Q	AFRA
PELL, WILLIAM H	1XNSF	2O	AFRA
PELLAM, JOHN R	8NRNC		AFNA
PELLINI, WILLIAM S	1DNRL	2U	AFRA
PENNINGTON, WILLIAM A	1IX	2U	AFNA
PENTZER, WILBUR T	1ARMR	2B	AFRA
PERKINS, LOUIS R	3HDCG		AMRA
PERROS, THEODORE P	2HGWU	2B2E3F	AFRA
PHAIR, GEORGE	1IGES	2H	AFRA
PHILLIPS, MARCELLA L	4CONS	2B2N	AFRA
PIGMAN, W WARD	8NRNC		AFNA
PIKL, JOSEF	8NRNC	2E	AFNA
PIORE, E R	8NRNC	2B	AFNA
PITTMAN, MARGARET	1HNIH	2Q2T	AFRA
PITTS, JOSEPH W	1CNBS	2U3D	AFRA
POLACHEK, HARRY	1XAEC	2B	AFRA
POLING, AUSTIN C	1CCGS	2N	AFRA
POLLOCK, BRUCE M	1ARFR	2K	AFNA
POMMER, ALFRED M	1ARNI	2E2G2H2T	AFRA
POOS, FRED W	7RETD	2F2G2Y	AFRA
POPE, MERRITT N	7RETD	2K	AFNE
POPENOE, WILSON	7RETD	2L	AFNE
PORTER, B A	7RETD	2F2G2Y	AFRA
POSNER, AARON S	8NRNC	2E2V	AFNA
POTTS, B L	1DNX		AMRA
PRATT, HARRY D	1HPHS	2F	AFNA
PRESLEY, JOHN T	1ARFR		AFRA
PRICE, E W	8NRNC	2D2P	AFNE
PRO, MAYNARD J	1TIRS	2E2G3B	AFRA
PROSEN, EDWARD J	1CNBS	2E	AFRA
PUTNINS, PAUL H	1CWEB	2G2X	AFRA
QUIMBY, FREEMAN H	1XNAS		AFRA
RABINOW, JACOB	5RBEN	2B2N	AFRA
RADO, GEORGE T	1DNRL	2B	AFRA
RAINWATER, H IVAN	1ARRP	2Y	AMRA
RALL, DAVID P	1HNIH	2T	AFRA
RAMBERG, WALTER	1SX	2B2O2W	AFNA
RANDS, ROBERT D	7RETD	2G2K	AFNE
RAPPLEYE, HOWARD S	7RETD	2B2G2M2R2S	AFRA
RAUSCH, ROBERT	1HPHS	2D2G2P	AFNA
RAVITSKY, CHARLES	1DAX		AFNA
READ, W T	7RETD	2E	AFRA
READING, OLIVER S	8NRNC	2B	AFNE
REAM, DONALD F	1DNBS		AFRA
REED, WILLIAM D	7RETD	2F2G2R	AFRA
REEVE, E WILKINS	2HUMD	2E	AFRA
REHDER, HARALD A	1XSMI	2D2G	AFRA
REICHELDERFER, F W	4CONS	2B2G2W2X	AFRA
REICHEN, LAURA E	1IGES	2E	AFRA
REID, MARY E	7RETD	2K2P	AFRE
REINHART, BRUCE L	8NRNC		AFNA
REINHART, FRANK W	4CONS	2E2G	AFRA
REINHART, FRED M	1DNBY	2U	AFNA
REITEMEIER, ROBERT F	1XAEC		AFRA
RENKIN, EUGENE M	8NRNC		AFNA
REYNOLDS, HELEN L	1HFDA	2E2G	AMRA
REYNOLDS, HOWARD	1ARNI	2Q3C	AFRA
REYNOLDS, ORR E	1D-S	2V	AFRA
RHODES, IDA	1CNBS		AFRA
RICE, DONALD A	1CCGS	2R	AFRA
RICE, FRANCIS O	8NRNC	2E	AFNA
RICE, FREDERICK A H	2HAMU	2E2G	AFRA

RICE, STUART A	5SURE		AFRA
RICHMOND, JOSEPH C	1CNBS	2B2G2M2W3D	AFRA
RICKER, PERCY L	7RETD	2G2K	AFRE
RIDDLE, OSCAR	8NRNC		AFNE
RIFE, DAVID C	1HNIH		AFRA
RINEHART, JOHN S	1CX	2G2U	AFRA
RIOCH, DAVID M	1DAWR	2I	AFRA
RITT, PAUL E	5MELP	2E2N2W	AFRA
RITTS, ROY E JR	8NRNC		AFNA
RIVELLO, ROBERT M	2HUMD	2O2W	AFRA
RIVLIN, RONALD S	8NRNC		AFNA
ROBBINS, MARY L	2HGWU	2G2Q2T	AFRA
ROBERTS, ELLIOTT B	4CONS	2B2G2R2S	AFRE
ROBERTS, FRANK H H	7RETD	2C	AFRA
ROBERTS, IRENA Z	2HTRI	2E	AMRA
ROBERTS, RICHARD B	3IDTM		AFRA
ROBERTS, RICHARD C	1DNOL	2G	AFRA
ROBERTSON, A F	1CNBS	2G	AFRA
ROBERTSON, RANDAL M	1XNSF	2B2G2L	AFRA
ROBINSON, HENRY E	1CNBS		AFRA
ROBINSON, WARREN A	1HFDA		AMRA
ROCK, GEORGE D	2HCUA		AFRA
RODENHISER, HERMAN A	1ARFR	2K	AFRA
RODNEY, WILLIAM S	1XNSF	2B	AFRA
RODRIGUEZ, RAUL	1DAER	2G2R	AFRA
ROEDDER, EDWIN	1IGES	2B2H	AFRA
ROGERS, LORE A	7RETD	2Q	AFNE
ROLLER, PAUL S	5LIPR	2B2E2G	AFRA
ROMNEY, CARL F	1DFX	2H	AFRA
ROSE, JOHN C	2HGEU	2I2T	AFRA
ROSENBLATT, DAVID	1CNBS	2B	AFRA
ROSENTHAL, SANFORD M	1HNIH		AFRE
ROSS, SHERMAN	3AAPS		AFRA
ROSSINI, FREDERICK D	8NRNC	2B	AFNA
ROTH, FRANK L	7RETD	2G	AFNE
ROTKIN, ISRAEL	1DAHD	2B2N	AFRA
ROWE, WALLACE P	1HNIH		AFRA
RUBEY, WILLIAM W	8NRNC	2D2H3F	AFNA
RUBIN, MEYER	1IGES	2H	AFRA
RUBIN, MORTON J	1CWEB	2X	AFRA
RUBIN, ROBERT J	1CNBS	2B	AFRA
RUBIN, VERA C	3IDTM	2B	AFRA
RUFF, ARTHUR W JR	1CNBS	2G	AFRA
RUSSELL, LOUISE M	1ARFR	2D2F2G	AFRA
RYALL, A LLOYD	1ARMR	2K3C	AFRA
RYERSON, KNOWLES A	7RETD	2G	AFNA
SAENZ, ALBERT W	1DNRL		AFRA
SAGER, WILLIAM F	8NRNC	2E	AFNA
SAILER, REECE I	1ARFR	2F	AFNA
SALISBURY, LLOYD L	1DAWR	2G2N	AMRA
SALKOVITZ, EDWARD I	1DNOR	2B	AFRA
SAN ANTONIO, JAMES P	1ARFR		AMRA
SANDERSON, JOHN A	1DNRL	2B	AFRA
SANDOZ, GEORGE	1DNRL	2G2U	AFRA
SANFORD, RAYMOND L	7RETD	2B	AFRE
SARLES, MERRITT P	2HCUA	2G2P2Y	AFRA
SAULMON, ERNEST E	1ARRP		AMRA
SAVILLE, THORNDIKE JR	1DACE	2G2S	AFRA
SAYLOR, CHARLES P	9CLUN		AFRA
SCHAEFFER, CLAUDE E	1IX		AFNA
SCHAFFER, ROBERT	1CNBS	2E	AFRA
SCHALLER, WALDEMAR T	1IGES	2E2H	AFRE
SCHAMP, HOMER W JR	2HUMD		AFRA
SCHECHTER, MILTON S	1ARFR	2E2Y	AFRA
SCHEER, MILTON D	1CNBS	2B2E	AFRA
SCHERTENLEIB, CHARLES	6MOCO		AMRA
SCHIEFER, HERBERT F	1CNBS	2B	AFRA
SCHINDLER, ALBERT I	1DNRL	2B	AFRA
SCHMITT, WALDO L	1XSMI	2D	AFRA
SCHOEN, LOUIS J	1CNBS		AFRA
SCHOENBORN, HENRY W	2HUMD		AFRA
SCHOENEMAN, ROBERT L	1TIRS		AFRA
SCHOENING, HARRY W	7RETD	2G2T	AFRA
SCHOOLEY, ALLEN H	1DNRL	2B2G2N3G	AFRA
SCHOONOVER, IRL C	1CNBS	2B2E2V	AFRA
SCHRECKER, ANTHONY W	1HNIH	2E	AFRA

SCHUBAUER, GALEN B	1CNBS	2B2G2W	AFRA
SCHUBERT, LEO	2HAMU	2B2E3F	AFRA
SCHULMAN, JAMES H	1DNRL	2B3E	AFRA
SCHULTZ, EUGENE S	1ARFR	2K	AFRE
SCHWARTZ, ANTHONY M	5HARE	2E	AFRA
SCHWARTZ, BENJAMIN	7RETD	2P	AFNE
SCOFIELD, FRANCIS	3ANPV	2E	AMRA
SCOTT, ARNOLD H	1CNBS	2B2G2N	AFRA
SCOTT, DAVID B	8NRNC	2G2V	AFNA
SCOVILLE, HERBERT JR	1SACD		AFRA
SCRIBNER, BOURDON F	1CNBS	2E	AFRA
SEAMSTER, AARON	1XNAS		AFRA
SEEGER, RAYMOND J	1XNSF	2B2G3F3G	AFRA
SERVICE, JERRY H	7RETD	2G	AFNE
SETZLER, FRANK M	7RETD	2C2G	AFNE
SHAFRIN, ELAINE G	1DNRL	2E	AMRA
SHALOWITZ, AARON L	7RETD		AFRE
SHANAHAN, ARTHUR J	1XNSF	2Q	AFRA
SHANNON, JAMES A	1HNIH	2I	AFRA
SHAPIRO, GUSTAVE	1CNBS	2N	AFRA
SHAPIRO, LEONARD	1IGES	2E	AFRA
SHAPIRO, MAURICE M	1DNRL	2B	AFRA
SHAPLEY, A H	8NRNC		AFNA
SHAPOVALOV, MICHAEL	7RETD	2G	AFNE
SHAW, JOSEPH C	8NRNC		AFNA
SHELTON, EMMA	1HNIH		AFRA
SHEN, SHAN-FU	8NRNC		AFNA
SHEPARD, HAROLD H	1AASC	2F2Y	AFRA
SHERESHEFSKY, J LEON	2HHOU	2E	AFRA
SHERLIN, GROVER C	1CNBS	2B2G2N3G	AMRA
SHIMER, H W	7RETD	2G	AFNE
SHIMKIN, DEMITRI B	8NRNC		AFNA
SHMUKLER, LEON	8NRNC		AMNA
SHORB, DOYS A	1ARFR	2P	AFRA
SHORB, MARY S	2HUMD	2G2Q2T	AFRA
SHROPSHIRE, WALTER A	1XSMI	2G2K	AMRA
SHULER, KURT E	1CNBS	2B	AFRA
SIEGLER, EDOUARD H	7RETD	2F2Y	AFRE
SILBERSCHMIDT, KARL M	8NRNC		AFNA
SILSBEE, FRANCIS B	7RETD	2B2G2N	AFRA
SILVERMAN, SHIRLEIGH	1CNBS	2B	AFRA
SIMHA, ROBERT	8NRNC		AFNA
SIMMONS, JOHN A	1CNBS	2G	AFRA
SIMMONS, LANSING G	1CCGS	2R2S	AFRA
SITTERLY, BANCROFT W	2HAMU	2B3G	AFRA
SITTERLY, CHARLOTTE M	1CNBS	2B2G	AFRA
SIU, RALPH G H	1DAMC		AFRA
SLACK, LEWIS	3INAS	2B2G	AFRA
SLADEK, JAROMIL V	1HFDA	2E	AFRA
SLAWSKY, MILTON M	1DFOS	2G2M2W3G	AFRA
SLAWSKY, ZAKA I	1DNOL	2B	AFRA
SLOCUM, GLENN G	1HFDA	2Q3C	AFRA
SMALL, JAMES B	1CCGS	2B2M2R	AFRA
SMART, J SAMUEL	8NRNC	2B	AFNA
SMITH, CHARLES M	7RETD	2Y	AFRE
SMITH, EDGAR R	7RETD	2E	AFNE
SMITH, FALCONER	2HAMU	2B2T	AFRA
SMITH, FLOYD F	1ARFR	2F2Y	AFRA
SMITH, FRANCIS A	7RETD		AFNE
SMITH, HENRY L JR	8NRNC	2C	AFNA
SMITH, JACK C	1CNBS		AFRA
SMITH, NATHAN R	7RETD	2G2K2Q	AFNE
SMITH, PAUL A	5RACO	2B2G2H2S2W	AFRA
SMITH, PAUL L	1DNRL	2B2N	AFRA
SMITH, RAYMOND G	1CWEB	2X	AMRA
SMITH, SIDNEY T	1DNRL	2B2N	AFRA
SMITH, WILLIE W	1HNIH	2T	AFRA
SNAVELY, BENJAMIN L	1DNOL	2G2Z	AFRA
SNAY, HANS G	1DNOL	2G2Z	AFRA
SNOKE, HUBERT R	7RETD		AFRE
SOLLNER, KARL	1HNIH	2E3E	AFRA
SOMMER, HELMUT	1DAHD	2N	AFRA
SOOKNE, ARNOLD M	5HARE	2E	AFRA
SPECHT, HEINZ	1HNIH	2B2G2T	AFRA
SPENCER, J T	1XNSF	2G	AFRA
SPENCER, LEWIS V	1CNBS	2G	AFNA
SPENCER, ROSCOE R	7RETD		AFNE
SPICER, H CECIL	7RETD	2H	AFNE

SPIES, JOSEPH R	1ARNI	2E2T	AFRA
SPOONER, CHARLES S JR	5RAYC	2H	AFRA
SPRAGUE, GEORGE F	1ARFR		AFRA
ST GEORGE, RAYMOND A	7RETD	2D2F2L2Y	AFRA
STADTMAN, E R	1HNIH		AFRA
STAIR, RALPH	1CNBS	2G2N	AFRA
STAKMAN, E C	8NRNC		AFNA
STAUSS, HENRY E	1XNAS	2U	AFRA
STEARN, JOSEPH L	1CCGS		AFRA
STEELE, LENDELL E	1DNRL	2U	AFRA
STEERE, RUSSELL L	1ARFR	2K	AFRA
STEGUN, IRENE A	1CNBS		AFRA
STEINER, ROBERT F	1DNMR	2B2E	AFRA
STEINHARDT, JACINTO	2HGEU	2E	AFRA
STEPHAN, ROBERT M	1HNIH	2V	AFRA
STEPHENS, ROBERT E	1CNBS	2B	AFRA
STERN, KURT H	1CNBS	2E3E3F	AFRA
STEVENS, HENRY	1ARNI	2E2G2T	AFRA
STEVENS, ROLLIN E	8NRNC		AFNA
STEVENS, RUSSELL B	2HGWU	2K	AFRA
STEVENSON, FREDERICK J	4CONS	2G	AFRA
STEVENSON, JOHN A	7RETD	2K	AFRE
STEWART, DEWEY	1ARFR	2G2K	AFRA
STEWART, ILEEN E	1XNSF		AFRA
STEWART, SARAH E	1HNIH	2T	AFRA
STEWART, T DALE	1XSMI	2C2G	AFRA
STIEBELING, HAZEL K	7RETD	2E	AFRA
STIEHLER, ROBERT D	1CNBS	2B2E2G2O	AFRA
STILL, JOSEPH W	4PHYS	2B	AFNA
STILLER, BERTRAM	1DNRL	2B2G	AFRA
STIMSON, HAROLD F	7RETD	2B2G	AFRE
STIRLING, MATHEW W	7RETD	2C2G	AFRA
STRASBERG, MURRAY	1DNDT	2Z	AFRA
STRAUB, HARALD W	1CCGS		AFRA
STREEVER, RALPH L JR	1CNBS		AFRA
STRINGFIELD, VICTOR T	1IGES	2G2H2L	AFRA
STUART, NEIL W	1ARFR	2K	AFRA
SULLIVAN, DANIEL A JR	4CONS	2U	AMRA
SULZBACHER, WILLIAM L	1ARNI	2Q3C	AFRA
SUTCLIFFE, WALTER D	7RETD	2B2G2M2R	AFRE
SWEENEY, WILLIAM T	1CNBS	2E2U2V	AFRA
SWICK, CLARENCE H	7RETD	2B2G2M	AFRA
SWINDELLS, JAMES F	1CNBS	2B2G	AFRA
SWINGLE, CHARLES F	7RETD		AFNE
SYSKI, RYSZARD	2HUMD		AFRA

TALBERT, PRESTON T	2HHOU	2E	AFRA
TALBOTT, F LEO	2HCUA	2B2G3G	AFRA
TALIAFERRO, W H	1XAEC		AFNA
TALMADGE, HARVEY G JR	1DNRL	2G2N	AMRA
TASAKI, ICHIJI	1HNIH		AFRA
TATE, DOUGLAS R	1CNBS	2B	AFRA
TAUSSKY, OLGA	8NRNC		AFNE
TAYLOR, ALBERT L	1ARFR	2P	AFNA
TAYLOR, JAMES H	2HGWU		AFRE
TAYLOR, JOHN K	1CNBS	2B2E2G3E	AFRA
TAYLOR, LAURISTON S	3INAS		AFRA
TAYLOR, MARIE C	2HHOU	2K	AMRA
TAYLOR, MODDIE D	2HHOU	2E	AFRA
TAYLOR, RAYMOND L	3AAAS		AFRA
TCHEN, CHAN-MOU	1CNBS	2B	AFRA
TEELE, RAY P	1CNBS	2B2G	AFRA
TEPPER, MORRIS	1XNAS	2W2X	AFRA
TEWELES, SIDNEY	1CWEB	2X	AFRA
THALER, WILLIAM J	2HGEU		AFRA
THAYER, THOMAS P	1IGES	2H	AFRA
THOM, HERBERT C S	1CWEB	2X	AFRA
THOMAS, CHARLES A	1ARFR	2K	AMRA
THOMAS, JAMES L	4CONS		AFRA
THOMAS, PAUL D	1DNOC	2R	AFRA
THOMPSON, JACK C	8NRNC	2X	AFNA
THURMAN, ERNESTINE B	1HNIH	2F2G	AFNA
TIDBALL, CHARLES S	2HGWU	2I2T	AFRA
TILDEN, EVELYN B	7RETD	2G	AFNE
TILLYER, E D	8NRNC		AFNA
TIPSON, R STUART	1CNBS	2E	AFRA
TITTSLER, RALPH P	1ARNI	2Q3C	AFRA
TITUS, HARRY W	4X	2G	AFNA
TODD, FRANK E	1ARFR	2F2Y	AFRA
TODD, MARGARET R	1IGES	2G2H	AFRA
TOLL, JOHN S	8NRNC	2B3G	AFNA
TOOL, ARTHUR Q	1CNBS	3D	AFRA
TORGESEN, JOHN L	1CNBS	2E2G	AFRA
TORRESON, OSCAR W	7RETD	2B2G	AFRE
TOULMIN, PRIESTLEY	1IGES	2H	AFRA
TOUSEY, RICHARD	1DNRL	2B	AFRA
TOWNSEND, JOHN R	4CONS	2B	AFRA
TRAUB, ROBERT	2HUMD	2F2P2T	AFRA
TRAVIS, CLARENCE W	1XDCG	2F	AMRA
TREADWELL, CARLETON R	2HGWU	2E2T	AFRA
TREXLER, JAMES H	1DNRL	2B2G2S	AFRA
TROMBA, FRANCIS G	1ARFR	2P	AFRA
TRUEBLOOD, CHARLES K	7RETD		AFRA
TRYON, MAX	1CNBS	2E2G	AFRA
TULANE, VICTOR J	8NRNC		AFNA
TUNELL, GEORGE	8NRNC	2H	AFNA
TURNER, JAMES H	1HNIH	2P	AFRA
TURRELL, GEORGE C	2HHOU		AFRA
TUVE, MERLE A	3IDTM	2B	AFRA

UHLANER, J E	1DAX		AMRA
UHLER, FRANCIS M	1IFWS		AFRA
UMPLEBY, JOSEPH B	7RETD	2H	AFNE

VACHER, HERBERT C	7RETD		AFRE
VAN DERSAL, WILLIAM R	1ASCS		AFRA
VAN EVERA, BENJAMIN D	2HGWU	2E2G	AFRA
VAN EVERA, R W	9CLUN		AMRA
VANDERSLICE, JOSEPH T	2HUMD	2B2E	AFRA
VANGELI, MARIO G	8NRNC	2G	AMRA
VEITCH, FLETCHER P JR	2HUMD	2E2T	AFRA
VERNICK, SANFORD H	2HGEU		AMRA
VESTINE, E H	8NRNC		AFNA
VIGNESS, IRWIN	1DNRL	2B2G	AFRA
VIGUE, KENNETH J	5ITTC	2N3G	AMRA
VINAL, GEORGE W	7RETD	2B2G	AFNE
VINTI, JOHN P	1CNBS	2B2G2W	AFRA
VOLWILER, ERNEST H	7RETD	2G	AFNA
VON BRAND, THEODOR C	1HNIH	2P2T	AFRA
VON HIPPEL, ARTHUR	1DNRL	2G	AFRA

WACHTMAN, JOHN B JR	1CNBS	2B2G	AFRA
WAGMAN, DONALD D	1CNBS	2E	AFRA
WALKER, EGBERT H	7RETD	2K	AFRA
WALKER, RONALD E	3IAPL	2G2W	AFRA
WALL, LEO A	1CNBS	2B2E	AFRA
WALLEN, IRVIN E	1XSMI	2G	AFRA
WALTER, DEAN I	1DNRL	2E2G	AFRA
WALTHER, CARL H	2HGWU	2G2S	AFRA
WALTON, GEORGE P	7RETD	2G	AFRE
WALTON, WILLIAM W	1CNBS	2E	AFRA
WARD, HENRY P	7RETD	2E	AFRE
WARD, JUSTUS C	1ARRP		AFRA
WARD, THOMAS G	5MIAS	2Q2T	AFRA
WARGA, MARY E	3AOSA	2B2G3G	AFRA
WARING, JOHN A	4CONS	3F	AMRA
WASHER, F E	1CNBS		AFRA
WASIK, STANLEY P	1CNBS	2E	AMRA
WATERMAN, ALAN T	7RETD	2B3G	AFRA
WATERMAN, PETER	1DNRL	2G2N	AFRA
WATSTEIN, DAVID	1CNBS		AFRA
WATTS, CHESTER B	7RETD	2B2G	AFRA
WEAVER, DE FORREST E	1IGES	2E	AMRA
WEAVER, ELMER R	7RETD	2C2E	AFRE
WEBB, ROBERT W	7RETD	2B2G	AFRA
WEBBER, ROBERT T	1SX		AFNA
WEBER, EUGENE W	1DAEX	2M2R2S	AFRA
WEBER, ROBERT S	1DNBY	2N2R	AMRA
WEIDA, FRANK M	7RETD	2B	AFRE
WEIDLEIN, EDWARD R	8NRNC	2G	AFNE
WEIHE, WERNER K	1DAER	2G2N	AFRA
WEIL, GEORGE L	4CONS	3B	AFRA

WEINBERG, HAROLD P	5VAEN 2U	AFRA
WEINTRAUB, ROBERT L	2HGWU 2E2K2Q	AFRA
WEIR, CHARLES E	1CNBS 2G	AFRA
WEISS, FRANCIS J	1XLIC 3B3C	AFRA
WEISS, FRANCIS J	1XLIC 2B2E2G2K2Q	AFRA
WEISS, FREEMAN A	7RETD 2Q	AFNE
WEISS, RICHARD A	1DARO	AFRA
WEISSBERG, SAMUEL G	1CNBS 2B2E	AFRA
WEISSLER, ALFRED	1DFOS 2B2E2W2Z	AFRA
WEISSMAN, STANLEY	2HUMD 2B	AFRA
WELLMAN, FREDERICK L	8NRNC	AFNE
WENSCH, GLEN W	1XAEC 2G2U3B	AFRA
WEST, WILLIAM L	2HHOU	AMRA
WESTENBERG, ARTHUR A	3IAPL 2E	AFRA
WETMORE, ALEXANDER	1XSMI 2D2G	AFRA
WEXLER, ARNOLD	1CNBS 2B	AFRA
WEYL, F JOACHIM	1DNOR 2B	AFRA
WHEELER, WILLIS H	1ARRP 2G2K	AMRA
WHERRY, EDGAR T	7RETD 2G	AFNE
WHITE, CHARLES E	2HUMD 2E	AFRA
WHITE, ORLAND E	7RETD	AFNE
WHITE, ROBERT M	1CWEB 2X	AFRA
WHITMAN, MERRILL J	1XAEC 2U3B	AFRA
WHITTAKER, COLIN W	7RETD 2E2G	AFRA
WHITTEN, CHARLES A	1CCGS 2B2G2R	AFRA
WICHERS, EDWARD	7RETD 2E	AFRA
WILDHACK, WILLIAM A	1CNBS 2B2G2W3G	AFRA
WILLIAMS, DONALD H	3ADIS 2G3C	AMRA
WILLIER, LILLIAN E	7RETD 2K	AMRA
WILSON, BRUCE L	1CNBS 2B2G	AFRA
WILSON, RAYMOND E	8NRNC 2B2G	AFNA
WILSON, WILLIAM K	1CNBS 2E2G	AFRA
WINSTON, JAY S	1CWEB 2G2X	AFRA
WINT, CECIL T	8NRNC	AFNA
WITHROW, ALICE P	1XNSF	AFRA
WITKOP, BERNHARD	1HNIH 2E	AFRA
WITZIG, WARREN F	5NUUT 2N3B	AMRA
WOLCOTT, NORMAN M	1CNBS	AFRA
WOLFF, EDWARD A	5AEGE 2G2N2W	AFRA
WOLFLE, DAEL	3AAAS	AFRA
WOLICKI, ELIGIUS A	1DNRL 2G	AFRA
WOMACK, MADELYN	1ARNI 2E2T	AFRA
WOOD, LAWRENCE A	1CNBS 2B2E	AFRA
WOOD, REUBEN E	2HGWU 2E3E	AFRA
WOODS, G FORREST	2HUMD 2E	AFRA
WOODS, MARK W	1HNIH 2G2K2T	AFRA
WORKMAN, WILLIAM G	4CONS 2G2I	AFRE
WRENCH, CONSTANCE P	2SMOC 2G	AMRA
WRENCH, JOHN W JR	1DNDT 2G	AFRA
WULF, OLIVER R	8NRNC	AFNA
WYMAN, LEROY L	1CNBS 2G2U	AFRA

YAO, AUGUSTINE Y M	1CWEB 2X	AMRA
YAPLEE, BENJAMIN S	1DNRL 2N	AFRA
YEAGER, J FRANKLIN	1HNIH	AFRA
YEOMANS, ALFRED H	1ARFR	AFRA
YOCUM, L EDWIN	7RETD 2K	AFNE
YODER, HATTEN S JR	3IGEL 2E2H	AFRA
YOUDEN, WILLIAM J	2HGWU 2B2E2G	AFRA
YOUNG, DAVID A JR	8NRNC 2F	AFNA
YOUNG, ROBERT T JR	1DAHD 2G	AFRA
YUILL, JOSEPH S	1AFOR 2F2G2L2Y	AFRA

ZELEN, MARVIN	1HNIH	AFRA
ZELENY, LAWRENCE	1AMRP 2G	AFRA
ZEN, E-AN	1IGES 2H	AFRA
ZIES, EMANUEL G	7RETD 2E2G2H	AFRE
ZIKEEV, NINA	1CWEB 2X	AMRA
ZIMERMANN, ALFRED G	7RETD	AFRA
ZISMAN, WILLIAM A	1DNRL 2E	AFRA
ZMUDA, ALFRED J	3IAPL 2B	AFRA
ZOCH, RICHMOND T	7RETD 2X	AFRA
ZWANZIG, ROBERT W	1CNBS 2B2G	AFRA
ZWEMER, RAYMUND L	3AFAS	AFRA

Classification by Place of Employment

1 GOVERNMENT

1A AGRICULTURE DEPARTMENT

1AASC AGRICULTURAL STAB & CONS SER

SHEPARD, HAROLD H	2F2Y	AFRA

1ACSR COOP STATE RESEARCH SERVICE

BYERLY, THEODORE C	2T	AFRA

1AFAS FOREIGN AGRICULTURAL SERVICE

HOPP, HENRY	2L	AFNA

1AFOR FOREST SERVICE

FOWELLS, HARRY A	2L	AFRA
HACSKAYLO, EDWARD	2G2K2L	AFRA
LITTLE, ELBERT L JR	2K2L	AFRA
MORRISS, DONALD J	2L	AFRA
PARKER, KENNETH W	2D2K2L	AFRA
YUILL, JOSEPH S	2F2G2L2Y	AFRA

1AM AGRICULTURAL MARKETING SERVICE

1AMRP MARKETING REGULATORY PROGRAMS

HUNT, W HAWARD	2G	AMRA
ZELENY, LAWRENCE	2G	AFRA

1AR AGRICULTURAL RESEARCH SERVICE

1ARAO OFFICE OF ADMINISTRATOR, ARS

HAINES, KENNETH A	2F2G2Y	AFRA
IRVING, GEORGE W JR	2E3C	AFRA
PARKER, MARION W	2D2K	AFRA

1ARFR FARM RESEARCH

ANDREWS, JOHN S	2P	AFRA
BENJAMIN, CHESTER R	2D2G2K	AFRA
BEROZA, MORTON S	2E2T2Y	AFRA
BORTHWICK, HARRY A	2D2G2K	AFRA
BOSWELL, VICTOR R	2G	AFRA
CHRISTENSON, LEROY D	2F2G2Y	AFRA
DERMEN, HAIG E	2K	AFRA
DRECHSLER, CHARLES	2G2K	AFRA
EGOLF, DONALD R	2K	AFRA
EMSWELLER, SAMUEL L	2K	AFRA
ENNIS, WILLIAM B JR		AFRA
FOSTER, AUREL O	2P2Y	AFRA
FRAPS, RICHARD M	2B2T	AFRA
GRASSL, CARL O		AFNA
GURNEY, ASHLEY B	2D2F2G	AFRA
HALL, STANLEY A	2E2Y	AFRA
HENNEBERRY, THOMAS J	2F2Y	AFNA
HILDEBRAND, EARL M	2G2K2Q	AMRA
HILTON, JAMES L		AFRA
HOFFMANN, CLARENCE H	2F2Y	AFRA
JACOBSON, MARTIN	2E2Y	AFRA
KANE, EDWARD A	2E	AFRA
KNIPLING, EDWARD F	2F	AFRA
KREITLOW, KERMIT W	2G	AFRA
LAMBERT, EDMUND B	2G2K	AFRA
MC CLELLAN, WILBUR D	2G2K	AFRA
MEANS, URA MAE	2Q	AMRA
MILLER, PAUL R	2K	AFRA
MITCHELL, JOHN W		AFRA
POLLOCK, BRUCE M	2K	AFNA
PRESLEY, JOHN T		AFRA
RODENHISER, HERMAN A	2K	AFRA
RUSSELL, LOUISE M	2D2F2G	AFRA
SAILER, REECE I	2F	AFNA
SAN ANTONIO, JAMES P		AMRA
SCHECHTER, MILTON S	2E2Y	AFRA
SCHULTZ, EUGENE S	2K	AFRE
SHORB, DOYS A	2P	AFRA
SMITH, FLOYD F	2F2Y	AFRA
SPRAGUE, GEORGE F		AFRA
STEERE, RUSSELL L	2K	AFRA
STEWART, DEWEY	2G2K	AFRA
STUART, NEIL W	2K	AFRA
TAYLOR, ALBERT L	2P	AFNA
THOMAS, CHARLES A	2K	AMRA
TODD, FRANK E	2F2Y	AFRA
TROMBA, FRANCIS G	2P	AFRA
YEOMANS, ALFRED H		AFRA

1ARMR MARKETING RESEARCH

COOK, HAROLD T	2B2K3C	AFRA
GOLUMBIC, CALVIN	2E3C	AFRA
HARDENBURG, ROBERT E		AFRA
HEINZE, PETER H	2E2G2K3C	AFRA
LIEBERMAN, MORRIS	2E	AFRA
LUTZ, JACOB M	2K3C	AFRA
NORRIS, KARL H	3C	AFRA
PENTZER, WILBUR T	2B	AFRA
RYALL, A LLOYD	2K3C	AFRA

1ARNI NUTR, CONSUMER & INDUSTRIAL USE

COULSON, E JACK	2E2T	AFRA
DETWILER, SAMUEL B JR	2E	AFRA
FORZIATI, FLORENCE H	2E	AFRA
FREEMAN, ANDREW F	2E	AMRA
KURTZ, FLOYD E	2E	AFRA
LEVERTON, RUTH M		AFRA
PATTERSON, WILBUR I	2E2G2T3C	AFRA
POMMER, ALFRED M	2E2G2H2T	AFRA
REYNOLDS, HOWARD	2Q3C	AFRA
SPIES, JOSEPH R	2E2T	AFRA
STEVENS, HENRY	2E2G2T	AFRA
SULZBACHER, WILLIAM L	2Q3C	AFRA
TITTSLER, RALPH P	2Q3C	AFRA
WOMACK, MADELYN	2E2T	AFRA

1ARRP ARS REGULATORY PROGRAMS

RAINWATER, H IVAN	2Y	AMRA
SAULMON, ERNEST E		AMRA
WARD, JUSTUS C		AFRA
WHEELER, WILLIS H	2G2K	AMRA

1ASCS SOIL CONSERVATION SERVICE

ALEXANDER, LYLE T	2E	AFRA
VAN DERSAL, WILLIAM R		AFRA

1AX AGRICULTURE MISC

CLARK, FRANCIS E		AFNA
CRAFT, CHARLES C		AFNA

1C COMMERCE DEPARTMENT

1C-S OFFICE OF SECRETARY

1CBDS BUSINESS & DEFENSE SERVICES ADM

HERSCHMAN, HARRY K	2U	AFRA

1CBUC BUREAU OF THE CENSUS

HANSEN, MORRIS H		AFRA

1CCGS COAST & GEODETIC SURVEY

BRAATEN, NORMAN F	2B2M2R	AFRA
CARDER, DEAN S	2B2H	AFNA
DEMUTH, HAL P	2N2R	AMRA
HICKLEY, THOMAS J	2S2Z	AFRA
KNAPP, DAVID G	2G	AFRA
MEADE, BUFORD K	2R	AFRA
MURPHY, LEONARD M	2B	AFRA
POLING, AUSTIN C	2N	AFRA

RICE, DONALD A	2R	AFRA
SIMMONS, LANSING G	2R2S	AFRA
SMALL, JAMES B	2B2M2R	AFRA
STEARN, JOSEPH L		AFRA
STRAUB, HARALD W		AFRA
WHITTEN, CHARLES A	2B2G2R	AFRA

1CMAA MARITIME ADMINISTRATION

ALLEN, WILLIAM G	2O	AFRA

1CNBS NATIONAL BUREAU OF STANDARDS

ALEXANDER, SAMUEL N	2B2N	AFRA
ALLEN, HARRY C JR	2B2E2G	AFRA
ALT, FRANZ L	2B	AFRA
ARMSTRONG, GEORGE T	2B2E2G	AFRA
ASTIN, ALLEN V	2B2N2W	AFRA
AUSLOOS, PIERRE J	2E	AFRA
BARBROW, LOUIS E	2B2N	AFRA
BASS, ARNOLD M	2B	AFRA
BATES, ROGER G	2E3E	AFRA
BECKETT, CHARLES W	2B2E	AFRA
BEKKEDAHL, NORMAN	2B2E2G	AFRA
BENNETT, JOHN A	2U	AFRA
BENNETT, LAWRENCE H	2U	AFRA
BESTUL, ALDEN B	2B2E2G	AFRA
BLOCK, STANLEY	2E	AFRA
BLUNT, ROBERT F		AFRA
BOWER, VINCENT E		AFRA
BOYLE, DON R	2N	AMRA
BRAUER, GERHARD M	2E2V	AFRA
BRENNER, ABNER	2E2G3E	AFRA
BURNETT, HARRY C	2G2U	AFRA
CALDWELL, FRANK R	2B2G	AFRA
CANDELA, GEORGE A		AFRA
CANNON, EDWARD W	2B	AFRA
CARRINGTON, TUCKER	2B2E	AFRA
CASSEL, JAMES M	2E2G	AFRA
CAUL, HAROLD J	2E2G2U2V	AFRA
COOK, RICHARD K	2B2Z	AFRA
COOTER, IRVIN L	2B2N	AFRA
COSTRELL, LOUIS	2B2N	AFRA
COYLE, THOMAS D	2E2G	AFRA
CREITZ, E CARROLL	2E	AFRA
DAVIS, MARION M	2E2G	AFRA
DE WIT, ROLAND		AFRA
DESLATTES, RICHARD D		AFRA
DIAMOND, JACOB J	2E3D	AFRA
DICKSON, GEORGE	2G2V	AFRA
DOUGLAS, CHARLES A	2B2G	AFRA
DOUGLAS, THOMAS B	2E	AFRA
EISENHART, CHURCHILL	2B	AFRA
ELBOURN, ROBERT D	2B2N	AFRA
ELLINGER, GEORGE A	2G2U3E	AFRA
FERGUSON, ROBERT E	2E	AFRA
FLETCHER, DONALD G	2E	AMRA
FLORIN, ROLAND E	2E2G	AFRA
FRANKLIN, PHILIP J	2E2N	AFRA
FREDERIKSE, H P R		AFRA
FRUSH, HARRIET L	2E	AFRA
FULLMER, IRVIN H	2B2G2O	AFRA
FURUKAWA, GEORGE T	2B2E2G	AFRA
GARVIN, DAVID	2E	AFRA
GARY, ROBERT		AFRA
GEIL, GLENN W	2G2U	AFRA
GINNINGS, DEFOE C	2E2G	AFRA
GRAY, VANNIE E	2E	AMRA
GREEN, MELVILLE S	2B	AFRA
GREENOUGH, M L		AFRA
GREENSPAN, MARTIN	2B2Z	AFRA
GUILDNER, LESLIE A	2B2G	AFRA
HAGUE, JOHN L	2E2G	AFRA
HALLER, WOLFGANG	2E2G3D	AFRA
HAMER, WALTER J	2E2G2N3E	AFRA
HARRIS, FOREST K	2N	AFRA
HOBBS, ROBERT B	2B2E2G	AFRA
HOFFMAN, JOHN D	2B2F2L2Y	AFRA
HOOVER, THOMAS B	2E	AFRA
HOWARD, ROBERT E		AFRA
HUNTOON, ROBERT D	2B2N	AFRA
ISBELL, HORACE S	2E	AFRA
JENKINS, WILLIAM D	2U	AMRA
JOHANNESEN, ROLF B	2E2G	AFRA
JOHNSON, DANIEL P	2B	AFRA
JUDD, DEANE B	2B	AFRA
KAHN, ARNOLD H		AFRA
KANAGY, JOSEPH R	2E	AFRA
KEEGAN, HARRY J	2E2G	AFRA
KESSLER, KARL G	2B	AFRA
KLEBANOFF, PHILIP S	2B2W	AFRA
KOSTKOWSKI, HENRY J	2B	AFRA
KOTTER, F RALPH	2G2N	AFRA
KRUGER, JEROME	2E3E	AFRA
KUSHNER, LAWRENCE M	2U	AFRA
LASHOF, THEODORE W	2B2G3G	AFRA
LEVIN, ERNEST M	2E3D	AFRA
LIDE, DAVID R JR		AFRA
LOGAN, HUGH L	2U3E	AFRA
MANDEL, JOHN	2B2E	AFRA
MANN, DAVID E	2E	AFRA
MANNING, JOHN R	2G	AFRA
MARTON, L L	2B	AFRA
MARVIN, ROBERT S	2B2E2G	AFRA
MARYOTT, ARTHUR A	2E2G	AFRA
MAZUR, JACOB	2B2G	AFRA
MC MURDIE, HOWARD F	3D	AFRA
MC NESBY, JAMES R		AFRA
MEBS, RUSSELL W	2M2U	AFRA
MEINKE, W WAYNE	2E	AFRA
MELMED, ALLAN J		AFRA
MENDLOWITZ, HAROLD		AFRA
MEYERSON, MELVIN R	2U	AFRA
MILLIKEN, LEWIS T	2B2E2G2H	AMRA
MOORE, GEORGE A	2G2U3E	AFRA
MUEHLHAUSE, CARL O	2B3B	AFRA
NEWMAN, MORRIS		AFRA
NEWMAN, SANFORD B		AFRA
NEWTON, CLARENCE J		AFRA
OKABE, HIDEO		AFRA
OREM, THEODORE H	2U	AFRA
PAFFENBARGER, GEORGE C	2V	AFRA
PAGE, CHESTER H	2B2G2N	AFRA
PARKER, ROBERT L		AFRA
PASSAGLIA, ELIO		AFRA
PEISER, H STEFFEN	2B2E3D	AFRA
PITTS, JOSEPH W	2U3D	AFRA
PROSEN, EDWARD J	2E	AFRA
RHODES, IDA		AFRA
RICHMOND, JOSEPH C	2B2G2M2W3D	AFRA
ROBERTSON, A F	2G	AFRA
ROBINSON, HENRY E		AFRA
ROSENBLATT, DAVID	2B	AFRA
RUBIN, ROBERT J	2B	AFRA
RUFF, ARTHUR W JR	2G	AFRA
SCHAFFER, ROBERT	2E	AFRA
SCHEER, MILTON D	2B2E	AFRA
SCHIEFER, HERBERT F	2B	AFRA
SCHOEN, LOUIS J		AFRA
SCHOONOVER, IRL C	2B2E2V	AFRA
SCHUBAUER, GALEN B	2B2G2W	AFRA
SCOTT, ARNOLD H	2B2G2N	AFRA
SCRIBNER, BOURDON F	2E	AFRA
SHAPIRO, GUSTAVE	2N	AFRA
SHERLIN, GROVER C	2B2G2N3G	AMRA
SHULER, KURT E	2B	AFRA
SILVERMAN, SHIRLEIGH	2B	AFRA
SIMMONS, JOHN A	2G	AFRA
SITTERLY, CHARLOTTE M	2B2G	AFRA
SMITH, JACK C		AFRA
SPENCER, LEWIS V	2G	AFNA
STAIR, RALPH	2G2N	AFRA
STEGUN, IRENE A		AFRA
STEPHENS, ROBERT E	2B	AFRA
STERN, KURT H	2E3E3F	AFRA
STIEHLER, ROBERT D	2B2E2G2O	AFRA
STREEVER, RALPH L JR		AFRA
SWEENEY, WILLIAM T	2E2U2V	AFRA

SWINDELLS, JAMES F	2B2G	AFRA
TATE, DOUGLAS R	2B	AFRA
TAYLOR, JOHN K	2B2E2G3E	AFRA
TCHEN, CHAN-MOU	2B	AFRA
TEELE, RAY P	2B2G	AFRA
TIPSON, R STUART	2E	AFRA
TOOL, ARTHUR Q	3D	AFRA
TORGESEN, JOHN L	2E2G	AFRA
TRYON, MAX	2E2G	AFRA
VINTI, JOHN P	2B2G2W	AFRA
WACHTMAN, JOHN B JR	2B2G	AFRA
WAGMAN, DONALD D	2E	AFRA
WALL, LEO A	2B2E	AFRA
WALTON, WILLIAM W	2E	AFRA
WASHER, F E		AFRA
WASIK, STANLEY P	2E	AMRA
WATSTEIN, DAVID		AFRA
WEIR, CHARLES E	2G	AFRA
WEISSBERG, SAMUEL G	2B2E	AFRA
WEXLER, ARNOLD	2B	AFRA
WILDHACK, WILLIAM A	2B2G2W3G	AFRA
WILSON, BRUCE L	2B2G	AFRA
WILSON, WILLIAM K	2E2G	AFRA
WOLCOTT, NORMAN M		AFRA
WOOD, LAWRENCE A	2B2E	AFRA
WYMAN, LEROY L	2G2U	AFRA
ZWANZIG, ROBERT W	2B2G	AFRA

1CWEB WEATHER BUREAU

BLANC, MILTON L	2G2X	AFNA
BRIER, GLENN W	2G2X	AFRA
CRESSMAN, GEORGE P	2X	AFRA
CRY, GEORGE W	2X	AMRA
HUBERT, LESTER F	2X	AFRA
KLEIN, WILLIAM H	2X	AFRA
KOHLER, MAX A	2S2X	AFRA
LANDSBERG, HELMUT E	2X	AFRA
LIST, ROBERT J	2X	AFRA
MAC DONALD, TORRENCE H	2X	AMRA
MACHTA, LESTER	2X	AFRA
MITCHELL, J MURRAY JR	2G2X	AFRA
NAMIAS, JEROME	2X	AFRA
NOFFSINGER, TERRELL L	2X	AFRA
OLIVER, VINCENT J	2X	AFRA
OSMUN, J W	2X	AFNA
PACK, DONALD H	2X	AFRA
PUTNINS, PAUL H	2G2X	AFRA
RUBIN, MORTON J	2X	AFRA
SMITH, RAYMOND G	2X	AMRA
TEWELES, SIDNEY	2X	AFRA
THOM, HERBERT C S	2X	AFRA
WHITE, ROBERT M	2X	AFRA
WINSTON, JAY S	2G2X	AFRA
YAO, AUGUSTINE Y M	2X	AMRA
ZIKEEV, NINA	2X	AMRA

1CX COMMERCE MISC

RINEHART, JOHN S	2G2U	AFRA

1D DEFENSE DEPARTMENT

1D-IP ARMED FORCES INST PATHOLOGY

MOSTOFI, F K	2T3B	AFRA

1D-S OFFICE OF SECRETARY

FORZIATI, ALPHONSE F	2E2V3E	AFRA
HAMMERSCHMIDT, WM W	2B	AMRA
HERZFELD, CHARLES M	2B	AFRA
REYNOLDS, ORR E	2V	AFRA

1D-X DEFENSE MISC

CAMPAIGNE, HOWARD H		AFRA
HAAS, PETER H		AMRA
JACOBS, WALTER W	2B	AFRA

1DA DEPARTMENT OF ARMY

1DACE COASTAL ENGINEERING RES CTR

CALDWELL, JOSEPH M	2S	AFRA
SAVILLE, THORNDIKE JR	2G2S	AFRA

1DAER ENGINEER RES & DEV LABS

CLEAVER, OSCAR P	2M2N2R	AFRA
HARVALIK, Z V	2E2G3G	AFRA
HASS, GEORG H		AFRA
HOWARD, GEORGE W	2S	AFRA
RODRIGUEZ, RAUL	2G2R	AFRA
WEIHE, WERNER K	2G2N	AFRA

1DAEX CORPS OF ENGINEERS MISC

WEBER, EUGENE W	2M2R2S	AFRA

1DAHD HARRY DIAMOND LABORATORIES

APSTEIN, MAURICE	2B2N	AFRA
ARSEM, COLLINS	2G2N	AMRA
DOCTOR, NORMAN J	2N	AFRA
GODFREY, THEODORE B		AFRA
GUARINO, P A	2N	AFRA
HORTON, BILLY M	2B2G2N	AFRA
KALMUS, HENRY P	2N	AFRA
KLUTE, CHARLES H	2B2E	AFRA
KOHLER, HANS W	2G2N3G	AFRA
LANDIS, PAUL E	2N	AFRA
ROTKIN, ISRAEL	2B2N	AFRA
SOMMER, HELMUT	2N	AFRA
YOUNG, ROBERT T JR	2G	AFRA

1DAMC MATERIEL COMMAND HEADQUARTERS

SIU, RALPH G H		AFRA

1DARO ARMY RESEARCH OFFICE

BALDES, EDWARD J	2B2G	AFRA
LAMANNA, CARL	2Q2T	AFRA
WEISS, RICHARD A		AFRA

1DAWR WALTER REED MEDICAL CENTER

ALEXANDER, AARON D	2Q2T	AFRA
ALEXANDER, BENJAMIN H	2E	AFRA
BARON, LOUIS S	2Q	AFRA
BOZEMAN, F MARILYN	2Q2T	AFRA
HAHN, FRED E	2Q	AFRA
KNOBLOCK, EDWARD C	2E2T	AFRA
MC MULLEN, DONALD B	2P	AFRA
NOYES, HOWARD E	2Q2T	AFNA
RIOCH, DAVID M	2I	AFRA
SALISBURY, LLOYD L	2G2N	AMRA

1DAX ARMY MISC

BABERS, FRANK H	2F2G	AFNA
BARNHART, CLYDE S	2F	AFNA
HOGE, HAROLD J	2B	AFNA
KEULEGAN, GARBIS H	2B	AFNA
RAVITSKY, CHARLES		AFNA
UHLANER, J E		AMRA

1DF DEPARTMENT OF AIR FORCE

1DFOS OFFICE OF SCIENTIFIC RESEARCH

HARRINGTON, MARSHALL C	2B2N2W3G	AMRA
SLAWSKY, MILTON M	2G2M2W3G	AFRA
WEISSLER, ALFRED	2B2E2W2Z	AFRA

1DFX AIR FORCE MISC

ROMNEY, CARL F	2H	AFRA

1DN DEPARTMENT OF NAVY

1DNBS BUREAU OF SHIPS

REAM, DONALD F		AFRA

1DNBW BUREAU OF NAVAL WEAPONS

BURINGTON, RICHARD S	2B2G	AFRA
MAY, DONALD C JR	2B	AFRA

1DNBY BUREAU OF YARDS & DOCKS

AMIRIKIAN, ARSHAM	2R2S	AFRA
HUTTON, GEORGE L	2F2G	AFRA

REINHART, FRED M	2U	AFNA
WEBER, ROBERT S	2N2R	AMRA

1DNDT DAVID TAYLOR MODEL BASIN

CHAPLIN, HARVEY R JR	2W	AFRA
FRANZ, GERALD J	2G2Z	AMRA
FRENKIEL, FRANCOIS N	2B2W2X	AFRA
STRASBERG, MURRAY	2Z	AFRA
WRENCH, JOHN W JR	2G	AFRA

1DNHS NAVAL HOSPITAL

COHN, ROBERT	2B	AFRA

1DNMC NAVAL MEDICAL CENTER

HANSEN, LOUIS S	2V	AFRA

1DNMR NAVAL MEDICAL RESEARCH INST

FRIESS, SEYMOUR L	2E	AFRA
GORDON, FRANCIS B	2G2Q2T	AFRA
STEINER, ROBERT F	2B2E	AFRA

1DNNO OFFICE OF CHIEF OF NAVAL OPER

BREWER, A KEITH	2B2E2G	AFRA

1DNOC NAVAL OCEANOGRAPHIC OFFICE

THOMAS, PAUL D	2R	AFRA

1DNOD NATL OCEANOGRAPHIC DATA CENTER

MARCUS, SIDNEY O JR	2X	AMRA
MYERS, WILLIAM H	2G2X	AMRA

1DNOL NAVAL ORDNANCE LABORATORY

BUTLER, FRANCIS E	2G2O	AMRA
FAULKNER, JOSEPH A	2G	AMRA
HARTMANN, GREGORY K	2B2Z	AFRA
HUMPHREYS, CURTIS J	2B	AFNA
MAXWELL, LOUIS R	2B	AFRA
ROBERTS, RICHARD C	2G	AFRA
SLAWSKY, ZAKA I	2B	AFRA
SNAVELY, BENJAMIN L	2G2Z	AFRA
SNAY, HANS G	2G2Z	AFRA

1DNOR OFFICE OF NAVAL RESEARCH

BLACK, RICHARD B	2G	AFRA
DE VORE, CHARLES	2B2M2N3B	AMRA
KING, PETER	2B2E	AFNA
SALKOVITZ, EDWARD I	2B	AFRA
WEYL, F JOACHIM	2B	AFRA

1DNRL NAVAL RESEARCH LABORATORY

ABRAHAM, GEORGE	2B2G2N3B	AFRA
ACHTER, MEYER R	2U	AFRA
ALEXANDER, ALLEN L	2E	AFRA
ANDERSON, WENDELL L	2E	AFRA
BEACH, LOUIS A	2B2G3G	AFRA
BELSHEIM, ROBERT O	2B2G2M2O	AFRA
BIRKS, LAVERNE S		AFRA
BLOOM, MORTIMER C	2B2E3E	AFRA
BONDELID, ROLLON O		AFRA
BROWN, B F	2U3E	AFRA
CARHART, HOMER W	2E2G	AFRA
CHAPIN, EDWARD J	2G2U	AFRA
CHEEK, CONRAD H	2E	AFRA
CLEMENT, J REID JR		AFRA
DAVISSON, JAMES W	2B	AFRA
DE LAUNAY, JULES R		AFRA
DE PACKH, DAVID C	2B	AFRA
DE PUE, LELAND A	2G2U	AFRA
DEITZ, VICTOR R	2E	AFRA
DOLECEK, RICHARD L	2B2G3G	AFRA
DRUMMETER, LOUIS F JR		AFRA
DUNNING, KENNETH L	2B	AFRA
EGLI, PAUL H	2B2E	AFRA
FAUST, WILLIAM R	2B2G	AFRA
FISK, BERT	2G	AFRA
FORD, T FOSTER	2E	AFRA
FOX, ROBERT B	2E2G	AFRA
GIBSON, JOHN E	2N	AFRA
GINTHER, ROBERT J	3E	AFRA
HALL, WAYNE C	2B2G2N3G	AFRA
HAUPTMAN, HERBERT	2B2G	AFRA
HICKS, GRADY T	2G	AMRA
HOOVER, JOHN I	2B2G	AFRA
HUNTER, WILLIAM R	2B2G	AFRA
IRWIN, GEORGE R	2B2G	AFRA
KAGARISE, RONALD E		AFRA
KARLE, ISABELLA	2E2G	AFRA
KARLE, JEROME	2B2E	AFRA
KIES, JOSEPH A	2B2G2U	AFRA
KOLB, ALAN C	2B	AFRA
LINNENBOM, VICTOR J	2E2G2N	AFRA
LOCKHART, LUTHER B JR	2E	AFRA
MASKET, ALBERT V H		AFRA
MAYER, CORNELL H	2B2N	AFRA
MC CLAIN, EDWARD F JR	2B2N	AFRA
MC ELHINNEY, JOHN	2B2G	AFRA
MILLER, ROMAN R	2E2G3D	AFRA
PAGE, ROBERT M	2N	AFRA
PELLINI, WILLIAM S	2U	AFRA
RADO, GEORGE T	2B	AFRA
SAENZ, ALBERT W		AFRA
SANDERSON, JOHN A	2B	AFRA
SANDOZ, GEORGE	2G2U	AFRA
SCHINDLER, ALBERT I	2B	AFRA
SCHOOLEY, ALLEN H	2B2G2N3G	AFRA
SCHULMAN, JAMES H	2B3E	AFRA
SHAFRIN, ELAINE G	2E	AMRA
SHAPIRO, MAURICE M	2B	AFRA
SMITH, PAUL L	2B2N	AFRA
SMITH, SIDNEY T	2B2N	AFRA
STEELE, LENDELL E	2U	AFRA
STILLER, BERTRAM	2B2G	AFRA
TALMADGE, HARVEY G JR	2G2N	AMRA
TOUSEY, RICHARD	2B	AFRA
TREXLER, JAMES H	2B2G2S	AFRA
VIGNESS, IRWIN	2B2G	AFRA
VON HIPPEL, ARTHUR	2G	AFRA
WALTER, DEAN I	2E2G	AFRA
WATERMAN, PETER	2G2N	AFRA
WOLICKI, ELIGIUS A	2G	AFRA
YAPLEE, BENJAMIN S	2N	AFRA
ZISMAN, WILLIAM A	2E	AFRA

1DNSP SPECIAL PROJECTS OFFICE

CRAVEN, JOHN P	2B2Z	AFRA

1DNWS NAVAL WEATHER SERVICE

MARTIN, ROBERT H	2X	AMRA

1DNX NAVY MISC

ESTERMANN, IMMANUEL	2B	AFNA
NEUENDORFFER, J A	2G	AFRA
POTTS, B L		AMRA

1H DEPT OF HEALTH EDUCATION & WELFARE

1HFDA FOOD & DRUG ADMINISTRATION

DURBIN, CHARLES G	2G2P	AFRA
FOX, M R SPIVEY	2E2G2T	AFRA
GLASGOW, AUGUSTUS R JR	2E2G	AFRA
MAIENTHAL, MILLARD	2E	AFRA
MILLER, CLEM O	2E	AFRA
REYNOLDS, HELEN L	2E2G	AMRA
ROBINSON, WARREN A		AMRA
SLADEK, JAROMIL V	2E	AFRA
SLOCUM, GLENN G	2Q3C	AFRA

1HNIH NATIONAL INSTITUTES OF HEALTH

AKERS, ROBERT P	2G	AFRA
AMES, BRUCE N	2Q2T	AFRA
ANDREWS, HOWARD L		AFRA
BARRETT, MARGARET D	2G2T	AFRA
BECKER, EDWIN D	2E	AFRA
BELKIN, MORRIS		AFRA
BERLINER, ROBERT W	2B2T	AFRA
BOWMAN, PAUL W	2D2K	AFRA

BRODIE• BERNARD B	2T	AFRA
BURK• DEAN	2E2T	AFRA
BYRNE• ROBERT J	2Q	AFRA
CARROLL• WILLIAM R	2E	AFRA
COLE• KENNETH S	2B	AFRA
CORNFIELD• JEROME		AFRA
EDDY• BERNICE E	2G2Q2T	AFRA
EMMART• EMILY W	2Q2T	AFRA
ENDICOTT• KENNETH M	2T	AFRA
FLETCHER• HEWITT G JR	2E	AFRA
FRAME• ELIZABETH G	2E	AFRA
FRANK• KARL		AFRA
HAMPP• EDWARD G	2Q2V	AFRA
HEWITT• CLIFFORD A	2E	AMRA
HIATT• CASPAR W	2E2G2Q2T	AFRA
KERESTZTESY• JOHN C	2E	AFRA
LAKI• KOLOMAN	2E	AFRA
LEIKIND• MORRIS C	3F	AFRA
LIKINS• ROBERT C	2V	AFRA
MALONEY• CLIFFORD J		AFRA
MARSHALL• LOUISE H		AFRA
MARSHALL• WADE H	2B	AFRA
MC CLURE• FRANK J	2N2T	AFRA
MC CULLOUGH• NORMAN B	2G2I2Q	AFRA
MIDER• G BURROUGHS	2G	AFRA
MORRIS• J A	2E2P2Q	AMRA
NIRENBERG• MARSHALL W	2E	AFRA
PARK• HELEN D		AFRA
PITTMAN• MARGARET	2Q2T	AFRA
RALL• DAVID P	2T	AFRA
RIFE• DAVID C		AFRA
ROSENTHAL• SANFORD M		AFRE
ROWE• WALLACE P		AFRA
SCHRECKER• ANTHONY W	2E	AFRA
SHANNON• JAMES A	2I	AFRA
SHELTON• EMMA		AFRA
SMITH• WILLIE W	2T	AFRA
SOLLNER• KARL	2E3E	AFRA
SPECHT• HEINZ	2B2G2T	AFRA
STADTMAN• E R		AFRA
STEPHAN• ROBERT M	2V	AFRA
STEWART• SARAH E	2T	AFRA
TASAKI• ICHIJI		AFRA
THURMAN• ERNESTINE B	2F2G	AFNA
TURNER• JAMES H	2P	AFRA
VON BRAND• THEODOR C	2P2T	AFRA
WITKOP• BERNHARD	2E	AFRA
WOODS• MARK W	2G2K2T	AFRA
YEAGER• J FRANKLIN		AFRA
ZELEN• MARVIN		AFRA

1HOED OFFICE OF EDUCATION

OBOURN• ELLSWORTH S	2B3G	AFRA

1HPHS PUBLIC HEALTH SERVICE

BOND• HOWARD W	2E	AFRA
CARTER• HUGH		AFRA
HUNDLEY• JAMES M		AFRA
PRATT• HARRY D	2F	AFNA
RAUSCH• ROBERT	2D2G2P	AFNA

1I INTERIOR DEPARTMENT

1IFWS FISH & WILDLIFE SERVICE

ALDRICH• JOHN W	2D	AFRA
HERMAN• CARLTON M	2G2P2T	AFRA
LYMAN• JOHN	2E	AFRA
UHLER• FRANCIS M		AFRA

1IGES GEOLOGICAL SURVEY

BAKER• ARTHUR A	2H	AFRA
BENNETT• ROBERT R	2H	AFRA
CARRON• MAXWELL K	2E2H	AFRA
CUTTITTA• FRANK	2E2G2H	AFRA
DANE• CARLE H	2H	AFRA
DUNCAN• HELEN M	2H	AFRA
FAHEY• JOSEPH J	2E2G2H	AFRA
FAUST• GEORGE T	2H3D	AFRA
GLASS• JEWELL J	2G2H	AFRA
HOOKER• MARJORIE	2H	AFRA
LAKIN• HUBERT W	2H	AFNA
LOVE• S KENNETH	2E2H	AFRA
MAY• IRVING	2E2G2H	AFRA
MC KELVEY• VINCENT E	2H	AFRA
MC KNIGHT• EDWIN T	2H	AFRA
MEYROWITZ• ROBERT	2E	AFRA
MISER• HUGH D	2H	AFRE
MYERS• ALFRED T	2E2G	AFNA
OWENS• JAMES P	2G2H	AFRA
PALMER• ALLISON R		AFRA
PECORA• WILLIAM T	2H	AFRA
PHAIR• GEORGE	2H	AFRA
REICHEN• LAURA E	2E	AFRA
ROEDDER• EDWIN	2B2H	AFRA
RUBIN• MEYER	2H	AFRA
SCHALLER• WALDEMAR T	2E2H	AFRE
SHAPIRO• LEONARD	2E	AFRA
STRINGFIELD• VICTOR T	2G2H2L	AFRA
THAYER• THOMAS P	2H	AFRA
TODD• MARGARET R	2G2H	AFRA
TOULMIN• PRIESTLEY	2H	AFRA
WEAVER• DE FORREST E	2E	AMRA
ZEN• E-AN	2H	AFRA

1IX INTERIOR MISC

PENNINGTON• WILLIAM A	2U	AFNA
SCHAEFFER• CLAUDE E		AFNA

1S STATE DEPARTMENT

1SACD ARMS CONTROL & DISARM AGENCY

SCOVILLE• HERBERT JR		AFRA

1SX STATE MISC

EDWARDS• H KENNETH	2E	AMRA
JOYCE• J WALLACE	2B2G	AFRA
RAMBERG• WALTER	2B2O2W	AFNA
WEBBER• ROBERT T		AFNA

1T TREASURY DEPARTMENT

1TIRS INTERNAL REVENUE SERVICE

MATHERS• ALEX P	2E	AFRA
PRO• MAYNARD J	2E2G3B	AFRA
SCHOENEMAN• ROBERT L		AFRA

1X OTHER GOVERNMENT AGENCIES

1XAEC ATOMIC ENERGY COMMISSION

DALZELL• R CARSON	2O2U3B	AFRA
FOWLER• EMIL E	3B	AMRA
MAGIN• GEORGE B JR	2E2H3B	AFRA
POLACHEK• HARRY	2B	AFRA
REITEMEIER• ROBERT F		AFRA
TALIAFERRO• W H		AFNA
WENSCH• GLEN W	2G2U3B	AFRA
WHITMAN• MERRILL J	2U3B	AFRA

1XCAB CIVIL AERONAUTICS BOARD

HOLSHOUSER• WILLIAM L	2G2U	AFRA

1XDCG DISTRICT OF COLUMBIA GOVT

O DAY• RICHARD		AMRA
TRAVIS• CLARENCE W	2F	AMRA

1XFPC FEDERAL POWER COMMISSION

MC CABE• WILLIAM J	2H	AMRA

1XLIC LIBRARY OF CONGRESS

KENK• ROMAN	2G	AFRA
OSTEN• EDWARD J	2B2W	AMRA
WEISS• FRANCIS J	3B3C	AFRA
WEISS• FRANCIS J	2B2E2G2K2Q	AFRA

1XMDG MARYLAND GOVERNMENT

MORAN• FREDERICK A	2G2X	AMRA

1XNAS NAT AERONAUTICS & SPACE AGENCY

COHN• ERNST M	2E3E	AMRA

DRYDEN, HUGH L	2B2G2O2W	AFRA
EASTER, DONALD	2E	AMRA
GHAFFARI, ABOLGHASSEM	2B	AFRA
KURZWEG, HERMAN H	2B2W	AFRA
LIDDEL, URNER	2B2N2W	AFRA
O KEEFE, JOHN A	2B	AFRA
QUIMBY, FREEMAN H		AFRA
SEAMSTER, AARON		AFRA
STAUSS, HENRY E	2U	AFRA
TEPPER, MORRIS	2W2X	AFRA

1XNOD NAT OCEANOGRAPHIC DATA CENTER

JACOBS, WOODROW C	2X	AFRA

1XNSF NATIONAL SCIENCE FOUNDATION

CRANE, LANGDON T JR	2B	AFRA
EDMUNDS, LAFE R	2F	AFRA
ETZEL, HOWARD W	2G	AFRA
KENNEY, ARTHUR W	2B	AFRA
MC MILLEN, J HOWARD	2B3G	AFRA
PELL, WILLIAM H	2O	AFRA
ROBERTSON, RANDAL M	2B2G2L	AFRA
RODNEY, WILLIAM S	2B	AFRA
SEEGER, RAYMOND J	2B2G3F3G	AFRA
SHANAHAN, ARTHUR J	2Q	AFRA
SPENCER, J T	2G	AFRA
STEWART, ILEEN E		AFRA
WITHROW, ALICE P		AFRA

1XSMI SMITHSONIAN INSTITUTION

BLAKE, DORIS H	2F	AFRE
BOWMAN, THOMAS E	2D	AFRA
COCHRAN, DORIS M	2G	AFRA
COLLINS, HENRY B	2C	AFRA
CONGER, PAUL S		AFRA
COOPER, G ARTHUR	2H	AFRA
EWERS, JOHN C	2C2G	AFRA
FIELD, WILLIAM D		AFRA
FREEMAN, MONROE E	2E	AFRA
GAZIN, CHARLES L	2D2H	AFRA
HENDERSON, E P	2H	AFRA
MILLER, CARL F	2C2G	AFRA
MORRISON, JOSEPH P	2D	AFRA
OEHSER, PAUL H	2B2D3F	AFRA
REHDER, HARALD A	2D2G	AFRA
SCHMITT, WALDO L	2D	AFRA
SHROPSHIRE, WALTER A	2G2K	AMRA
STEWART, T DALE	2C2G	AFRA
WALLEN, IRVIN E	2G	AFRA
WETMORE, ALEXANDER	2D2G	AFRA

1XUST TARIFF COMMISSION

GONET, FRANK	2E	AFRA

1XVET VETERANS ADMINISTRATION

FUSILLO, MATTHEW H	2Q	AMRA

2 EDUCATION

2H HIGHER EDUCATION

2HAMU AMERICAN UNIVERSITY

AMES, LAWRENCE M	2G2K	AFRA
FARBER, EDUARD	2E2G3F	AFRA
HARRISON, MARK	2B3G	AFRA
MOORE, HARVEY C	2C	AFRA
RICE, FREDERICK A H	2E2G	AFRA
SCHUBERT, LEO	2B2E3F	AFRA
SITTERLY, BANCROFT W	2B3G	AFRA
SMITH, FALCONER	2B2T	AFRA

2HCUA CATHOLIC UNIVERSITY OF AMERICA

BIBERSTEIN, FRANK A JR	2B2M2S	AFRA
DARWENT, BASIL DE B	2B2E	AFRA
DUTILLY, ARTHEME	2K	AFRA
HELLER, ISIDORE		AFRA
HENDERSON, MALCOLM C	2B2Z3B3G	AFRA
HERZFELD, KARL F	2B	AFRA
HERZFELD, REGINA F	2C	AFRA
KENNEDY, E R	2G2Q	AFRA
LITOVITZ, THEODORE A	2B2Z	AFRA
LYNN, W GARDNER	2B	AFRA
O BRIEN, JOHN A	2K	AFRA
OSGOOD, WILLIAM R	2O	AFRA
ROCK, GEORGE D		AFRA
SARLES, MERRITT P	2G2P2Y	AFRA
TALBOTT, F LEO	2B2G3G	AFRA

2HDCT D C TEACHERS COLLEGE

LLOYD, DANIEL B		AMRA
OLSON, HENRY W		AFRA

2HGEU GEORGETOWN UNIVERSITY

BAKER, LOUIS C W	2E	AFRA
CHAPMAN, GEORGE B		AFRA
GRAY, IRVING	2G2T	AFRA
HEYDEN, FRANCIS J	2B2G3G	AFRA
KIESS, CARL C	2G	AFRA
KOPPANYI, THEODORE	2T	AFRA
LADO, ROBERT		AFRA
LAMBERTON, BERENICE		AMRA
MAENGWYN-DAVIES, G D	2B2E2G2T	AFRA
OLIPHANT, MALCOLM W		AFRA
ROSS, JOHN C	2I2T	AFRA
STEINHARDT, JACINTO	2E	AFRA
THALER, WILLIAM J		AFRA
VERNICK, SANFORD H		AMRA

2HGWU GEORGE WASHINGTON UNIVERSITY

ADAMS, CAROLINE L	2K	AMRA
AFFRONTI, LEWIS	2Q2T	AMRA
ALLAN, FRANK D		AMRA
BARTONE, JOHN C	2T	AMRA
BROWN, THOMAS M	2I	AFRA
CRAFTON, PAUL A	2G2N2O2W	AFRA
FINAN, JOHN L		AMRA
GRISAMORE, NELSON T	2B2G2N	AFRA
HANSEN, IRA B	2D2G	AFRA
HENNEY, DAGMAR	2B	AMRA
HUGH, RUDOLPH	2Q2T	AFRA
KOEHL, GEORGE M	3G	AMRA
KULLBACK, SOLOMON	2N	AFRA
MANDEL, H GEORGE	2E2T	AFRA
MASON, MARTIN A	2M2O2S	AFRA
MEARS, FLORENCE M		AFRA
NAESER, CHARLES R	2E2H	AFRA
O HERN, ELIZABETH M	2Q	AMRA
PARLETT, ROBERT C	2Q	AFRA
PERROS, THEODORE P	2B2E3F	AFRA
ROBBINS, MARY L	2G2Q2T	AFRA
STEVENS, RUSSELL B	2K	AFRA
TAYLOR, JAMES H		AFRE
TIDBALL, CHARLES S	2I2T	AFRA
TREADWELL, CARLETON R	2E2T	AFRA
VAN EVERA, BENJAMIN D	2E2G	AFRA
WALTHER, CARL H	2G2S	AFRA
WEINTRAUB, ROBERT L	2E2K2Q	AFRA
WOOD, REUBEN E	2E3E	AFRA
YOUDEN, WILLIAM J	2B2E2G	AFRA

2HHOU HOWARD UNIVERSITY

BARNES, R PERCY	2E	AFRA
BRANSON, HERMAN	2B2G3G	AFRA
DAVIS, STEPHEN S	2O	AMRA
DOWNING, LEWIS K	2S	AFRA
FERGUSON, LLOYD N	2E	AFRA
FINLEY, HAROLD E	2D	AFRA
GRIFFITHS, NORMAN H C	2V	AFRA
HAMMOND, H DAVID	2K	AMRA
HANSBOROUGH, LOUIS A		AMRA
HAWTHORNE, EDWARD W		AFRA
JACKSON, JULIUS L	2B	AFRA
MORRIS, JOSEPH B	2E	AFRA
MORRIS, KELSO B	2E	AFRA
SHERESHEFSKY, J LEON	2E	AFRA
TALBERT, PRESTON T	2E	AFRA

TAYLOR, MARIE C	2K	AMRA
TAYLOR, MODDIE D	2E	AFRA
TURRELL, GEORGE C		AFRA
WEST, WILLIAM L		AMRA

2HJHU JOHNS HOPKINS UNIVERSITY

BENEDICT, WILLIAM S		AFRA

2HMJC MONTGOMERY JUNIOR COLLEGE

BREEDLOVE, C H JR		AMRA

2HTRI TRINITY COLLEGE

ROBERTS, IRENA Z	2E	AMRA

2HUMD UNIVERSITY OF MARYLAND

ANDREWS, T G		AFRA
BAILEY, WILLIAM J	2E	AFRA
BAMFORD, RONALD	2K	AFRA
BECKMANN, ROBERT B	2E	AFRA
BENESCH, WILLIAM	2B	AFRA
BICKLEY, WILLIAM E	2F2Y	AFRA
BROWN, JOSHUA R C		AFRA
BROWN, RUSSELL G	2K	AFRA
BURGERS, J M	2B	AFRA
DAVIS, R F	2T	AFRA
DOETSCH, RAYMOND N	2Q	AFRA
DOSS, MILDRED A	2P	AFRA
FABER, JOHN E	2Q	AFRA
FARR, MARION M	2P	AFRA
FERRELL, RICHARD A	2G3G	AFRA
GALLOWAY, RAYMOND A	2K	AFRA
GARSTENS, HELEN L		AFRA
GLASSER, ROBERT G	2B	AFRA
HETRICK, FRANK	2Q	AMRA
HOLMGREN, HARRY D	2B	AFRA
KRAUSS, ROBERT W	2K	AFRA
LANGFORD, GEORGE S	2F2Y	AFRA
LASTER, HOWARD J	2B3G	AFRA
LIPPINCOTT, ELLIS R	2B2E	AFRA
LOCKARD, J DAVID		AMRA
MAC DONALD, WILLIAM M	2B2G3G	AFRA
MARTIN, MONROE H		AFRA
MASON, EDWARD A	2B2E3F3G	AFRA
MISNER, CHARLES W		AFRA
MORGAN, RAYMOND	2B	AFRE
MYERS, RALPH D	2B	AFRA
PELCZAR, MICHAEL J JR	2Q	AFRA
REEVE, E WILKINS	2E	AFRA
RIVELLO, ROBERT M	2O2W	AFRA
SCHAMP, HOMER W JR		AFRA
SCHOENBORN, HENRY W		AFRA
SHORB, MARY S	2G2Q2T	AFRA
SYSKI, RYSZARD		AFRA
TRAUB, ROBERT	2F2P2T	AFRA
VANDERSLICE, JOSEPH T	2B2E	AFRA
VEITCH, FLETCHER P JR	2E2T	AFRA
WEISSMAN, STANLEY	2B	AFRA
WHITE, CHARLES E	2E	AFRA
WOODS, G FORREST	2E	AFRA

2S SECONDARY EDUCATION

2SARC ARLINGTON COUNTY SCHOOLS

FRANKLIN, TEMPIE R		AFRA
KNIPLING, PHOEBE H	3G	AFRA

2SDCP D C PUBLIC SCHOOLS

CONTEE, CARL T		AMRA
JOHNSON, KEITH C	2B3G	AFRA

2SMOC MONTGOMERY CO BD EDUCATION

ADELMAN, DAVID M		AMRA
DIAMOND, PAULINE		AFRA
LEONARD, LORRAINE I		AMRA
WRENCH, CONSTANCE P	2G	AMRA

2SMSA MOUNT ST ALBANS

LEE, RICHARD H	3G	AFRA

2SPGC PR GEORGES CO BD EDUCATION

MC KOWN, BARRETT L	2G	AMRA
OWENS, HOWARD B	2D2F2G	AFRA

3 ASSOCIATIONS & INSTITUTIONS

3A ASSOCIATIONS

3AAAS AMER ASSN FOR ADV OF SCIENCE

KABISCH, WILLIAM T	2G	AMRA
MAYOR, JOHN R	2G	AFRA
TAYLOR, RAYMOND L		AFRA
WOLFLE, DAEL		AFRA

3AACS AMERICAN CHEMICAL SOCIETY

EMERY, ALDEN H	2E2G	AFRA

3AAPS AMER PSYCHOLOGICAL ASSN

ROSS, SHERMAN		AFRA

3ADIS DAIRY INDUSTRIES SUPPLY ASSN

WILLIAMS, DONALD H	2G3C	AMRA

3AESA ENTOMOLOGICAL SOC OF AMERICA

BUNN, RALPH W	2F2Y	AFRA
NELSON, R H	2F2G2Y	AFRA

3AFAS FED AMER SOC EXPTL BIOL

ZWEMER, RAYMUND L		AFRA

3ANCA NAT CANNERS ASSOCIATION

FARROW, RICHARD P	2E2G3C	AFRA

3ANPV NAT PAINT VAR & LACQUER ASSN

SCOFIELD, FRANCIS	2E	AMRA

3AOSA OPTICAL SOCIETY OF AMERICA

WARGA, MARY E	2B2G3G	AFRA

3H HOSPITALS

3HDCG D C GENERAL HOSPITAL

PERKINS, LOUIS R		AMRA

3I INSTITUTIONS

3IAPL APPLIED PHYSICS LABORATORY, JHU

BERL, WALTER G	2B2E2W	AFRA
BRUCK, STEPHEN D	2E2G	AFRA
FONER, SAMUEL N	2B	AFRA
GIBSON, RALPH E	2B2E2W	AFRA
GRAY, ERNEST P	2B	AMRA
HILL, FREEMAN K	2G2W	AFRA
JEN, CHIH K	2B	AFRA
MAHAN, ARCHIE I	2B	AFRA
MASSEY, JOSEPH T	2B2N	AFRA
MC CLURE, FRANK T	2B2E	AFRA
MONCHICK, LOUIS	2B2E	AFRA
WALKER, RONALD E	2G2W	AFRA
WESTENBERG, ARTHUR A	2E	AFRA
ZMUDA, ALFRED J	2B	AFRA

3ICIW CARNEGIE INSTITUTION OF WASH

BOLTON, ELLIS T	2G	AFRA
BURKE, BERNARD F		AFRA
COWIE, DEAN B		AFRA
HASKINS, CARYL P	2F2G2R	AFRA

3IDTM DEPT TERRESTRIAL MAGNETISM, CIW

ROBERTS, RICHARD B		AFRA
RUBIN, VERA C	2B	AFRA
TUVE, MERLE A	2B	AFRA

3IFOF FORD FOUNDATION

PATTERSON, MARGARET E		AFRA

3IGEL GEOPHYSICAL LABORATORY, CIW

ABELSON, PHILIP H	2B2E2H2Q3B	AFRA
HOERING, THOMAS C	2E2G2H	AFRA
KULLERUD, GUNNAR	2G	AFRA

YODER, HATTEN S JR	2E2H	AFRA

3IIDA INST FOR DEFENSE ANALYSIS

BRADLEY, WILLIAM E	2N	AMRA
MONTROLL, ELLIOTT W	2B	AFRA

3IJBS JOINT BD ON SCIENCE EDUCATION

EDMUNDS, WADE M	2M2N3B	AMRA

3INAS NAT ACADEMY SCIENCES - NRC

COLEMAN, JOHN S	2Z	AFRA
COOLIDGE, HAROLD J	2G	AFRA
DE CARLO, MICHAEL	2G	AMRA
FOOTE, PAUL D	2B	AFRA
LARRIMER, WALTER H	2G2L2Y	AFRA
SLACK, LEWIS	2B2G	AFRA
TAYLOR, LAURISTON S		AFRA

3INGS NATIONAL GEOGRAPHIC SOCIETY

CARMICHAEL, LEONARD	2B2G2J2T	AFRA

3ISCS SCIENCE SERVICE

DAVIS, WATSON	2B2H2M	AFRA

3IWMI WILDLIFE MANAGEMENT INSTITUTE

GABRIELSON, IRA N		AFRA

4 SELF-EMPLOYED

4CONS CONSULTANTS

ADAMS, LEASON H	2B2E2G2H	AFNE
ASLAKSON, CARL I	2B2M	AFRA
BATEMAN, ALAN M	2H	AFNE
BEACH, PRISCILLA A		AMRA
BEAN, HOWARD S	2G2O	AFRA
BENNETT, MARTIN T	2E	AFRA
BLUM, WILLIAM	2E2G3E	AFRE
BOUTWELL, JOHN M	2G2H	AFNA
BRECKENRIDGE, F C	2B	AFRA
CURRIER, LOUIS W	2H	AFRE
DIEHL, WALTER S	2W	AFRA
EDDY, NATHAN B	2G2T	AFRA
GILLMAN, JOSEPH L JR	2E2M2O2U	AFRA
GRAHAM, EDWARD H		AFRA
HINMAN, WILBUR S JR	2S	AFRA
HOWE, PAUL E	2E2T	AFRA
INSLEY, HERBERT	2B2G2H3D	AFRA
JACOB, KENNETH D	2E	AFRA
KAUFMAN, H PAUL	2M	AFRA
LORING, BLAKE M	2U	AFRA
MEGGERS, WILLIAM F	2B2G	AFRA
NICKERSON, DOROTHY	2G	AFRA
PARSONS, DOUGLAS E	2B2G2S	AFRE
PHILLIPS, MARCELLA L	2B2N	AFRA
REICHELDERFER, F W	2B2G2W2X	AFRA
REINHART, FRANK W	2E2G	AFRA
ROBERTS, ELLIOTT B	2B2G2R2S	AFRE
STEVENSON, FREDERICK J	2G	AFRA
SULLIVAN, DANIEL A JR	2U	AMRA
THOMAS, JAMES L		AFRA
TOWNSEND, JOHN R	2B	AFRA
WARING, JOHN A	3F	AMRA
WEIL, GEORGE L	3B	AFRA
WORKMAN, WILLIAM G	2G2I	AFRE

4PHYS PHYSICIANS

BERNTON, HARRY S	2I	AFRA
BURKE, FREDERIC G	2I	AFRA
DRAEGER, R HAROLD		AFNE
GANT, JAMES Q JR	2G2I2X	AMRA
STILL, JOSEPH W	2B	AFNA

4X MISCELLANEOUS SELF-EMPLOYED

AXILROD, BENJAMIN M	2B	AFRA
HENRY, THOMAS R	2B	AFRA
LAPP, RALPH E	2B	AFRA
MC PHERSON, ARCHIBALD	2B2E2G3C	AFRA
TITUS, HARRY W	2G	AFNA

5 BUSINESS CONCERNS

5AEGE AERO GEO ASTRO CORP

WOLFF, EDWARD A	2G2N2W	AFRA

5ARCO AUERBACH CORP

CLARK, GEORGE E JR		AFRA

5ASPR ASSOCIATED PRESS

CAREY, FRANCIS E		AFRA

5BERA BENDIX RADIO DIVISION

CARROLL, THOMAS J	2B	AFRA

5BIRE BIOMETRICS RESEARCH LAB

PALLOTTA, ARTHUR J		AMRA

5BOEN BOWLES ENGINEERING CO

BOWLES, ROMALD E	2G2W	AFRA

5CEIR CEIR INC

MOSHMAN, JACK		AMRA

5DERE DEFENSE RESEARCH CORP

BOGLE, ROBERT W	2B2G	AFNA

5GEEL GENERAL ELECTRIC CO

ELLIOTT, FRANCIS E		AFRA

5GICO GILLETTE COMPANY

HARRIS, MILTON	2E	AFRA

5HALA HAZELTON LABORATORIES

GARGUS, JAMES L		AMRA
HAZLETON, LLOYD W	2E2G2T	AFRA

5HARE HARRIS RESEARCH LABORATORIES

ALTER, HARVEY	2E	AFRA
BERCH, JULIAN	2E	AMRA
BROWN, ALFRED E	2B2E2G	AFRA
BURAS, EDMUND M JR	2E	AFRA
FOURT, LYMAN	2E2W	AFRA
HOLLIES, NORMAN R S	2E	AFRA
KRASNY, JOHN F		AFRA
MENKART, JOHN H	2E	AFRA
MIZELL, LOUIS R	2E	AFRA
SCHWARTZ, ANTHONY M	2E	AFRA
SOOKNE, ARNOLD M	2E	AFRA

5HONE HONEYWELL

HONIG, JOHN G		AMRA

5HOWR HOWARD RESEARCH CORP

DYKE, EDWIN	2N	AMRA

5HUAS HUNTER ASSOCIATES LAB

HUNTER, RICHARD S	2G	AFRA

5ITTC INTERNATIONAL TELEPHONE & TELEG

VIGUE, KENNETH J	2N3G	AMRA

5LIPR LIQUIDS PROCESS CO

ROLLER, PAUL S	2B2E2G	AFRA

5MELP MELPAR INC

FALLON, ROBERT J	2B2E	AFRA
MORTON, JOHN D	2X	AFRA
ORDWAY, FRED D JR	2E2G3D	AFRA
RITT, PAUL E	2E2N2W	AFRA

5MIAS MICROBIOLOGICAL ASSOCIATES

JAY, GEORGE E JR	2G	AFRA
WARD, THOMAS G	2Q2T	AFRA

5MIPI MINERAL PIGMENTS CORP

KARKENNY, MOSES	2E	AMRA

5NUUT NUCLEAR UTILITY SERVICES

WITZIG, WARREN F	2N3B	AMRA

5PORB POPULATION REFERENCE BUREAU

COOK, ROBERT C	2K	AFRA

5RACO RAND CORPORATION

SMITH, PAUL A	2B2G2H2S2W	AFRA

5RAYC RAYTHEON CORPORATION

SPOONER, CHARLES S JR	2H	AFRA

5RBEN RABINOW ENGINEERING CO

RABINOW, JACOB	2B2N	AFRA

5RERS RESOURCES RESEARCH CORP

MC CABE, LOUIS C	2E2G	AFRA

5SURE SURVEYS & RESEARCH CORP

RICE, STUART A		AFRA

5VAEN VALUE ENGINEERING CO

WEINBERG, HAROLD P	2U	AFRA

5WAPO WASHINGTON POST

HASELTINE, NATE	2X	AFRA

5WEEL WESTINGHOUSE ELECTRIC CO %BALTO

CURTIS, ROGER W	2B2G2N	AFRA

6 FOREIGN & INTERNATIONAL

6FAOR FOOD & AGRICULTURE ORG, UN

DAWSON, ROY C	2Q	AFRA
LATTA, RANDALL	2F	AFNE
LING, LEE		AFNA

6MOCO MONOCAN CONSULATE

SCHERTENLEIB, CHARLES		AMRA

7RETD RETIRED

ABBOT, CHARLES G	2B	AFRE
ALLISON, FRANKLIN E	2E2G2Q	AFRE
ANDERSON, MYRON S	2E	AFRA
APPEL, WILLIAM D	2E	AFRA
ARMSTRONG, CHARLES	2T	AFRE
BARRETT, MORRIS K	2T	AFRA
BARSS, HOWARD P	2K	AFNE
BATES, PHAON H		AFNE
BAUER, HUGO	2E	AFRA
BEARCE, HENRY W	2B	AFNE
BEIJ, K HILDING	2B	AFNA
BIRCKNER, VICTOR		AFRE
BISHOPP, FRED C	2C2D2F	AFRE
BROMBACHER, W G	2B	AFRE
BROWN, EDGAR	2D2K	AFRE
BUHRER, EDNA M	2P	AFRA
BURKEY, LLOYD A	2Q	AFRE
BYERLY, PERRY		AFNA
CAMPBELL, FRANK L	2F2Y	AFNA
CASH, EDITH K	2K	AFRE
CHALKLEY, HAROLD W	2T	AFRE
CHAPIN, EDWARD A		AFNE
CHAPLINE, W R	2G2K2L	AFRE
CLAIRE, CHARLES N	2B2M	AFRA
CLARK, KENNETH G	2E2G	AFRE
CLAUSEN, CURTIS P	2F	AFNE
COLE, HOWARD I	2G	AFNE
COOKE, C WYTHE	2H	AFRE
COOLIDGE, WILLIAM D		AFNA
COONS, GEORGE H	2K	AFRE
COOPER, STEWART R		AFRE
CORY, ERNEST N	2F2G2Y	AFRE
CRAGOE, CARL S	2B2G	AFRE
CULLINAN, FRANK P	2K	AFRE
CURRAN, HAROLD R	2Q	AFRA
CURTISS, LEON F	2B	AFNE
DAFT, FLOYD S	2E2T	AFRA
DAUER, CARL C		AFRA
DAVIS, RAYMOND	2B2E	AFRE
DAWSON, PAUL R		AFNE
DEBORD, GEORGE G	2Q	AFNE
DETWILER, SAMUEL B	2G2K2L	AFRA
DIEHL, WILLIAM W	2D2K	AFRE
DIGGES, THOMAS G	2U	AFRE
DUERKSEN, JACOB A	2B2G	AFRE
ECKHARDT, E A		AFNE
ELLIOTT, CHARLOTTE	2G2K	AFNE
ELLIS, NED R	2E2T	AFRE
FERGUSON, HENRY G		AFRE
FIELDNER, ARNO C	2E2G2M	AFRA
FIVAZ, ALFRED E	2L	AFRE
FULTON, ROBERT A	2E2Y	AFNE
GAFAFER, WILLIAM M		AFNE
GALTSOFF, PAUL S	2D	AFNE
GARDNER, IRVINE C	2B2G	AFRE
GARNER, CLEMENT L	2B2G2M2R	AFRE
GELLER, ROMAN F	2B2G3D	AFRA
GIBSON, KASSON S	2B2G	AFRE
GISH, OLIVER H	2B	AFNE
GOLDBERG, MICHAEL	2B	AFRA
GORDON, CHARLES L	2B2E2G	AFRA
GRAF, JOHN E	2F2G	AFRA
GRANT, ULYSSES S III	2G2J2R2S	AFRA
GRAVATT, G FLIPPO	2K2L	AFRE
GROSVENOR, GILBERT H	2G2J	AFRA
HALL, R CLIFFORD	2G2L	AFRE
HALLER, HERBERT L	2E2F2G2Y	AFRA
HAMBLETON, EDSON J	2D2F2G	AFRA
HAMBLETON, JAMES I	2F	AFRA
HARRISON, WILLIAM N	2B2G2U3D	AFRA
HENLEY, ROBERT R	2G	AFRE
HOLLINGSHEAD, ROBERT S		AFRE
HOLMES, FRANK H	2G2U	AMRA
HOUGH, FLOYD W	2G	AFNA
HUBBARD, DONALD	2E2G	AFRA
JACKSON, HARTLEY H T	2D	AFRE
JENKINS, ANNA E	2D2G2K3F	AFNE
JESSUP, RALPH S	2B2G	AFRA
JOHNSTON, FRANCIS E	2B	AFRE
JUDD, NEIL M	2C	AFRE
JUDSON, LEWIS V	2B2G	AFNE
JUHN, MARY	2T	AFRA
KARRER, ANNIE M H		AFRE
KARRER, SEBASTIAN	2B2E2G3G	AFRA
KENNARD, RALPH B	2B2G3G	AFRE
KINNEY, JAY P	2L	AFNE
KNOWLTON, KATHRYN	2E2T	AFRA
LAMBERT, WALTER D	2B	AFNE
LANG, WALTER B		AFRE
LAPHAM, EVAN G	2B	AFNA
LE CLERG, ERWIN L	2K	AFRA
LEIGHTY, CLYDE E	2G2K	AFRE
LINDQUIST, ARTHUR W	2F	AFNA
MADORSKY, SAMUEL L	2E	AFRA
MARTIN, JOHN H	2G2K	AFRA
MATLACK, MARION B	2E2G	AFRE
MAUSS, BESSE D		AFRA
MC INTOSH, ALLEN	2G2P	AFRA
MC KEE, SAMUEL A		AFRA
MC KINNEY, HAROLD H	2G2K2Q	AFRE
MC PHEE, HUGH C	2G	AFRE
MEARS, ATHERTON H		AFRE
MERRIAM, CARROLL F	2G	AFNA
MERZ, ALBERT R		AFRE
MIDDLETON, HOWARD E		AFNE
MILLER, J CHARLES	2H	AFNA
MOHLER, FRED L	2B	AFRE
MOLLARI, MARIO	2Q	AFRE
MORRISON, BENJAMIN Y		AFNE
MUESEBECK, CARL F W	2D2F	AFRE
NIKIFOROFF, C C	2G2H	AFRE
O NEILL, HUGH T		AFRE
PAGE, BENJAMIN L	2B2G	AFRE
PARR, LELAND W	2Q	AFRE
POOS, FRED W	2F2G2Y	AFRA
POPE, MERRITT N	2K	AFNE

POPENOE, WILSON	2L	AFNE
PORTER, B A	2F2G2Y	AFRA
RANDS, ROBERT D	2G2K	AFNE
RAPPLEYE, HOWARD S	2B2G2M2R2S	AFRA
READ, W T	2E	AFRA
REED, WILLIAM D	2F2G2R	AFRA
REID, MARY E	2K2P	AFRE
RICKER, PERCY L	2G2K	AFRE
ROBERTS, FRANK H H	2C	AFRA
ROGERS, LORE A	2Q	AFNE
ROTH, FRANK L	2G	AFNE
RYERSON, KNOWLES A	2G	AFNA
SANFORD, RAYMOND L	2B	AFRE
SCHOENING, HARRY W	2G2T	AFRA
SCHWARTZ, BENJAMIN	2P	AFNE
SERVICE, JERRY H	2G	AFNE
SETZLER, FRANK M	2C2G	AFNE
SHALOWITZ, AARON L		AFRE
SHAPOVALOV, MICHAEL	2G	AFNE
SHIMER, H W	2G	AFNE
SIEGLER, EDOUARD H	2F2Y	AFRE
SILSBEE, FRANCIS B	2B2G2N	AFRA
SMITH, CHARLES M	2Y	AFRE
SMITH, EDGAR R	2E	AFNE
SMITH, FRANCIS A		AFNE
SMITH, NATHAN R	2G2K2Q	AFNE
SNOKE, HUBERT R		AFRE
SPENCER, ROSCOE R		AFNE
SPICER, H CECIL	2H	AFNE
ST GEORGE, RAYMOND A	2D2F2L2Y	AFRA
STEVENSON, JOHN A	2K	AFRE
STIEBELING, HAZEL K	2E	AFRA
STIMSON, HAROLD F	2B2G	AFRE
STIRLING, MATHEW W	2C2G	AFRA
SUTCLIFFE, WALTER D	2B2G2M2R	AFRE
SWICK, CLARENCE H	2B2G2M	AFRA
SWINGLE, CHARLES F		AFNE
TILDEN, EVELYN B	2G	AFNE
TORRESON, OSCAR W	2B2G	AFRE
TRUEBLOOD, CHARLES K		AFRA
UMPLEBY, JOSEPH B	2H	AFNE
VACHER, HERBERT C		AFRE
VINAL, GEORGE W	2B2G	AFNE
VOLWILER, ERNEST H	2G	AFNA
WALKER, EGBERT H	2K	AFRA
WALTON, GEORGE P	2G	AFRE
WARD, HENRY P	2E	AFRE
WATERMAN, ALAN T	2B3G	AFRA
WATTS, CHESTER B	2B2G	AFRA
WEAVER, ELMER R	2C2E	AFRE
WEBB, ROBERT W	2B2G	AFRA
WEIDA, FRANK M	2B	AFRE
WEISS, FREEMAN A	2Q	AFNE
WHERRY, EDGAR T	2G	AFNE
WHITE, ORLAND E		AFNE
WHITTAKER, COLIN W	2E2G	AFRA
WICHERS, EDWARD	2E	AFRA
WILLIER, LILLIAN E	2K	AMRA
YOCUM, L EDWIN	2K	AFNE
ZIES, EMANUEL G	2E2G2H	AFRE
ZIMERMANN, ALFRED G		AFRA
ZOCH, RICHMOND T	2X	AFRA

8NRNC NONRESIDENT, EMPLOYER NOT CODED

ADAMS, ELLIOT Q		AFNE
AMBS, WILLIAM J		AFNA
BARBEAU, MARIUS		AFNA
BENDER, MAURICE	2E3C	AFNA
BENNETT, WILLARD H	2B	AFNA
BERKNER, L V	2G	AFNA
BIRD, H R	2G	AFNA
BRECKENRIDGE, ROBERT G		AFNA
BREIT, GREGORY		AFNA
BREWER, CARL R	2Q	AFNA
BRICKWEDDE, F G	2B	AFNE
CALLEN, EARL R	2B	AFNA
CHITWOOD, BENJAMIN G		AFNA
CLEVEN, GALE W	2B2W	AFNA
COMPTON, W DALE		AFNA
COTTAM, CLARENCE	2D	AFNA
DAVIS, PHILIP J		AFNA
DE FERIET, J KAMPE		AFNA
DU PONT, JOHN E		AMNA
DUPONT, JEAN R		AFNA
ECKERT, W J		AFNA
EVANS, W DUANE		AFNA
FELSENFELD, OSCAR	2G2T	AMNA
FOURNIER, ROBERT O	2H	AFNA
FRIEDMAN, LEO	2G2T	AFNA
GAMOW, GEORGE	2B	AFNA
GATES, G E	2D	AFNA
GORDON, RUTH E	2Q	AFNA
GOULD, IRA A		AFNA
GRATON, LOUIS C		AFNE
HAKALA, REINO W		AFNA
HALL, E RAYMOND	2D2G	AFNA
HALSTEAD, BRUCE W	2T	AFNA
HAND, CADET H JR	2G	AFNA
HARDER, E C		AFNA
HARWOOD, PAUL D	2D2G2P	AFNA
HERMAN, ROBERT C		AFNA
HERSEY, MAYO D	2B	AFNA
HERZ, ALBERT J	2B	AFNA
HICKOX, GEORGE H	2G	AFNA
HICKS, VICTOR		AFNA
HOSTETTER, J C		AFNE
HUNTER, GEORGE W III	2P	AFNE
HUTCHINS, LEE M	2K2L	AFNA
IMAI, ISAO		AFNA
JAMES, L H		AFNE
JAMES, MAURICE T	2F	AFNA
JOHNSON, PHYLLIS T	2F2G	AFNA
JONES, HENRY A		AFNA
JORDAN, GARY B	2N	AMNA
KARR, PHILIP R		AFNA
KEGELES, GERSON		AFNA
KELLUM, LEWIS B	2G	AFNA
KNOPF, ELEANORA B	2H	AFNE
LAMB, FRANK W		AFNA
LEINER, ALAN L		AFNA
LEVY, SAMUEL		AFNA
LEY, HERBERT L JR	2Q	AFNA
LI, HUI-LIN		AFNA
LICKLIDER, JOSEPH C R		AFNA
LIEBSON, SIDNEY H		AFNA
LILLY, JOHN C		AFNA
LOTHROP, S K		AFNA
LUDFORD, GEOFFREY S S		AFNA
MARCUS, MARVIN		AFNA
MARTIN, GEORGE W		AFNE
MARZKE, OSCAR T		AFNA
MATOSSI, FRANK		AFNA
MC BRIDE, GORDON W	2E3C	AFNA
MC DONALD, EMMA J	2E	AFNA
MC KENZIE, LAWSON M	2B	AFNA
MC WHORTER, FRANK P		AFNE
MEYERHOFF, HOWARD A	2G2H	AFNA
MINARD, DAVID		AFNA
MITTLEMAN, DON	2B	AFNA
NOLLA, JOSE A B		AFNA
OLSON, BYRON J JR		AFNA
OVERTON, WILLIAM C JR	2B2G	AFNA
PARK, J HOWARD	2N	AFNA
PAYNE, LAWRENCE E		AFNA
PELLAM, JOHN R		AFNA
PIGMAN, W WARD		AFNA
PIKL, JOSEF	2E	AFNA
PIORE, E R	2B	AFNA
POSNER, AARON S	2E2V	AFNA
PRICE, E W	2D2P	AFNE
READING, OLIVER S	2B	AFNE
REINHART, BRUCE L		AFNA
RENKIN, EUGENE M		AFNA
RICE, FRANCIS O	2E	AFNA
RIDDLE, OSCAR		AFNE
RITTS, ROY E JR		AFNA

RIVLIN, RONALD S		AFNA
ROSSINI, FREDERICK D	2B	AFNA
RUBEY, WILLIAM W	2D2H3F	AFNA
SAGER, WILLIAM F	2E	AFNA
SCOTT, DAVID B	2G2V	AFNA
SHAPLEY, A H		AFNA
SHAW, JOSEPH C		AFNA
SHEN, SHAN-FU		AFNA
SHIMKIN, DEMITRI B		AFNA
SHMUKLER, LEON		AMNA
SILBERSCHMIDT, KARL M		AFNA
SIMHA, ROBERT		AFNA
SMART, J SAMUEL	2B	AFNA
SMITH, HENRY L JR	2C	AFNA
STAKMAN, E C		AFNA
STEVENS, ROLLIN E		AFNA
TAUSSKY, OLGA		AFNE
THOMPSON, JACK C	2X	AFNA
TILLYER, E D		AFNA
TOLL, JOHN S	2B3G	AFNA
TULANE, VICTOR J		AFNA
TUNELL, GEORGE	2H	AFNA
VANGELI, MARIO G	2G	AMRA
VESTINE, E H		AFNA
WEIDLEIN, EDWARD R	2G	AFNE
WELLMAN, FREDERICK L		AFNE
WILSON, RAYMOND E	2B2G	AFNA
WINT, CECIL T		AFNA
WULF, OLIVER R		AFNA
YOUNG, DAVID A JR	2F	AFNA

9CLUN CLASSIFICATION UNKNOWN

CUTHILL, JOHN R		AFRA
DAVIS, CHARLES M JR		AMRA
EMERSON, W B		AFRE
EULER, ELVIRA A		AMRA
FOX, DAVID W		AFRA
HESS, WALTER C	2V	AFRE
HOCHWALD, FRITZ G	2K	AMRA
HOFFMASTER, EDMUND S		AMRA
OSWALD, ELIZABETH J		AFRA
SAYLOR, CHARLES P		AFRA
VAN EVERA, R W		AMRA

9NCOC NOT CLASSIFIED BY OCCUPATION

AMRINE, MICHAEL		AMRA
PEACOCK, ELIZABETH D		AMRA

Classification by Membership in Affiliated Societies

2B PHILOSOPHICAL SOCIETY OF WASHINGTON

ABBOT, CHARLES G	7RETD	AFRE
ABELSON, PHILIP H	3IGEL	AFRA
ABRAHAM, GEORGE	1DNRL	AFRA
ADAMS, LEASON H	4CONS	AFNE
ALEXANDER, SAMUEL N	1CNBS	AFRA
ALLEN, HARRY C JR	1CNBS	AFRA
ALT, FRANZ L	1CNBS	AFRA
APSTEIN, MAURICE	1DAHD	AFRA
ARMSTRONG, GEORGE T	1CNBS	AFRA
ASLAKSON, CARL I	4CONS	AFRA
ASTIN, ALLEN V	1CNBS	AFRA
AXILROD, BENJAMIN M	4X	AFRA
BALDES, EDWARD J	1DARO	AFRA
BARBROW, LOUIS E	1CNBS	AFRA
BASS, ARNOLD M	1CNBS	AFRA
BEACH, LOUIS A	1DNRL	AFRA
BEARCE, HENRY W	7RETD	AFNE
BECKETT, CHARLES W	1CNBS	AFRA
BEIJ, K HILDING	7RETD	AFNA
BEKKEDAHL, NORMAN	1CNBS	AFRA
BELSHEIM, ROBERT O	1DNRL	AFRA
BENESCH, WILLIAM	2HUMD	AFRA
BENNETT, WILLARD H	8NRNC	AFNA
BERL, WALTER G	3IAPL	AFRA
BERLINER, ROBERT W	1HNIH	AFRA
BESTUL, ALDEN B	1CNBS	AFRA
BIBERSTEIN, FRANK A JR	2HCUA	AFRA
BLOOM, MORTIMER C	1DNRL	AFRA
BOGLE, ROBERT W	5DERE	AFNA
BRAATEN, NORMAN F	1CCGS	AFRA
BRANSON, HERMAN	2HHOU	AFRA
BRECKENRIDGE, F C	4CONS	AFRA
BREWER, A KEITH	1DNNO	AFRA
BRICKWEDDE, F G	8NRNC	AFNE
BROMBACHER, W G	7RETD	AFRE
BROWN, ALFRED E	5HARE	AFRA
BURGERS, J M	2HUMD	AFRA
BURINGTON, RICHARD S	1DNBW	AFRA
CALDWELL, FRANK R	1CNBS	AFRA
CALLEN, EARL R	8NRNC	AFNA
CANNON, EDWARD W	1CNBS	AFRA
CARDER, DEAN S	1CCGS	AFNA
CARMICHAEL, LEONARD	3INGS	AFRA
CARRINGTON, TUCKER	1CNBS	AFRA
CARROLL, THOMAS J	5BERA	AFRA
CLAIRE, CHARLES N	7RETD	AFRA
CLEVEN, GALE W	8NRNC	AFNA
COHN, ROBERT	1DNHS	AFRA
COLE, KENNETH S	1HNIH	AFRA
COOK, HAROLD T	1ARMR	AFRA
COOK, RICHARD K	1CNBS	AFRA
COOTER, IRVIN L	1CNBS	AFRA
COSTRELL, LOUIS	1CNBS	AFRA
CRAGOE, CARL S	7RETD	AFRE
CRANE, LANGDON T JR	1XNSF	AFRA
CRAVEN, JOHN P	1DNSP	AFRA
CURTIS, ROGER W	5WEEL	AFRA
CURTISS, LEON F	7RETD	AFNE
DARWENT, BASIL DE B	2HCUA	AFRA
DAVIS, RAYMOND	7RETD	AFRE
DAVIS, WATSON	3ISCS	AFRA
DAVISSON, JAMES W	1DNRL	AFRA
DE PACKH, DAVID C	1DNRL	AFRA
DE VORE, CHARLES	1DNOR	AMRA
DOLECEK, RICHARD L	1DNRL	AFRA
DOUGLAS, CHARLES A	1CNBS	AFRA
DRYDEN, HUGH L	1XNAS	AFRA
DUERKSEN, JACOB A	7RETD	AFRE
DUNNING, KENNETH L	1DNRL	AFRA
EGLI, PAUL H	1DNRL	AFRA
EISENHART, CHURCHILL	1CNBS	AFRA
ELBOURN, ROBERT D	1CNBS	AFRA
ESTERMANN, IMMANUEL	1DNX	AFNA
FALLON, ROBERT J	5MELP	AFRA
FAUST, WILLIAM R	1DNRL	AFRA
FONER, SAMUEL N	3IAPL	AFRA
FOOTE, PAUL D	3INAS	AFRA
FRAPS, RICHARD M	1ARFR	AFRA
FRENKIEL, FRANCOIS N	1DNDT	AFRA
FULLMER, IRVIN H	1CNBS	AFRA
FURUKAWA, GEORGE T	1CNBS	AFRA
GAMOW, GEORGE	8NRNC	AFNA
GARDNER, IRVINE C	7RETD	AFRE
GARNER, CLEMENT L	7RETD	AFRE
GELLER, ROMAN F	7RETD	AFRA
GHAFFARI, ABOLGHASSEM	1XNAS	AFRA
GIBSON, KASSON S	7RETD	AFRE
GIBSON, RALPH E	3IAPL	AFRA
GISH, OLIVER H	7RETD	AFNE
GLASSER, ROBERT G	2HUMD	AFRA
GOLDBERG, MICHAEL	7RETD	AFRA
GORDON, CHARLES L	7RETD	AFRA
GRAY, ERNEST P	3IAPL	AMRA
GREEN, MELVILLE S	1CNBS	AFRA
GREENSPAN, MARTIN	1CNBS	AFRA
GRISAMORE, NELSON T	2HGWU	AFRA
GUILDNER, LESLIE A	1CNBS	AFRA
HALL, WAYNE C	1DNRL	AFRA
HAMMERSCHMIDT, WM W	1D-S	AMRA
HARRINGTON, MARSHALL C	1DFOS	AMRA
HARRISON, WILLIAM N	7RETD	AFRA
HARRISON, MARK	2HAMU	AFRA
HARTMANN, GREGORY K	1DNOL	AFRA
HAUPTMAN, HERBERT	1DNRL	AFRA
HENDERSON, MALCOLM C	2HCUA	AFRA
HENNEY, DAGMAR	2HGWU	AMRA
HENRY, THOMAS R	4X	AFRA
HERSEY, MAYO D	8NRNC	AFNA
HERZ, ALBERT J	8NRNC	AFNA
HERZFELD, CHARLES M	1D-S	AFRA
HERZFELD, KARL F	2HCUA	AFRA
HEYDEN, FRANCIS J	2HGEU	AFRA
HOBBS, ROBERT B	1CNBS	AFRA
HOFFMAN, JOHN D	1CNBS	AFRA
HOGE, HAROLD J	1DAX	AFNA
HOLMGREN, HARRY D	2HUMD	AFRA
HOOVER, JOHN I	1DNRL	AFRA
HORTON, BILLY M	1DAHD	AFRA
HUMPHREYS, CURTIS J	1DNOL	AFNA
HUNTER, WILLIAM R	1DNRL	AFRA
HUNTOON, ROBERT D	1CNBS	AFRA
INSLEY, HERBERT	4CONS	AFRA
IRWIN, GEORGE R	1DNRL	AFRA
JACKSON, JULIUS L	2HHOU	AFRA
JACOBS, WALTER W	1D-X	AFRA
JEN, CHIH K	3IAPL	AFRA
JESSUP, RALPH S	7RETD	AFRA
JOHNSON, DANIEL P	1CNBS	AFRA
JOHNSON, KEITH C	2SDCP	AFRA
JOHNSTON, FRANCIS E	7RETD	AFRE
JOYCE, J WALLACE	1SX	AFRA
JUDD, DEANE B	1CNBS	AFRA
JUDSON, LEWIS V	7RETD	AFNE
KARLE, JEROME	1DNRL	AFRA
KARRER, SEBASTIAN	7RETD	AFRA
KENNARD, RALPH B	7RETD	AFRE
KENNEY, ARTHUR W	1XNSF	AFRA
KESSLER, KARL G	1CNBS	AFRA
KEULEGAN, GARBIS H	1DAX	AFNA
KIES, JOSEPH A	1DNRL	AFRA
KING, PETER	1DNOR	AFNA
KLEBANOFF, PHILIP S	1CNBS	AFRA
KLUTE, CHARLES H	1DAHD	AFRA

KOLB, ALAN C	1DNRL	AFRA
KOSTKOWSKI, HENRY J	1CNBS	AFRA
KURZWEG, HERMAN H	1XNAS	AFRA
LAMBERT, WALTER D	7RETD	AFNE
LAPHAM, EVAN G	7RETD	AFNA
LAPP, RALPH E	4X	AFRA
LASHOF, THEODORE W	1CNBS	AFRA
LASTER, HOWARD J	2HUMD	AFRA
LIDDEL, URNER	1XNAS	AFRA
LIPPINCOTT, ELLIS R	2HUMD	AFRA
LITOVITZ, THEODORE A	2HCUA	AFRA
LYNN, W GARDNER	2HCUA	AFRA
MAC DONALD, WILLIAM M	2HUMD	AFRA
MAENGWYN-DAVIES, G D	2HGEU	AFRA
MAHAN, ARCHIE I	3IAPL	AFRA
MANDEL, JOHN	1CNBS	AFRA
MARSHALL, WADE H	1HNIH	AFRA
MARTON, L L	1CNBS	AFRA
MARVIN, ROBERT S	1CNBS	AFRA
MASON, EDWARD A	2HUMD	AFRA
MASSEY, JOSEPH T	3IAPL	AFRA
MAXWELL, LOUIS R	1DNOL	AFRA
MAY, DONALD C JR	1DNBW	AFRA
MAYER, CORNELL H	1DNRL	AFRA
MAZUR, JACOB	1CNBS	AFRA
MC CLAIN, EDWARD F JR	1DNRL	AFRA
MC CLURE, FRANK T	3IAPL	AFRA
MC ELHINNEY, JOHN	1DNRL	AFRA
MC KENZIE, LAWSON M	8NRNC	AFNA
MC MILLEN, J HOWARD	1XNSF	AFRA
MC PHERSON, ARCHIBALD	4X	AFRA
MEGGERS, WILLIAM F	4CONS	AFRA
MILLIKEN, LEWIS T	1CNBS	AMRA
MITTLEMAN, DON	8NRNC	AFNA
MOHLER, FRED L	7RETD	AFRE
MONCHICK, LOUIS	3IAPL	AFRA
MONTROLL, ELLIOTT W	3IIDA	AFRA
MORGAN, RAYMOND	2HUMD	AFRE
MUEHLHAUSE, CARL O	1CNBS	AFRA
MURPHY, LEONARD M	1CCGS	AFRA
MYERS, RALPH D	2HUMD	AFRA
O KEEFE, JOHN A	1XNAS	AFRA
OBOURN, ELLSWORTH S	1HOED	AFRA
OEHSER, PAUL H	1XSMI	AFRA
OSTEN, EDWARD J	1XLIC	AMRA
OVERTON, WILLIAM C JR	8NRNC	AFNA
PAGE, BENJAMIN L	7RETD	AFRE
PAGE, CHESTER H	1CNBS	AFRA
PARSONS, DOUGLAS E	4CONS	AFRE
PEISER, H STEFFEN	1CNBS	AFRA
PENTZER, WILBUR T	1ARMR	AFRA
PERROS, THEODORE P	2HGWU	AFRA
PHILLIPS, MARCELLA L	4CONS	AFRA
PIORE, E R	8NRNC	AFNA
POLACHEK, HARRY	1XAEC	AFRA
RABINOW, JACOB	5RBEN	AFRA
RADO, GEORGE T	1DNRL	AFRA
RAMBERG, WALTER	1SX	AFNA
RAPPLEYE, HOWARD S	7RETD	AFRA
READING, OLIVER S	8NRNC	AFNE
REICHELDERFER, F W	4CONS	AFRA
RICHMOND, JOSEPH C	1CNBS	AFRA
ROBERTS, ELLIOTT B	4CONS	AFRE
ROBERTSON, RANDAL M	1XNSF	AFRA
RODNEY, WILLIAM S	1XNSF	AFRA
ROEDDER, EDWIN	1IGES	AFRA
ROLLER, PAUL S	5LIPR	AFRA
ROSENBLATT, DAVID	1CNBS	AFRA
ROSSINI, FREDERICK D	8NRNC	AFNA
ROTKIN, ISRAEL	1DAHD	AFRA
RUBIN, ROBERT J	1CNBS	AFRA
RUBIN, VERA C	3IDTM	AFRA
SALKOVITZ, EDWARD I	1DNOR	AFRA
SANDERSON, JOHN A	1DNRL	AFRA
SANFORD, RAYMOND L	7RETD	AFRE
SCHEER, MILTON D	1CNBS	AFRA
SCHIEFER, HERBERT F	1CNBS	AFRA
SCHINDLER, ALBERT I	1DNRL	AFRA
SCHOOLEY, ALLEN H	1DNRL	AFRA
SCHOONOVER, IRL C	1CNBS	AFRA
SCHUBAUER, GALEN B	1CNBS	AFRA
SCHUBERT, LEO	2HAMU	AFRA
SCHULMAN, JAMES H	1DNRL	AFRA
SCOTT, ARNOLD H	1CNBS	AFRA
SEEGER, RAYMOND J	1XNSF	AFRA
SHAPIRO, MAURICE M	1DNRL	AFRA
SHERLIN, GROVER C	1CNBS	AMRA
SHULER, KURT E	1CNBS	AFRA
SILSBEE, FRANCIS B	7RETD	AFRA
SILVERMAN, SHIRLEIGH	1CNBS	AFRA
SITTERLY, BANCROFT W	2HAMU	AFRA
SITTERLY, CHARLOTTE M	1CNBS	AFRA
SLACK, LEWIS	3INAS	AFRA
SLAWSKY, ZAKA I	1DNOL	AFRA
SMALL, JAMES B	1CCGS	AFRA
SMART, J SAMUEL	8NRNC	AFNA
SMITH, FALCONER	2HAMU	AFRA
SMITH, PAUL A	5RACO	AFRA
SMITH, PAUL L	1DNRL	AFRA
SMITH, SIDNEY T	1DNRL	AFRA
SPECHT, HEINZ	1HNIH	AFRA
STEINER, ROBERT F	1DNMR	AFRA
STEPHENS, ROBERT E	1CNBS	AFRA
STIEHLER, ROBERT D	1CNBS	AFRA
STILL, JOSEPH W	4PHYS	AFNA
STILLER, BERTRAM	1DNRL	AFRA
STIMSON, HAROLD F	7RETD	AFRE
SUTCLIFFE, WALTER D	7RETD	AFRE
SWICK, CLARENCE H	7RETD	AFRA
SWINDELLS, JAMES F	1CNBS	AFRA
TALBOTT, F LEO	2HCUA	AFRA
TATE, DOUGLAS R	1CNBS	AFRA
TAYLOR, JOHN K	1CNBS	AFRA
TCHEN, CHAN-MOU	1CNBS	AFRA
TEELE, RAY P	1CNBS	AFRA
TOLL, JOHN S	8NRNC	AFNA
TORRESON, OSCAR W	7RETD	AFRE
TOUSEY, RICHARD	1DNRL	AFRA
TOWNSEND, JOHN R	4CONS	AFRA
TREXLER, JAMES H	1DNRL	AFRA
TUVE, MERLE A	3IDTM	AFRA
VANDERSLICE, JOSEPH T	2HUMD	AFRA
VIGNESS, IRWIN	1DNRL	AFRA
VINAL, GEORGE W	7RETD	AFNE
VINTI, JOHN P	1CNBS	AFRA
WACHTMAN, JOHN B JR	1CNBS	AFRA
WALL, LEO A	1CNBS	AFRA
WARGA, MARY E	3AOSA	AFRA
WATERMAN, ALAN T	7RETD	AFRA
WATTS, CHESTER B	7RETD	AFRA
WEBB, ROBERT W	7RETD	AFRA
WEIDA, FRANK M	7RETD	AFRE
WEISS, FRANCIS J	1XLIC	AFRA
WEISSBERG, SAMUEL G	1CNBS	AFRA
WEISSLER, ALFRED	1DFOS	AFRA
WEISSMAN, STANLEY	2HUMD	AFRA
WEXLER, ARNOLD	1CNBS	AFRA
WEYL, F JOACHIM	1DNOR	AFRA
WHITTEN, CHARLES A	1CCGS	AFRA
WILDHACK, WILLIAM A	1CNBS	AFRA
WILSON, BRUCE L	1CNBS	AFRA
WILSON, RAYMOND E	8NRNC	AFNA
WOOD, LAWRENCE A	1CNBS	AFRA
YOUDEN, WILLIAM J	2HGWU	AFRA
ZWANZIG, ROBERT W	1CNBS	AFRA
ZMUDA, ALFRED J	3IAPL	AFRA

2C ANTHROPOLOGICAL SOCIETY OF WASHINGTON

BISHOPP, FRED C	7RETD	AFRE
COLLINS, HENRY B	1XSMI	AFRA
EWERS, JOHN C	1XSMI	AFRA
HERZFELD, REGINA F	2HCUA	AFRA
JUDD, NEIL M	7RETD	AFRE
MILLER, CARL F	1XSMI	AFRA
MOORE, HARVEY C	2HAMU	AFRA
ROBERTS, FRANK H H	7RETD	AFRA

SETZLER, FRANK M	7RETD	AFNE
SMITH, HENRY L JR	8NRNC	AFNA
STEWART, T DALE	1XSMI	AFRA
STIRLING, MATHEW W	7RETD	AFRA
WEAVER, ELMER R	7RETD	AFRE

2D BIOLOGICAL SOCIETY OF WASHINGTON

ALDRICH, JOHN W	1IFWS	AFRA
BENJAMIN, CHESTER R	1ARFR	AFRA
BISHOPP, FRED C	7RETD	AFRE
BORTHWICK, HARRY A	1ARFR	AFRA
BOWMAN, PAUL W	1HNIH	AFRA
BOWMAN, THOMAS E	1XSMI	AFRA
BROWN, EDGAR	7RETD	AFRE
COTTAM, CLARENCE	8NRNC	AFNA
DIEHL, WILLIAM W	7RETD	AFRE
FINLEY, HAROLD E	2HHOU	AFRA
GALTSOFF, PAUL S	7RETD	AFNE
GATES, G E	8NRNC	AFNA
GAZIN, CHARLES L	1XSMI	AFRA
GURNEY, ASHLEY B	1ARFR	AFRA
HALL, E RAYMOND	8NRNC	AFNA
HAMBLETON, EDSON J	7RETD	AFRA
HANSEN, IRA B	2HGWU	AFRA
HARWOOD, PAUL D	8NRNC	AFNA
JACKSON, HARTLEY H T	7RETD	AFRE
JENKINS, ANNA E	7RETD	AFNE
MORRISON, JOSEPH P	1XSMI	AFRA
MUESEBECK, CARL F W	7RETD	AFRE
OEHSER, PAUL H	1XSMI	AFRA
OWENS, HOWARD B	2SPGC	AFRA
PARKER, KENNETH W	1AFOR	AFRA
PARKER, MARION W	1ARAO	AFRA
PRICE, E W	8NRNC	AFNE
RAUSCH, ROBERT	1HPHS	AFNA
REHDER, HARALD A	1XSMI	AFRA
RUBEY, WILLIAM W	8NRNC	AFNA
RUSSELL, LOUISE M	1ARFR	AFRA
SCHMITT, WALDO L	1XSMI	AFRA
ST GEORGE, RAYMOND A	7RETD	AFRA
WETMORE, ALEXANDER	1XSMI	AFRA

2E CHEMICAL SOCIETY OF WASHINGTON

ABELSON, PHILIP H	3IGEL	AFRA
ADAMS, LEASON H	4CONS	AFNE
ALEXANDER, ALLEN L	1DNRL	AFRA
ALEXANDER, BENJAMIN H	1DAWR	AFRA
ALEXANDER, LYLE T	1ASCS	AFRA
ALLEN, HARRY C JR	1CNBS	AFRA
ALLISON, FRANKLIN E	7RETD	AFRE
ALTER, HARVEY	5HARE	AFRA
ANDERSON, MYRON S	7RETD	AFRA
ANDERSON, WENDELL L	1DNRL	AFRA
APPEL, WILLIAM D	7RETD	AFRA
ARMSTRONG, GEORGE T	1CNBS	AFRA
AUSLOOS, PIERRE J	1CNBS	AFRA
BAILEY, WILLIAM J	2HUMD	AFRA
BAKER, LOUIS C W	2HGEU	AFRA
BARNES, R PERCY	2HHOU	AFRA
BATES, ROGER G	1CNBS	AFRA
BAUER, HUGO	7RETD	AFRA
BECKER, EDWIN D	1HNIH	AFRA
BECKETT, CHARLES W	1CNBS	AFRA
BECKMANN, ROBERT B	2HUMD	AFRA
BEKKEDAHL, NORMAN	1CNBS	AFRA
BENDER, MAURICE	8NRNC	AFNA
BENNETT, MARTIN T	4CONS	AFRA
BERCH, JULIAN	5HARE	AMRA
BERL, WALTER G	3IAPL	AFRA
BEROZA, MORTON S	1ARFR	AFRA
BESTUL, ALDEN B	1CNBS	AFRA
BLOCK, STANLEY	1CNBS	AFRA
BLOOM, MORTIMER C	1DNRL	AFRA
BLUM, WILLIAM	4CONS	AFRE
BOND, HOWARD W	1HPHS	AFRA
BRAUER, GERHARD M	1CNBS	AFRA
BRENNER, ABNER	1CNBS	AFRA
BREWER, A KEITH	1DNNO	AFRA
BROWN, ALFRED E	5HARE	AFRA
BRUCK, STEPHEN D	3IAPL	AFRA
BURAS, EDMUND M JR	5HARE	AFRA
BURK, DEAN	1HNIH	AFRA
CARHART, HOMER W	1DNRL	AFRA
CARRINGTON, TUCKER	1CNBS	AFRA
CARROLL, WILLIAM R	1HNIH	AFRA
CARRON, MAXWELL K	1IGES	AFRA
CASSEL, JAMES M	1CNBS	AFRA
CAUL, HAROLD J	1CNBS	AFRA
CHEEK, CONRAD H	1DNRL	AFRA
CLARK, KENNETH G	7RETD	AFRE
COHN, ERNST M	1XNAS	AMRA
COULSON, E JACK	1ARNI	AFRA
COYLE, THOMAS D	1CNBS	AFRA
CREITZ, E CARROLL	1CNBS	AFRA
CUTTITTA, FRANK	1IGES	AFRA
DAFT, FLOYD S	7RETD	AFRA
DARWENT, BASIL DE B	2HCUA	AFRA
DAVIS, MARION M	1CNBS	AFRA
DAVIS, RAYMOND	7RETD	AFRE
DEITZ, VICTOR R	1DNRL	AFRA
DETWILER, SAMUEL B JR	1ARNI	AFRA
DIAMOND, JACOB J	1CNBS	AFRA
DOUGLAS, THOMAS B	1CNBS	AFRA
EASTER, DONALD	1XNAS	AMRA
EDWARDS, H KENNETH	1SX	AMRA
EGLI, PAUL H	1DNRL	AFRA
ELLIS, NED R	7RETD	AFRE
EMERY, ALDEN H	3AACS	AFRA
FAHEY, JOSEPH J	1IGES	AFRA
FALLON, ROBERT J	5MELP	AFRA
FARBER, EDUARD	2HAMU	AFRA
FARROW, RICHARD P	3ANCA	AFRA
FERGUSON, LLOYD N	2HHOU	AFRA
FERGUSON, ROBERT E	1CNBS	AFRA
FIELDNER, ARNO C	7RETD	AFRA
FLETCHER, DONALD G	1CNBS	AMRA
FLETCHER, HEWITT G JR	1HNIH	AFRA
FLORIN, ROLAND E	1CNBS	AFRA
FORD, T FOSTER	1DNRL	AFRA
FORZIATI, ALPHONSE F	1D-S	AFRA
FORZIATI, FLORENCE H	1ARNI	AFRA
FOURT, LYMAN	5HARE	AFRA
FOX, M R SPIVEY	1HFDA	AFRA
FOX, ROBERT B	1DNRL	AFRA
FRAME, ELIZABETH G	1HNIH	AFRA
FRANKLIN, PHILIP J	1CNBS	AFRA
FREEMAN, ANDREW F	1ARNI	AMRA
FREEMAN, MONROE E	1XSMI	AFRA
FRIESS, SEYMOUR L	1DNMR	AFRA
FRUSH, HARRIET L	1CNBS	AFRA
FULTON, ROBERT A	7RETD	AFNE
FURUKAWA, GEORGE T	1CNBS	AFRA
GARVIN, DAVID	1CNBS	AFRA
GIBSON, RALPH E	3IAPL	AFRA
GILLMAN, JOSEPH L JR	4CONS	AFRA
GINNINGS, DEFOE C	1CNBS	AFRA
GLASGOW, AUGUSTUS R JR	1HFDA	AFRA
GOLUMBIC, CALVIN	1ARMR	AFRA
GONET, FRANK	1XUST	AFRA
GORDON, CHARLES L	7RETD	AFRA
GRAY, VANNIE E	1CNBS	AMRA
HAGUE, JOHN L	1CNBS	AFRA
HALL, STANLEY A	1ARFR	AFRA
HALLER, HERBERT L	7RETD	AFRA
HALLER, WOLFGANG	1CNBS	AFRA
HAMER, WALTER J	1CNBS	AFRA
HARRIS, MILTON	5GICO	AFRA
HARVALIK, Z V	1DAER	AFRA
HAZLETON, LLOYD W	5HALA	AFRA
HEINZE, PETER H	1ARMR	AFRA
HEWITT, CLIFFORD A	1HNIH	AMRA
HIATT, CASPAR W	1HNIH	AFRA
HOBBS, ROBERT B	1CNBS	AFRA
HOERING, THOMAS C	3IGEL	AFRA
HOLLIES, NORMAN R S	5HARE	AFRA
HOOVER, THOMAS B	1CNBS	AFRA

HOWE, PAUL E	4CONS	AFRA
HUBBARD, DONALD	7RETD	AFRA
IRVING, GEORGE W JR	1ARAO	AFRA
ISBELL, HORACE S	1CNBS	AFRA
JACOB, KENNETH D	4CONS	AFRA
JACOBSON, MARTIN	1ARFR	AFRA
JOHANNESEN, ROLF B	1CNBS	AFRA
KANAGY, JOSEPH R	1CNBS	AFRA
KANE, EDWARD A	1ARFR	AFRA
KARKENNY, MOSES	5MIPI	AMRA
KARLE, ISABELLA	1DNRL	AFRA
KARLE, JEROME	1DNRL	AFRA
KARRER, SEBASTIAN	7RETD	AFRA
KEEGAN, HARRY J	1CNBS	AFRA
KERESZTZTESY, JOHN C	1HNIH	AFRA
KING, PETER	1DNOR	AFNA
KLUTE, CHARLES H	1DAHD	AFRA
KNOBLOCK, EDWARD C	1DAWR	AFRA
KNOWLTON, KATHRYN	7RETD	AFRA
KRUGER, JEROME	1CNBS	AFRA
KURTZ, FLOYD E	1ARNI	AFRA
LAKI, KOLOMAN	1HNIH	AFRA
LEVIN, ERNEST M	1CNBS	AFRA
LIEBERMAN, MORRIS	1ARMR	AFRA
LINNENBOM, VICTOR J	1DNRL	AFRA
LIPPINCOTT, ELLIS R	2HUMD	AFRA
LOCKHART, LUTHER B JR	1DNRL	AFRA
LOVE, S KENNETH	1IGES	AFRA
LYMAN, JOHN	1IFWS	AFRA
MADORSKY, SAMUEL L	7RETD	AFRA
MAENGWYN-DAVIES, G D	2HGEU	AFRA
MAGIN, GEORGE B JR	1XAEC	AFRA
MAIENTHAL, MILLARD	1HFDA	AFRA
MANDEL, H GEORGE	2HGWU	AFRA
MANDEL, JOHN	1CNBS	AFRA
MANN, DAVID E	1CNBS	AFRA
MARVIN, ROBERT S	1CNBS	AFRA
MARYOTT, ARTHUR A	1CNBS	AFRA
MASON, EDWARD A	2HUMD	AFRA
MATHERS, ALEX P	1TIRS	AFRA
MATLACK, MARION B	7RETD	AFRE
MAY, IRVING	1IGES	AFRA
MC BRIDE, GORDON W	8NRNC	AFNA
MC CABE, LOUIS C	5RERS	AFRA
MC CLURE, FRANK T	3IAPL	AFRA
MC DONALD, EMMA J	8NRNC	AFNA
MC PHERSON, ARCHIBALD	4X	AFRA
MEINKE, W WAYNE	1CNBS	AFRA
MENKART, JOHN H	5HARE	AFRA
MEYROWITZ, ROBERT	1IGES	AFRA
MILLER, CLEM O	1HFDA	AFRA
MILLER, ROMAN R	1DNRL	AFRA
MILLIKEN, LEWIS T	1CNBS	AMRA
MIZELL, LOUIS R	5HARE	AFRA
MONCHICK, LOUIS	3IAPL	AFRA
MORRIS, J A	1HNIH	AMRA
MORRIS, JOSEPH B	2HHOU	AFRA
MORRIS, KELSO B	2HHOU	AFRA
MYERS, ALFRED T	1IGES	AFNA
NAESER, CHARLES R	2HGWU	AFRA
NIRENBERG, MARSHALL W	1HNIH	AFRA
ORDWAY, FRED D JR	5MELP	AFRA
PATTERSON, WILBUR I	1ARNI	AFRA
PEISER, H STEFFEN	1CNBS	AFRA
PERROS, THEODORE P	2HGWU	AFRA
PIKL, JOSEF	8NRNC	AFNA
POMMER, ALFRED M	1ARNI	AFRA
POSNER, AARON S	8NRNC	AFNA
PRO, MAYNARD J	1TIRS	AFRA
PROSEN, EDWARD J	1CNBS	AFRA
READ, W T	7RETD	AFRA
REEVE, E WILKINS	2HUMD	AFRA
REICHEN, LAURA E	1IGES	AFRA
REINHART, FRANK W	4CONS	AFRA
REYNOLDS, HELEN L	1HFDA	AMRA
RICE, FRANCIS O	8NRNC	AFNA
RICE, FREDERICK A H	2HAMU	AFRA
RITT, PAUL E	5MELP	AFRA
ROBERTS, IRENA Z	2HTRI	AMRA
ROLLER, PAUL S	5LIPR	AFRA
SAGER, WILLIAM F	8NRNC	AFNA
SCHAFFER, ROBERT	1CNBS	AFRA
SCHALLER, WALDEMAR T	1IGES	AFRE
SCHECHTER, MILTON S	1ARFR	AFRA
SCHEER, MILTON D	1CNBS	AFRA
SCHOONOVER, IRL C	1CNBS	AFRA
SCHRECKER, ANTHONY W	1HNIH	AFRA
SCHUBERT, LEO	2HAMU	AFRA
SCHWARTZ, ANTHONY M	5HARE	AFRA
SCOFIELD, FRANCIS	3ANPV	AMRA
SCRIBNER, BOURDON F	1CNBS	AFRA
SHAFRIN, ELAINE G	1DNRL	AMRA
SHAPIRO, LEONARD	1IGES	AFRA
SHERESHEFSKY, J LEON	2HHOU	AFRA
SLADEK, JAROMIL V	1HFDA	AFRA
SMITH, EDGAR R	7RETD	AFNE
SOLLNER, KARL	1HNIH	AFRA
SOOKNE, ARNOLD M	5HARE	AFRA
SPIES, JOSEPH R	1ARNI	AFRA
STEINER, ROBERT F	1DNMR	AFRA
STEINHARDT, JACINTO	2HGEU	AFRA
STERN, KURT H	1CNBS	AFRA
STEVENS, HENRY	1ARNI	AFRA
STIEBELING, HAZEL K	7RETD	AFRA
STIEHLER, ROBERT D	1CNBS	AFRA
SWEENEY, WILLIAM T	1CNBS	AFRA
TALBERT, PRESTON T	2HHOU	AFRA
TAYLOR, JOHN K	1CNBS	AFRA
TAYLOR, MODDIE D	2HHOU	AFRA
TIPSON, R STUART	1CNBS	AFRA
TORGESEN, JOHN L	1CNBS	AFRA
TREADWELL, CARLETON R	2HGWU	AFRA
TRYON, MAX	1CNBS	AFRA
VAN EVERA, BENJAMIN D	2HGWU	AFRA
VANDERSLICE, JOSEPH T	2HUMD	AFRA
VEITCH, FLETCHER P JR	2HUMD	AFRA
WAGMAN, DONALD D	1CNBS	AFRA
WALL, LEO A	1CNBS	AFRA
WALTER, DEAN I	1DNRL	AFRA
WALTON, WILLIAM W	1CNBS	AFRA
WARD, HENRY P	7RETD	AFRE
WASIK, STANLEY P	1CNBS	AMRA
WEAVER, DE FORREST E	1IGES	AMRA
WEAVER, ELMER R	7RETD	AFRE
WEINTRAUB, ROBERT L	2HGWU	AFRA
WEISS, FRANCIS J	1XLIC	AFRA
WEISSBERG, SAMUEL G	1CNBS	AFRA
WEISSLER, ALFRED	1DFOS	AFRA
WESTENBERG, ARTHUR A	3IAPL	AFRA
WHITE, CHARLES E	2HUMD	AFRA
WHITTAKER, COLIN W	7RETD	AFRA
WICHERS, EDWARD	7RETD	AFRA
WILSON, WILLIAM K	1CNBS	AFRA
WITKOP, BERNHARD	1HNIH	AFRA
WOMACK, MADELYN	1ARNI	AFRA
WOOD, LAWRENCE A	1CNBS	AFRA
WOOD, REUBEN E	2HGWU	AFRA
WOODS, G FORREST	2HUMD	AFRA
YODER, HATTEN S JR	3IGEL	AFRA
YOUDEN, WILLIAM J	2HGWU	AFRA
ZIES, EMANUEL G	7RETD	AFRE
ZISMAN, WILLIAM A	1DNRL	AFRA

2F ENTOMOLOGICAL SOCIETY OF WASHINGTON

BABERS, FRANK H	1DAX	AFNA
BARNHART, CLYDE S	1DAX	AFNA
BICKLEY, WILLIAM E	2HUMD	AFRA
BISHOPP, FRED C	7RETD	AFRE
BLAKE, DORIS H	1XSMI	AFRE
BUNN, RALPH W	3AESA	AFRA
CAMPBELL, FRANK L	7RETD	AFNA
CHRISTENSON, LEROY D	1ARFR	AFRA
CLAUSEN, CURTIS P	7RETD	AFNE
CORY, ERNEST N	7RETD	AFRE
EDMUNDS, LAFE R	1XNSF	AFRA
GRAF, JOHN E	7RETD	AFRA

GURNEY, ASHLEY B	1ARFR	AFRA
HAINES, KENNETH A	1ARAO	AFRA
HALLER, HERBERT L	7RETD	AFRA
HAMBLETON, EDSON J	7RETD	AFRA
HAMBLETON, JAMES I	7RETD	AFRA
HASKINS, CARYL P	3ICIW	AFRA
HENNEBERRY, THOMAS J	1ARFR	AFNA
HOFFMAN, JOHN D	1CNBS	AFRA
HOFFMANN, CLARENCE H	1ARFR	AFRA
HUTTON, GEORGE L	1DNBY	AFRA
JAMES, MAURICE T	8NRNC	AFNA
JOHNSON, PHYLLIS T	8NRNC	AFNA
KNIPLING, EDWARD F	1ARFR	AFRA
LANGFORD, GEORGE S	2HUMD	AFRA
LATTA, RANDALL	6FAOR	AFNE
LINDQUIST, ARTHUR W	7RETD	AFNA
MUESEBECK, CARL F W	7RETD	AFRE
NELSON, R H	3AESA	AFRA
OWENS, HOWARD B	2SPGC	AFRA
POOS, FRED W	7RETD	AFRA
PORTER, B A	7RETD	AFRA
PRATT, HARRY D	1HPHS	AFNA
REED, WILLIAM D	7RETD	AFRA
RUSSELL, LOUISE M	1ARFR	AFRA
SAILER, REECE I	1ARFR	AFNA
SHEPARD, HAROLD H	1AASC	AFRA
SIEGLER, EDOUARD H	7RETD	AFRE
SMITH, FLOYD F	1ARFR	AFRA
ST GEORGE, RAYMOND A	7RETD	AFRA
THURMAN, ERNESTINE B	1HNIH	AFNA
TODD, FRANK E	1ARFR	AFRA
TRAUB, ROBERT	2HUMD	AFRA
TRAVIS, CLARENCE W	1XDCG	AMRA
YOUNG, DAVID A JR	8NRNC	AFNA
YUILL, JOSEPH S	1AFOR	AFRA

2G NATIONAL GEOGRAPHIC SOCIETY

AKERS, ROBERT P	1HNIH	AFRA
ABRAHAM, GEORGE	1DNRL	AFRA
ALLEN, HARRY C JR	1CNBS	AFRA
ALLISON, FRANKLIN E	7RETD	AFRE
ADAMS, LEASON H	4CONS	AFNE
AMES, LAWRENCE M	2HAMU	AFRA
ARMSTRONG, GEORGE T	1CNBS	AFRA
ARSEM, COLLINS	1DAHD	AMRA
BABERS, FRANK H	1DAX	AFNA
BALDES, EDWARD J	1DARO	AFRA
BARRETT, MARGARET D	1HNIH	AFRA
BLACK, RICHARD B	1DNOR	AFRA
BLANC, MILTON L	1CWEB	AFNA
BLUM, WILLIAM	4CONS	AFRE
BURINGTON, RICHARD S	1DNBW	AFRA
BURNETT, HARRY C	1CNBS	AFRA
BUTLER, FRANCIS E	1DNOL	AMRA
BEACH, LOUIS A	1DNRL	AFRA
BEAN, HOWARD S	4CONS	AFRA
BEKKEDAHL, NORMAN	1CNBS	AFRA
BELSHEIM, ROBERT O	1DNRL	AFRA
BENJAMIN, CHESTER R	1ARFR	AFRA
BERKNER, L V	8NRNC	AFNA
BESTUL, ALDEN B	1CNBS	AFRA
BOGLE, ROBERT W	5DERE	AFNA
BOLTON, ELLIS T	3ICIW	AFRA
BORTHWICK, HARRY A	1ARFR	AFRA
BOSWELL, VICTOR R	1ARFR	AFRA
BOUTWELL, JOHN M	4CONS	AFNA
BOWLES, ROMALD E	5BOEN	AFRA
BRANSON, HERMAN	2HHOU	AFRA
BRENNER, ABNER	1CNBS	AFRA
BREWER, A KEITH	1DNNO	AFRA
BRIER, GLENN W	1CWEB	AFRA
BROWN, ALFRED E	5HARE	AFRA
BIRD, H R	8NRNC	AFNA
BRUCK, STEPHEN D	3IAPL	AFRA
CALDWELL, FRANK R	1CNBS	AFRA
CARHART, HOMER W	1DNRL	AFRA
CARMICHAEL, LEONARD	3INGS	AFRA
CASSEL, JAMES M	1CNBS	AFRA
CAUL, HAROLD J	1CNBS	AFRA
CLARK, KENNETH G	7RETD	AFRE
CURTIS, ROGER W	5WEEL	AFRA
CUTTITTA, FRANK	1IGES	AFRA
COCHRAN, DORIS M	1XSMI	AFRA
COLE, HOWARD I	7RETD	AFNE
COOLIDGE, HAROLD J	3INAS	AFRA
CORY, ERNEST N	7RETD	AFRE
COYLE, THOMAS D	1CNBS	AFRA
CHAPIN, EDWARD J	1DNRL	AFRA
CHAPLINE, W R	7RETD	AFRE
CHRISTENSON, LEROY D	1ARFR	AFRA
CRAFTON, PAUL A	2HGWU	AFRA
CRAGOE, CARL S	7RETD	AFRE
DAVIS, MARION M	1CNBS	AFRA
DUERKSEN, JACOB A	7RETD	AFRE
DURBIN, CHARLES G	1HFDA	AFRA
DE CARLO, MICHAEL	3INAS	AMRA
DE PUE, LELAND A	1DNRL	AFRA
DETWILER, SAMUEL B	7RETD	AFRA
DOLECEK, RICHARD L	1DNRL	AFRA
DOUGLAS, CHARLES A	1CNBS	AFRA
DICKSON, GEORGE	1CNBS	AFRA
DRECHSLER, CHARLES	1ARFR	AFRA
DRYDEN, HUGH L	1XNAS	AFRA
ELLINGER, GEORGE A	1CNBS	AFRA
ELLIOTT, CHARLOTTE	7RETD	AFNE
ETZEL, HOWARD W	1XNSF	AFRA
EDDY, BERNICE E	1HNIH	AFRA
EDDY, NATHAN B	4CONS	AFRA
EMERY, ALDEN H	3AACS	AFRA
EWERS, JOHN C	1XSMI	AFRA
FAHEY, JOSEPH J	1IGES	AFRA
FARBER, EDUARD	2HAMU	AFRA
FARROW, RICHARD P	3ANCA	AFRA
FAULKNER, JOSEPH A	1DNOL	AMRA
FAUST, WILLIAM R	1DNRL	AFRA
FLORIN, ROLAND E	1CNBS	AFRA
FULLMER, IRVIN H	1CNBS	AFRA
FURUKAWA, GEORGE T	1CNBS	AFRA
FELSENFELD, OSCAR	8NRNC	AMNA
FERRELL, RICHARD A	2HUMD	AFRA
FOX, M R SPIVEY	1HFDA	AFRA
FOX, ROBERT B	1DNRL	AFRA
FRANZ, GERALD J	1DNDT	AMRA
FIELDNER, ARNO C	7RETD	AFRA
FRIEDMAN, LEO	8NRNC	AFNA
FISK, BERT	1DNRL	AFRA
GANT, JAMES Q JR	4PHYS	AMRA
GARDNER, IRVINE C	7RETD	AFRE
GARNER, CLEMENT L	7RETD	AFRE
GLASGOW, AUGUSTUS R JR	1HFDA	AFRA
GLASS, JEWELL J	1IGES	AFRA
GUILDNER, LESLIE A	1CNBS	AFRA
GURNEY, ASHLEY B	1ARFR	AFRA
GEIL, GLENN W	1CNBS	AFRA
GELLER, ROMAN F	7RETD	AFRA
GORDON, CHARLES L	7RETD	AFRA
GORDON, FRANCIS B	1DNMR	AFRA
GRAF, JOHN E	7RETD	AFRA
GRANT, ULYSSES S III	7RETD	AFRA
GRAY, IRVING	2HGEU	AFRA
GIBSON, KASSON S	7RETD	AFRE
GRISAMORE, NELSON T	2HGWU	AFRA
GINNINGS, DEFOE C	1CNBS	AFRA
GROSVENOR, GILBERT H	7RETD	AFRA
HACSKAYLO, EDWARD	1AFOR	AFRA
HAGUE, JOHN L	1CNBS	AFRA
HAINES, KENNETH A	1ARAO	AFRA
HALL, E RAYMOND	8NRNC	AFNA
HALL, R CLIFFORD	7RETD	AFRE
HALL, WAYNE C	1DNRL	AFRA
HALLER, HERBERT L	7RETD	AFRA
HALLER, WOLFGANG	1CNBS	AFRA
HAMBLETON, EDSON J	7RETD	AFRA
HAMER, WALTER J	1CNBS	AFRA
HAND, CADET H JR	8NRNC	AFNA
HANSEN, IRA B	2HGWU	AFRA

HARRISON, WILLIAM N	7RETD	AFRA
HARVALIK, Z V	1DAER	AFRA
HARWOOD, PAUL D	8NRNC	AFNA
HASKINS, CARYL P	3ICIW	AFRA
HAUPTMAN, HERBERT	1DNRL	AFRA
HAZLETON, LLOYD W	5HALA	AFRA
HUBBARD, DONALD	7RETD	AFRA
HUNT, W HAWARD	1AMRP	AMRA
HUNTER, RICHARD S	5HUAS	AFRA
HUNTER, WILLIAM R	1DNRL	AFRA
HUTTON, GEORGE L	1DNBY	AFRA
HEINZE, PETER H	1ARMR	AFRA
HENLEY, ROBERT R	7RETD	AFRE
HERMAN, CARLTON M	1IFWS	AFRA
HEYDEN, FRANCIS J	2HGEU	AFRA
HOBBS, ROBERT B	1CNBS	AFRA
HOERING, THOMAS C	3IGEL	AFRA
HOLMES, FRANK H	7RETD	AMRA
HOLSHOUSER, WILLIAM L	1XCAB	AFRA
HOOVER, JOHN I	1DNRL	AFRA
HORTON, BILLY M	1DAHD	AFRA
HOUGH, FLOYD W	7RETD	AFNA
HIATT, CASPAR W	1HNIH	AFRA
HICKOX, GEORGE H	8NRNC	AFNA
HICKS, GRADY T	1DNRL	AMRA
HILDEBRAND, EARL M	1ARFR	AMRA
HILL, FREEMAN K	3IAPL	AFRA
INSLEY, HERBERT	4CONS	AFRA
IRWIN, GEORGE R	1DNRL	AFRA
JAY, GEORGE E JR	5MIAS	AFRA
JUDSON, LEWIS V	7RETD	AFNE
JENKINS, ANNA E	7RETD	AFNE
JESSUP, RALPH S	7RETD	AFRA
JOHANNESEN, ROLF B	1CNBS	AFRA
JOHNSON, PHYLLIS T	8NRNC	AFNA
JOYCE, J WALLACE	1SX	AFRA
KABISCH, WILLIAM T	3AAAS	AMRA
KARLE, ISABELLA	1DNRL	AFRA
KARRER, SEBASTIAN	7RETD	AFRA
KULLERUD, GUNNAR	3IGEL	AFRA
KNAPP, DAVID G	1CCGS	AFRA
KEEGAN, HARRY J	1CNBS	AFRA
KELLUM, LEWIS B	8NRNC	AFNA
KENK, ROMAN	1XLIC	AFRA
KENNARD, RALPH B	7RETD	AFRE
KENNEDY, E R	2HCUA	AFRA
KOHLER, HANS W	1DAHD	AFRA
KOTTER, F RALPH	1CNBS	AFRA
KREITLOW, KERMIT W	1ARFR	AFRA
KIES, JOSEPH A	1DNRL	AFRA
KIESS, CARL C	2HGEU	AFRA
LAMBERT, EDMUND B	1ARFR	AFRA
LARRIMER, WALTER H	3INAS	AFRA
LASHOF, THEODORE W	1CNBS	AFRA
LEIGHTY, CLYDE E	7RETD	AFRE
LINNENBOM, VICTOR J	1DNRL	AFRA
MAC DONALD, WILLIAM M	2HUMD	AFRA
MAENGWYN-DAVIES, G D	2HGEU	AFRA
MANNING, JOHN R	1CNBS	AFRA
MARTIN, JOHN H	7RETD	AFRA
MARVIN, ROBERT S	1CNBS	AFRA
MARYOTT, ARTHUR A	1CNBS	AFRA
MATLACK, MARION B	7RETD	AFRE
MAY, IRVING	1IGES	AFRA
MAYOR, JOHN R	3AAAS	AFRA
MAZUR, JACOB	1CNBS	AFRA
MC CABE, LOUIS C	5RERS	AFRA
MC CLELLAN, WILBUR D	1ARFR	AFRA
MC CULLOUGH, NORMAN B	1HNIH	AFRA
MC ELHINNEY, JOHN	1DNRL	AFRA
MC INTOSH, ALLEN	7RETD	AFRA
MC KINNEY, HAROLD H	7RETD	AFRE
MC KOWN, BARRETT L	2SPGC	AMRA
MC PHEE, HUGH C	7RETD	AFRE
MC PHERSON, ARCHIBALD	4X	AFRA
MEGGERS, WILLIAM F	4CONS	AFRA
MERRIAM, CARROLL F	7RETD	AFNA
MEYERHOFF, HOWARD A	8NRNC	AFNA

MOORE, GEORGE A	1CNBS	AFRA
MORAN, FREDERICK A	1XMDG	AMRA
MYERS, ALFRED T	1IGES	AFNA
MYERS, WILLIAM H	1DNOD	AMRA
MIDER, G BURROUGHS	1HNIH	AFRA
MILLER, CARL F	1XSMI	AFRA
MILLER, ROMAN R	1DNRL	AFRA
MILLIKEN, LEWIS T	1CNBS	AMRA
MITCHELL, J MURRAY JR	1CWEB	AFRA
NELSON, R H	3AESA	AFRA
NEUENDORFFER, J A	1DNX	AFRA
NICKERSON, DOROTHY	4CONS	AFRA
NIKIFOROFF, C C	7RETD	AFRE
OVERTON, WILLIAM C JR	8NRNC	AFNA
OWENS, HOWARD B	2SPGC	AFRA
OWENS, JAMES P	1IGES	AFRA
ORDWAY, FRED D JR	5MELP	AFRA
PAGE, BENJAMIN L	7RETD	AFRE
PAGE, CHESTER H	1CNBS	AFRA
PARSONS, DOUGLAS E	4CONS	AFRE
PATTERSON, WILBUR I	1ARNI	AFRA
PUTNINS, PAUL H	1CWEB	AFRA
POMMER, ALFRED M	1ARNI	AFRA
POOS, FRED W	7RETD	AFRA
PORTER, B A	7RETD	AFRA
PRO, MAYNARD J	1TIRS	AFRA
RANDS, ROBERT D	7RETD	AFNE
RAPPLEYE, HOWARD S	7RETD	AFRA
RAUSCH, ROBERT	1HPHS	AFNA
RUFF, ARTHUR W JR	1CNBS	AFRA
RUSSELL, LOUISE M	1ARFR	AFRA
REED, WILLIAM D	7RETD	AFRA
REHDER, HARALD A	1XSMI	AFRA
REICHELDERFER, F W	4CONS	AFRA
REINHART, FRANK W	4CONS	AFRA
REYNOLDS, HELEN L	1HFDA	AMRA
ROBBINS, MARY L	2HGWU	AFRA
ROBERTS, ELLIOTT B	4CONS	AFRE
ROBERTS, RICHARD C	1DNOL	AFRA
ROBERTSON, A F	1CNBS	AFRA
ROBERTSON, RANDAL M	1XNSF	AFRA
RODRIGUEZ, RAUL	1DAER	AFRA
ROLLER, PAUL S	5LIPR	AFRA
ROTH, FRANK L	7RETD	AFNE
RYERSON, KNOWLES A	7RETD	AFNA
RICE, FREDERICK A H	2HAMU	AFRA
RICHMOND, JOSEPH C	1CNBS	AFRA
RICKER, PERCY L	7RETD	AFRE
RINEHART, JOHN S	1CX	AFRA
SALISBURY, LLOYD L	1DAWR	AMRA
SANDOZ, GEORGE	1DNRL	AFRA
SARLES, MERRITT P	2HCUA	AFRA
SAVILLE, THORNDIKE JR	1DACE	AFRA
SLACK, LEWIS	3INAS	AFRA
STAIR, RALPH	1CNBS	AFRA
SLAWSKY, MILTON M	1DFOS	AFRA
STEVENS, HENRY	1ARNI	AFRA
STEVENSON, FREDERICK J	4CONS	AFRA
STEWART, DEWEY	1ARFR	AFRA
STEWART, T DALE	1XSMI	AFRA
SCHOENING, HARRY W	7RETD	AFRA
SCHOOLEY, ALLEN H	1DNRL	AFRA
SCHUBAUER, GALEN B	1CNBS	AFRA
STIEHLER, ROBERT D	1CNBS	AFRA
STILLER, BERTRAM	1DNRL	AFRA
STIMSON, HAROLD F	7RETD	AFRE
STIRLING, MATHEW W	7RETD	AFRA
SCOTT, ARNOLD H	1CNBS	AFRA
SCOTT, DAVID B	8NRNC	AFNA
STRINGFIELD, VICTOR T	1IGES	AFRA
SMITH, NATHAN R	7RETD	AFNE
SMITH, PAUL A	5RACO	AFRA
SUTCLIFFE, WALTER D	7RETD	AFRE
SNAVELY, BENJAMIN L	1DNOL	AFRA
SNAY, HANS G	1DNOL	AFRA
SEEGER, RAYMOND J	1XNSF	AFRA
SERVICE, JERRY H	7RETD	AFNE
SETZLER, FRANK M	7RETD	AFNE

SWICK, CLARENCE H	7RETD	AFRA
SWINDELLS, JAMES F	1CNBS	AFRA
SPECHT, HEINZ	1HNIH	AFRA
SPENCER, J T	1XNSF	AFRA
SPENCER, LEWIS V	1CNBS	AFNA
SHAPOVALOV, MICHAEL	7RETD	AFNE
SHERLIN, GROVER C	1CNBS	AMRA
SHIMER, H W	7RETD	AFNE
SHORB, MARY S	2HUMD	AFRA
SHROPSHIRE, WALTER A	1XSMI	AMRA
SILSBEE, FRANCIS B	7RETD	AFRA
SIMMONS, JOHN A	1CNBS	AFRA
SITTERLY, CHARLOTTE M	1CNBS	AFRA
TALBOTT, F LEO	2HCUA	AFRA
TALMADGE, HARVEY G JR	1DNRL	AMRA
TAYLOR, JOHN K	1CNBS	AFRA
TEELE, RAY P	1CNBS	AFRA
TODD, MARGARET R	1IGES	AFRA
TORGESEN, JOHN L	1CNBS	AFRA
TORRESON, OSCAR W	7RETD	AFRE
THURMAN, ERNESTINE B	1HNIH	AFNA
TREXLER, JAMES H	1DNRL	AFRA
TILDEN, EVELYN B	7RETD	AFNE
TITUS, HARRY W	4X	AFNA
TRYON, MAX	1CNBS	AFRA
VAN EVERA, BENJAMIN D	2HGWU	AFRA
VANGELI, MARIO G	8NRNC	AMRA
VOLWILER, ERNEST H	7RETD	AFNA
VON HIPPEL, ARTHUR	1DNRL	AFRA
VIGNESS, IRWIN	1DNRL	AFRA
VINAL, GEORGE W	7RETD	AFNE
VINTI, JOHN P	1CNBS	AFRA
WACHTMAN, JOHN B JR	1CNBS	AFRA
WALKER, RONALD E	3IAFL	AFRA
WALLEN, IRVIN E	1XSMI	AFRA
WALTER, DEAN I	1DNRL	AFRA
WALTHER, CARL H	2HGWU	AFRA
WALTON, GEORGE P	7RETD	AFRE
WARGA, MARY E	3AOSA	AFRA
WATERMAN, PETER	1DNRL	AFRA
WATTS, CHESTER B	7RETD	AFRA
WEBB, ROBERT W	7RETD	AFRA
WEIDLEIN, EDWARD R	8NRNC	AFNE
WEIHE, WERNER K	1DAER	AFRA
WEIR, CHARLES E	1CNBS	AFRA
WEISS, FRANCIS J	1XLIC	AFRA
WENSCH, GLEN W	1XAEC	AFRA
WETMORE, ALEXANDER	1XSMI	AFRA
WOLFF, EDWARD A	5AEGE	AFRA
WOLICKI, ELIGIUS A	1DNRL	AFRA
WOODS, MARK W	1HNIH	AFRA
WORKMAN, WILLIAM G	4CONS	AFRE
WHEELER, WILLIS H	1ARRP	AMRA
WHERRY, EDGAR T	7RETD	AFNE
WHITTAKER, COLIN W	7RETD	AFRA
WHITTEN, CHARLES A	1CCGS	AFRA
WYMAN, LEROY L	1CNBS	AFRA
WRENCH, CONSTANCE P	2SMOC	AMRA
WRENCH, JOHN W JR	1DNDT	AFRA
WILDHACK, WILLIAM A	1CNBS	AFRA
WILLIAMS, DONALD H	3ADIS	AMRA
WILSON, BRUCE L	1CNBS	AFRA
WILSON, RAYMOND E	8NRNC	AFNA
WILSON, WILLIAM K	1CNBS	AFRA
WINSTON, JAY S	1CWEB	AFRA
YUILL, JOSEPH S	1AFOR	AFRA
YOUDEN, WILLIAM J	2HGWU	AFRA
YOUNG, ROBERT T JR	1DAHD	AFRA
ZELENY, LAWRENCE	1AMRP	AFRA
ZWANZIG, ROBERT W	1CNBS	AFRA
ZIES, EMANUEL G	7RETD	AFRE

2H GEOLOGICAL SOCIETY OF WASHINGTON

ABELSON, PHILIP H	3IGEL	AFRA
ADAMS, LEASON H	4CONS	AFNE
BAKER, ARTHUR A	1IGES	AFRA
BATEMAN, ALAN M	4CONS	AFNE
BENNETT, ROBERT R	1IGES	AFRA
BOUTWELL, JOHN M	4CONS	AFNA
CARDER, DEAN S	1CCGS	AFNA
CARRON, MAXWELL K	1IGES	AFRA
COOKE, C WYTHE	7RETD	AFRE
COOPER, G ARTHUR	1XSMI	AFRA
CURRIER, LOUIS W	4CONS	AFRE
CUTTITTA, FRANK	1IGES	AFRA
DANE, CARLE H	1IGES	AFRA
DAVIS, WATSON	3ISCS	AFRA
DUNCAN, HELEN M	1IGES	AFRA
FAHEY, JOSEPH J	1IGES	AFRA
FAUST, GEORGE T	1IGES	AFRA
FOURNIER, ROBERT O	8NRNC	AFNA
GAZIN, CHARLES L	1XSMI	AFRA
GLASS, JEWELL J	1IGES	AFRA
HENDERSON, E P	1XSMI	AFRA
HOERING, THOMAS C	3IGEL	AFRA
HOOKER, MARJORIE	1IGES	AFRA
INSLEY, HERBERT	4CONS	AFRA
KNOPF, ELEANORA B	8NRNC	AFNE
LAKIN, HUBERT W	1IGES	AFNA
LOVE, S KENNETH	1IGES	AFRA
MAGIN, GEORGE B JR	1XAEC	AFRA
MAY, IRVING	1IGES	AFRA
MC CABE, WILLIAM J	1XFPC	AMRA
MC KELVEY, VINCENT E	1IGES	AFRA
MC KNIGHT, EDWIN T	1IGES	AFRA
MEYERHOFF, HOWARD A	8NRNC	AFNA
MILLER, J CHARLES	7RETD	AFNA
MILLIKEN, LEWIS T	1CNBS	AMRA
MISER, HUGH D	1IGES	AFRE
NAESER, CHARLES R	2HGWU	AFRA
NIKIFOROFF, C C	7RETD	AFRE
OWENS, JAMES P	1IGES	AFRA
PECORA, WILLIAM T	1IGES	AFRA
PHAIR, GEORGE	1IGES	AFRA
POMMER, ALFRED M	1ARNI	AFRA
ROEDDER, EDWIN	1IGES	AFRA
ROMNEY, CARL F	1DFX	AFRA
RUBEY, WILLIAM W	8NRNC	AFNA
RUBIN, MEYER	1IGES	AFRA
SCHALLER, WALDEMAR T	1IGES	AFRE
SMITH, PAUL A	5RACO	AFRA
SPICER, H CECIL	7RETD	AFNE
SPOONER, CHARLES S JR	5RAYC	AFRA
STRINGFIELD, VICTOR T	1IGES	AFRA
THAYER, THOMAS P	1IGES	AFRA
TODD, MARGARET R	1IGES	AFRA
TOULMIN, PRIESTLEY	1IGES	AFRA
TUNELL, GEORGE	8NRNC	AFNA
UMPLEBY, JOSEPH B	7RETD	AFNE
YODER, HATTEN S JR	3IGEL	AFRA
ZEN, E-AN	1IGES	AFRA
ZIES, EMANUEL G	7RETD	AFRE

2I MEDICAL SOCIETY OF THE DIST OF COL

BERNTON, HARRY S	4PHYS	AFRA
BROWN, THOMAS M	2HGWU	AFRA
BURKE, FREDERIC G	4PHYS	AFRA
GANT, JAMES Q JR	4PHYS	AMRA
MC CULLOUGH, NORMAN B	1HNIH	AFRA
RIOCH, DAVID M	1DAWR	AFRA
ROSE, JOHN C	2HGEU	AFRA
SHANNON, JAMES A	1HNIH	AFRA
TIDBALL, CHARLES S	2HGWU	AFRA
WORKMAN, WILLIAM G	4CONS	AFRE

2J COLUMBIA HISTORICAL SOCIETY

CARMICHAEL, LEONARD	3INGS	AFRA
GRANT, ULYSSES S III	7RETD	AFRA
GROSVENOR, GILBERT H	7RETD	AFRA

2K BOTANICAL SOCIETY OF WASHINGTON

ADAMS, CAROLINE L	2HGWU	AMRA
AMES, LAWRENCE M	2HAMU	AFRA
BAMFORD, RONALD	2HUMD	AFRA
BARSS, HOWARD P	7RETD	AFNE
BENJAMIN, CHESTER R	1ARFR	AFRA

BORTHWICK, HARRY A	1ARFR	AFRA
BOWMAN, PAUL W	1HNIH	AFRA
BROWN, EDGAR	7RETD	AFRE
BROWN, RUSSELL G	2HUMD	AFRA
CASH, EDITH K	7RETD	AFRE
CHAPLINE, W R	7RETD	AFRE
COOK, HAROLD T	1ARMR	AFRA
COOK, ROBERT C	5PORB	AFRA
COONS, GEORGE H	7RETD	AFRE
CULLINAN, FRANK P	7RETD	AFRE
DERMEN, HAIG E	1ARFR	AFRA
DETWILER, SAMUEL B	7RETD	AFRA
DIEHL, WILLIAM W	7RETD	AFRE
DRECHSLER, CHARLES	1ARFR	AFRA
DUTILLY, ARTHEME	2HCUA	AFRA
EGOLF, DONALD R	1ARFR	AFRA
ELLIOTT, CHARLOTTE	7RETD	AFNE
EMSWELLER, SAMUEL L	1ARFR	AFRA
GALLOWAY, RAYMOND A	2HUMD	AFRA
GRAVATT, G FLIPPO	7RETD	AFRE
HACSKAYLO, EDWARD	1AFOR	AFRA
HAMMOND, H DAVID	2HHOU	AMRA
HEINZE, PETER H	1ARMR	AFRA
HILDEBRAND, EARL M	1ARFR	AMRA
HOCHWALD, FRITZ G	9CLUN	AMRA
HUTCHINS, LEE M	8NRNC	AFNA
JENKINS, ANNA E	7RETD	AFNE
KRAUSS, ROBERT W	2HUMD	AFRA
LAMBERT, EDMUND B	1ARFR	AFRA
LE CLERG, ERWIN L	7RETD	AFRA
LEIGHTY, CLYDE E	7RETD	AFRE
LITTLE, ELBERT L JR	1AFOR	AFRA
LUTZ, JACOB M	1ARMR	AFRA
MARTIN, JOHN H	7RETD	AFRA
MC CLELLAN, WILBUR D	1ARFR	AFRA
MC KINNEY, HAROLD H	7RETD	AFRE
MILLER, PAUL R	1ARFR	AFRA
O BRIEN, JOHN A	2HCUA	AFRA
PARKER, KENNETH W	1AFOR	AFRA
PARKER, MARION W	1ARAO	AFRA
POLLOCK, BRUCE M	1ARFR	AFNA
POPE, MERRITT N	7RETD	AFNE
RANDS, ROBERT D	7RETD	AFNE
REID, MARY E	7RETD	AFRE
RICKER, PERCY L	7RETD	AFRE
RODENHISER, HERMAN A	1ARFR	AFRA
RYALL, A LLOYD	1ARMR	AFRA
SCHULTZ, EUGENE S	1ARFR	AFRE
SHROPSHIRE, WALTER A	1XSMI	AMRA
SMITH, NATHAN R	7RETD	AFNE
STEERE, RUSSELL L	1ARFR	AFRA
STEVENS, RUSSELL B	2HGWU	AFRA
STEVENSON, JOHN A	7RETD	AFRE
STEWART, DEWEY	1ARFR	AFRA
STUART, NEIL W	1ARFR	AFRA
TAYLOR, MARIE C	2HHOU	AMRA
THOMAS, CHARLES A	1ARFR	AMRA
WALKER, EGBERT H	7RETD	AFRA
WEINTRAUB, ROBERT L	2HGWU	AFRA
WEISS, FRANCIS J	1XLIC	AFRA
WHEELER, WILLIS H	1ARRP	AMRA
WILLIER, LILLIAN E	7RETD	AMRA
WOODS, MARK W	1HNIH	AFRA
YOCUM, L EDWIN	7RETD	AFNE

2L SOCIETY OF AMERICAN FORESTERS

CHAPLINE, W R	7RETD	AFRE
DETWILER, SAMUEL B	7RETD	AFRA
FIVAZ, ALFRED E	7RETD	AFRE
FOWELLS, HARRY A	1AFOR	AFRA
GRAVATT, G FLIPPO	7RETD	AFRE
HACSKAYLO, EDWARD	1AFOR	AFRA
HALL, R CLIFFORD	7RETD	AFRE
HOFFMAN, JOHN D	1CNBS	AFRA
HOPP, HENRY	1AFAS	AFNA
HUTCHINS, LEE M	8NRNC	AFNA
KINNEY, JAY P	7RETD	AFNE
LARRIMER, WALTER H	3INAS	AFRA
LITTLE, ELBERT L JR	1AFOR	AFRA
MORRISS, DONALD J	1AFOR	AFRA
PARKER, KENNETH W	1AFOR	AFRA
POPENOE, WILSON	7RETD	AFNE
ROBERTSON, RANDAL M	1XNSF	AFRA
ST GEORGE, RAYMOND A	7RETD	AFRA
STRINGFIELD, VICTOR T	1IGES	AFRA
YUILL, JOSEPH S	1AFOR	AFRA

2M WASHINGTON SOCIETY OF ENGINEERS

ASLAKSON, CARL I	4CONS	AFRA
BELSHEIM, ROBERT O	1DNRL	AFRA
BIBERSTEIN, FRANK A JR	2HCUA	AFRA
BRAATEN, NORMAN F	1CCGS	AFRA
CLAIRE, CHARLES N	7RETD	AFRA
CLEAVER, OSCAR P	1DAER	AFRA
DAVIS, WATSON	3ISCS	AFRA
DE VORE, CHARLES	1DNOR	AMRA
EDMUNDS, WADE M	3IJBS	AMRA
FIELDNER, ARNO C	7RETD	AFRA
GARNER, CLEMENT L	7RETD	AFRE
GILLMAN, JOSEPH L JR	4CONS	AFRA
KAUFMAN, H PAUL	4CONS	AFRA
MASON, MARTIN A	2HGWU	AFRA
MEBS, RUSSELL W	1CNBS	AFRA
RAPPLEYE, HOWAR^ S	7RETD	AFRA
RICHMOND, JOSEPH C	1CNBS	AFRA
SLAWSKY, MILTON M	1DFOS	AFRA
SMALL, JAMES B	1CCGS	AFRA
SUTCLIFFE, WALTER D	7RETD	AFRE
SWICK, CLARENCE H	7RETD	AFRA
WEBER, EUGENE W	1DAEX	AFRA

2N INST ELECTRICAL & ELECTRONICS ENGRS

ABRAHAM, GEORGE	1DNRL	AFRA
ALEXANDER, SAMUEL N	1CNBS	AFRA
APSTEIN, MAURICE	1DAHD	AFRA
ARSEM, COLLINS	1DAHD	AMRA
ASTIN, ALLEN V	1CNBS	AFRA
BARBROW, LOUIS E	1CNBS	AFRA
BOYLE, DON R	1CNBS	AMRA
BRADLEY, WILLIAM E	3IIDA	AMRA
CLEAVER, OSCAR P	1DAER	AFRA
COOTER, IRVIN L	1CNBS	AFRA
COSTRELL, LOUIS	1CNBS	AFRA
CRAFTON, PAUL A	2HGWU	AFRA
CURTIS, ROGER W	5WEEL	AFRA
DE VORE, CHARLES	1DNOR	AMRA
DEMUTH, HAL P	1CCGS	AMRA
DOCTOR, NORMAN J	1DAHD	AFRA
DYKE, EDWIN	5HOWR	AMRA
EDMUNDS, WADE M	3IJBS	AMRA
ELBOURN, ROBERT D	1CNBS	AFRA
FRANKLIN, PHILIP J	1CNBS	AFRA
GIBSON, JOHN E	1DNRL	AFRA
GRISAMORE, NELSON T	2HGWU	AFRA
GUARINO, P A	1DAHD	AFRA
HALL, WAYNE C	1DNRL	AFRA
HAMER, WALTER J	1CNBS	AFRA
HARRINGTON, MARSHALL C	1DFOS	AMRA
HARRIS, FOREST K	1CNBS	AFRA
HORTON, BILLY M	1DAHD	AFRA
HUNTOON, ROBERT D	1CNBS	AFRA
JORDAN, GARY B	8NRNC	AMNA
KALMUS, HENRY P	1DAHD	AFRA
KOHLER, HANS W	1DAHD	AFRA
KOTTER, F RALPH	1CNBS	AFRA
KULLBACK, SOLOMON	2HGWU	AFRA
LANDIS, PAUL E	1DAHD	AFRA
LIDDEL, URNER	1XNAS	AFRA
LINNENBOM, VICTOR J	1DNRL	AFRA
MASSEY, JOSEPH T	3IAPL	AFRA
MAYER, CORNELL H	1DNRL	AFRA
MC CLAIN, EDWARD F JR	1DNRL	AFRA
MC CLURE, FRANK J	1HNIH	AFRA
PAGE, CHESTER H	1CNBS	AFRA
PAGE, ROBERT M	1DNRL	AFRA
PARK, J HOWARD	8NRNC	AFNA

	PHILLIPS, MARCELLA L	4CONS	AFRA
	POLING, AUSTIN C	1CCGS	AFRA
	RABINOW, JACOB	5RBEN	AFRA
	RITT, PAUL E	5MELP	AFRA
	ROTKIN, ISRAEL	1DAHD	AFRA
	SALISBURY, LLOYD L	1DAWR	AMRA
	SCHOOLEY, ALLEN H	1DNRL	AFRA
	SCOTT, ARNOLD H	1CNBS	AFRA
	SHAPIRO, GUSTAVE	1CNBS	AFRA
	SHERLIN, GROVER C	1CNBS	AMRA
	SILSBEE, FRANCIS B	7RETD	AFRA
	SMITH, PAUL L	1DNRL	AFRA
	SMITH, SIDNEY T	1DNRL	AFRA
	SOMMER, HELMUT	1DAHD	AFRA
	STAIR, RALPH	1CNBS	AFRA
	TALMADGE, HARVEY G JR	1DNRL	AMRA
	VIGUE, KENNETH J	5ITTC	AMRA
	WATERMAN, PETER	1DNRL	AFRA
	WEBER, ROBERT S	1DNBY	AMRA
	WEIHE, WERNER K	1DAER	AFRA
	WITZIG, WARREN F	5NUUT	AMRA
	WOLFF, EDWARD A	5AEGE	AFRA
	YAPLEE, BENJAMIN S	1DNRL	AFRA
2O	AMERICAN SOCIETY OF MECH ENGINEERS		
	ALLEN, WILLIAM G	1CMAA	AFRA
	BEAN, HOWARD S	4CONS	AFRA
	BELSHEIM, ROBERT O	1DNRL	AFRA
	BUTLER, FRANCIS E	1DNOL	AMRA
	CRAFTON, PAUL A	2HGWU	AFRA
	DALZELL, R CARSON	1XAEC	AFRA
	DAVIS, STEPHEN S	2HHOU	AMRA
	DRYDEN, HUGH L	1XNAS	AFRA
	FULLMER, IRVIN H	1CNBS	AFRA
	GILLMAN, JOSEPH L JR	4CONS	AFRA
	MASON, MARTIN A	2HGWU	AFRA
	OSGOOD, WILLIAM R	2HCUA	AFRA
	PELL, WILLIAM H	1XNSF	AFRA
	RAMBERG, WALTER	1SX	AFNA
	RIVELLO, ROBERT M	2HUMD	AFRA
	STIEHLER, ROBERT D	1CNBS	AFRA
2P	HELMINTHOLOGICAL SOCIETY OF WASH		
	ANDREWS, JOHN S	1ARFR	AFRA
	BUHRER, EDNA M	7RETD	AFRA
	DOSS, MILDRED A	2HUMD	AFRA
	DURBIN, CHARLES G	1HFDA	AFRA
	FARR, MARION M	2HUMD	AFRA
	FOSTER, AUREL O	1ARFR	AFRA
	HARWOOD, PAUL D	8NRNC	AFNA
	HERMAN, CARLTON M	1IFWS	AFRA
	HUNTER, GEORGE W III	8NRNC	AFNE
	MC INTOSH, ALLEN	7RETD	AFRA
	MC MULLEN, DONALD B	1DAWR	AFRA
	MORRIS, J A	1HNIH	AMRA
	PRICE, E W	8NRNC	AFNE
	RAUSCH, ROBERT	1HPHS	AFNA
	REID, MARY E	7RETD	AFRE
	SARLES, MERRITT P	2HCUA	AFRA
	SCHWARTZ, BENJAMIN	7RETD	AFNE
	SHORB, DOYS A	1ARFR	AFRA
	TAYLOR, ALBERT L	1ARFR	AFNA
	TRAUB, ROBERT	2HUMD	AFRA
	TROMBA, FRANCIS G	1ARFR	AFRA
	TURNER, JAMES H	1HNIH	AFRA
	VON BRAND, THEODOR C	1HNIH	AFRA
2Q	AMERICAN SOCIETY FOR MICROBIOLOGY		
	ABELSON, PHILIP H	3IGEL	AFRA
	AFFRONTI, LEWIS	2HGWU	AMRA
	ALEXANDER, AARON D	1DAWR	AFRA
	ALLISON, FRANKLIN E	7RETD	AFRE
	AMES, BRUCE N	1HNIH	AFRA
	BARON, LOUIS S	1DAWR	AFRA
	BOZEMAN, F MARILYN	1DAWR	AFRA
	BREWER, CARL R	8NRNC	AFNA
	BURKEY, LLOYD A	7RETD	AFRE
	BYRNE, ROBERT J	1HNIH	AFRA
	CURRAN, HAROLD R	7RETD	AFRA
	DAWSON, ROY C	6FAOR	AFRA
	DEBORD, GEORGE G	7RETD	AFNE
	DOETSCH, RAYMOND N	2HUMD	AFRA
	EDDY, BERNICE E	1HNIH	AFRA
	EMMART, EMILY W	1HNIH	AFRA
	FABER, JOHN E	2HUMD	AFRA
	FUSILLO, MATTHEW H	1XVET	AMRA
	GORDON, FRANCIS B	1DNMR	AFRA
	GORDON, RUTH E	8NRNC	AFNA
	HAHN, FRED E	1DAWR	AFRA
	HAMPP, EDWARD G	1HNIH	AFRA
	HETRICK, FRANK	2HUMD	AMRA
	HIATT, CASPAR W	1HNIH	AFRA
	HILDEBRAND, EARL M	1ARFR	AMRA
	HUGH, RUDOLPH	2HGWU	AFRA
	KENNEDY, E R	2HCUA	AFRA
	LAMANNA, CARL	1DARO	AFRA
	LEY, HERBERT L JR	8NRNC	AFNA
	MC CULLOUGH, NORMAN B	1HNIH	AFRA
	MC KINNEY, HAROLD H	7RETD	AFRE
	MEANS, URA MAE	1ARFR	AMRA
	MOLLARI, MARIO	7RETD	AFRE
	MORRIS, J A	1HNIH	AMRA
	NOYES, HOWARD E	1DAWR	AFNA
	O HERN, ELIZABETH M	2HGWU	AMRA
	PARLETT, ROBERT C	2HGWU	AFRA
	PARR, LELAND W	7RETD	AFRE
	PELCZAR, MICHAEL J JR	2HUMD	AFRA
	PITTMAN, MARGARET	1HNIH	AFRA
	REYNOLDS, HOWARD	1ARNI	AFRA
	ROBBINS, MARY L	2HGWU	AFRA
	ROGERS, LORE A	7RETD	AFNE
	SHANAHAN, ARTHUR J	1XNSF	AFRA
	SHORB, MARY S	2HUMD	AFRA
	SLOCUM, GLENN G	1HFDA	AFRA
	SMITH, NATHAN R	7RETD	AFNE
	SULZBACHER, WILLIAM L	1ARNI	AFRA
	TITTSLER, RALPH P	1ARNI	AFRA
	WARD, THOMAS G	5MIAS	AFRA
	WEINTRAUB, ROBERT L	2HGWU	AFRA
	WEISS, FRANCIS J	1XLIC	AFRA
	WEISS, FREEMAN A	7RETD	AFNE
2R	SOCIETY OF AMER MILITARY ENGINEERS		
	AMIRIKIAN, ARSHAM	1DNBY	AFRA
	BRAATEN, NORMAN F	1CCGS	AFRA
	CLEAVER, OSCAR P	1DAER	AFRA
	DEMUTH, HAL P	1CCGS	AMRA
	GARNER, CLEMENT L	7RETD	AFRE
	GRANT, ULYSSES S III	7RETD	AFRA
	HASKINS, CARYL P	3ICIW	AFRA
	MEADE, BUFORD K	1CCGS	AFRA
	RAPPLEYE, HOWARD S	7RETD	AFRA
	REED, WILLIAM D	7RETD	AFRA
	RICE, DONALD A	1CCGS	AFRA
	ROBERTS, ELLIOTT B	4CONS	AFRE
	RODRIGUEZ, RAUL	1DAER	AFRA
	SIMMONS, LANSING G	1CCGS	AFRA
	SMALL, JAMES B	1CCGS	AFRA
	SUTCLIFFE, WALTER D	7RETD	AFRE
	THOMAS, PAUL D	1DNOC	AFRA
	WEBER, EUGENE W	1DAEX	AFRA
	WEBER, ROBERT S	1DNBY	AMRA
	WHITTEN, CHARLES A	1CCGS	AFRA
2S	AMERICAN SOCIETY OF CIVIL ENGINEERS		
	AMIRIKIAN, ARSHAM	1DNBY	AFRA
	BIBERSTEIN, FRANK A JR	2HCUA	AFRA
	CALDWELL, JOSEPH M	1DACE	AFRA
	DOWNING, LEWIS K	2HHOU	AFRA
	GRANT, ULYSSES S III	7RETD	AFRA
	HICKLEY, THOMAS J	1CCGS	AFRA
	HINMAN, WILBUR S JR	4CONS	AFRA
	HOWARD, GEORGE W	1DAER	AFRA
	KOHLER, MAX A	1CWEB	AFRA
	MASON, MARTIN A	2HGWU	AFRA
	PARSONS, DOUGLAS E	4CONS	AFRE

RAPPLEYE, HOWARD S	7RETD	AFRA
ROBERTS, ELLIOTT B	4CONS	AFRE
SAVILLE, THORNDIKE JR	1DACE	AFRA
SIMMONS, LANSING G	1CCGS	AFRA
SMITH, PAUL A	5RACO	AFRA
TREXLER, JAMES H	1DNRL	AFRA
WALTHER, CARL H	2HGWU	AFRA
WEBER, EUGENE W	1DAEX	AFRA

2T SOC EXPERIMENTAL BIOLOGY & MEDICINE

AFFRONTI, LEWIS	2HGWU	AMRA
ALEXANDER, AARON D	1DAWR	AFRA
AMES, BRUCE N	1HNIH	AFRA
ARMSTRONG, CHARLES	7RETD	AFRE
BARRETT, MARGARET D	1HNIH	AFRA
BARRETT, MORRIS K	7RETD	AFRA
BARTONE, JOHN C	2HGWU	AMRA
BERLINER, ROBERT W	1HNIH	AFRA
BEROZA, MORTON S	1ARFR	AFRA
BOZEMAN, F MARILYN	1DAWR	AFRA
BRODIE, BERNARD B	1HNIH	AFRA
BURK, DEAN	1HNIH	AFRA
BYERLY, THEODORE C	1ACSR	AFRA
CARMICHAEL, LEONARD	3INGS	AFRA
CHALKLEY, HAROLD W	7RETD	AFRE
COULSON, E JACK	1ARNI	AFRA
DAFT, FLOYD S	7RETD	AFRA
DAVIS, R F	2HUMD	AFRA
EDDY, BERNICE E	1HNIH	AFRA
EDDY, NATHAN B	4CONS	AFRA
ELLIS, NED R	7RETD	AFRE
EMMART, EMILY W	1HNIH	AFRA
ENDICOTT, KENNETH M	1HNIH	AFRA
FELSENFELD, OSCAR	8NRNC	AMNA
FOX, M R SPIVEY	1HFDA	AFRA
FRAPS, RICHARD M	1ARFR	AFRA
FRIEDMAN, LEO	8NRNC	AFNA
GORDON, FRANCIS B	1DNMR	AFRA
GRAY, IRVING	2HGEU	AFRA
HALSTEAD, BRUCE W	8NRNC	AFNA
HAZLETON, LLOYD W	5HALA	AFRA
HERMAN, CARLTON M	1IFWS	AFRA
HIATT, CASPAR W	1HNIH	AFRA
HOWE, PAUL E	4CONS	AFRA
HUGH, RUDOLPH	2HGWU	AFRA
JUHN, MARY	7RETD	AFRA
KNOBLOCK, EDWARD C	1DAWR	AFRA
KNOWLTON, KATHRYN	7RETD	AFRA
KOPPANYI, THEODORE	2HGEU	AFRA
LAMANNA, CARL	1DARO	AFRA
MAENGWYN-DAVIES, G D	2HGEU	AFRA
MANDEL, H GEORGE	2HGWU	AFRA
MC CLURE, FRANK J	1HNIH	AFRA
MOSTOFI, F K	1D-IP	AFRA
NOYES, HOWARD E	1DAWR	AFNA
PATTERSON, WILBUR I	1ARNI	AFRA
PITTMAN, MARGARET	1HNIH	AFRA
POMMER, ALFRED M	1ARNI	AFRA
RALL, DAVID P	1HNIH	AFRA
ROBBINS, MARY L	2HGWU	AFRA
ROSE, JOHN C	2HGEU	AFRA
SCHOENING, HARRY W	7RETD	AFRA
SHORB, MARY S	2HUMD	AFRA
SMITH, FALCONER	2HAMU	AFRA
SMITH, WILLIE W	1HNIH	AFRA
SPECHT, HEINZ	1HNIH	AFRA
SPIES, JOSEPH R	1ARNI	AFRA
STEVENS, HENRY	1ARNI	AFRA
STEWART, SARAH E	1HNIH	AFRA
TIDBALL, CHARLES S	2HGWU	AFRA
TRAUB, ROBERT	2HUMD	AFRA
TREADWELL, CARLETON R	2HGWU	AFRA
VEITCH, FLETCHER P JR	2HUMD	AFRA
VON BRAND, THEODOR C	1HNIH	AFRA
WARD, THOMAS G	5MIAS	AFRA
WOMACK, MADELYN	1ARNI	AFRA
WOODS, MARK W	1HNIH	AFRA

2U AMERICAN SOCIETY FOR METALS

ACHTER, MEYER R	1DNRL	AFRA
BENNETT, JOHN A	1CNBS	AFRA
BENNETT, LAWRENCE H	1CNBS	AFRA
BROWN, B F	1DNRL	AFRA
BURNETT, HARRY C	1CNBS	AFRA
CAUL, HAROLD J	1CNBS	AFRA
CHAPIN, EDWARD J	1DNRL	AFRA
DALZELL, R CARSON	1XAEC	AFRA
DE PUE, LELAND A	1DNRL	AFRA
DIGGES, THOMAS G	7RETD	AFRE
ELLINGER, GEORGE A	1CNBS	AFRA
GEIL, GLENN W	1CNBS	AFRA
GILLMAN, JOSEPH L JR	4CONS	AFRA
HARRISON, WILLIAM N	7RETD	AFRA
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The Menace of Methuselah: Possible Consequences of Increased Life Expectancy*

Kenneth E. Boulding

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In the past ten years we have been witnessing an extraordinary explosion of biological knowledge. It seems not unreasonable to suppose, indeed, that in the field of biology we are now in the position corresponding to where we were in the field of nuclear energy in about 1900. We know that life has a code; we know that the building up of the body or the phenotype of various living organisms is done by information carriers; and we have a pretty fair idea what the code is. If past experience is any guide, this information should begin to result in profound practical results in a couple of generations. In 1900, we knew that nuclear energy existed, but we did not have the slightest idea as to how to tap it. Today we can almost say that we know the code of life; we just don't know how to write it. The possibility, however, of quite radical changes in our control over biological processes is something which every student of the future has to take into account.

One of the greatest mysteries of biological systems is aging. In the short run, the biological system is an open system, in von Bertalanffy's sense. That is, it consists of a structure which we might almost describe as a role structure, the role occupants of which are constantly changing. In the body of any organism, the particular atoms which comprise the body are continually changing; the structure, however, remains much the same, just as in a flame the atoms are continually moving from one zone to the other but the zones remain constant.

Flames do not age. They go out when they have no more fuel or when the environment is disturbed; but if fuel and oxygen are continually provided, there is no reason why a flame should not last forever. The flame, indeed, in many cultures has been a symbol of immortality. The body is likewise an open system, but it seems to have certain irreversible processes at work in it, which eventually change the nature of the system. Part of these processes are the processes of growth, the element in the biological organism which assures that we do not simply maintain the open system of the baby, but change this gradually to the adult. We really understand very little about this. It may be the same growth process that produces aging, which is a kind of negative growth, or it may be quite a different process. All we seem to have at the moment is a few speculations regarding the accumulation by irreversible processes of certain substances in the body, but at present we certainly don't know enough about aging to do anything about it. If indeed, however, as one suspects is the case, aging is built into the organism by its genetic information system, the possibilities of intercepting this information and changing it seem to open

* An address before the Washington Academy of Sciences on March 18, 1965.

up, even though the techniques of doing this are as inconceivable today as the techniques of nuclear energy were in 1900. It may be, of course, that this is a pipe dream, that some fatal Heisenberg Principle will be discovered which will deprive us of the opportunity of putting new information into the system; but at the moment, at any rate, there seems to be no nonexistence theorem to this effect, and the possibility of the discovery of the Fountain of Youth is perhaps just around the corner.

If the aging process were really understood and controlled, this would open up the possibility of an almost indefinite expansion of the human life span. Up to the present, all improvement in medicine has only enabled more people to live to be aged. The probability of living to be seventy is much greater today than it was a hundred years ago; the probability of living to be a hundred is no greater at all, and may even be less. Once we crack the aging barrier, however, there seems to be no reason why the process should not be slowed down indefinitely, and why man should not remain in full vigor for centuries. Bernard Shaw, with the uncanny insight of the artist, foreshadowed something like this in his "Back to Methuselah," though the methods which he proposed were more akin to Christian Science than to modern biology.

One caution must be added here, against undue hopes of immortality. Old age is by no means the only cause of death, and even though we have had remarkable success in eliminating causes of death in the young, we have not eliminated them completely. A particularly intractable cause of death which is not closely related to age is accidents; and even if we eliminated all causes of death except this, the existence of an accident rate would prevent the expectation of life from shooting off toward infinity. Indeed, at the present accident rate, even if all other causes of death were removed, the average expectation of life would probably not rise much above two or three hundred years. Even this relatively modest extension, however, as we shall see, would create an enormous crisis.

All this, of course, is science fiction. In these days, however, one seems to have to read science fiction in order to keep up with the news. What is certain is that any major extension of the span of active human life would create a crisis for the human race almost beyond imagining. Even if there is the slightest possibility of such an event, we should begin to think about it now and to prepare ourselves for the totally new, wonderful, and terrifying world which this possibility opens up. What I am trying to do in this paper is little more than social science fiction. Our knowledge of social systems is still fairly primitive, and our knowledge of any system whatever beyond the limits of the variables which we have experienced is precarious. We do know enough about social systems, however, to be able to make at least speculative projections of these extreme values.

The essential problem arises because society has an age-specific role structure, and if the age distribution of the population does not correspond to the role structure, various tensions and difficulties arise. There is one role for the new-born baby, another for the ten-year-old, another for the teenager, another for the college student, another for the person of middle age, another for the aged. This is true of occupational roles; we do not expect a teenager to be a college president, or a grandfather to be an office boy. Age specificity is even more important in other roles. The five-year-old is most unlikely to be a parent, and it is a rare woman who gives birth to a child after the age of sixty. We expect children to play hopscotch; we do not expect elderly bankers to do the same. The one item of information which tells us more about anybody than anything else is the date of his birth. The age specificity of roles is not, of course, absolute. There is a certain amount of flexibility. Occasionally we find a man of thirty becoming a college president, or a child prodigy giving a concert, or a man of eighty becoming a father. For each role in society we may have perhaps a ten-year margin in regard to the age that can occupy it. Even when all allowance is made for this flexibility, however, the age specificity of roles is a limiting factor of enormous importance.

We are perceiving at the moment, especially in the tropical countries, a little foretaste of what a major upset in age distribution can bring about. In large parts of the tropical world, there was a drastic decline in infant mortality in the years around 1950, due mainly to the introduction of chemical insecticides and the subsequent control of malaria. In some countries in less than two years the infant death rate was halved. As a result we now find in many countries enormous cohorts of teenagers, almost twice as many as their somewhat elder brothers and sisters. The impact of this is only beginning to be felt in urban unemployment, juvenile delinquency, and the general disruption of these societies, and this is something which is likely to increase and become a world-wide problem in the next ten years, as these youngsters enter the labor market. The effects on traditional societies are going to be particularly disruptive. If twice the usual number of teenagers are seeking to enter the role structure of a traditional society, it is hard to see how it can avoid being blown to pieces. Either half the teenagers will have to be driven out of it into the cities, or there will be widespread disruption and maladjustment.

At the other end of the scale, we find that even the increase in the number of the aged has created severe social problems. In the ancient world, old age was a respectable and honorable role, mainly because so few people survived to it, and scarcity gave value. In the modern world, where almost everyone survives into his seventies, the aged become of little value to society, they have no clear role, they become disorganized, they tend to be segregated, and old age begins to take on terrors which it did not have in an earlier society. I was struck when I was in Korea with the extraordinary serenity and beauty of the faces of the old people in the villages, by contrast with the anxiety, the striving after a false youthfulness, and the pathetic discontent of so many old people in our own society. In the traditional society, if you succeeded in living to be old, you had something to look forward to. In modern society it is so easy to live to be old that there is nothing much to look forward to, and this can easily have a disintegrating effect on the whole of life.

What might be called the traditional age-specific role structure in society has been developed over the course of human history to fit in with pre-scientific mortality tables. Even the relatively small changes in age distribution which have occurred in the present century have created severe problems. Imagine, then, the kind of problems which would be created if large numbers of people started to live to be a hundred and fifty or two hundred, or even five hundred. This would create a set of wholly unprecedented problems, simply because the age-specific role structure would be unable to adjust fast enough to correspond to the age distribution. It would create problems not only for the old but for the young, because of the fact that it is not the absolute age structure which matters so much as the relative age structure, that is, the proportion of people of different ages. In a society in which everyone lives to be seventy, the equilibrium proportion of children and young people up to adolescence is about a quarter of the total population. In a society in which everybody lives to be a hundred and eighty, this would fall to a tenth of the population. If we can imagine a society in which the average age of death is a thousand, only one percent of the population in equilibrium would be under the age of ten. Formal education, assuming that this ended in the twenties as it does now, would be a very small part of the total human enterprise, and it is almost inconceivable for us to imagine a set of age-specific roles which would correspond to such longevity.

On the positive side of the picture, one may point to the fact that while longevity would create enormous problems, it would also increase the power of the human race, one would hope, to deal with these problems. In terms of simple economics, economic development is impossible if the average age at death is below a certain figure, at a guess about thirty. Under these circumstances, half the population is under the age of fifteen, the working force is a small fraction of the population, and the sheer requirements of transmitting the culture from such a small adult population to such a large child population are so great that there is nothing left over for growth, development, and change. An absolutely necesary prerequisite for economic development is an increase in the average age at death, and one suspects that this was a major factor in the extraordinary and apparently irreversible development which followed the invention of agriculture and the domestication of plants and animals. The difference between the average age at death of Paleolithic and Neolithic man may not have been more than five or ten years, but this small margin was enough to insure that Paleolithic man, in effect, stagnated for an inconceivable length of time. The moment man entered the Neolithic, he began an irreversible and accelerating process of development, simply because he now lived long enough, thanks to more secure and adequate food supplies, so that he did not have to spend all his time and energy in simply transmitting his culture to the next generation. A substantial increase in longevity, such as we are contemplating here, would release even more resources for growth and development, assuming, of course, as I am doing throughout, that the increase in longevity is accomplished without any substantial impairment of the physical or mental powers.

Let us now take a brief glimpse at some of the organizations and institutions of society which are likely to be affected by a substantial increase in longevity—let us say, modestly, to two hundred years. The first of these is obviously the family. A substantial increase in longevity would correspondingly reduce the childbearing and child-raising function of the family. If the population is eventually to reach equilibrium, each couple will not be able to average much more than two children. One can imagine, therefore, a couple marrying, say, in the twenties, having all their children raised and independent by the time they are fifty, and then enjoying say a hundred and fifty years more of childless married life. It would be surprising if this did not produce some strains, especially if sexual activity remained unimpaired for most of this period. It would not be surprising to see the development of new forms of household arrangements, for instance joint families on the Oneida Community plan, or even a rise in monasticism, or perhaps a retreat to the desert and the hermits' caves. One certainly wonders what will happen to the sense of kinship, even with a stationary population. By the time a man gets to be two hundred, he will have quite a lot of descendants, and how interested he will remain in his great-great-great-great-great-grandchildren is a little hard to predict. The economics of the family certainly changes somewhat under this kind of structure. Inheritance will become a relatively unimportant aspect of income redistribution, and any great expectations will indeed be long deferred. Wages and salaries are likely to be the only form of income which will be adequate to support most persons, though the pattern of retirement on the death of one's parents would probably become the dominant model, as it would only be very late in life, say at about a hundred and seventy-five, that anything would be inherited.

The effect on other organizations, such as businesses, universities, or government departments, of a substantial increase in longevity, would be even more drastic than on the family. In the family, at least, the main difference in reorganization would be over fairly early, and after that the reaction would be optional. In the case of the organization, there is a much more age-specific role structure, with each level of the hierarchy corresponding roughly to a certain age group. It is even written in the American Constitution that the President must be over thirty-five. Because of the fact that income, status, and responsibility usually rise with age, an individual can make economic progress even if the society does not. The rate at which his income and status are likely to increase, however, depends on the age distribution. There are always fewer roles in the higher levels of a hierarchy than in the lower levels. If the mortality at each age was such that the number of survivors at each age group corresponded to the number of places in the hierarchy, everyone who survived would be automatically promoted, and those who don't survive presumably don't mind. Even the present decline in mortality in middle age has created real problems, as now there are far more individuals in each age group than there are positions in the hierarchy which correspond to the age group. If everybody lives to be seventy, there may be only one position at the top of the hierarchy which is appropriate for the age, and a very large number of frustrated and disappointed seventy-year-olds will be found at the lower levels.

An increase in longevity, to say two hundred, would accentuate this problem enormously. The average rate of rise of income and status is likely to be lower, the greater the average age at death. If the average age at death is two hundred, the rate of rise in income and status perhaps for the first hundred years of life will be almost negligible, and the prospect of being an assistant professor for a hundred and fifty years might daunt the most enthusiastic of academics. It is the propensity of the old, rich, and powerful to die that gives the young, poor, and powerless, hope. When death is postponed, so is promotion. This will unquestionably introduce enormous psychological strains, which might well threaten the functioning of large hierarchical organizations.

The effect on the educational system would not be confined to the general effect on organizations. Knowledge tends to grow at such a rate that a professor easily finds himself obsolete even in his fifties, and certainly the Ph.D. could hardly be regarded as a union card for university teaching for a hundred and seventy-five years, again assuming that intellectual vigor was unimpaired with age. The contrast between the distinguished and the undistinguished would be enormously accentuated. Imagine the universities today scrambling for Adam Smith and Ricardo, still in their prime at the age of two hundred or so.

In a society of Methuselahs, formal education would become a very small part of human activity. In some ways, this might be desirable. As scarcity develops value, the scarcity of children and young people would make them highly valuable to society, and a great deal would be put into their education. It would almost certainly happen, for instance, that formal education would be extended many years beyond what it is now. We might very well expect it to go on for forty or fifty years if the life span increased to two hundred. Whether this would really increase the competence of the human race is a nice point on which I would not venture an answer.

The impact on savings, insurance, pension plans, and indeed economic life in general would certainly be drastic. The consumption function in any society is highly dependent on the age distribution.

By and large, the young and the old consume more than they produce and those in middle life produce more than they consume. If the proportion, both of the young and of the unproductive old, is small, with the present psychology at least, the consumption function is likely to be very low. Unless, therefore, there are deliberate attempts to offset this in the form of government expenditures or budget deficits, there is very likely to be a chronic state of deficient demand and unemployment. A man who lives to be two hundred would be able to accumulate enormous amounts of capital by saving a relatively small proportion of his income each year. Suppose, for instance, he were saving on the usual kind of pension plan, by which he saved, say 10 percent of his income; and suppose his income averages $10,000 a year. In a working life of two hundred years, with interest at 5 percent, he would accumulate $358,000,000. Even if the rate of interest were only a modest 1 percent, he would still accumulate $145,000. If there were only a few Methuselahs in a society, and if they had an inclination towards thrift, it would not be long before they had gathered unto themselves most of the wealth of the economy. Indeed, this problem is not unknown. In the Middle Ages, the church and its constituent bodies operated as Methuselahs, a monastery, for instance, being theoretically immortal; and in many countries the church did in fact acquire so much of the wealth that it was eventually dispossessed. In Swift's wonderful chapter on the Struldbrugs in *Gulliver's Travels*, which is the first, and still the best, essay on this "copious and delightful" subject, as Swift calls it, he says, ". . . if it had been my good fortune to come into the world a *struldbrug*, as soon as I could discover my own happiness, by understanding the difference between life and death, I would first resolve, by all arts and methods whatever, to procure myself riches. In the pursuit of which, by thrift and management, I might reasonably expect, in about two hundred years, to be the wealthiest man in the kingdom." What would happen if all the other struldbrugs had the same ambition is not altogether clear.

The impact of longevity on saving and interest rates raises problems of economic motivation which have haunted economics for a long time. Let us take first a simple but quite unrealistic assumption, that a person saves during his working life in order to equalize his consumption in all the years of his life, including the years of retirement when he has no income. Let us suppose, then, that the individual has fifteen years of retirement without income. The following table shows what proportion of his income in each year of his working life he must save in order to provide for his retirement, leaving no net worth at the end, with various rates of interest. We see, for instance, that with a working life of fifty years at 5 percent per annum rate of interest, we need to save 4.7 percent of our income in order to provide for our old age. If the working life is 185 years, we need only save $1 in $10,000. Saving for old age, of course, is not the only motivation for saving, and indeed in an equilibrium population, saving of this kind would result in no net saving at all, as the dis-saving of the old would exactly offset the saving of those in middle life. However, the fact that in a population of Methuselahs a very large proportion of the population would in fact be in middle life and of working age means that in a market society it would be very easy to run into an under-consumption problem, and every effort would have to be made to diminish saving and see that people spent almost up to the hilt of their income.

The effect on interest rates is somewhat problematical, and indeed merely to pose the problem reveals the extraordinary deficiencies of economics in this respect. High interest rates are in a sense a subsidy for thrift, and in a world of Methuselahs, this subsidy could become very large at interest rates which are common today, as we see, for instance, by the fact that a difference in interest rates between 1 percent and 5 percent changes the lifetime accumulation of our decumulations, and inheritance. In the absence of any explicit model of the problem, however, we can only guess at the answer.

Table 1. Proportion of Income That Must be Saved to Provide for a Retirement Period of 15 Years

Rate of interest (% per annum)	0	1	2	3	4	5
Percentage income saved in working years:						
(1) Working life = 50 years	23.1	18.3	13.2	9.6	6.8	4.7
(2) Working life = 185 years	7.5	2.6	0.7	0.2	0.03	0.012

(Note: if n is the number of years lived after starting work, and s the number of years of retirement, n-s being the working life span, and i the rate of interest, the proportion of income saved in each year of working life, assuming constant income, is $a = [(1+i)^s - 1]/[(1+i)^n - 1]$.)

Methuselah above from a modest and reasonable $145,000 to an absurd $358,000,000. It seems almost certain that if the redistributional effects of different capacities for thrift and different inheritance patterns are not to be intolerable, rates of interest would have to fall at least to the neighborhood of 1 percent and below.

The impact of longevity on the distribution of property is again a problem of enormous interest, but one which at the moment economists seem to have no apparatus to solve. It is an astonishing tribute, indeed, to the extent to which we take the average length of human life for granted, that we never work it in as an explicit variable in our models. Death is like bankruptcy; it breaks up an existing *gestalt* of assets which are bound together by the person, and the component parts of a divided inheritance almost certainly do not grow as fast as the asset complex did before death broke it up, especially, of course, where the deceased himself was an important element in the asset complex. In a world of Methuselahs, this event would be much rarer, hence one suspects that there would be much less redistribution from the rich to the poor in the natural course of accumulations,

All these considerations suggest that longevity is likely to present a much more serious problem for a market economy than, for instance, automation presents, when it comes to maintaining full employment on the one hand and maintaining a distribution of property which is reasonably equitable on the other. It is by no means impossible that a serious extension of longevity would make market economies quite unmanageable and unstable and that the degree of centralized planning and control would have to increase. This might be all too acceptable to the Methuselahs themselves, if there were not too many of them, who would certainly be in an admirable position to dominate all the positions of power, both political and economic, in the society. This might lead either to a stable subordination for the non-Methuselahs, or there might be revolutions, and a certain equilibrium in the length of human life might assert itself through violence.

The short-run dynamic effects might be very different from the long-run, depending very much on how the increase in longevity came about. We might suppose, for instance, as the extreme case, that the treatment for longevity was very easy and could be given to everybody, so that almost literally, death would take a holiday for, say, a hundred or two hundred years. This would be a black day for the morticians. Furthermore, it would completely upset all existing contractual arrangements regarding pensions and annuities, which are calculated, of course, on what we think of as a normal life table. All existing pension plans would soon be bankrupted; old age and survivors' insurance would soon gobble up the whole national budget; and there would have to be a general moratorium on earlier contractual agreements. The problem could easily be solved, of course, by simply raising the age at which retirement began and pension benefits were paid. The sellers of life insurance, of course, would enjoy a corresponding capital gain, and this again would probably be adjusted by the renegotiation of contracts. While there would be many difficult technical problems involved in all this, there seems nothing in the nature of the case to make these problems insoluble.

If longevity is costly and can only be given to a few people, a political problem of some magnitude would almost certainly arise. Is longevity a civil right? Is it an economic good, to be appropriated by the wealthy? Is it to go to the politically deserving? Is it to be allocated according to some eugenic test? These are problems which we may be thankful we do not have to face at the moment. The only thing which I can think of which would make a greater political upset is weather control, which would almost certainly create political and legal problems quite beyond our ability to manage.

Finally, one wonders what longevity would do to the human condition and to the stock of knowledge, wisdom, and competence which is the most important stock of the human race. If we are to believe Bernard Shaw, we must go back to Methuselah before the human race can hope to better its condition, simply because, in the Pennsylvania Dutch proverb, we get "too soon oldt and too late schmardt." If we envisage the human organism growing in experience and knowledge while maintaining its health and vigor for much longer periods of time than it does now, the predictions of Bernard Shaw might come true. It is certainly true that death causes an enormous wastage and depreciation of human knowledge, which has to be replaced painfully and expensively in each generation. It is a somewhat frightening thought that the whole mass of human culture is totally lost every seventy years or thereabouts, and has to be replaced by education and experience in that period. This may easily put a very sharp limitation on the total amount of knowledge that the human race can acquire, unless there is indeed an increase in longevity.

On the other hand, we may easily run into the problem of the inhibiting effect of old knowledge on the acquisition of new. The unlearning that must often be done if new knowledge is to be acquired seems to be more difficult than the acquisition of the knowledge itself. The great virtue of the institution of death is that this is a way of unlearning, painfully drastic, but effective from the point of view of society. If, as Will Rogers is supposed to have said, "The trouble with people isn't what they don't know, it's what they do know that ain't so," the possibility of lifetimes of two hundred years—or more—applied in the acquisition of negative knowledge is a little frightening. Certainly the rate of social evolution might easily be slowed up rather than advanced by the possession of such an enormous dead weight of experience. It may be, of course, that along with the kinds of knowledge which will be necessary to produce genuine longevity we may also crack the problem of the obstacles to learning, and learning drugs may be as common as aspirin or DDT. Still, one shudders a little to contemplate the possibilities of organizational rigidity which might be introduced if there were no powerful people in a society under the age of two hundred. Under these circumstances, youth might easily despair of ever rising to positions of power, and would dissipate its freshness and energy in folly and riotous living.

At the other end of the scale, there is Swift's hideous vision of the Struldbrugs.* Suppose longevity did not go along with the increase of knowledge and wisdom, but with a slow and progressive moral and mental decay. Under these circumstances, of course, it is improbable that we would encourage it or permit it. Nevertheless, the taste for life is so strong that if life were for sale, many would unquestionably buy it. One can perhaps visualize the extreme case in which longevity passes into immortality. The church has promised immortality for a long time. It is probably fortunate, for it and for us, that the promise has been cashed only in hope. If you could have an operation for immortality, would you have it? How much would you pay for it? This frightening prospect now at least seems to be somewhere over the horizon. Under these circumstances, the business of departing from life would have to be a voluntary act, and we would at least begin to appreciate the enormous benefits which the institution of death has brought to mankind.

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* "They were the most mortifying sight I ever beheld; and the women were more horrible than the men. Besides the usual deformities in extreme old age, they acquired an additional ghastliness, in proportion to their number of years, which is not to be described; and among half a dozen I soon distinguished which was the eldest, although there was not about a century or two between them." Jonathan Swift, *Gulliver's Travels*, Part Three, Chapter X (page 213 of Pocket edition, New York, 1939).

ACHIEVEMENT AWARD NOMINATIONS REQUESTED

The Committee on Awards for Scientific Achievement has called attention to the Academy's annual scientific achievement awards program. Nominations for awards will be received at the Washington Academy of Sciences office, 1530 P St., N.W., until November 12.

Each year the Academy gives awards for outstanding achievement in each of five areas—biological sciences, engineering sciences, physical sciences, mathematics, and teaching of science (including mathematics). The 1965 winners of these awards will be honored at the annual dinner meeting of the Academy early in 1966. Academy fellows and members are invited to submit nominations for the awards, in accordance with the following procedures.

Eligibility. Candidates for the first four awards must have been born in 1926 or later; there is no age limit on the teaching of science award. All candidates must reside within a radius of 25 miles from the zero milestone behind the White House. It is not necessary that a candidate be a member of a society affiliated with the Washington Academy of Sciences.

Recommendation. Nomination forms can be obtained from the Academy office. Use of these forms is not mandatory, but the sponsor's recommendation should include the following: (a) General biography of candidate, including date of birth, residence address, academic experience with degrees and dates, and post-academic experience with particular detailed reference to work for which an award is recommended; (b) list of publications with reprints, particularly of that work for which recognition is suggested. If reprints are not available, complete references to publications must be included.

Citation. Particular attention should be given to preparation of a citation (80 typewriter spaces or less) which, in summary, states the candidate's specific accomplishments and which would be used in connection with presentation of award to the successful candidate.

Re-nomination. Former nominees may be re-nominated with or without additional evidence, provided sponsors make known their desires by letter to the general chairman of the Committee.

Early submission of biographical and publications information will facilitate the evaluation of nominations. Further information can be obtained from the various chairmen, as follows:

Edward A. Mason (general chairman), University of Maryland (WA 7-3800, Ext. 212).

George B. Chapman (biological sciences), Georgetown University (337-3300, Ext. 391).

Maurice Apstein (engineering sciences), Harry Diamond Laboratories (244-7700, Ext. 7735).

John D. Hoffman (physical sciences), National Bureau of Standards (362-4040, Ext. 564 or 612).

Franz L. Alt (mathematics), National Bureau of Standards (362-4040, Ext. 7686).

J. David Lockard, (teaching of science), University of Maryland (WA 7-3800, Ext. 221 or 7529).

T-THOUGHTS *

Environment for Creativity

Is poverty inimical to creativity? It did not prevent Saavedra de Cervantes from writing *Don Quixote* nor Rembrandt Van Rijn from becoming Holland's greatest painter.

We find Cervantes, the son of destitute parents, as a common soldier in Philip II's army, severely wounded in the Battle of Lepanto, captured on his way home by Algerian pirates and released in 1586 after five difficult years in prison. Returning home, he faced a family sunken in debt. As a subordinate assistant in the tax collector's office, he had to struggle incessantly to make ends meet. He had even been imprisoned innocently during the course of this employment.

Rembrandt's poverty was such that his creditors sold his house and auctioned off his collection. When he died in 1669, all he had to his name was some old clothes and painting gear.

Does this infer that poverty actually stimulates creativity? It wasn't so in the case of Leo Tolstoy and Charles Dickens.

Tolstoy was a nobleman who loved horses and the hunt. He spent much time looking over his estate, expanding it until he finally owned 16,000 acres. He had a large family with 13 children. He did not have to worry about money. It was during such a period of wealth that he completed *Anna Karenina* and *War and Peace*, two of the greatest novels the world had ever seen. "How this came about," as Somerset Maugham puts it, "is a mystery as inexplicable as that the son and heir of a stodgy Sussex squire should have written the *Ode to the West Wind.*"

Dickens was also blessed with material goods. He was respected, admired, and sought after. He enjoyed success as a public performer and celebrity. Yet, in the midst of this affluence, prolific and very good writings kept pouring from Dickens' pen.

Is being ordered to do something a great hindrance? It did not interfere with Michelangelo's completion of the tour de force of the huge frescoes of the Sistine Chapel within four years, painting on his back looking upwards.

We read in his letter rebuking someone for addressing him as Sculptor Michelangelo: "Tell him not to address his letters to the Sculptor Michelangelo, for here I

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* Dr. Ralph Siu's "T-Thoughts on Research and Engineering Management" have been issued since August 1960 as a series of weekly memoranda on the management of research and engineering. Originally addressed to Army science management personnel, they have attained a considerable circulation in Government and other circles. For ready reference, the Army Research Council republished the first 222 T-Thoughts in collected form, in January 1965.

Selected T-Thoughts will be quoted in the *Journal* from time to time.

am known only as Michelangelo Buonarroti . . . I have never been painter nor sculptor, in the sense of having kept a shop . . . although I have served the people; but this I did under compulsion."

Is good health a prerequisite? It was not so for Marcel Proust.

Marcel Proust suffered from asthma, rheums, fevers, and the attendant torments that continually plagued him. He would seldom leave his bed, with sweaters and mufflers over a long night gown, stockings and night cap. His room was darkened with closed shutters and drawn curtains; correspondence, manuscripts, clothing, medicines, and manuscripts, paraphernalia scattered about in total disorder. Yet it was under these conditions that he practiced, as he called it, his "travaux d'architecte" and composed the greatest novel of the century, *Remembrance of Things Past.*

Is peace of mind essential? No. There are many examples of which we may quote three.

There is the writer Fyodor Dostoyevsky, the creator of *Crime and Punishment* and *The Brothers Karamozov.* He seemed to have always been in a rush to complete his stories so as to satisfy his creditors. He was subject to fits of epilepsy. He had a deep passion for gambling which led to disaster. His mind was continually tormented by carnal temptations and the search for harmony, truth, and God.

There is Paul Gauguin, whose beautiful Tahitian natives and landscapes are joys to behold. He left his wife and four children and made himself disgustingly disagreeable to his wife's relatives, from whom he sponged. He lived under terrible poverty and mental distress. He even attempted to commit suicide with arsenic atop a tropical mountain. And, as if fate was determined that his life of turbulence was not to cease then, he did not steal sufficient arsenic, which amount left him only deathly ill for days.

Even sanity does not appear indispensable. We are familiar with Vincent Van Gogh, with his desperate loneliness, with the feverish strain under which he worked, with his attack of insanity, and finally with his suicide at the age of 37.

It would appear that, while we may be able to establish conditions in our research organization that will foster productivity by the average man of talent, it is clear that environment alone will not lead to the greeat "breakthrough." The source of man's greatness seems to be within himself. What the environment can do, however, is to entice the genius to remain or to force him to move on—like Leonardo Da Vinci restlessly migrating from Florence to Milan, from Milan to Florence, from the employ of Cesare Borgia to the Pope to King Francis I.

The Big Itch

There is a tendency on the part of top management to concentrate on the "big" issues and let the little petty annoyances continue uncorrected. Yet there's an old proverb to the effect that "it is easier for a person to stand pain than to stand itch."

Hot Water

I do not wish to suggest G. K. Chesterton's approach to everyone. But for those who can take it, he said, "I believe in getting into hot water. It keeps you clean."

We

Some people do try so hard to be modest. But Mark Twain insisted that: "The only people entitled to use 'we' in the singular sense are kings, editors, and people with tapeworms."

—*Ralph G. H. Siu*

Academy Proceedings

ELECTIONS TO FELLOWSHIP

The following persons were elected to fellowship in the Academy at the Board of Managers meeting on May 20:

BRUCE N. AMES, chief, Section of Microbial Genetics, National Institutes of Health, "in recognition of his outstanding contributions to molecular genetics." (Sponsors: E. A. Mason, E. T. Bolton.)

ROBERT B. BECKMANN, professor and head of the Chemical Engineering Department, "in recognition of his contributions to chemical engineering and chemical engineering education, in particular his researches on mass transfer in liquid-liquid extraction systems." (Sponsors: E. A. Mason, H. W. Schamp, Jr., C. E. White.)

DONALD F. BRANDEWIE, chairman of Science Department, Swanson Junior High School, Arlington, "in recognition of his competence and effective teaching of science to junior high school students, and his contribution to the development of a curriculum in earth and space science." (Sponsors: L. Schubert, R. K. Cook.)

JEAN R. DUPONT, neuropathologist, Department of Neurophysiology, Walter Reed Army Institute of Research, "in recognition of his outstanding and original research in the peripheral innervation of the gut." (Sponsors: E. T. Bolton, E. A. Mason.)

JOSEPH A. FAULKNER, head of Acoustics and Electronics Division, Naval Ordnance Laboratory, "in recognition of project management of the highest order during development of the "Puffs" system for submarine sonar." (Sponsors: M. A. Mason, E. A. Mason.)

WILLIAM M. FRANK, head, Theoretical Group, Nuclear Physics Division, Naval Ordnance Laboratory, "in recognition of contributions to static meson theory and convergence of quantum field theory." (Sponsors: S. N. Foner, E. A. Mason.)

RAYMOND A. GALLOWAY, associate professor of plant physiology, Department of Botany, University of Maryland, "in recognition of his outstanding contributions to our knowledge of the metabolism and enzyme systems in Alga, and his excellence in the areas of plant biochemistry and biophysics. (Sponsors: R. W. Krauss, E. A. Mason.)

LESLIE A. GUILDNER, project leader, Gas Thermometry, National Bureau of Standards, "in recognition of his contribution to the thermodynamic scale, and in particular his research in gas thermometry." (Sponsors: J. F. Swindells, D. C. Ginnings, M. S. Green.)

W. WAYNE MEINKE, chief, Analytical Chemistry Division, National Bureau of Standards, "in recognition of his contributions to analytical chemistry, in particular to the methodology of activation analysis and radiochemical separations." (Sponsors: R. G. Bates, B. F. Scribner, J. K. Taylor.)

CHARLES W. MISNER, associate professor of physics, University of Maryland, "in recognition of his research in relativity and relativistic astrophysics." (Sponsors: S. N. Foner, E. A. Mason.)

DONALD J. MORRISS, chief, T. M. Branch of Mensuration and Planning, Forest Service, Department of Agriculture, "in recognition of his contributions to scientific planning in the management of forest lands for multiple use." (Sponsors: K. W. Parker, H. A. Fowells, J. S. Yuill.)

JOHN D. MORTON, senior scientist, Research Division, Melpar, Inc., "in recognition of his contribution to the study of infectious disease, and in particular his development of experimental techniques in aerobiology." (Sponsors: P. E. Ritt, G. E. Jay, Jr.)

ALLISON R. PALMER, paleontologist, Geological Survey, "in recognition of noteworthy qualities that show both mastery and achievement in such diverse disciplines as taxonomy, ecology, and geology." (Sponsors: E. T. Bolton, E. A. Mason.)

WILBUR I. PATTERSON, assistant director, Eastern Utilization Research and Development Division, Agricultural Research Service, "in recognition of his researches on the toxicity of chemicals in foods." (Sponsors: Henry Stevens, J. R. Spies, E. J. Coulson.)

BRUCE L. REINHART, associate professor, Mathematics Department, University of Maryland, "in recognition of his contributions to the topology of differentiable manifolds." (Sponsors: L. Schubert, W. H. Pell.)

ARTHUR R. VON HIPPEL, consultant, Naval Research Laborary, and professor emeritus, Massachusetts Institute of Technology, "in recognition of his contributions to electrophysics, and in particular his research in the fields of ferroelectrics and ferromagnetics, electric breakdown, dielectric polarization rectifiers and photocells, gas discharges, solid state physics, and his pioneering development of the field of molecular engineering." (Sponsors: F. R. Kotter, A. T. McPherson, A. H. Scott.)

DONALD D. WAGMAN, chief, Thermochemistry Section, National Bureau of Standards, "in recognition of his contributions to the generation, critical evaluation, and compilation of thermodynamic data." (Sponsors: J. J. Diamond, E. J. Prosen, L. H. Bennett.)

RONALD E. WALKER, physicist, Hypersonic Propulsion Group, Applied Physics Laboratory, "in recognition of his contributions to basic molecular physics and to engineering, especially his work leading to improved performance of rocket and ramjet engines." (Sponsors: E. A. Mason, R. E. Gibson.)

JAY S. WINSTON, head, Planetary Meteorology Branch, Meteorological Satellite Laboratory, Weather Bureau, "in recognition of his wide-ranging contributions to knowledge of the planetary atmospheric circulation, and to the application of meteorological satellite data to climatology and weather forecasting." (Sponsors: J. M. Mitchell, Jr., H. E. Landsberg.)

EDWARD A. WOLFF, manager, Space Engineering Laboratory, Aero Geo Astro Corporation, "in recognition of his outstanding work on radar systems: for contributions to development and teaching of space and antenna technology." (Sponsors: M. A. Mason, E. A. Mason.)

ELECTIONS TO MEMBERSHIP

The following persons were elected to membership in the Academy by action of the Committee on Membership at its meeting on March 30:

MICHAEL R. DeCARLO, assistant executive secretary, Biology and Agriculture Division, National Academy of Sciences.

CHARLES DeVORE, deputy executive assistant for scientific information, Office of Naval Research.

BERENICE G. LAMBERTON, teacher, Georgetown Visitation Preparatory School and staff member, Georgetown College Observatory.

ROBERT S. WEBER, manager, Utilities Management Branch, Bureau of Yards and Docks, Navy Department.

CONSTANCE P. WRENCH, biology teacher, Walt Whitman High School, Bethesda.

The following persons were similarly elected to membership in the Academy on May 3:

ERNST M. COHN, head, Electrochemical Systems, National Aeronautics and Space Administration.

RICHARD O'DAY, mathematics teacher, Western High School.

The following persons were similarly elected to membership in the Academy in June:

JAMES M. CRETSOS, head, Technical Information Center, Melpar, Inc.

DOROTHY K. CULBERT, chemistry teacher, Yorktown High School, Arlington.

CHARLES M. DAVIS, JR., assistant professor of physics, American University.

JACK MOSHMAN, vice president, E-E-I-R, Inc.

JOINT BOARD

Officers of the Joint Board for the 1966 fiscal year are Edward Hacskaylo, chairman; Leonard Crook, vice-chairman; Marjorie Townsend, secretary; and Zaka I. Slawsky, treasurer.

Committee chairmen have been appointed as follows: Grover Sherlin, Secondary School Contacts Committee; Kenneth Vigue, ES&A Day Award Committee; Edward Wolff, Finance Committee; Ralph Cole, Grants-in-Aid Committee; David Lockard, NSF Projects; Joseph Broome, 21st International Science Fair; William Wockenfuss, *The Reporter;* Leo Schubert, Research Participation Committee; Russell Mebs, Science Fairs Committee; Zaka Slawsky, Greater Washington Interscholastic Mathematics League; Keith Johnson, Scientific and Technical Writing Committee.

WASHINGTON JUNIOR ACADEMY OF SCIENCES

This year's officers of the Junior Academy are James Fishkin, president (Oxon Hill High School) (home phone 567-4615); Walter G. Twitty, vice-president (Fairmont Heights High School); Mary June Will, secretary (Woodrow Wilson High School) (home phone 244-5436); Larry Meisel, treasurer (Yorktown High School); and Betsy Boehner, membership chairman (home address 9806 Cahart Place, Silver Spring, Md., HE 4-7716.)

WJAS aims at the promotion of science among young people of the Washington area. It pursues its objectives through scientific lectures, field trips, a gala for winners of the Westinghouse Science Talent Search, the annual *Proceedings,* and an annual convention at Christmas time. It also sponsors annual railroad trips to New York and Philadelphia museums and planetariums; as many as 5,000 junior and senior high school students may take these trips in each season. Thus, the Junior Academy promotes science not only among its own selective membership, but also among a segment of the rest of Washington's youth.

Membership in WJAS is awarded according to a point system, based on outstanding participation in area science fairs, the Westinghouse Science Talent Search, the Future Scientists of America, or high school science clubs. Other factors such as publication of a paper, participation in a convention or other scientific activity, or a teacher recommendation, may be considered. Further information on membership is available from Betsy Boehner at the foregoing address.

Science in Washington

SCIENTISTS IN THE NEWS

Contributions to this column may be addressed to Harold T. Cook, Associate Editor, c/o Department of Agriculture, Agricultural Research Service, Federal Center Building, Hyattsville, Md.

AGRICULTURE DEPARTMENT

W. T. PENTZER was elected a fellow of the American Society for Horticultural Science at the annual meeting of the Society on August 17, in Urbana, Ill.

ELBERT L. LITTLE, JR., Forest Service dendrologist, spent six weeks in Esmeraldas Province, Ecuador, with a forestry project under United Nations (FAO) Special Fund. His tree identification work included collection of wood samples for the Forest Products Laboratory.

C. H. HOFFMANN, associate director of the Entomology Research Division, Agricultural Research Service, attended a planning meeting of the U.S.-Japan Cooperative Research Program on Pesticides, held at Honolulu April 7-9. Dr. Hoffmann presented a paper entitled "Development of New Pesticides and Alternative Techniques for the Control of Pests."

W. B. ENNIS, JR., Agricultural Research Service, gave an invited paper on "Weed Control—The Soybean Growers' Number 1 Problem" at the Annual Convention of the American Soybean Association, August 16-18, in Memphis.

In July, *VICTOR R. BOSWELL* was appointed an assistant director of the Crops Research Division, Agricultural Research Service. For several years Dr. Boswell had been chief of the Vegetables and Ornamentals Research Branch in that Division.

THEODORE C. BYERLY, administrator of the Cooperative State Research Service, was one of seven Department employees who received the 1965 USDA Distinguished Service Award on May 16.

AMERICAN UNIVERSITY

LEO SCHUBERT, chairman of the Chemistry Department, has been appointed to a Teacher of the Year Committee, whose function is to select the outstanding teacher of the year from nominees proposed by State commissioners of education. The competition is sponsored by the Council of Chief State School Officers and *Look* magazine.

APPLIED PHYSICS LABORATORY

FRANK T. McCLURE, chairman of the Research Center, has been awarded a John Scott Award for 1965 of the Philadelphia Directors of City Trusts. The award, to be made this fall, is for Dr. McClure's invention of the satellite doppler navigation system that is now being used to fix positions of Navy vessels at sea; the system is based upon signals from satellites that are received and processed by special equipment in the ships. The John Scott awards, which carry a premium of $2,000 as well as a medal and scroll, were provided for in the will of a 19th-century Scotch chemist, and are presented to "ingenious men and women who make inventions"; they have been administered by the City of Philadelphia since 1816.

COAST AND GEODETIC SURVEY

EINAR B. KULLENBERG has joined the Office of Research and Development. Dr. Kullenberg, who is on leave of absence from the University of Goteborg, Sweden, is engaged in basic research in oceanography.

DEAN S. CARDER has been assigned to the Advanced Seismic Experiments Group, San Francisco.

BUFORD K. MEADE participated in

the Second Symposium of the International Association of Geodesy Commission on Recent Movements of the Earth's Crust, held in Aulanko, Finland, August 3-7.

CHARLES A. WHITTEN was awarded the honorary D.Sc. degree by Carthage College at Kenosha, Wisc., on June 7.

ENVIRONMENTAL SCIENCE SERVICES ADMINISTRATION

ROBERT M. WHITE was appointed administrator of ESSA on July 27. Dr. White had served as chief of the Weather Bureau since October 1, 1963.

FOREIGN AGRICULTURAL ORGANIZATION

ROY C. DAWSON represented FAO and the International Atomic Energy Agency at the opening session of an international Training Course in the Use of Radioisotopes in Animal Science and Veterinary Medicine, which began on July 19 at Cornell University. Dr. Dawson explained the purpose and activities of the Joint Division of Atomic Energy in Agriculture, formed recently by the two agencies.

GEOLOGICAL SURVEY

WILLIAM T. PECORA, chief geologist, was one of 35 distinguished scientists elected to the National Academy of Sciences during its annual meeting last April.

MARGARET D. FOSTER, chemist with the Geologic Division, retired on March 31. Dr. Foster was the first woman chemist to be employed by the Geological Survey, beginning her career with the Water Resources Division in 1918 after graduating from Illinois College. She did some of the pioneer work on the geochemistry of ground water of the Atlantic and Gulf coastal plains. In recent years her attention has turned to the geochemistry of the clay mineral groups, the micas, chlorites, and zeolites, where she has made fundamental contributions.

NAS-NRC

JOHN S. COLEMAN, formerly staff deputy for plans and programs, has been named executive officer of NAS-NRC. He succeeds *S. DOUGLAS CORNELL,* who has left to become president of the newly-established Mackinac College, which will be located on Mackinac Island, Mich.

NATIONAL BUREAU OF STANDARDS

The Spectrochemical Analysis Section was well represented by invited papers at three international conferences in Europe this year. *BOURDON F. SCRIBNER,* chief of the Section, presented a plenary lecture on "Advances in Excitation in Spectrochemical Analysis" at the XXth Congress of the International Union of Pure and Applied Chemistry, in Moscow on July 15. *MARVIN MARGOSHES* presented an opening lecture, "Recent Advances in Excitation of Atomic Spectra," at the XIIth Colloquium Spectroscopicum Internationale in Exeter, England, July 12. *KURT F. J. HEINRICH* gave a paper entitled "Electron Probe Microanalysis by Specimen Current Measurement" at the IVth International Congress of X-ray Optics and X-ray Microanalysis, held at Orsay, France, on September 10. In each case, the speaker was a guest of the conference and presided at one of the conference sessions.

NATIONAL INSTITUTES OF HEALTH

JAMES A. SHANNON, director of NIH, was one of 35 distinguished scientists elected to the National Academy of Sciences during its annual meeting last April.

MORRIS K. BARRETT, National Cancer Institute biologist since 1940, retired July 2. For a number of years he headed the Gastric Cancer Unit and served as executive secretary for a Gastric Cancer Committee of the National Advisory Cancer Council.

MARGARET D. BARRETT, wife of Morris Barrett and also a National Cancer Institute biologist, retired July 31. She retained her maiden name of Margaret K. Deringer for professional use.

BERNICE EDDY, chief of the Section on Experimental Virology, Division of Biologics Standards, and *SARAH E. STEWART*, Division of Viral Oncology, National Cancer Institute, participated in a Symposium by Distinguished Women of Science, sponsored by the Putnam Memorial Hospital Institute for Medical Research in Bennington, Vt.

HEINZ SPECHT, formerly chief of the Laboratory of Physical Biology, National Institute of Arthritis and Metabolic Diseases, has been appointed assistant chief for scientific affairs, Office of International Research, OD. Prior to this assignment, he had served as chief of the Pacific Area Office in Tokyo.

CARL J. WITKOP, chief of the Human Genetics Branch, National Institute of Dental Research, participated in a 17-member team that recently made an extensive nutritional health survey in Paraguay.

ROBERT W. BERLINER, director of intramural research, National Heart Institute, was winner of the Homer W. Smith Award in Renal Physiology which is given annually by the New York Heart Association.

KARL FRANK, acting associate director for intramural research, National Institute of Neurological Diseases and Blindness, received the Superior Service Award at the 14th Annual DHEW Awards Ceremony on April 9.

BERNARD BRODIE, chief of the National Heart Institute's Laboratory of Chemical Pharmacology, delivered the 1965 Otto Loewi Award Lecture at New York University School of Medicine. The Philadelphia College of Pharmacy and Science conferred an honorary Doctor of Science degree on Dr. Brodie at its commencement convocation, June 14.

NATIONAL SCIENCE FOUNDATION

RAYMOND J. SEEGER gave an invited address on "The Humanism of Science" at the Annual Meeting of the Iowa Academy of Sciences. He spoke also at the Marshall University, where he installed the Sigma Xi Club. Dr. Seeger's commencement address at St. Mary's Junior College (Raleigh) was entitled, "The Great Society, 1984." Together with *GEORGE TEMPLE*, Sedlerian professor of natural philosophy, Oxford University, he has edited a recent book, "Research Frontiers in Fluid Dynamics." He gave an address on "The Humanism of Atmospheric Science" at the annual dinner of the Washington Chapter, American Meteorological Society.

NAVAL RESEARCH LABORATORY

VICTOR J. LINNENBOM and *CONRAD H. CHEEK* attended the Moscow meeting of the International Union of Pure and Applied Chemistry, July 10-18. They presented a paper on "The Effect of pH on the Evolution of Hydrogen from Irradiated Halide Solutions" at the Symposium on Radiation Chemistry.

JOHN SANDERSON, superintendent of the Optics Division, has been given an interim appointment as associate director of research for planning. In his new position, Dr. Sanderson will be responsible for planning long-rang programs.

ALLEN L. ALEXANDER, associate superintendent of the Chemistry Division, participated in the First Inter-American Research Conference held in San Juan, Puerto Rico, July 25-31.

ALLEN SCHOOLEY, associate director of research, has returned to NRL following a two-year assignment at the ASW Research Center in La Spezia, Italy.

WILLIAM A. ZISMAN, superintendent of the Chemistry Division, was awarded an honorary D.Sc. degree at the national Colloid Symposium at Clarkson College of Technology, Potsdam, N. Y., on June 22. Dr. Zisman, as secretary to the Commission on Colloid and Surface Chemistry of IUPAC, went to a Paris meeting and visited laboratories in France and England.

C. H. TSAO has joined the Cosmic Ray Branch of the Nucleonics Division as a research associate. Dr. Tsao's appointment was made under a joint program of the National Academy of Sciences and NRL; he was formerly on the cosmic ray staff at the University of Chicago.

BENJAMIN LEPSON has been appointed consultant in mathematics and computation to the Nucleonics Division. Dr. Lepson was formerly head of the Numerical Analysis Branch at the Laboratory.

TRINITY COLLEGE

IRENA Z. ROBERTS has been appointed chairman of the Chemistry Department. Dr. Roberts, who has been associated with the Trinity faculty since 1955, is a Ph.D. graduate of Columbia University; she was formerly a postdoctoral fellow at the National Cancer Institute, and a research associate with the Carnegie Institution of Washington.

UNIVERSITY OF MARYLAND

HOWARD LASTER, a specialist in cosmic ray theory and related areas of astrophysics, has been appointed head of the Physics and Astronomy Department. He succeeds *JOHN S. TOLL*, who recently became president of the Stony Brook (L.I.) branch of the State University of New York. During Dr. Toll's 12 years at Maryland, the Physics and Astronomy full-time faculty grew from 4 to 82 members.

HOMER W. SCHAMP, professor of physics and director of the University's Institute for Molecular Physics, has been appointed dean of faculty for the University of Maryland in Baltimore County by the Board of Regents.

WEATHER BUREAU

GEORGE P. CRESSMAN was made acting director of the Weather Bureau on July 13. Dr. Cressman came to the Bureau in 1958 as director of the National Meteorological Center.

SCIENCE AND DEVELOPMENT

Catholic University's Department of Biology will hold a symposium on November 3, commemorating the centenary of Gregor Mendel's completion of the first fundamental laws of genetics. In this endeavor, which will be open to the Washington scientific community and which may be continued on November 4, the Biology Department will be joined by distinguished geneticists from Johns Hopkins, Cornell, the Carnegie Institution, and the Universities of Chicago and Pennsylvania. The proceedings of the symposium will be published as part of a series sponsored by CU's Institute for the Study of Natural Species.

A purification technique developed at the National Bureau of Standards may produce the purest materials ever obtained. The technique appears to have most of the desirable features of conventional purification procedures, but avoids the disadvantages associated with each. Impurity is reduced by a factor as great as 10^4 in each stage of operation; and since it is believed that any number of stages may be employed with the same degree of improvement and no recontamination, the process may be able to produce absolutely perfect crystals.

Thirty-four universities have been invited to participate in Universities Research Association, Inc., a new corporation formed as a result of a meeting of university presidents at the National Academy of Sciences on June 20. The corporation will offer its services to the Federal Government as manager of a proposed high-energy proton accelerator, should Congress approve its construction. Johns Hopkins and Maryland Universities are among those invited to participate.

There is a certain desirably humbling effect from contemplating such major natural phenomena as the Gulf Stream, a strange "ocean river" first commented upon by one of the really remarkable men of modern times, Benjamin Franklin, nearly two hundred years ago. Consider, for example, that the Stream is in effect a river 40 miles wide and 2000 feet deep, and has a surface velocity of four miles an hour. Every hour, one hundred billion tons of water leaves the Gulf of Mexico, an amount 1000 times that of the Mississippi, and 22 times that discharged into the sea by all the rivers of the world combined! That the Gulf Stream profoundly influences the climate of both continents is well known; what is insufficiently clear are the details of its pathway, the degree of fluctuations, and its specific effects on fisheries, weather patterns, commerce, and so on. As an effort to improve understanding, a major, coordinated program of study will be carried out during the next year, using ships, planes, and personnel of the Coast and Geodetic Survey, Weather Bureau, MIT, Woods Hole Oceanographic Institution, University of Rhode Island, Lamont Geological Observatory of Columbia University, and the University of Miami.

To the middle-aged generation, the Lindbergh kidnapping case was the most publicized crime in its memory, and the detective work linking the wood from the kidnap ladder with the floor of the suspect's attic perhaps the most dramatic episode in the long trial and conviction. Others have heard the story of tree-ring dating in the pueblo ruins of the Southwest. Much the same approach is reported by R. S. Sigafoos in his work with the Potomac River Basin trees and the story left behind by past flood periods. By patiently assembling the evidence of scars and other damage, fixing the date of the event by tree-ring studies, and so on, Dr. Sigafoos has added much to the accuracy and completeness of our knowledge of flooding in the Potomac and its tributaries. Once the method has been established by comparison with known high water periods, it can be applied to river basins where the written record is virtually non-existent.

A Symposium on the Coupling of Basic and Applied Corrosion Research is planned for March 21-22, 1966, under the sponsorship of the National Bureau of Standards, the Naval Research Laboratory, and the Office of Naval Research. Chairman is Richard C. Carlston of the Metallurgy Branch, ONR. The preliminary announcement states: "This symposium is designed to bring about a dialogue between workers conducting basic and applied research in the field of aqueous corrosion. Communication between these groups is frequently poor because of diverse points of view and differences in professional goals. A better understanding of the overall problems faced by both groups is essential in working toward eventual solution of individual problems. The symposium attempts to achieve this understanding by presenting widely recognized, representative speakers from both areas and encouraging open discussions among those actively engaged in the aqueous corrosion field."

A series of lectures on differential equations is being conducted in 1965-67 under the sponsorship of the Air Force Office of Scientific Research, the University of Maryland, and the universities of the Joint Graduate Consortium. The first session, with three lectures on control theory, was held October 2 at Georgetown University. The remaining sessions are as follows: December 4, at Howard University, on dynamical systems; March 5, 1966, at University of Maryland, on boundary value problems; May 7, 1966, at Georgetown University, on differential operators; October 1, 1966, at American University, on differential equations of mathematical physics; December 3, 1966, at Georgetown University, on differential equations in a Banach space; March 4, 1967, at Catholic University, on stochastic differential equations; and May 6, 1967, at George Washington University, on numerical solutions. Particulars are available from M. W. Oliphant, professor of mathematics, Georgetown University.

THE WASHINGTON ACADEMY OF SCIENCES

Objectives

The objectives of the Washington Academy of Sciences are (a) to stimulate interest in the sciences, both pure and applied, and (b) to promote their advancement and the development of their philosophical aspects by the Academy membership and through cooperative action by the affiliated societies.

Activities

The Academy pursues its objectives through such activities as (a) publication of a periodical and of occasional scientific monographs; (b) holding of public lectures on scientific subjects; (c) sponsorship of a Washington Junior Academy of Sciences; (d) promotion of science education and a professional interest in science among people of high school and college age; (e) accepting or making grants of funds to aid special research projects; (f) sponsorship of scientific symposia and conferences; (g) assistance in scientific expeditions; (h) cooperation with other academies and scientific organizations; and (i) award of prizes and citations for special merit in science.

Membership

The membership consists of two major classes—**members** and **fellows.**

Members are persons who are interested in science and are willing to support the Academy's objectives as described above. A letter or form initiated by the applicant and requesting membership may suffice for action by the Academy's Committee on Membership; approval by the Committee constitutes election to membership.

Dues for members are $7.50 a year.

Fellows are persons who have performed original research or have made other outstanding contributions to the sciences, mathematics, or engineering. Candidates for fellowship must be nominated by at least two fellows, recommended by the Committee on Membership, and elected by the Board of Managers.

Dues are $10.00 a year for resident fellows (living within 50 miles of the White House) and $7.50 a year for nonresident fellows.

Persons who join the Academy as members may later be considered for fellowship.

Application forms for membership may be obtained from the office of the Washington Academy of Sciences, 1530 P St., N.W., Washington, D. C.

Delegates to the Washington Academy of Sciences, Representing the Local Affiliated Societies*

Philosophical Society of Washington	Urner Liddel
Anthropological Society of Washington	Stephen T. Boggs
Biological Society of Washington	John L. Paradiso
Chemical Society of Washington	Florence H. Forziati
Entomological Society of Washington	Harold H. Shepard
National Geographic Society	Alexander Wetmore
Geological Society of Washington	Luna Leopold
Medical Society of the District of Columbia	Thomas M. Brown
Columbia Historical Society	U. S. Grant, III
Botanical Society of Washington	Peter H. Heinze
Society of American Foresters	Harry A. Fowells
Washington Society of Engineers	Martin A. Mason
Institute of Electrical and Electronics Engineers	George Abraham
American Society of Mechanical Engineers	William G. Allen
Helminthological Society of Washington	Marion M. Farr
American Society for Microbiology	Francis B. Gordon
Society of American Military Engineers	H. P. Demuth
American Society of Civil Engineers	Thorndike Saville, Jr.
Society for Experimental Biology and Medicine	Falconer Smith
American Society for Metals	Hugh L. Logan
International Association for Dental Research	Harold J. Caul
American Institute of Aeronautics and Astronautics	Delegate not appointed
American Meteorological Society	J. Murray Mitchell, Jr.
Insecticide Society of Washington	H. Ivan Rainwater
Acoustical Society of America	Malcolm C. Henderson
American Nuclear Society	George L. Weil
Institute of Food Technologists	Richard P. Farrow
American Ceramic Society	J. J. Diamond
Electrochemical Society	Kurt H. Stern
Washington History of Science Club	Morris Leikind
American Association of Physics Teachers	Delegate not appointed

* Delegates continue in office until new selections are made by the respective affiliated societies.

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Journal of the

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NOVEMBER 1965

JOURNAL OF THE WASHINGTON ACADEMY OF SCIENCES

This Journal, the official organ of the Washington Academy of Sciences, publishes historical articles, critical reviews, and scholarly scientific articles; notices of meetings and abstract proceedings of meetings of the Academy and its affiliated societies; and regional news items, including personal news, of interest to the entire membership. The Journal appears nine times a year, in January to May and September to December. It is included in the dues of all active members and fellows.

Subscription rate to non-members: $7.50 per year (U.S.) or $1.00 per copy; foreign postage extra. Subscription orders should be sent to the Washington Academy of Sciences, 1530 P St., N.W., Washington, D.C., 20005. Remittances should be made payable to "Washington Academy of Sciences."

Back issues, volumes, and sets of the Journal (Volumes 1-52, 1911-1962) can be purchased direct from Walter J. Johnson, Inc., 111 Fifth Avenue, New York 3, N. Y. This firm also handles the sale of the Proceedings of the Academy (Volumes 1-13, 1898-1910), the Index (to Volumes 1-13 of the Proceedings and Volumes 1-40 of the Journal), and the Academy's monograph, "The Parasitic Cuckoos of Africa."

Current issues of the Journal (past two calendar years) may still be obtained directly from the Academy office at 1530 P Street, N.W., Washington, D.C., 20005.

Claims for missing numbers will not be allowed if received more than 60 days after date of mailing plus time normally required for postal delivery and claim. No claims will be allowed because of failure to notify the Academy of a change of address.

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ACADEMY OFFICERS FOR 1965

Mass Transportation, Scientific Technology, and Urban Life*

Henry Fagin

Professor of Urban and Regional Planning, University of Wisconsin, Madison, Wisconsin

In this setting of the National Academy of Sciences, it seems peculiarly appropriate for us to consider mass transportation in a somewhat broader-than-usual context—the relationship of our evolving general scientific technology to the evolving urban structure of the Nation's Capital. The current focus of public attention on transportation provides a convenient access point to this inquiry.

After all, everyman is an expert on transportation—a fact that explains why so many affluent people today insist on driving cars. When I was young, driving was widely held to be a rather low-level occupation, a boring pursuit to be relegated to the chauffeur, on a par with other things for which one might wish to have a maid, a cook, or a butler. Seductive packaging has trapped our wives into operating *home*-based machinery that releases maids, cooks, and butlers for higher types of work out in the world; while we have been enticed by Ted-Holmes-based machinery in the form of superb highways and Detroit's irresistibly-packaged four-wheeled cocoons. We have made air pilots of the boys who used to watch the road while we watched the girls. We have indeed ended up as integral working cogs in the transportation system, disciplined by the appalling and self-enforcing law of the road to pay attention or perish.

A half year and a thousand decisions ago, your program chairman asked me to address you on the subject of mass transportation. This was said to be a highly controversial local issue on which someone talking about facts might be listened to, provided he came from far enough away. Wisconsin qualified. He wanted me to explain the general ideas current among people who think about urban transportation planning. Now, a half year and a thousand decisions later, I find that many questions, then controversial, have been reasonably happily resolved. A consensus appears to have crystallized about the big things to do next in transportation action in this metropolis —the city and its suburbs. While this consensus is not yet fully embodied in enacted legislation, it is nonetheless operative. With questions about the character of the overall system of subway, railroad, and highway services reaching agreement, attention is moving to the details that will afford the best possible fit between the large multimode system and the particularities of local development. At this level of discussion, however, someone like me, from afar, has relatively little to contribute.

I feel impelled to speak out here tonight, nevertheless, because I sense that the significant debate is about the shift from the immediate transportation program to a set of more fundamental questions concerned with the broad social, economic, cultural, and political evolution of the National Capital region—questions in no way settled by the transportation consensus. Your present program promises workability for the Nation's Capital region—but in no sense, greatness.

*An address before the Washington Academy of Sciences on May 20, 1965.

I propose to explore the latter issue at some length, here this evening, precisely because your present transportation program appears to be a satisfactory guide for effective needed measures in both mass transportation and highway development for at least the decade to come. But first, briefly, let me justify my change in emphasis by a short explanation of why I do regard the mass transportation problem here as reasonably settled. Then I shall go on to the broader questions.

My view of metropolitan transportation is tempered by a sense of the great diversity of types of urban areas, and hence the great diversity of transport system needs. In generalizing about metropolises, I find it convenient to note several dimensions in which people already have observed that metropolises differ. Each urban area can be understood best if placed uniquely in a sort of multi-dimensional measuring model. I will ask you to imagine each metropolis a point along four different yardsticks. You may readily imagine three of these in the angles where the ceiling tops two walls at a corner of this room. How to visualize the fourth yardstick is more difficult, but it's there somewhere.

The first yardstick or dimension of this measuring model is *extent*, the magnitude of the region. The big ones, say over one million in population and twenty to thirty miles across, behave quite differently from the small ones.

Second, there is the matter of *density*. How many people, or homes, or plants per square mile? How far you have to go to get from one activity to another is another useful way of looking at density. What is the density in terms of straight-line distance separating people or establishments, or time required, or travel costs, or an *index* that reflects all of these? A given density may look high from the standpoint of someone with an auto, but unworkably low to a pedestrian.

Third, there is the degree of centrality. Along this yardstick are several significant points. Let me illustrate centrality with the question of obtaining food. At one extreme is total diffusion when each household raises its food in its own garden. Less diffuse is the urban pattern of the corner grocery store, or the suburban pattern of the roadside stand. Further along the scale are cities where the corner stores have yielded to the supermarket and roadside stores to regional shopping centers. The extreme of centrality in retailing would be a metropolis with stores only to be found in a single downtown business district. Please note that I have illustrated centrality only with food. Other centrality scales describe the patterns respectively of the commercial, industrial, and cultural establishments of a particular metropolis. You see that this dimension is really measured by a whole bundle of yardsticks of relative centrality.

The fourth set of yardsticks measures the scale and degree of various kinds of segregation within the area. A salt-and-pepper pattern of diversity is at one end of the yardstick; very large areas, internally homogeneous, characterize the other extreme. The yardstick in this dimension measures *separately* each of the patterns of segregation—for example, area specialization by race, income, family type, age, housing type, manufacturing, warehousing, etc. A particular metropolis may have a salt-and-pepper pattern for one of these elements, while having large-scale districts with respect to others.

Fifth, among the yardsticks there is one that measures the level of communications. As R. F. Muraca of Stanford once pointed out, "If travel were instantaneous and costless, other factors, including personal ones, would have *more* influence on the localities of employment and residence. As transportation is made more and more efficient, employment and residence will be driven in opposite directions." Indeed, I might add, at zero travel time and cost, the city as such would likely disappear. One must know the transport network and the costs and levels of service available, then, before one can fully describe an urban area. The same is true of the other utilities—water, drainage, power, communications.

With the foregoing framework for classification in mind, where would one place the National Capital metropolitan region in the multi-dimensional space that describes significant urban difference?

(1) Washington in *extent* is well beyond the minimum size at which grade-separated, high-capacity, high-speed mass transit is feasible and begins to become essential. Today Washington's density dictates rail service. Some day, perhaps, a more individualized and footloose vehicle will take over the same rail cuts and tunnels. Some people will drive battery-powered cars or buses to the electrified rights of way that you are about to develop. But instead of changing to trains, they will switch to automatic control, and make the journey downtown or back, riding while reading. More than a dozen national capitals elsewhere, with smaller metropolitan populations than Washington, already are served by rail rapid transit systems. Washington is nearly alone among the major capitals of the western world in not having rail rapid transit.

(2) It is my impression that Washington stands toward the lower end of the scale of residential or night-time density. In this respect you are more like Los Angeles and Milwaukee than Philadelphia or New York. This suggests the need for auto and bus distribution, at least in your one-family suburban areas; and for this you need to improve your highway system with better circumferential freeways leading to the rapid transit corridors. Day-time densities, however, which reflect your concentrations of people at work, are toward the high end of the metropolitan scale, unlike Los Angeles. Rail rapid transit to and in the central areas, like the Boston and Philadelphia systems, seems essential.

(3) A relatively high level of centrality characterizes most of the components of Washington's non-residential structures. Your governmental establishments are heavily clustered in the central strip from the Pentagon to the Capitol. Hotels, non-governmental offices, and major businesses are equally concentrated *alongside.* Thus, the major work places of the region can be reached on foot from a small number of stations in a central distribution grid. Moreover, with the Federal Government as the main employer of the larger non-central establishments, the metropolis is in a position to, and should, direct future regional sub-centers of governmental employment to strategic locations along, or at the extremities of, the mass transit network as radial routes extend outward into the suburban areas.

(4) A number of kinds of segregation in the Washington metropolis already result in relatively large areas of homogeneity. Not only is there a heavy city-suburban split by ethnic background, but also extensive areas cater to people of one income level, or one type of housing accommodation. Certain neighborhoods of Philadelphia, by way of contrast, successfully contain greater mixtures of one-, two-, and multi-family houses than does Washington —and greater mixtures of ethnic groups, too, for that matter.

(5) Finally, in relation to the level of transportation services, Washington's automobile flows, particularly during the peak hours of work travel, are relatively slow and congested. In this respect, Los Angeles stands high in the numbers of persons accommodated, though certain of its highway network sectors have become dramatically inefficient. In Washington, the service level of the taxi system is at the high end of the scale for major cities. The level would be even higher were it not for the congestion of thousands who use autos because there is not yet any practical alternative. But in terms of mass transportation, Washington stands low on the scale of service level, despite its extensive surface transit system, because the metropolis has grown beyond

the size and density that can be served adequately without grade separation. Your present attempt to utilize the *same* right-of-way for individual and mass travel not only produces a low efficiency for your bus operation, but also guarantees a frustrating trip for the private car and taxicab as well.

In sum, quite aside from its future growth and change, Washington already has the cluster of characteristics that typify metropolises in need of grade-separated rapid transit facilities. It is like Stockholm or the Philadelphia of 1920—not like Madison, Wisconsin, with only a fourth of a million in the metropolitan area. I hope and trust that an excellent system will be created here and placed in operation with no further delay. With this minimum basis for an effective modern metropolis coming into being, Washington can now turn to further issues of very great significance. It is to these issues that I shall now address my remarks.

By good fortune, I recently came across a unique book that deals extensively with the very questions that seem most timely and germane to our National Capital in 1965. I have been reading the "Proceedings of the Dunsmuir House Conference on Space, Science, and Urban Life," a report on a series of sessions held in 1963 among scientists, planners, industrialists, and government officials. The group met in Oakland, California, to see what should be done to capitalize on advances in science and technology, made in the space program but perhaps applicable also to improving urban life.

I imagine you share the curiosity I felt when the report came into my hands. It was clearly stamped with the magic letters NASA. I think I detected in myself at that moment a faint reverberation of the emotion released three milleniums ago in the breast of the Prophet on Mount Sinai, when he recognized an earlier four-letter symbol, also with repeating second and fourth letters, at the top of certain tablets which were passed into his hands.

In the Dunsmuir House Conference document, a great many stimulating ideas appear that are quite relevant to your metropolitan problems. Two major concepts are especially pertinent to what I want to emphasize about Washington tonight. Moreover, the flavor of the observations is so remarkable that I am inclined to offer them verbatim before summarizing their implications for us here.

The first general subject is what to do in the face of the awesome magnitude of the modern metropolis and its bewildering complexity. The second is how to close the widening gap between what we *have* and what twentieth-century mankind *could* have.

Unity and Complexity

The first subject might be called the dilemma of the complex—whether to treat the whole, which may be a formidable prospect, or to treat parts as though they were separable, which may violate the whole. We have always approached the metropolis as essentially a problem for decentralized handling, both geographic and functional. We fragment regional water, air pollution control, transit, and housing among dozens of local geographical jurisdictions. We fragment economic development, social welfare, and transportation among dozens of separate functional departments of government. It is fascinating in this regard to hear a strongly contrary view arise as a major finding of people reflecting on the significances of the space effort for urban life. For example, in a summary of immediate progress that can be made to apply new technology in urban communities, Burnham Kelly of Cornell, who earlier had worked on defense against nuclear bombing, said:

> The important contribution to come from NASA research is not the fallout from special studies, but the possibility of applying to modern, metropolitan complexity a new and comprehensive research method. I agree with Karl Wolf that the more powerful the organization and the wider the scope, the greater the chances of success. In the end, I believe the concern will

stretch so far beyond municipal limits that the effective organization for such research may well be the State, making use of a regional framework that is at best only suggested in our States at the present time.

In a similar vein, Carl F. Stover of Stanford said:

> The point is that the city has to be seen as an organic whole. In the life of the city, as in the life of man and nature, it is impossible to change just one thing. This is a fundamental lesson of the record of urban growth and of every effort we have made to improve our cities and metropolitan areas. With the increasing power that modern scientific technology provides, I think it is even more important that we know what we are changing before we start to change it . . . We have to be prepared to get solid information about our situation and about the implications of the change that we want to introduce before we act. Having the information, we must be willing to act on it and not ignore it in terms of some passionate political or personal predilection. This area of municipal research is, I think, an area where there is a great deal of very shabby action on both the part of the researchers and the policymakers.
>
> Probably the most important thing that the space effort has to teach us is how to go about a big job, involving science and technology in achieving a social purpose. It gives us the clear lesson that we need to know what our goals are and what kinds of problems we are going to have to face in achieving those goals. It tells us that these goals and problems must be operationally defined in terms of the total environment in which we are working. It provides us a model for drawing on available knowledge and technical capacity, and for going about systematically developing the necessary additional knowledge and technical capacity. It is a good prototype, in other words, for an orderly, toughminded attack on a problem and its resolution through the use of man's knowledge and his technical skill.

With these initial bold assertions of the need to tackle a whole, irrespective of its apparent magnitude, the truth is that the problem is really *raised* rather than *solved.* Neither in the space program nor in the metropolis is it conceivable that all decisions could be made in one place at the top. The key question then is: What is the best way of distributing various kinds of decisions throughout the structure of a large system?—the metropolis being an example of a very large system, indeed. William O. Baker of Bell Telephone Laboratories gave one clue in discussing the relation between suppliers and operators. He said:

> In some industries, such as transportation, there has been an unfortunate division between the components suppliers and the systems operators. Hence, while the automotive firms have vastly improved diesel and electric power for the railroads, there has not necessarily been a corresponding increase in the effectiveness of the systems technology. A similar situation is seen in many aspects of the construction industry, where the component suppliers, including chemical, metallurgical, and material manufacturing sources, have kept at the very forefront of modern science, but systems operators—the assemblers, building trades, and even architects, to say nothing of regulatory bodies—have not supported most efficient assimilation of these components into systems of new structures.
>
> On the other hand, in the power industries, the components resources—the makers of boilers and other energy converters, turbines, generators, distributing equipment, appliances, and so forth —have largely, on their own initiative, kept close to the systems engineers and operators, that is, the electric utility companies. The generally excellent results that accrue are noted subsequently. In the communications industry, it has so far been largely possible to integrate the research components developers and manufacturers directly with the systems operators, as is seen in radio companies, such as RCA with their manufacturing and broadcast activities; the telephone companies, such as General Telephone and Electronics, with its Sylvania manufacturing branch, the Bell System with the Western Electric Company, and others. Here the efficiency and responsiveness to human and public needs seem to be the highest, and it may be that the demands of modern society for use of science and technology will require more and more of this kind of integration.

In the foregoing remarks, one sort of inseparability was asserted, the essential continuity of suppliers and operators. George L. Simpson, Jr., of NASA, observed the underlying mechanics of the connections in the following passages, in which he established a second principle of linkage to guide organizational subdivision—the continuity of information and decision:

> Somehow a source of information, of communication must be tied rather closely and insistently to a structure of action. Communication must be sharp enough and focussed enough to be

acted on; the best source of information can only give information. To be effective it must be brought very close to a structure of action.

Let me give an illustration. The present Council of Economic Advisors is at once a source of information with a specific directive, and a part of the structure for governmental action. Because it is built into this structure, its study, its work, its communications cannot be ignored.

In the metropolitan community, [a mechanism for information] must be established in the structure of government, the structure of action, that it cannot be ignored—not that the information must be accepted, not that it must be applied. But the mechanism must be such that the information cannot be ignored in the normal course of that community's life and action.

Two of the Conference participants in their divergent remarks highlighted a major tension in modern urban life over the best mix between public policy and the private market in the determination of many metropolitan questions. This again is an aspect of decentralization. Dr. Baker reminded the Conference of the remarkable role of profits in achieving effective exploitation of resources. He said:

It is always interesting that the great diversity, the choices, the options that are provided to man by modern science and technology have actually made true profits one of the most valuable and essential gauges of social progress. . . . Society chooses, often with the sure touch of mass preference, to get from among many the particular type and quality of goods and services it wants. By its willingness to pay and to provide profits in this way, society stimulates the emergence of the best and the most effective. This process, subject of course to exceptions and to the scoffs of the cynic, still seems to be the greatest hope for the proper selective use of science and technology in the national interest. The American people seem to have a shrewd realization that this is a good tactic for the wisest exploitation of technical discovery and engineering. These policies must be accepted governmentally and politically if there is to be progress in the great urban complexes which are emerging, and wherein especially there is a temptation to collectivize and to ignore the selectivity and thrust toward quality provided by a responsible profit system.

Dr. Baker was speaking, of course, of the profit motive as a general selective mechanism. It is hard to imagine that the central current role of NASA, the moon-landing mission in this decade, could have been determined in the marketplace; and he did not challenge the validity of the space effort. Whether the evolution of the metropolis itself should be placed in the public-policy category was the subject of the following assertions by Karl W. Wolf of North American Research Corporation.

But the key question remains: What is the system supposed to do? In other words, how do we want to live, and, even, what really do we individually want to become and what kind of environment or city is necessary to our growth?

In contrast to their utilization in the space program and in defense, science and technology must be seen within the framework of socioeconomic systems in the metropolitan sphere. Science and technology here are genuinely enabling factors, which, when properly planned, can lead to a maximum freedom of choice. Considering interdisciplinary approaches as well as the impact of science and technology across all kinds of metropolitan areas and functions, it becomes clear that partial, half-hearted planning cannot encompass the range of choices which our technology and wealth theoretically can make possible.

This realization that our problems can only be solved on a revolutionarily large scale means that a whole range of values now becomes a matter of social policy. Comprehensive planning will be necessary in a different sense of the word than is used today. Key elements in this new type of planning require the contributions of the philosopher, the statesman, the visionary, the scientist, and the artist who is capable of transforming the concepts and goals into the physical shape of urban architecture. Such planning might demand technical, economic, and administrative means not yet in existence.

Thus far, you will note, I have drawn on the Conference participants for related ideas about how to deal effectively with a complex phenomenon like the urban metropolis. The following propositions summarize the statements:

(1) It is essential that someone be responsible for seeing the metropolis as a whole and for setting policy with respect to the parts in full appreciation of the effects on the whole and *vice versa*.

(2) In this process, there must be as much continuity and integration as possible, both within the chain from supplier

to operator, and within the chain from information and plan formulation to responsible action.

(3) The mechanisms of the market, including the energizing search for profits, have proved strikingly effective in advancing technology and distributing its fruits. Any contrary policy for decisions in the metropolis should be regarded and applied with great caution.

(4) Nevertheless, through deliberate social policy the range of choices about homes and jobs and shopping and recreation within the urban system could be greatly extended over the choices the market now offers. This could be achieved through the adoption and realization of governmentally-initiated measures to influence the evolution of an environment of a kind that would not be likely to arise merely out of the market mechanism. Our exploitation of the profit motive has outstripped our techniques of public action in the urban area. The highest priority, therefore, should be given to the creation of technical, economic, and administrative means for achieving, in the excellence of the urban environment, the potential that is implicit in the scientific and technological revolution of our day.

The second major contribution of the Conference on the potential application of space program concepts to the improvement of urban life, like the first one, was not a technique or an invention but another very general concept. This was the powerful conviction, voiced by scientists who had been involved in the space effort, that what a people accomplishes is very directly the outcome of what they expect to accomplish. If this be true, it has vital implications for the urban community. By what means will we set the goals for metropolitan action? How will we pitch our aspirations high enough to spur our efforts to the maximum level of excellence attainable? Before coming to these operational questions, let us look first at the underlying premise. Dr. Baker expressed it when he was commenting on the key impact of the space program on urban life:

Thus, there will not be a loose spillage of these efforts and results into other main channels of industry and commerce. Presumably, the better the management of these missions, the less the byproduct that emerges casually in the form of commercial technology. This quality of modern science and technology is probably not yet well understood, since in an earlier part of this century it was fitting and fashionable to emphasize the unity of knowledge in technology as well as in science. In the meantime, however, and even just during the past decade, the accumulated knowledge about each of several different technologies has become so large that practical transfer among them is increasingly inhibited.

However, there does seem to be a deep coupling of the major forces of our space program with the most central needs of our society. This can be shown in respect to the transportation, communication, power resources, and construction industries. This coupling is through the *expectations* which space systems and programs represent to the people of our nation. Thus our people see, first, that our national leaders bespeak expectations from science and engineering beyond those ever realized before. Then they see our national abilities, led by scientists and engineers, turned actually to achieve many of those seemingly fantastic expectations. Manned space flight is probably the classic example, so far, of this national gaining of the "insuperable." Here is seen, indeed, a very subtle quality of the Free World's approach, even in the formulation of these expectations, in contrast to the approach of other societies. We have been critized for announcing beforehand our expectations of space achievements, particularly of manned flight, and most recently of lunar voyages. Our habits are in striking contrast to the practices of other nations, whose achievements in this field have been announced only after the fact.

It is true that exercising such restraint is a conservative and certainly canny way to play a cosmic and costly game. On the other hand, if, indeed, the aspirations of man in science and technology are to liberate wellsprings of human energy—as in the great cathedral building waves of the Middle Ages or the oceanic explorations of a few centuries ago—is it not wise, and also just, to have the detailed nature of science and engineering behind these feats laid out as great expectations beforehand? It is experience with these new dimensions of expectations by our people and the reasonable achievement of such expectations in such domains as our national space program that will, in fact, have the most profound influence on the role of science in other and perhaps even more vital affairs. It is in this context that I would like to suggest the effects of expectations on scientific developments in industries that will be central to progress in regional and urban well-being and advance in the years ahead. . . .

Why are aspects of operations in outer space so prominent in our foresight about the industrial strength which must underlie urban welfare? This is because the industries involved in urban support — transportation, communication, power resources, and construction—are composed of large technical systems. They cannot be either advanced or best directed by any single miracle of discovery . . . Thus, on the whole, what is required most for progress in these areas is a progressive set of expectations, very great and very brave ones, that will challenge the scientists and engineers of these enterprises and of our national community to do the best things for each of them.

Later in the Conference, Dr. Wolf carried this thinking a step further in its direct application to the metropolis as a unified entity, an urban system for producing excellence in the human environment. He said:

Comprehensive planning, furthermore, must incorporate to some degree a revival of Utopian thinking as an intellectual challenge in order to identify the numerous possibilities of metropolitan life. First, in the two-phase new planning approach, the planning team must deliberately divorce itself from narrowly practical considerations. It must forget about pragmatics and address itself to the potentials of the urban environment, since the ideas of the future influence to a great extent what the future will be. Creative foresight and planning go beyond experience. Together, they not only copy the past; they also combine past elements in new ways to construct better fitting results and they also introduce a host of new factors.

Planning is characterized by its forward look. It is, however, much more than prediction—it means shaping the future as one wants it to be and is capable of making it.

This, then, leads us to the incorporation of "the existing" or, in other words, the experiences, and to the *second* phase of the new planning approach. Here the dream or the idea is transformed to the attainable. Here, the more powerful the organization that implements and the more comprehensive the plan, the greater the chances of success because the more factors can be kept under control.

We do not leave, for example, the matter of defense or space research solely to private industry or to groups and associations dealing with foreign affairs. It is done in a tremendous cooperative effort in which professional military men and government scientists lead in the projection of systems requirements, the subsequent identification of inventions, and the consequently needed research. An inter-disciplinary group of men must first identify the fundamental questions to be answered before genuinely "practical" or completely fitting solutions are possible.

The same should be done for solving metropolitan problems, especially in the utilization of science and technology. Both are ambiguous and can be made to serve a variety of often non-compatible needs.

The operative question is: How can we bring this kind of process about? Here is Carl Stover's view, continuing the remarks I alluded to in part earlier:

We would never, I believe, have thought it sensible to try to get to the moon with spin-off from the regular operation of American industry—even though some of the knowledge and some of the technical skills that have been developed in American industry for other purposes have been helpful in getting the space job done. If we had approached the space job with the goodness of heart, the weakness of mind, and the confusion of purpose that characterize most of our efforts to improve urban areas, we would never have gotten off the launching pad.

At the outset we must decide what cities ought to be. We have to discover how a city can be a good home, fostering good men. This is another reason for caution in approaching the problems of the urban area strictly from the standpoint of technology—for while the city is an engineering system, it is also a human system. In attempting to apply technology to the human system, some of technology's greatest virtues actually turn out to be its greatest liabilities. The values inherent in technology may not always be the values we want for man—efficiency, order, and rationality as technology projects it. Would a city perfectly ordered by technology be a good home for man?

By tradition, the pursuit of the common good is the purpose of politics. Thus, if technology is to serve the common good, there must be a political judgment. Here, I think, all of us are inclined to balk, because when we look at politics, we see a bad image. We are reminded of deals, of inefficiency, of wastefulness, and of disorder. One answer to this has been to transform politics into administration. I do not think that this is ultimately the correct answer for a society as dedicated as we are to the importance of the citizen's role in determining not only the directions of his government but also the processes through which his government operates. Thus, a very important consideration which comes about as a result of thinking about technology and its impact on the metropolitan area and upon our national life is how we can somehow restore politics to its proper role as a process whereby the total community can participate in making judgments about the future shape of the common life.

A tremendous burden falls today on you who are the citizens of the Nation's Capital metropolis. For the people of America, Washington is the symbol of urban beauty. Your majestic public spaces, your trees in blossom, your monuments, and your monumental design are the images Americans carry with them when they envision urban magnificence.

But you and I know also that there is an ugly and sordid Washington, a city of poverty where the human spirit sickens and children grow in bitterness at the contrast between the marble city and the asphalt city. You and I know that true urban beauty resides deeper than the architecture, the sculpture, the plantings, however splendid.

A century ago too, our urban cities were places of sorrow as well as hope, of misery as well as prosperity. What redeemed them and made them essentially human places was the ever-flickering community involvement toward raising the standards of city life. Old law tenements *were* an advance over the warrens that preceded them. The new multiple dwelling laws, the settlement house movement, the early public housing efforts, the urban social work and welfare programs were all products of a vital political community that marked the 19th century city, however inhuman some of its aspects.

What is so paralyzing today, inhibiting effective human interaction on perfectly evident problems, is the way the contemporary urban community, in overleaping the central city boundaries, has destroyed the old mechanism of metropolitan politics—the big city that embraced the whole metropolis; the place where men of all kinds, bound together by the common threads of urban production, came to terms with each other in the give and take of municipal political life. It is not that the 19th century political behavior was especially elevated. Frequently it was not. But the *political* metropolis did then exist, and it was a means of grappling with the urban problems of the day. The whole community could face the whole set of problems.

A very major problem for us is that metropolitan politics really does not now exist. We have conflicts and we have interests in common among the peoples of our spreading urban regions. We have begun informal and voluntary efforts to talk about these matters. But we have not yet created the governmental structures within which metropolitan politics can be played out. Until we do so, we will not solve our tough urban problems, to say nothing of realizing our magnificent urban potentialities. We will have at best a high-capacity transport nework with no worthwhile place to go.

As I experience Washington today, I sense a ferment toward the invention of some new governmental concept embracing the whole expanding metropolis. I see a search for something that will link city and suburb in a new and different unity. Something that will link planning and action together, information and decision. Something that will link social and economic and environmental policy. Something beyond an areawide transportation agency, however comprehensive; beyond a regional land use planning agency, however well staffed. I see coming some instrumentality that will enlist the many leaderships throughout expanding metropolitan Washington and will commit you and your neighbors to the creation here in this century of a great city not yet dreamed.

Pecora Appointed Director Of Geological Survey

William T. Pecora was named director of the Geological Survey in an announcement on September 27 by Secretary of the Interior Stewart L. Udall. He succeeded Thomas B. Nolan, director since 1956, who had resigned the post in order to return to full-time research activity.

Dr. Pecora is the eighth director in the 86-year history of the largest scientific agency in the Department of the Interior. In announcing the appointment, Secretary Udall praised him as a "scientist of unusual depth and stature," and termed the job a "most responsible one, particularly at a time when the mineral and water resources needs in support of our Nation's economy and well-being have never been greater, and when evolving knowledge of the physical structure of the earth is becoming increasingly important in domestic and international affairs."

An outstanding expert in mineralogy, petrology, and geochemistry, with special emphasis on determinations of scientific principles as guides in the exploration of mineral, fuel, and water resources, Dr. Pecora received the B.S. degree in geology at Princeton University in 1933, and the Ph.D. degree in geology at Harvard University in 1940.

Dr. Pecora has acquired international stature for his work in a number of geologic fields, such as rare minerals and volcanic regions. He is the author of over 40 scientific publications based on field and laboratory research. His research studies have been made throughout the United States, and—on behalf of foreign aid programs—have extended into many parts of Latin America.

Among his professional affiliations, Dr. Pecora is a member or fellow of the National Academy of Sciences, the American Academy of Arts and Sciences, the Washington Academy of Sciences, the Geological Society of America, the Geological Society of Washington, and the Executive Committee of NRC's Division of Earth Sciences.

T-THOUGHTS

The Function of an Executive

The following is a delightful delineation of the function of an executive:

"As nearly everyone knows, an executive has practically nothing to do except to decide what is to be done; to tell somebody to do it, to listen to reasons why it should not be done, why it should be done by someone else, or why it should be done in a different way; to follow up to see if the thing has been done; to discover that it has not; to enquire why; to listen to excuses from the person who should have done it; to follow up again to see if the thing has been done, only to discover that it has been done incorrectly; to point out how it should have been done; to conclude that as long as it has been done, it may as well be left where it is; to wonder if it is not time to get rid of a person who cannot do a thing right; to reflect that he probably has a wife and a large family, and that certainly any successor would be just as bad, and maybe worse; to consider how much simpler and better the thing would have been done if one had done it oneself in the first place; to reflect sadly that one could have done it right in twenty minutes, and, as things turned out, one has had to spend two days to find out why it has taken three weeks for somebody else to do it wrong."

Also I might add a quote from Major General Leslie E. Simon, USA (Retired):

"It is good to have the strength of a giant; it is shameful to exercise it."

—Ralph G. H. Siu

A CONTRIBUTION FROM THE ARCHIVIST

A Critical View of Mendel's Law In the Proceedings of 1907

The centenary of Mendel's main work provides the occasion for recalling a discussion of "Mendelism" in this Academy 58 years ago. At the meeting of February 26, 1907, Charles B. Davenport spoke about "Heredity and Mendel's Law"(1). In the discussion, O. F. Cook voiced his objections. He then elaborated his remarks into a 50-page article(2), of which some parts from the beginning and from the end are reprinted below.

Orator Fuller Cook (1867-1949) was an active biologist, a great traveler, and a prolific writer (3). W. Andrew Archer, his colleague at the National Arboretum, compiled a bibliography, dated June 15, 1950, in which he listed 397 items published by Cook between 1887 and 1947. In an additional report, Archer filled 70 pages with a chronological "Itinerary of O. F. Cook" which he introduces as follows:

> The not inconsiderable task in compiling this itinerary has been done mainly in the hope that it might guide to determine the origin (in doubtful cases) of the innumerable specimens accumulated by Dr. Cook in various fields, principally palms, wild cottons, economic plants, general tropical flora, fungi, millipedes, ants, and fossils" (4).

In one of his many publications in the Academy, Cook explains his "kinetic view of prepotency" which he wants to be understood "not in the Mendelian sense of an arbitrary and inexplicable 'dominance' of one character over another, but mindful of the law of proportion between symbiasis and prepotency" (5).

As the following excerpts from his 1907 article show, Cook has two fundamental objections: (1) "The methods of reproduction rather than the methods of inheritance" are responsible for "the definite mathematical relations which appear in a Mendelian experiment." (2) We must distinguish "the process of transmission" from "the process of expression"; often, there is a polarity between these two.

References

(1) C. B. Davenport, Proc. Wash. Acad. Sci. *9* 179-187 (1907).

(2) O. F. Cook, Mendelism and other methods of descent. Ibid. 189-239.

(3) Obituary by H. F. Loomis. J. Washington Acad. Sci. *40*, 173-5 (1950).

(4) The two mimeographed reports are available in the Department of Agriculture Library.

(5) O. F. Cook, The vital fabric of descent. Proc. Wash. Acad. Sci. 7, 301-323, (esp. p. 314) (1906).

—*Eduard Farber*

Excerpts from the Cook Article

[190] In Mendelian crosses or hybrids there is a definite and uniform proportion between the expression of characters in what are called the first and second generations. It has not unnaturally been supposed that this regularity of proportion must obey an internal law or principle of descent governing the relations and combinations of characters. Definite mathematical relations must represent, it has been argued, definite entities inside the germ-cells. Here, at last, appeared to be a triumphant justification for the mechanical speculations of Darwin, Nägeli, and Weismann, to the effect that characters are transmitted from generation to generation by means of minute determinant particles or character-units of the germ-cells. It was found possible to explain the mathematical relations of typical cases of Mendelism by supposing that the presence or absence of certain particles in the germ-cells determined the presence or absence of the character in the adult organism.

In a Mendelian cross the parents differ in at least one pair of definitely contrasted characters. All the individuals of the so-called first generation show the character of one of the parents, which is called the dominant. In the following generations three-quarters of the individuals have this character of the dominant parent, and one quarter the other character (recessive), which did not appear at all in the first generation. . . .

[191] The Nature of Experiments in Descent

But if the facts of Mendelism are examined somewhat more closely and in the light of modern knowledge of the peculiar nature of the reproductive processes of the higher plants and animals, it will be found that the definite mathematical relations which appear in a Mendelian experiment arise from the methods of reproduction rather than from the methods of inheritance. Other interpretations are possible. . . .

[218] Position of Mendelism as a Method of Descent

Mendelism is one of the methods of descent in which unlike produce unlike. Mendelism has aroused special interest in the scientific world largely because it seemed to contradict the earlier inferences from the idea of heredity, by showing that contrasted differences are preserved, and not reduced to a uniform intermediate average. Instead of being a form of heredity, Mendelism is a specialization of heterism; it is one of the methods of increasing diversity of descent, which sustains the efficiency of the processes of sexual reproduction. The preservation of differences inside the species by means of sex-inheritance is one of the most familiar phenomena of descent, but the intimate resemblance between Mendelism and sex-inheritance has not been adequately appreciated.

[238] Conclusions

A typical experiment in Mendelism, instead of involving two successive crosses or conjugations of gametes, includes only one such cross. The so-called first generation is built up by the vegetative subdivisions of the gamete parents, before conjugation is completed. The so-called second generation represents the first organisms produced after the completion of the conjugation of the gamete parents.

The difference of proportion between the two generations in the expression of divergent parental characters is to be explained by the peculiar methods of reproduction followed by the higher plants and animals, and by the fact of dominance or expression-polarity, instead of by the Mendelian theory of alternative inheritance of character-unit particles.

Mutations do not differ from Mendelian hybrids in any essential respect, either at the time of their first appearance or in later combinations. The preservation of the new character by definitely reciprocal inheritance of expression-polarities is favored by the same conditions of restricted descent which induce the mutative variations.

The analogy of the Mendelian phenomena, applied to variations induced by crossing, shows that new characters which come to expression in the first or conjugate generation are not likely to be permanent. Dominant variations can gain expression in the second or perjugate generation, but recessive variations are not shown before thc third generation, and may not be brought into expression until still later generations, unless the first perjugate generation is self-fertilized. As many variations of economic value behave as recessives, this fact is of practical significance in breeding experiments.

Two distinct phenomena have been confused in the Mendelian conception of inheritance, transmission and expression. The failure of a character to secure expression does not indicate that it has failed of transmission. Polarity, or reciprocal expression inheritance of divergent parental characters, explains the phenomena of Mendelism and related forms of descent without requiring the assumption of pure germ-cells or of character-unit particles.

There is no evidence that normal transmission-inheritance is a phenomenon involving the alternative admission or exclusion of character-units, or that characters are transmitted as particles or mechanisms. The process of transmission is independent and separate from the process of expression, which often yields polar or reciprocal results. This reciprocal polarity of expression-inheritance shows how new characters can be preserved and thus contribute to the normal diversity of a species or gradually transform it. Evolutionary advance can thus take place without selective or geographical isolation. The general evolutionary significance of Mendelism lies in its testimony to this fact, and not in the theories of inheritance by character-units and pure germ-cells.

Academy Proceedings

491st Meeting of the Washington Academy of Sciences

SUBJECT: MENDELIAN CENTENNIAL CELEBRATION (1865-1965)

PLACE: GEORGETOWN UNIVERSITY
37th and O Streets, N.W.

DATE: THURSDAY, NOVEMBER 18, 1965

SCHEDULE

Cocktails at 6:00 p.m. in the Faculty Lounge, New South Hall
Dinner at 6:45 in the Main Dining Room, New South Hall
After-dinner lectures at 8:30 in Gaston Hall Auditorium

DINNER SPEAKER

Alexander Weinstein, Harvard University, "The Reception of Mendel's Paper by His Contemporaries"

In 1866 there appeared a paper on hybridization which advocated further research into the problem, "to what extent the characters of the paternal and the maternal plant remain unmodified in the hybrid, and to what extent, after they have blended with each other, they can separate again." Geneticists will recognize in this a statement of the Mendelian theory of segregation. The writer of the words, however, was not Mendel but Nageli.

Obviously this contradicts the ordinary view that Nageli did not understand Mendel's work and ultimately forgot it. Because of his reputation as the leading expert of his day on matters of heredity, the opinion of Nageli was decisive in the case of Mendel. We can say he understood, but that he failed to grasp the full significance of Mendel's ideas, perhaps because other features, thought to influence development, had not been properly evaluated.

AFTER-DINNER LECTURES

(1) Louis Levine, City College of New York, "Mendelian and Evolutionary Genetics"

Mendel's theory of heredity included the principles of dominance, segregation, and independent assortment. Subsequent research indicated that the genes are located on the chromosomes which can break and form new combinations or arrangements of the genes. The demonstration of gene mutation combined with the facts of heredity permitted investigations on evolutionary genetics. Distributions of genotypes in populations and the factors that would alter their frequencies were studied. Field and laboratory studies of Drosophila have indicated the possible ways that natural selection can operate in evolution.

(*Continued on next page*)

(2) Ellis Bolton, Carnegie Institution of Washington, "The Physical Basis of Inheritance"

The nucleotide sequences in deoxynucleic acid (DNA) represent the total genetic potential of organisms and those in ribonucleic acid (RNA) molecules, the primary gene products, indicate the activity of genes. DNA is a duplex structure whose complementary strands may be separated and caused to recombine. RNA, in general, is a single-stranded structure and since it is the primary gene product that reflects the nucleotide sequences in DNA, it may also be induced to combine with complementary regions in DNA. These observations have led to the development of powerful new tools which are being used to penetrate into the most intimate aspects of the architecture and molecular behavior of living cells, and into gentic relationships among organisms.

Non-members wishing to attend the cocktail party and the dinner ($3.00) should telephone reservations to Mrs. Humphrey, Washington Academy of Sciences (AD 4-5323) by November 15. Members should use the forms that were sent to them by mail.

No reservations are needed for lectures in Gaston Hall Auditorium.

The Public Is Invited

BOARD OF MANAGERS MEETING NOTES

March Meeting

The Board of Managers held its 571st meeting on March 18 at the Cosmos Club, with President Schubert presiding.

The minutes of the 570th meeting were approved as previously distributed.

Announcements. Dr. Schubert announced that continued consideration had been given to establishment of a Membership Committee panel for behavioral sciences. However, a prospective chairman of the panel had declined appointment on the grounds that it was not clear what the behavioral sciences were thought to be by the Academy, and on what standards behavioral scientist nominees should be judged. The Board felt that these questions warranted further study; Dr. Schubert indicated that he would discuss them with the Executive Committee at its meeting on April 13.

Secretary and Treasurer. Mrs. Elizabeth Humphrey of the Academy office reported for the secretary and treasurer. She reported current balances of $5,758 for the Academy and $1,977 for the Junior Academy.

The Board approved requests by Franklin E. Allison, Donald B. Brooks, Kenneth G. Clark, Ned R. Ellis, Frank L. Roth, and Willis L. Tressier for transfer to emeritus status. Resignations by Raymond L. Nace, Myrna J. Robertson, George L. Trager, and Walter G. Wadey were accepted. The Board suggested that in considering requests for emeritus status, Mrs. Humphrey should ascertain whether the members had actually retired from gainful employment of any sort, or had merely retired from their official positions.

The Board declined a request from a junior high school in New York State for the loan of back issues of the Journal; it was suggested that Mrs. Humphrey try to determine whether Journals were available at some library within the area of the school, and so inform the school.

Public Information. Dr. DeVore reported that responsibility for publishing the Science Calendar has been transferred from the Joint Board on Science Education to the Washington Board of Trade, thereby saving the Academy $350 annually. Frank McManus of the Board of Trade is the contact for information regarding the Calendar.

Dr. Schubert commented that the Joint Board had expanded its name to "Joint Board on Education for Science, Engineering, and Technology of the Greater Washington Area."

Meetings. Dr. Steinhardt reported that the April "Conversazione" would be similar in format to the one held in 1964, with a new list of topics for discussion. Several Board members suggested that round tables for the discussion groups would be preferable to the long, rectangular tables used last year, although it was recognized that round tables would involve an extra charge by the Cosmos Club.

Special Events. Chairman Diamond pointed out that establishment of a Meeting Arrangements Committee appeared to have obviated the need for his Special Events Committee, and recommended that the latter be abolished. After considerable discussion of the functions of the Program, Meeting Arrangements, and Special Events Committees it was decided to continue the Special Events Committee during 1965.

Science Education. Dr. Taylor announced that the fifth curriculum conference for teachers, sponsored by the Joint Board, would be held at the Naval Ordnance Laboratory on April 3; also, that the last conference of the series, concerned with elementary school science teaching, would be held at Ramsey School, Alexandria, on May 1.

On Dr. Taylor's motion, the Board approved a contribution of $300 to the Joint Board, in accordance with its annual practice.

Encouragement of Science Talent. Dr. Schubert read a communication from Father Heyden, listing 40 local high school seniors selected by the Committee for 1965 awards, namely, a certificate of merit and a voucher worth $7.50 for a book to be selected by the student. It was also announced that the annual student award dinner would be held at Georgetown University on April 21; members of the Academy were welcome to attend.

Mrs. Humphrey stated that in 1964, only 23 students out of the 40 selected had purchased books, so that about $139 of the $300 deposited with Brentano's, to cover the estimated cost of the books, had been returned to the Academy. She hoped that the voucher arrangement set up for 1965 would prove more successful than the 1964 system, of depositing a lump sum and then issuing letters of credit to the students.

Dr. DeVore announced that on April 7, at the Cosmos Club, illustrated lectures would be presented by the three winners of the 1964 Young Engineers, Applied Scientists, and Architect Awards, sponsored by the D. C. Council of Engineering and Architectural Societies and the Washington Academy of Sciences.

Archivist. Dr. Farber reported that he had at hand a number of miscellaneous publications received at one time or another from other scientific organizations. The Board recommended that they be given to the United States Book Exchange.

History of Science in Washington. Dr. Leikind reported on the recent first meeting of this newly-organized committee. In response to a portion of the report, Mr. Detwiler commented that interesting articles on the history of science in Washington were always welcomed in the *Journal.*

Editor. Mr. Detwiler reported that copy for the April issue of the Journal had been sent to the printer.

Other Business. Dr. Schubert reported that he and Dr. Frenkiel had represented the Academy at the Engineers' Scientists, and Architects Day meeting, held February 17 at the Presidential Arms.

May Meeting

The Board of Managers held its 572nd meeting on May 20 at the National Academy of Sciences, with President Schubert presiding.

The minutes of the 571st meeting were approved as previously distributed.

Announcements. Dr. Schubert announced that Howard Owens of *Science,* Dorothy Calber of Yorktown High School, Virginia, and Charles Davis of American University had been appointed to the Joint Board on Education for Science, Engineering, and Technology of the Greater Washington area (formerly the Joint Board on Science Education). He also announced the death on May 20 of Ralph Goetzenberger, immediate past president of the D. C. Council of the Architectural and Engineering Societies.

Secretary. Dr. Forziati reported that Frank Neumann of Seattle, Wash., a fellow of the Academy, had been killed in the Alaskan earthquake of March 9, 1964. He also reported several changes in the Board of Managers, as follows: Peter H. Heinze as new delegate from the Botanical Society; Florence H. Forziati as new delegate from the Chemical Society of Washington; Morris Leikind as delegate from Washington History of Science Club; Elmer L. Mayer as new delegate from the Insecticide Society of America; Malcolm C. Henderson as new delegate from the Philosophical Society; and Maurice Apstein to be removed as delegate from the American Society of Mechanical Engineers.

Treasurer. Mr. Miller reported that at the end of April, the Academy's income (not counting a $1,000 loan repaid by the Junior Academy) was $14,333, and its expenses $11,641, leaving a balance of $2,692. Last year at the same date, $12,478 had been received, and by the end of the year a total of $18,539 had been received. If the same proportion holds, total income for 1965 could be about $21,000; if income is the same as in 1964, then expenditures again will be out of line with income.

Last year, total expenditures were $7,863 above income. Mr. Miller felt that 1965 expenses should be pared to bring them into line with anticipated income.

Mr. Miller also reported that 110 resident fellows, 29 nonresident fellows, and 19 members had not paid their 1965 dues; he estimated that the total back dues owed amounted to about $1,860. He planned to contact the delinquents during the summer when the membership lists were reviewed.

Dr. McClellan inquired about the causes of the Academy's deficit spending in 1964. Mr. Detwiler explained that this was due primarily to the need for an Academy office, with a part-time paid secretary, and to the desire of the 1964 Board for an expanded Journal. Dr. Forziati explained that meetings also have become more expensive: Board dinners are subsidized to the extent of a dollar per person attending, and the annual award dinner costs about $800. So far in 1965, $1600 had been spent on meetings.

Dr. Schubert stated that he planned to appoint a budget committee to allocate funds for the remainder of the year.

Membership. Dr. Cook reported that at meetings on March 30 and May 3, the Committee had elected eight candidates to membership, as follows: Michael R. DeCarlo, Charles DeVore, Berenice G. Lamberton, Donald J. Morriss, Robert S. Weber, Constance P. Wrench, Richard O'Day, and Ernst M. Cohn.

On Dr. Cook's recommendation, the Board elected 20 persons to fellowship in the Academy, as fellows: Arthur R. von Hippel, Ronald E. Walker, William M. Frank, John D. Morton, Jean R. DuPont, Jay S. Winston, Robert B. Beckmann, Joseph A. Faulkner, Edward A. Wolff, Charles W. Misner, Donald F. Brandewie, Wilbur I. Patterson, Bruce L. Reinhart, Raymond A. Galloway, Bruce N. Ames, W. Wayne Meinke, Allison R. Palmer, Donald J. Morriss, Donald D. Wagman, and Leslie A. Guildner.

Meetings. In the absence of the meetings chairman, Dr. Schubert announced that the fall meetings program was essentially complete. For the November meeting, a special program is planned to celebrate the Mendel centennial, with cooperation from the affiliated societies.

Grants-in-Aid. On recommendation of Dr. Cole, the Board approved a grant of not more than $200 to Jon R. Voskuil of George C. Marshall High School, Falls Church, for work in the field of piezoelectricity and crystal resonance. (The exact amount was later determined to be $70, to be spent for an ultrasonic generator, a Rochelle salt crystal, and miscellaneous electronic components.)

Science Education. Dr. Schubert announced that Dr. Taylor was approaching the end of his term as chairman of this committee, and did not wish to continue. He asked the Board to suggest names for a replacement.

Dr. Schubert reported that he had written to the Academy's affiliates to request financial support of the Joint Board; to date, he had received seven replies but only three contributions.

Dr. Schubert also mentioned that the Junior Academy was again financially solvent, since the Pennsylvania Railroad had paid the travel commission due for last year's group trips.

Encouragement of Science Talent, Father Heyden reported that the Committee had concluded its activities for this year with an award dinner for 40 outstanding high school science students, held in April.

Editor. Mr. Detwiler asked for expressions of opinion on the desirability of including rosters of various affiliated societies in the September directory, as was the case in 1963 and 1964.

Policy Planning. In the absence of Chairman Cowie, Dr. Schubert stated that he had reviewed the recommendations of this Committee over the past three years, and was surprised to find that no action had ever been taken by the Board. Dr. Robbins suggested that a summary of the Committee's recommendations be mailed to Board members for future consideration.

New Business. Dr. Farber announced that he had written a monograph, "Oxidation Theories and Techniques in the 19th Century and the Beginning of the 20th," which had been supported in part by an NSF grant, although he had borne most of the cost of preparing the manuscript. Dr. Schubert said that American University would be willing to provide funds for printing 2,000 copies of the monograph, and wondered whether the Academy would be willing to sponsor it. No formal decision was reached.

Dr. Schubert discussed a request that the Academy should support Engineers, Scientists, and Architects Day activities with a $150 contribution. There was a general discussion of the desirability of active participation in this affair, without a definite conclusion. The question of financial support was deferred to a fall meeting of the Board.

NAS-NRC will sponsor a public symposium on Scientific Aspects of Pest Control, in Washington on January 31-February 3, 1966. The program is intended to provide a comprehensive review of the present status of pest control in modern life. It will encompass the methods of pest control—biological, chemical, and genetic—presently in use, their development and regulation, and the multiplicity of ways in which pest control measures interact with the physical environment, with plant and animal life, and with man. Special emphasis will be given to the advances, problems, and future needs in pest control research. Attendance will be open to persons involved in every aspect of pest control. The Department of Agriculture, acting on behalf of HEW, Interior, and other Federal agencies, requested NAS-NRC to conduct the program, which will be held in the Department of State auditorium.

Science in Washington

SCIENTISTS IN THE NEWS

Contributions to this column may be addressed to Harold T. Cook, Associate Editor, c/o Department of Agriculture, Agricultural Research Service, Federal Center Building, Hyattsville, Md.

AGRICULTURE DEPARTMENT

A. M. POMMER has been elected to full membership by the Chapter-at-large, Society of the Sigma Xi. He also has been appointed co-chairman of the Research and Engineering Management Round Table; chairman of the Publicity Committee, Instrument Society of America; and chairman of the Research Committee, Maryland Association for Retarded Children.

C. R. BENJAMIN was named president-elect of the Mycological Society of America at its annual meeting, held at the University of Illinois last August. He will assume the duties of president of the society in August 1966.

ASHLEY B. GURNEY, Entomology Research Division, returned early in September after five months overseas; he was engaged in field and curatorial studies on grasshoppers and related insects in cooperation with the Egyptian Ministry of Agriculture, under a P. L. 480 project dealing with the insect fauna of Egypt. He also spent three weeks collecting insects in Ethiopia, and five weeks studying cockroach and grasshopper identifications in several European and English museums.

GEORGE W. IRVING, JR., has been appointed a member of the Scientific Advisory Board of the Sugar Research Foundation, Inc., New York City. Dr. Irving also will serve on the advisory board for American University's 11th Institute on Research Administration. During the month of October, he addressed the USDA Club in Chicago; the Hyattsville Lions Club; and participants in a Foreign Affairs Seminar held at the Agricultural Research Center in Beltsville.

JUSTUS C. WARD served as a member of the FAO Working Party on Official Control of Pesticides which met in Rome from September 20 to 25. The aim of the Working Party was to survey the possibility of proposing a model law on pesticides, for offer by FAO to any country that needs guidance in writing a pesticide law.

COAST AND GEODETIC SURVEY

DONALD A. RICE participated in symposia of the International Association of Geodesy for Electromagnetic Distance Measurements held at Oxford, England, September 6-11, and in the meeting of the International Gravimetric Commission, Paris, France, September 15-18.

DAVID G. KNAPP participated in the Second International Symposium on Equatorial Aeronomy, Sao Jose dos Campos, Brazil, September 5-11.

NATIONAL BUREAU OF STANDARDS

WILLIAM J. YOUDEN retired on June 30 from the Applied Mathematics Division. Internationally known as a statistician, Dr. Youden had been with the Bureau since 1948. He has done significant research in mathematical statistics, especially in the field of experiment design, and has vigorously promoted sound understanding and increased utilization of modern statistical techniques throughout science and industry.

ALLEN V. ASTIN received the fourth ASTM Award to Executives on June 16. Presented at the Society's Annual Meeting held at Purdue University, the award "honors an executive who, through his outstanding interest and support, has furthered the accomplishments of ASTM."

JOHN A. BENNETT, metallurgist in the Engineering Metallurgy Section, received the ninth Richard L. Templin Award of the American Society for Testing Materials on June 16, at an awards luncheon held during ASTM's 68th Annual Meeting at Purdue University. He was cited for an outstanding paper, "A Simple Environmental Chamber for Rotating-Beam Fatigue," published in the June 1963 issue of ASTM's monthly journal, *Materials Research & Standards.*

SAMUEL PENNER, an internationally known nuclear physicist, was recently appointed chief of the Accelerator Physics Laboratory in the Institute for Basic Standards. In this position, he will plan, direct, and conduct original research in nuclear physics with particular emphasis on determining the structure of nuclei with the technique of elastic and inelastic electron scattering.

OSCAR MENIS was recently appointed chief of the Quantitative Separations Section of the Analytical Chemistry Division, Institute for Materials Research. As head of this Section, he will be responsible for the development of a program to broaden and refine the traditional methods of chemical analysis which should lead to marked improvement of the Bureau's capabilities in the area of standard reference materials and in its program of service analysis.

Invitational papers have been given by staff members in foreign countries, as follows:

G. M. Brauer, H. J. Caul, G. Dickson, G. C. Paffenbarger and W. T. Sweeney at the International Association for Dental Research, Toronto, July 22-25.

D. R. Lide and C. M. Sitterly at the 8th European Congress on Molecular Spectroscopy, Copenhagen, August 16-20.

J. R. McNesby, H. Okabe, and M. D. Scheer before the International Conference on Photochemistry, Tokyo, August 25-28.

J. R. Manning at the International Conference on Electron Diffraction and Crystal Defects, Melbourne, Australia, August 16-21.

L. Marton at the 3rd Czechoslovak Conference on Electronics and Vacuum Physics, Prague, September 23; Indian Institute of Science, Bangalore, September 3; and the Hungarian Academy of Sciences, Research Institute for Technical Physics, Budapest, September 28.

K. E. Shuler, a series of lectures at the NATO Summer School on Theoretical Chemistry, Lake Constance, Germany, September 14-24.

J. R. McNesby at the Max-Planck-Institut für Kohlenforschung, Mulheim, West Germany, September 15.

M. D. Scheer before the Chemical Society of Japan, Tokyo Institute of Technology, Tokyo, September 3.

C. M. Tchen at the Laboratory for Plasma Physics, Faculty of Sciences, University of Paris, September 21.

NAVAL RESEARCH LABORATORY

W. S. PELLINI, superintendent of the Metallurgy Division, is now on detached service with the London Office of the Office of Naval Research for an extended period. In this assignment he will be making a survey of metallurgical developments in Europe.

PETER KING, currently chief scientist of the Office of Naval Research, London, recently spent two weeks in Washington visiting local laboratories and scientific organizations. Dr. King will remain at his post in London for an additional year.

A. I. SCHINDLER, head of the Metal Physics Branch, has been selected by the NRL Branch of the Research Society of America to receive the RESA Award for Pure Science. The award is made for distinguished research on the electronic structure and related physical properties of transition metal alloys.

JOSEPH A. KIES, head of the Ballistics Branch, was the 1966 winner of the Burgess Memorial Award, presented by the Washington Chapter of the American Society for Metals. Mr. Kies was recognized for his outstanding contributions to metallurgy, specifically as related to the application of fracture mechanics theory and practice to the solution of fracture problems in large rocket motor cases.

Publications Received During the Exchange Program

The Academy office harbors on its shelves a number of books and single issues of journals sent in by scientific organizations with which the Academy entertained an exchange. These publications, some of them relatively unknown and none more recent than 1963, deal with many different subjects. Here is a list of these publications; they are available to readers of this Journal.

Air Pollution Control District, City of Los Angeles (10 issues, 1956-8).

Annales Inst. Nac. de Anthropologia e Historia, *10, 11*, Mexico, 1958-9.

Anthropologia Fisica de Veracrus, by Johanna Faulhaber, 2 vols., 1950-6.

Argentina, Publ. Inst. de Invest. microquimicas, Rosario, *18*, 1954.

Biota *2*, 15, 16, Magdalena del Mar, Peru, 1958.

Bull. Inst. Nat. d'Hygiene, Paris, 4 issues, 1956-8.

Bull. Inst. Politehnic Din Jaci (Roumania), Tom IV (VIII), 1958.

Bull. New Jersey Acad. Sci. *3*, 1, Spring 1958.

Bul. de la Divulgacion Nos. 1, 2, 4, 8, Ministerio de Agric. de Colombia, Palmira, Valle, 1957-9.

Central Meteorological Office, Seoul, Korea, Monthly weather summaries, Oct.-Dec. 1959.

Ciencia e Naturaleza *1*, 1, June 1957, Quito, Ecuador.

Ciencia y Technologia *5*, 18, 19, 1955; *6*, 21, 22, 1956. Ciencias Sociales 7, 39, 40, 1956. Union Panamericana, Washington, D.C.

Conference on the facilities of the Smithsonian Institution, Feb. 27, 1927.

Colloque Interntl. de photochimie corpusculaire, Strassbourg, 1-6 Juillet, 1957 (Abstracts, Paris, 1958).

Faculte des Sciences de l'Universite de Skopje, 1963 (in Cyrillic alphabet, mathematical).

Fields, Robert W. Geology of the La Venta Badlands, Colombia, South America. Univ. of California Press, 1959.

Hindustan Antibiotics Bull. *2*, 2, Nov. 1959.

Iheringia, series scientificas do Museo Rio-Grandense de Ciencias Naturales Zoologicas Nos. 1-4, Porto Allegre, 1957.

Interntl. Union of Anthrop. & Ethnological Sciences, Bull. 2, Vienna, UNESCO, 1959.

Istanbul Teknik Univ. Bult. *11*, 1, Istanbul, 1958.

Memoirs of the Raffles Museum, Singapore *2*, June 1955. (Pridmore, F. Coins and Coinage of the Straits Settlements and British Malaya 1786-1951.)

Ministerio de Agriculture de Colombia, Agriculture tropical *14*, 1958; *15*, 5, 6, 1959.

Minneapolis J. Sci. *2*, 2, Dec. 1958.

New York Academy of Sciences, Trans. Ser. 2, *18* (7), May 1956.

Occupational med. Foundation & Inst. of occupational health, list of occ. health publns. 1940-50, 1951-57, Helsinki, 1958; annual report 1956, Helsinki, 1957.

Osterreichische Ak. d. Wiss. Wien, Math.- Naturwiss. Klasse, Anzeiger *92*, 1-15, 1955; *99*, 1-15, 1962.

Pesquisas No. 2, 1958; No. 3, 1959. Instituto Anchietano de Pesquisas, Porto Allegre, Rio Grande de Sul, Brasil.

Polish scientific abstr. ROK 5 (2), 1959.

Polska Ak. Nauk, Inst. Podstawowysh Probl. Technike, Tom V, 1; VII, 3; VIII, 1-4; IX, 2; 4, 5; XI 5. Warszawa, 1956-9. Subtitle on VIII and IX: Archives de mecanique appliquee.

Publicaciones de la Seccion Ciencia y Tecnologia, Guia de Inst. y Soc. cient. Latinamericanas, Union Panam., Washington, D. C., Part 6, 1953; Part 2, 2nd ed., 1954.

Republica de Venezuela, Minist. de Agricultura y Cria, Mem. 1960, Caracas.

Acta biol. Venezuelica, Vol. 2, Art. 18-28, 1958 (on Mallophaga).

Rev. Colombiana de anthropologia VII, Bogota, 1958.

Rev. Colomb. de Folclor, No. 3, 1959.

Rev. del S.O.P.D.E., Servicio Off. de Difusione Radio Electrica *4*, *5*, Montevideo, 1957.

Bol. inform. de la bibliotheca *42*, 3, 1958; *46*, 7, 1959; *48*, 9, 1960.

Sovjet Review, Nov. 1961, Interntl. Arts & Sciences Press, New York.

Texas Reports on Biol. & Med. *15*, 4, Winter 1957.

Universidad Central de las Villas, Cuba. Excursiones arqueologicas a Camaguey, 1958.

Universidade de Rio Grande do Sul, Escola de geologia, Porto Allegre, 1959. A. W. Schneider, Estudio do sub-sole de Porto Allegre.

Universidad Nacc. de San Marcos de Lima, Fac. de Chimica, 1956. Anti-protons—gravity.

Villars, G. E. Elementos de atomistica, Montevideo, 1953.

Wiss. Zeitschr. Humbold Universitat zu Berlin, Math.-Naturwiss. Reihe *5*, 3, 4, 1955-6. Ges.-und Sprachwiss. Rehie *5*,3, 4, 1955-6; *6*, 2-4; *7*, 3, 1958-9.

Wiss. Zeitschr. Padag. Hochschule Potsdam *4*, 1958-9.

Year Book of the Interntl. Council of the Scientific Unions, 1956 (Roy. Soc. London).

—*Eduard Farber*

Delegates to the Washington Academy of Sciences, Representing the Local Affiliated Societies*

Philosophical Society of Washington	Malcolm C. Henderson
Anthropological Society of Washington	Stephen T. Boggs
Biological Society of Washington	John L. Paradiso
Chemical Society of Washington	Florence H. Forziati
Entomological Society of Washington	Harold H. Shepard
National Geographic Society	Alexander Wetmore
Geological Society of Washington	Luna Leopold
Medical Society of the District of Columbia	Thomas M. Brown
Columbia Historical Society	U. S. Grant, III
Botanical Society of Washington	Peter H. Heinze
Society of American Foresters	Harry A. Fowells
Washington Society of Engineers	Martin A. Mason
Institute of Electrical and Electronics Engineers	George Abraham
American Society of Mechanical Engineers	William G. Allen
Helminthological Society of Washington	Aurel O. Foster
American Society for Microbiology	Francis B. Gordon
Society of American Military Engineers	H. P. Demuth
American Society of Civil Engineers	Thorndike Saville, Jr.
Society for Experimental Biology and Medicine	William H. Summerson
American Society for Metals	Hugh L. Logan
International Association for Dental Research	Harold J. Caul
American Institute of Aeronautics and Astronautics	Delegate not appointed
American Meteorological Society	J. Murray Mitchell, Jr.
Insecticide Society of Washington	H. Ivan Rainwater
Acoustical Society of America	Malcolm C. Henderson
American Nuclear Society	George L. Weil
Institute of Food Technologists	Richard P. Farrow
American Ceramic Society	J. J. Diamond
Electrochemical Society	Kurt H. Stern
Washington History of Science Club	Morris Leikind
American Association of Physics Teachers	Raymond J. Seeger

* Delegates continue in office until new selections are made by the respective affiliated societies.

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VOLUME 55 NUMBER 9

Journal of the WASHINGTON ACADEMY OF SCIENCES

DECEMBER 1965

JOURNAL OF THE WASHINGTON ACADEMY OF SCIENCES

This Journal, the official organ of the Washington Academy of Sciences, publishes historical articles, critical reviews, and scholarly scientific articles; notices of meetings and abstract proceedings of meetings of the Academy and its affiliated societies; and regional news items, including personal news, of interest to the entire membership. The Journal appears nine times a year, in January to May and September to December. It is included in the dues of all active members and fellows.

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Back issues, volumes, and sets of the Journal (Volumes 1-52, 1911-1962) can be purchased direct from Walter J. Johnson, Inc., 111 Fifth Avenue, New York 3, N. Y. This firm also handles the sale of the Proceedings of the Academy (Volumes 1-13, 1898-1910), the Index (to Volumes 1-13 of the Proceedings and Volumes 1-40 of the Journal), and the Academy's monograph, "The Parasitic Cuckoos of Africa."

Current issues of the Journal (past two calendar years) may still be obtained directly from the Academy office at 1530 P Street, N.W., Washington, D.C., 20005.

Claims for missing numbers will not be allowed if received more than 60 days after date of mailing plus time normally required for postal delivery and claim. No claims will be allowed because of failure to notify the Academy of a change of address.

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ACADEMY OFFICERS FOR 1965

Geologic History of the Michigan Basin*

George V. Cohee

U. S. Geological Survey

The Michigan structural basin has been recognized since the work of Douglass Houghton, the first state geologist of Michigan. The circular pattern of the rocks beneath the glacial drift in Michigan was shown on a map published by James Hall as far back as 1843. Hall credited Houghton with the information on Michigan incorporated in his colored geologic map of the middle and western states. Houghton's report of the Lake Superior region in 1841 aroused widespread interest in the possible copper and other mineral resources of the Northern Peninsula, and he and his associates had indicated the location of coal deposits in Michigan before his accidental death in 1845. The mineral resources of the basin area have been exploited for commercial use since the early history of the state. Coal was first mined near Jackson in 1835 and oil was discovered near Port Huron in 1886. Wells were drilled in search for brine as early as 1881, and gypsum has been mined since 1841. Exploration for these natural resources provided a wealth of geologic data that was of valuable asistance in the early interpretation of the geology of the state and the later exploration for its mineral resources. Twenty-six thousand wells have been drilled for oil and gas, and many thousands of test wells were drilled for coal and water. Sample study well logs are available for most of the oil test wells, and more than 7,500 sets of drill cuttings from wells drilled in different parts of the state have been available for study.

The Michigan Basin is a roughly circular structural basin (Fig. 1). It includes the Southern Peninsula and eastern part of the Northern Peninsula of Michigan, eastern Wisconsin, northeastern Illinois, northern Indiana, northwestern Ohio, and western Ontario. The basin is bordered on the west by the Wisconsin Arch, on the south by the Kankakee Arch, and on the east by the Findlay Arch and Algonquin axis. The basin includes an area of 122,000 square miles, part of which is covered by Lakes Michigan, Huron, and St. Clair.

The Trenton Limestone, one of the important structure contouring units in the central part of the country, is exposed at the surface in Wisconsin, northern Michigan, and Ontario and extends in the subsurface throughout the Michigan, Illinois, and Appalachian Basins. Contours on top of the Trenton Limestone of Middle Ordovician age show the circular shape of the basin (Fig. 2). It is at sea level along the Cincinnati Arch in central Indiana and western Ohio and dips into the basin at a rate of 60 feet per mile, or slightly more than 1% grade. In the central part of the basin the Trenton is estimated to be 10,000 feet below sea level. There is fairly good control for these estimates, as a well drilled in Bay County at the west edge of Saginaw Bay and east of the central part of the basin reached the top of the Trenton at a depth of 8,800 feet below sea level, and one drilled in Ogemaw County north of the central part of the basin reached it at a depth of 8,900 feet. Drawn to true scale, the configura-

* Address of retiring president of the Geological Society of Washington, December 8, 1965. Publication authorized by the Director, U. S. Geological Survey.

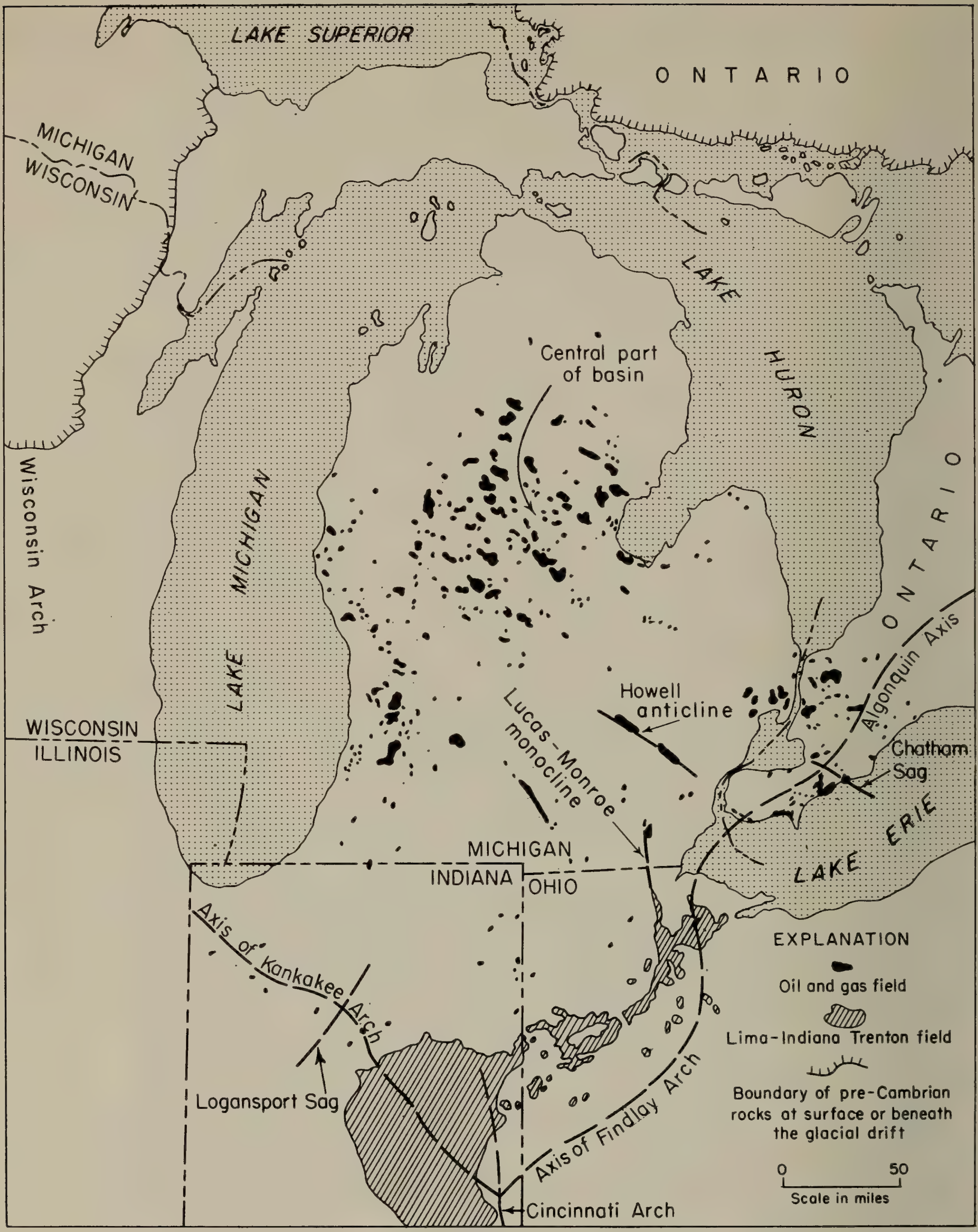

Figure 1. Map showing structural setting of the Michigan Basin and its oil and gas fields.

tion of the basin on the top of the Trenton Limestone would be inversely comparable to the topography of a baseball diamond. The deepest part of the basin would be about as deep as the pitcher's mound is high.

Sandstones of Late Cambrian age rest on Precambrian rocks throughout the area of the basin, which is bordered on the north by Precambrian rocks at the surface, on the south by Silurian rocks beneath the glacial drift, and on the southeast by Ordovician, Silurian, and Devonian rocks along the Algonquin axis in Ontario (Fig. 3).

The Cambrian deposits consist of about 2,600 feet of sandstone, dolomite, and shale. Dolomite is predominant in the upper part. Ordovician rocks are approximately 2,000 feet thick and consist of dolomite and limestone in the lower and middle parts of the sequence and shale in the upper part. Silurian rocks are predominantly dolomite, anhydrite, salt, and some shale and constitute an aggregate thickness of about 3,800 feet. Devonian rocks, which are about 3,500 feet thick, are largely dolomite, sandstone, salt, and anhydrite in the lower part and limestone and shale in the upper part. An abundance of black mud, later forming fissile shale, was deposited in Late Devonian time.

More than 2,100 feet of Mississippian sandstone and shale crop out almost entirely within the Southern Peninsula of Michigan and 750 feet of Pennsylvanian sandstone and shale occupy the central part of the basin. Overlying Pennsylvanian and Mississippian rocks in the western part of the central basin area is a Jurassic redbed sequence of unconsolidated to poorly consolidated sands and mudstones with some gypsum, which are generally 100 feet thick but may attain a thickness of 400 feet in places. All of the rocks are under a blanket of glacial drift. Bedrock is exposed in small limited outcrops in the southernmost and northernmost parts of the Southern Peninsula and at many places in the extension of the basin in the Northern Peninsula. Although the thickness of drift averages about 300 feet, in certain places in the northern half of the Southern Peninsula some wells have penetrated as much as 1,000 feet of drift.

It is estimated that approximately 14,000 feet of sedimentary rocks overlie the Precambrian in the central part of the basin west of Saginaw Bay (Cohee, 1948).

A north-south section across the basin shows a much greater thickness of Silurian and Devonian rocks in the central basin area than on the margins of the basin. This is due to the vast amount of salt and anhydrite included in both the Silurian and Devonian rocks. According to estimates by Hardenberg of the Michigan Geological Survey (oral communication), the Salina Formation of Late Silurian age includes 66 trillion tons of salt, or 7,210 cubic miles. One bed alone is 500 feet thick in places. The Detroit River Group of Middle Devonian age includes 5 trillion tons, or 543 cubic miles of salt. Anhydrite is also abundant in both the Salina and Detroit River.

An east-west section south of the central basin area shows the thinning and truncation of Late Cambrian and Early Ordovician sedimentary rocks from west to east. In a well drilled recently at the southern tip of Lake Michigan in northern Indiana, a total of 3,300 feet of Late Cambrian and Early Ordovician rocks is present, and in Ontario across the river from Detroit, all of these rocks are absent owing to thinning and erosion, and the Middle Ordovician rocks rest on Precambrian rocks.

The volume of rock in the Michigan Basin is estimated to be on the order of 108,000 cubic miles. Of this total volume, Pennsylvanian rocks constitute less than 1%, Mississippian 5%, Devonian 16, Silurian 30, Ordovician 21, and Cambrian 27%. About 47% of the rocks in the basin is carbonate rock; 23% sandstone, of which most is in the Cambrian; 18% shale; and 12% evaporites (Cohee and Landes, 1958). Most of the deposition of evaporites took place during Late Silurian and early Middle Devonian time. There was some deposition of evaporites during Mississippian time, and a very small amount of gypsum was deposited in Pennsylvanian and Jurassic time.

Basement Complex

Only a few wells have been drilled into the Precambrian basement rocks around

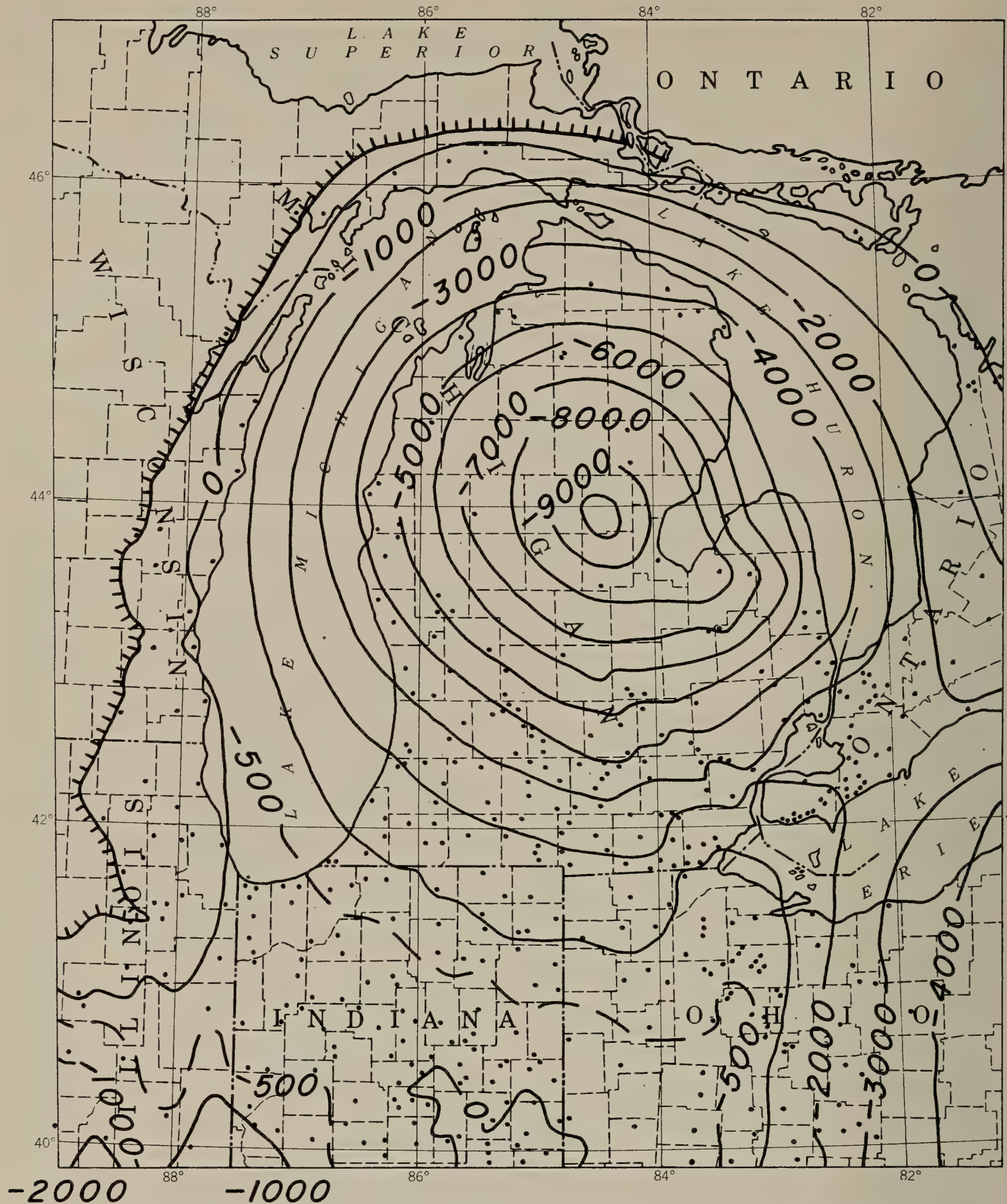

Figure 2. Contours on top of Trenton Limestone (dots are control points).

the margin of the basin, and none of the wells drilled in the deeper part of the basin reached the basement. The deepest well drilled in the Michigan Basin was completed as a dry hole at a depth of 13,000 feet in Cambrian sandstone. The well was drilled in Ogemaw County several miles north of the center of the basin. The basement was reached in two wells drilled on Beaver Island at the northern end of Lake Michigan. In one well, basement was reached at a depth of 4,705 feet below sea level and another well drilled about 3 miles to the southwest, somewhat down the dip, reached weathered granite about 700 feet higher. The amount of physiographic relief on the old weathered basement surface is of the order of hundreds of feet. A well at the southern end of Lake Michigan reached basement at a depth of 3,628 feet below sea level. A few wells were drilled to the basement along the Kankakee Arch in Indiana, the Findlay Arch in northwestern Ohio, southeastern Michigan, and southwestern Ontario. Here basement was reached at depths of from 2,000 to 3,000 feet below sea level. Many wells in southern Michigan have been drilled into the Cambrian sequence but not entirely through it. Cost of drilling, naturally, accounts for the lack of wells to the basement in the central basin area. A well drilled to 11,000 feet on the north side of the central basin area several years ago cost over $1,000,000.

The basement consists of many different sedimentary, igneous, and metamorphic rock types. From the small number of wells that have penetrated the basement, it is difficult to develop any definite pattern of rock types. In eastern Michigan, a few of the wells penetrated metamorphic rocks that may be associated with the Grenville orogeny of the Canadian Shield. C. H. Stockwell (1965) has given the name Grenville to the orogeny of 880 plus or minus million years ago. Basement in the northeastern part of the basin is characterized by rocks ranging in age from 0.8 to 1.1 billion years, and in most of the remainder by rocks up to 1.5 billion years old (Rudman, Summerson, and Hinze, 1965).

In the Northern Peninsula at the western edge of the Michigan Basin, the Precambrian rocks trend in an east-west direction, with the pattern dominated by a series of high-angle faults. Gravity data show that these trends probably connect with other trends in the Southern Peninsula (James et al., 1961; Case and Gair, 1965).

The Bouguer gravity anomaly map of midwestern United States, published by Rudman, Summerson, and Hinze in 1965, shows a gravity high, which is labelled trend B, extending northwest-southeast through the Michigan Basin. The authors infer that this "high" extends northward into Lake Superior and thence westward through the lake area to the western end, where it is a part of the prominent gravity feature known as the Mid-Continent gravity "high". Thiel (1956) showed that the positive part of the "Mid-Continent High" originated from dense basalt flows of Keweenawan age and that parallel negative anomalies result from a contrast with low-density Keweenawan sediments. Rudman and others show another linear positive anomaly, trend C, extending from eastern Kentucky across the Cincinnati Arch into southwestern Michigan.

Zietz and others (in press) have pointed out the strong possibility that the Michigan trend may tie up with the area of east-west-trending gravity and magnetic anomalies in the iron district in the Northern Peninsula. They state that the magnetic data indicate that anomaly C is not a continuing lithologic unit.

The Tectonic Map of Canada reveals numerous folded areas and major faults at the northern edge of the Michigan Basin, and similar features occur in northern Michigan and Wisconsin bordering the basin. We can assume that the basement under the Michigan Basin is characterized by such features.

We know that the Howell anticline, which is at the southeast end of the strong northwest-southeast anomaly through central Michigan, has been elevated at different times during the Paleozoic age and that some faulting has taken place along the fold. It is believed that other structural features, such as faults and folds in the basement of the Michigan Basin, were likewise reactivated at different times.

Cambrian Period

Deposition of sediments in the Michigan Basin following the Precambrian did not begin until Late Cambrian time when the sea transgressed from the south. Quartz sand from the old weathered Precambrian surface to the north and northwest ac-

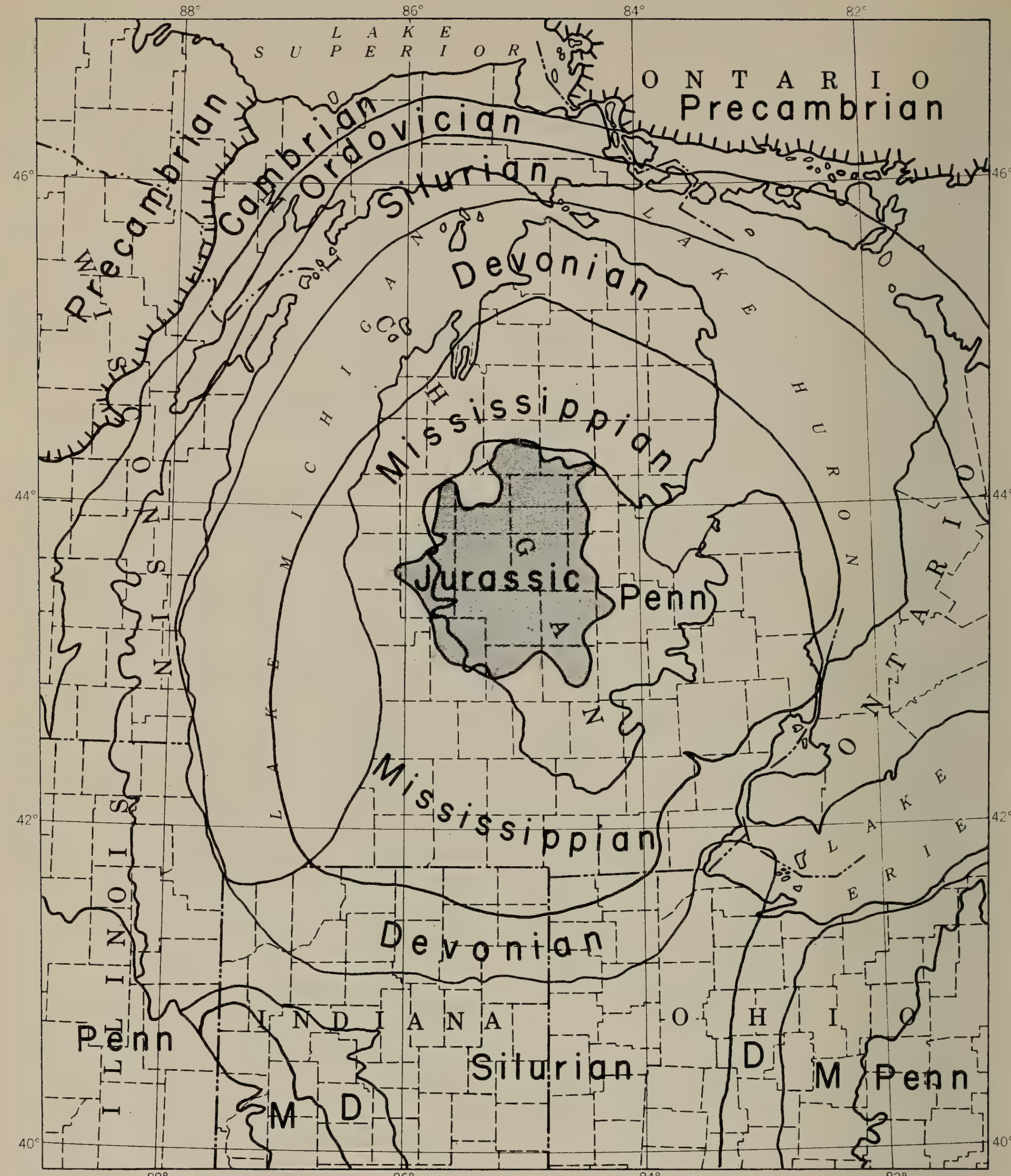

Figure 3. Map showing geology of the Michigan Basin beneath the glacial drift.

cumulated as a thick blanket of sandstone over the area of the Michigan Basin. The greatest accumulation was in a shallow trough centering on the west flank of the present basin, and it thinned to the east and west and thickened southward toward the Illinois Basin.

Ordovician Period

Sedimentation was continuous from Late Cambrian through Early Ordovician time. The rocks consist of sandstone, siltstone, shale, and dolomite. Clastic sediments were deposited around the margins of the basin on the north and carbonates were deposited to the south, in which direction they thicken greatly.

Near the close of Early Ordovician time the sea withdrew and the area of the Michigan Basin was exposed to subaerial erosion until into early Chazy time. The St. Peter Sandstone of Middle Ordovician age was deposited later in varying thicknesses on the eroded surface. Uplift occurred along the Findlay Arch, at which time the Cambrian and Lower Ordovician sequence was truncated along the axis of the arch. This sequence thins both westward and eastward, and at the northern end of the Findlay Arch it has been entirely eroded and the Middle Ordovician rocks overlie Precambrian rocks.

Middle Ordovician limestones and Upper Ordovician shales accumulated across the basin and the Kankakee and Findlay Arches without any apparent break in the sequence of deposition. There was a slight thickening of the deposits in the central basin area.

Silurian Period

Early Silurian rocks consist largely of shale and dolomite deposited across Michigan with little expression of the basin at that time. This deposition was followed by a clearing of the seas and the great accumulation of the Niagaran dolomite with an abundance of reefs, some of them as much as 400 feet thick. The reefs of the Niagaran have been highly productive of natural gas in southern Michigan and in southwestern Ontario. An east-west upwarp occurred in southern Michigan during Niagaran time, and now only 100 feet of Niagaran rocks occurs along this ridge, as compared to 400 feet in northern Indiana and 700 feet in the northern part of the Southern Peninsula.

Although there was minor subsidence in the Michigan Basin area during Middle and Late Ordovician time, the first pronounced downwarp was in Late Silurian time. During that time 4,500 feet of dolomite, salt, anhydrite, and some shale accumulated in the Southern Peninsula. The aggregate thickness of the salt is approximately 2,000 feet, and one bed of almost pure halite has been shown by drill records to be about 500 feet thick. Sylvite did not accumulate with the salt deposits. The greatest thickness is near the center of the basin and is limited to the Southern Peninsula and southwestern Ontario. At Detroit there is an aggregate thickness of more than 400 feet of salt; because of thinning and leaching, all of this salt is absent at Trenton, Michigan, 14 miles to the south (Landes, 1945).

The Salina, which includes all of the Silurian salt, began with widespread accumulation of limestone, dolomitic mud, salt, and anhydrite. Deposition of dolomite, anhydrite, halite, and shale continued until the end of Silurian time. Deposition of the salt was the result of the evaporation of brine in a closed basin in an arid climate. Once the basin became more or less tectonically stable and accumulated a large volume of saturated brine, continued evaporation caused the deposition of alternating bands of clear and cloudy salt. Salt deposition was interrupted occasionally by the influx of normal sea water, which was then followed by deposition of anhydrite and dolomite (Dellwig, 1955, and Alling and Briggs, 1961).

Salt is produced from the Salina Formation at Detroit, St. Clair, and Port Huron in southeastern Michigan by dissolving the rock salt in wells and evaporating the brine. It is mined at Detroit from a bed 1,135 feet below the surface. The mine has many miles of passageways, with caverns 22 feet high and 50 feet wide in 98.3% pure halite.

The Kankakee and Findlay Arches were shelf areas during much of Late Silurian time, and little sedimentation occurred there as compared to that in the Michigan Basin. The units extending across the arch are thin, and in general they differ lithologically from the deposits in the basin. Also it is difficult to correlate the Late Silurian deposits of the northern part of the Illinois and Ohio Basins with the thick evaporite deposits of the Michigan Basin.

Devonian Period

The Devonian Period was especially a time of sea transgressions and recessions; at times basin subsidence and isolation from seaways resulted in deposition of thick evaporite sequences in part of the section. Following the recession of the Late Silurian sea from the basin, there was a period during which no great amounts of sediment were deposited, or if deposited they were subsequently removed by erosion. Only 25 feet of Early Devonian dolomite and sandstone occurs on Garden Island in the northern part of Lake Michigan (Landes, Ehlers, and Stanley, 1945).

Middle Devonian time began with a period of dolomite, cherty limestone, and sand deposition. This was followed by the extensive deposition of the evaporite sequences of the Detroit River Group, which includes dolomite, anhydrite, and salt. More than 400 feet of salt accumulated in the northern half of the Southern Peninsula. This salt is mined in western Michigan by wells producing artificial brines.

The basin was not isolated in the latter part of Middle Devonian time, and much pure limestone and limestone and shale were deposited in the extensive seaways crossing the Michigan Basin and the Kankakee and Findlay Arches. The Dundee Limestone, deposited at that time, is quarried at Rogers City and Presque Isle in the northeastern part of the Southern Peninsula and consists almost entirely of calcium carbonate. The limestone is used in the steel, cement, and chemical industries. In the region of the Straits of Mackinac in Middle Devonian time, following the deposition of the Detroit River Group and prior to deposition of the Dundee Limestone, large masses of rock collapsed into caverns formed by the solution of salt beds in the Salina in that area. The resulting rubble, which ultimately involved about 3,500 feet of beds, is now found throughout the Straits region and it forms several important physiographic features in that region (Landes, Ehlers, and Stanley, 1945).

In Late Devonian time, black organic-rich mud was deposited widely in the eastern part of the country (McGregor, 1954). The Michigan Basin was a part of this huge depositional area, and more than 150 feet of Antrim black shale accumulated around the margin of the basin. Black, greenish-gray, and gray shale accumulation continued into Early Mississippian time, especially in the central part of the basin, where as much as 700 feet of Antrim black shale of Late Devonian and Early Mississippian age may be found.

Mississippian Period

Deposition of clastic sediments continued from Devonian through most of the early part of Late Mississippian (Meramec) time. Mississippian rocks are largely shale and sandstone, especially those of Early Mississippian age. In Early Mississippian (Kinderhook) time a large mass of green muds and silt was carried into the western side of the basin as a result of uplift and erosion in the Wisconsin highlands to the west. This body of shale and siltstone, which is called the Ellsworth Shale, overlies the black shale and intertongues with the Antrim black shale to the east near the central part of the basin. On the east side of the state the Bedford Shale, a gray, silt shale, and the Berea Sandstone were being deposited at the same time the Ellsworth was being deposited on the west side of the state. This clastic material came from Ontario and the Canadian Shield and was carried into the eastern side of the basin as deltaic deposits forming the here-named Thumb Delta. Near the close of Kinderhook time, the basin ceased to receive the large amounts of material from the east and west, and black mud (Sunbury) deposition occurred again throughout the basin. During Early Mississippian time (Osage) a great thickness of gray shale and sandstone was deposited across the basin and the Kankakee and Findlay Arches (Monnett, 1948). In the beginning of Late Mississippian time (Meramec) the basin continued to receive clastic material but became more restricted, and anhydrite was deposited with the shale. Also, sandstone and some dolomite were deposited in small amounts. These deposits, which have been named the Michigan Formation, serve as an important source of gypsum where the anhydrite is near enough to the surface to become hydrated. Sand was deposited in southern Michigan, while mud and dolomite were deposited to the north. The amount of dolomite in the Michigan Basin increases northward, which suggests a seaway to the north and northwest.

The youngest Mississippian unit in the basin is the Bayport Limestone of Meramec age, which is limited to the central part of the basin. It is very irregular in its thickness and distribution because of erosion during the post-Bayport pre-Pennsylvanian uplift near the close of Mississippian time. On some of the large anticlinal folds, several hundred feet of Mississippian rocks were removed during this period of erosion. The Michigan Basin was uplifted and eroded during the latest part of Mississippian (Chester) time. Although thickness maps indicate some thinning of pre-Mississippian units in the vicinities of major anticlinal folds, it is believed that the post-Bayport and pre-Pennsylvanian uplift and folding was the most important tectonic orogeny since the one at the close of the Early Ordovician time. The principal structural trends were formed at this time, which undoubtedly were the reactivation of old Precambrian structures.

Pennsylvanian Period

Pennsylvanian time in the Michigan Basin was principally a period of clastic deposition under deltaic and swamp conditions, with some marine inundations of sufficient magnitude to form beds of limestone, some of which are as much as 20 feet thick. A total of more than 750 feet of sandstone, shale, limestone, and coal was deposited in the basin, and these deposits range in age from Morrow (Early) to Des Moines (Middle) Pennsylvanian age.

The Early Pennsylvanian seaway apparently extended into the Michigan Basin from the north and west, as the limestone deposits of the lower part of the sequence thicken in that direction. Delta deposition proceeded from east to west across the basin, and according to Shidler (1965), after these deltaic deposits had nearly filled the basin, the western part of the state may have been the site of a small relict sea, which had become supersaturated with salines from the erosion of the Mississippian and older rocks. Red muds were deposited in this relict sea and later formed the red shales now found in western Michigan. These red shales, as well as associated green shales of western Michigan, grade eastward into gray and black shales. Also, the thick, buff-colored limestone wedges out eastward.

The early influx of deltaic deposition was followed by an invasion of shallow sea from the south and southwest. During this time a thin-bedded, fossiliferous limestone was deposited, and it is included in the Saginaw Formation as the Verne Limestone Member. The fauna of the Verne Limestone Member is related to that of the Seville Limestone of Atoka age in Illinois and the lower part of the Mercer of Pottsville age in Ohio (Cohee, Macha, and Holk, 1951). This was also the time of coal development in the swamps formed by the fluctuations in sea level during the Verne marine transgression.

Following the period of Verne marine transgression, clastic deposition increased from the east, and thick deltaic sandstone and shales were deposited again. The source of the clastic material was from the north and the east, as before. Some red shale and gypsum were deposited in northern and western Michigan.

Upper Pennsylvanian rocks are not present in the basin because of uplift that probably was associated with the Appalachian orogeny. The folds in the basin were rejuvenated at that time and the long period of marine transgressions in the Michigan Basin was brought to a close.

Jurassic Period

The youngest pre-Pleistocene deposits in the basin are a sequence of redbeds consisting of clay, shale, sandstone, and some gypsum. These deposits, which indicate accumulation in an arid climate, are limited to the central and western parts of the basin and overlap both Pennsylvanian and Mississippian rocks and underlie the glacial drift. A study of the well logs and samples in the area of the redbeds shows much variation and uneven distribution, suggesting that the sediments were deposited in topographic depressions. The beds are lenticular and vary greatly in thickness in short distances. The greatest thickness, of from 300 to 400 feet, was found in wells in the central part of the basin; elsewhere the beds are around 100 feet thick.

Recent spore studies of drill samples from the redbeds, by Aureal Cross of Michigan State University and his students, have indicated a Late Jurassic (Kimmeridgian) age for these deposits. Even though erosion prevailed upon the land from Late Pennsylvanian to Jurassic time, it is likely that these deposits accumulated in depressions as valley fill and in playa lakes.

The basin continued to be elevated and underwent erosion until the advance of the Pleistocene ice sheets.

Some Results of Tectonic Movements

As a result of faulting and other tectonic movements along some structures, secondary dolomitization has taken place by the circulation of magnesia-rich waters (Landes, 1946). The porosity that developed as a result of the solution of the limestone, its recrystallization as dolomite, and further solution of the dolomite created reservoirs for the accumulation of oil and gas in those areas of fracturing.

In an area near the Deerfield oil pool, Monroe County, the Trenton and Black River rocks are more than 700 feet thick and they are entirely dolomite. In a well nine miles east and another thirteen miles west of the anticlinal fold, the rocks are entirely limestone. Dolomitization of the limestone along the fold, which is faulted in part, developed sufficient porosity in certain zones for the accumulation of oil and gas. These porous zones are found at various depths in the dolomitized limestone.

Solution cavities and dolomite crystals may be observed in cores and drill cuttings from oil-producing zones in various dolomitized rocks (Fig. 4).

In the Lima-Indiana Trenton field in northwestern Ohio, dolomitization occurred throughout great thicknesses of the Trenton and Black River limestones along the Findlay Arch, and oil and gas production is confined to the areas where the limestones were dolomitized. The dolomite in the producing zone contains irregular areas of porosity, as shown by thin sections (Bownocker, 1903). Rock fragments from the producing zone blown out of the well at the time of shooting showed honeycomb structure with openings several inches long, and some specimens were porous on one side and dense on the other side. The surface of the cavities indicated that they were caused by solution. The largest oil well in Ohio, which produces approximately 40,000 barrels in 24 hours, was drilled in the Trenton of the Lima-Indiana field in northwestern Ohio.

The largest Trenton oil field found to date in the Michigan Basin is the Scipio field in southern Michigan where hundreds of oil wells and many dry holes have been drilled along a fracture zone that extends for 35 miles and along which

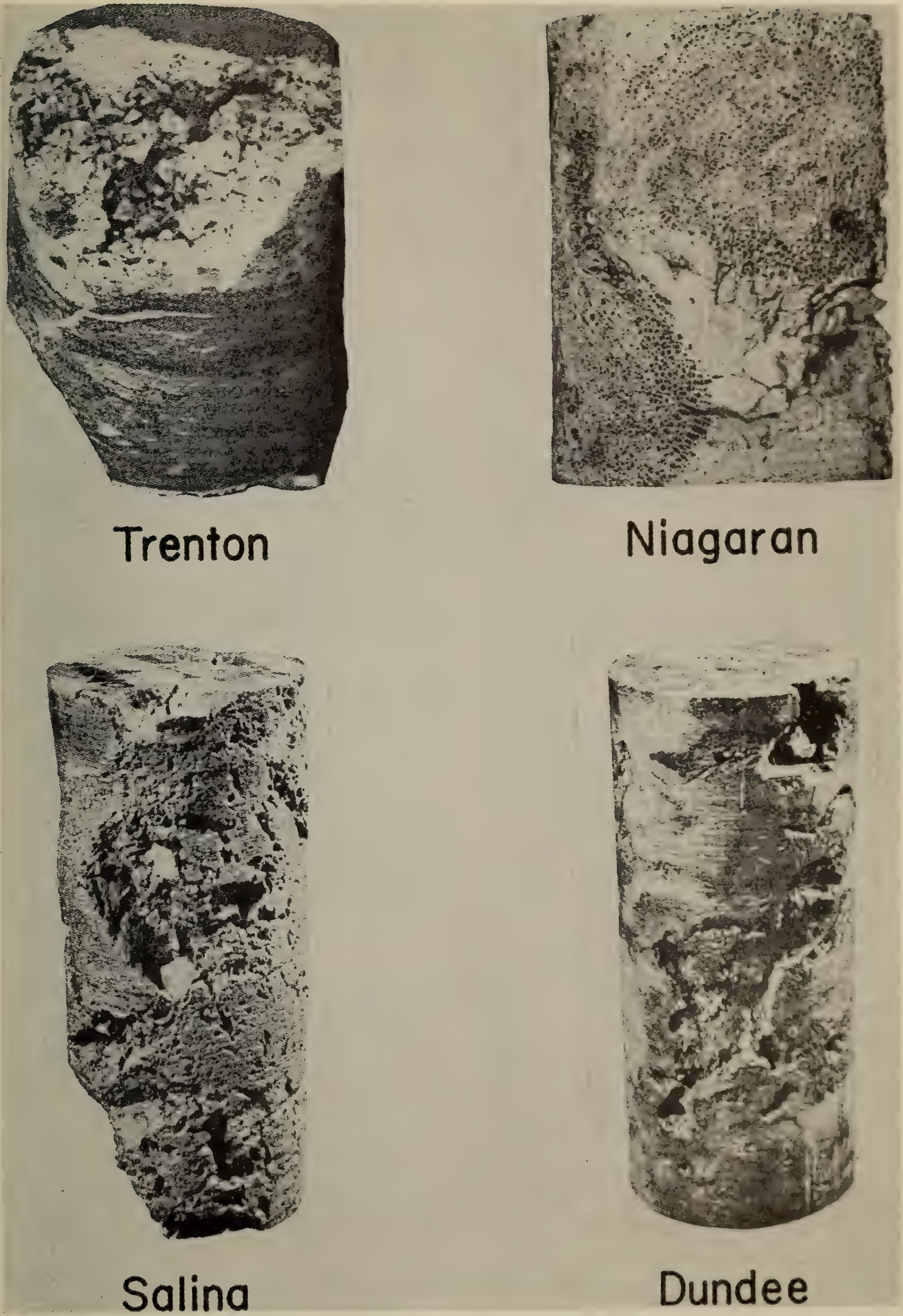

Figure 4. Cores of rocks from oil-producing zones showing solution and dolomitization.

there has been secondary domolitization of the limestone. The oil and gas accumulations are associated with the dolomitization and are in the synclines and on the flanks of the small folds. According to Ells (1962), structure contours on the top of the Trenton in the densely drilled parts of the field indicate numerous minor anticlinal folds and synclines in a near *en echelon* arrangement, suggesting deformation by shearing forces and movement along a pre-existing basement fault. As the Trenton and Black River limestones are dense and have little porosity except where they have been dolomitized, the occurrence and size of oil and gas fields are dependent upon the fracturing and amount of dolomitization of the limestone host rock.

In the Deep River oil field in Arenac County, Michigan, oil is obtained from rocks of Middle Devonian age on an anticline that was faulted on one side parallel to the trend of the structure. Secondary dolomitization of the limestone took place along the fault following faulting. Oil is found only in the dolomite made porous by the dolomitization process. Wells drilled in the limestone were dry holes and the top of the structure, where secondary dolomitization had not taken place, was dry (Landes, 1948).

Oil Shale Possibilities

At the beginning of this discussion I mentioned the early development of some of the natural resources of the Michigan Basin; I should like to end with reference to a future possible resource that may someday prove economic. The Michigan Basin is underlain by the black Antrim Shale of Late Devonian and Early Mississippian age, that varies in thickness from 150 feet around the eastern and northern margin of the basin to as much as 700 feet in an elongated area in the central part of the basin. Analysis of samples obtained some years ago from a well drilled in the northern part of the basin showed oil yields up to 17 gallons per ton of shale in the lowermost part of the Antrim. Samples from a well drilled in the southeastern part of the basin had yields up to 15 gallons per ton in the lower part of the Antrim (Swanson, 1960).

At the request of Donald C. Duncan, a set of drill cuttings was obtained recently from a well drilled in Midland County in the center of the basin. He has been interested for a long time in the oil possibilities of the Antrim in connection with his oil-shale studies. The Antrim Shale in this particular area is about 500 feet thick. The analysis showed that the lower 365 feet would yield an average of 5.3 gallons per ton, and one zone 200 feet below the top of the Antrim averaged better than 8 gallons per ton. Another zone 10 feet thick near the base averaged almost 10 gallons per ton.

These analyses suggest that if the Antrim Shale should someday be used as a source of oil, the best yield will not necessarily be limited to the lowermost 50 feet of the shale. These deposits contain large amounts of organic matter, and only a small fraction of this is converted to oil with presently used methods of analysis. Currently there is interest in developing methods to produce methane from such organic-rich shales. If these methods eventually become economic, this resource should be enormous.

Acknowledgments

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References

Alling, H. L., and Briggs, L. I. Stratigraphy of Upper Silurian Cayugan evaporites. Amer. Assoc. Petroleum Geologists Bull. *45,* 515-547 (1961).

Bownocker, J. A. The occurrence and exploitation of petroleum and natural gas in Ohio. Ohio Geol. Survey Bull. *1* (4th ser.), 31-101 (1903).

Case, J. E., and Gair, J. E. Aeromagnetic map of parts of Marquette, Dickinson, Baraca, Alger and Schoolcraft Counties, Michigan and its geologic interpretation. U. S. Geol. Survey Geophys. Inv. Map GP-467, 1965.

Cohee, G. V., and Landes, K. K. Oil in the Michigan Basin. Amer. Assoc. Petroleum Geologists, Habitat of Oil 473-493 (1958).

Cohee, G. V. Cambrian and Ordovician rocks in Michigan Basin and adjoining area. Amer. Assoc. Petroleum Geologists Bull. *32,* 1417-1448 (1948).

Cohee, G. V., Macha, C., and Holk, M. Thickness and lithology of Upper Devonian and Carboniferous rocks in Michigan. U. S. Geol. Survey Oil and Gas Investigations, Chart OC 41, 1951.

Dellwig, L. F. Origin of the Salina Salt of Michigan. Jour. Sed. Petrology *25,* 83 (1955).

Ells, G. D. Structures associated with the Albion-Cipio oil field trend. Michigan Geol. Survey, 1962.

James, H. L., and others. Geology of central Dickinson County, Michigan. U. S. Geol. Survey Prof. Paper 310, 1961.

Landes, K. K. The Salina and Bass Island rocks in the Michigan Basin. U. S. Geol. Survey Oil and Gas Inv., Prelim. Map 40, 1945.

Landes, K. K., Ehlers, G. M., and Stanley, G. M. Geology of the Mackinac Straits region. Michigan Geol. Survey, Div. Pub. 44, Geol. ser. 37, 1945.

Landes, K. K. Porosity through dolomitization. Amer. Assoc. Petroleum Geologists Bull. *30,* 317 (1946).

Landes, K. K. Structure of typical American oil fields. Amer. Assoc. Petroleum Geologists Bull. *3,* 299-304 (1948).

McGregor, D. J. Stratigraphic analysis of Upper Devonian and Mississippian rocks in Michigan Basin. Amer. Assoc. Petroleum Geologists Bull. *38,* 2324-2356 (1954).

Monnett, V. B. Mississippian Marshall formation of Michigan. Amer. Assoc. Petroleum Geologists Bull. *32,* 629-688 (1948).

Rudman, A. J., Summerson, C. H., and Hinze, W. J. Geology of basement in midwestern United States. Amer. Assoc. Petroleum Geologists Bull. *49,* 894-904 (1965).

Shidler, G. L. Pennsylvanian sedimentation patterns of the Michigan Basin. Master's thesis, Graduate College, University of Illinois, 1965.

Stockwell, C. H. Structural trends in Canadian Shield. Amer. Assoc. Petroleum Geologists Bull. *49,* 887-904 (1965).

Swanson, V. E. Oil yield and uranium content of black shales. U. S. Geol. Survey Prof. Paper 356-A, 1960, p. 37.

Thiel, E. Correlation of gravity anomalies with the Keweenawan geology of Wisconsin and Minnesota. Geol. Soc. America Bull. *67,* 1079-1100 (1956).

Zietz, I., King, E. R., Geddes, W., and Lidiak, E. G. Crustal study of a continental strip from the Atlantic Ocean to the Rocky Mountains. Geol. Soc. America, in press.

T-THOUGHTS

Promotion Ladder for Research Directors

Can one train to become a director of research through the administrative ladder? The following view was expressed by Dr. Charles H. Best* of the University of Toronto:

"While increasing amounts of non-specific administrative duties may be discharged by other than research personnel, I do not believe that we will ever evolve a successful strain of directors of research who have been developed along any route than that of extensive personal experience with the technical and scientific problems involved. The director must have experienced the thrills and disappointments himself if he is to act as the mentor and guide for successive waves of enterprising, efficient, and highly motivated young people. A director should be one who really knows when a junior

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* In Ilza Veith, Perspectives in physiology, pp 17-18. American Physiological Society, Washington, D. C. (1954).

worker is properly motivated and otherwise equipped for a career in investigation. He should be able to recognize those who are using research merely as a stepping stone and those, usually more senior and rather troubling people, who may be sheltering behind a forest of scientific names and complicated procedures in an obscure and little-used byway of research —or, on the other hand, may be the geniuses of the future. A director should realize, of course, that new techniques can unlock a stubborn door and reveal long, clear, upward trails—and that in exceptional circumstances they can produce plausible findings which may be published in long series of papers over many years before it is realized that these results are essentially meaningless and are devoid of physiological significance."

Lessons of History

Charles A. Beard, the noted historian, was once asked whether he could summarize all of the lessons of history in a short book. He replied that he could do it in four sentences:

"(1) Whom the gods would destroy, they first make mad with power.

"(2) The mills of the gods grind slowly, but they grind exceedingly fine.

"(3) The bee fertilizes the flower it robs.

"(4) When it is dark enough, you can see the stars."

The Worried Look

It has been said that "A good executive is a person who goes around with a worried look on his assistant's face."

—*Ralph G. H. Siu*

Membership to Vote On Officers for 1966

The Academy's Nominating Committee, headed by Malcolm C. Henderson as delegate from the Philosophical Society, met on October 21 to select the following candidates for office in 1966:

For president-elect: Heinz Specht of the National Institutes of Health.

For secretary: Richard P. Farrow of the National Canners Association.

For treasurer: Richard K. Cook of the National Bureau of Standards.

For manager-at-large, 1966-68 (two to be elected): Alphonse F. Forziati (Defense), Roman R. Miller, (Naval Research), Jacinto Steinhardt (Georgetown), and Edward A. Mason (Maryland).

These candidates, together with any independent nominations that may have been made before December 1, will be voted upon by the membership during December, by the usual mail ballot.

The successful candidates will take office at the close of the annual meeting in January. At this time, current President-elect John K. Taylor will automatically assume the presidency.

Previously elected managers-at-large who will continue in office during 1966 are Allen L. Alexander and Francis W. Reichelderfer (class of 1964-66) and Malcolm C. Henderson and George W. Irving, Jr. (class of 1965-67).

Academy Proceedings

December Meeting

492nd Meeting of the Washington Academy of Sciences

SPEAKER: VINCENT GIULIANO

Senior Staff Operations Group, Arthur D. Little, Inc.

SUBJECT: THE FACT AND FANCY OF INFORMATION RETRIEVAL

DATE: THURSDAY, DECEMBER 16, 1965

8:15 p.m.

PLACE: JOHN WESLEY POWELL AUDITORIUM, COSMOS CLUB

2170 Florida Avenue, N.W.

Abstract of Address—The speaker will identify some of the main innovations—both technological and social—for dealing with written information, primarily scientific information. He will distinguish between what is currently being done, what is realistically hoped to be accomplished, and what might best be described as science fiction. He will then attempt to relate the growing interest in information retrieval to two main kinds of change: new developments in the technology for dealing with the information on the one hand, and the changing nature of the social processes of technology and the sciences on the other. The technical developments include major innovations in the areas of copying and micro-image storage and reproduction, high-speed, low-cost data transmission, and a whole constellation of developments connected with digital computer techniques. The social changes include the tendency toward specialization in the basic sciences, leading to the accumulation of large, highly technical bodies of information, and the simultaneous increase in the demands of applied technology—whereby many "systems" applications require drawing upon detailed knowledge from numerous, quite diverse basic disciplinary lines.

The Speaker — Vincent Giuliano was born in 1929, studied at the University of Michigan (B.S. and M.A. degrees), and received the Ph.D. degree from Harvard University in 1958. He has been a visiting lecturer in the Mathematics Department at Harvard, and is at present a member of the Senior Staff Operations Group at Arthur D. Little, Inc. He is the author of 35 papers, and is a specialist in information processing research.

The Public Is Invited

BOARD OF MANAGERS MEETING NOTES

June Meeting

The Board of Managers held its 573rd meeting on June 24 at the Cosmos Club, with President Schubert presiding.

The minutes of the 572nd meeting were approved as previously distributed.

Announcements. Dr. Schubert announced that Malcolm W. Oliphant of the Georgetown University Mathematics Department would replace Richard K. Cook as chairman of the Committee on Membership. He also reported that he was writing to the major scientific organizations to solicit nominations for the Academy's 1965 annual awards.

Treasurer. Mr. Miller distributed a report showing expenses for the years 1961 through 1964, and January through May of 1965. To date in 1965, income was $15,-724.78 and expenses were $14,709, leaving a balance of $1,015.28. Calling attention to the 1965 deficit of $7,643.29, Mr. Miller felt that definite steps should be taken to reduce expenses or increase income in 1965.

In connection with costs of the Journal, Mr. Detwiler distributed an analysis of Journal expenses and income credits from January 1960 through May 1965. In this analysis it was shown that obligated expenses in 1964 ($11,073) exceeded the original budget (of $9,500) by $1,573. He explained that increased costs in 1964 were due to (a) two large issues addressed to the particular interests of certain Academy affiliates (76 pages for the April issue and 52 pages for the May issue) and (b) the September directory issue (88 pages), which included complete membership rosters for nine of the Academy's affiliates as well as the Academy's roster.

In a discussion of the merits of joint directories, it was generally agreed that the 1964 directory represented an excellent service to the scientific community. There was doubt, however, as to the extent to which it influenced members of the affiliated societies to join the Academy, or stimulated participation by the affiliates in Academy functions. And it appeared clear that, whatever the merits of joint directories, they were currently beyond the Academy's means. Accordingly, the Board directed that the 1965 directory should be limited to the Academy membership.

The Board agreed to Mr. Miller's proposal that a budget committee be appointed to establish a budget for 1965, with the treasurer as chairman.

Membership. Dr. Schubert discussed an apparently awkward situation created by the two classes of membership in the Academy ("members" and "fellows"), in that there seemed to be some confusion as to where applications for proposed members should be sent; the matter had been considered by the Executive Committee, which felt that one person—presumably the chairman of the Membership Committee—should receive all incoming nominations, sort them out, and route them appropriately.

Dr. Cook pointed out that such is the present procedure. The Membership Committee has been reviewing applications for both membership and fellowship. Applications for membership, involving simply an interest in Academy objectives, are sent to the Academy office for routine processing. Applications for fellowship, on the other hand, are transmitted to the appropriate panel of the Membership Committee, where they are carefully reviewed. Dr. Cook felt that the mission of promoting membership in the Academy belonged to the Membership Promotion Committee, but that all actions relating to becoming a member or fellow should funnel through the Membership Committee. He felt that the current operational procedure was satisfactory.

Dr. Cook also commented that the Membership Committee kept a tickler file on candidates for membership, who might at a future time be considered for fellowship. Dr. Irving suggested that the burden of this procedure might be spread by having the Membership Promotion Committee resubmit the names of members ready for fellowship status, to the Membership Committee; no action was taken.

Special Events. Mr. Diamond pointed out that inasmuch as a Meeting Arrangements Committee had been created, it seemed superfluous to have a Special Events Committee to handle essentially the same sort of work, but to function only once or twice during the year. The Board approved his recommendation that the Special Events Committee be discontinued. Dr. Schubert then announced that Mr. Diamond had been appointed the new chairman of the Membership Promotion Committee.

Archivist. Dr. Farber reported that he had finished compiling a list of books and articles on file in the Academy office, that had been received by exchange with other organizations over a period of several years. A list of these publications is to appear in the Journal; Academy members are welcome to select items of interest.

History of Science. Dr. Farber reported that the History of Science Committee planned to write a history of the Washington Academy of Sciences, and hoped that the National Science Foundation would underwrite its cost. The Board approved his recommendation that the Committee prepare a proposal for submission to NSF, requesting its support for the history.

Editor. (See under treasurer's report.)

Mendel Centennial. Plans for the November meeting of the Academy, celebrating the Mendel Centennial, were discussed. Dr. Schubert reported that this meeting would be held at Georgetown University, and that several Academy affiliates—the entomologists, the botanists, the foresters, and the microbiologists—had indicated a desire for active participation in the event. Mr. Miller saw in this collaboration an opportunity to recruit members for the Academy from these groups; and the Board agreed with his suggestion that a representative of each of these affiliates be invited to work with the Membership Promotion Comittee.

Monograph Committee. The question of sponsorship for Dr. Farber's monograph, "Oxidation Theories and Techniques in the 19th Century and the Beginning of the 20th" was raised. Dr. Farber thought that it would contain about 150 pages. Dr. Schubert believed that American University would contribute $1,500 toward publication costs, and that Pergamon Press would publish it; however, it was desired to have a sponsor who would assume responsibility for distribution. Dr. Cook suggested that the Committee on Monographs be revived and made responsible for the monograph; the Board agreed to this suggestion.

October Meeting

The Board of Managers held its 574th meeting on October 21 at the Cosmos Club, with President Schubert presiding.

The minutes of the 573rd meeting were approved with minor corrections.

Announcements. Dr. Schubert introduced James Fishkin, a student at Oxon Hill High School and president of the Washington Junior Academy of Sciences, who discussed some of the activities of the Junior Academy. In particular, he discussed the proceedings of the annual science convention, of which 1000 copies were printed last year, but only 100 copies sold, thus resulting in a substantial financial loss. He estimated that abstracts of papers presented at the next convention could be printed for about $600; and since WJAS has about 600 members, the cost could be absorbed by increasing the annual dues from $1.00 to $2.00 per member, and presenting each member with a copy of the abstracts. He asked the Board's approval for this increase, as well as for an increase in dues of new members from $1.50 to $2.50. These changes were agreeable to the Board.

Dr. Schubert announced that past President Frenkiel would represent the Academy at the next AAAS meeting in Berkeley. He also reported that he had met with representatives of the D. C. Council of Engineering and Architectural Societies, to discuss plans for more active participation by the Academy in ES&A Day.

President-elect Taylor introduced the new program chairman, Dr. Gray, who asked for ideas on a collegiate science congress, to be held at a local university on a Saturday in May 1966. He thought that NSF might support part of the costs of the congress.

Because of Dr. Taylor's expected absence from the city, the Board changed the date of the next annual meeting from the third Thursday (January 20, 1966) to the fourth Thursday (January 27). (Note: After the meeting, it was determined that the Cosmos Club auditorium was not available on January 27, and in an informal canvass of the Board the date was changed back to January 20.)

Dr. Henderson, as delegate of the Philosophical Society and chairman of the Nominating Committee, asked the delegates of the other affiliates to confer with him directly after the Board meeting, to set up a slate of candidates for office in 1966. (Note: The candidates are listed elsewhere in this issue.)

Treasurer. Mr. Miller presented a detailed report of income and expenses to date in 1965, and indicated that a year-end deficit of $4,500 was anticipated. The Board approved his request to sell Academy stocks in this amount, to make up the deficit.

Dr. Henderson advised that a lawyer, retained in 1964 to consult in the matter of obtaining tax-exempt status for the Academy, had presented a bill for $438.16. The Board approved payment of the bill.

Membership Promotion. Dr. Diamond reported that the Committee had developed a letter to be sent to members, to ask them whether they desired to be considered for fellow status; this letter, he felt, would simplify the upgrading of eligible members. He would be willing to serve as one of the sponsors for these candidates. Further, he felt that the nomination of such people could be streamlined by eliminating the customary letter of recommendation.

In connection with the solicitation of new members, Dr. Henderson suggested developing a form letter that could be sent to groups containing likely prospects for membership, particularly those societies to which issues of the Journal had been addressed over the last year or so.

The status of delegates from the affiliated societies, who were not members or fellows of the Academy, was next discussed. The Board agreed that such persons should automatically be elected to fellowship.

Ways and Means. Dr. Frenkiel reported the committee's view that corporate memberships should be established as a means of financial support for the Academy.

Meeting Arrangements. Dr. Menkart announced that the next general meeting would be held November 18 at Georgetown University. He indicated that the poster mailing list, used to advertise Academy meetings, needed to be updated.

Awards for Scientific Achievement. Dr. Mason reported that postcards had been mailed to the membership, soliciting nominations for the Academy's 1965 awards. The deadline for receipt of nominations is November 12.

History of Science. Dr. Farber reported that he was developing a proposal seeking NSF support for a study of the Academy's history. He expected to have this proposal ready for the next Board meeting.

Grants-in-Aid. Dr. Schubert advised the Board of a letter received from AAAS, to the effect that an unused balance of $163 from the 1963 AAAS grant was to be considered as forfeited; but that $312 from the 1964 grant and $457 from the 1965 grant were available to the Academy. Dr. Schubert asked that students with worthwhile research projects be referred to the committee chairman (Dr. Cole).

Editor. Mr. Detwiler reported that the September (directory) issue of the Journal had been printed, that the October issue was in press, and that work was about to begin on the November issue.

BYLAWS OF THE WASHINGTON ACADEMY OF SCIENCES

(Last Revised in December 1964)

Article I—Purposes

Section 1. The purposes of the Washington Academy of Sciences shall be: (a) to stimulate interest in the sciences, both pure and applied, and (b) to promote their advancement and the development of their philosophical aspects by the Academy membership and through cooperative action by the affiliated societies.

Section 2. These objectives may be attained by, but are not limited to:

(a) Publication of a periodical and of occasional scientific monographs and such other publications as may be deemed desirable.
(b) Public lectures of broad scope and interest in the fields of science.
(c) Sponsoring a Washington Junior Academy of Sciences.
(d) Promoting science education and a professional interest in science among people of high school and college age.
(e) Accepting or making grants of funds to aid special research projects.
(f) Symposia, both formal and small informal, on any aspects of science.
(g) Scientific conferences.
(h) Organization of, or assistance in, scientific expeditions.
(i) Cooperation with other Academies and scientific organizations.
(j) Awards of prizes and citations for special merit in science.
(k) Maintaining an office and staff to aid in carrying out the purposes of the Academy.

Article II—Membership

Section 1. The membership shall consist of three general classes: members, fellows and patrons.

Section 2. Members shall be persons who are interested in and will support the objectives of the Academy and who are otherwise acceptable to at least two thirds of the Committee on Membership. A letter or application form requesting membership and signed by the applicant may suffice for action by the Committee; approval by the Committee constitutes election to membership.

Section 3. Fellows shall be persons who by reason of original research or other outstanding service to the sciences, mathematics, or engineering are deemed worthy of the honor of election to Academy fellowship, which may be attained only through nomination as provided in Section 4.

Section 4. Nominations of fellows shall be presented to the Committee on Membership on a form approved by the Committee. The form shall be signed by the sponsor, a fellow who has knowledge of the nominee's field, and shall be endorsed by at least one other fellow. An explanatory letter from the sponsor and a bibliography of the nominee's publications shall accompany the completed nomination form.

Section 5. Election to fellowship shall be by vote of the Board of Managers upon recommendation of the Committee on Membership. Final action on nominations shall be deferred at least one week after presentation to the Board, and two-thirds of the vote cast shall be necessary to elect.

Section 6. Persons who have given to the Academy not less than one thousand (1,000) dollars or its equivalent in property shall be eligible for election by the Board of Managers as patrons (for life) of the Academy.

Section 7. Life members or fellows shall be those individuals who have made a single payment in accordance with Article III, Section 2, in lieu of annual dues.

Section 8. Members or fellows in good standing who have attained the age of 65 and are retired, or are retired before the age of 65 because of disability, may become emeritus. Upon request to the treasurer for transfer to this status, they shall be relieved of the further payment of dues, beginning with the following January first; shall receive notices of meetings without charge; and, at their request, shall be entitled to receive the Academy periodical at cost.

Section 9. Members or fellows living more than 50 miles from the White House, Washington, D. C., shall be classed as nonresident members or fellows.

Section 10. An election to any dues-paying class of membership shall be void if the candidate does not within three months thereafter pay his dues or satisfactorily explain his failure to do so.

Section 11. Former members or fellows who resigned in good standing may be reinstated upon application to the Secretary and approval by the Board of Managers. No reconsideration of the applicant's qualifications need be made by the Membership Committee in these cases.

Article III—Dues

Section 1. The annual dues of resident fellows shall be $10.00 per year. The annual dues of members and of nonresident fellows shall be $7.50 per year. Dues for fractional parts of the year shall be at the monthly rate of one-twelfth the annual rate. No dues shall be paid by emeritus members and fellows, life members and fellows, and patrons.

Section 2. Members and fellows in good standing may be relieved of further payment of dues by making a single payment to provide an annuity equal to their annual dues. (See Article II, Section 7.) The amount of the single payment shall be computed on the basis of an interest rate to be determined by the Board of Managers.

Section 3. Members or fellows whose dues are in arrears for one year shall not be entitled to receive Academy publications.

Section 4. Members or fellows whose dues are in arrears for more than two years shall be dropped from the rolls of the Academy, upon notice to the Board of Managers, unless the Board shall otherwise direct. Persons who have been dropped from membership for nonpayment of dues may be reinstated upon approval of the Board and upon payment of back dues for two years together with dues for the year of reinstatement.

Article IV—Officers

Section 1. The officers of the Academy shall be a President, a President-elect, a Secretary, and a Treasurer. All shall be chosen from resident fellows of the Academy.

Section 2. The President shall appoint all committees and such non-elective officers as are needed unless otherwise directed by the Board of Managers or provided in the Bylaws. He (or his substitute—the President-elect, the Secretary, or the Treasurer, in that order), shall preside at all meetings of the Academy and of the Board of Managers.

Section 3. The Secretary shall act as secretary to the Board of Managers and to the Academy at large. He shall conduct all correspondence relating thereto, except as otherwise provided, and shall be the custodian of the corporate seal of the Academy. He shall arrange for the publication in the Academy periodical of the names and professional connections of new members, and also of such proceedings of the Academy, including meetings of the Board of Managers, as may appropriately be of interest to the membership. He shall be responsible for keeping a register of the membership, showing such information as qualifications, elections, acceptances, changes of residence, lapses of membership, resignations and deaths, and for informing the Treasurer of changes affecting the status of members. He shall act as secretary to the Nominating Committee (see Art. VI, Sect. 2).

Section 4. The Treasurer shall be responsible for keeping an accurate account of all receipts and disbursements, shall select a suitable depository for current funds which shall be approved by the Executive Committee, and shall invest the permanent funds of the Academy as directed by that Committee. He shall prepare a budget at the beginning of each year which shall be reviewed by the Executive Committee for presentation to and acceptance by the Board of Managers. He shall notify the Secretary of the date when each new member qualifies by payment of dues. He shall act as business adviser to the Editor and shall keep necessary records pertaining to the subscription list. In view of his position as Treasurer, however, he shall not be required to sign contracts. He shall pay no bill until it has been approved in writing by the chairman of the committee or other persons authorized to incur it. The fiscal year of the Academy shall be the same as the calendar year.

Section 5. The President and the Treasurer, as directed by the Board of Managers, shall jointly assign securities belonging to the Academy and indorse financial and legal papers necessary for the uses of the Academy, except those relating to current expenditures authorized by the Board. In case of disability or absence of the President or Treasurer, the Board of Managers may designate the President-elect or a qualified Delegate as Acting President or an officer of the Academy as Acting Treasurer, who shall perform the duties of these officers during such disability or absence.

Section 6. An Editor shall be in charge of all activities connected with the Academy's publications. He shall be nominated by the Executive Committee and appointed by the President for an indefinite term subject to annual review by the Board of Managers. The Editor shall serve as a member of the Board.

Section 7. An Archivist may be appointed by the President. If appointed, he shall maintain the permanent records of the Academy, including important records which are no longer in current use by the Secretary, Treasurer, or other officer, and such other documents and material as the Board of Managers may direct.

Section 8. All officers and chairmen of standing committees shall submit annual reports at the January meeting of the Board of Managers.

Section 9. Prior to November 1 of each year the Nominating Committee (Art. VI, Sect. 2), having been notifed by the Secretary, shall meet and nominate by preferential ballot, in the manner prescribed by the Board of Managers, one person for each of the offices of President-elect, of Secretary and of Treasurer, and four persons for the two Managers-at-large whose terms expire each year. It shall, at the same time and in like manner, make nominations to fill any vacancy in the foregoing. Not later than November 15, the Secretary shall forward to each Academy member a printed notice of these nominations, with a list of incumbents. Independent nominations may be made in writing by any ten active members. In order to be considered, such nominations must be received by the Secretary before December 1.

Section 10. Not later than December 15, the Secretary shall prepare and mail ballots to members and fellows. Independent nominations shall be included on the ballot, and the names of the nominess shall be arranged in alphabetical order. When more than two candidates are nominated for the same office the voting shall be by preferential ballot in the manner prescribed by the Board of Managers. The ballot shall contain also a notice to the effect that votes not received by the Secretary before the first Thursday of January, and votes of individuals whose dues are in arrears for one year or more, will not be counted. The Committee of Tellers shall count the votes and report the results at the annual meeting of the Academy.

Section 11. The newly elected officers shall take office at the close of the annual meeting, the President-elect of the previous year automatically becoming President.

Article V—Board of Managers

Section 1. The activities of the Academy shall be guided by the Board of Managers, consisting of the President, the President-elect, one Delegate from each of the affiliated societies, the Secretary, the Treasurer, six elected Managers-at-large, and the Editor. The elected officers of the Academy shall hold like offices on the Board of Managers.

Section 2. One Delegate shall be selected by each affiliated society (see Art. VIII, Sect. 3). He shall serve until replaced by his society. Each Delegate is expected to participate in the meetings of the Board of Managers and vote on behalf of his society.

Section 3. The Board of Managers shall transact all business of the Academy not otherwise provided for. A quorum of the Board shall be nine of its members.

Section 4. The Board of Managers may provide for such standing and special committees as it deems necessary.

Section 5. The Board shall have power to fill vacancies in its own membership until the next annual election. This does not apply to the offices of President and Treasurer (see Art. IV, Sect. 5), nor to Delegates (see Art. V, Sect. 2).

Article VI—Committees

Section 1. An Executive Committee shall have general supervision of Academy finances, approve the selection of a depository for the current funds, and direct the investment of the permanent funds. At the beginning of the year it shall present to the Board of Managers an itemized statement of receipts and expenditures of the preceding year and a budget based on the estimated receipts and disbursements of the coming year, with such recommendations as may seem desirable. It shall be charged with the duty of considering all activities of the Academy which may tend to maintain and promote relations with the affiliated societies, and with any other business which may be assigned to it by the Board. The Executive Committee shall consist of the President, the President-elect, the Secretary and the Treasurer (or Acting Treasurer) ex officio, as well as two members appointed annually by the President from the membership of the Board.

Section 2. The Delegates shall constitute a Nominating Committee (see Art. IV, Sect. 9). The Delegate from the Philosophical Society shall be chairman of the Committee, or, in his absence, the Delegate from another society in the order of seniority as given in Article VIII, Section 1.

Section 3. The President shall appoint in advance of the annual meeting an Auditing Committee consisting of three persons, none of whom is an officer, to audit the accounts of the Treasurer (Art. VII, Sect. 1).

Section 4. On or before the last Thursday of each year the President shall appoint a committee of three Tellers whose duty it shall be to canvass the ballots (Art. IV, Sect. 10, Art. VII, Sect. 1).

Section 5. The President shall appoint from the Academy membership such committees as are authorized by the Board of Managers and such special committees as necessary to carry out his functions. Committee appointments shall be staggered as to term whenever it is determined by the Board to be in the interest of continuity of committee affairs.

Article VII—Meetings

Section 1. The annual meeting shall be held each year in January. It shall be held on the third Thursday of the month unless otherwise directed by the Board of Managers. At this meeting the reports of the Secretary, Treasurer, Auditing Committee (see Art. VI, Sect. 3), and Committee of Tellers shall be presented.

Section 2. Other meetings may be held at such time and place as the Board of Managers may determine.

Section 3. The rules contained in "Robert's Rules of Order Revised" shall govern the Academy in all cases to which they are applicable, and in which they are not inconsistent with the bylaws or the special rules of order of the Academy.

Article VIII—Cooperation

Section 1. The term "affiliated societies" in their order of seniority (see Art. VI, Sect. 2) shall be held to cover the:

Philosophical Society of Washington
Anthropological Society of Washington
Biological Society of Washington
Chemical Society of Washington
Entomological Society of Washington
National Geographic Society
Geological Society of Washington
Medical Society of the District of Columbia
Columbia Historical Society
Botanical Society of Washington
Washington Section of Society of American Foresters
Washington Society of Engineers
Washington Section of Institute of Electrical and Electronics Engineers
Washington Section of American Society of Mechanical Engineers
Helminthological Society of Washington
Washington Branch of American Society for Microbiology
Washington Post of Society of American Military Engineers
National Capital Section of American Society of Civil Engineers
District of Columbia Section of Society for Experimental Biology and Medicine
Washington Chapter of American Society for Metals
Washington Section of the International Association for Dental Research
Washington Section of American Institute of Aeronautics and Astronautics
D. C. Branch of American Meteorological Society
Insecticide Society of Washington
Washington Chapter of the Acoustical Society of America
Washington Section of the American Nuclear Society
Washington Section of Institute of Food Technologists
Baltimore-Washington Section of the American Ceramic Society
Washington-Baltimore Section of the Electrochemical Society
Washington History of Science Club
Chesapeake Section of American Association of Physics Teachers

and such others as may be hereafter recommended by the Board and elected by two-thirds of the members of the Academy voting, the vote being taken by correspondence. A society may be released from affiliation on recommendation of the Board of Managers, and the concurrence of two-thirds of the members of the Academy voting.

Section 2. The Academy may assist the affiliated scientific societies of Washington in any matter of common interest, as in joint meetings, or the publication of a joint directory: Provided, it shall not have power to incur for or in the name of one or more of these societies any expense or liability not previously authorized by said society or societies, nor shall it without action of the Board of Managers be responsible for any expenses incurred by one or more of the affiliated societies.

Section 3. No affiliated society shall be committed by the Academy to any action in conflict with the charter, constitution, or bylaws of said society, or of its parent society.

Section 4. Each affiliated society shall select one of its members as Delegate to the Academy who is a resident member or fellow of the Academy.

Section 5. The Academy may establish and assist a Washington Junior Academy of Sciences for the encouragement of interest in science among students in the Washington area of high school and college age.

Article IX—Awards and Grants-in-aid

Section 1. The Academy may award medals and prizes, or otherwise express its recognition and commendation of scientific work of high merit and distinction in the Washington area. Such recognition shall be given only on approval by the Board of Managers of a recommendation by a committee on awards for scientific achievement.

Section 2. The Academy may receive or make grants to aid scientific research in the Washington area. Grants shall be received or made only on approval by the Board of Managers of a recommendation by a committee on grants-in-aid for scientific research.

Article X—Amendments

Section 1. Amendments to these bylaws shall be proposed by the Board of Managers and submitted to the members of the Academy in the form of a mail ballot accompanied by a statement of the reasons for the proposed amendment. A two-thirds majority of those members voting is required for adoption. At least two weeks shall be allowed for the ballots to be returned.

Section 2. Any affiliated society or any group of ten or more members may propose an amendment to the Board of Managers in writing. The action of the Board in accepting or rejecting this proposal to amend the bylaws shall be by a vote on roll call, and the complete roll call shall be entered in the minutes of the meeting.

ACT OF INCORPORATION OF THE WASHINGTON ACADEMY OF SCIENCES

We, the undersigned, persons of full age and citizens of the United States, and a majority being citizens of the District of Columbia, pursuant to and in conformity with sections 545 to 552, inclusive, of the Revised Statutes of the United States relating to the District of Columbia, as amended by an Act of Congress entitled "An Act to amend the Revised Statutes of the United States relating to the District of Columbia and for other purposes," approved April 23, 1884, hereby associate ourselves together as a society or body corporate and certify in writing:

1. That the name of the society is the Washington Academy of Sciences.
2. That the term for which the Corporation is organized shall be perpetual.
3. That the Corporation is organized and shall be operated exclusively for charitable, educational and scientific purposes and in furtherance of these purposes and for no other purpose shall have, but not be limited to, the following specific powers and purposes:

a. To encourage in the broadest and most liberal manner the advancement and promotion of science.
b. To acquire, hold, and convey real estate and other property and to establish general and special funds.
c. To hold meetings.
d. To publish and distribute documents.
e. To conduct lectures.
f. To conduct, endow, or assist investigation in any department of science.
g. To acquire and maintain a library.
h. And, in general, to transact any business pertinent to an academy of sciences.

Provided, however, that notwithstanding the foregoing enumerated powers, the Corporation shall not engage in activities, other than as an insubstantial part thereof, which are not in themselves in furtherance of its charitable, educational and scientific purposes.

4. That the affairs, funds, and property of the Corporation shall be in general charge of a Board of Managers, the number of whose members for the first year shall be nineteen, all of whom shall be chosen from among the members of the Academy.

5. That in the event of dissolution or termination of the Corporation, title to and possession of all of the property of the Corporation shall pass to such organization, or organizations, as may be designated by the Board of Managers; provided, however, that in no event shall any property of the Corporation be transmitted to or vested in any organization other than an organization which is then in existence and then qualified for exemption as a charitable, educational or scientific organization under the Internal Revenue Code of 1954, as amended.

Editor's Note: This Act of Incorporation is shown as amended in 1964 by Francois N. Frenkiel, President, and George W. Irving, Jr., Secretary, acting for the Washington Academy of Sciences, in a Certificate of Amendment notarized on September 16, 1964. A copy of the original Act of Incorporation dated February 18, 1898, appears in the Journal for November 1963, page 212.

Science in Washington

SCIENTISTS IN THE NEWS

Contributions to this column may be addressed to Harold T. Cook, Associate Editor, c/o Department of Agriculture, Agricultural Research Service, Federal Center Building, Hyattsville, Md.

AGRICULTURE DEPARTMENT

ALFRED H. YEOMANS, Pesticide Chemicals Research Branch, Agricultural Research Service, is retiring from government service effective December 30.

PAUL R. MILLER was designated a fellow of the American Phytopathological Society, in recognition of his outstanding contribution to the profession of plant pathology, at the Society's National Meeting in Miami Beach on October 6.

COAST AND GEODECTIC SURVEY

JOSEPH L. STEARN retired recently after 34 years of service in the Geodesy Division.

JOHN S. RINEHART has been appointed director of the Office of Science and Engineering, Environmental Science Services Administration.

HOWARD UNIVERSITY

MODDIE D. TAYLOR, professor of chemistry, has been elected member-at-large of the Executive Committee of the Division of Chemical Education, American Chemical Society, for the 1966 term. Dr. Taylor spent the summer at Chandigarh University, Punjab, India, where he served as a consultant on the revision of the chemical education program of India.

GEORGE C. TURRELL, associate professor of chemistry, presented a paper entitled "On the Vibrational Spectra of Polyatomic Impurities in Crystals" at the Eighth European Congress on Molecular Spectroscopy in Copenhagen, August 14-20. He also visited spectroscopists and facilities at the University of Lund, Sweden; Institüt für Physikalische Chemie der Universität, Frankfurt; and Laboratoire de Spectroscopie Infrarouge, Faculté des Sciences de Bordeaux. Dr. Turrell will be on sabbatical leave for the academic year 1966-67 as an exchange professor at the University of Bordeaux.

NATIONAL BUREAU OF STANDARDS

HARRY C. ALLEN, JR., formerly chief of the Inorganic Materials Division, has been named deputy director of IMR.

The following staff members presented papers in foreign countries:

J. R. McNESBY, "Far-Ultraviolet Photochemistry in Free Radical Studies," Seventh International Symposium on Free Radicals, Padua, Italy, September 5-10.

C. M. TCHEN, "Statistical Theory of Magnetohydrodynamic Turbulence," Faculty of Sciences, University of Paris, October 7; and "Kinetic Theory of Turbulence in a Rarefied Plasma," Division of Applied Physics, Centre d'Etudes Nucleaires, Saclay, Gif-sur-Yvette, France, October 8.

NAVAL RESEARCH LABORATORY

JOHN A. SANDERSON, acting associate director of research for program planning, has been named president-elect of the Optical Society of America. He will take office on January 1, 1966.

DEATHS

PAUL CHARLES MARTH, 56, plant physiologist in the Crops Research Division, Agricultural Research Service, died at Prince Georges General Hospital on November 4, following a long illness. Dr. Marth was best known for his work on the use of plant growth-regulating substances in the production of horticultural crops, postharvest handling of horticultural products, and control of weeds. He held B.S., M.S., and Ph.D. degrees from the University of Maryland. In 1963 he received the Superior Service Award of the Department of Agriculture.

SCIENCE AND DEVELOPMENT

The spectacular electric power failure in the Northeast has somewhat overshadowed, to coin a pun, the less dramatic water crisis in New York of last spring and summer. In the long run, the latter may be the harder to solve.

In any event, a possible means to construct enormous wells in the form of underground, rubble-filled chimneys, by nuclear explosions has been broached. Aside from the obvious problems attending the use of atomic devices in any peacetime situation, it would seem entirely practical to produce, more or less at will, reservoirs of some millions of gallons capacity. A one-kiloton explosive, detonated 400 feet below the land surface, would form a rubble-chimney about 90 feet in diameter and 270 feet high, with a storage volume of 3 million gallons. Besides, ground water would flow from surrounding rocks as much as 100 times that into a drilled well of equivalent depth, in the opinion of Arthur M. Piper of the Interior Department's Menlo Park installation. A 100-kiloton explosive, by the same reasoning, would form a chimney 420 feet in diameter and 1,250 feet high, with a storage volume of 30 million gallons and an inflow area as much as 500 times that of a drilled well.

When condensation within stills, air conditioners, dehumidifiers, and all similar devices can be continued over a long period of time as distinct drops, the efficiency is materially better and the cost correspondingly reduced. At the moment this is accomplished largely by adding organic promoters to the system, or by coating the surfaces with a thin hydrophobic polymer. Robert A. Erb, of the Franklin Institute in Philadelphia, now suggests a coating for condenser surfaces that will resist the formation of films without necessitating additives or accepting the retardation in heat transfer of presently available plating materials. The so-called noble metals, particularly gold itself, seem to be the answer. Increases in condensation rates in gold-plated tubes over that in stainless steel or copper alloy run in the neighborhood of 50 percent. An added benefit is that sea-water steam has virtually no more detrimental effect than ordinary distilled-water steam on the gold surfaces, even after exposure continuously for more than a year. The implications for fresh water recovery from oceans are obvious.

Problems emerge in our increasingly dense and complex society appreciably faster than they can be solved, and often a hoped-for solution proves either less effective than had been hoped or brings with it other difficulties. We now read, in an article by Cooper Wayman, of the Geological Survey, that the much touted soft detergents will not of themselves solve the nettlesome problems of froth in water supplies, oxygen depletion in rivers and streams, and so on. One practical difficulty, at least, is that neither the hard nor the soft detergents break down adequately under anaerobic conditions; that is, unless sufficient oxygen is available to microorganisms they cannot accomplish the task of degradation, even though the substrate itself is such as to be biodegradable. Threats to ground water, and related problems brought on by detergent use, can perhaps only be met by the development of "super-soft" materials that will decompose even when supplies of oxygen are negligible. Research indicates that detergents having this property can be made from sugar and certain natural oils such as cottonseed oil. It remains to demonstrate the technical and economic feasibility of using sugar-based detergents.

Enthusiasm for the Nation's efforts to land man on the moon varies from whole-hearted dedication to outright disapproval, depending upon the individual consulted, but there does seem to be a certain amount of ancillary research of interest to all. For example, in studies of the volcanic pumice of the Mono Craters of California, just east of Yosemite National Park, on behalf of the space program, staff members of the Geological Survey have obtained samples of permafrost that may well be the southernmost occurrence of that material in North America. Because many features of the site are similar to those observed on the moon, extensive examinations are under way. Among these, cores have been taken to a depth of 60 feet which in turn showed ice scattered throughout, mostly between 7 and 20 feet below the surface. Laboratory studies of the ice samples are being made to determine age, composition, and possible bearing on theories of naturally-occurring ice on the moon.

Some years back there appeared a delightful story bearing the title, "The Final Traffic Jam," which described the gradual increase in congestion until at some fateful moment every square foot of every highway, street, or alley, plus all driveways, turnoffs, and parking lots, was occupied by a vehicle. Matters came to a complete halt, which led many if not all to view the situation as an emergency of the utmost concern. As the tale unfolds, an absurdly simple solution was adopted—to pour concrete over the whole thing and start again!

Whether this fate is in store for the land areas of the United States—and many who commute from the suburbs of our larger cities may feel at times that we are perilously close to reaching this stage—it is apparently not unlike that in the Gulf of Mexico. There, with 2,000 oil well structures scattered in a zone reaching 60 miles from shore, and another 3,500 in inshore waters, it has become necessary to show traffic lanes on the nautical charts of the Gulf put out by the Coast and Geodetic Survey.

Thirty such lanes will be shown, generally two miles wide and extending approximately one to 125 nautical miles from the Gulf coast. In these areas, no oil drilling structures will be permitted. Action in this connection has become necessary as the number of wells increased in the past three years by 1000, and in view of the nearly 50 collisions that have taken place.

Occasionally, a simple tabulation is more effective than any other device in impressing upon the reader the enormous consumption of natural resources within the United States. We read, for example, that during the period from the opening of the New York World's Fair in April 1964 to its closing in October of this year, the Geological Survey's data showed the following amounts of materials used:

180 trillion gallons of water
68,000,000 tons of iron ore

760,000 tons of copper
7,200,000 tons of aluminum ore
438,000,000 tons of sand and gravel
4,290,000 tons of sulfur
4,424,000,000 barrels (oil equivalent) of mineral fuels
9,274,000 tons of phosphate rock

It is not always the more profound aspects of a scientific project that strike the fancy. A story in the NIH Record tells in some detail how Zenzo Tamura, a Japanese scientist visiting the Laboratory of Clinical Biochemistry of the National Heart Institute, has affixed fluorescent dyes to the peptides in wasp venom and thus greatly facilitated chromatographic separations. This step leads in turn to studies of the effect of these individual peptides on high blood pressure, and is of interest to those concerned with the sometimes fatal after-effects of wasp attack on humans. Yet to the ordinary reader, the most poignant impressions are gained from the simple statistic that in the decade of the 1950's, 229 of the total of 460 deaths from venomous animals were due to Hymenopteran insects (snakes killed only 138), and from viewing a small photograph showing a wasp pinioned to a tiny straitjacket, being "stung," as it were, by a miniature electrode. Few victims of a wasp's displeasure in the past will fail to recognize in themselves a sense of revenge at this adroit turning of the tables.

Biophysicists, who like biochemists tend not to know one organism from another and even to give the impression of caring little for this traditional kind of biology, are very likely to be well aware of the giant squid. This animal, a not very attractive member of the mollusc group, has long been used as a source of large nerve axons for research in the physiology of impulse transmission. A particularly valuable species, the giant form of South American waters, provides an axon with diameters above a millimeter, thus permitting experiments not otherwise possible. Behind this story, which is of course well known, lies the nagging worry that if only the molecular biologists at one end of the spectrum and the systematists at the other could talk more successfully to each other, any number of other species not now used in research could be uncovered and a host of problems made more tractable. There are obvious advantages to experimenting upon well-known and long-studied organisms, but it is hardly likely that they are the most favorable material for some of the experiments that now need to be devised.

Surely one of the most effective researchers with the electron microscope is H. Fernandez-Moran of the University of Chicago. When he suggests, in a seminar at the National Institutes of Health, the direct readout of such fundamental cellular elements as the base pairings of nucleic acids, it must be taken very seriously indeed. On the other hand, we cannot but remark that his ancillary proposal that the instrument be used for ultraminiaturization, making printed circuits on surfaces the size of cells, is less attractive. True, one could then impress the entire contents of the Library of Congress on a surface the size of a single page and read it with the electron microscope. True, too, it would postpone the day when we will be physically engulfed by the products of our scientific and technical effort. But it will not help one whit to ease the impossible burden of comprehending the vast compilation of published information, nor help in its wise evaluation and use.

One of the more intriguing suggestions to be found in freshman geology, as most encounter it, is that the present continents are formed from the drifting apart of an ancient land mass. Presumably, as soon as map-making was sufficiently precise to reflect a realistic picture of the coast lines of the east and west borders of the Atlantic, many must have been struck by the goodness of fit between the two. Certainly debate has lasted for many years over whether this was a geological possibility, let alone a probability.

Robert S. Dietz, a staff member of what now calls itself the Environmental Science Services Administration, suggests that a search be made for what might be called microcontinents, the left-over pieces from such a supercontinental breakup. In his view, a major effort in this direction would go far to settle once and for all the controversy and, if successful, uncover the missing, Texas-sized pieces necessary to make the jigsaw puzzle complete. He points out, incidentally, that the advocates of continental drift have tended to overlook an argument which strongly supports their thesis, in that the "fit" of the edges of the continental shelves of the two land masses bordering the Atlantic is vastly better than that of the shorelines themselves. He considers the San Andreas Fault in California as an example of drift on a small scale.

Many who espouse unpopular scientific notions will take comfort in Dr. Dietz' remark that the continental drift is "an example of an outrageous hypothesis which may well be true."

But evidence derived by scientists of the Applied Physics Laboratory, from gravitational effects measured on satellite orbital changes, and which suggest that the earth has four distinct bulges or corners, does not justify a return to the equally outrageous hypothesis that the world is flat.

Not long ago there were reports, as indeed there had been several times previously, of exceptionally hot and salty waters to be found in the depths of the Red Sea, temperatures running above 44°C and salinity approximating 27 per cent. *Atlantis II*, a vessel of the Woods Hole Oceanographic Institution, has made possible still further sampling with even more startling results. Specimens at temperatures as high as 56° have been taken in acid brines with heavy metals 100 to 1000 times that of normal sea water.

In these days when "wet" chemistry is scorned by the more sophisticated analysts, it is amusing to read that the scientists aboard the research vessel were unable to make the old-fashioned chemical analyses of sediments taken from the ocean floor just beneath the hot brine regions, although they seemed almost certain to be rich in iron, manganese, zinc, and other materials. As the story goes, they were obliged to wait until they found an Arabian college with a chemistry laboratory sufficiently antiquated to permit the simple tests of a former day.

Egon T. Degens suggests that the brines may not be sea water at all, but rather derived from rifts in underlying strata, through which the material moved upward from volcanic intrusions. If so, they can be interpreted as the equivalent of what the oceans were in pre-Cambrian times, some two to three billion years ago.

—*Russell B. Stevens*

Delegates to the Washington Academy of Sciences, Representing the Local Affiliated Societies*

Philosophical Society of Washington	Malcolm C. Henderson
Anthropological Society of Washington	Stephen T. Boggs
Biological Society of Washington	John L. Paradiso
Chemical Society of Washington	Florence H. Forziati
Entomological Society of Washington	Harold H. Shepard
National Geographic Society	Alexander Wetmore
Geological Society of Washington	Luna Leopold
Medical Society of the District of Columbia	Thomas M. Brown
Columbia Historical Society	U. S. Grant, III
Botanical Society of Washington	Peter H. Heinze
Society of American Foresters	Harry A. Fowells
Washington Society of Engineers	Martin A. Mason
Institute of Electrical and Electronics Engineers	George Abraham
American Society of Mechanical Engineers	William G. Allen
Helminthological Society of Washington	Aurel O. Foster
American Society for Microbiology	Francis B. Gordon
Society of American Military Engineers	H. P. Demuth
American Society of Civil Engineers	Thorndike Saville, Jr.
Society for Experimental Biology and Medicine	William H. Summerson
American Society for Metals	Hugh L. Logan
International Association for Dental Research	Harold J. Caul
American Institute of Aeronautics and Astronautics	Delegate not appointed
American Meteorological Society	J. Murray Mitchell, Jr.
Insecticide Society of Washington	H. Ivan Rainwater
Acoustical Society of America	Malcolm C. Henderson
American Nuclear Society	George L. Weil
Institute of Food Technologists	Richard P. Farrow
American Ceramic Society	J. J. Diamond
Electrochemical Society	Kurt H. Stern
Washington History of Science Club	Morris Leikind
American Association of Physics Teachers	Raymond J. Seeger

* Delegates continue in office until new selections are made by the respective affiliated societies.

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