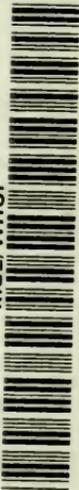


MBL/WHOI



0 0301 0037831 1

DATA LIBRARY
Woods Hole Oceanographic Institution

1923-26
3266-6
12

TREASURY DEPARTMENT
UNITED STATES COAST GUARD

Bulletin No. 10

International
Ice Observation and Ice Patrol
Service
in the
NORTH ATLANTIC OCEAN



Season of 1922



WASHINGTON
GOVERNMENT PRINTING OFFICE
1923

FRONTISPIECE.



THE FEBRUARY ICE CRUISE.

February 20, 1922, northeast of the Tail of the Grand Banks, the "Seneca" hove to in a northwest gale; force 10; ice making on deck. With the exception of two days, continuous gales were experienced the entire cruise. The bergs do not arrive until later, and the scientific observations are difficult to obtain.

TREASURY DEPARTMENT
UNITED STATES COAST GUARD

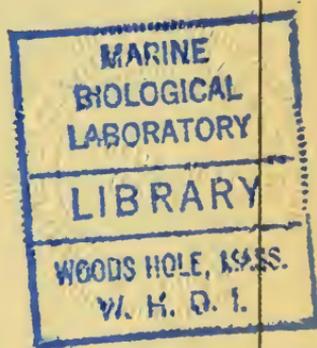
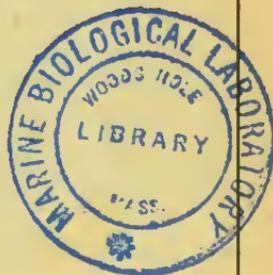
Bulletin No. 10

International
Ice Observation and Ice Patrol
Service

in the
NORTH ATLANTIC OCEAN



Season of 1922



WASHINGTON
GOVERNMENT PRINTING OFFICE
1923

THE UNIVERSITY OF CHICAGO
LIBRARY

International
Journal of Law and Economics



TREASURY DEPARTMENT,
UNITED STATES COAST GUARD,
Washington, January 13, 1923.

The Honorable the SECRETARY OF THE TREASURY:

Referring to the requisition of this office dated January 13, 1923, for the printing of Bulletin No. 10, International Ice Observation and Ice Patrol Service in the North Atlantic Ocean, 1922, I would state that this publication is necessary in the conduct of the ordinary routine business of this department. This service was begun by the United States in 1914 at the request of Great Britain acting on behalf of the various powers interested, under the conditions set forth in the International Convention for the Safety of Life at Sea, which was signed at London, January 20, 1914, by the representatives of those powers. Under those conditions the several powers assumed the obligation to contribute to the expense of the international service in certain proportions, enumerated in article 7 of the said convention. The Government of the United States pays about 18 per cent of the cost of the service, the other powers interested paying the balance. An Executive order was issued on September 20, 1916, creating an interdepartmental board. Under the provisions of the Executive order it is the duty of the board to—

(a) Prepare a systematic program for the work in connection with the international service of ice observation, ice patrol, and ocean derelict destruction, undertaken by the United States, especially that part which pertains to observations and related scientific work.

(b) Direct the scientific observers, receive their reports, and prepare the same for publication.

(c) Make recommendation for such special appropriations or legislation as may be necessary.

It is desired to incorporate in the bulletin 12 photographs and 31 charts, which are necessary to illustrate the activities and conditions connected with the service and will be of unusual interest to the several powers and scientists who are watching the progress of this work.

Respectfully,

(Signed)

W. E. REYNOLDS,
Commandant.

Approved,

EDWARD CLIFFORD,
Assistant Secretary.

TABLE OF CONTENTS.

| | Page. |
|--|-------------|
| Frontispiece..... | Face title. |
| Orders, ice observation..... | 1 |
| Orders, ice patrol..... | 4 |
| Commanding officer's report, ice observation..... | 7 |
| Commanding officers' reports, ice patrol..... | 18 |
| Summary report by senior officer patrol..... | 50 |
| Oceanographer's reports..... | 54 |
| Oceanographic station chart "A"..... | 66 |
| Scientific observer's report..... | 67 |
| Station table..... | 70 |
| Profiles of subsurface sections (1 to 14)..... | 84 |
| Discussion of profiles..... | 84 |
| Oceanographic summary..... | 93 |
| Monthly limits of cold-wall (chart "B")..... | 98 |
| Annual limits of cold-wall (chart "C")..... | 98 |
| Iceberg chart "D"..... | 98 |
| Iceberg chart "E"..... | 98 |
| Iceberg chart "F"..... | 98 |
| Iceberg chart "G"..... | 98 |
| Wind diagram and fog scale for April (fig. 1)..... | 59 |
| Wind diagram and fog scale for May (fig. 2)..... | 61 |
| Wind diagram and fog scale for June (fig. 3)..... | 63 |
| Surface temperature charts: | |
| Chart "H"..... | 98 |
| Chart "I"..... | 98 |
| Chart "J"..... | 98 |
| Chart "K"..... | 98 |
| Chart "L"..... | 98 |
| Chart "M"..... | 98 |
| Chart "N"..... | 98 |
| Chart "O"..... | 98 |
| Chart "P"..... | 98 |

INSTRUCTIONS FOR ICE OBSERVATION.

TREASURY DEPARTMENT,
UNITED STATES COAST GUARD,
Washington, January 6, 1922.

To the Commanding Officer, Coast Guard Cutter "Seneca":

1. Prepare the *Seneca* for duty in connection with the International Ice Observation. On February 5, 1922, the *Seneca* is detached from the New York division, and assigned to independent duty International Ice Observation, with headquarters at New York, N. Y. The *Seneca* will sail from New York, February 5, 1922, or as soon thereafter as practicable, and proceed to the Grand Banks of Newfoundland and locate the ice fields and positions of the icebergs, thereafter keeping in touch with the ice situation, making such observations as practicable on the quantities of ice, its kind, extent, and drift, and obtaining such information as may seem to be of value.

2. The service to be performed is primarily the ascertainment of the locations and the progressive movement of the limiting lines of the regions in which icebergs and field ice exist in the vicinity of the Grand Banks of Newfoundland, and the dissemination of the information so ascertained for the guidance and warning of navigators; and, coordinately with these primary duties, the making of such oceanographical and meteorological observations as will form a contribution toward the knowledge of the reason why the limiting lines assume their observed locations.

3. Observations at recorded times, extending from the surface to the bottom, should be made in well determined geographical positions throughout the patrolled region for determining:

(a) The temperature and salinity of the water by readings in series at definite intervals of depth.

(b) The direction and rate of movements of the waters at the different depths.

These observations in each locality should be repeated as often as such locality is revisited.

4. Each hour there will be recorded the reading of the barometer, the temperature of the air, both wet and dry bulb thermometers, temperature of sea water at surface, the direction and force of the wind, the forms of clouds, direction from which moving, the amount and the visibility, the state of the weather, and the condition of the sea and directions from which swells are coming.

5. Scientific Observer E. F. B. Fries will be directed to assemble the scientific instruments and the matériel necessary for making and recording oceanographic data, and to report on board the *Seneca* at New York, January 25, 1922. You will afford the scientist every facility for, and assistance in, making such observations and collecting such data as he may desire, bearing in mind that the main duty of the *Seneca* is to keep track of the ice movements; and this practical work of the *Seneca* must not be subordinated to the work of scientific observation. It should be borne in mind, however, that the work of ice observation is highly important, and it is believed that most valuable data can be collected from these observations without in any way interfering with the primary duty of the *Seneca*.

6. It is the present intention of Headquarters to detail two vessels, other than the *Seneca*, to perform the continuous ice patrol which past experience has shown should commence about April 1, and continue throughout the season of dangerous ice conditions. You will make such recommendation as is pertinent if, in your opinion, from your observation, the constant ice patrol should commence earlier than April 1, 1922.

7. On your passage to the eastward, you will report your position daily to Headquarters through coast naval radio stations as long as practicable, and thereafter through Canadian radio stations. If not practicable to send by any of these stations, you will relay through any vessel within reach. After locating the ice, you will discontinue reports to Headquarters, and make these radio reports to the Hydrographic Office, New York City. These reports for the Hydrographic Office will be sent by you daily at 4 a. m., seventy-fifth meridian time, and addressed to "Hydrographic, New York." The ice information to be sent to that office will be in as plain and concise English as practicable, and will state the following, all numbers to be spelled out:

- (a) Ice (berg or field).
- (b) Date.
- (c) Time (seventy-fifth meridian time).
- (d) Latitude.
- (e) Longitude.
- (f) Other data as may be necessary.

Whenever practicable these ice reports will be sent via Cape Race Radio Station.

8. Ice information will be given at any time to any ship with which the *Seneca* can communicate. You will notify the Canadian radio stations through which you communicate that they are at liberty to forward a copy of your ice reports to the proper Canadian authorities.

9. While on ice-observation duty, you will make reports in triplicate to Headquarters from time to time as opportunity affords. These reports should be as full and complete as circumstances will permit and should be accompanied by charts, graphs, and photographs as appropriate.

10. During the period of ice observation the *Seneca* will base at Halifax, Nova Scotia. Arrange for fuel and supplies at that port, and for delivery of mail, express, and freight to your vessel.

11. The work of the *Seneca* on this duty will be of international character, and, as the various maritime nations of the world have intrusted the management of the ice observation and ice patrol service to the United States, it is important that the work be done as thoroughly as possible in order that the record of the United States, and the Coast Guard in particular, for efficiency, shall be sustained.

12. Upon being relieved of this duty return with your command to New York, N. Y., and resume your regular station, reporting to the commander, New York division, for duty in that division.

13. You will acknowledge receipt of this order.

W. E. REYNOLDS, *Commandant.*

INSTRUCTIONS FOR THE ICE PATROL.

TREASURY DEPARTMENT,
UNITED STATES COAST GUARD,
Washington, March 3, 1922.

To the Commanding Officers of Coast Guard cutters on ice patrol, 1922:

1. The *Modoc* and *Tampa* are designated to carry out the International Ice Patrol during the season of 1922. Lieut. Commander B. M. Chiswell is assigned to command the patrol. Lieut. Commander W. J. Wheeler will command until first arrival of patrol commander on patrol. Vessels concerned will make the necessary preparations to carry out these orders.

2. The object of the patrol is to locate the icebergs and field ice nearest to the trans-Atlantic steamship lanes. It will be the duty of patrol vessels to determine the southerly, easterly, and westerly limits of the ice and to keep in touch with these fields as they move to the southward, in order that radio messages may be sent out daily, giving the whereabouts of the ice, particularly the ice that may be in the immediate vicinity of the regular trans-Atlantic steamship lanes.

3. The patrol will continue until the ice no longer constitutes a danger to navigation in the trans-Atlantic steamship lanes. The ice season is usually three months, April, May, and June.

4. While on this patrol the *Modoc* and *Tampa* will base temporarily and obtain fuel and other necessary supplies at Halifax, Nova Scotia. The two vessels will make alternate cruises of about 15 days in the ice region, the 15 days to be exclusive of time occupied in going to and from base. The patrol commander will so regulate the movements of the vessels that on the fifteenth day after reaching the ice region the vessel on patrol will be relieved by the second vessel, if possible, at which time the first vessel will proceed to base, replenish her fuel supply, and return in time to relieve the other vessel at the end of the latter's 15-day cruise. It is important that the patrol be continuous, and the vessel on patrol must not leave her station until relieved by the other vessel, unless it is absolutely necessary to do so.

5. Having located the ice, the patrol vessel will send the following daily radiograms. All times in radiograms will be in seventy-fifth meridian time:

(a) At 6 p. m. (seventy-fifth meridian time) ice information will be sent broadcast for the benefit of vessels, using 600-meter wave length. This message will be sent three times with an interval of two minutes between each.

(b) At 4 a. m. (seventy-fifth meridian time) a radiogram will be sent to the branch Hydrographic Office, New York City, defining the ice danger zone, its southern limits, or other definite ice news. The telegraphic address of the Hydrographic Office is "Hydrographic, New York."

(c) Ice information will be given at any time to any ship with which the patrol vessel can communicate.

(d) Communication probably can be carried on throughout the patrol via the naval radio stations at Otter Cliffs, Me., and Boston, Mass. Dispatches from Headquarters to vessels on ice patrol will be sent via the naval radio station at Boston, Mass. Vessels on patrol should, when practicable, send all reports via the Otter Cliffs Radio Station, using either 952 or 975 meter wave length. If Otter Cliffs can not be reached, reports may be sent via Cape Race or by the most convenient route. Whenever for any reason patrol vessels are unable to hear the radio station at Boston, Mass., Headquarters should be notified of that fact at once via any available route, in order that messages may be transmitted to patrol vessels by route other than Boston.

6. Ice information will be given in as plain, concise English as practicable, and will state in the following order:

- (a) Ice (berg or field).
- (b) Date.
- (c) Time (seventy-fifth meridian time).
- (d) Latitude.
- (e) Longitude.
- (f) Other data as may be necessary.

7. Attention is called to article 3235 (c), Regulations, the provisions of which will be followed in radiograms sent to the Hydrographic Office. (See par. 5 (b) of this order.) In radiograms sent to vessels other than Coast Guard cutters the words "latitude" and "longitude" will be used.

8. Each patrol vessel will keep a remark book in which will be entered all data and information concerning the ice that can be collected.

9. Each vessel, on being relieved by the other vessel, will deliver to the relieving vessel copies of all radiograms sent to or received from the Hydrographic Office during the cruise, and copies of all instructions received from Headquarters by radio.

10. At the end of each cruise each vessel will forward to Headquarters a full report in triplicate. These reports should not include any matters of purely ship's business which do not relate to the ice patrol. Each vessel will send these reports direct to Headquarters and furnish a copy of such reports to the other vessel on patrol.

11. Each vessel will plot on tracing paper used in connection with the appropriate plotting sheet, the positions and extent of the ice as located from time to time. Such data will also be plotted on a duplicate tracing paper, and this duplicate will be delivered to the relieving vessel.

12. If, in an emergency, it becomes necessary for the junior commanding officer to communicate directly with Headquarters, in order to avoid delay, a copy of all such communications will be furnished to the patrol commander.

13. Barometers of patrol vessels shall be calibrated by the United States Weather Bureau before sailing on patrol duty.

W. E. REYNOLDS, *Commandant.*



GREENE-BIGELOW WATER BOTTLES.

Here is shown the manner of stowing the Greene-Bigelow water bottles on board the "Modoc." They are secured in a rack by means of a slide bolt in such a manner that they can be tripped after the sample of sea water is drawn off.

REPORTS OF COMMANDING OFFICERS.

ICE OBSERVATION.

COAST GUARD CUTTER "SENECA," LIEUT. COMMANDER A. L. GAMBLE,
ICE OBSERVATION, FIRST CRUISE, FEBRUARY 8 TO 26, 1922.

The *Seneca* sailed from New York February 8, 1922, in accordance with Headquarters' orders of January 6, 1922, to take up the ice observation duties in the vicinity of the Grand Banks of Newfoundland. En route to the Great Bank a succession of gales from NW. to SSW., with very rough sea, and rain, hail, and fog at intervals, was experienced.

On the 14th the steamship *Pioneer* reported extensive ice fields on the east edge of the Great Bank. The *Seneca* was unable to locate these ice fields, but continued her search for ice.

At 4 p. m., February 19, took sea-water tests at station 172, in lat. $45^{\circ} 32' N.$, long. $48^{\circ} 36' W.$, and then steamed on a 150° true course across the Labrador Current for the purpose of making other oceanographical tests.

On February 20, stopped at station 173, in lat. $45^{\circ} 34' N.$, long. $47^{\circ} 32' W.$, and took sea-water temperatures every 50 meters to a depth of 250 meters, and made vertical and surface drags with nets for biological specimens. The temperature of the sea at a depth of 250 meters was $50^{\circ} F.$, while on the preceding day, at station 172, it was $32^{\circ} F.$ This showed that the *Seneca* had crossed the Labrador Current and was well into the Gulf Stream. The sea, which had been rough since the 16th, calmed down this day. The barometer fell rapidly during the night and the wind increased in force until it was blowing a moderate SW. gale, which shifted to W. during the morning of the 21st, with a rough sea, which caused us to heave to. This blow was of short duration, and the *Seneca* proceeded on her course, heading across the Labrador Current and taking the usual oceanographical observations at stations 174 and 175. (See chart "A.") The wind increased to a fresh gale by night and veered from SW. to NW., causing the *Seneca* to heave to. On the 22d the barometer continued falling, and the wind increased in force to a whole gale from the NW., the vessel being heavily coated with ice from the spray and falling snow. After falling to 29.79 inches, the barometer started up slowly at midnight and continued to rise during the 23d, on which date the wind moderated to a strong breeze. After reaching 30.06 at midnight on the 23d, the barometer began dropping at the rate of 0.10 inch per hour, and by 3 a. m. of the 24th the wind backed to S. and increased from a gentle breeze to a moderate southerly gale at 8 a. m. The southerly gale continued to blow throughout the day and by 6 p. m. had veered to NW. without abating in force. At noon on this date the barometer, which stood at 29.49, started to rise and continued rising until it reached 30.00, at midnight, when the wind moderated to a fresh N. breeze. On the 24th the *Seneca* passed clear of the Great Bank and set a course to pass south of Sable Island, en route to Halifax.

After passing Nantucket New South Shoal lightship, the *Seneca* was accompanied by a flock of herring gulls and kittiwakes, and by a few dovekies. This flock left us as we neared the Great Bank, on the 14th, and a few murrens then appeared. On the 15th, when on the southern portion of the Great Bank, which we found to be the best fishing ground last year, birds became more numerous and many herring gulls, kittiwakes, and great black-back gulls were seen. With the exception of these flocks, only scattered birds were seen occasionally until the 19th. This was probably due to the fact that the wind blew with gale force from the 14th to the 18th, inclusive. On the 19th, when we had reached our northernmost position, lat. $46^{\circ} 50' N.$, long. $48^{\circ} 30' W.$, the weather had moderated to such an extent that a large flock of birds, consisting of greater shearwaters, sooty shearwaters, great black-back and glaucous gulls, and kittiwakes, joined the ship and accompanied us to the Gulf Stream, in lat. $44^{\circ} 50' N.$, long. $46^{\circ} 55' W.$ Gales and rough seas prevailed during the remainder of our stay on and near the Great Bank, from the 21st to the 24th, inclusive, and only a few scattered kittiwakes trailed the ship at times. Three greater shearwaters were observed as we cleared the Bank on the 24th, a NW. gale and rough sea prevailing at the time.

On February 9, the steamship *Nitinat* reported ice fields in the area between lats. $48^{\circ} 10' N.$ and $45^{\circ} 50' N.$ and longs. $47^{\circ} 48' W.$ and $50^{\circ} 00' W.$ This was the first report of ice received this season. On the 10th, St. Johns Radio Station broadcasted the same information, and also reported that there was a small field north of Sable Island. On the 12th, the steamship *Faraby* reported field ice far to the north, extending from lat. $48^{\circ} 02' N.$, long. $48^{\circ} 24' W.$ to lat. $47^{\circ} 20' N.$, long. $48^{\circ} 46' W.$ On the 13th, the steamship *Bilbster* sighted field ice between lat. $47^{\circ} 00' N.$, long. $49^{\circ} 30' W.$ and lat. $46^{\circ} 20' N.$, long. $50^{\circ} 20' W.$ On the 14th, the steamship *Empire Arrow* saw field ice in lat. $46^{\circ} 00' N.$, long. $47^{\circ} 50' W.$, and on the same date, the steamship *Digby*, while coasting off St. Johns, Newfoundland, reported field ice extending 11 miles and containing one berg in lat. $46^{\circ} 59' N.$, long. $52^{\circ} 44' W.$ She also reported two other bergs in lat. $47^{\circ} 16' N.$, long. $52^{\circ} 28' W.$ These were the only bergs reported during the month of February.

Commencing with February 14, the *Seneca* every four hours broadcasted requests for ice information and temperatures of sea water. On the 15th the steamship *Digby* reported having passed clear of the ice field, in lat. $46^{\circ} 06' N.$, long. $50^{\circ} 15' W.$ On the same date the steamship *Pioneer* reported an ice field extending from lat. $46^{\circ} 25' N.$, long. $47^{\circ} 28' W.$, to lat. $45^{\circ} 30' N.$, long. $48^{\circ} 50' W.$ On the 18th, the steamship *Sachem* reported having entered an ice field in lat. $45^{\circ} 45' N.$, long. $51^{\circ} 50' W.$, while standing a course of N. $43^{\circ} W.$, true. As no further reports were received from her, it is supposed that the field must have been of limited extent. On the 24th, the steamship *Gallileo* reported slob ice as extending for 60 miles in an ESE. direction from Halifax.

Ice information was supplied to steamships as follows: *Manchester* and *Severance*, February 15; *Springfield*, February 18; *Wheeling Mold* and *Gustavsholm*, February 23; *La Lorraine* and *Hoxie*, February 25. On February 17, the steamship *Merry Mount* requested instructions by radio for the treatment of a seaman suffering from an ulcerated tooth, and the *Seneca's* surgeon prescribed the necessary

treatment. Four hundred and fifty sea-water temperatures were furnished to us by 120 steamships.

The following oceanographical and biological stations were established: (See chart "A.")

| Station. | Latitude. | Longitude. | Date. |
|----------|------------|------------|---------|
| 167..... | 42° 35' N. | 57° 10' W. | Feb. 13 |
| 168..... | 42° 56' N. | 55° 33' W. | Do. |
| 169..... | 43° 31' N. | 51° 38' W. | Feb. 14 |
| 170..... | 43° 50' N. | 50° 25' W. | Feb. 15 |
| 171..... | 44° 35' N. | 51° 07' W. | Feb. 16 |
| 172..... | 46° 47' N. | 48° 26' W. | Feb. 19 |
| 173..... | 45° 34' N. | 47° 32' W. | Feb. 20 |
| 174..... | 44° 52' N. | 46° 50' W. | Do. |
| 175..... | 44° 33' N. | 47° 53' W. | Feb. 21 |

The only icebergs reported to date were those sighted by the steamship *Digby* on the SE. coast of Newfoundland on February 14. By February 25, 1921, two bergs had been reported in lat. 45° 56' N., long. 50° 57' W., and one berg in lat. 44° 25' N., long. 50° 54' W. In comparing the location of the bergs sighted in February of this year with those sighted in February of last year, it will be noted that the southernmost berg sighted in 1921 (on February 25) was 150 miles south of the southernmost berg sighted in February, 1922. To date the season is no further advanced than it was last year, when the first bergs arrived below the Tail of the Bank on April 4. It is fair to assume that their progress southward this year will not be in advance of that of last year.

No field ice was observed on February 18, 19, and 20, during our cruise along the east edge of the Bank, between lats. 44° 30' N. and 46° 50' N., although it had been reported in that locality on February 12, 13, and 14.

At the intersection of the 45th parallel and 47th meridian, where we expected to find "mixed water," the sea water was of a uniform temperature of 50° from the surface to a depth of 250 meters. This would seem to indicate that the Labrador Current had not gathered its spring velocity. On the 14th light field ice in patches was reported as extending across the Bank, just north of the 46th parallel. No other report concerning this ice was received until the 18th, when the steamship *Sachem* encountered an ice field in lat. 45° 45' N., long. 51° 50' W. As these ice fields were light and far removed from the steamship lanes, no attempt was made to locate them.

Reports to the Hydrographic Office, New York, were made from the date of arrival on the Great Bank, February 19, to date of arrival in the longitude of Sable Island, February 26, inclusive.

COAST GUARD CUTTER "SENECA," LIEUT. COMMANDER A. L. GAMBLE,
ICE OBSERVATION, SECOND CRUISE, MARCH 13 TO APRIL 1, 1922.

The *Seneca* left Halifax March 13 and set course south of Sable Island, as considerable field ice had been reported to the north of that island. On the 14th, the barometer fell steadily from 30.21 to 29.49. There was a fresh SW. wind, which at the end of the day veered to NW.; the sky was partly cloudy to overcast and hazy; and there was a rough sea. On the 15th, the wind increased to a

strong breeze and veered from NW. to N. The usual tests were taken at oceanographic station 176, lat. $42^{\circ} 40' N.$, long. $57^{\circ} 10' W.$ The temperature of the sea water, which was $54^{\circ} F.$ at the surface and $51^{\circ} F.$ at a depth of 250 meters, placed the vessel in the Gulf Stream. Observations taken 12 hours later, at station 177, lat. $42^{\circ} 53' N.$, long. $55^{\circ} 35' W.$, 60 miles to the eastward of station 176, showed the temperature of the sea water at the surface to be $34^{\circ} F.$, while at station 178, lat. $43^{\circ} 15' N.$, long. $53^{\circ} 45' W.$, the temperature of the sea water at the surface was $51^{\circ} F.$ The high temperatures of the sea at stations 176 and 178 indicated that we were in the Gulf Stream. The *Seneca* arrived at the edge of the Great Bank at 6 p. m., March 16, where we took the usual tests at station 179, in lat. $43^{\circ} 38' N.$, long. $51^{\circ} 48' W.$

On the 16th, the barometer fell from 29.80 to 29.26 and the wind veered from N. to ESE. at noon, and then backed to ENE. at midnight, by which time it had increased in force from a gentle breeze to a moderate gale. The sky was overcast and there were frequent snow squalls, while the sea was rough, with a heavy swell from SE. On the 17th, the barometer rose steadily from 29.26 to 29.84 and the wind moderated to a gentle breeze, which backed from ENE. to NW. at noon and then veered to ESE. at sunset, later backing to ENE. at midnight. The rough NE. sea was followed by a heavy SE. swell, and the sky was overcast throughout the day. At station 180, lat. $43^{\circ} 50' N.$, long. $50^{\circ} 25' W.$, the usual oceanographical tests were taken. On the 18th, the barometer fell slowly; the wind moderated to a light breeze which veered from ENE. to S. The weather was foggy and rainy, except during the forenoon and afternoon watches. The *Seneca* steamed to the NE., to search for bergs which the steamship *Breizzel* reported as having sighted this morning in lat. $43^{\circ} 24' N.$, long. $49^{\circ} 25' W.$ Observations taken at noon this date showed that we had been set 30 miles SW. during the preceding 24 hours. On the 14th, the steamship *Bothwell* reported having sighted a berg in lat. $42^{\circ} 56' N.$, long. $48^{\circ} 44' W.$ This report was relayed through the steamship *Saxonia* and was received by us on the 17th. The location given is believed to have been in error, as the steamship *Corsican* passed through it and searched between meridians $50^{\circ} W.$ and $48^{\circ} W.$ during daylight. At the same time, the steamship *Mexico* searched the zone between longs. $49^{\circ} 00' W.$ and $47^{\circ} 30' W.$ and lats. $42^{\circ} 05' N.$ and $42^{\circ} 25' N.$ The steamship *Melrose Head*, on the 16th, searched between longs. $48^{\circ} 00' W.$ and $49^{\circ} 00' W.$, lats. $43^{\circ} 00' N.$ and $43^{\circ} 15' N.$ On the 16th, the steamship *Saxonia* passed through the zone embraced between longs. $50^{\circ} 00' W.$ and $48^{\circ} 00' W.$, lats. $43^{\circ} 00' N.$ and $43^{\circ} 20' N.$, and on the same date the steamship *Canadian Conqueror* stood a parallel course to the north of that of the *Saxonia*. None of these vessels sighted any ice, although warned by the *Seneca* to keep a lookout. On the dates given the visibility was excellent, especially on the 17th. The *Corsican's* track is exactly that which the *Seneca* would have followed, so it was concluded that the position given by the *Bothwell* was in error, and the *Seneca* proceeded to search for the bergs reported by the *Breizzel*.

On the 18th, fog set in at 5 p. m., interrupting our search, whereupon the *Seneca* was stopped and drifted. The fog lifted the morning

of the 19th, when we steamed to lat. $43^{\circ} 24' N.$, long. $49^{\circ} 28' W.$, which was the position of the bergs reported by the *Breizzel*, but none was sighted. We continued to search to the southward, passing through slob ice and finding more birds than heretofore seen on this cruise. Fulmars, a few great black-back gulls, kittiwakes, and dovekeys were seen. At 3 p. m., arrived alongside of a small, saddle-shaped berg, or growler, in lat. $43^{\circ} 05' N.$, long. $49^{\circ} 40' W.$, whereupon the vessel was stopped and permitted to drift. At sunrise, March 19, observations showed that the growler had drifted SW. 2 miles per hour. The steamship *Alness* reported having sighted a large berg in lat. $43^{\circ} 24' N.$, long. $49^{\circ} 15' W.$, at 2.45 p. m. the 19th. The *Seneca* proceeded in search of this berg at daylight on the 20th and found it at noon in lat. $43^{\circ} 04' N.$, long. $49^{\circ} 20' W.$ On account of the positions of these bergs and the strong set of the Labrador Current, recommended to Headquarters, by radiogram, that the ice patrol commence. It was planned to drift with this berg and to gauge the current, but the weather was overcast and foggy on the 21st, so that the position of the berg was not plotted until noon of the 22d, when it was found to be in lat. $42^{\circ} 53' N.$, long. $49^{\circ} 34' W.$ Observations showed that the strength of the current had decreased to 7 knots per day. During the afternoon of the 23d, fog again set in and the vessel was permitted to drift. On the 25th, received a radiogram from Headquarters, directing the *Seneca* to continue the ice patrol until relieved by the *Tampa*. On the 25th, the fog lifted, the wind having hauled to NW., and search was started at daylight for the berg last seen on the 22d in lat. $42^{\circ} 53' N.$, long. $49^{\circ} 34' W.$ This berg was sighted shortly before noon and observations placed it in lat. $43^{\circ} 04' N.$, long. $50^{\circ} 31' W.$, showing that it had drifted 48 miles, 290° true, in three days. The ship drifted 70 miles, 290° true, during the same period of time. The berg was only one-half as large as when sighted on the 22d and not more than one-fourth as large as when seen on the 20th. Its high pinnacles and shallow base had made it a good sailer. From the time when it was reported by the steamship *Alness*, on the 19th, until its position was observed on the 25th, it had drifted a distance of about 80 miles in a curve paralleling the Tail of the Bank, its track being the resultant of the current and the gentle to fresh easterly breezes. (See chart "D.") Another berg was also sighted at sunset on the 25th in lat. $43^{\circ} 10' N.$, long. $50^{\circ} 50' W.$

During the 26th the *Seneca* drifted, keeping the berg to the south in sight. The berg sighted at sunset on the 25th was no longer visible. The first large flock of tern was seen this day. The morning of the 27th set in misty, so that the berg to the south could not be seen. On the evening of the 26th the steamship *Canadian Seigneur* reported having sighted a berg in lat. $41^{\circ} 35' N.$, long. $50^{\circ} 32' W.$ On the morning of the 27th the steamship *Polonia* reported having sighted one in lat. $41^{\circ} 30' N.$, long. $50^{\circ} 05' W.$ These reports probably related to the same berg. The *Seneca* steamed for the latter position and located the berg on the westbound track for Boston. A broadcast was sent at noon, calling attention to the extreme southern position of this berg and warning vessels to keep to the southward of it. This berg was probably on the boundary between

the cold Labrador and the warm Gulf Stream water, and it should disintegrate rapidly. Many murres were seen this day, the sea-water temperature being 50° F. The murre is a cold-water bird. At dark the *Seneca* was in lat. $41^{\circ} 40' N.$, long. $50^{\circ} 07' W.$ and drifted during the night. At daylight of the 28th search was renewed, the vessel steaming in widening and open squares 20 miles between legs and crossing the border of the two currents, which was plainly distinguished by eddies and the choppy surface of the sea. At 7 a. m. on this date the steamship *Canadian Trapper* reported having sighted a berg in lat. $41^{\circ} 51' N.$, long. $50^{\circ} 43' W.$, 30 miles to the NW. of our position. A mirage was noted to the NW., where a portion of the sea appeared to be lifted above the surrounding waters, with a streak of sky showing between the two. From our noon position in lat. $41^{\circ} 40' N.$, long. $49^{\circ} 50' W.$, we stood along the boundary between the Gulf Stream and the Labrador Current to the position of the berg reported by the *Canadian Trapper*, the temperature of the surface of the sea changing at times as much as 20° in a few ship's lengths. Although the visibility was high and several steamships stood across this area on parallel courses, none of the last three bergs reported to us were again sighted this day.

The unusual mirage existing on this date must have affected all astronomical observations to such an extent as to account for the failure of these vessels to pick up these bergs again, or it may have been that the same berg was reported in different positions on the 26th, 27th, and 28th. The inverted reflection of a steamer below the horizon was observed, and a cask floating at the boundary of the two streams loomed up out of all proportion to its actual size. On the 28th we made the usual observations at oceanographic station 183, in lat. $41^{\circ} 40' N.$, long. $49^{\circ} 43' W.$ Dovekies, murres, and fulmars were seen this date. The weather was generally clear, with a smooth sea, an unusual mirage, and was excellent for scouting purposes.

On the 29th we received a radiogram from the *Tampa* stating that she had left Boston for the patrol waters. The day began with a dense fog, so we steamed to the SW. to work into clear weather, where observations could be made. At 2 p. m. the weather cleared, and our position was located as lat. $41^{\circ} 37' N.$, long. $51^{\circ} 00' W.$ The barometer fell during the day from 30.18 to 29.78, and the light SSE. wind veered to W. by S. and increased to a strong breeze, which caused a rough, choppy sea to make up. On this date received a radiogram from Headquarters directing that Hydrographic, New York, be informed as to the position of the latest berg sighted. Accordingly a radiogram was sent to Hydrographic stating that the three bergs reported farther south were probably one and the same; that the positions were in warm water, and that until their disintegration was assured the *Seneca* would continue to warn vessels to keep south of lat. $41^{\circ} 30' N.$ between meridians $48^{\circ} W.$ and $51^{\circ} W.$ In the morning watch of the 30th the wind veered from W. by S. to NW. by N. and blew a moderate gale, which caused a rough cross sea. At 8.30 a. m. the steamship *Paris* passed a mile to the northward of us and gave us a position in lat. $41^{\circ} 23' N.$, long. $51^{\circ} 48' W.$ Our noon latitude, crossed by radio bearing from Cape Race, checked fairly with the position given by the *Paris*. The 31st began with a

slowly falling barometer, the wind holding steady, but increasing in force to a strong gale, which caused a very rough sea. It had been the intention to cruise on the 30th and 31st in the vicinity of the southernmost bergs reported, but the northwesterly gale and the rough sea compelled the *Seneca* to head to the sea, and this worked us away from the vicinity of the bergs. These bergs were sighted on the 26th, 27th, and 28th, when they were in warm water, were not sighted again, and either must have melted or been set to the north-eastward.

Ice reports were received from the following steamships on the dates stated: 16th, *Canadian Conqueror*; 17th, *Bothwell*; 18th, *Breizizel*, *Alsená*, *Aldermin*, *Laura Meet*; 19th, *Alness*; 20th, *Alness*, *Canadian Squatter*, *Canadian Ranger*, *Hastings County*, *Sierra Nevada*; 21st, *Scatwell*; 23rd, *Nanedosa*; 26th, *Canadian Seigneur*; 27th, *Polonia*; 28th, *Canadian Trapper*, *Romsdalsholm*; 29th, 30th, *Canada*.

Special ice warnings were sent to the following vessels on the dates stated: 17th, *Corsican*; 18th, *Tartania*, *Lunois*, *Alsená*, *Duel*, *Laura Meet*; 19th, *West Arrow*, *Fanet Head*, *Tartania*; 20th, *Sierra Nevada*; 21st, *Regina*, *Albania*, *New Rochelle*, *Lord Antrim*; 22nd, *Mineadosa*, *Canada*; 23rd, *Homestead*, *Celtic*, *Aquitania*, *Bosworth*, *Lorraine*, *Merry Mount*; 24th, *Stureholm*; 25th, *Woodmansie*, *Dunbridge*; 26th, *Metagama*, *Olympic*, *Adriatic*.

After receiving the first report of ice, on March 16, ice conditions and ice warnings were broadcasted at 6 p. m. each day; and beginning on the 17th report was made to Hydrographic, New York, at 4 a. m. each day, 75th meridian time. The *Seneca* broadcasted requests for ice reports and sea-water temperatures every four hours.

Derelict reports were received, broadcasted, and forwarded to the Hydrographic Office as follows: March 17, from steamship *Cantigny*, wooden hulk, lat. 43° 05' N., long. 42° 32' W.; from steamship *Nanhole*, black buoy, lat. 40° 05' N., long. 50° 45' W.; 19th, from steamship *Canadian Explorer*, wreck, lat. 43° 12' N., long. 46° 33' W.; 28th, from steamship *Venonia*, 40-foot spar, lat. 41° 50' N., long. 50° 41' W.; 31st, from steamship *Benkelsdilk*, bell buoy, lat. 40° 34' N., long. 46° 38' W.

The *Seneca* and *Tampa* met at 6.30 p. m., April 1, in lat. 41° 32' N., long. 53° 55' W., whereupon the oceanographic observer, together with the oceanographic outfit, were transferred to the latter-named vessel. After the *Seneca* had sent out the evening broadcast, the patrol duties were taken over by the *Tampa*, and the *Seneca* set course for Halifax.

COAST GUARD CUTTER "TAMPA," LIEUT. COMMANDER W. J. WHEELER,
ICE PATROL, FIRST CRUISE, MARCH 28 TO APRIL 16, 1922.

At 2 p. m., March 28, 1922, the *Tampa* sailed from Boston for the Grand Banks of Newfoundland to relieve the *Seneca* on ice patrol. On March 29 radio communication with the *Seneca* was established. Thereafter the *Tampa* followed the 42d parallel to rendezvous with that vessel. Moderate NW. winds to fresh NW. gales, with rough seas, were experienced until April 1, upon which date the *Tampa* was directed to lay to and permit the *Seneca* to approach her on radio compass bearings. The *Seneca* was sighted about 4 p. m. and

reached the *Tampa* at 5 p. m., when, the wind and sea having moderated, the *Seneca's* boat transferred the oceanographical observer to the *Tampa*, which thereupon relieved the *Seneca* and the latter-named vessel proceeded to Halifax. The *Tampa* then set course for lat. $41^{\circ} 50' N.$, long. $51^{\circ} 50' W.$, so as to arrive at that position at daylight April 2.

At 5 a. m., April 2, established lookout aloft and began systematic rectangular search of the area between meridians $52^{\circ} W.$ and $50^{\circ} W.$ and from parallel $42^{\circ} N.$ southward to the Gulf Stream. The above area was covered without sighting any icebergs. At 6.10 p. m. the vessel stopped and lay to for the night. During daylight fresh ESE. wind to fresh E. gale was experienced, with moderate to rough sea. The steamship *Lord Ormon* reported a berg in lat. $42^{\circ} 28' N.$, long. $50^{\circ} 00' W.$, and the steamship *Digby* reported field ice extending to the northward from lat. $43^{\circ} 55' N.$, long. $49^{\circ} 40' W.$ Broadcast warnings were sent and vessels were warned to keep south of lat. $42^{\circ} 00' N.$ between longs. $51^{\circ} W.$ and $49^{\circ} W.$

At 4.40 a. m., April 3, steamed ahead on course E., true, to search the area south of lat. $42^{\circ} 00' N.$ between longs, $50^{\circ} W.$ and $49^{\circ} W.$ At 5.45 a. m. located our position as 25 miles SW. of dead-reckoning position, the difference being due to drift, mainly at night. Stood 45° true for 25 miles, and then resumed rectangular search of the probable ice area south of lat. $42^{\circ} N.$ as far east as long. $49^{\circ} W.$ The day began with fresh ENE. gale, which moderated to gentle and moderate breezes from ENE. The barometer was lowest at 4 a. m., when it stood at 29.05 inches. Rain and fog were experienced at intervals. One berg and one growler were reported in lat. $44^{\circ} N.$, long. $49^{\circ} 10' W.$ The field ice report was the same as yesterday.

On April 4 lay to the entire day, on account of fog. Gentle to strong NE. to ENE. breezes; moderate to rough sea. The barometer registered between 29.17 and 29.20 during the day. The steamship *Regina* reported open ice fields in lat. $43^{\circ} 30' N.$, between longs. $59^{\circ} 13' W.$ and $59^{\circ} 35' W.$

At 4.15 a. m., April 5, steamed ahead on a N., true, course to investigate ice conditions north of parallel $42^{\circ} N.$ and west of meridian $49^{\circ} W.$ At 5.15 a. m. a dense fog shut in and we stood S., true, to escape fog and secure observations. At 6.55 a. m., clear of fog, stopped and lay to to await clearing weather to the northward. Observations showed vessel SW. of dead-reckoning position. At 9.40 a. m. stood NE. true to recover position. At 10.20 a. m. received a report of small bergs to the westward and stood 278° , true, for their reported position. The steamship *Old North State* reported a berg in lat. $41^{\circ} 18' N.$, long. $51^{\circ} 40' W.$ The steamship *Cairnvanrola* reported a berg in lat. $41^{\circ} 16' N.$, long. $51^{\circ} 03' W.$, with a sea-water temperature of $54^{\circ} F.$ The steamship *Mottisfont* reported a berg in lat. $41^{\circ} 39' N.$, long. $51^{\circ} 17' W.$, with a sea-water temperature of $30^{\circ} F.$ At 6 p. m. stopped in lat. $41^{\circ} 29' N.$, long. $50^{\circ} 16' W.$ and lay to for the night. Moderate to strong NE. winds, increasing to fresh N. to NNE. gale, prevailed during the day, with moderate to rough sea. The weather was overcast, with fog around the horizon at intervals. The barometer read between 29.29 and 29.34 inches. The report of the *Mottisfont* was regarded as the most reliable received this date, the positions of the other bergs reported being questionable.

At midnight, the beginning of the day, April 6, steamed ahead on 285° , true, course, to reach by daybreak starting point for search for a berg reported on the 5th. At 7.20 a. m., course 342° , true; at 8.25 a. m. course 254° , true. Searched the area south of lat. 42° N. between long's. 51° W. and $52^{\circ} 30'$ W. without sighting any bergs. Two steamships which traversed this area this date reported that they had seen no bergs, so it was concluded that the bergs reported were small ones and had melted in the warm water of the Gulf Stream. At 6 p. m. set course 344° , true, to reach by daybreak position in lat. $42^{\circ} 10'$ N., long. $51^{\circ} 55'$ W., from which it was planned to search north of lat. 42° N. between meridians 52° W. and 50° W. Fresh NNE. gale to strong NNE. to N. winds prevailed throughout the day. Sea rough. Weather overcast, partly clear at intervals. Barometer rose from 29.35 to 29.50.

At 5 a. m., April 7, set course E., true. At 6.15 a. m. stopped on account of dense fog. At 8.45 a. m., fog clearing, stood ahead on E., true, course. At 10.20 fixed position by radio bearing and observation. At 10.50 a. m. stopped because of dense fog and drifted until 4 p. m., when we stood 350° true to counteract drift and to gain position north of steamer track for the night. At 6.30 p. m. stopped and drifted for the night. Moderate to strong breezes from N. to NNE.; thick fog, partially clear at intervals. Barometer rose slowly from 29.48 to 29.68.

At 4.40 a. m., April 8, steamed ahead on an E., true, course for the purpose of searching the area north of lat. 42° N. between meridians 51° W. and 49° W. At 5 a. m. thick fog shut in and we stopped and drifted until 3.40 p. m., when we stood 330° , true, to counteract probable drift from wind and current, the sea-water temperatures showing that we were on the edge of the Gulf Stream. At 5.40 p. m. stopped and drifted for the night. Moderate to strong breezes from N. to NNE., moderating to gentle breeze at end of the day, were encountered. The weather was foggy throughout the day, partially clearing at intervals.

Bergs and growlers were reported on the east side of the Great Bank and extending southward. The southern limit of the field ice was lat. $43^{\circ} 20'$ N., long. $49^{\circ} 30'$ W. At 10 p. m., the steamship *Rhode Island* reported three growlers in lat. $42^{\circ} 25'$ N., long. $50^{\circ} 15'$ W.

At 4.35 a. m., April 9, steamed ahead on course E., true, to continue the search of the area immediately north of lat. 42° N. between meridians 51° W. and 49° W. At 5.25 a. m. stopped on account of dense fog. At 6.20 a. m. steamed ahead again. At 10.35 a. m. set course N., true. At 12.10 p. m., course W., true. At 12.40 p. m., the visibility being reduced, stood SW., true, to reduce our distance from the eastbound steamship track. At 3.30 p. m. stopped on account of dense fog and lay to the remainder of the day. The fog continued during the remainder of the day and night. Light airs to moderate breezes, shifting from S. to NNW., prevailed, with fog at intervals and smooth sea. At the close of the day intercepted a broadcast message from Hydrographic Office, Washington, advising all trans-Atlantic shipping to adopt, on April 8, eastbound track crossing long. 47° W. in lat. $39^{\circ} 30'$ N., and on April 15 to adopt westbound track crossing long. 47° W. in lat. $40^{\circ} 30'$ N.

On April 10 we drifted in a dense fog until 7.30 a. m., when, the weather having cleared, stood ahead on a W., true, course to search

along lat. $42^{\circ} 30' N.$ between longs. $49^{\circ} W.$ and $51^{\circ} W.$ At 8 a. m., made out a small iceberg nearly ahead and at 8.30 a. m. stopped alongside the same and photographed it, and then continued on W., true, course. At 10.25 a. m., passed a small growler on port beam. At 10.57 a. m., set course 225° , true, for a large growler. Photographed it and then stood for another growler, which was found to be a small one. At 1.30 p. m., set course E., true, to return to iceberg sighted at 8 a. m., and to search farther south from its position. At 4.38 p. m., passed a growler on our starboard beam. At 6 p. m., stopped alongside iceberg visited at 8.30 a. m., and drifted for the night. At the end of the day, the *Tampa* was lying near a small berg in lat. $42^{\circ} 20' N.$, long. $49^{\circ} 37' W.$ Another small berg and three growlers were scattered in the vicinity of lat. $42^{\circ} 15' N.$, long. $50^{\circ} 30' W.$ Light to gentle SE. breezes, with partly clear to overcast and rainy weather, prevailed.

At 4.40 a. m., April 11, steamed ahead on course 140° , true, to return to the berg alongside of which we stopped for the night on April 10, having drifted 9 miles from it during the hours of the night. Picked up the berg and photographed it from various positions; also ascertained that its drift was 90° , true, 0.25 knot per hour. At 11.40 a. m., set course 213° , true, for oceanographic station 184, in lat. $41^{\circ} 23' N.$, long. $50^{\circ} 18' W.$ At 4.45 p. m., stopped at station 184 and took the usual oceanographic observations. At 8 p. m., having completed the work at station 184, set course 350° , true, for station 185, in lat. $41^{\circ} 55' N.$, long. $50^{\circ} 19' W.$ At 10.55 p. m., stopped at station 185 and began oceanographic observations. Light to moderate variable breezes, with partly clear weather, prevailed during the day.

April 12 began with our occupying station 185, where we completed observations at 2.40 a. m., and then stood 352° , true, for station 186 in lat. $42^{\circ} 25' N.$, long. $50^{\circ} 20' W.$ At 5.18 a. m., passed close to the small berg sighted at noon on April 10. At 6.20 a. m., stopped at oceanographic station 186 and took observations. At 9.25 a. m., completed observations and stood on course 13° , true, for station 187 in lat. $42^{\circ} 55' N.$, long. $50^{\circ} 22' W.$ At 11.20 a. m., passed two growlers. As our noon observation showed that we had overrun station 187, the *Tampa* continued to station 188 in lat. $43^{\circ} 45' N.$, long. $50^{\circ} 25' W.$ During the afternoon we passed a number of growlers. At 3.30 p. m., stopped and took the usual observations at station 188. At 4.45 p. m., stood on a 212° , true, course for a small to medium-sized berg. At 5.12 p. m., alongside berg, stood around it and took photographs. At 5.36 p. m., stood 163° , true, for station 187. At 10 p. m., passed a small growler close aboard and at 10.20 p. m., stopped at station 187 and began observations. Fresh to light breezes, NE. to N., followed by light variable airs, with cloudy weather and intermittent fogs in the afternoon, prevailed. The sea was from moderate to smooth.

April 13 began with our taking observations at station 187, in lat. $42^{\circ} 55' N.$, long. $50^{\circ} 22' W.$ At 2.05 a. m. completed observations and stood on a 124° , true, course for the southernmost berg sighted on the 12th. At 10.50 a. m. arrived alongside the berg and photographed it from various positions. At 11.40 a. m. stopped alongside berg and drifted. At 3.35 p. m., weather thickening, stood for berg which was then some 5 miles to windward. At 4.26 p. m. very thick

fog, stopped approximately 1 mile to leeward of berg and drifted. The chip log showed that the vessel drifted 1.25 miles per hour approximately north, true, under the influence of the wind alone. Light to fresh breezes, SE. to S., with cloudy weather and very thick fog the latter part of the day prevailed.

April 14 began with a dense fog, which lasted until daylight. At 6.15 a. m. set course 200° , true, and stood back to the berg, alongside of which we hove to yesterday. The *Tampa* lay to during the day and drifted, keeping the berg in sight. It was found that this berg was drifting north at the rate of 0.3 knot per hour. (See chart "D.") The wind was moderate to light from WNW. to SE., and the weather was partly cloudy, with dense fog at the beginning of the day.

April 15 began with our drifting near the southernmost berg, which was now melting rapidly. During the afternoon steamed back to the berg, from which we had drifted 7 miles in 10 hours. Light to moderate N. to W. winds, partly cloudy weather, and smooth sea to moderate swell prevailed during the day. At 8 p. m. the steamship *Cantigny* reported a small berg in lat. $42^{\circ} 02' N.$, long. $50^{\circ} 42' W.$

At midnight, the beginning of April 16, stood to the westward in search of the small berg reported by the steamship *Cantigny*. At 9 a. m. passed a growler in lat. $42^{\circ} 03' N.$, long. $50^{\circ} 36' W.$, which was evidently the berg reported by the *Cantigny*. At 9.30 a. m. set course 281° , true, to intercept the *Seneca*. At 11 a. m. passed a small growler in lat. $42^{\circ} 06' N.$, long. $51^{\circ} 02' W.$ At 2.30 p. m. we were relieved by the *Seneca*, in lat. $42^{\circ} 12' N.$, long. $51^{\circ} 55' W.$, and the oceanographer and scientific observer were transferred to that vessel. Light to moderate NE. breezes and mostly cloudy weather were experienced during the day.

During this cruise of the *Tampa* we received approximately 460 sea-water temperature reports, positions, and courses from vessels in the ice areas between longs. $43^{\circ} W.$ and $55^{\circ} W.$ Daily broadcast warnings were sent by radio to all vessels, and daily ice reports were sent to the Hydrographic Office, New York, and, beginning April 8, also to Fuelite, Halifax, Nova Scotia. Vessels were, for the most part, warned to keep south of lat. $42^{\circ} N.$ between longs. $49^{\circ} W.$ and $52^{\circ} W.$

The following steamships were given special ice warnings on the dates specified: April 2, *Digby* and *Northwestern Miller*; April 3, *Cassandra* and *West Samoset*; April 4, *Absaroka*, *La Bordonna*, and *America*; April 6, *Baltic* and *Lucerna*; April 7, *Sachem*, *Wells City*, *Lucerna*, and *Tiger*; April 8, *Sachem*; April 9, *Suisinawa* and *YJM*; April 12, *Finland* and *Lexington*; April 13, *Lexington*, *Cedric*, and *Cythia*; April 14, *La Touraine* and a vessel whose name was not obtained.

On April 11 the following broadcast was sent out: "Ice patrol *Tampa*, 42 N., 50 W. Bergs and growlers along east side Great Bank extending southward. All vessels advised keep south of 42 between 49th and 52d meridians. Report positions, courses, water temperatures often."

On April 15 the following broadcast was sent: "42 30, 49 17, drifting near small berg 0.2 knot per hour northerly. Small berg reported 42 02, 50 42. Warning all vessels south of this position between 49th and 52d meridians."

The following reports relative to derelicts and other floating dangers to navigation were received and broadcasted on the dates given:

April 1, derelict wooden hull, 75 feet long, in lat. $45^{\circ} 17' N.$, long. $37^{\circ} 14' W.$

April 3, floating mine, lat. $40^{\circ} 18' N.$, long. $52^{\circ} 56' W.$

April 4, whistling buoy, lat. $40^{\circ} 44' N.$, long. $43^{\circ} 21' W.$

April 5, spar attached to wreckage, lat. $41^{\circ} N.$, long. $50^{\circ} 55' W.$

April 6, whistling buoy, lat. $40^{\circ} 26' N.$, long. $55^{\circ} 28' W.$

COAST GUARD CUTTER "SENECA," LIEUT. COMMANDER A. L. GAMBLE,
ICE PATROL, FIRST CRUISE, APRIL 16 TO 30, 1922.

The *Seneca* left Halifax the forenoon of April 10, to relieve the *Tampa* on ice patrol. Communication was established with that vessel in the early morning of April 16, at which time the *Tampa* was searching for growlers reported by the steamship *Cantigny* in lat. $42^{\circ} 02' N.$, long. $50^{\circ} 42' W.$ The two vessels then steamed to rendezvous on a line of bearing, checked by radio compasses, and each sighted the other dead ahead, meeting at 2.30 p. m., April 16, in lat. $42^{\circ} 09' N.$, long. $52^{\circ} 06' W.$, where the *Seneca* took over the ice patrol duty. The *Seneca* then steamed ESE. for the position reported by the *Cantigny*, stopping and drifting at dark in that position. From April 10 to 15, light northerly to moderate NNE. winds prevailed. On April 16 we had fresh NE. winds with moderate sea. The weather was overcast and rainy, with light snow at the end of the day.

On April 17, the wind backed to N. The barometer rose steadily to 30.37 inches and a moderate swell prevailed. At daylight, steamed east on the 42d parallel, searching for growlers between the 50th and 51st meridians. The temperature of the surface water of the sea was $32^{\circ} F.$, except for a stretch of 4 miles, where it was $56^{\circ} F.$ During the night, headed to NE., swell with steerageway only. Kittiwakes, terns, dovekeys, and murre were sighted in the cold waters passed through this date.

April 18 began with wind calm. During the day, the wind increased to a moderate WNW. breeze, which backed to SW. at the end of the day. Sky partly cloudy to overcast, with moderate NE. swell. At daylight, the visibility being high, we started to search for the growlers reported by the *Cantigny* on the 16th and sighted two between lats. $42^{\circ} 05' N.$ and $42^{\circ} 20' N.$ and longs. $50^{\circ} 45' W.$ and $50^{\circ} 55' W.$ One was a growler the size of a box freight car, while the other had wasted to such an extent that it supplied barely sufficient ice to fill our refrigerators. At dark we stopped and drifted for the night. Fulmars, kittiwakes, murre, and petrels were seen in the water during the day. The temperature of the surface waters was found to be $34^{\circ} F.$ The barometer rose slowly to 30.34 inches at noon, and then fell slowly to 30.32 inches at the end of the day.

April 19 we had light to moderate variable breezes from SW. to NE. by way of NW. Fog set in at 4 p. m. and prevailed during the remainder of the day. Steamed ahead at daylight and stood east along the 42d parallel as far as the 48th meridian, then north to lat. $42^{\circ} 30' N.$, where we stopped and drifted on account of fog.



A BERG THAT HAS JUST CALVED.

June 15, 1922, in $42^{\circ} 43' N.$, $51^{\circ} 27' W.$, water temperature 48° . When approaching this berg, 1 mile distant, a side of the pinnacle on the left detached itself. The detached piece, weighing thousands of tons, slid down into the sea. This photograph was taken from the crow's nest of the "Modoc" shortly afterwards. The brash ice and small growler can be seen floating away.



A LARGE PINNACLE BERG.

A large berg observed by the patrol May 1, 1922, $42^{\circ} 50' N.$, $49^{\circ} 30' W.$, drifting 228° true at the rate of 0.25 knot per hour. This photograph was taken from the main deck of the "Tampa."

April 20, gentle to moderate E. to SW. winds prevailed. The barometer fell this date from 30.38 inches to 30.09 inches. Steamed ahead at daylight, to continue the search to the northward and westward, but fog set in at 9 a. m., causing postponement of search. Checked position by radio bearing from Cape Race and then stood on that bearing, sounding at hourly intervals, to pick up the edge of the Great Bank. At 3 p. m., sounded in 35 fathoms, and at 5.30 p. m. anchored in lat. $43^{\circ} 26' N.$, long. $50^{\circ} 07' W.$

April 21 began with a moderate E. breeze, which veered to SW. and moderated to light winds; weather overcast, with intervals of fog and rain; long westerly swell. The barometer fell from 30.07 inches to 30.02 inches at 8 a. m., and then rose slowly to 30.14 inches. We steamed ahead at daylight and stood SW. to search for bergs, reported on the 12th to westward of the Tail of the Bank. The weather became so thick in the early afternoon that the *Seneca* was stopped and drifted during the night. On this date the steamship *Winefredian*, which was 200 miles south of us, reported a SW. gale and heavy sea, while a westerly gale was reported 300 miles north of us on the Newfoundland coast.

April 22, light variable winds, shifting from SSE. to WSW. and then back through S. to E., prevailed. The weather was overcast and generally foggy. At daylight, stood SW. to continue search interrupted on the 21st, but fog set in at 7 a. m., and the vessel was permitted to drift, except for a few hours in the afternoon, when the search was resumed. Stopped for the night and drifted in lat. $42^{\circ} 16' N.$, long. $51^{\circ} 13' W.$ The barometer rose from 30.14 inches to 30.29 inches during the day.

April 23 fresh southerly winds, with moderate to heavy SSW. swell and fog, were experienced. At daylight, headed to the southwestward to continue search, but fog set in at 7 a. m., causing us to stop and drift. The temperature of the surface water rose from $38^{\circ} F.$; at noon, to $56^{\circ} F.$ at 8 p. m., which showed that we had worked to westward out of the tongue of cold Labrador water extending south of the Great Bank into the bight of the Gulf Stream, spreading north to the westward of the Great Bank.

April 24 gentle to fresh SSW. winds, backing to SE. at end of the day, with moderate to heavy SSW. swell, prevailed. We were unable to search during the day, on account of the low visibility. Tropical rain squalls were experienced during the first part of the day, while the temperature of the sea water and air registered $58^{\circ} F.$; in the afternoon, when the temperature of the air fell to $52^{\circ} F.$ and that of the water to $42^{\circ} F.$, dense fog shut in. The vessel drifted to the NW. in the mixed waters of the Labrador Current and the Gulf Stream.

On April 25 the weather conditions continued unfavorable. We experienced fresh SSE. winds, with rain and fog except for two hours at midday, and a heavy SE. swell. The barometer was low and fairly steady, being 29.76 inches at the beginning of the day, falling to 29.64 inches at noon, and rising to 29.72 inches at midnight. While steaming south to oceanographic station 190, lat. $42^{\circ} 05' N.$, long. $52^{\circ} 15' W.$, we passed from water with a surface temperature of $60^{\circ} F.$ into a 5-mile stretch of water with a surface temperature of $36^{\circ} F.$, and then into water of a surface temperature of $54^{\circ} F.$ In the afternoon, while proceeding on the reverse course to oceano-

graphic station 191, lat. $42^{\circ} 30' N.$, long. $51^{\circ} 47' W.$, we found the surface temperatures to be $52^{\circ} F.$ and $40^{\circ} F.$ in the same locality, lat. $42^{\circ} 20' N.$, long. $52^{\circ} 30' W.$ These variations in temperature would indicate a rapid mingling of the surface waters. At station 191, we found that the Labrador Current was overriding the Gulf Stream. During the night of the 25th we stood NE. at slow speed.

April 26, the weather continued unfavorable, with fresh SE. winds and fog throughout the day, with rough sea, the barometer being steady and low. At daylight, we arrived at station 192, lat. $42^{\circ} 50' N.$, long. $51^{\circ} 25' W.$, and, after taking the usual observations, proceeded to station 193, lat. $43^{\circ} 10' N.$, long. $51^{\circ} 05' W.$ We then stood for central station on the Grand Banks, but as we could not make it by daylight, stopped at dark and drifted. The temperature of the surface water on the Grand Banks this date was found to be $32^{\circ} F.$

On April 27, steamed ahead at daylight for the central oceanographical station, lat. $43^{\circ} 45' N.$, long. $50^{\circ} 25' W.$, where we arrived at 9.30 a. m. and took the usual tests, after which the *Seneca* anchored in 27 fathoms of water. During the day, we experienced fresh winds from SSW., which fell to light winds at the end of the day. Dense fog prevailed until sunset and a heavy SSW. swell, which moderated toward night. The barometer rose from 29.63 inches to 29.80 inches.

April 28 began with gentle SSW. wind, increasing to strong wind at noon, with heavy SSW. swell. The weather was foggy in the forenoon and clearing in the afternoon. At 2 p. m., weighed anchor and steamed to the southward. During the day, intercepted messages to vessels passing to the northward on tracks 8 and 9, bound to Halifax and the St. Lawrence, concerning ice conditions on their routes. The *Seneca* informed Cape Race Radio Station that such information would hereafter be broadcast by the patrol vessel and requested that station to so inform inquiring vessels.

April 29 began with a moderate SW. wind, which veered to a light NW. breeze during the day. Cloudy weather, which became overcast with showers at sunset, was experienced. By forenoon the sea had moderated and we steamed, full speed, to search for bergs to the southward and westward of the Great Bank. At dark, stopped and drifted, having covered the area between meridians $50^{\circ} W.$ and $51^{\circ} W.$ and parallels $42^{\circ} N.$ and $43^{\circ} N.$ We received Headquarters' radiogram directing the *Seneca* to return to New York upon being relieved by the *Tampa*, and also a radiogram from the *Tampa* giving her noon position as lat. $43^{\circ} 13' N.$, long. $58^{\circ} 56' W.$

The patrol vessels met in lat. $42^{\circ} 39' N.$, long. $52^{\circ} 45' W.$, at 2.30 p. m., April 30, 1922, at which time the *Tampa* assumed the patrol duties.

From the date of assumption of the patrol duties, on April 16, to the time the *Tampa* relieved the *Seneca* on May 1, the routine radio reports were sent each day to the Hydrographic Office, New York, and the prescribed ice warnings were broadcasted. In addition to the 6 p. m. broadcast, an 11 a. m. broadcast was sent out during foggy weather. As fog conditions prevailed from the 19th to the 27th, no reports from vessels south of the 45th parallel were received, and the *Seneca* was unable to search the area to the SW. of the Great Bank, where bergs had been reported during the latter part of the

Tampa's April cruise. A menace was presented by the berg reported by the *Tanaford* on April 17 in lat. $43^{\circ} 35' N.$, long. $48^{\circ} 00' W.$ If this berg were in the Labrador Current, it would have set toward the Tail of the Bank. Owing to the uncertainty of the movements of these untraced bergs, the *Seneca's* broadcast zone was successively swung around a fixed point at the intersection of the 43d parallel and the 48th meridian; through the following positions:

April 21, lat. $43^{\circ} 30' N.$, long. $51^{\circ} 00' W.$, then west to $53^{\circ} 00' W.$

April 23, lat. $42^{\circ} 20' N.$, long. $51^{\circ} 00' W.$, then west to $53^{\circ} 00' W.$

April 24, lat. $42^{\circ} 20' N.$, long. $50^{\circ} 00' W.$, then west to $53^{\circ} 00' W.$

April 25, lat. $42^{\circ} 20' N.$, long. $49^{\circ} 00' W.$, then west to $53^{\circ} 00' W.$

April 26, lat. $42^{\circ} 10' N.$, long. $49^{\circ} 00' W.$, then west to $53^{\circ} 00' W.$

Special warnings and routings were given to the following steamships on the dates specified: April 20, *Winifredian* and *Canadian Coaster*; April 21, *Gustavholm*; April 23, *Litunia* and *Vellavia*; April 24, *Wyncote*, *Cedric*, and *Homestead*; April 26, *Bothwell* and *Metagama*.

During the cruise, 670 water-temperature reports were received from various steamships.

The following steamships reported having sighted ice on the dates specified: April 17, *Tanaford*; April 20, *Cornishman*; April 22, *Canadian Navigator* and *Canadian Hunter*; April 23, *Canadian Navigator*, *Fontee*, and *Vellavia*; April 25, *Venusea*, *Wisley*, and *Bothwell*; April 26, *Edward Jeramae*; April 28, *Kaiserin Auguste*, *Minabrea*, and *Metagama*; April 29, *Canadian Explorer*, *Digby*, *Cassandra*, and *Cairnross*. The ice reported by these vessels, with exception of that reported by the *Tanaford* on April 17, was on routes to the north of the 45th parallel.

Notices of the following obstructions were received and forwarded to the Hydrographic Office, New York, from the steamships named on the dates specified: *Brittania*, wreckage, April 16; *Le Coq*, buoy, April 17; *Atlantic Sun*, buoy, April 18; *Canadian Hunter*, spar, April 22; *Maddequest*, buoy, April 23; *Carmania*, buoy, April 23; *Anaconda*, buoy, April 24; *Victorio Emanuel III*, wreckage, April 28; *Surico*, large tree stump, April 28.

This cruise was disappointing, as no ice, except a small growler and a few cakes, was observed. The Grand Banks and adjacent waters were enveloped in fog, limiting the number of ice reports from merchant steamers and interfering with scouting by the patrol vessel. Southerly winds prevailed from April 19 to April 28, veering to the NW. on April 29. During this period, there was no day when the visibility was fair or on which the fog whistle was not in use.

COAST GUARD CUTTER "TAMPA," LIEUT. COMMANDER W. J. WHEELER,
ICE PATROL, SECOND CRUISE, APRIL 30 TO MAY 15, 1922.

The *Tampa* left Halifax at 2.30 p. m., April 28, and set course to pass 20 miles south of Sable Island, thence 102° true, until radio communication was established with the *Seneca*. At 1.40 a. m., April 30, lat. $42^{\circ} 40' N.$, course was changed to E. true, for the purpose of meeting the *Seneca* on this line. At 1.30 p. m., April 30, sighted the *Seneca* ahead, and at 2 p. m. lay to while the *Seneca* transferred the oceanographer and the scientific observer to the *Tampa*. The *Tampa* then took over the ice patrol, lat. $42^{\circ} 40' N.$, long. $42^{\circ} 50' W.$, and stood on an 82° true course for lat. $42^{\circ} 50'$

N., long. $50^{\circ} 20'$ W., whence at daylight, May 1, search could be carried out east of this longitude between lats. 42° N. and 43° N. At 10.30 p. m., fog set in, when we changed course to 118° true, for lat. $42^{\circ} 10'$ N., long. $50^{\circ} 20'$ W., which was the southern end of the first line of search, with the expectation of running out of the fog. Gentle to moderate W. to NNW. winds, with smooth to moderate seas, were experienced on April 28 and 29, while on April 30 we had gentle to light SW. winds, with calm and fog at the end of the day. At 11 p. m., G. M. T. sent the following broadcast: "Ice patrol *Tampa*. 42 40 N., 52 30 W. Ice area with following bounds: 48th meridian, 43d parallel; thence to 42 00, 49 00; thence to 42 00, 50 30; thence to 43 00, 50 30; thence on 43d parallel to 53d meridian; thence northward on 53d meridian. For vessels making Cabot Straits many bergs and growlers on tracks 8 and 9 between longitudes $47 10$ W. and $51 50$ W." The *Tampa* communicated with Cape Race and arranged for that station to broadcast, free of charge, ice warnings regarding Cabot Straits.

May 1 began with light airs to moderate breezes from N.; weather clear after 3 a. m.; moderate confused swell. Vessel on course 118° true, for southern end of first line of search. At 7.37 a. m., in lat. $42^{\circ} 10'$ N., long. $50^{\circ} 20'$ W., set course N. true, on line of search. During the day, covered the area between lats. 42° N. and 43° N. and longs. $50^{\circ} 10'$ W. and 49° W. At 12.25 p. m., sighted a berg in lat. $42^{\circ} 50'$ N., long. $49^{\circ} 30'$ W. At dark stopped search for the day, reduced speed, and stood 300° true for 23 miles, for the dead-reckoning position of the berg sighted. At 9.20 p. m., stopped and lay to for the night, having failed to pick up the berg in the darkness. The following radiogram was broadcasted: "2300 G. M. T. Ice patrol *Tampa*. 42 40, 49 10, standing for berg in 42 50, 49 30. No other ice south of 43d parallel westward. Vessels should keep south of 42 10 between meridians 48 and 49."

May 2, light to moderate WNW. to SW. winds; partly cloudy; good visibility; moderate swell. At 4 a. m., sighted the berg sought (berg "D," chart "F"), bearing 48° true, 10 miles distant; stood to same and photographed it from various positions. This berg was in lat. $42^{\circ} 50'$ N., long. $49^{\circ} 30'$ W., and proved to be a large one, having a spiral-like pinnacle, approximately 100 feet high, on one side. At 6.19 a. m., steamed ahead on course 90° true, and soon sighted another berg (berg "E," chart "F,") slightly north of our course. At 7.15 a. m., stopped alongside this second berg and photographed it from various bearings. This berg was found to be in lat. $42^{\circ} 53'$ N., long. $49^{\circ} 33'$ W. It was larger than the first one sighted this date and had two nearly parallel vertical walls, 75 feet in height, with an open space, approximately 60 feet wide, between them, the supporting base not being visible from the ship. A third berg, a small one, was sighted to the NW., in lat. $42^{\circ} 51'$ N., long. $49^{\circ} 17'$ W. Dovekies, fulmars, murrees, and jaegers were sighted on or in the vicinity of the bergs. At 7.40 a. m., steamed ahead on an E. true course, for the purpose of searching the area between parallels 43° N. and 42° N. and meridians 48° W. and 49° W. This search was completed at 5.38 p. m., whereupon course was laid E. true until 10.25 p. m., then 48° true, for oceanographic station 195, lat. $42^{\circ} 17'$ N., long. $44^{\circ} 34'$ W. The following radiogram was broadcasted at 11 p. m., G. M. T.: "Ice patrol *Tampa*. 42 50,

48 10. Three bergs within radius 12 miles of 42 50, 49 30. Except this no ice south of 43d parallel. Vessels keep south of this position, as much ice farther north."

May 3, moderate to fresh SW. to W. winds, increasing during the last two hours to moderate to fresh SW. gale, prevailed. Weather partly cloudy to overcast, with rain and vivid flashes of lightning last two hours. Moderate SW. swell to rough SW. sea. At 9.15 a. m., stopped to examine an obstruction, which proved to be an old float and not dangerous to navigation. At 9.35 a. m., stopped in lat. $44^{\circ} 17' N.$, long. $44^{\circ} 34' W.$, and occupied oceanographic station 195. At 12.25 p. m., having completed oceanographical observations, steamed ahead for station 196, in lat. $44^{\circ} 10' N.$, long. $45^{\circ} 20' W.$, which we occupied at 4.25 p. m. At 8 p. m., completed observations at station 196 and stood for station 197. At 11.15 p. m., stopped and drifted because of the intense darkness and the danger from icebergs. The following radiogram was broadcasted: "Ice patrol *Tampa*. 44 10, 45 20. Bergs and growlers along east side of the Great Bank and around tail. Vessels keep south 42 40 between meridians 49 and 51. St. Lawrence steamers will encounter bergs between longitudes 45 10 and 47 and 20 miles either side 48th parallel. Berg 47 00, 47 00; berg 46 50, 50 20; berg 45 54, 46 30; berg 46 17, 45 34."

May 4 began with a strong WSW. wind, which increased to a moderate gale from WNW. and blew a fresh gale during the afternoon, moderating to a moderate breeze at the end of the day. Rough W. to NW. sea. Weather overcast, dark and raining to mostly clear. At 2.45 a. m., steamed ahead on a 258° true course. At 6.37 a. m., stopped in lat. $44^{\circ} 05' N.$, long. $46^{\circ} 30' W.$, and occupied oceanographic station 197. At 8.40 a. m., completed observations and stood for station 198. At 11.27 a. m., changed course to 283° true, and reduced speed on account of rough sea. At 4.15 p. m., occupied station 198, lat. $44^{\circ} 00' N.$, long. $47^{\circ} 30' W.$ Took temperatures at the various depths with difficulty, on account of the rough sea. At 6.13 p. m., completed observations and stood 270° true, sea moderating, and fairly bright moonlight. At 11.14 p. m., stopped in lat. $43^{\circ} 55' N.$, long. $48^{\circ} 20' W.$, and began taking observations at oceanographic station 199. Sent special ice warnings to steamships *Gracian*, *West Durfee*, and *Regina*.

May 5, fresh to moderate NNW. to NW. winds, falling to light breeze at 8 p. m., were experienced; weather cloudy to clear, and sea moderate to light. At 1.30 a. m. finished observations at oceanographic station 199 and steamed for station 200. At 4.50 a. m. stopped at station 200, lat. $43^{\circ} 54' N.$, long. $48^{\circ} 42' W.$, and took the usual observations. At 8 a. m. finished observations and steamed for station 201. At 9.05 a. m. sighted a berg on port bow and stood a 210° , true, course for the same. At 10.05 a. m. arrived alongside the berg, photographed it, and then stood for station 201. This was a medium-sized berg and was calving rapidly. Flocks of fulmars and murre were sighted near it. At 5 p. m. occupied station 201, and at 6.05 p. m., having completed observations, stood 60° , true, until 7 p. m., when we anchored for the night in 34 fathoms of water, with shell and sand bottom.

May 6, light NW. airs to gentle WNW. wind; clear; smooth sea. At 4.30 a. m. weighed anchor and began search for bergs reported on May 3. At 7.10 a. m. sighted a berg, stood for it, and at 7.40 a. m. photographed the berg, which was a medium-sized one, in lat. $43^{\circ} 15' N.$, long. $58^{\circ} 18' W.$, and identified it as the berg reported by the steamship *Scotian* on May 5 (berg "H," chart "F"). At 8.05 a. m. set course for berg reported on the 3d and sighted it at 10.40 a. m. At 11.50 a. m. we were alongside the berg (berg "J"), a large, solid one, lat. $42^{\circ} 42' N.$, long. $51^{\circ} 03' W.$, and photographed it. This berg had drifted 18 miles, 225° , true, from the position in which it was reported on May 3. (See chart "F.") Many fulmars were around the berg. At 12.10 p. m. shaped course for the bergs sighted by the *Tampa* on May 2. At 2.15 p. m. sighted and recognized the pinnacle berg (berg "D") previously reported. The towering pinnacle of this berg was sighted when we were some 18 miles distant and upon subsequent examination showed some calving and wasting. At 5.10 p. m. stopped alongside of a second berg that had been sighted; sent boat's crew for the purpose of examining and photographing it, and found that one-third of one of its large walls had calved and wasted away while the other was still some 75 feet high. Both bergs had drifted approximately 32 miles in four days, the pinnacle one about 225° , true, and the other about 265° , true. (See chart "F.") Large flocks of fulmars were sighted around both bergs. As the small berg sighted to the northward of these on May 2 could not be seen, although the visibility was clear, we decided that it had broken up. At 6 p. m. boat returned and we shaped course for station 202, lat. $42^{\circ} 55' N.$, long. $50^{\circ} 20' W.$, where we arrived at 8.15 p. m. At 9.50 p. m. completed observations at station 202 and stood for station 203, in lat. $42^{\circ} 25' N.$, long. $50^{\circ} 20' W.$

May 7, light to gentle wind, WNW. to WSW.; weather clear to cloudy, with good visibility; smooth sea to light swell. At 12.55 a. m. stopped and occupied oceanographic station 203, where we finished observations at 2.50 a. m., and then stood for station 204, in lat. $41^{\circ} 55' N.$, long. $50^{\circ} 19' W.$ At 6 a. m. arrived at station 204 and took the usual observations, which were finished at 7.45 a. m., when we stood for station 205, in lat. $41^{\circ} 23' N.$, long. $50^{\circ} 19' W.$ At 10.45 a. m. arrived at station 205, where we completed work at 2.40 p. m. and stood for station 206, in lat. $40^{\circ} 55' N.$, long. $50^{\circ} 10' W.$ At 2 p. m. intercepted a report from the steamship *Lumincana* of a mine sighted. Determined that the reported position of the mine was too distant to be reached before dark this day and made tentative arrangements to reach its vicinity by daybreak to-morrow, but the ice report from the steamship *West Quechee* and indications of weather unfavorable for search for the mine caused a change of plan. We arrived at station 206 at 4.06 p. m. and left it at 6.30 p. m. to investigate the ice report received from the steamship *West Quechee*. Broadcasted special warning concerning the mine reported by the steamship *Lumincana* and requested that any steamer sighting it attempt to destroy it by rifle or revolver fire, advising the *Tampa* regarding the same.

May 8, gentle S. to moderate W. wind, with calm at the end of the day; weather mostly foggy, with drizzling rain at intervals. From the beginning of the day until 3.25 p. m. searched for the ice reported yesterday by the steamship *West Quechee* (berg "K," chart "E"),

without finding any indications of it, visibility from one-half to three-quarters of a mile, with heavy fog at 6 a. m. At 3.25 p. m. stopped search and lay to on account of fog conditions, which remained generally unchanged until the end of the day.

May 9, light SW. airs to breezes; weather foggy, partially clearing for short intervals; smooth sea to light swell. The *Tampa* drifted in the fog throughout the day. At 12.45 p. m. the steamship *Eurana*, whose whistle had been sounding near us, came close aboard and took our mail, which was sent to her by boat.

May 10, light and gentle SW. winds to calm; mostly cloudy, clearing at intervals. The day began and ended with fog. At 4.10 a. m., visibility somewhat improved, started to search for the icebergs reported by the steamship *Eurana* on the 9th instant. At 5.40 a. m., fog shut in, stopped and drifted. At 7.45 a. m., fog lifting, resumed search. At 3.25 p. m., in lat. $43^{\circ} 00' N.$, long. $48^{\circ} 10' W.$, sighted several small pieces of ice, which would seem to indicate that the small bergs being sought had broken up. These small bergs had evidently drifted 22° true, 0.5 mile per hour, after they were reported by the steamship *West Quechee* on May 7 (berg "K," chart "E"). Resumed search for other bergs. At 6.30 p. m., stopped and lay to for the night. Cape Race and Bona Vista reported no ice, while Fogo, Battle Harbor, reported heavy loose ice about Fogo and that light and boggy ice had moved off the coast.

May 11, light airs to light breezes, WNW. to SW.; weather partly cloudy, with light fog and rain at intervals; smooth sea. A remarkable lunar bow was observed in the early evening, the full moon in the east causing an almost complete lunar bow in the west. At 4.10 a. m., steamed ahead in search of the icebergs last seen by us on May 6. At 11.15 a. m. sighted an iceberg and stood for the same, arriving alongside of it at 11.50 a. m., in lat. $42^{\circ} 52' N.$, long. $51^{\circ} 30' W.$ After investigation decided that this berg was one not previously sighted by us. It had wasted considerably, the water temperature being $39^{\circ} F.$ After photographing this berg stood in search of others and at 2.25 p. m. raised a berg on the starboard bow, which we passed close to at 3.50 p. m. We photographed this berg and identified it as the one with a high pinnacle which we had visited on May 6 (berg "D," chart "F"). This berg also had wasted away and turned over, the pinnacle now being submerged. Its position in lat. $42^{\circ} 33' N.$, long. $51^{\circ} 09' W.$, would indicate that it had drifted 251° true, 0.4 mile per hour, since May 6. At 4 p. m. stood for a third berg which was visible and arrived alongside of it and photographed it at 4.47 p. m. This berg was identified as the one with double walls visited by us on May 6 (berg "E," chart "F"). Its position in lat. $42^{\circ} 28' N.$, long. $51^{\circ} 14' W.$, would indicate that it had drifted 251° true, 0.4 mile per hour, since May 6. This berg had wasted considerably. The sea-water temperature in its vicinity was found to be $39^{\circ} F.$ Upon completing the examination of these bergs stopped and drifted for the night.

May 12, light SW. to gentle SSE. wind; partly clear to foggy and rainy. The vessel drifted during the entire day, fog prevailing after daybreak. Drifted from berg in lat. $42^{\circ} 28' N.$, long. $51^{\circ} 14' W.$, to berg in lat. $42^{\circ} 33' N.$, long. $51^{\circ} 09' W.$, it being necessary to work the engine to clear the latter berg.

May 13, first hour gentle S. wind, then strong NW. wind for eight hours, which later shifted to W. and S. and decreased in force to light

breezes at the end of the day. At 4.50 a. m. stood for iceberg last visited and stopped alongside of it at 6.35 a. m. Photographed it and ascertained that it had drifted 279° , true, 0.68 knot per hour. (See chart "F.") At 7.17 a. m. stopped off the second berg, photographed it, and ascertained that it had drifted 285° , true, 0.59 knot per hour. Lay to and drifted, and at 11.50 a. m., visibility high, sighted another berg some 13 miles distant. At 12.35 p. m. stood for this berg, and at 1.55 p. m. arrived alongside of it and made numerous photographs. Determined that this berg was the one visited about noon, May 6, in lat. $42^{\circ} 42' N.$, long. $51^{\circ} 03' W.$ As it was found to be in lat. $42^{\circ} 24' N.$, long. $51^{\circ} 38' W.$, it was assumed that it had drifted first SW. and then E. Mother Carey's chickens, fulmars, and dovekeys were seen in the vicinity of the bergs visited this date. At 3.50 p. m. lay to and drifted for the night.

May 14, light W. to moderate WNW. wind in the forenoon, increasing to strong WNW. wind and moderate NW. gale in the afternoon; partly cloudy to overcast; smooth to rough seas. At 5.50 a. m. resumed search for icebergs, but observed none during the day. At 2.25 p. m. stopped at oceanographic station 207, lat. $43^{\circ} 32' N.$, long. $51^{\circ} 55' W.$, and experienced considerable difficulty in taking observations on account of the rough sea. At 8 p. m. stopped at station 208, lat. $43^{\circ} 23' N.$, long. $52^{\circ} 40' W.$, and took the usual observations, upon the completion of which stood for station 209.

May 15, strong to moderate NW. wind; mostly clear; rough to moderate sea. At 4.25 a. m. stopped at oceanographic station 209 and, upon completion of the usual observations, stood to meet the *Modoc*. At 3 p. m. met the *Modoc*, in lat. $43^{\circ} 14' N.$, long. $53^{\circ} 36' W.$ The oceanographic observer and the scientific observer were transferred from the *Tampa* to the *Modoc*, whereupon the *Tampa* stood for Halifax, Nova Scotia.

Daily routine ice reports were sent to Hydrographic Office, New York; Fuelite, Nova Scotia; and Cape Race, Newfoundland, and were also broadcasted.

Ice reports were received as follows: May 1, steamship *Arlierborg*, large berg, lat. $44^{\circ} 37' N.$, long. $48^{\circ} 17' W.$; May 2, steamship *Amalienborn*, large berg, lat. $43^{\circ} 47' N.$, long. $49^{\circ} 04' W.$; May 3, steamship *Sachem*, berg and two growlers, lat. $46^{\circ} 50' N.$, long. $50^{\circ} 20' W.$; steamship *Minedora*, two large bergs and several growlers, lat. $46^{\circ} 56' N.$, long. $50^{\circ} 32' W.$; steamship *Suholco*, one berg, lat. $42^{\circ} 54' N.$, long. $49^{\circ} 01' W.$, another berg, lat. $42^{\circ} 50' N.$, long. $50^{\circ} 52' W.$; steamship *Gracian*, bergs in lat. $47^{\circ} 53' N.$, long. $45^{\circ} 37' W.$, lat. $47^{\circ} 46' N.$, long. $45^{\circ} 58' W.$, lat. $47^{\circ} 50' N.$, long. $46^{\circ} 10' W.$, three bergs and several growlers, lat. $47^{\circ} 42' N.$, long. $46^{\circ} 35' W.$, one berg and growlers, lat. $47^{\circ} 42' N.$, long. $45^{\circ} 44' W.$; May 4, steamship *Regina*, 5 bergs and one growler between lat. $46^{\circ} 37' N.$, long. $48^{\circ} 31' W.$, and lat. $46^{\circ} 20' N.$, long. $49^{\circ} 05' W.$; steamship *Sachem*, two bergs in lat. $46^{\circ} 25' N.$, long. $48^{\circ} 55' W.$; steamship *Gracian*, a small berg and several growlers in lat. $46^{\circ} 53' N.$, long. $47^{\circ} 20' W.$, two bergs in lat. $46^{\circ} 42' N.$, long. $48^{\circ} 20' W.$, one berg in lat. $46^{\circ} 35' N.$, long. $48^{\circ} 35' W.$, one berg and one growler in lat. $46^{\circ} 20' N.$, long. $49^{\circ} 05' W.$; May 5, steamship *Scotian*, one berg in lat. $43^{\circ} 23' N.$, long. $49^{\circ} 08' W.$, and another berg in lat. $43^{\circ} 25' N.$, long. $50^{\circ} 17' W.$; steamship *Poland*, one berg and four growlers on track between lat. $46^{\circ} 37' N.$, long. $47^{\circ} 02' W.$, and lat. $46^{\circ} 23' N.$, long. $48^{\circ} 04' W.$, berg in lat. $46^{\circ} 40' N.$, long. $47^{\circ} 15' W.$

The steamship *Rosalind* reported, via Cape Race: "A number of large and small bergs along coast from Cape Spear to Ballard, two bergs about 8 miles east of St. Johns, two off Motion Head, two close inshore off Bulls Head and one about 4 miles from North Cape Broyle, one off Fermuse and just north of Cape Bullard, outside ones dangerous." May 6, steamship *Manchester Producer*, berg in lat. $44^{\circ} 18' N.$, long. $47^{\circ} 07' W.$; steamship *Knock Fern* passed numerous growlers and small bergs and sighted numerous growlers, bergs, and field ice to the northward on a S. $48^{\circ} W.$ course from lat. $50^{\circ} 05' N.$, long. $48^{\circ} 04' W.$; steamship *Hoxie*, two bergs, lat. $47^{\circ} 37' N.$, long. $50^{\circ} 30' W.$, field ice and bergs from lat. $47^{\circ} 50' N.$, long. $50^{\circ} 00' W.$, to lat. $48^{\circ} 30' N.$, long. $48^{\circ} 28' W.$; steamship *Rathlin Head*, iceberg with growlers in lat. $49^{\circ} 16' N.$, long. $44^{\circ} 51' W.$; steamship *Emperor of Scotland* passed 11 bergs and several growlers on or near track in lat. $47^{\circ} 00' N.$, between longs. $50^{\circ} 00' W.$; and $45^{\circ} 50' W.$; steamship *Ballygalleyhead*, several small and one large berg, from lat. $47^{\circ} 15' N.$, long. $49^{\circ} 00' W.$, to lat. $47^{\circ} 20' N.$, long. $49^{\circ} 22' W.$; steamship *Jehauen*, one berg in lat. $46^{\circ} 40' N.$, long. $46^{\circ} 40' W.$, two bergs in lat. $46^{\circ} 36' N.$, long. $47^{\circ} 00' W.$, three bergs in lat. $46^{\circ} 30' N.$, long. $47^{\circ} 08' W.$; steamship *Poland*, berg in lat. $46^{\circ} 40' N.$, long. $47^{\circ} 15' W.$; Cape Race reported many growlers and several bergs in lat. $49^{\circ} 16' N.$, long. $49^{\circ} 38' W.$ May 7, steamship *West Quechee* reported several small bergs and drift ice in lat. $42^{\circ} 30' N.$, long. $48^{\circ} 23' W.$; steamship *Rathlin Head*, berg, lat. $47^{\circ} 41' N.$, long. $50^{\circ} 17' W.$, several growlers in lat. $47^{\circ} 03' N.$, long. $50^{\circ} 28' W.$, numerous bergs and growlers from lat. $48^{\circ} 11' N.$, long. $48^{\circ} 59' W.$, to lat. $47^{\circ} 49' N.$, long. $49^{\circ} 44' W.$, open field ice from lat. $48^{\circ} 00' N.$, long. $49^{\circ} 25' W.$, to lat. $47^{\circ} 49' N.$, long. $49^{\circ} 44' W.$; steamship *Canadian Otter*, bergs, lat. $48^{\circ} 49' N.$, long. $44^{\circ} 40' W.$, lat. $47^{\circ} 55' N.$, long. $46^{\circ} 22' W.$, several bergs and growlers between lat. $47^{\circ} 42' N.$, long. $46^{\circ} 45' W.$, and lat. $47^{\circ} 19' N.$, long. $47^{\circ} 31' W.$, berg, lat. $46^{\circ} 56' N.$, long. $48^{\circ} 11' W.$, several small bergs, lat. $46^{\circ} 28' N.$, long. $48^{\circ} 02' W.$; May 8, steamship *Canadian Otter*, large berg, lat. $45^{\circ} 56' N.$, long. $50^{\circ} 57' W.$; steamship *Tonowanda*, two bergs, lat. $44^{\circ} 44' N.$, long. $48^{\circ} 32' W.$; May 9, steamship *Eurana*, two small bergs, close together, lat. $42^{\circ} 27' N.$, long. $48^{\circ} 35' W.$; May 10, steamship *Empress of Ratick*, ice in lat. $46^{\circ} 50' N.$, long. $45^{\circ} 59' W.$, and also in lat. $45^{\circ} 55' N.$, long. $50^{\circ} 10' W.$; steamship *Canadian Raider*, field ice in every direction, lat. $47^{\circ} 38' N.$, long. $48^{\circ} 30' W.$; steamship *Knock Furna*, field ice, with growlers, lat. $50^{\circ} 41' N.$, long. $51^{\circ} 00' W.$; May 11, steamship *Megantic*, three growlers in lat. $47^{\circ} 28' N.$, long. $46^{\circ} 21' W.$, two small bergs, lat. $47^{\circ} 13' N.$, long. $46^{\circ} 44' W.$; unknown steamer reported medium-sized berg and several growlers in lat. $45^{\circ} 55' N.$, long. $48^{\circ} 20' W.$; steamship *Fishpool*, one berg in lat. $42^{\circ} 27' N.$, long. $51^{\circ} 10' W.$, and another in lat. $42^{\circ} 19' N.$, long. $51^{\circ} 20' W.$; May 12, steamship *Maplebarn*, iceberg 9 miles E. by N. from Cape Race; steamship *Lakonia*, two icebergs and growlers in lat. $46^{\circ} 06' N.$, long. $49^{\circ} 25' W.$; steamship *Megantic*, large iceberg in lat. $46^{\circ} 25' N.$, long. $48^{\circ} 41' W.$; May 13, steamship *Albania*, two growlers in lat. $46^{\circ} 36' N.$, long. $47^{\circ} 14' W.$; May 14, steamship *Mexicano*, large berg in lat. $47^{\circ} 40' N.$, long. $48^{\circ} 10' W.$; steamship *America*, three large bergs in lat. $45^{\circ} 10' N.$, long. $48^{\circ} 30' W.$

Obstruction reports were received as follows: May 2, steamships *New Amsterdam* and *Oropesa* reported red conical buoy in lat. $39^{\circ} 42' N.$, long. $51^{\circ} 37' W.$; May 4, steamship (name not obtained) reported red conical buoy with black stripes in lat. $39^{\circ} 17' N.$, long. $49^{\circ} 17' W.$; May 6, steamship *Plattsboro* reported whistling buoy in lat. $37^{\circ} 50' N.$, long. $49^{\circ} 48' W.$; May 7, steamship *Lumincana* reported an object awash, covered with seaweed, with five visible horns, believed to be a mine, in lat. $40^{\circ} 26' 30'' N.$, long. $48^{\circ} 44' W.$; steamship *El Conadado* reported a Grand Bank conical buoy in lat. $40^{\circ} 06' 30'' N.$, long. $49^{\circ} 21' W.$; steamship *Schoon* reported a whistling buoy in lat. $37^{\circ} 50' N.$, long. $49^{\circ} 43' W.$; May 14, steamship *Western Plains* passed large piece of wreckage, 60 feet long and 40 feet wide, attached to framework of wooden vessel, connecting frames and knees, projecting upward, dangerous to navigation, in lat. $40^{\circ} 44' N.$, long. $50^{\circ} 16' W.$

During the cruise, special ice warnings were sent as follows: May 4, steamships *Gracian*, *West Durfee*, and *Regina*; May 8, steamships *Wurtemberg* and *Aludro*; May 9, steamship *Eurana*.

During the cruise, 400 sea-water temperature reports and 88 ice reports were received from passing steamships.

COAST GUARD CUTTER "MODOC," LIUET. COMMANDER B. M. CHISWELL, ICE PATROL, FIRST CRUISE, MAY 15 TO 30, 1922.

The *Modoc* left Halifax, Nova Scotia, at 10.25 a. m., May 13, 1922, and relieved the *Tampa* at 4 p. m., May 15, in lat. $43^{\circ} 15' N.$, long. $53^{\circ} 36' W.$, and directed that vessel to proceed to Halifax. The oceanographic and the scientific observers reported on board from the *Tampa*. The *Modoc* then set course for the three bergs last seen by the *Tampa* on the morning of May 14.

The following ice reports were received May 15: Battle Harbor reported a heavy ice jam everywhere; the steamship *Canadian Commander* reported having passed a number of bergs and growlers from lat. $48^{\circ} 07' N.$, long. $47^{\circ} 11' W.$, to lat. $47^{\circ} 05' N.$, long. $41^{\circ} 00' W.$; the steamship *Minnedosa* reported bergs in lat. $46^{\circ} 22' N.$, long. $48^{\circ} 21' W.$, and lat. $46^{\circ} 24' N.$, long. $48^{\circ} 00' W.$, and growlers in lat. $46^{\circ} 13' N.$, long. $48^{\circ} 18' W.$; the steamship *Hampstead Heath* reported two small bergs in lat. $46^{\circ} 30' N.$, long. $52^{\circ} 10' W.$

On the morning of May 16, visibility very good, we scouted the SW. limits of the probable ice drift. At 2.20 p. m., we located a small berg, with several small growlers, in lat. $42^{\circ} 28' N.$, long. $51^{\circ} 33' W.$ This berg had drifted 20 miles, 123° , true, since it was last seen by the *Tampa* on the 13th. (See chart "F.")

At 3 p. m., we arrived at another berg, in lat. $42^{\circ} 26' N.$, long. $51^{\circ} 29' W.$, which had drifted $2\frac{1}{2}$ miles, 26° , true, since the 14th. At 4.25 p. m., a third berg, which had drifted $9\frac{1}{2}$ miles, 131° , true, since the 14th, was found in lat. $42^{\circ} 21' N.$, long. $51^{\circ} 16' W.$ This berg, which was about twice the size of the others sighted on this date, is thought to have been less affected in its drift by the wind on account of its size and shape. All of these bergs were disintegrating rapidly. The temperature of the air in their vicinity was $43^{\circ} F.$ and that of the sea water $38^{\circ} F.$ A number of fulmars and small flocks of dovebies were flying about in the vicinity of the bergs.

Ice reports were received as follows: Battle Harbor reported heavy ice jam; Fogo reported loose ice everywhere; the steamship *Cairnross* reported a berg in lat. $46^{\circ} 45' N.$, long. $41^{\circ} 55' W.$, a large berg in lat. $46^{\circ} 54' N.$, long. $51^{\circ} 37' W.$, a large berg in lat. $47^{\circ} 20' N.$, long. $50^{\circ} 14' W.$, and two bergs in lat. $47^{\circ} 50' N.$, long. $49^{\circ} 38' W.$; the steamship *Hampstead Heath* reported a large berg in lat. $48^{\circ} 12' N.$, long. $51^{\circ} 25' W.$, and about 18 small bergs in lat. $48^{\circ} 40' N.$, long. $49^{\circ} 10' W.$ We also received a broadcast of a berg in lat. $46^{\circ} 17' N.$, long. $48^{\circ} 09' W.$

The morning of May 17 opened clear, with excellent visibility, and search was started to the eastward, between the 42d and 43d parallels. At 2 p. m., we found a small berg (berg "G," chart "E") and two small growlers in lat. $42^{\circ} 39' N.$, long. $49^{\circ} 47' W.$ This berg calved and rolled over as we were passing and apparently was rapidly disintegrating. The temperature of the air in its vicinity was $41^{\circ} F.$ and that of the water $33^{\circ} F.$ The steamship *Gustavholm*, bound east, passed within $5\frac{1}{2}$ miles of this berg at 4 a. m. She sent a message during the morning that she had sighted no ice. She paid no heed to our broadcast warning of May 16. At 4.30 p. m., we passed a large, flat berg, in lat. $42^{\circ} 22' N.$, long. $49^{\circ} 17' W.$ (berg "F," chart "E"). This ice looked hard and showed no signs of early disintegration. The temperature of the air in its vicinity was $42^{\circ} F.$ and that of the water $34^{\circ} F.$ Many fulmars and dovekies were seen near these bergs.

Ice reports were received as follows: Battle Harbor reported ice jam along the shore, with clear water one-half mile off and numerous small bergs drifting south; the steamship *R. C. Rickmers* reported having sighted, on May 16, a mine covered with barnacles in lat. $39^{\circ} 15' N.$, long. $48^{\circ} 28' W.$; the steamship *Canadian Ranger* reported a berg in lat. $46^{\circ} 48' N.$, long. $52^{\circ} 28' W.$, and a growler in lat. $46^{\circ} 38' N.$, long. $52^{\circ} 00' W.$; the steamship *Rosalind* reported a number of bergs and growlers from north of Cape Ballard to Cape Loche and large bergs east of Cape Race; the steamship *Fanad Head* passed numerous bergs and growlers from lat. $48^{\circ} 22' N.$, long. $47^{\circ} 45' W.$, to lat. $47^{\circ} 36' N.$, long. $49^{\circ} 57' W.$ Special ice information was furnished the Italian steamship *Castera*.

At 8 p. m. on May 17, in lat. $42^{\circ} 23' N.$, long. $48^{\circ} 10' W.$, the engine was stopped and the *Modoc* allowed to drift for the night, the wind being strong from NNW. to N., with rough sea.

At 5 a. m., May 18, it was found we had been set south, true, 13 miles during the night. At daylight search was resumed between the 42d and 43d parallels eastward to the 48th meridian. The visibility was excellent, but no ice was seen. At 8.45 p. m. we stopped near the last berg sighted on the 17th (berg "F") and found it to be in lat. $42^{\circ} 06' N.$, long. $49^{\circ} 00' W.$, and that it had traveled 20 miles, 143° , true, in $28\frac{1}{4}$ hours. (See chart "E.") Upon approaching this berg, one hour after sunset, with clear, bright starlight night, it was apparent that a lookout not specially on the alert would probably not have picked it up at a greater distance than a quarter of a mile. Knowing its bearing and watching intently with binoculars, we could see an occasional bright spot in its direction at a distance of a mile or more, due to the swell breaking against the ice wall. We were now satisfied that all ice south of the 43d parallel had been located during the last three days.

Ice reports were received as follows: Battle Harbor reported ice moving off the land; Fogo reported numerous bergs; Buena Vista lots of slob ice off the cape; the steamship *Wisley* reported a large berg in lat. $46^{\circ} 54' N.$, long. $51^{\circ} 38' W.$, a berg in lat. $47^{\circ} 15' N.$, long. $50^{\circ} 58' W.$, and one in lat. $47^{\circ} 00' N.$, long. $51^{\circ} 02' W.$; the steamship *Fanad Head* reported a large berg in lat. $47^{\circ} N.$, long. $50^{\circ} 27' W.$, another berg in lat. $47^{\circ} 00' N.$, long. $51^{\circ} 09' W.$, one in lat. $46^{\circ} 55' N.$, long. $51^{\circ} 30' W.$, one in lat. $46^{\circ} 47' N.$, long. $52^{\circ} 05' W.$, and a berg and growler 6 miles, 55° , true, from Cape Race.

May 19 was a beautiful, clear day, with smooth sea, and we lay to near the berg which was sighted at 8.40 p. m., May 18 (berg "F"), which was drifting south, true, one-half mile per hour. At 4.30 p. m., the Standard Oil steamship *W. H. Tilford*, Bremen to New York, passed us and inquired if there was any ice to the westward. They were informed that we were lying by the southernmost berg. Ice information was sent to the steamships *Meline*, *West Elbara*, *Taurus*, and to "PGZ."

Ice reports were received as follows: Steamship *Canopic* reported numerous bergs and growlers in lat. $47^{\circ} 09' N.$, long. $47^{\circ} 51' W.$, and a few growlers in lat. $47^{\circ} 05' N.$, long. $48^{\circ} 30' W.$; Battle Harbor reported ice moving off the land and Fogo reported fine water for 15 miles off shore. A broadcast was received of a berg in lat. $47^{\circ} 25' N.$, long. $50^{\circ} 29' W.$, and another in lat. $47^{\circ} 25' N.$, long. $50^{\circ} 04' W.$

On May 20 the weather continued fine, with smooth sea and high barometer. We lay to near yesterday's berg (berg "F"), believing it to be the southernmost and therefore the most dangerous one, and kept a careful record of its drift. (See chart "E.") In the forenoon remarkable mirage effects were noted. A flock of tern was perched on the berg during the greater part of the forenoon. Specimens of plankton and temperatures at various depths were obtained in lat. $41^{\circ} 47' N.$, long. $49^{\circ} 08' W.$ At 11.00 G. M. T., the steamship *Kastalia* reported a small berg in lat. $41^{\circ} 25' N.$, long. $49^{\circ} 21' W.$ In the afternoon we ran down to this position, and although the visibility was excellent, we saw no ice. As the temperature of the sea water in the reported locality of the berg was $55^{\circ} F.$, it was believed that the *Kastalia's* position was in error. We then returned to our forenoon position and lay by the berg for the night. During the afternoon run, Gulf Stream temperatures were encountered in lat. $41^{\circ} 30' N.$ At 8 p. m. the berg near which we were lying was in lat. $41^{\circ} 40' N.$, long. $49^{\circ} 00' W.$, and during the day had drifted south, true, 0.4 knot per hour. Ice information was furnished the steamships *Thyra* and *Miami*.

Ice information was received as follows: Steamship *Thyra* reported a berg in lat. $41^{\circ} 48' N.$, long. $51^{\circ} 35' W.$; the steamship *Arminco* reported a small piece of ice in lat. $42^{\circ} 05' N.$, long. $49^{\circ} 06' W.$; the steamship *City of Lincoln* reported two small bergs in lat. $41^{\circ} 38' N.$, long. $51^{\circ} 10' W.$; the steamship *West Kebar* reported numerous bergs and growlers from lat. $48^{\circ} 19' N.$, long. $47^{\circ} 40' W.$, to lat. $48^{\circ} 09' N.$, long. $48^{\circ} 14' W.$, a large berg in lat. $47^{\circ} 40' N.$, long. $49^{\circ} 19' W.$, and numerous bergs and growlers between lat. $47^{\circ} 48' N.$, long. $49^{\circ} 31' W.$, and lat. $47^{\circ} 22' N.$, long. $50^{\circ} 45' W.$

On May 21, a moderately thick fog shut in during the morning and continued until noon, when it lifted. We ran up to lat. $42^{\circ} 50' N.$, long. $48^{\circ} 30' W.$, and thence W., true, for 60 miles. Visibility



A LARGE BERG.

June 29, 1922, $41^{\circ} 57' N.$, $50^{\circ} 50' W.$, surface-water temperature 58° . This berg was apparently in an eddy which held it in about the same locality. It was in warm water, however, on the northern edge of the Gulf Stream, and was disintegrating rapidly. Several growlers will be noticed drifting off to leeward. By July 8, 1922, this berg had melted so much that it was no longer considered a menace.



THE COLD WALL.

March 27, 1922, 41° 40' N., 51° 07' W., looking westward. This is a rare photograph showing the meeting of the Arctic Drift and the Gulf Stream. The surface of the water on the cold side of the "Wall" was smooth and glassy, its temperature being 34°, while on the south side the surface was chopped and rippled, the sea temperature being 56°—a range of 22° in the length of a step.

was very good during the afternoon, but no ice was seen. At dark, thick fog shut in, whereupon we stopped and drifted for the night. Special ice information was furnished the steamships *Stadsy* and *Espagne*.

Ice information was received as follows: The steamship *Gemma* reported having passed, at 10.50 p. m., May 20, a berg and growler in lat. $41^{\circ} 42' N.$, long. $51^{\circ} 03' W.$; the steamship *Melmore Head* reported several bergs and growlers in lat. $47^{\circ} 25' N.$, long. $51^{\circ} 33' W.$; the steamship *Merry Mount* reported growlers in lat. $47^{\circ} 35' N.$, long. $50^{\circ} 39' W.$, lat. $47^{\circ} 37' N.$, long. $50^{\circ} 26' W.$, and bergs in lat. $47^{\circ} 26' N.$, long. $50^{\circ} 19' W.$, lat. $47^{\circ} 44' N.$, long. $50^{\circ} 07' W.$, lat. $47^{\circ} 25' N.$, long. $49^{\circ} 45' W.$, lat. $47^{\circ} 28' N.$, long. $49^{\circ} 35' W.$, lat. $47^{\circ} 34' N.$, long. $49^{\circ} 22' W.$, and lat. $47^{\circ} 34' N.$, long. $48^{\circ} 43' W.$

On May 22 dense fog prevailed all day. We ran in to the Great Bank and anchored on it at 8.15 p. m. Special ice information was given the steamship *Rochambeau*.

Ice information was received as follows: Battle Harbor reported open ice everywhere; Fogo reported loose ice everywhere; the steamship *Merry Mount* reported numerous bergs and growlers in lat. $47^{\circ} 45' N.$, long. $50^{\circ} 20' W.$, to lat. $48^{\circ} 00' N.$, long. $48^{\circ} 50' W.$; the steamship *Poland* reported numerous bergs and growlers from lat. $47^{\circ} 28' N.$, long. $49^{\circ} 35' W.$, to lat. $47^{\circ} 46' N.$, long. $48^{\circ} 00' W.$; the steamship *Megantic* reported large bergs in lat. $47^{\circ} 36' N.$, long. $50^{\circ} 40' W.$, lat. $47^{\circ} 31' N.$, long. $50^{\circ} 36' W.$, and lat. $46^{\circ} 31' N.$, long. $50^{\circ} 31' W.$, and a berg and growlers in lat. $47^{\circ} 36' N.$, long. $50^{\circ} 38' W.$

On May 23 temperature and salinity tests and specimens of plankton were taken at station 217, lat. $43^{\circ} 40' N.$, long. $50^{\circ} 29' W.$ From this position we stood to the eastward for station 218, passing several Canadian and French fishing vessels anchored on the Great Bank. A school of whales and a few shearwaters were seen. Heavy tide rips on the eastern edge of the Great Bank indicated a strong Labrador Current setting to the southward. At 5.20 p. m. we made the usual observations at oceanographic station 218, lat. $43^{\circ} 56' N.$, long. $48^{\circ} 55' W.$

Ice information was received as follows: Battle Harbor reported heavy, closely packed ice extending to the shore; Fogo reported heavy open ice everywhere; Buena Vista reported no ice; the steamship *Atlantic City* reported a medium-sized berg and several growlers in lat. $42^{\circ} 08' N.$, long. $49^{\circ} 16' W.$; the steamship *Megantic* reported large bergs in lat. $48^{\circ} 13' N.$, long. $49^{\circ} 37' W.$, lat. $48^{\circ} 17' N.$, long. $49^{\circ} 38' W.$, and several bergs in lat. $48^{\circ} 05' N.$, long. $49^{\circ} 24' W.$; the steamship *Empress of India* reported two small bergs in lat. $48^{\circ} 16' N.$, long. $49^{\circ} 20' W.$, a large berg in lat. $48^{\circ} 17' N.$, long. $49^{\circ} 08' W.$, four large bergs in lat. $48^{\circ} 21' N.$, long. $49^{\circ} 03' W.$, and one large berg and several growlers in lat. $48^{\circ} 23' N.$, long. $49^{\circ} 03' W.$; the steamship *West Bridge* reported 20 bergs and numerous growlers between lat. $48^{\circ} 43' N.$, long. $48^{\circ} 53' W.$, and lat. $48^{\circ} 05' N.$, long. $51^{\circ} 09' W.$, and large bergs in lat. $48^{\circ} 57' N.$, long. $51^{\circ} 07' W.$, and lat. $47^{\circ} 54' N.$, long. $51^{\circ} 10' W.$

On May 24 oceanographic and biological observations were made at the following stations: Station 219, lat. $44^{\circ} 00' N.$, long. $48^{\circ} 20' W.$; station 220, lat. $44^{\circ} 00' N.$, long. $47^{\circ} 27' W.$; station 221, lat. $44^{\circ} 07' N.$, long. $46^{\circ} 30' W.$; and station 222, lat. $44^{\circ} 13' N.$, long. $45^{\circ} 12' W.$ At 5.20 a. m. we passed a large berg in lat. $44^{\circ} 07' N.$, long. $47^{\circ} 55' W.$

Ice information was received as follows: Battle Harbor reported ice tight to land; Fogo reported water about 1 mile offshore; the steamship *Canadian Pioneer* reported having sighted, on May 23, a small berg in lat. $45^{\circ} 45' N.$, long. $49^{\circ} 00' W.$, and a large berg and growlers in lat. $45^{\circ} 42' N.$, long. $48^{\circ} 20' W.$; the steamship *Cohasset* reported a berg in lat. $41^{\circ} 23' N.$, long. $48^{\circ} 21' W.$; the steamship *Bradford City* reported a small berg and growler in lat. $44^{\circ} 16' N.$, long. $46^{\circ} 40' W.$, and a medium-sized berg in lat. $44^{\circ} 34' N.$, long. $47^{\circ} 13' W.$

At 1.15 p. m., May 25, we arrived at lat. $42^{\circ} 50' N.$, long. $48^{\circ} 00' W.$, and then stood W., true, until dark. The visibility was good, but no ice was sighted. Reports concerning ice were received as follows: Battle Harbor and Fogo reported ice moving off; the steamship *Canal* reported a very large berg in lat. $48^{\circ} 20' N.$, long. $48^{\circ} 58' W.$; the steamship *Delaware* reported a large berg in lat. $44^{\circ} 20' N.$, long. $48^{\circ} 50' W.$; the steamship *Rathlin Head* reported numerous bergs and growlers from lat. $47^{\circ} 36' N.$, long. $50^{\circ} 45' W.$, to lat. $48^{\circ} 11' N.$, long. $49^{\circ} 18' W.$; the steamship *Bradford City* reported top of berg 10 miles to northward of lat. $44^{\circ} 30' N.$, long. $48^{\circ} 40' W.$ Obstruction reports were received from the following steamships: *Cedric*, a large conical buoy in lat. $41^{\circ} 25' N.$, long. $45^{\circ} 18' W.$; *Cameronia*, passed wreckage in lat. $45^{\circ} 45' N.$, long. $48^{\circ} 10' W.$, on May 24; and *Storm King*, a spar in lat. $41^{\circ} 20' N.$, long. $47^{\circ} 06' W.$ Special ice information was furnished the steamships *Celtic* and *Consort*.

May 26 was spent in searching the area between the 42d and 43d parallels and the 48th and 51st meridians. The visibility was excellent, but no ice was sighted. We arrived at the conclusion that there was no ice south of the 43d parallel except the bergs located on May 16 and May 17. As these bergs were in warm water, drifting to the northward and eastward and disintegrating rapidly, they would remain a menace but for a few days longer at the most. The steamship *Londonier*, whose course was taking her into the danger zone, was warned. Special ice information was furnished the steamship *Mount Carroll*.

Ice reports were received as follows: Battle Harbor, ice packed in on land; Fogo, bay full of ice, clear water about 1 mile off shore, numerous bergs; steamship *Empress of Canada* reported having sighted on May 25 bergs and growlers in lat. $46^{\circ} 39' N.$, long. $53^{\circ} 03' W.$, lat. $46^{\circ} 44' N.$, long. $52^{\circ} 48' W.$, lat. $47^{\circ} 19' N.$, long. $50^{\circ} 16' W.$, and lat. $48^{\circ} 09' N.$, long. $49^{\circ} 30' W.$; steamship *Londonier*, one berg and growler in lat. $41^{\circ} 43' N.$, long. $48^{\circ} 20' W.$, and three growlers in lat. $41^{\circ} 39' N.$, long. $48^{\circ} 52' W.$ The steamship *West Inskip* reported having sighted on May 25 a buoy in lat. $41^{\circ} 17' N.$, long. $45^{\circ} 46' W.$

At 7.40 a. m., May 27, we located a small berg (berg "F") and growler in lat. $41^{\circ} 45' N.$, long. $48^{\circ} 50' W.$, which was last seen by the *Modoc* on the morning of May 21. (See chart "E.") It was now in water with a surface temperature of $41^{\circ} F.$, drifting to the northeastward and disintegrating rapidly. When first sighted, on May 17, this was a fairly large berg, but now it was nothing more than a large growler. During the day we searched for the three

growlers reported by the *Londonier* on the 26th in lat. $41^{\circ} 39' N.$, long. $48^{\circ} 52' W.$, without finding them. As the wind and sea were increasing and fog setting in, we ran up for the Great Bank. Special ice information was furnished the steamship *Rapidan*. Battle Harbor reported ice jam extending to the land to the northward, with scattered ice everywhere to the southward; Fogo reported heavy ice moving SE.; Buena Vista reported no ice; the steamship *Galley Head* reported bergs from lat. $47^{\circ} 30' N.$, long. $50^{\circ} 50' W.$, to lat. $47^{\circ} 53' N.$, long. $50^{\circ} 20' W.$

On May 28 we stood on to the Great Bank and anchored, at 7.15 p. m., in lat. $43^{\circ} 30' N.$, long. $50^{\circ} 50' W.$ Ice information was furnished the steamships *Emeltonian*, *East Cape*, and *Susquehanna*. The steamship *Comino* reported a large berg in lat. $46^{\circ} 18' N.$, long. $52^{\circ} 42' W.$, and another in lat. $46^{\circ} 18' N.$, long. $51^{\circ} 41' W.$

On May 29, the usual observations were made at oceanographic and biological stations as follows: Station 223, lat. $43^{\circ} 23' N.$, long. $50^{\circ} 57' W.$; station 224, lat. $43^{\circ} 00' N.$, long. $51^{\circ} 20' W.$; station 225, lat. $42^{\circ} 42' N.$, long. $51^{\circ} 29' W.$; station 226, lat. $42^{\circ} 30' N.$, long. $51^{\circ} 50' W.$; and station 227, lat. $42^{\circ} 05' N.$, long. $52^{\circ} 15' W.$

Ice reports were received as follows: Battle Harbor, ice moving off; Fogo, numerous bergs, bay full of ice; Buena Vista, no ice; steamship *Cassandra*, large berg in lat. $48^{\circ} 14' N.$, long. $49^{\circ} 05' W.$, growler in lat. $48^{\circ} 08' N.$, long. $49^{\circ} 33' W.$, growler in lat. $48^{\circ} 10' N.$, long. $49^{\circ} 51' W.$, berg in lat. $47^{\circ} 45' N.$, long. $50^{\circ} 24' W.$, and two bergs in lat. $47^{\circ} 37' N.$, long. $50^{\circ} 40' W.$; steamship *Canadian Trooper*, 11 bergs and several growlers within sight in lat. $45^{\circ} 00' N.$, long. $48^{\circ} 00' W.$; steamship *Gargoyle*, one berg and five growlers in lat. $44^{\circ} 40' N.$, long. $47^{\circ} 05' W.$, large berg in lat. $44^{\circ} 35' N.$, long. $47^{\circ} 18' W.$, large berg in lat. $47^{\circ} 27' N.$, long. $47^{\circ} 25' W.$, large berg in lat. $44^{\circ} 14' N.$, long. $48^{\circ} 27' W.$, large berg in lat. $44^{\circ} 20' N.$, long. $48^{\circ} 29' W.$, and a medium-sized berg in lat. $44^{\circ} 26' N.$, long. $48^{\circ} 22' W.$; steamship *Skymer*, small berg and drift ice in lat. $43^{\circ} 17' N.$, long. $49^{\circ} 41' W.$; steamship *Svend Foynj*, berg in lat. $43^{\circ} 25' N.$, long. $48^{\circ} 54' W.$, one in lat. $43^{\circ} 08' N.$, long. $48^{\circ} 43' W.$, and one in lat. $43^{\circ} 30' N.$, long. $48^{\circ} 35' W.$, also scattered brash ice in the vicinity of those positions.

The *Modoc* was relieved by the *Tampa* on the morning of the 30th in lat. $41^{\circ} 15' N.$, long. $53^{\circ} 05' W.$, and then proceeded to Halifax.

During the period of this patrol the weather, on the whole, was very good. May 19, 20, 23, 25, and 29 were clear, sunny days, with smooth sea and excellent visibility. We had one day of dense and two days of intermittent fog. The other days were cloudy to overcast. Northwesterly winds prevailed on the 15th, 17th, 18th, 22d, 23d, 24th, and 28th, with a maximum force of 6 on the 17th and 18th. Southwesterly winds prevailed on the 20th, 21st, 26th, 27th, and 29th; easterly airs, increasing to moderate breezes, on the 16th; light variable airs on the 19th, and northerly winds on the 25th. Rough sea was encountered on the 15th, 17th, 18th, and 27th. Ice information was broadcasted and sent daily to the branch Hydrographic Office, New York; to Fuelite, Halifax; and to Cape Race.

Four hundred and fifty sea-water temperature reports were received from 140 different vessels and 51 ice reports from 40 different vessels.

COAST GUARD CUTTER "TAMPA," LIEUT. COMMANDER W. J. WHEELER,
ICE PATROL, THIRD CRUISE, MAY 27 TO JUNE 14, 1922.

The *Tampa* left Halifax at 3 p. m., May 27, to resume the ice patrol, and relieved the *Modoc* at 5 a. m., May 30, in lat. $41^{\circ} 15' N.$, long. $53^{\circ} 00' W.$ The oceanographic observer and the scientific observer were transferred from the *Modoc* to the *Tampa*, after which the former vessel steamed for Halifax.

On the run from Halifax stops were made at the following oceanographic stations, where the usual observations were taken: May 27, station 214, lat. $45^{\circ} 15' N.$, long. $62^{\circ} 40' W.$; May 28, station 215, lat. $43^{\circ} 50' N.$, long. $61^{\circ} 15' W.$, May 28, station 216, lat. $43^{\circ} 28' N.$, long. $60^{\circ} 04' W.$, May 30, station 228, lat. $41^{\circ} 15' N.$, long. $53^{\circ} 00' W.$ On completion of work at the latter station, set course for lat. $43^{\circ} 05' N.$, long. $49^{\circ} 30' W.$, to investigate icebergs reported in that vicinity on May 29. On May 30, gentle to light southerly breezes, shifting to ESE. during the latter part of the day, with fog after dark, prevailed.

May 31. Gentle to fresh breezes, ESE. to NE.; foggy for most part. Unable to search for bergs on account of thick weather. At 1.40 p. m., anchored on the southern end of the Great Bank, lat. $43^{\circ} 15' N.$, long. $50^{\circ} 08' W.$, and remained at anchor the remainder of the day. Thick fog. Special ice warnings sent to steamships *Peninsular State*, *Panhandle State*, *Stockholm*, and *George Washington*.

June 1 began with strong NE. breeze, falling to moderate ENE. wind; foggy except for a short interval in the forenoon; intervals of intermittent fog in the afternoon. At 9.15 a. m., weather clearing, got under way and searched for bergs. At 4.05 p. m., stopped on account of thick fog and lay to the remainder of the day. Special ice warning was sent to the steamship *Lavoie*.

On June 2 we experienced light easterly breezes to airs and fog. At 9.45 a. m., stood for oceanographic station 229, lat. $42^{\circ} 28' N.$, long. $50^{\circ} 11' W.$, where the usual observations were taken. Occupied oceanographic station 230, lat. $42^{\circ} 53' N.$, long. $50^{\circ} 22' W.$ Upon the completion of work, stood for station 231.

June 3. Light airs to light breezes, NNE. to SE.; foggy, partially clearing at intervals in the forenoon and at other times very dense. At 7.10 a. m., stopped at station 231, lat. $44^{\circ} 00' N.$, long. $50^{\circ} 35' W.$, where the usual oceanographic and biological observations were made. At 11.50 a. m., anchored near the French barkentine *Eugene Louis* and ascertained that the crew were living on hard bread and fresh fish. At 2.25 p. m., up anchor and stood various courses through the fog. At 6.10 p. m., anchored in lat. $43^{\circ} 13' N.$, long. $53^{\circ} 03' W.$ Special ice warning was sent to the steamship *Hoxie*.

June 4. Light airs to light breezes, SE. to SSW.; foggy throughout; sun showing overhead at intervals. The vessel remained at anchor in the fog throughout the day. Special ice warning was sent to the steamship *Lithuania*.

June 5. Light to moderate SSW. to W. by S. winds; dense fog throughout the day. Choppy sea in the forenoon; mostly smooth thereafter. The vessel remained at anchor. A few dovekies and fulmars were seen.

June 6. Gentle breezes to light airs, W. to NW.; foggy and hazy, partially clear at intervals. At 7.20 a. m., under way and searched

for bergs. At 11.40 a. m., fog remaining thick made search impracticable. At 4.50 p. m., occupied oceanographic station 232, lat. $41^{\circ} 55' N.$, long. $50^{\circ} 19' W.$ At 10.35 p. m., occupied station 233, lat. $41^{\circ} 25' N.$, long. $50^{\circ} 21' W.$ Fulmars and dovekeys were sighted from time to time during the day.

June 7. Light N. airs to gentle W. winds; foggy, clearing at intervals. At 5.10 a. m., weather having cleared somewhat, started search for bergs. At 4.45 p. m. stopped and lay to on account of dense fog with no indications of clearing, lat. $42^{\circ} 12' N.$, long. $49^{\circ} 34' W.$ Fulmars and dovekeys were sighted at intervals.

June 8. Light wind, W. to SW. by W., to calm; dense fog, with maximum visibility of 100 to 200 yards. The vessel lay to in fog throughout the day. Noon position, lat. $42^{\circ} 07' N.$, long. $49^{\circ} 25' W.$ A few fulmars were sighted. Special ice warnings were sent to the steamships *Aquitania* and *Santa Olivia*.

June 9. Light SW. to W. winds to calm at intervals; fog first part and intermittent haze at intervals thereafter. Dense fog after 10 p. m. Smooth sea. At 10.25 a. m., began search for bergs. Found current setting 77° true, 1 knot per hour. At 7.30 p. m., stopped and lay to for the night, having ascertained that there was no ice from $42^{\circ} 00' N.$ to $42^{\circ} 35' N.$ between meridians $48^{\circ} 30' W.$ and $50^{\circ} 00' W.$

June 10. Gentle to light wind, W. to SW.; foggy for the most part. At midnight, under way for position in lat. $42^{\circ} 10' N.$, long. $50^{\circ} 10' W.$, to search for bergs. At 5.35 a. m. stopped on account of dense fog and drifted. Ascertained that current was setting 77° , true, one knot per hour. At 8 a. m. lat. $42^{\circ} 15' N.$, long. $49^{\circ} 30' W.$, under way for the purpose of utilizing the foggy weather in tracing the limits of the Gulf Stream by means of the changing temperatures of the surface waters. Found that the northern limit of the Gulf Stream was near parallel $42^{\circ} N.$ (See chart "N.") A few fulmars and dovekeys were seen during the day.

June 11. Gentle W. to light NE. to SE. winds during the day, with light to moderate SSW. wind at the close; foggy, with light passing rain squalls. After 8 p. m. cloudy to partly clear. Smooth to moderate SW. sea. Continued tracing the boundary of the Gulf Stream during the day. At 8 p. m. set course to be in position to take up search for ice north of $42^{\circ} 00' N$ and east of $52^{\circ} 00' W.$ at daylight to-morrow. Fulmars were seen occasionally and some gulf weed was observed in the warmer waters. Special ice reports were sent to the steamships *Majestic*, *Dallas*, *Helgoland*, and *Pittsburgh*.

June 12. Gentle to fresh SSW. to WSW. wind; foggy, slightly clearing overhead at intervals. Moderate SW. swell, latter part. At 6.05 a. m. stopped on account of dense fog; 8 a. m. position, lat. $42^{\circ} 03' N.$, long. $51^{\circ} 32' W.$; 9 a. m., no indications of clearing weather, resumed work of tracing northern boundary of the Gulf Stream. Special ice warning was sent to the steamship *Samland*, which vessel was advised to keep south of $42^{\circ} 00' N.$ between meridians $49^{\circ} 00'$ and $51^{\circ} 00' W.$

June 13. Fresh SW. to SSW. wind; foggy, partially clearing when within warmer waters of the Gulf Stream. Moderate to heavy SW. swell. At the beginning of the day we were delineating the northern limits of the Gulf Stream; 6 a. m., stopped and lay to on account of

dense fog; 9.25 a. m., continued to delineate the limits of the Gulf Stream; 8 p. m. position, lat. $42^{\circ} 38' N.$, long. $47^{\circ} 21' W.$ Sent special ice warning to the steamship *Satanta*.

June 14. Moderate to fresh SW. to moderate to light N. wind; fog and rain first part, mostly clear latter part. Rough sea first part, smooth sea with southerly swell latter part. The day began with the *Tampa* standing for central station "C." (See chart "A.") Dense fog prevailed in the ice area. At 9.10 a. m., passed several small pieces of ice. Established communication with the *Modoc* and arranged for the *Tampa* to occupy the oceanographic stations toward Halifax, while the *Modoc* would take the more northern ones, including station "C" (see chart "A"), on account of existing fog. At 11 a. m. the wind shifted to N. and blew a moderate breeze, clearing away the fog and enabling us to resume search for bergs. At 12.35 p. m. sighted a medium-sized grounded berg and at 1 p. m. photographed it, in lat. $43^{\circ} 21' N.$, long. $50^{\circ} 45' W.$ At 1.28 p. m., photographed a second berg, in lat. $43^{\circ} 15' N.$, long. $50^{\circ} 14' W.$, and then stood on course to meet the *Modoc*. A third grounded berg was sighted, bearing 120° , true, 12 miles distant from the second berg. At 3 p. m. passed a number of growlers, and at 4.15 p. m. passed another growler. Sent special ice reports to steamships *Ampetco*, *Woodmansie*, and *Kristianeafjerl*. At 9.30 p. m. met the *Modoc*, in lat. $42^{\circ} 55' N.$, long. $52^{\circ} 35' W.$, when the oceanographic and scientific observers were transferred to that vessel, which relieved the *Tampa* of ice-patrol duty.

Ice reports were received as follows: May 30, steamship *Caserta*, bergs in lat. $43^{\circ} 22' N.$, long. $49^{\circ} 16' W.$; steamship *Canopic*, bergs from lat. $46^{\circ} 35' N.$, long. $52^{\circ} 56' W.$, to lat. $47^{\circ} 10' N.$, long. $51^{\circ} 10' W.$; steamship *Canadian Challenger*, three large bergs in lat. $46^{\circ} 56' N.$, long. $51^{\circ} 27' W.$, and a smaller berg in lat. $46^{\circ} 41' N.$, long. $52^{\circ} 31' W.$; steamship *Columbia*, three bergs from lat. $43^{\circ} 15' N.$, long. $49^{\circ} 07' W.$, to lat. $43^{\circ} 21' N.$, long. $48^{\circ} 40' W.$; steamship *Gen. Consul Pallisen*, numerous bergs and growlers between lat. $48^{\circ} 06' N.$, long. $49^{\circ} 56' W.$, and lat. $47^{\circ} 12' N.$, long. $51^{\circ} 31' W.$ May 31, steamship *Albania*, numerous bergs and growlers between lat. $47^{\circ} 41' N.$, long. $49^{\circ} 07' W.$, and lat. $50^{\circ} 43' N.$, long. $50^{\circ} 32' W.$; steamship *Hastings County*, two large bergs in lat. $45^{\circ} 16' N.$, long. $45^{\circ} 57' W.$, and lat. $45^{\circ} 14' N.$, long. $46^{\circ} 00' W.$ June 1, steamship *Hastings County*, two bergs in lat. $43^{\circ} 36' N.$, long. $49^{\circ} 08' W.$; steamship *W. H. Tilford*, one big and several small bergs in lat. $45^{\circ} 00' N.$, long. $46^{\circ} 00' W.$ June 3, steamship *Knockfern*, passed several large bergs and growlers, from 3 to 5 miles apart, between lat. $48^{\circ} 41' N.$, long. $51^{\circ} 21' W.$, to Cape St. Francis. June 4, steamship *Bramell Point*, numerous bergs and growlers from off Cape St. Francis to lat. $48^{\circ} 38' N.$, long. $49^{\circ} 48' W.$, three bergs in lat. $48^{\circ} 30' N.$, long. $50^{\circ} 19' W.$, and growlers in lat. $48^{\circ} 38' N.$, long. $49^{\circ} 58' W.$ June 5, steamship *Esther Eliza*, 13 large bergs 20 miles east of St. Johns. June 6, steamship *Canadian Cruiser*, a berg in lat. $47^{\circ} 21' N.$, long. $51^{\circ} 12' W.$, a large berg in lat. $47^{\circ} 30' N.$, long. $50^{\circ} 00' W.$, three bergs and several growlers between meridians $48^{\circ} 30' W.$ and $47^{\circ} 50' W.$ along blue track 6. June 10, steamship *Cairnvalona*, many bergs between lat. $48^{\circ} 12' N.$, long. $49^{\circ} 03' W.$, and Cape Race. June 11, steamship *Cairnvalona*, large berg in lat. $46^{\circ} 26' N.$, long. $54^{\circ} 00' W.$ June 13, Cape Bona Vista reported no ice.

Obstruction reports were received as follows: June 3, steamship *Bramell Point* reported that the steamship *Texas*, on May 30, passed a floating mine or buoy, very dangerous to navigation, in lat. $50^{\circ} 02'$ N., long. $15^{\circ} 39'$ W., and that on June 2 she passed an unlighted gas buoy, painted black and white, in lat. $44^{\circ} 38'$ N., long. $36^{\circ} 35'$ W.; June 4, steamship *Bramell Point*, two heavy wooden beams, 20 by 20 feet, dangerous to navigation, in lat. $41^{\circ} 11'$ N., long. $46^{\circ} 40'$ W.; June 6, steamship *Argus*, a large red can buoy, with black horizontal stripes, in lat. $43^{\circ} 43'$ N., long. $43^{\circ} 58'$ W.; June 8, spar projecting 5 feet above water, connected with submerged wreckage, in lat. $40^{\circ} 21'$ N., long. $43^{\circ} 38'$ W.

Daily routine ice warnings, weather reports, and, when necessary, obstruction reports, were broadcasted and sent to Hydrographic Office, New York; Fuelite, Halifax, Nova Scotia; and Cape Race.

This patrol cruise has been a remarkable one, in that fog has prevailed each day except the first and one-half of the last. There were a few times when we were favored with a few hours of partially clear weather; otherwise, the ship was enveloped in fog. Advantage was taken of the opportunity for tracing out, in part, the northern limits of the Gulf Stream, and it is to be remarked that the stream was found to be as far north as $42^{\circ} 00'$ N. the entire distance south of the Great Bank. The *Tampa* constantly bore in mind the necessity of searching the area between lats. 42° N. and 43° N. and longs. 48° W. and 51° W., and the vessel remained within reach of some part of this area to take advantage of clear weather, should any occur. However, we were able to search only a limited part of that area. It is believed that the bergs reported in the vicinity of lat. $43^{\circ} 15'$ N. and long. $48^{\circ} 30'$ W., on May 29 and 30, will drift down to some part of the above area, and vessels were generally warned to keep south of lat. 42° N. between longs. 48° and 51° W.

During the cruise we received approximately 750 sea-water reports and some 54 ice reports. Only five of the latter were south of lat. $46^{\circ} 00'$ N.

COAST GUARD CUTTER "MODOC," LIEUT. COMMANDER B. M. CHISWELL, ICE PATROL, SECOND CRUISE, JUNE 14 TO 30, 1922.

The *Modoc* sailed from Halifax, Nova Scotia, at 4 p. m., June 12, to relieve the *Tampa* on the ice patrol, and made contact with that vessel, in lat. $42^{\circ} 53'$ N., long. $52^{\circ} 48'$ W., at 9.30 p. m., June 14, at which time the *Tampa* left for Halifax. Fresh to strong SW. to WSW. winds, with rough sea, were experienced on the 12th and 13th, upon which latter date the wind moderated until, on the 14th, we had light easterly airs, clear weather, and smooth sea. Numbers of petrels accompanied the ship until the wind moderated, on the afternoon of the 13th, when they left us and many shearwaters appeared. Anticipating a clear day on the 15th, we proceeded to lat. $42^{\circ} 50'$ N., long. $51^{\circ} 30'$ W., for the purpose of starting search at daylight between the 43d and 42d parallels east of long. $51^{\circ} 30'$ W.

June 15. Moderate wind, hauling from E. to S. and bringing the fog along in waves, was experienced, an hour or so of dense fog being followed by a like interval of fair visibility. At 5.40 a. m. a large, two-pinnacle berg was located in lat. $42^{\circ} 43'$ N., long. $51^{\circ} 28'$ W. (Berg "N," Chart "G.") At 7.20 a. m. thick fog shut in, with

moderate E. wind and rain. At 8.15 a. m. we headed back for the berg passed early in the morning. When within about one-half mile of it, the loftier pinnacle broke off and fell with a great splash. (See Plate 3.) At 2.10 p. m. we passed a small, saddleback berg and growlers, in lat. $42^{\circ} 44' N.$, long. $51^{\circ} 19' W.$ At 3.55 p. m. a small berg and growlers were sighted in lat. $42^{\circ} 52' N.$, long. $51^{\circ} 06' W.$, and at 4.10 p. m. we passed, in lat. $42^{\circ} 54' N.$, long. $51^{\circ} 05' W.$, a large, flat-topped berg, marked with blue veins and earth-colored streaks. At 5.50 p. m. we arrived alongside of a large, single-peak berg, which was grounded in 55 fathoms on the Tail of the Bank, in lat. $43^{\circ} 07' N.$, long. $51^{\circ} 55' W.$ (See Chart "O".) This was the largest berg we have sighted this season, being about 125 feet high and marked with several earth-colored streaks. We drifted near by for the night. Upon approaching this berg, numbers of fulmars and shearwaters were noted in its vicinity, but they all disappeared within an hour of our arrival.

June 16. Gentle to moderate S. winds, with thick fog, prevailed all day. We drifted in the fog until 11.35 a. m., when, the weather showing no signs of clearing, we proceeded to oceanographic station 239, in lat. $43^{\circ} 50' N.$, long. $50^{\circ} 25' W.$, where water temperatures were taken and specimens of plankton collected. At 7.05 p. m. anchored for the night.

The steamship *Marinlea* was furnished special ice information. A radio message was received from the steamship *Western Plains*, reporting that an engineer officer on that vessel had been ill since the 14th inst., with high temperature, slight pain in left groin, general feeling of nausea, and other symptoms, and asking advice from our medical officer. This was given promptly.

June 17. Light to gentle SW. wind; generally foggy. At 6.10 a. m. we got under way and stood for oceanographic station 240, in lat. $43^{\circ} 10' N.$, long. $51^{\circ} 15' W.$, where sea-water temperatures were taken and plankton collected. Received a radio message from the steamship *Eastern Tempest*, stating that a seaman had dislocated his shoulder and that they were unable to get it back in place. Our medical officer gave the necessary advice. At 7.50 p. m., fog shutting in thick, we stopped and drifted for the night.

June 18. Gentle SW. winds to light SW. airs; foggy first half, clear latter half. Occupied oceanographic station 241, in lat. $42^{\circ} 30' N.$, long. $51^{\circ} 45' W.$; station 242, in lat. $42^{\circ} 05' N.$, long. $52^{\circ} 14' W.$, and station 243, in lat. $41^{\circ} 44' N.$, long. $52^{\circ} 35' W.$ At 12.30 p. m., lat. $42^{\circ} 14' N.$, long. $52^{\circ} 06' W.$, we passed into the warm water of the Gulf Stream and had fine, clear, semitropical weather for the remainder of the day. Porpoises, Portuguese men-of-war, gulf seaweed, and a few petrels and shearwaters were sighted.

Special ice information was sent to the steamships *Clearton* and *Orkild*.

June 19. Light airs to gentle winds, backing from S. to ENE., with dense fog over the colder waters and misty to hazy over the Gulf Stream. We devoted the day to an attempt to delineate the northern limits of the Gulf Stream between longs. $51^{\circ} 38' W.$ and $50^{\circ} 30' W.$, and found it to be approximately lat. $41^{\circ} 50' N.$ The steamship *Duca de Abruzzi* reported by radio that she passed a large ice field in lat. $40^{\circ} 34' N.$, long. $49^{\circ} 25' W.$ This information was no doubt incorrect, as the sea water in the reported locality had a temperature

of 73° F. and was above 50° F. for a distance of 90 miles to the northward. All efforts to verify this report were unsuccessful. At 2.30 p. m., while in lat. 41° 20' N., long. 51° 20' W., a large passenger steamer of the Compagnie Générale Transatlantique, westbound, passed us. She was about 50 miles north of her prescribed track. During the night, a Leach petrel flew on board, having been stunned by flying into something in the fog. It was identified and released.

Special ice information was furnished to the steamship *West Quechee*.

June 20. Light E. to SE. airs and winds; partly clear over the warm water area and thick fog over the cold water. As thick fog prevailed during the night and early morning, we ran down into the clearer weather of the Gulf Stream, in order to check our position by latitude and longitude sights. Ascertained that our latitude was 41° 00' N., longitude 49° 49' W., and then headed for a small berg reported by the steamship *West Quechee* as in lat. 41° 30' N., long. 50° 42' W. The berg (berg "N," chart "G") was located in lat. 41° 50' N., long. 50° 22' W. It consisted of three separate ice masses united under water into one berg. The temperature of the surface sea water in its vicinity was 55° F. and that of the air 59° F. The temperature of the surface water was 66° F. 10 miles distant from the berg and dropped quickly to 55° F. This did not indicate the presence of ice, but that the berg was in the belt between the Labrador Current and the Gulf Stream. The following temperatures were taken at various depths in the vicinity: At surface, 55° F.; 50 meters, 36° F.; 125 meters, 34° F.; 250 meters, 32° F.; 400 meters, 40° F., and 750 meters, 34° F. These temperatures would show that the Gulf Stream water was at the surface, while the cooler water was below. This berg was melting rapidly, and drifting to the eastward at about 1 mile per hour. After dark a dense fog prevailed, and we lay to and drifted near the berg. At 3.30 p. m., lat. 41° 25' N., long. 50° 32' W., we passed the large eastbound passenger steamship *Van Dyck*, which was about 115 miles to the northward of the prescribed track.

June 21. Light SE. to ENE. airs and breezes; clear over the warm and foggy over the cold water; smooth sea. About 6 a. m. we heard the fog signal of a passing steamer and tried to warn her by radio that she was very near the berg by which we were lying, but could get no response. At 9.50 a. m. the fog lifted in our locality, but held over the colder water to the northward all day. We drifted with the berg, which now bore no resemblance to the one we saw the night before. Its drift was 126°, true, 1.3 miles per hour. When in its immediate vicinity, a constant crackling sound could be heard, and all exposed parts showed many surface cracks. By nightfall several large pieces had broken from the berg, and it was plain that it would break up and melt in a few hours.

June 22. Gentle breeze to light airs, E. to SE., fog banks on the horizon to the northward and eastward; smooth sea. At daylight, our berg of the day before, when seen at a distance of about 2 miles, looked no larger than a ship's boat, and had almost ceased to be a menace to navigation. (See Plate 6.) At 11.40 a. m. sighted a berg (berg "P"), and at 1.05 p. m. passed it, in lat. 42° 26' N., long. 50° 36' W. This was a very large berg, shaped like a pyramid, and was about 150 feet high and 250 feet through at its waterline. It could be seen from the crow's nest (height 90 feet) about 15 minutes

before it was visible from the bridge. We scouted for bergs during the day, until 4 p. m., when it shut in thick, and at 6 p. m. we headed south, to run out of the fog. At 6.50 p. m., fog lifting somewhat, lat. $42^{\circ} 02' N.$, long. $51^{\circ} 26' W.$, we picked up a large, crescent-shaped berg (berg "M", chart "G"), with a high ridge terminating in peaks at each end. This was now our southernmost berg. The sea-water temperatures in its vicinity were as follows: At surface, $53^{\circ} F.$; 50 meters depth, $34^{\circ} F.$; 125 meters, $31^{\circ} F.$; 250 meters, $36^{\circ} F.$; 450 meters, $39^{\circ} F.$, and 750 meters, $39^{\circ} F.$ At 8 p. m. the fog shut in thick again, and shortly thereafter the steamship *Cameronia*, westbound, passed within one-half mile of the berg. We drifted for the night, in a thick fog, near the last berg mentioned. Three small whales came up close alongside while we were drifting and were not disturbed in the least by our fog whistle.

Special ice information was furnished the steamships *Merry Mount* and *African Prince*.

June 23. The day began with light ESE. winds, increasing to gentle breezes, then falling to light airs and calms and ending with light SW. airs. The sea was notably smooth. The dense fog which had prevailed during the night lifted in our locality at 6.35 a. m., when we began searching to the westward of the 50th meridian. Visibility was excellent, except for occasional patches of fog of short duration, and, due to the mirage, objects could be seen while still below the horizon. During the morning watch, the inverted image of a steamship below the horizon was seen in the clouds. The last berg sighted this day was picked up from the fore-castle deck at a distance of 21 miles and looked like a square-rigged ship under full sail. It could not be seen from either the bridge or the crow's nest at the time. At 6.25 p. m., we arrived alongside the berg (berg "P") that we passed at 1.05 p. m. on the 22d. It was now in lat. $42^{\circ} 21' N.$, long. $50^{\circ} 31' W.$, and had capsized and bore no resemblance to the berg of the day before, being rather flat-topped and not anything like as lofty. The surface-water temperature in its vicinity was $53^{\circ} F.$ At 8.15 p. m., we stopped alongside a large, saddleback berg, in lat. $42^{\circ} 46' N.$, long. $50^{\circ} 25' W.$; surface-water temperature $48^{\circ} F.$, air $61^{\circ} F.$ Another berg, bearing 81° true, distant 7 miles, could be seen dimly from this position. The near-by berg was giving off a light mist to leeward and appeared to be drifting against a light surface current setting to the northward. Two blackfish were observed very near the berg as darkness set in.

During the morning watch, while lying to in the fog near the berg in lat. $42^{\circ} 02' N.$, long. $51^{\circ} 26' W.$, the fog signals of a passing steamer were heard. Our whistle gave back distinct echoes. This we believed to be due, not to the presence of the berg, which was probably 2 miles, or more distant, but to fog banks of different densities surrounding the vessel.

We covered this date the area of probable ice south of the 43d parallel and west of the 50th meridian.

Special ice information was furnished the steamships *President Garfield*, *Mont Grappa*, *Ardantza Mendiez*, and *Rapidan*.

June 24. Light SW. to WSW. airs and winds; dense fog over the cold and partly clear over the warm water. Smooth sea. We were enveloped in a low, dense fog from midnight until noon, when we stood to the southward. During the time we were in the fog, our

whistle gave back a distinct echo, with no appreciable change as we drew away from the berg. At 2 p. m., the weather cleared and at 4.05 p. m. we arrived alongside the berg which we passed at 6.25 p. m. of the 23d. This berg was now in lat. $42^{\circ} 20' N.$, long. $50^{\circ} 47' W.$, and, although still large, was appreciably smaller than when seen on the 22d inst. No other bergs were sighted before dark. The following radiogram was received from the steamship *Luxpale*: "Please have doctor prescribe for man with strained back. Symptoms as follows: Severe pain continually at second vertebra from base of spine, more so when coughing, can not sit up or raise head without causing extra severe pain, some relief when pressure applied to second vertebra from base, can move limbs. Accident happened while in bent-over position while picking up weight." Our medical officer prescribed treatment, but was handicapped by information that the *Luxpale* had no medicines on board.

June 25. Light airs to light and gentle winds, W. and SW., partly clear, hazy. At daylight the weather outlook was favorable for scouting and we started, at 4.45 a. m., to cover as much area as possible before dark. The berg last seen on the 24th, in lat. $42^{\circ} 20' N.$, long. $50^{\circ} 47' W.$, was passed at 9.40 a. m., in lat. $42^{\circ} 20' N.$, long. $51^{\circ} 02' W.$ At 12.50 p. m., a large berg, about 65 feet high and 200 feet in diameter, was located in lat. $43^{\circ} 01' N.$, long. $50^{\circ} 54' W.$ At 3.35 p. m., we were alongside of a conical-shaped berg, 140 feet high and 500 feet in diameter, in lat. $42^{\circ} 59' N.$, long. $50^{\circ} 12' W.$ While in this vicinity, another berg was seen to the northward in lat. $43^{\circ} 08' N.$, long. $50^{\circ} 12' W.$ It was believed that the bergs sighted on this date would drift to the westward until they encountered the Gulf Stream current and then be set to the southward and eastward, possibly reaching lat. $41^{\circ} 30' N.$, or even farther to the southward, and be a menace for two weeks longer. (See Chart "O.") As the visibility was good, but with a hazy horizon, the day was devoted to a search of the area west of long. $49^{\circ} 50' W.$ and south of the 43d parallel. Bergs loomed through the haze at a considerable distance. At the close of the day we were standing for the position of the berg reported in lat. $41^{\circ} 46' N.$, long. $49^{\circ} 49' W.$, and arrived there at 10.40 p. m., when we stopped and drifted for the remainder of the night. A number of whales were seen during the day. The medical officer continued treatment, by radio, of the sick man on the steamship *Luxpale*.

June 26. Light airs to gentle breezes, W. to SW.; partly clear and hazy. Moderate SW. swell. The clear weather enabled us to almost complete a survey of the ice field south of lat. $43^{\circ} 20' N.$ This survey indicated that the berg menace existed much later this year than during any season since the patrol was taken over by the Coast Guard in 1914. Eleven bergs were located during the day. Many of these were huge masses of ice, which would constitute a potential menace to the steamship lanes for many days to come, unless prevailing conditions materially change in the near future. The presence of these bergs so far south is difficult to understand, as we have had almost continuous southerly winds for the past month, or longer. It is probable that the larger bergs will constitute a menace to navigation for about two weeks longer and, under the influences of the various currents, would drift down near the trans-Atlantic tracks before they finally disintegrated. Because of these conditions, the

Tampa was this day ordered to relieve the *Modoc* upon the expiration of the latter's patrol period on June 30, and to carry on the patrol until the ice situation cleared up. At daylight we were alongside of a small, two-pinnacle berg, in lat. $41^{\circ} 45' N.$, long. $49^{\circ} 34' W.$ The sea-water temperature in the vicinity was $59^{\circ} F.$ This berg was calving frequently and had a long streak of brash ice trailing off to leeward. During the day six other bergs were located, as follows: A medium-sized one, with no prominent characteristics, in lat. $42^{\circ} 44' N.$, long. $49^{\circ} 41' W.$; one in lat. $42^{\circ} 38' N.$, long. $49^{\circ} 22' W.$; one, with two pinnacles and a channel way between, the loftier pinnacle 190 feet high, diameter of base 400 feet, in lat. $43^{\circ} 08' N.$, long. $49^{\circ} 34' W.$; a small one in lat. $42^{\circ} 59' N.$, long. $49^{\circ} 22' W.$; one, 85 feet high and 540 feet long, in lat. $43^{\circ} 03' N.$, long. $48^{\circ} 53' W.$; and one resembling a floating dry dock in lat. $42^{\circ} 46' N.$, long. $49^{\circ} 08' W.$ During the night we drifted near the last berg mentioned. A few fulmars, petrels, and whales were seen during the day.

Gave special ice information to the steamship *Gloria de Larrinaga*.

June 27. Light SW. to W. airs and gentle winds; partly clear, hazy, good visibility. Smooth sea. We searched the southeastern quadrant of the probable berg area and saw no ice. The late afternoon was given over to searching for the small berg last seen on the morning of the 26th, in lat. $41^{\circ} 45' N.$, long. $49^{\circ} 34' W.$, and believed to be the southernmost berg. The berg could not be found. The motor ship *Hamlet* reported having sighted a berg this date in lat. $41^{\circ} 01' N.$, long. $51^{\circ} 08' W.$, and search was begun for it.

Special ice information was furnished the steamships *Seydlitz* and *President Taft*.

June 28. Light SW. to W. airs and gentle breezes; partly clear, hazy, good visibility. Smooth sea. The forenoon was given over to a search for the small berg which had engaged our attention on the afternoon of yesterday, but, as it could not be found, we believed that it had disintegrated. The berg reported by the motor ship *Hamlet* on the 27th, which was believed to be the southernmost berg, was located at 5.10 p. m., in lat. $41^{\circ} 57' N.$, long. $50^{\circ} 50' W.$ The sea-water temperatures near this berg were as follows: At surface, $57^{\circ} F.$; 50 meters depth, $40^{\circ} F.$; 125 meters, $35^{\circ} F.$; 250 meters, $37^{\circ} F.$; 450 meters, $38^{\circ} F.$, and 750 meters, $37^{\circ} F.$ The Dutch steamship *Alchiba* reported that she had sighted a large berg on this date, in lat. $41^{\circ} 36' N.$, long. $51^{\circ} 37' W.$, but we believed her position to be in error and that she sighted the berg reported by the motor ship *Hamlet* on the 27th. We passed this berg (berg "P") several times during the last few days and had noted its rate of shrinkage. Making due allowance for the rise in the temperature of both the air and the sea water, as it drifts to the southward and eastward, it was conservatively estimated that the berg would probably last a week or 10 days longer. A clear, distinct echo from the steam whistle was obtained when we were about three ship's lengths from one of the perpendicular concave sides of this berg. We lay by this berg during the night. From 12.50 p. m. to 2 p. m., a brilliant, prismatic halo, 42° in diameter, was observed around the sun.

June 29. At daybreak we ran down to the position of the berg reported on the 25th in lat. $41^{\circ} 36' N.$, long. $51^{\circ} 37' W.$, but saw nothing of it and returned to the berg we had left, in order to keep a record of its drift and disintegration. At 8 p. m. it was in lat. $41^{\circ} 57' N.$, long. $50^{\circ} 55' W.$



THE LAST STAGES OF A BERG.

June 22, 1922, $41^{\circ} 32' N.$, $49^{\circ} 45' W.$, water temperature 62° . The photograph shows extreme disintegration of the berg, and the patrol is ready to strike it off the list of menaces to navigation. It is now in the northern edge of the Gulf Stream, as is evidenced by the water temperature and the warm-weather clouds to leeward.



THE FIRST ARRIVAL.

March 20, 1922, in $42^{\circ} 58' N.$, $49^{\circ} 24' W.$, water temperature 34° . This was the first berg to put in an appearance off the Tail of the Grand Banks in 1922. It was drifting 206° true at the rate of 0.5 knot per hour, and was the immediate cause for inaugurating the ice patrol as of that date. The "Seneca" is shown in the center.

June 30. At daybreak we stood to the westward to meet the *Tampa*, and made contact with her at 3.30 p. m., in lat. $42^{\circ} 18' N.$, long. $53^{\circ} 12' W.$, where we were relieved of ice-patrol duty, after which we set course for Halifax. We were pleased to note that the berg by which we had been lying was beginning to go to pieces fast when we last saw it on this date. It was calving at frequent intervals and there was a long track of drift ice to leeward, some of the pieces being large growlers which had broken off from the parent berg.

After the first two days out of Halifax we had remarkably mild weather. Mostly light southerly airs to winds prevailed. The maximum barometer was 30.47 and the minimum 30.14. Fog held over the colder waters in the vicinity of the Tail of the Bank continuously until the 25th inst., after which date the visibility was very good.

The cooperation of passing vessels in giving us sea-water temperatures was gratifying, 141 different vessels sending in 438 sea-water temperature reports.

Routine ice warnings and, where necessary, obstruction reports were broadcasted and sent daily to Hydrographic Office, New York; Fuelite, Halifax, Nova Scotia; and Cape Race.

The following ice and obstruction reports were received (the first group of figures, in each case, represents north latitude, and the second group west longitude): June 14, steamship *Bothwell*, ice (no description given), $48^{\circ} 01'$, $48^{\circ} 36'$; $48^{\circ} 00'$, $48^{\circ} 11'$; $47^{\circ} 58'$, $48^{\circ} 49'$; $47^{\circ} 44'$, $49^{\circ} 06'$; $47^{\circ} 47'$, $49^{\circ} 25'$; $47^{\circ} 46'$, $49^{\circ} 55'$; $47^{\circ} 03'$, $51^{\circ} 51'$; $47^{\circ} 10'$, $51^{\circ} 33'$; June 15, steamship *Lord Kelvin*, berg and growler, $45^{\circ} 37'$, $47^{\circ} 35'$; two bergs, $45^{\circ} 00'$, $48^{\circ} 55'$; four bergs, $44^{\circ} 55'$, $48^{\circ} 47'$; steamship *Idefjord*, two bergs, $44^{\circ} 40'$, $48^{\circ} 15'$; steamship *Graindon*, small bergs 10 miles south of Cape Race; June 16, Battle Harbor, ice off shore north, none south; Fogo, numerous bergs and growlers; steamship *Malmen*, berg, $42^{\circ} 59'$, $51^{\circ} 32'$; June 17, Battle Harbor, heavy jam ice north, no ice south; Fogo, numerous bergs and growlers; Bonavista, no ice; steamship *Empress of France*, growlers, $46^{\circ} 47'$, $48^{\circ} 40'$; steamship *Marilia*, two growlers, $44^{\circ} 10'$, $48^{\circ} 50'$; berg, $44^{\circ} 15'$, $49^{\circ} 12'$; several growlers, $44^{\circ} 03'$, $48^{\circ} 40'$; steamship *Cragness*, berg, $43^{\circ} 05'$, $49^{\circ} 13'$; steamship *Samuel L. Fuller*, red buoy, $42^{\circ} 54'$, $45^{\circ} 53'$; June 18, steamship *Storm King*, berg, $42^{\circ} 21'$, $51^{\circ} 22'$; steamship *Redondo*, large berg, $42^{\circ} 57'$, $50^{\circ} 37'$; steamship *Hastings County*, berg, $45^{\circ} 10'$, $47^{\circ} 30'$; steamship *Tyrltena*, small growlers, $48^{\circ} 25'$, $48^{\circ} 53'$; berg, $48^{\circ} 17'$, $49^{\circ} 19'$; large growlers, $48^{\circ} 11'$, $49^{\circ} 14'$; two growlers, $48^{\circ} 10'$, $49^{\circ} 22'$; large berg, $48^{\circ} 14'$, $49^{\circ} 38'$; steamship *Canopic*, berg, $48^{\circ} 06'$, $49^{\circ} 50'$; berg, $47^{\circ} 47'$, $50^{\circ} 07'$; berg, $47^{\circ} 50'$, $50^{\circ} 11'$; steamship *Tyrrhenia*, large berg, $47^{\circ} 49'$, $50^{\circ} 17'$; large berg, $47^{\circ} 48'$, $50^{\circ} 21'$; large berg, $47^{\circ} 27'$, $51^{\circ} 11'$; large berg, $47^{\circ} 20'$, $51^{\circ} 36'$; steamship *Carmania*, large conical buoy covered with rust and marine growth, $40^{\circ} 14'$, $52^{\circ} 49'$; steamship *Polonia*, vessel's mast, 15 feet high, $41^{\circ} 15'$, $49^{\circ} 50'$; June 19, Battle Harbor, numerous bergs; Fogo, numerous bergs; steamship *Canopic*, growler, $46^{\circ} 31'$, $53^{\circ} 22\frac{1}{2}'$; steamship *Nascopee*, three bergs and drift ice from $48^{\circ} 48'$, $50^{\circ} 08'$, to $48^{\circ} 39'$, $50^{\circ} 32'$; steamship *Gilwennave*, large growler 183 $\frac{1}{2}$ miles from Cape Pine; steamship *Dunbridge*, growlers in $48^{\circ} 29'$ from $47^{\circ} 00'$ to $49^{\circ} 30'$; several bergs and growlers north and south of track 5-6 blue; very large berg on track 5-6 blue in long. $49^{\circ} 20' W.$; steam-

ship *Manchester*, growlers, $46^{\circ} 22'$, $53^{\circ} 29'$; small berg, $46^{\circ} 21'$, $53^{\circ} 25'$; June 20, steamship *West Quechee*, small berg, $41^{\circ} 30'$, $50^{\circ} 42'$; steamship *Opelike*, part of wooden vessel, 150 feet long, awash, covered with marine growth, $43^{\circ} 36'$, $41^{\circ} 35'$; June 21, steamship *Mount Clay*, red buoy, base about 8 feet in diameter, $44^{\circ} 12'$, $41^{\circ} 38'$; June 22, Battle Harbor, numerous bergs; Fogo, numerous bergs and growlers; intercepted, berg, $48^{\circ} 50'$, $48^{\circ} 12'$; June 23, Fogo, numerous bergs and growlers; steamship *Anfora*, one big and two little bergs, $42^{\circ} 45'$, $50^{\circ} 52'$; steamship *Rapidan*, large berg and four growlers, $43^{\circ} 05'$, $50^{\circ} 39'$; steamship *Ardantza Mendiez*, large berg, $42^{\circ} 43'$, $50^{\circ} 40'$; "MJN," large berg, $48^{\circ} 37'$, $48^{\circ} 26'$; June 24, Battle Harbor, numerous bergs; Fogo, numerous bergs and growlers; Bonavista, no ice; steamship *Epsom Bláde*, buoy, $40^{\circ} 30'$, $49^{\circ} 54'$; steamship *Callea*, perpendicular mast, 8 feet out of water, burnt black, dangerous to navigation, attached to submerged wreckage, visible 2 miles, $41^{\circ} 36'$, $47^{\circ} 45'$; June 25, steamship *Skjensfjord*, berg, $42^{\circ} 36'$, $49^{\circ} 29'$; steamship *Gloria de Larrinaga*, large berg, $42^{\circ} 28'$, $51^{\circ} 07'$; steamship *Genesee*, two bergs and growlers, $41^{\circ} 46'$, $49^{\circ} 49'$; steamship *Chicago City*, small berg, $41^{\circ} 28'$, $49^{\circ} 59'$; steamship *Kockfermack*, growlers, $48^{\circ} 06'$, $48^{\circ} 23'$; large berg, $48^{\circ} 04'$, $48^{\circ} 30'$; June 26, Battle Harbor, numerous bergs; Fogo, numerous bergs; June 27, Battle Harbor, numerous bergs; Fogo, numerous bergs; steamship *Sunoco*, berg, $43^{\circ} 23'$, $50^{\circ} 37'$; berg, $43^{\circ} 08'$, $50^{\circ} 50'$; berg, $43^{\circ} 18'$, $50^{\circ} 53'$; motorship *Hamlet*, large berg, $42^{\circ} 01'$, $51^{\circ} 08'$; June 28, Battle Harbor, numerous bergs; Fogo, numerous bergs; steamship *Argus*, small berg, $42^{\circ} 33'$, $47^{\circ} 40'$; berg, $42^{\circ} 35'$, $50^{\circ} 16'$; steamship *Alchiba*, large berg, $41^{\circ} 36'$, $51^{\circ} 37'$; June 29, Battle Harbor, numerous bergs; Fogo, numerous bergs; steamship *Manoa*, small bergs, $46^{\circ} 45'$, $52^{\circ} 52'$; two bergs, close inshore, Renewse Rock.

COAST GUARD CUTTER "TAMPA," LIEUT. COMMANDER W. J. WHEELER,
ICE PATROL, FOURTH CRUISE, JUNE 28 TO JULY 14, 1922.

The *Tampa* sailed from Halifax, Nova Scotia, at 8 p. m., June 28, to relieve the *Modoc* on ice patrol, and relieved that vessel at 3.05 p. m., June 30, in lat. $42^{\circ} 20' N.$, long. $53^{\circ} 00' W.$ the oceanographic and scientific observers being transferred from the *Modoc* to the *Tampa*. Upon assuming the duties of the patrol the *Tampa* set course for the position of the southernmost berg, in lat. $41^{\circ} 57' N.$, long. $50^{\circ} 50' W.$ Light and gentle SW. breezes were experienced from June 28 to 30.

July 1. Gentle to moderate SW. to WSW. winds, with slight haze; slight to moderate SW. swell. At 3.15 a. m. stopped at reported position of southernmost berg. At 5.05 a. m., there being no berg in sight, started rectangular search to the southward and eastward for the berg. At 8.55 p. m. stopped and lay to for the night, the berg not having been located. A few petrels followed the vessel during the day.

Broadcasted the following ice warning: "Ice patrol *Tampa*, 42 00, 50 45, near southernmost berg. Eleven bergs with growlers around Tail of Bank and southwestward."

July 2. Gentle WSW. to light W. winds; mostly clear; hazy and light fog at intervals. Fog appeared at 3 a. m. and cleared at 8.35 a. m., search for the berg last seen on June 29 being resumed at the

latter hour. At 1.35 p. m., sighted the berg (berg "P," chart "G"), and arrived alongside of it at 2.20 p. m., in lat. $42^{\circ} 10' N.$, long. $50^{\circ} 50' W.$ Photographed the berg and lay to and took water temperatures near it. These temperatures, together with those taken near the same berg on June 29, were as follows:

| June 29.—Lat. $41^{\circ} 57' N.$, long. $50^{\circ} 50' W.$ | July 2.—Lat. $42^{\circ} 10' N.$, long. $50^{\circ} 50' W.$ |
|---|--|
| °F. | °F. |
| Surface..... 57 | Surface..... 58 |
| 50 meters..... 40.1 | 50 meters..... 58 |
| 125 meters..... 34.7 | 150 meters..... 42.4 |
| 250 meters..... 37 | 300 meters..... 41.1 |
| 450 meters..... 38 | 600 meters..... 40 |
| 750 meters..... 37 | |

The berg was a rather large, solid one, some 50 feet in height, and was wasting rapidly, with water trickling down all its sides and mist rising from it. At 5 p. m., having drifted some 2 miles from the berg, stood back and stopped 2 miles to windward and slightly to one side of it, to allow for drift. Lay to and drifted for the night. While approaching this berg, we sighted the steamship *Esthonia*, west-bound, passing just north of it. No bird life was seen in the vicinity of the berg. At 5 p. m. we received the following radiogram from the *Esthonia*: "Passed two more large bergs, positions 42 09, 51 15, and 42 02, 51 24." We decided that these bergs were sighted by the *Modoc* farther north and east on June 23.

Special ice information was sent to the steamships *Majestic*, *President Polk*, *Tritonia*, and *Oscar II*.

July 3. Light to moderate WSW. winds; haze, with light fog at intervals. At 4.45 a. m., daylight, stood for the berg and arrived alongside of it at 5.45 a. m., the vessel having drifted 6 miles in eight hours with gentle and light winds. The berg's position was found to be lat. $42^{\circ} 12' N.$, long. $50^{\circ} 51' W.$ (See Chart "G.") We then set course for the northernmost berg reported by the *Esthonia* yesterday, and at 8.45 a. m. arrived alongside of it in lat. $42^{\circ} 10' N.$, long. $51^{\circ} 22' W.$, and photographed it. This berg was in two parts, the larger part having a wall some 200 feet long by 75 feet high and 50 feet thick, while the smaller one was of a cylindrical shape and separated from the large part by a distance of some 75 feet, the supporting base not being visible. The berg was wasting rapidly. At 8.50 a. m. stood for the southernmost berg and at 10.10 a. m. stopped alongside of it, in lat. $42^{\circ} 00' N.$, long. $51^{\circ} 23' W.$ We photographed the berg and took deep-sea temperatures near it, as follows: At surface, $57.5^{\circ} F.$; 25 meters, $50^{\circ} F.$; 50 meters, $36.5^{\circ} F.$; 150 meters, $39.9^{\circ} F.$; 300 meters, $39.9^{\circ} F.$; 600 meters, $38^{\circ} F.$ The temperatures taken on July 2 near the easternmost berg, 10 miles farther north, showed greater strength and depth of the Gulf Stream. It is probable that this apparent curving of the Gulf Stream is the reason for the more southern position of this berg. At 4.30 p. m. stood for the second berg sighted this day and passed it at 6.15 p. m., and found it to be wasting rapidly and portions of its steep walls falling. The sounding of our steam whistle appeared to bring down a portion. After passing this berg, we stood for the easternmost one sighted this day, but, owing to failing visibility, did not pick it up. After running the distance by log, lay to for the night.

July 4. Light to moderate W. to WSW. winds; light fog and haze, partially clearing during the latter part of day. Petrels were seen about the vessel, but otherwise no bird life was sighted. At 9.25 a. m. steamed ahead to the southward, thinking to run out of the fog on this course. At 3.30 p. m. raised the southernmost berg, and at 3.45 p. m. arrived alongside of the berg, in lat. $42^{\circ} 04' N.$, long. $51^{\circ} 16' W.$ Photographed the berg and then stood 3 miles to windward of it, to allow for drift, and lay to for the remainder of the day.

July 5. Light to gentle W. to WSW. winds; slightly hazy. At 4.30 a. m. stood back to small berg, now in lat. $42^{\circ} 09' N.$, long. $51^{\circ} 11' W.$ At 5.30 a. m. stopped alongside of the berg and lay to to await better visibility. The berg showed marked signs of wasting. At 8.25 a. m. stood to the small berg and at 8.50 a. m. took departure for the westernmost berg. At 12.35 p. m. raised the berg 8.8 miles distant and arrived alongside of it at 2.40 p. m. The westernmost berg, now in lat. $42^{\circ} 08' N.$, long. $51^{\circ} 20' W.$, had wasted greatly. The separate pinnacle had collapsed and a blast of our steam whistle brought down a mass of ice from the nearest side of the vertical wall of the berg. From the 3d to the 5th instant, this berg had drifted south 6 miles. After observing this berg, we shaped course for the easternmost berg, but, as we were unable to locate it, at 7.12 p. m. we stood for the small berg and at 8.40 p. m. lay to for the night, 1 mile to windward of it. Petrels and an occasional other bird were seen from time to time.

Special ice report was sent to the Coast Guard cutter *Vicksburg*.

July 6. Moderate WSW. winds to light W. airs; partly cloudy and hazy to foggy. At 5 a. m., stood ahead for the berg and at 5.30 a. m. passed it, the vessel having drifted 6 miles from it during the night. The berg was in lat. $42^{\circ} 10' N.$, long. $51^{\circ} 07' W.$, and was melting rapidly. The temperature of the surface water in the vicinity was $58^{\circ} F.$ After passing this berg, we set course for the westernmost one, and at 6.20 a. m. passed a large growler, which had evidently broken off from it. At 6.45 a. m., arrived alongside the westernmost berg, in lat. $42^{\circ} 09' N.$, long. $51^{\circ} 30' W.$, the berg having drifted west 8 miles in 24 hours. The berg was markedly reduced in size and there were many growlers and ice floes to leeward of it. After leaving this berg, we searched for the easternmost berg but, owing to the intermittent fog, were unable to find it. At 8.43 p. m., lay to for the night. A number of petrels and a few other birds were seen during the day.

Broadcasted the following radiogram: "Ice patrol *Tampa*, 42 10, 51 07, near berg. Foggy. Another berg 10 miles west. This southernmost ice. Berg reported 42 28, 50 05."

Special ice information was furnished to the steamships *Western Plains* and *Astoimendi*.

July 7. Light to moderate WSW. to SSW. winds; fog at the beginning and close of day. At 8 a. m., stood ahead to locate small berg and at 9.18 a. m. passed it, in lat. $42^{\circ} 06' N.$, long. $51^{\circ} 14' W.$ The berg was disintegrating rapidly. At 3.40 p. m., sighted a medium-sized berg, and at 4.16 p. m. passed it, in lat. $42^{\circ} 35' N.$, long. $50^{\circ} 25' W.$ It was melting rapidly, as shown by water marks and water trickling down its sides. It was identified as the one sighted on June 25, in lat. $42^{\circ} 57' N.$, long. $50^{\circ} 18' W.$, and had probably drifted westward and southward before coming eastward

After photographing this berg, we resumed search to the eastward and at 6.55 p. m. stopped, because of dense fog. A few petrels were sighted near the vessel from time to time during the day.

Broadcasted the following radiogram: "Ice patrol *Tampa*, 42 42, 49 50. Foggy. Two growlers 42 10, 51 20, no longer menace by to-morrow. Berg 42 35, 50 25. Two bergs reported aground Tail of Bank."

Sent message to patrol commander, *Modoc*, recommending that steamer tracks be shifted to normal.

July 8. Light SW. winds to WNW. airs; partly cloudy to foggy and hazy. Vessel drifting in fog at beginning of the day. At 9 a. m., took sea-water temperatures, in lat. 42° 43' N., long. 49° 45' W., in axis of the Labrador Current, as follows: At surface, 49° F.; 40 meters, 36.6° F.; 80 meters, 33.7° F.; 125 meters, 36.5° F.; 250 meters, 36.6° F.; 450 meters, 37.3° F.; 750 meters, 38.2° F. At 11 a. m., steamed ahead to return to berg sighted yesterday afternoon and also, if possible, to run out of the fog. At 6.15 p. m., sighted the berg and arrived alongside of it, in lat. 42° 30' N., long. 51° 00' W., at 7.20 p. m., the berg having drifted 257°, true, one mile per hour, since yesterday. The berg was greatly reduced in size and water was trickling down all its sides. We lay to near it for the night. Petrel and an occasional shearwater were seen at intervals during the day, but there was no bird life near any of the bergs.

Broadcasted the following warning: "Ice patrol *Tampa*, 42 30, 51 00, near berg. This southernmost ice. Spar 41 32, 43 30."

Special ice reports were sent to the steamships *Parktown*, *Laconia*, *Olympic*, and *Merclay*.

July 9. Light to moderate SW. to SSW. winds; partly cloudy to foggy. Moderate SW. swell. Drifting in fog until 7.45 a. m., when, the fog lifting, we stood for the berg alongside of which we were lying during the night. At 8.45 a. m., arrived at the berg, in lat. 42° 22' N., long. 51° 16' W., and found that it had melted during the night and was reducing in size rapidly. At 10.02 a. m., we began a search of the area south of 43° 00' N. At 1 p. m. ran into fog. Fog hanging over the colder water to the eastward. At 3.53 p. m. raised a large grounded berg, in lat. 43° 08' N., long. 50° 19' W. It was grounded in 42 fathoms. A large mass of ice fell from both its vertical side walls as the vessel approached. The berg was about 70 feet high, hollowed in the center by melting, and had a trail of small pieces of ice floating to leeward. At 5.25 p. m., passed alongside a second large grounded berg, which was much larger than the first one. It also was hollowed by melting and its shell-like walls were about 80 feet in height and possibly 200 feet square. At 7.55 p. m. anchored on the Tail of the Bank, in lat. 43° 13' N., long. 50° 20' W. Petrels followed the ship at intervals and an occasional shearwater was seen, but there was no bird life in the vicinity of the bergs.

July 10. Moderate SW. winds, falling to light breezes and airs from WSW. to SE.; partly cloudy; foggy over the cold waters of the Labrador Current. At 6 a. m. began taking observations at anchorage, designating it station 224, lat. 42° 13' N., long. 50° 20' W. At 7.15 a. m. under way to make biological haul with dragnet. At 8.07 a. m. observations completed, stood for westernmost grounded berg and found it to be melting rapidly, with a trail of small ice to leeward. At 9.47 a. m. arrived at easternmost grounded berg and found it to

be breaking up and melting rapidly. We then started on a search of the area to the southeastward of the Tail of the Bank. At noon dense fog set in, and we continued on our course to reach oceanographic station 245, in the axis of the Labrador Current, lat. $42^{\circ} 49' N.$, long. $49^{\circ} 33' W.$ After completing work at station 245, we shaped course to reach station on the banks and to find anchorage for the night. The thick fog began to clear as the edge of the Labrador Current was approached, and the water became warmer. At 6.39 p. m. occupied oceanographic station 246, in lat. $43^{\circ} 10' N.$, long. $49^{\circ} 51' W.$, and then anchored for the night. A few petrels followed the vessel at intervals during the day and a few shearwaters were seen, but there was no bird life around the bergs.

Special ice information was furnished to the steamship *Ampetco*.

July 11. Light to gentle winds, SE. to SSW.; foggy over cold water comprising tongue of the Labrador Current, partially clear otherwise. At 7.30 a. m. under way and began search for bergs. After examining the berg grounded on the Tail of the Bank, which we found to be melting and breaking up rapidly, set course to search to the southward and westward. Found fog over the cold water of the Labrador Current and from time to time worked to the northward to skirt it. At 2.28 p. m. set course through the cold-water foggy area to search to the southward. At 8.14 p. m. lay to for the night in dead-reckoning position of berg which had been reported, lat. $42^{\circ} 01' N.$, long. $51^{\circ} 28' W.$ The visibility was fair, but there was nothing in sight. Petrels and shearwaters were sighted during the day.

Special ice formation was sent to the steamship *Påleberg*.

July 12. Light southeasterly winds to calm; foggy over cold water in Labrador Current zone, with occasional rifts around its edges. The vessel lying to in fog until 8.40 a. m., when search was resumed for the berg reported yesterday. At 11.35 a. m. stopped on account of fog and drifted. Took sea-water temperatures in lat. $42^{\circ} 23' N.$, long. $51^{\circ} 25' W.$, with following results: At surface, $65^{\circ} F.$; 25 meters, $45^{\circ} F.$; 225 meters, $38^{\circ} F.$; 725 meters, $38^{\circ} F.$ At 3.05 p. m. resumed search for bergs, and at 4 p. m., the fog clearing, raised a small berg, which we passed in lat. $42^{\circ} 13' N.$, long. $51^{\circ} 33' W.$ (Berg "S," chart "G.") The berg was photographed and found to be melting rapidly, the sea-water temperature in the vicinity being $68^{\circ} F.$ At 7.30 p. m. passed the British steamship *Kurdistan*, bound east. At 8.40 p. m. stopped near the berg sighted during the afternoon and lay to near it for the night.

Special ice warnings were sent to the steamships *Rochester*, *Assyria*, and *Kurdistan*.

July 13. Calm to light variable winds; dense fog to mostly clear; vessel lying to in dense fog near southernmost berg. The fog having lifted, we sighted the berg, and at 5.35 a. m. arrived alongside of it and again hove to and drifted. The berg (berg "S") was reduced by melting to two shell-like walls and a pinnacle and would cease to be a menace in another day. The horizon cleared at sunset, permitting us to obtain a series of star sights, which enabled us to locate the present position of the berg as lat. $41^{\circ} 18' N.$, long. $51^{\circ} 28' W.$ (see chart "G"), showing that it had had a remarkable drift to the southward since its position was last accurately determined. At 10 p. m. lay to until morning.

At 10 p. m. the following broadcast was sent: "Ice patrol *Tampa*, 41 18, 51 28. near small berg. Two bergs grounded on Tail of Bank. Foggy."

July 14. At 2 a. m. a steamship passed us. We attempted to notify her of the berg and ascertained that she would pass a safe distance from it. At 5.30 a. m. stood back to the berg and found it to be a mere growler and no longer a menace to navigation. We then stood on course to meet the *Modoc*. At 6 p. m., after a conference with the commander of the ice patrol on the *Modoc*, in lat. $41^{\circ} 52' N.$, long. $53^{\circ} 20' W.$, the ice patrol season was declared at an end and the vessel stood for Boston, Mass.

Daily routine ice reports were sent to the Hydrographic Office, New York; Fuelite, Halifax, Nova Scotia; and Cape Race; and were broadcasted.

The following ice formation and obstruction reports were received; July 3, steamship *Canadian Trooper*, one berg and several small growlers, lat. $48^{\circ} 30' N.$, long. $49^{\circ} 04' W.$; July 5, steamship *Sanugon*, large bergs, lat. $43^{\circ} 00' N.$, long. $50^{\circ} 20' W.$, and lat. $42^{\circ} 58' N.$, long. $50^{\circ} 10' W.$; July 6, steamship *Western Plains*, berg, lat. $42^{\circ} 28' N.$, long. $50^{\circ} 05' W.$; July 7, steamship *Parktown*, a large berg, lat. $43^{\circ} 04' N.$, long. $50^{\circ} 34' W.$, and another 8 miles E. by S. from that position; July 8, steamship *Seattle Spirit*, spar buoy, projecting four feet out of water, lat. $41^{\circ} 32' N.$, long. $45^{\circ} 30' W.$; July 10, steamship *Rhode Island*, berg, lat. $43^{\circ} 40' N.$, long. $47^{\circ} 20' W.$; July 11, steamship *Chicago*, berg and growlers, lat. $42^{\circ} 01' N.$, long. $51^{\circ} 28' W.$; steamship *Sunoco*, large berg, lat. $42^{\circ} 17' N.$, long. $51^{\circ} 40' W.$

Some 200 sea-water temperature reports were received during this cruise.

SUMMARY OF ICE PATROL, SEASON OF 1922.

By Lieut. Commander B. M. CHISWELL, Senior Officer.

The ice patrol season began March 20 and ended July 14, 1922. During the months of April and June fog prevailed during a large percentage of the time in the vicinity of the Grand Banks of Newfoundland and the efforts of the patrol vessels to locate the bergs and disseminate accurate information concerning them and their movements were seriously handicapped thereby. April began with a fresh NW. gale on the first day, followed by a fresh SE. gale on the 2d, and then by NE. strong breezes to fresh gales until the 9th. During this stormy period there were five days of dense fog. From the 19th until the end of the month, SW. winds and continuous thick fog prevailed. Fog prevailed about 50 per cent of the time in April. Ice was sighted by the patrol on April 10, 12, 13, 16, and 18; mostly small bergs and growlers, and all north of the 42d parallel.

In May, weather conditions were favorable for the work, with mostly westerly winds, reaching gale force on only two days, and with fog prevailing about 25 per cent of the time. Ice conditions were better than normal and only two bergs were located south of the 42d parallel; one large one on the 20th, lat. $41^{\circ} 40' N.$, long. $49^{\circ} 00' W.$, and a small berg and growlers on the 27th, lat. $41^{\circ} 45' N.$, long. $48^{\circ} 50' W.$

In June, from the 1st until the 25th, the prevailing breezes were SW., and fog hung over the colder water of the banks like a blanket, effectively concealing from the patrol the presence and movements of bergs in that area. When the fog finally lifted, many bergs, some of unusually large size, were located between lats. $42^{\circ} 00' N.$ and $43^{\circ} 20' N.$ and longs. $49^{\circ} 00' W.$ and $52^{\circ} 00' W.$ During June, the southernmost berg, a small one, was sighted on the 21st, lat., $41^{\circ} 28' N.$, long. $49^{\circ} 52' W.$ and was rapidly disintegrating.

From July 1 to 14, on which latter date the patrol was discontinued, the prevailing winds were SW., varying from light airs to moderate breezes. Fog was prevalent over the colder water of the Labrador Current, with clear weather over the Gulf Stream. The warm water was pushing its way farther to the northward and spreading over, or forcing back, the Labrador Current. During this period the many bergs sighted during the last week of June melted and disappeared.

An unusual phenomenon was witnessed during the last days of the patrol. A berg (berg "S," chart "G,") which had drifted to the westward of the Tail of the Bank, suddenly began a rapid movement almost due south, and before it finally disappeared on July 14 had reached lat. $41^{\circ} 05' N.$, long. $51^{\circ} 28' W.$, the farthest south of any berg of the season, so far as authentic records go. The most reasonable explanation for this seemed to be that the Gulf Stream

had developed a big bight (see chart "P") to the northward and westward of the Grand Banks, in the vicinity of the entrance to Cabot Straits, and, meeting the resistance of the shoals and the cold tongue of the Labrador Current (at that time about 40 miles wide at the Tail of the Bank and extending southwestward to lat. $42^{\circ} 05' N.$, long. $51^{\circ} 35' W.$), its current was diverted south until finally overcome by the eastward movement between lats. $41^{\circ} 00' N.$ and $41^{\circ} 30' N.$, in longitude approximately $51^{\circ} 30' W.$

The unexpected appearance of a large number of bergs in June (see chart "O"), under unfavorable local conditions, suggests the thought that weather and other conditions of previous months in far distant localities probably have a determining influence upon ice movements toward the steamer lanes. For instance, an accurate knowledge and intelligent coordination of weather and current conditions observed in the Straits of Florida and off the coast of Labrador or Greenland in the month of December might enable one to predict with some approach to accuracy what may be expected off the Grand Banks of Newfoundland in the way of ice in the following April, May, or June.

In a general way, the present season has been a normal one with regard to the positions and strengths of the two main ocean currents, the Labrador Current and the Gulf Stream. The average drift along the east side of the Grand Banks was 0.4 knot per hour, in a direction paralleling the steep part of the slope. South of the Tail of the Bank the drift of bergs indicated a set ranging from W. to SW. with a strength of 0.4 knot per hour. (See charts "D," "E," "F," and "G.") The following exception was observed: One berg (berg "S") after passing the Tail of the Bank and reaching long. $49^{\circ} 30' W.$, drifted nearly south. After reaching the vicinity of lat. $42^{\circ} 30' N.$, long. $51^{\circ} 30' W.$, the berg ceased moving to the westward and turned sharply back, influenced more and more by the current on the northerly edge of the Gulf Stream, which was here setting easterly at 0.8 knot per hour. There was very little ice on the Grand Banks during the season, but from other observations, the current, as in previous years, was found to be tidal. Only two bergs were reported west of Cape Race, indicating that there is not much westerly tendency to the Labrador Current in that vicinity. At the close of the patrol season, the Gulf Stream had pushed well to the northward and rendered rather remote the probability of bergs reaching the steamer tracks. In connection with observations as to the movements of ice in the Labrador Current around the Tail of the Great Bank, there were no indications of a flow of said current W. and SW. of long. $52^{\circ} 00' W.$

Whenever weather conditions and the primary duties of the patrol permitted, the patrol vessel occupied oceanographic stations. At these points the scientific observer collected material upon which to base studies of the oceanography and plankton of the vicinity of the Grand Banks of Newfoundland. This material consisted of temperature observations and corresponding water samples from several depths, in vertical series, obtained at each station by means of the Greene-Bigelow deep-sea, reversing-thermometer water bottles; also of plankton, taken in vertical and horizontal hauls with tow nets of different sizes and preserved in formalin. In general,

the stations were located along lines radiating outward from a point in lat. 43° 50' N., long. 50° 25' W., near the 30-fathom bank frequented by fishing vessels, in general accordance with the program for 1920 and 1921 of the Inter-Departmental Board on Ice Patrol. (See Chart "A.") Sixty-three stations were occupied during the continuance of the patrol, in addition to 17 during the February and March ice observation cruises. Half-hourly surface sea-water temperatures were taken and recorded by the patrol vessels during the entire period of duty, and, in addition, approximately 3,000 reports were received by radio from passing ships. (See temperature charts "H" to "P.") The cooperation of shipping was much appreciated and enabled the oceanographer to keep a fairly accurate record of surface temperature conditions over a wide area.

Bird and marine life and natural phenomena, such as mirages, etc., were carefully observed, but nothing was seen to differentiate the season of 1922 from past seasons, as described in annual reports.

Whales were seen feeding close to bergs and flocks of birds of different species, mostly shearwaters, dovekies, petrels, and terns, were seen in the vicinity and at times perched on the bergs. On the other hand, in many cases there was an entire absence of bird and visible marine life near the bergs for long periods of time. Echoes of the steam whistle were obtained from the walls of lofty bergs, and at other times, in thick weather, echoes were heard when it was positively known that there were no bergs in the vicinity. From these observations, it is believed that the mariner navigating the ice area in thick weather, or at night, can depend upon no forewarning of a berg beyond the limit of his visibility. The drop in surface sea-water temperature would not be noticed appreciably until his vessel was in contact with the ice, or too close to avoid contact.

At the beginning of the patrol season, an agreement was made with the Canadian Naval Intelligence, Halifax, Nova Scotia, whereby the ice-patrol ship was designated as sole disseminator of information relating to ice and to obstructions to navigation in the vicinity of the Grand Banks of Newfoundland. In previous years the Canadian Government had been operating an ice information duplicate of its own, independent of the international ice patrol. This duplication and obvious confusion of information was removed by the agreement that the vessel on patrol should gather all information for broadcasting during the existence of the patrol, the Canadian Intelligence to receive a daily report of ice conditions and to resume its service when the patrol was discontinued. Through courtesy of the Canadian authorities, the patrol was furnished daily ice and weather reports from the Government stations at Battle Harbor, Fogo, and Bonavista. In connection with the above agreement, Cape Race Radio Station forwarded all ice reports received there from trans-Atlantic traffic to the patrol vessel. This information was confined largely to ice reported in the vicinity of Cape Race. Cape Race Station was also of great assistance to the patrol in broadcasting ice warnings to steamers on the St. Lawrence River tracks, out of range of the patrol vessel's radio.

The patrol, as now organized, is believed to be conducted as efficiently as possible under the severe handicaps of gales and fog that ordinarily are so prevalent in this region. The plan of detailing an officer as oceanographic aide, to shift from vessel to vessel and

remain in the field for the entire season, as practiced this year, helps very materially to make the patrol uniform and continuous, bridging over the break that comes when one vessel relieves the other.

A study of communication possibilities is recommended, in order that, if possible, the ice situation as developed by the patrol vessels during the hours of daylight may be broadcasted from Arlington the same night or early the following morning. The importance of prompt information regarding positions of dangerous bergs is explained by the fact that these bergs are constantly moving and a report 24 or 36 hours' old may be misleading except in a general way.

OCEANOGRAPHER'S REPORTS.

FEBRUARY.

In assembling and recording data relating to ice and sea-water temperatures the method adopted last year was again employed this year. The temperature of the sea water at the surface in the area observed has been recorded on the oceanographical chart. This chart (chart "H") shows the sea-water temperatures and the ice and meteorological conditions in the vicinity of the Grand Banks of Newfoundland between February 8 and February 26, 1922. A wider distribution of sea-water temperatures was secured during this period than ever before so early in the year. The cooperation of passing trans-Atlantic steamships was excellent and facilitated the plotting in detail of the conditions in the area observed. A rise in the temperature of the sea was observed in lat. 43° N. between longs. 57° W. and 60° W., the highest temperature of the sea water in this area being 52° F. To the eastward of this area the temperature of the surface water was lower, but in lat. 43° N., long. 54° W., another rise in temperature occurred, which continued until the west slope of the Great Bank was reached. Over the Great Bank cold water of approximately 32° F. was found to extend from the surface to the bottom of the sea. This temperature is the normal temperature of water over the Great Bank and the smaller banks lying off the Newfoundland shore at this time of the year. Isotherms indicating the conditions noted have been drawn on the chart.

During the month of February the temperature of the surface water of the northern edge of the Gulf Stream in the vicinity of the Great Bank was approximately 54° F. This is represented on the chart by a shaded boundary line, which was definitely located and found to be sharply defined. No current observations were possible, owing to the prevailing rough sea, but a set to the eastward was noted along the south side of the Great Bank. In lat. 41° N., long. 47° W., this set turned sharply and continued in a general swirl in a northerly direction. When it reached the 45th parallel it again changed direction, setting about ENE. true. It was not further investigated.

On the chart the 54° isotherm represents the northern edge of the Gulf Stream, which flowed along the 41st parallel and, in 47° west longitude, swept in a gentle curve to the ENE. and then on across the 43d meridian. The divergence between the 54° isotherm and the 60° isotherm indicates that the northern set in this locality was a branch from the main current of the Gulf Stream. This conclusion seems to be borne out by the temperatures recorded in lat. $44^{\circ} 52'$ N., long. $46^{\circ} 50'$ W., at oceanographical station 174, where, at a depth of 250 meters, a temperature of 50° F. was found. Below this depth the temperature of the water dropped suddenly to 41° F. and the water continued to grow colder as the depth increased.



A DEEP-SEA CAST.

One thousand meters of $\frac{1}{4}$ -inch flexible steel wire is carried on the 1-ton Sprague electric hoist shown in the photograph. A member of the "Modoc's" crew is seen unclamping a water bottle after it has been submerged for observations.



A BERG WITH A BLUE STREAK.

June 14, 1922, $43^{\circ} 15' N.$, $50^{\circ} 10' W.$ This picture of one of the few bergs on the Tail of the Bank during 1922 was taken from the "Tampa." The dark streak in the center of the berg was caused by a fissure, when in the glacier in Greenland, filling with water and freezing. It was plainly distinguishable from the surrounding white snow ice by a clear, dark-blue color.

The depth of the main trunk of the Gulf Stream was found to be greater than 250 meters. The contour of this wall of cold water approximates very closely the 100-fathom contour of the Grand Banks and of the banks farther to the westward. In longitude 55° W., it was found that this similarity of contours did not exist. Here the wall of cold water extended to the southward; this was probably due to the effects of the cold St. Lawrence drift through the Laurentian Channel. During this period the water on the Great Banks, like that of the Gulf Stream, had approximately definite bounds and an approximate temperature of 32° F. Off the Tail of the Bank the 32° isotherm extended 30 miles farther south into deep water. It was found that warm water was projected over and on to the west slope of the Great Bank. The finding of both warm and cold water in this area indicates a large ocean eddy. An examination of the records for the same time of year in 1921 shows that similar conditions prevailed then. If a few more years' observations show that similar conditions continue to prevail, it would seem fair to assume that a great eddy exists on the west side of the Tail of the Great Bank at this season.

While a strong set was observed in the Gulf Stream eastward of the Great Bank, no current was noted while in the cold waters. Where a definite set to the Labrador Current has been found in previous years during April, none was experienced this year in February. In 1921 no appreciable drift was observed in this area during February or early in March. It is thought that there is no drift, or, if any, only a slight one, to the Labrador Current during the late fall and during the winter months. This subject will be discussed in another place, when an effort will be made to submit proof of the correctness of the above conclusions.

The direction of the winds experienced while in the vicinity of the Great Bank was averaged for each 12-hour period, and the mean force and direction is indicated by the straight radial lines in the center of chart "H." The Beaufort scale is shown in the lower right-hand corner. The prevalence of northerly and westerly winds is noticeable; there were a few winds from the southwest quadrant, but practically none from the other quadrants. The length of the lines strikingly illustrates the force of the winds encountered. Nearly all were above a force of 6 of the Beaufort scale. The winds are worthy of consideration for their effect in setting up temporary surface currents.

Ice was not found in any large amount during the first part of February, but later in the month large areas of field ice were reported. Many of the local mariners stated that there had been more field ice this spring than for many years past. These fields extended as far south as parallel $45^{\circ} 30'$, east to the edge of the Great Bank, and west to just north of Sable Island, and thence to Cape Canso. The large amount of field ice appears to have been due to a predominance of northwesterly winds during the month and during the preceding winter months. Only three bergs were reported, and these were close inshore off St. Johns, Newfoundland.

Field ice in this vicinity may be of three kinds, viz, Arctic ice, shore and bay ice, and Gulf of St. Lawrence ice. The predominance of northwesterly winds for a long period would tend to increase the quantity of all three. The northerly winds tend to break the Arctic

fields away from the Labrador coast and the coasts to the northward and drive them southward. The same winds drive the Newfoundland bay and shore ice away from the coast and offshore to meet the Arctic drift ice. These winds also bring "cold waves," which, with their low temperatures, cause new ice to make quickly inshore, which, in turn, is blown offshore and is packed up on that already there. The St. Lawrence drift is augmented by the northwesterly winds, which form temporary surface drifts and probably cause the field ice to extend south to Sable Island. The foregoing shows why there was so much field ice this year. In connection with the prevalence of northwesterly winds during the past winter, as shown on the February chart (chart "H"), it is interesting to note the effect produced upon the climate of Newfoundland. The chart shows that the northern branch of the Gulf Stream was farther north this year than at the same time last year. If south and east winds had prevailed this winter, as they did last winter, with the Gulf Stream lying so far north, the climate of Newfoundland would have been milder than a year ago. The mildness of the winter in 1921 was principally due to the predominance of southeasterly winds, which carried the warm air over the Gulf Stream to the northward. The predominance of northwest winds in 1922 rendered nil the heating effect of the large reservoir of warm water to the southeast of Newfoundland and resulted in cold weather in that region.

MARCH.

Attention is invited to the oceanographical chart for the period between March 13 and 18, 1922 (chart "I").

The *Seneca* sailed from Halifax, Nova Scotia, March 13, 1922, on ice-observation work, with its attendant scientific investigations. Bergs and growlers which were found drifting southward around the Tail of the Bank required a continuous patrol, which was inaugurated on March 21.

On the run from Halifax to the Great Bank the temperature of the sea water fluctuated between 38° and 45° F., but upon reaching the 57th meridian the temperature rose to 54° F. Proceeding to the eastward the temperature dropped to 38° F., but again rose to 52° F. in long. 53° 40' W. At 53° W. long. the temperature of the sea water began to drop, and it continued to grow colder as the west slope of the Grand Banks was approached. The variations in the temperature of the surface of the sea are graphically indicated on the oceanographical chart, which shows a shaded warm-water thermal extending far north into the cold-water area west of the Great Bank. The usual break in direction of the Gulf Stream to the north along the 47th meridian was observed.

Oceanographical conditions in general had not changed materially from those observed during the cruise of February 8-26, 1922. The "cold wall," represented by the shaded cross-hatched isotherm of approximately 55° F., had not changed position on its southern and western sides. On the eastern side, in lat. 42° N., long. 48° W., the warm water had progressed farther to the westward. The area of cold water, temperature of 32° F., had extended, however, southward nearly 60 miles and was found to be closely and compactly butted against the warm water of the Gulf Stream. This agrees with the

conditions found last year, when the packing up of the thermals upon the southern boundary between the warm and the cold water indicated that the current from the north was beginning to attain a definite drift and an appreciable set. The pushing southward of the area of cold water of the temperature of about 32° F. during the latter part of March was an early sign of the growing spring freshet of the Labrador Current in this area. On February 14 three icebergs were sighted off St. Johns, Newfoundland. Two of these bergs were again sighted and identified on February 27 on the Great Bank, in lat. 43° 55' N., long. 50° 35' W. They had drifted southeast at the rate of 0.4 knot per hour. On March 9 two small bergs were reported in lat. 45° 13' N., long. 48° 33' W. It is believed that these were the same bergs as those previously sighted on February 14 and 27. Their drift had changed to ESE., but the rate of drift remained about the same. The prevailing winds during this period had been northwesterly. Later, bergs were reported drifting to the southward along the east side of the Great Bank, and it appears logical to assume that the two bergs traced from off St. Johns across the Great Bank followed the same course and that their drift could be accounted for only by the absence of the Labrador Current in this locality at that time. During the period covered by this report, however, the bergs had begun to drift southward along the east side of the Great Bank. This appears to be an indication that the Labrador Current had begun to assume velocity. During the February cruise of the *Seneca* no current was observed off the east slope of the Great Bank where a definite set is to be found later in the season. The field ice which had covered most of the Great Bank the first part of March had nearly all disappeared by the end of that month. On March 31 field ice was present only along the east side of the Great Bank in the Labrador Current, which would appear to be the logical place for it. In the oceanographical report for the first cruise of 1922 the field ice conditions were described and discussed.

The position of the first berg observed by the ice patrol this year is shown by a "△" on chart "I," which is connected by a dotted line to other "△'s," which mark the path of its drift from March 19 to March 27. Since this berg, due to its high air-surface body, was unduly affected by the wind, its drift was not considered a true indication of the ocean current. A drift of 2 knots per hour was observed, which undoubtedly was due to favoring winds. The general southwesterly drift of this berg around the Tail of the Bank was, however, believed to be indicative that the Labrador Current prevailed at that time and place. During April of last year the rate of drift along the east side of the bank was 0.3 knot per hour, and this year the rate was estimated to be the same. During the cruise it was noted that all the bergs which came under our observation presented evidences of having been under the influence of warm water and air, and that they had the same appearance as bergs that are in the final stages of disintegration near the Gulf Stream. Hence it was assumed that they had drifted southward during the latter part of the summer of 1921, but before complete disintegration had been saved by the advent of cold weather, or perhaps had been set to the north by a countercurrent, where they had been held fast by field ice. If this were the case, they naturally would be the first bergs to put in an appearance this year. The boundary line between the warm and the cold water was sighted on

March 27 in lat. $41^{\circ} 40' N.$, long. $51^{\circ} 07' W.$ This is the well-known "cold wall" of oceanographers. (See plate 5.) The surface of the water on the cold side of the wall was smooth and glassy, its temperature registering $34^{\circ} F.$, while on the south side of the wall the surface was chopped and rippled, with a temperature of $56^{\circ} F.$ At places the demarcation was very pronounced, and was indicated by a series of small eddies, which caused air bubbles and froth to form. The boundary was still more clearly defined by driftwood and débris which had collected here and there. This would appear to indicate the presence of a suction force which caused the flow of surface waters toward the demarcation line. This phenomenon is present to a less marked degree along the northern and western sides of the Gulf Stream where it parallels the coastal reservoir of the United States and has been observed off Cape Hatteras.

During this cruise the direction and force of the wind was averaged for each 12-hour period. The mean force and direction is shown by the radial lines in the center of chart "I," and the Beaufort scale is drawn in the lower right-hand corner. There were three 12-hour periods of calm. From the 15th to the 28th calms to light southerly and easterly winds were experienced, but from the 28th to the 31st strong north to west winds prevailed. The usual amount of fog was observed.

To sum up: During the first part of the month the Great Bank was covered with field ice, which disappeared by the end of the month, leaving traces of the old fields along the east slope of the Bank and south to lat. $43^{\circ} 20' N.$ The first icebergs appeared at parallel $45^{\circ} N.$ on the 9th and drifted southward along the east side of the bank at the rate of 0.25 knot per hour. The first berg arrived at the Tail of the Bank on March 20. It is estimated that there were not over 5 bergs and 10 growlers in the vicinity of the Tail of the Bank during the month. The Labrador Current at the end of the month had attained a velocity of 0.25 knot per hour. The "cold wall" had assumed a position as shown on the oceanographical chart (chart "I").

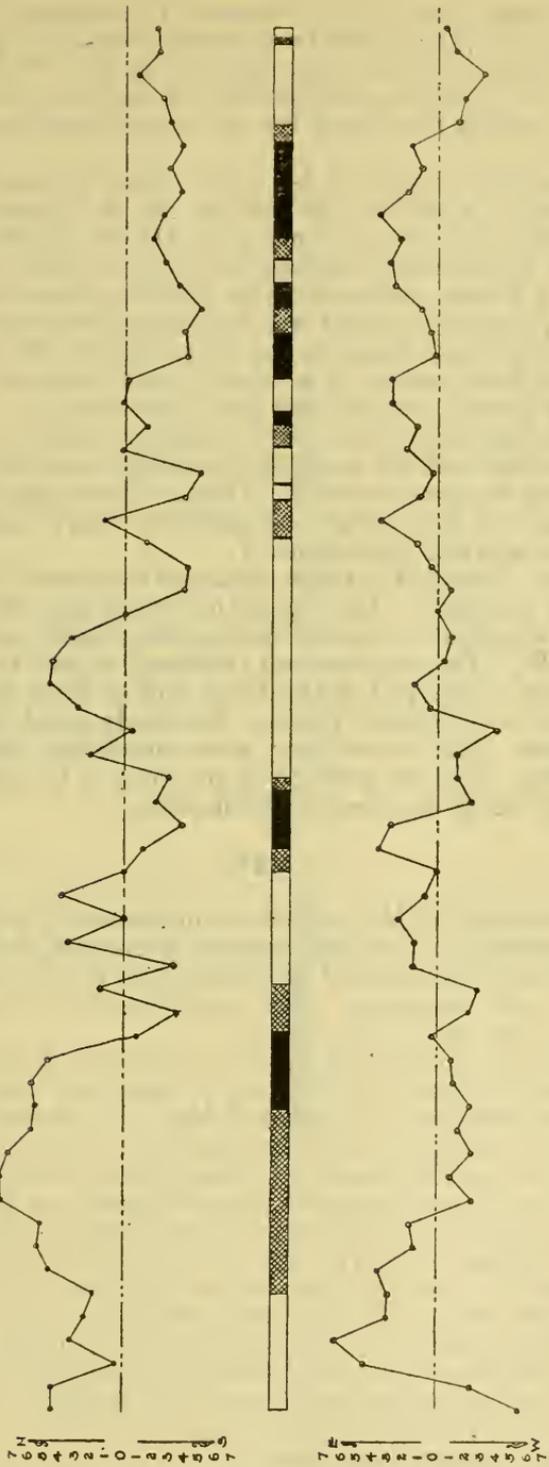
APRIL.

Since the physical phenomena in general will be discussed later in the bulletin, under the heading "Oceanographic summary," the monthly reports will be reduced to a minimum.

Various changes will be noted in the position of the "cold wall" as shown by the isotherms on the surface temperature charts "J" and "K." The "cold wall" south of the Tail of the Bank moved 30 miles to the northward in the course of the month. Southeast of the Grand Banks the so-called "knuckle" of cold water formed by the Labrador Current became manifest. The head of warm water west of the Tail of the Bank, which was so noticeable during the early part of the year, began to break up during April, and receded southward to $42^{\circ} 30' N.$, $54^{\circ} 00' W.$ The subnormal amount of ice observed during the month should be noted. The two bergs that drifted around the Tail of the Bank and grounded on its southwest slope during March drifted off into deep water. The drift of one of these bergs is shown on berg chart "D." This berg was sighted on April 2, 10, 14, and 15. When last observed, it was drifting due north at a rate of 0.4 knot per hour and had disintegrated to such an extent

WIND DIAGRAM AND FOG SCALE

■ FOG
 2-4 1/2 FOG
 ▨ HAZE
 5-3 1/2 FOG AND LOW
 □ VISIBILITY
 CLEAR



APRIL - 1922. FIG. 1

that it no longer constituted a menace to shipping. The only ice found south of the Tail of the Bank during the last half of the month was a small growler, which was observed in $42^{\circ} 19' N.$, $50^{\circ} 46' W.$ (See chart "K"). During this period fog enveloped the entire cold-water area, making the search for ice very difficult and almost impossible.

Several currents were noted by means of astronomical positions, as follows: April 4, in $42^{\circ} 56' N.$, $50^{\circ} 00' W.$, a 0.2-knot current was observed setting 246° , true; April 6, in $41^{\circ} 48' N.$, $50^{\circ} 30' W.$, a 1-knot current was observed setting 68° , true; April 8, in $41^{\circ} 48' N.$, $49^{\circ} 50' W.$, a 1-knot surface current was observed setting 85° , true. On April 27, while the vessel was at anchor, with very smooth sea and light airs, current observations were made in $43^{\circ} 45' N.$, $50^{\circ} 25' W.$, and a surface current of a rotary tidal character, the same as found in this locality in 1915 and 1921, was noted.

During the first half of the month northerly winds prevailed, while during the second half the wind blew steadily from the SE. quadrant and much fog was encountered. This is shown graphically on the wind diagrams of the surface temperature charts and also on the wind diagram and fog scale, figure 1.

To sum up: The Gulf Stream advanced northward 30 miles south of the Tail of the Bank. The "knuckle" which was observed so often during 1921 was again observed during this month, and extended to $41^{\circ} N.$, $48^{\circ} W.$ The ice observed consisted of two bergs and a few growlers south of the Tail of the Bank and of three small bergs and two growlers on the Grand Banks. Northerly winds prevailed from the 1st to the 15th, when they were succeeded by southeasterly winds and fog. Fog was present 24 per cent of the month, and low visibility and fog 53 per cent of the month.

MAY.

During the month of May, north to northwesterly winds, with good visibility, prevailed. The clear weather permitted the patrol vessels to locate all the bergs around the Tail of the Bank and to plot their drift tracks with accuracy. (See berg charts "E" and "F," and temperature charts "L" and "M.")

Berg "D" was reported on April 17, in $43^{\circ} 35' N.$, $48^{\circ} 20' W.$, the sea-water temperature in its vicinity at the time being $38^{\circ} F.$ This berg was first observed by the patrol May 2, as shown on berg chart "F." Its track is shown on succeeding days of the month as it was followed by the patrol vessel. It was a large berg when observed May 2, but was a mere growler when last seen, on May 22. In 33 days it had drifted 250 miles at an average rate of 0.32 knot per hour. The drifts of bergs "E," "H," and "J" are also shown on berg chart "F." Bergs "F" and "G" arrived off the Tail of the Bank about May 17, or two weeks after the bergs shown on chart "F." Their drift is shown in chart "E." It will be noted that bergs "F" and "G" did not drift to the southwest of the Tail of the Bank, but continued nearly due south and then easterly into the "knuckle." The cause for the difference in the drift of these bergs is explained in the summary of oceanographic conditions, page 95.

On May 7, berg "K" was reported in the position shown on chart "E." It was also observed on May 9 and 10. During this three-day

WIND DIAGRAM AND FOG SCALE

■ FOG
 12 1/2 FOF
 ■ HAZE
 ▨ FOF AND LOW
 20 % VISIBILITY
 □ CLEAR

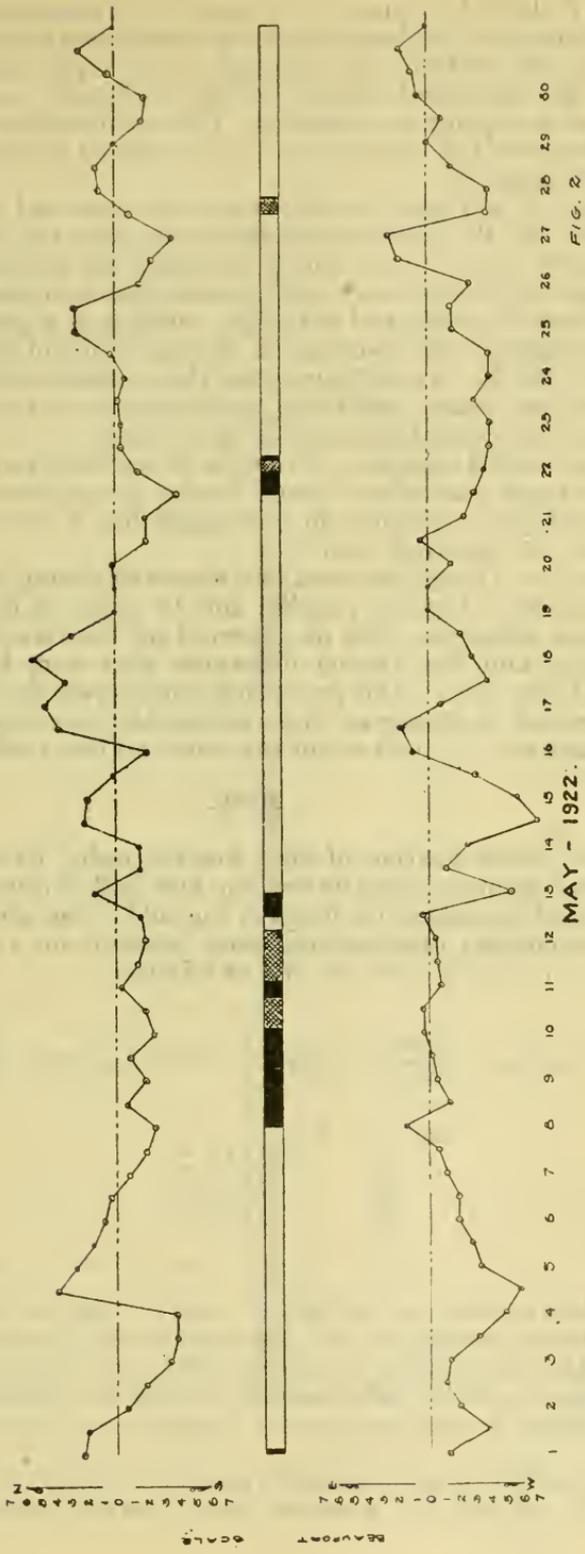


FIG. 2

interval it drifted 33 miles, 17° , true. It is interesting to note that the movement of this berg was due to the effects of the Gulf Stream's northerly and easterly set, although it was approximately 35 miles north of the southern boundary of the "cold wall" and the surrounding water was polar in character. This demonstrates the frictional action between the two currents, as described in the oceanographic summary, page 95.

On May 23, a French fishing vessel was observed at anchor in $43^\circ 50' N.$, $49^\circ 36' W.$ She was headed south, true, the wind at the time being WNW., force 2 to 3, which indicated the presence of a surface current setting to the northward at that time and place.

A number of swirls and tide rips, running in a general north and south direction, were observed on the east slope of the Grand Banks in lat. $44^\circ 00' N.$ In cutting across this current an allowance of 0.8 of a knot was made, and from later astronomical observations this proved to be a correct estimate of its strength.

From a careful selection of reports of ice observed in the vicinity of the northern part of the Grand Banks, it was determined that the current setting to the south in that region had a velocity between 0.4 knot and 0.5 knot per hour.

To sum up: The ice reported and observed during May consisted of 8 bergs south of the 43d parallel and 16 south of the 45th parallel. No ice was either reported or observed on the Grand Banks during the month, and the French fishermen who were interviewed corroborated this fact. The prevailing winds were from the west and they were not so strong as those during the preceding month. Fog was present only 12 per cent of the time and low visibility and fog 20 per cent.

JUNE.

The fine, clear weather of May was succeeded by southerly winds and a great amount of fog during the first half of June, which greatly handicapped the search for bergs in the cold-water area. (See Fig. 3.)

Surface current observations were taken June 4, while lying at anchor in $43^\circ 13' N.$, $50^\circ 03' W.$, as follows:

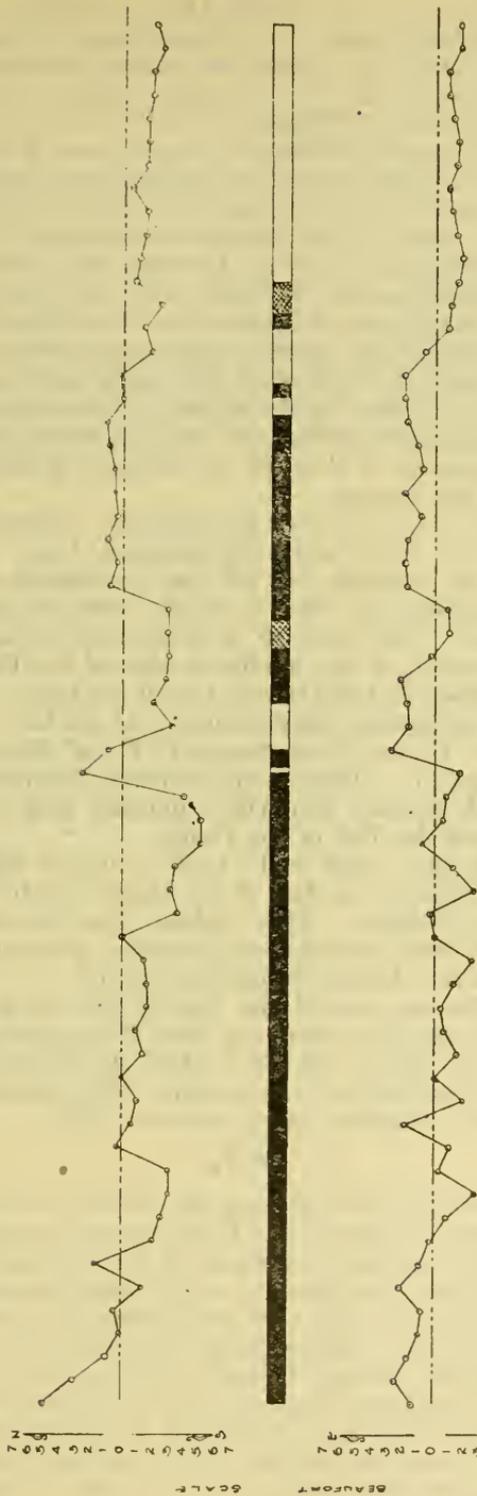
| Time (45th meridian). | Direction of current (true). | Velocity of current. | Time (45th meridian). | Direction of current (true). | Velocity of current. |
|-----------------------|------------------------------|----------------------|-----------------------|------------------------------|----------------------|
| | <i>Degrees.</i> | <i>Knot.</i> | | <i>Degrees.</i> | <i>Knot.</i> |
| 10 a. m. | 84 | 0.12 | 4 p. m. | 169 | 0.5 |
| 11 a. m. | 194 | .12 | 5 p. m. | 354 | .4 |
| Noon. | 284 | .12 | 6 p. m. | 94 | .6 |
| 1 p. m. | 284 | .15 | 7 p. m. | 109 | .6 |
| 2 p. m. | 284 | .12 | 8 p. m. | 124 | .6 |
| 3 p. m. | 314 | .5 | | | |

The observations are subject to error, owing to the crudeness of the apparatus employed, but the results are of value in that they indicate that the surface current on the Grand Banks at the position given was of a rotary tidal nature, moving in a clockwise direction. This agrees with previous current observations taken on the Grand Banks.

Currents in the deep water were noted as follows: In the vicinity of $42^\circ 10' N.$, $49^\circ 00' W.$, a current was observed setting 77° , true, at

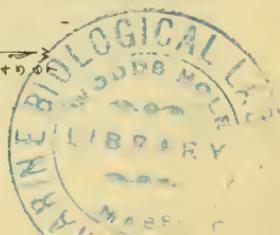
WIND DIAGRAM AND FOG SCALE

80% FOG
 60% FOG AND LOW
 70% VISIBILITY
 HAZE
 CLEAR



1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
 JUNE - 1922.

FIG. 3



the rate of 1 knot per hour. When the edge of the "cold wall" lay along the 42d parallel, during June, the strength of the current south of the Tail of the Bank was 1 knot per hour and its set 90° , true. On June 8, in $42^\circ 06' N.$, $49^\circ 23' W.$, a surface current was observed with a set of 1 knot per hour, 77° , true.

On the 15th the wind shifted to the northwest and the fog lifted, enabling us to locate three bergs on the Tail of the Bank. From the 15th to the 30th fog was intermittent, and the days of good visibility were employed in searching the areas around the Tail of the Bank. During this period seven bergs were tracked, as shown on chart "G." A comparison of berg charts "F" and "G," which contain the drifts of almost all the bergs present around the Tail of the Bank during the season of 1922, shows that most of the bergs drift to the west and southwest after passing the Tail of the Bank and continue in those directions until they arrive in the vicinity of the square bounded by parallels 42 and 43 and meridians 51 and 52, where they are sharply turned and commence to flow in an easterly direction, under the influence of the Gulf Stream.

Berg "N" chart "G," is shown by sketches. When first observed, in $42^\circ 43' N.$, $51^\circ 27' W.$, it was a high pinnacle berg. While we were approaching it this pinnacle fell off and the sketch of June 15 was taken from the photograph, Plate 2, which shows the berg surrounded by small growlers. On June 20 it was observed again, see chart "G," nine miles north of the northern edge of the Gulf Stream and drifting to the eastward at the rate of 1 knot per hour. It was floating in water of the following temperatures: At surface, $55^\circ F.$; at 50 meters depth, $36^\circ F.$; at 125 meters, $34^\circ F.$; at 250 meters, $32^\circ F.$; at 400 meters, $40^\circ F.$ These temperatures illustrate the manner in which the Gulf Stream imparts a parallel flow to the adjacent polar water around the Tail of the Bank.

About June 20 the "cold wall" took a sudden dip to the southward in the longitude of the Tail of the Bank, but by June 28 it had resumed its old position. This sudden fluctuation between the boundaries of the warm and the cold water is explained by the shallowness of the surface layers during this period.

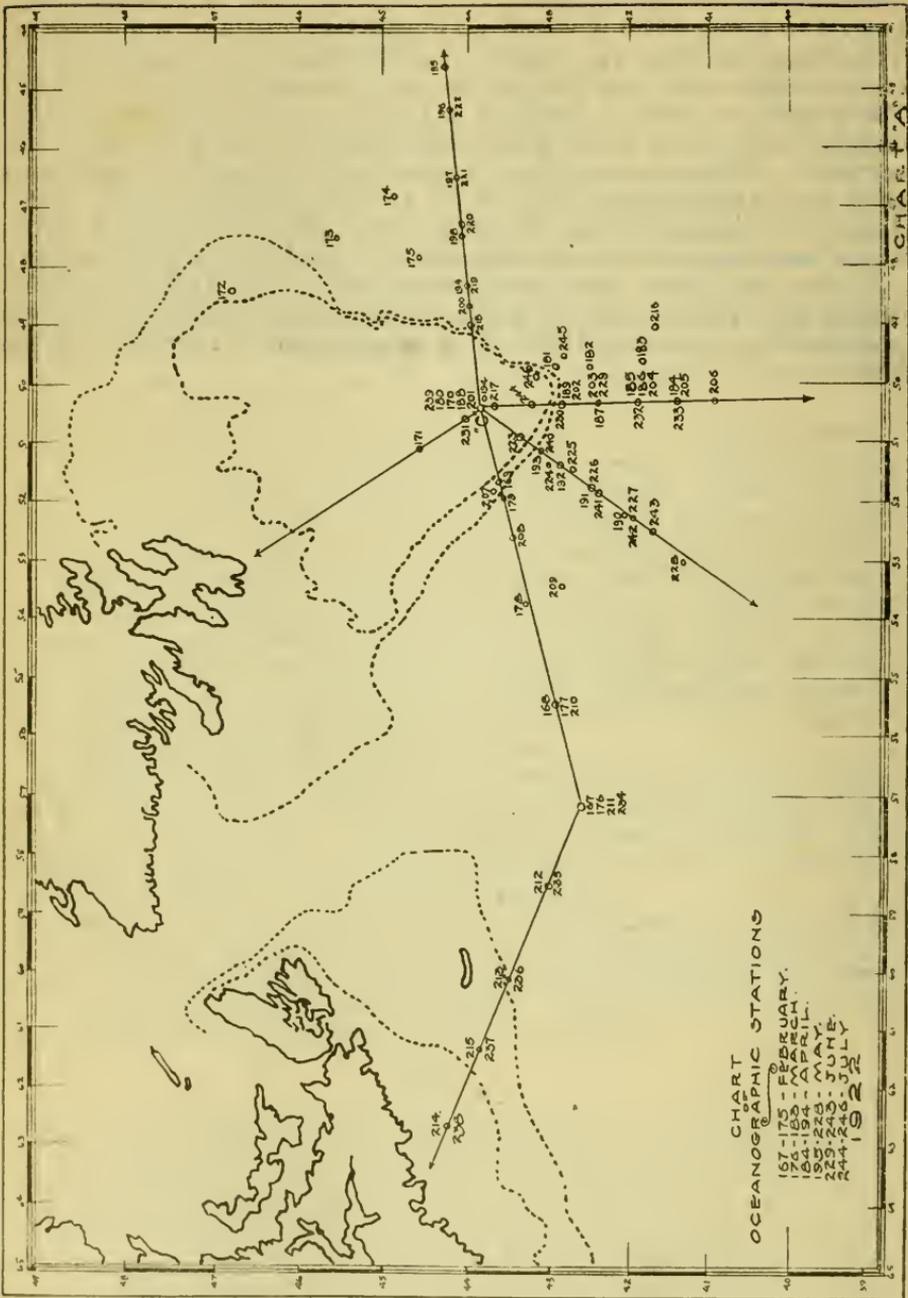
To sum up: The ice around the Tail of the Bank consisted of a total of 12 bergs, and there were not over 20 bergs south of the 45th parallel. Fog was present 68 per cent of the month, and low visibility and fog 70 per cent of the month. The prevailing wind was from the southerly quadrant and was very light.

JULY.

The most notable feature during the month, as shown by chart "P," is the manner in which the Gulf Stream increased in volume and restricted the southern extension of the Labrador Current to a narrow tongue of water, all trace of which disappeared in $42^\circ 00' N.$, $51^\circ 30' W.$ The great amount of fog during this period interfered with the search for ice. Three bergs, however, were located in the extreme end of the pocket formed by the cold current. They remained in this restricted area and were closely observed for several days, during which they were found to be under the influence of many small and temporary eddies, which carried them to no appreciable distance from the locality. These bergs finally completely disintegrated at this place.

During the last days of the patrol a berg, berg "S," chart "G," was observed to drift southward past the Tail of the Bank and through the "cold wall" into very warm water. It reached the southernmost limit of ice for the year, $41^{\circ} 05' N.$, $51^{\circ} 28' W.$, before it had melted to a size when it would no longer be a menace to navigation. This berg evidently was caught by Gulf Stream water escaping out of the bight which had formed to the westward of the Tail of the Bank and was carried south in a band of southerly current until caught by the main body of the Gulf Stream, when it quickly disintegrated. This is an example of a situation that may occur and shows that the extraordinary drift of ice to low latitudes in the North Atlantic is probably due to temporary surface branches of warm water moving south in contradistinction to an abnormal polar current.

To sum up: There were seven bergs south of the Tail of the Bank during this period, one of which drifted to the farthest southern position for ice during 1922. Fog was present 46. per cent of the period.





A LARGE BERG.

Photographed from the "Tampa" on May 6, $42^{\circ} 38' N.$, $51^{\circ} 10' W.$; sea-water temperature 38° .
Drifting 231° true, 0.25 knot per hour.



THE MIDWINTER ICE CRUISE.

Taking an oceanographic station in the vicinity of the Grand Banks. The cutter is the only visitor to this lonely region during the winter months. Here is shown one of the oceanographic casts; the wire with the bottles on it can be seen running over the side. The weather is extremely severe.

REPORT ON SCIENTIFIC OBSERVATIONS AND OPERATIONS.

E. F. B. FRIES, Scientific Observer.

From February until the termination of the ice patrol in July, 80 stations for oceanography and marine biology were occupied.

At these stations a program similar to that of 1921 was in effect.¹ First, temperatures and corresponding water samples were obtained by means of deep-sea, reversing thermometers and Greene-Bigelow water bottles from about six levels in vertical series between the surface and the usual maximum depth of 750 meters, or the bottom. Then by means of different silk townets collections of the plankton were made and preserved in formalin. Generally four tows were made—one being vertical from a maximum depth of 600 meters, or the bottom, one restricted to the surface, and two horizontal at different depths, of which the greater was usually 200 meters and never exceeded 350 meters.

This scientific station work was, for the first time, not confined to one of the cutters engaged in the ice duty. It was begun on the "observation" cruises of the *Seneca* in February and March, both its oceanographic and biological phases being conducted by Lieutenant Smith.² When the *Tampa* and the *Modoc* took over the duty of ice patrol, they in turn were the base of operations, as the oceanographer and the scientific observer transferred from one to the other in order to remain continuously on active duty during the season. In April and the following months the scientific observer took charge of both physical observations and biological collections, and thereby avoided any confusion tending to arise from the splitting of authority in the station work.

The Inter-Departmental Board on Ice Patrol had, as in 1921, recommended that the stations be located along lines running from Halifax to about 42° 30' N., 57° W., thence to the southern portion of the Grand Banks of Newfoundland, and from this point, respectively, over the banks toward Cape Race, east into the Gulf Stream, and south into the Gulf Stream. In fulfillment, these recommendations were subjected to some modifications. Instead of the suggested 50-mile intervals between stations, 30-mile and even 25-mile intervals were the rule to the southward and eastward of the banks where the nature of the water varied abruptly. And a radial line from the Grand Banks southwest into the Gulf Stream, promising an interesting section of the mixing of the banks and Labrador Current waters with those of the Gulf Stream, was adopted in addition. Because the primary duty of the vessel on patrol was to keep in close touch with the icebergs southward of the banks and because the weather conditions were frequently adverse, it was impossible always to occupy the stations regularly according to this plan. Yet in consequence of having the scientific duty taken over by each relieving vessel, most of the total of 80 stations were located along these radials and the remainder were believed productive by themselves of interesting data. (See chart "A.") Furthermore, the different stations in any one of the radials are embraced by a span of

¹ U. S. Coast Guard, Bulletin No. 9, 1922, p. 61.

² In the absence of Mr. Fries.

rarely more than a few days for each occasion that radial was covered. In other words, not only was the number of stations greater than for any preceding year, but the material was collected in such a way as to give it more significance than it would derive merely from its mass.

The material furnishes profile views (see profiles 1-14) of the currents, eddies, and tidal water of the Grand Banks region, and of the plankton. An enumeration of the lines of these profiles follows: The radial east from the banks was covered early in May and again late that month; the radial south from the banks during the first half of April, May, and June; the southwest radial during the second half of April, May, and June; the westerly radial, extending more than halfway to Halifax from the banks, during the second half of February and March, and again the middle of May; also a west-east line from the banks across the Labrador Current in February; a north-south line across the end of the Labrador Current late in March; and profiles from Halifax out to deep water during the middle of May and the middle of June.

The material obtained along the last-mentioned line is not very satisfactory. Since the cruising area of the vessels did not extend so far west while on active patrol, neither the oceanographer nor the scientific observer was present at the working of these stations. Because the information to be obtained seemed eminently desirable, a substitute was pressed into service to conduct the work. Although he seemed qualified for it, as a result of instruction and practice, too many of the temperature data were fantastically impossible. The value of the water sample and plankton collections is thereby lessened, yet certainly not nullified.

The northerly radial over the Grand Banks was not covered, despite the desirability of an increase in knowledge of the conditions there, particularly in the gutterlike formation off Cape Race. Several plans for fitting such a run to the northward into the schedule were formulated, but each had to be abandoned as the immediate necessity of patrolling southward intervened, until the ice menace ceased to exist.

As the oceanographer is giving thorough consideration to the oceanographic data, comments on that subject are out of place here. With regard to the biological collections, the examination which has so far been made of the plankton is not sufficient to warrant any discussion of the results. But the study undertaken for the coming few months should be productive of some conclusions. It is expected that some correlation of the life and distribution of at least certain species with the oceanography of the region of the Grand Banks and, it is hoped, with the movements of the icebergs will be indicated.

The complete station data are presented in the table which follows this report. In the table are included the corrected temperature observations, the salinity values obtained by the titration of the water samples, and the record of the towings made at each station. The numbers of the stations commence with 167 to follow those of the International Ice Patrol for previous years.

In addition to the oceanographic and biological data the correlative records of the time and position of each station, the depth, and the weather are given. The local depths of water are quoted between parentheses when they were read off the chart and not found by sounding. The Beaufort scale is used in indicating the force of the wind.

The depths quoted for the physical data are the lengths of line paid out in lowering the Greene-Bigelow reversing water bottles. The

depth values are, on that account, exact only in the absence of winds and currents. When the series of bottles were, by the drift, carried away from the vertical, the values given were maxima to which the true depths approached fairly closely—more or less in proportion to the vessel's leeway.

Generally two thermometers were used, as checks on each other, in securing the temperature reading for each depth. But sometimes the action of one of the thermometers was obviously faulty, or for other reasons only one thermometer supplied the data. In such cases the temperature value is marked in the table with a dagger. Only such thermometers were used as had been tested for errors—the Schmidt and Vossberg thermometers at the Hydrographic Laboratory of the International Committee for the Exploration of the Sea in Copenhagen; of the Negretti and Zambra, the older at United States Bureau of Standards, the newer at the National Physical Laboratory in Teddington, England. The correction certificates from these sources have been used to obtain the corrected temperatures from the original readings of the reversing thermometers and the auxiliary stems. These final values are subject to an error lying within $\pm 0.1^\circ$ (C.). Certain of the temperature determinations were found to contain a larger error, of $\pm 0.2^\circ$ or even $\pm 0.3^\circ$, and they are indicated in the table by asterisks. Furthermore, since the temperatures marked with daggers were obtained from single thermometers, it is not possible to be as confident in their accuracy as otherwise. Yet for the most part they are probably no more in error than the unmarked temperatures, certainly no more than those marked with asterisks.

The standard method of titration with silver nitrate was employed to determine the salinity of the water samples which were preserved in citrate of magnesia bottles.³

In general the results, expressed in grams of total salts per 1,000 grams of water, are estimated to be accurate within ± 0.04 . But in the case of values marked with asterisks the error may be as great as ± 0.08 .

First in the column of specifications of the nets is given the diameter of the mouth, as $\frac{1}{2}$ m. (meter). Next is stated the number of the netting fabric. No. 18 specifies cloth having 166 meshes per inch; No. 6, 74 meshes per inch; No. 0, 38 meshes per inch. The $\frac{1}{2}$ and $\frac{1}{3}$ meter nets are made all of one fabric. The 1-meter nets are coarser at the forward, or oval, end than at the after cones. Thus the 1 meter, No. 6 net has a tip of No. 6 cloth and an entrance of No. 0. Similarly, the 1-meter, No. 0 net has a tip of No. 0 and an entrance of No. 000 (23 meshes per inch). The No. 0 and No. 000 cloths are of XX, double extra heavy grade, while the No. 6 and No. 18 cloths are of standard weight.

For the horizontal tows there is recorded approximately that depth, or range of depths, at which the net was towed for most of the haul. But since the net remained open while being hoisted on board, a small proportion of its contents were, inevitably, organisms occurring in levels overlying the stated depths.

In regard to the duration of the hauls, the times quoted are approximate and the speed of towing was variable. Still, the catches are roughly quantitatively comparable on a basis of the stated durations and an average speed of 2 knots or slightly less.

³ Titration done at Cambridge, Mass.

Table of data concerning scientific stations occupied

[See Chart "A".]

| Station No. | Date. | Time of day. | Position. | | Depth of water. | Weather. | |
|-------------|------------------|--------------------|-----------|----------|--------------------|---------------------------------------|----------------------------|
| | | | Lat. N. | Long. W. | | Wind, direction and force (Beaufort). | Sky. |
| 167 | 1922. Feb. 13 | 8.10-10.30 p. m. | 42 35 | 57 10 | Meters. (4,000) | NW.; 2..... | Partly cloudy..... |
| 168 | Feb. 14 | 9.15-11 a. m..... | 42 56 | 55 30 | (4,300) | ESE.; 5..... | Overcast..... |
| 169 | ...do.... | 1-2.25 p. m..... | 43 34 | 51 38 | 80 | NW.; 8..... | Partly cloudy..... |
| 170 | Feb. 15 | 4.20-5.25 p. m.... | 43 50 | 50 25 | 60 | NW.; 6..... | Overcast..... |
| 171 | Feb. 16 | 6.20-6.40 a. m.... | 44 35 | 51 07 | 65 | S.; 7..... | Overcast; snow and rain... |
| 172 | Feb. 19 | 4-4.30 p. m..... | 46 47 | 48 26 | 80 | WNW.; 6.. | Overcast..... |
| 173 | Feb. 20 | 8-9.25 a. m..... | 45 34 | 47 32 | (2,200) | W.; 5..... | Partly cloudy..... |
| 174 | ...do.... | 4.30-6.50 p. m.... | 44 52 | 46 50 | (3,700) | SW.; 5-6..... | ...do..... |
| 175 | Feb. 21 | 4-5.50 p. m..... | 44 33 | 47 53 | (3,300) | NW.; 6-7..... | ...do..... |
| 176 | Mar. 15 | 6.45-7.15 a. m.... | 42 35 | 57 10 | (4,000) | NNW.; 6-7..... | ...do..... |
| 177 | ...do.... | 4.30-6.15 p. m.... | 42 56 | 55 30 | (4,300) | N.; 5..... | ...do..... |
| 178 | Mar. 16 | 6.30-8.35 a. m.... | 43 15 | 53 45 | (2,750) | W.; 2..... | Overcast..... |
| 179 | ...do.... | 4.30-5 p. m..... | 43 38 | 51 48 | 130 | E.; 6..... | ...do..... |
| 180 | Mar. 17 | 10-11.30 a. m.... | 43 50 | 50 25 | 65 | NNW.; 5-6..... | ...do..... |

by the "Seneca," "Tampa," and "Modoc" during 1922.

| Water, physical data. | | | Biological collections. | | | Remarks. |
|-----------------------|--------------|---|---|----------------|-------------|---|
| At depth. | Temperature. | Salinity (% ₀₀ , by weight). | Nets (size, mesh, and direction of haul). | Depth of haul. | Duration. | |
| <i>Meters.</i> | ° C. | | | <i>Meters.</i> | <i>Min.</i> | |
| 0 | 1.9 | 33.05 | 1 m., No. 6, vertical.... | 500 | 15 | Copepods. |
| 50 | 3.0* | 33.23 | 1 m., No. 0, horizontal. | 200-150 | 30 | |
| 100 | 3.0 | 33.28 | ½ m., No. 18, horizontal. | 5-0 | 30 | |
| 200 | 4.3 | 34.69 | ..... | ..... | ..... |  |
| 300 | 4.4 | 34.83 | ..... | ..... | ..... |  |
| 500 | 6.3† | 34.90 | ..... | ..... | ..... |  |
| 0 | 1.4 | 33.23 | 1 m., No. 6, vertical.... | 465 | 15 | Do. |
| 50 | 1.5* | 33.22 | 1 m., No. 0, horizontal. | 250-200 | 30 | |
| 100 | 1.8* | 33.51 | ½ m., No. 18, horizontal. | 5-0 | 30 | |
| 200 | 3.5 | 34.47 | ..... | ..... | ..... |  |
| 300 | 3.4 | 34.69 | ..... | ..... | ..... |  |
| 500 | 3.8† | 34.86 | ..... | ..... | ..... |  |
| 0 | 1.9 | 32.61 | 1 m., No. 6, vertical.... | 65 | 2 | Rough, cold; work difficult. |
| 20 | 2.2* | 32.59 | ½ m., No. 18, horizontal. | 5-0 | 30 | Minute copepods, small medusæ, chaetognaths. |
| 40 | 2.1 | 32.44 | ..... | ..... | ..... |  |
| 65 | 2.2† | 32.53 | ..... | ..... | ..... |  |
| 0 | 1.7 | 32.57 | 1 m., No. 6, vertical.... | 60 | 2 | Minute copepods. |
| 10 | 2.1 | 32.57 | 1 m., No. 0, horizontal. | 40-32 | 30 | |
| 25 | 2.2† | 32.54 | ½ m., No. 18, horizontal. | 5-0 | 30 | |
| 40 | 2.1 | 32.54 | ..... | ..... | ..... |  |
| 55 | 2.1 | 32.57 | ..... | ..... | ..... |  |
| 0 | 0.7 | 32.52 | ..... | ..... | ..... | Weather too severe for use of nets. |
| 10 | 0.6 | 32.57 | ..... | ..... | ..... |  |
| 25 | 0.6 | 32.59 | ..... | ..... | ..... |  |
| 40 | 0.6 | 32.63* | ..... | ..... | ..... |  |
| 55 | 0.6* | 32.45* | ..... | ..... | ..... |  |
| 0 | -1.8 | 33.06 | ..... | ..... | ..... |  |
| 15 | -1.8* | 33.04 | ..... | ..... | ..... |  |
| 35 | -1.4† | 33.06 | ..... | ..... | ..... |  |
| 55 | -1.4* | 33.06 | ..... | ..... | ..... |  |
| 75 | -1.2 | 33.27 | ..... | ..... | ..... |  |
| 0 | -0.3 | 33.62 | 1 m., No. 6, vertical.... | 700 | 15 | Copepods, chaetognaths. |
| 50 | -0.6 | 33.96 | 1 m., No. 6, horizontal. | 330-250 | 30 | |
| 150 | 1.7† | 34.42 | ½ m., No. 18, horizontal. | 5-0 | 30 | |
| 250 | 3.2 | 34.50 | ..... | ..... | ..... |  |
| 450 | 3.8 | 34.85 | ..... | ..... | ..... |  |
| 750 | 4.9† | 34.85 | ..... | ..... | ..... |  |
| 0 | 10.0 | 34.87 | 1 m., No. 6, vertical.... | 515 | 15 | Copepods, chaetognaths—both mostly small. |
| 50 | 10.8 | 34.96 | 1 m., No. 6, horizontal. | 330-250 | 30 | |
| 150 | 9.4 | 34.96 | ½ m., No. 18, horizontal. | 5-0 | 30 | |
| 250 | 9.5* | 34.38 | ..... | ..... | ..... |  |
| 550 | 5.4* | 34.88 | ..... | ..... | ..... |  |
| 0 | 1.5 | 33.88 | 1 m., No. 6, horizontal. | 330-250 | 30 | Vertical tow attempted, but net destroyed by wind and rough sea. |
| 50 | ..... | 33.82 | ½ m., No. 18, horizontal. | 5-0 | 30 | |
| 150 | ..... | 33.84 | ..... | ..... | ..... |  |
| 250 | 2.4* | 34.31 | ..... | ..... | ..... |  |
| 450 | 3.3 | 34.35 | ..... | ..... | ..... |  |
| 750 | 4.1† | 34.31 | ..... | ..... | ..... |  |
| 0 | 11.5 | 35.67 | ..... | ..... | ..... | Weather too severe for use of nets. |
| 50 | 12.2† | ..... | ..... | ..... | ..... |  |
| 150 | 11.1† | 35.16 | ..... | ..... | ..... |  |
| 250 | 11.6 | 35.63 | ..... | ..... | ..... |  |
| 450 | 6.5 | 35.50 | ..... | ..... | ..... |  |
| 750 | ..... | 35.57 | ..... | ..... | ..... |  |
| 0 | 0.0 | 33.10 | 1 m., No. 6, horizontal. | 330-250 | 30 | Vertical tow made, but net tore—no catch. Copepods, chaetognaths. |
| 50 | 1.6† | 33.28 | ½ m., No. 18, horizontal. | 5-0 | 30 | |
| 150 | 2.3† | 34.27 | ..... | ..... | ..... |  |
| 250 | 3.1 | 34.52 | ..... | ..... | ..... |  |
| 450 | 3.7 | 35.03 | ..... | ..... | ..... |  |
| 750 | 3.7† | 34.97 | ..... | ..... | ..... |  |
| 0 | 10.3 | 35.35 | 1 m., No. 6, vertical.... | 500 | 15 | |
| 50 | 10.9† | 35.30 | 1 m., No. 6, horizontal. | 330-250 | 30 | |
| 100 | 11.0* | 35.21 | ½ m., No. 18, horizontal. | 5-0 | 30 | |
| 250 | 10.5 | 35.36 | ..... | ..... | ..... |  |
| 450 | 6.7 | 35.03 | ..... | ..... | ..... |  |
| 750 | 4.6† | 35.05 | ..... | ..... | ..... |  |
| 0 | 0.5 | 32.48 | ..... | ..... | ..... | Thick snow and high wind prevented use of nets. |
| 30 | 0.9† | 32.61 | ..... | ..... | ..... |  |
| 60 | 1.0 | 32.63 | ..... | ..... | ..... |  |
| 90 | 1.5 | 32.88 | ..... | ..... | ..... |  |
| 120 | 4.6† | ..... | ..... | ..... | ..... |  |
| 0 | 0.2 | 32.47* | 1 m., No. 6, vertical.... | 60 | 2 | Horizontal tow made, but net tore—no catch. Small medusæ (Aglantha), minute copepods. |
| 20 | 0.4 | 32.57* | ½ m., No. 18, horizontal. | 5-0 | 30 | |
| 40 | 0.5 | 32.56* | ..... | ..... | ..... |  |
| 60 | 0.4† | 32.51* | ..... | ..... | ..... |  |

Table of data concerning scientific stations occupied

[See Chart "A".]

| Station No. | Date. | Time of day. | Position. | | Depth of water. | Weather. | |
|-------------|------------------|---------------------------|-----------|----------|------------------|---------------------------------------|------------------------------|
| | | | Lat. N. | Long. W. | | Wind, direction and force (Beaufort). | Sky. |
| 181 | 1922. Mar. 18 | 5.30-6 a. m. | 42 55 | 49 43 | Meters. (900) | E.; 4-5..... | Overcast..... |
| 182 | Mar. 21 | 4-5.50 p. m. | 42 33 | 49 45 | (2,750) | Calm..... | Clear, except for some fog.. |
| 183 | Mar. 28 | 5-5.40 a. m. | 41 49 | 49 43 | (4,500) | Calm..... | Partly cloudy..... |
| 184 | Apr. 11 | 4.55-8 p. m. | 41 25 | 50 18 | (4,200) | E.; 2..... | Overcast..... |
| 185 | Apr. 11 -12. | 11.55 p. m.-1.10 a. m. | 41 55 | 50 19 | (4,000) | SE.; 2..... | do..... |
| 186 | Apr. 12 | 1.15-2.40 a. m. | 41 55 | 50 19 | (4,000) | NE.; 4..... | do..... |
| 187 | ...do.... | 6.30-9.20 a. m. | 42 25 | 50 20 | (2,550) | N.; 4..... | do..... |
| 188 | ...do.... | 3.30-4.45 p. m. | 43 50 | 50 25 | 73 | N. to NW.; 1-3. | Partly overcast..... |
| 189 | Apr. 12 -13. | 10.20 p. m.-1.50 a. m. | 42 53 | 50 22 | > 750 | S.; 1..... | Partly cloudy and hazy.. |
| 190 | Apr. 25 | 11.30 a. m.-1.30 p. m. | 42 05 | 52 15 | (4,000) | SSE.; 4.... | Cloudy..... |
| 191 | ...do.... | 5.45-7.15 p. m. | 42 30 | 51 46 | (2,750) | ESE.; 4.... | Partly cloudy..... |

by the "Seneca," "Tampa," and "Modoc" during 1922—Continued.

| Water, physical data. | | | Biological collections. | | | Remarks. |
|-----------------------|--------------|--------------------------|---|----------------|-----------|---|
| At depth. | Temperature. | Salinity (‰, by weight). | Nets (size, mesh, and direction of haul). | Depth of haul. | Duration. | |
| Meters. | ° C. | | | Meters. | Min. | |
| 0 | -1.2 | 33.42 | | | | |
| 50 | -1.2† | 33.52 | | | | |
| 150 | -1.0 | 33.79 | | | | |
| 250 | -0.4* | 33.86 | | | | |
| 450 | 1.2 | 34.31 | | | | |
| 0 | 0.1 | 33.73 | 1 m., No. 6, vertical | 750 | 18 | Copepods, chaetognaths. |
| 50 | 0.7† | 33.74 | 1 m., No. 6, horizontal | 350-250 | 30 | |
| 150 | 1.6 | 34.29 | ½ m., No. 18, horizontal | 5-0 | 30 | |
| 250 | 2.8 | 34.63 | | | | |
| 450 | 4.0* | 34.92 | | | | |
| 750 | 3.6 | 34.94 | | | | |
| 0 | 1.0 | 33.70 | | | | |
| 50 | 0.4† | | | | | Nets not used because of hurry to search for berg. |
| 150 | 0.4 | 34.04 | | | | |
| 250 | 1.4 | 34.35 | | | | |
| 450 | 5.0* | 34.86 | | | | |
| 750 | 4.7† | 34.89 | | | | |
| 0 | 10.0 | 35.30 | 1 m., No. 6, horizontal | 175 | 30 | Vertical tow made, but net fouled—no catch; no time to repeat. |
| 50 | 10.5† | 35.12 | ½ m., No. 18, horizontal | 3-0 | 30 | Large medusa seen, not collected. |
| 150 | 7.1 | 34.97* | | | | Salps, copepods, chaetognaths. |
| 250 | 11.1 | 34.58 | | | | 125 m. and 250 m. temperatures seem anomalous, especially since (in situ) at 125 m. would be greater than at 250 m. Yet explaining it by assuming mistaken exchange of G.-B. bottles in recording observations seems unwarranted. |
| 450 | 5.9 | 34.90 | | | | Stations 185 and 186 within a mile or two of each other at abrupt junction of warm and cold waters. |
| 750 | 5.1† | 34.99 | | | | At 185 thermometers failed to trip because of drift. When difficulty was overcome, vessel had drifted into cold surface water; hence observations considered as of another station. Rich, varied plankton, copepods. |
| 0 | 12.7 | 35.52 | | | | |
| 50 | | 35.08 | | | | |
| 250 | | 34.44 | | | | |
| 0 | 1.0 | | 1 m., No. 6, vertical | 485 | 20 | |
| 150 | 5.6† | 34.42 | ½ m., No. 18, horizontal | 3-0 | 25 | |
| 250 | 7.7 | 35.03 | | | | |
| 450 | 1.9 | | | | | |
| 750 | 3.9† | 34.85 | | | | |
| 0 | 0.0 | 33.51 | 1 m., No. 6, vertical | 485 | 15 | Copepods. |
| 50 | 0.9* | | 1 m., No. 6, horizontal | 160 | 30 | |
| 150 | 0.5* | 34.04 | ½ m., No. 18, horizontal | 3-0 | 30 | |
| 250 | -0.4 | | | | | |
| 450 | 2.5 | 34.52 | | | | |
| 750 | 0.7† | | | | | |
| 0 | 0.6 | 32.47 | 1 m., No. 6, vertical | 65 | 3 | Horizontal tow made, but net tore—no catch. Rich, green phytoplankton. |
| 20 | 0.1* | 32.58 | ½ m., No. 18, horizontal | 3-0 | 35 | |
| 40 | -0.2 | 32.66 | | | | |
| 60 | -0.2* | 32.72 | | | | |
| 0 | -0.6 | 33.47 | 1 m., No. 6, vertical | 600 | 20 | Varied plankton. |
| 50 | -1.0† | 33.53 | 1 m., No. 6, horizontal | 200-175 | 35 | |
| 150 | -1.1† | 33.66 | ½ m., No. 18, horizontal | 3-0 | 30 | |
| 250 | -0.7 | 33.94 | | | | |
| 450 | -0.3 | 34.04 | | | | |
| 750 | 3.9 | 34.85 | | | | |
| 0 | 12.3 | 34.99 | 1 m., No. 6, vertical | 580 | 15 | 1 m. net used for horizontal tow |
| 50 | 11.4 | 35.15 | 1 m., No. 6, horizontal | 200-175 | 30 | tore—small catch. Varied plankton, including salps. |
| 125 | 10.8 | 35.27 | ½ m., No. 18, horizontal | 3-0 | 30 | |
| 250 | 9.5 | 35.17 | | | | |
| 450 | 6.0 | 34.88 | | | | |
| 750 | 4.5† | 34.97 | | | | |
| 0 | 9.7 | 34.16 | 1 m., No. 6, vertical | 580 | 15 | 1 m. net tore during vertical tow |
| 50 | 12.6 | 35.40 | ½ m., No. 18, horizontal | 3-0 | 25 | and became unfit for further use. |
| 125 | 11.4 | 35.31 | | | | Surface water of about 5° encountered midway between stations |
| 250 | | 35.32 | | | | 190 and 191. Varied plankton, |
| 450 | 6.7 | 35.01 | | | | Minute copepods, salps. |
| 750 | 4.6† | 34.96 | | | | |

Table of data concerning scientific stations occupied

[See Chart "A".]

| Station No. | Date. | Time of day. | Position. | | Depth of water. | Weather. | |
|-------------|------------------|---------------------------|-----------|-----------|--------------------|---------------------------------------|-----------------------|
| | | | Lat. N. | Long. W. | | Wind, direction and force (Beaufort). | Sky. |
| 192 | 1922, Apr. 26 | 5-6.05 a. m. | ° ' 42 51 | ° ' 51 25 | Meters. (1,800) | SE.; 3. | Foggy |
| 193 | ...do.... | 11.10 a. m.-12 m.. | 43 09 | 51 05 | 250 | ESE.; 3.... | Overcast, foggy |
| 194 | Apr. 27 | 9.30-11.15 a. m... | 43 47 | 50 08 | 55 | SE.; 4. | Foggy |
| 195 | May. 3 | 9.35 a. m.-12.25 p. m. | 44 17 | 44 37 | (4,500) | SW.; 3. | Cloudy..... |
| 196 | ...do.... | 4.30-7.55 p. m.... | 44 12 | 45 20 | (4,500) | SW.; 4. | ...do..... |
| 197 | May 4 | 6.35-8.40 a. m.... | 44 07 | 46 30 | (3,700) | SW.; 7. | ...do..... |
| 198 | ...do.... | 4.20-6.15 p. m.... | 44 03 | 47 30 | (3,900) | NW.; 7-8.. | Overcast..... |
| 199 | May 4-5. | 11.15 p. m.-1.10 a. m. | 43 59 | 48 20 | (3,300) | NW.; 5. | ...do..... |
| 200 | May 5 | 5.05-8 a. m. | 43 54 | 48 42 | (2,575) | NW.; 4. | Cloudy..... |
| 201 | ...do.... | 5-6.05 p. m. | 43 50 | 50 25 | 62 | WNW.; 4.. | Mostly clear..... |
| 202 | May 6 | 8.15-9.50 p. m.... | 42 53 | 50 22 | (700-1,500) | WNW.; 2.. | Clear..... |

by the "Seneca," "Tampa" and "Modoc" during 1922—Continued.

| Water, physical data. | | | Biological collections. | | | Remarks. |
|-----------------------|--------------|--------------------------|---|----------------|-----------|--|
| At depth. | Temperature. | Salinity (‰, by weight). | Nets (size, mesh, and direction of haul). | Depth of haul. | Duration. | |
| Meters. | ° C. | | | Meters. | Min. | |
| 0 | 2.1 | 32.77 | ½ m., No. 18, horizontal. | 3-0 | 30 | Temperature for 250 m. depth obtained from a thermometer whose action was faulty at next station. |
| 50 | -0.6 | 33.50 | ..... | ..... | ..... |  |
| 125 | 4.4* | 34.27 | ..... | ..... | ..... |  |
| 250 | 2.6† | 34.33 | ..... | ..... | ..... |  |
| 450 | 4.9 | 34.92 | ..... | ..... | ..... |  |
| 750 | 6.6† | 34.87 | ..... | ..... | ..... |  |
| 0 | 1.1 | 33.24 | ½ m., No. 18, horizontal. | 3-0 | 30 | |
| 15 | 0.2 | 33.44 | ..... | ..... | ..... |  |
| 55 | -0.6* | 33.51 | ..... | ..... | ..... |  |
| 105 | -1.0† | 33.66 | ..... | ..... | ..... |  |
| 165 | -1.1 | 33.71 | | | | Rich, green, phytoplankton. |
| 245 | -0.6 | 33.95 | ..... | ..... | ..... |  |
| 0 | 2.8 | 31.85 | ½ m., No. 18, horizontal. | 3-0 | 30 | |
| 10 | 0.9 | 32.71 | 1 m., No. 6, vertical. | 50 | 2 | |
| 20 | 0.7 | 32.90 | 1 m., No. 6, horizontal. | 35 | 35 | |
| 30 | 0.8† | 32.70 | ..... | ..... | ..... |  |
| 40 | -0.2 | 33.15 | ..... | ..... | ..... |  |
| 52 | ..... | 33.23 | ..... | ..... | ..... |  |
| 0 | 12.7 | 35.52 | 1 m., No. 6, vertical. | 575 | 15 | |
| 50 | 11.8† | 35.42 | 1 m., No. 6, horizontal. | 180 | 30 | |
| 125 | 9.5 | 35.16 | ½ m., No. 18, horizontal. | 3-0 | 30 | Gulf Stream east of Grand Banks. Plankton varied but scanty. Copepods. |
| 250 | 5.3† | 34.70 | ..... | ..... | ..... |  |
| 450 | 4.8 | 34.77 | ..... | ..... | ..... |  |
| 750 | 4.5† | 35.01 | ..... | ..... | ..... |  |
| 0 | 12.8 | 35.36 | 1 m., No. 6, vertical. | 550 | 15 | |
| 50 | 11.4 | 35.30 | ½ m., No. 18, horizontal. | 3-0 | 40 | |
| 125 | 7.8 | 34.93 | ..... | ..... | ..... |  |
| 250 | 11.4 | 34.78 | ..... | ..... | ..... |  |
| 450 | 5.4† | 34.90 | ..... | ..... | ..... |  |
| 750 | 4.3 | ..... | ..... | ..... | ..... |  |
| 0 | 5.2 | 33.96 | 1 m., No. 6, horizontal. | 165 | 40 | Green phytoplankton, copepods. |
| 50 | 5.9† | 34.42 | ½ m., No. 18, horizontal. | 80 | 35 | |
| 125 | 3.9* | 34.31 | ½ m., No. 18, horizontal. | 3-0 | 35 | |
| 250 | 4.4 | 34.61 | ..... | ..... | ..... |  |
| 450 | 4.6† | 34.87 | ..... | ..... | ..... |  |
| 750 | 3.9† | 34.85 | ..... | ..... | ..... |  |
| 0 | 8.3 | 34.86 | ½ m., No. 18, horizontal. | 3-0 | 25 | |
| 50 | 9.4† | 34.98 | ..... | ..... | ..... |  |
| 125 | 6.6 | 34.63 | ..... | ..... | ..... |  |
| 250 | 4.8 | 34.64 | ..... | ..... | ..... |  |
| 450 | 4.7† | 34.81 | | | | Copepods, many, small. |
| 750 | 4.4 | 34.88 | ..... | ..... | ..... |  |
| 0 | 2.3 | 33.58 | ½ m., No. 6, horizontal. | 180 | 35 | |
| 50 | 2.2* | 33.95 | ½ m., No. 18, horizontal. | 3-0 | 35 | |
| 125 | 1.3 | 34.20 | ..... | ..... | ..... |  |
| 250 | 3.9† | ..... | ..... | ..... | ..... |  |
| 450 | 4.0 | 34.92 | ..... | ..... | ..... |  |
| 750 | 3.6 | 34.92 | ..... | ..... | ..... |  |
| 0 | 2.1 | 33.63 | ½ m., No. 18, horizontal. | 3-0 | 30 | |
| 50 | 1.7* | 33.98 | ½ m., No. 6, horizontal. | 165-0 | 30 | |
| (50) | (2.2*) | | | | | Plankton scanty. Phytoplankton, copepods (mostly small). Difficulties encountered in temperature observations (2 thermometers at same depth disagreeing) led to second cast—results quoted in parentheses. Vessel drifted meanwhile. Difference between first and second values suggested abrupt temperature change, vertically, here. |
| 125 | ..... | 34.52 | ..... | ..... | ..... |  |
| 250 | 3.5* | 34.72 | ..... | ..... | ..... |  |
| (250) | (3.7*) | ..... | ..... | ..... | ..... |  |
| 450 | ..... | 34.78 | ..... | ..... | ..... |  |
| (450) | (3.4) | ..... | ..... | ..... | ..... |  |
| 750 | 3.6† | 34.87 | ..... | ..... | ..... |  |
| (750) | (3.4) | ..... | ..... | ..... | ..... |  |
| 0 | 2.0 | 32.34 | ½ m., No. 6, horizontal. | 45 | 30 | |
| 10 | 1.6† | 32.36 | ½ m., No. 18, horizontal. | 3-0 | 30 |  | Crustacean larvae. |
| 20 | 1.6 | 32.42 | ..... | ..... | ..... |  |
| 30 | 1.5* | 32.39 | ..... | ..... | ..... |  |
| 45 | -0.3 | 32.54 | ..... | ..... | ..... |  |
| 60 | -0.6† | 32.73 | ..... | ..... | ..... |  |
| 0 | 1.5 | 33.35 | ½ m., No. 6, horizontal. | 190 | 40 | |
| 50 | -0.1 | 33.46 | ½ m., No. 18, horizontal. | 3-0 | 30 | |
| 125 | -0.6 | 33.95 | ..... | ..... | ..... |  |
| 250 | 0.5† | 34.16 | ..... | ..... | ..... |  |
| 450 | 1.5 | 34.46 | ..... | ..... | ..... |  |
| 750 | 3.0 | 34.79 | ..... | ..... | ..... |  |

Table of data concerning scientific stations occupied

[See Chart "A".]

| Station No. | Date. | Time of day. | Position. | | Depth of water. | Weather. | |
|-------------|----------------|-------------------------|-----------|----------|--------------------|---------------------------------------|--------------------|
| | | | Lat. N. | Long. W. | | Wind, direction and force (Beaufort). | Sky. |
| 203 | 1922. May 7 | 12.55-2.50 a. m. | 42° 25' | 50° 20' | Meters. (2,550) | W.; 2..... | Clear..... |
| 204 | ...do.... | 6-7.45 a. m. | 41 55 | 50 19 | (4,000) | WSW.; 2.. | Hazy..... |
| 205 | ...do.... | 10.45 a. m.-12.40 p. m. | 41 25 | 50 18 | (4,200) | SSE.; 1.... | Partly cloudy..... |
| 206 | ...do.... | 4.10-6.25 p. m. | 40 55 | 50 17 | (4,200) | SSW.; 4.... | Overcast..... |
| 207 | May 14 | 2.30-4.15 p. m. | 43 55 | 51 50 | ca. 700 | W.; 5..... |do..... |
| 208 | ...do.... | 7.55-9.55 p. m. | 43 24 | 52 40 | (2,500) | WNW.; 7.. |do..... |
| 209 | May 15 | 4.25-6.05 a. m. | 42 50 | 53 25 | (3,300) | WNW.; 6.. |do..... |
| 210 | May 15-16 | 10.35 p. m.-12.35 a. m. | 42 53 | 55 25 | (4,200) | SE.; 1-2.... |do..... |
| 211 | May 16 | 6.35-8.20 a. m. | 42 35 | 57 10 | (4,500) | NNW.; 2.. |do..... |
| 212 | ...do.... | 3.35-5.55 p. m. | 43 00 | 58 35 | (3,700) | NNE.; 3.... |do..... |
| 213(a) | ...do.... | 9.35-11.15 p. m. | 43 30 | 60 05 | (>475) | NNE.; 3.... | Cloudy..... |
| 213(b) | May 28.. | 2-3.35 p. m. | 43 30 | 60 05 | (>475) | WNW.; 1.... |do..... |
| 214 | May 27.. | 7.40-9.40 p. m. | 44 15 | 62 38 | (>175) | NE.; 1..... |do..... |

by the "Seneca," "Tampa," and "Modoc" during 1922—Continued.

| Water, physical data. | | | Biological collections. | | | Remarks. |
|-----------------------|--------------|-------------------------|---|----------------|-------------|---|
| At depth. | Temperature. | Salinity (‰ by weight). | Nets (size, mesh, and direction of haul). | Depth of haul. | Duration. | |
| <i>Meters.</i> | <i>° C.</i> | | | <i>Meters.</i> | <i>Min.</i> | |
| 0 | 4.8 | 33.15 | ½ m., No. 6, horizontal. | 160 | 35 | Phytoplankton. |
| 50 | -0.9* | 33.57 | ½ m., No. 18, horizontal. | 95 | 35 | |
| 125 | 2.3† | 34.14 | ½ m., No. 18, horizontal. | 3-0 | 35 | |
| 250 | 2.4* | 34.31 | ..... | ..... | ..... |  |
| 450 | 4.8 | 35.01 | ..... | ..... | ..... |  |
| 750 | 3.8 | 34.94 | ..... | ..... | ..... |  |
| 0 | 4.4 | 33.07 | ½ m., No. 6, horizontal. | 170 | 35 | Do. |
| 50 | -0.1 | ..... | ½ m., No. 18, horizontal. | 85 | 35 | |
| 75 | 0.4 | 33.87 | ½ m., No. 18, horizontal. | 3-0 | 35 | |
| 200 | 2.6* | 34.57 | ..... | ..... | ..... |  |
| 400 | 4.4 | 34.98 | ..... | ..... | ..... |  |
| 700 | 4.3 | 35.07 | ..... | ..... | ..... |  |
| 0 | 5.7 | 33.02 | ½ m., No. 6, horizontal. | 170 | 30 | Observations at 25 m. made separately. Plankton varied but scanty. Few salps. |
| 25 | 11.2 | 35.08 | ½ m., No. 18, horizontal. | 85 | 28 | |
| 50 | 12.0* | 35.31 | ½ m., No. 18, horizontal. | 3-0 | 35 | |
| 125 | 10.1 | 35.16 | ..... | ..... | ..... |  |
| 250 | 6.7† | 35.28 | ..... | ..... | ..... |  |
| 450 | 5.4 | 34.90 | ..... | ..... | ..... |  |
| 750 | 4.6 | 35.01 | ..... | ..... | ..... |  |
| 0 | 18.1 | 36.21 | ½ m., No. 6, horizontal. | 170 | 30 | Observations at 700 m. made separately. Scanty, varied plankton. |
| 50 | 18.0 | 36.33 | ½ m., No. 18, horizontal. | 85 | 30 | |
| 125 | 16.3† | 36.26 | ½ m., No. 18, horizontal. | 3-0 | 30 | |
| 250 | 12.9† | 35.56 | ..... | ..... | ..... |  |
| 450 | 9.2* | ..... | ..... | ..... | ..... |  |
| 700 | 6.9 | 34.96 | ..... | ..... | ..... |  |
| 0 | 5.0 | 32.83 | ½ m., No. 6, horizontal. | 175 | 30 | Bottle sent to 750 m. struck bottom and fouled. Green phytoplankton, copepods (mostly small). |
| 50 | 0.3* | 33.39 | ½ m., No. 18, horizontal. | 3-0 | 30 | |
| 125 | 4.3 | 34.25 | ..... | ..... | ..... |  |
| 250 | 4.0 | 34.23 | ..... | ..... | ..... |  |
| 450 | 1.8* | 34.39 | ..... | ..... | ..... |  |
| 0 | 4.1 | 32.46 | ..... | ..... | ..... | Surface tow attempted, but net tore—no catch. (Rough.) |
| 50 | 3.3* | 33.75 | ..... | ..... | ..... |  |
| 125 | 7.3 | 34.16 | ..... | ..... | ..... |  |
| 250 | 5.9 | 34.70 | ..... | ..... | ..... |  |
| 450 | 5.8† | 34.79 | ..... | ..... | ..... |  |
| 750 | 4.4 | 34.92 | ..... | ..... | ..... |  |
| 0 | 7.2 | 34.11 | ½ m., No. 6, horizontal. | 150 | 35 | Stations 210-215, inclusive, occupied by Tampa, while scientific observer on duty on Modoc. Copepods. |
| 50 | 9.6* | 34.66 | ½ m., No. 18, horizontal. | 3-0 | 35 | |
| 125 | 11.5 | 35.21 | ..... | ..... | ..... |  |
| 250 | 10.1 | 35.16 | ..... | ..... | ..... |  |
| 450 | 5.6† | 34.66 | ..... | ..... | ..... |  |
| 750 | 4.7 | 34.87 | ..... | ..... | ..... |  |
| 0 | 5.7 | 33.04 | 1 m., No. 0, vertical. | 600 | 15 | Copepods, medusæ (Aglantha). |
| 50 | 5.1* | 33.40 | 1 m., No. 0, horizontal. | 170 | 30 | |
| 125 | 7.3† | 34.45 | ½ m., No. 18, horizontal. | 3-0 | 30 | |
| 250 | 5.2* | 34.57 | ..... | ..... | ..... |  |
| 450 | 4.8† | 34.88 | ..... | ..... | ..... |  |
| 750 | 4.1 | 34.85 | ..... | ..... | ..... |  |
| 0 | 4.5 | 32.56 | 1 m., No. 0, vertical. | 600 | 15 | Salps and chaetognaths abundant. |
| 50 | 0.0 | 32.89 | 1 m., No. 0, horizontal. | 170 | 30 | |
| 125 | 6.3† | 34.22 | ½ m., No. 18, horizontal. | 3-0 | 30 | |
| 250 | 9.1 | 35.12 | ..... | ..... | ..... |  |
| 450 | 4.0† | 34.62 | ..... | ..... | ..... |  |
| 750 | 4.2 | 35.01 | ..... | ..... | ..... |  |
| 0 | 11.6† | 35.44 | 1 m., No. 0, vertical. | 550 | 15 | Hoist broke down during attempted vertical tow. |
| 50 | 12.4* | 35.37 | 1 m., No. 0, horizontal. | 170 | 30 | |
| 125 | 11.6† | 35.31 | ½ m., No. 18, horizontal. | 3-0 | 30 | |
| 250 | 10.1* | 34.88 | ..... | ..... | ..... |  |
| 450 | 5.3† | 35.41 | ..... | ..... | ..... |  |
| 750 | 4.4 | 35.06 | ..... | ..... | ..... |  |
| 0 | 9.4† | ..... | ½ m., No. 18, horizontal. | 3-0 | 30 | Copepods. |
| 50 | 11.1† | ..... | ..... | ..... | ..... |  |
| 100 | 11.6† | ..... | ..... | ..... | ..... |  |
| 200 | 5.3* | ..... | ..... | ..... | ..... |  |
| 325 | 3.5† | ..... | ..... | ..... | ..... |  |
| 475 | 4.1 | ..... | ..... | ..... | ..... |  |
| 0 | 4.0† | 33.07 | 1 m., No. 0, vertical. | 475 | 15 | Copepods, medusæ (Aglantha). |
| 50 | 4.1 | 33.01 | 1 m., No. 0, horizontal. | 170 | 30 | |
| 100 | 9.6 | 34.79 | ½ m., No. 18, horizontal. | 3-0 | 30 | |
| 200 | 5.2† | 34.61 | ..... | ..... | ..... |  |
| 325 | 5.0† | 34.81 | ..... | ..... | ..... |  |
| 475 | ..... | 34.87 | ..... | ..... | ..... |  |
| 0 | 6.2 | 31.76 | 1 m., No. 0, vertical. | 175 | 5 | Copepods, medusæ (Aglantha). |
| 25 | ..... | 31.83 | 1 m., No. 0, horizontal. | 85 | 30 | |
| 50 | ..... | 32.36* | ½ m., No. 18, horizontal. | 3-0 | 30 | |
| 75 | ..... | 32.33* | ..... | ..... | ..... |  |
| 125 | 6.5† | 32.30* | ..... | ..... | ..... |  |
| 175 | 5.0† | 32.43* | ..... | ..... | ..... |  |

Table of data concerning scientific stations occupied*

[See Chart "A".]

| Station No. | Date. | Time of day. | Position. | | Depth of water. | Weather. | |
|-------------|-------------------|--|-----------|-----------|----------------------|---------------------------------------|-------------------------|
| | | | Lat. N. | Long. W. | | Wind, direction and force (Beaufort). | Sky. |
| 215 | 1922, May 23.. | 4.30-6 a. m. | ° ' 43 50 | ° ' 61 15 | Meters. (ca. 125) | NNW.; 1.. | Cloudy..... |
| 216 | May 20.. | 11.15 a. m.-8.10 p. m. Work interrupted by search for southerly ice. | 41 44 | 49 09 | (3,700) | SSW.-SSE.; 1-2. | Blue, hazy..... |
| 217 | May 23.. | 7-9.15 a. m. | 43 40 | 50 29 | 59 | W.; 4..... | Clear..... |
| 218 | ...do.... | 5.25-9.25 p. m. ... | 43 55 | 49 02 | >750 | W.; 3..... | Blue, hazy horizon..... |
| 219 | May 24.. | 12.45-3.45 a. m. ... | 43 59 | 48 20 | (3,300) | W.; 3..... | Cloudy..... |
| 220 | ...do.... | 7.30-10.45 a. m. ... | 44 03 | 47 23 | (3,900) | WNW.; 4.. | ...do..... |
| 221 | ...do.... | 1.50-4.05 p. m. ... | 44 07 | 46 30 | (3,700) | W.; 5..... | ...do..... |
| 222 | ...do.... | 8.55-11.20 p. m. ... | 44 12 | 45 12 | (4,400) | WNW.; 3.. | Partly cloudy..... |
| 223 | May 23.. | 7.50-9 p. m. | 43 23 | 50 57 | 80 | NW.; 2.... | Cloudy..... |
| 224 | May 29.. | 7.35-10.25 a. m. ... | 43 01 | 51 20 | (900) | SW.; 1.... | Clear..... |
| 225 | ...do.... | 12.40-2.25 p. m. ... | 42 42 | 51 28 | (2,500) | SW.; 2.... | ...do..... |
| 226 | ...do.... | 4.25-6.25 p. m. ... | 42 30 | 51 46 | (2,750) | SSW.; 1.... | Cloudy..... |

by the "Seneca," "Tampa," and "Modoc" during 1922—Continued.

| Water, physical data. | | | Biological collections. | | | Remarks. | |
|-----------------------|--------------|--------------------------|---|----------------|-----------|--|---|
| At depth. | Temperature. | Salinity (‰, by weight). | Nets (size, mesh, and direction of haul). | Depth of haul. | Duration. | | |
| Meters. | ° C. | | | Meters. | Min. | | |
| 0 | 4.4† | 32.30 | 1 m., No. 0, vertical.... | 125 | 4 | Difficulties experienced with reversing thermometers; surface temperature taken by quartermaster is quoted here. Pleurobrachia. | |
| 25 | ..... | 32.27 | ½ m., No. 18, horizontal. | 3-0 | 30 | | |
| 50 | ..... | 32.32* | ..... | ..... | ..... |  |  |
| 75 | ..... | 32.29* | ..... | ..... | ..... |  |  |
| 100 | ..... | ..... | ..... | ..... | ..... |  |  |
| 125 | | 32.41* | | | | First towing encircled an iceberg. First flock of terns (Arctic) observed here. No kittiwakes since 10 days earlier. Many small fish at surface killed by waste. Salps and beve seen from deck. Varied plankton. About 12 whales seen. Shearwaters among fishing schooners to westward. Aglantha, appendicularians, Pleurobrachia. | |
| 0 | 6.5 | 33.56 | ½ m., No. 6, horizontal. | 3-0 | 40 | | |
| 50 | 7.4 | 33.81 | 1 m., No. 6, vertical.... | 600 | 15 | | |
| 125 | 8.1 | 34.69 | 1 m., No. 0, horizontal. | 200-175 | 30 | | |
| 250 | 7.2 | 34.98 | ½ m., No. 18, horizontal. | 3-0 | 30 | | |
| 450 | 6.3† | 34.95 | ..... | ..... | ..... |  |  |
| 750 | 3.8 | 34.94 | ..... | ..... | ..... |  |  |
| 0 | 3.5† | 32.51 | 1 m., No. 6, vertical.... | 57 | 2 | | |
| 10 | 3.6 | 32.51 | 1 m., No. 0, horizontal. | 28 | 30 | | |
| 20 | 2.9 | 32.72 | ½ m., No. 18, horizontal. | 3-0 | 30 | | |
| 30 | -0.2 | 32.84 | ..... | ..... | ..... |  |  |
| 40 | -0.3 | 32.95 | ..... | ..... | ..... |  |  |
| 55 | -0.1 | 33.07 | ..... | ..... | ..... |  |  |
| 0 | 1.0† | 33.13 | 1 m., No. 6, vertical.... | 600 | 20 | All hauls rich, except surface. Olive green phytoplankton. | |
| 50 | -0.4 | 33.50 | ½ m., No. 18, horizontal. | 3-0 | 25 | | |
| 125 | 0.8 | 34.27 | 1 m., No. 0, horizontal. | 180 | 25 | | |
| 250 | 1.8 | 34.52 | ½ m., No. 6, horizontal. | 90 | 25 | | |
| 450 | 2.4 | 34.71 | ..... | ..... | ..... |  |  |
| 750 | 3.0 | 34.87 | ..... | ..... | ..... |  |  |
| 0 | 4.7 | 33.52 | 1 m., No. 6, vertical.... | 600 | 20 | Copepods. | |
| 50 | 1.5 | 33.88 | ½ m., No. 18, horizontal. | 3-0 | 25 | | |
| 125 | 2.1 | 34.42 | 1 m., No. 0, horizontal. | 180 | 25 | | |
| 250 | 3.7 | 34.79 | ½ m., No. 6, horizontal. | 90 | 25 | | |
| 450 | 3.9† | 34.90 | ..... | ..... | ..... |  |  |
| 750 | 3.5* | 34.92 | ..... | ..... | ..... |  |  |
| 0 | 9.5* | 34.88 | 1 m., No. 6, vertical.... | 600 | 20 | | Temperatures quoted for 50, 125, 250 m. depths obtained from a second cast. ½ m. net had slid down line to 1 m., No. 6 net, hence contents were joined in preserving. Copepods. |
| 50 | 10.1 | 34.97 | ½ m., No. 18, horizontal. | 3-0 | 30 | | |
| 125 | 9.8 | 35.13 | 1 m., No. 0, horizontal. | 170 | 30 | | |
| 250 | 7.7 | 35.00 | ½ m., No. 6, horizontal. | 85 | 30 | | |
| 450 | 5.5 | 34.72 | ..... | ..... | ..... |  |  |
| 750 | 4.4† | 34.94 | ..... | ..... | ..... |  |  |
| 0 | 8.6* | 34.52 | 1 m., No. 6, vertical.... | 550 | 20 | | |
| 50 | 9.6 | 34.94 | ½ m., No. 18, horizontal. | 3-0 | 35 | | |
| 125 | 7.8 | 34.80 | 1 m., No. 0, horizontal. | 180 | 30 | | |
| 250 | 4.9 | 34.54 | ½ m., No. 6, horizontal. | 90 | 30 | | |
| 450 | 4.5 | 34.86 | ..... | ..... | ..... |  |  |
| 750 | 3.8† | 34.94 | ..... | ..... | ..... |  |  |
| 0 | 12.7 | 35.54 | 1 m., No. 6, vertical.... | 600 | 20 | Gulf stream east of Grand Banks. Copepods, schizopods. | |
| 50 | 12.8 | 35.54 | ½ m., No. 18, horizontal. | 3-0 | 30 | | |
| 125 | 9.6 | 35.07 | 1 m., No. 0, horizontal. | 190 | 25 | | |
| 250 | 7.4 | 35.03 | ½ m., No. 6, horizontal. | 80 | 25 | | |
| 450 | 4.8 | 34.94 | ..... | ..... | ..... |  |  |
| 750 | 4.3† | 34.97 | ..... | ..... | ..... |  |  |
| 0 | 3.9 | | 1 m., No. 6, vertical.... | 75 | 2 | | No horizontal tows, since vessel at anchor. Minute copepods, Aglantha. |
| 15 | 3.7 | 32.40 | ..... | ..... | ..... |  |  |
| 30 | 3.5 | 32.50 | ..... | ..... | ..... |  |  |
| 45 | -0.2 | 32.98 | ..... | ..... | ..... |  |  |
| 60 | -0.1 | 33.24 | ..... | ..... | ..... |  |  |
| 75 | -0.5† | 33.36 | ..... | ..... | ..... |  |  |
| 0 | 6.0 | 32.87 | 1 m., No. 6, vertical.... | 600 | 15 | Copepods. | |
| 50 | 6.3 | 34.13 | ½ m., No. 18, horizontal. | 3-0 | 30 | | |
| 125 | 7.9 | 34.87 | 1 m., No. 0, horizontal. | 150 | 30 | | |
| 250 | 4.0 | 34.47 | ½ m., No. 6, horizontal. | 75 | 30 | | |
| 450 | 3.7 | 34.74 | ..... | ..... | ..... |  |  |
| 750 | 3.4† | 34.88 | ..... | ..... | ..... |  |  |
| 0 | 5.9 | 32.88 | 1 m., No. 6, vertical.... | 600 | 15 | | Do. |
| 50 | 1.6 | 33.62 | ½ m., No. 18, horizontal. | 3-0 | 30 | | |
| 125 | 2.5 | 34.11 | 1 m., No. 0, horizontal. | 170 | 30 | | |
| 250 | 0.3 | 34.04 | ½ m., No. 6, horizontal. | 85 | 30 | | |
| 450 | 2.0 | 34.45 | ..... | ..... | ..... |  |  |
| 750 | 3.6† | 34.87 | ..... | ..... | ..... |  |  |
| 0 | 6.3 | 33.28 | 1 m., No. 6, vertical.... | 600 | 18 | Do. | |
| 50 | 0.4 | 33.45 | ½ m., No. 18, horizontal. | 3-0 | 35 | | |
| 125 | 1.1 | 33.91 | 1 m., No. 0, horizontal. | 170 | 35 | | |
| 250 | 2.6 | 34.46 | ½ m., No. 6, horizontal. | 85 | 35 | | |
| 450 | 3.4 | 34.78 | ..... | ..... | ..... |  |  |
| 750 | 3.8† | 34.88 | ..... | ..... | ..... |  |  |

Table of data concerning scientific stations occupied

[See Chart "A".]

| Station No. | Date. | Time of day. | Position. | | Depth of water. | Weather. | |
|-------------|-----------------|-------------------------|-----------|-----------|--------------------|---------------------------------------|--------------------------------|
| | | | Lat. N. | Long. W. | | Wind, direction and force (Beaufort). | Sky. |
| 227 | 1922. May 29 | 9.40-11.55 p. m... | ° ' 42 05 | ° ' 52 15 | Meters. (4,000) | SSW.; 2... | Cloudy..... |
| 228 | May 30 | 7.30-9.35 a. m.... | 41 22 | 52 58 | (5,500) | SSE.; 3..... | do..... |
| 229 | June 2 | 1.40-3.45 p. m.... | 42 25 | 50 20 | (2,550) | E.; 1..... | Sun visible through heavy fog. |
| 230 | ...do.... | 8.15-11.35 p. m.... | 42 53 | 50 22 | Ca. 550 | E.; 1..... | Low clouds and fog..... |
| 231 | June 3 | 7.10-8.40 a. m.... | 44 00 | 50 35 | 67 | Calm..... | Foggy..... |
| 232 | June 6 | 4.50-7.10 p. m.... | 41 55 | 50 19 | (4,000) | NW.; 2..... | do..... |
| 233 | June 6-7 | 10.40 p. m.-12.55 a. m. | 41 25 | 50 18 | (4,200) | WNW.; 1... | Hazy..... |
| 234 | June 15 | 3.45-6.30 p. m.... | 42 38 | 57 10 | (4,000) | ESE.-SSW.; 2. | Cloudy..... |
| 235 | June 15-16. | 11.30 p. m.-1.45 a. m. | 43 00 | 58 35 | (3,500) | N.; 4-3..... | Overcast; foggy..... |
| 236 | June 16 | 7.50-9.15 a. m.... | 43 30 | 60 05 | (>375) | NNE.; 4-2. | do..... |
| 237 | ...do.... | 2-3.20 p. m..... | 43 50 | 61 15 | 50 | N.-NNW.; 1. | Foggy to clearing..... |
| 238 | June 16-17. | 11 p. m.-12.20 a. m. | 44 15 | 62 38 | 200 | SSW.; 2... | Foggy to clear..... |

by the "Seneca," Tampa," and "Modoc" during 1922—Continued.

| Water, physical data. | | | Biological collections. | | | Remarks. |
|-----------------------|--------------|---|---|----------------|-------------|--|
| At depth. | Temperature. | Salinity (% ₀₀ , by weight). | Nets (size, mesh, and direction of haul). | Depth of haul. | Duration. | |
| <i>Meters.</i> | <i>° C.</i> | | | <i>Meters.</i> | <i>Min.</i> | |
| 0 | 12.7 | 34.79 | 1 m., No. 6, vertical.... | 500 | 15 | Varied, fairly rich plankton. Salps. |
| 50 | 14.3 | 35.62 | ½ m., No. 18, horizontal. | 3-0 | 25 | |
| 125 | 12.3 | 35.43 | 1 m., No. 0, horizontal. | 150 | 35 | |
| 250 | 10.9 | 35.28 | ½ m., No. 6, horizontal. | 75 | 35 | |
| 450 | 6.7 | 34.96 | ..... | ..... | ..... |  |
| 750 | 4.7† | 34.99 | ..... | ..... | ..... |  |
| 0 | 18.3 | 36.05 | 1 m., No. 0, vertical.... | 500 | 15 | Large salps. Plankton varied but scanty, lacking green. Phytoplankton. |
| 50 | 17.5† | 36.16 | ½ m., No. 18, horizontal. | 3-0 | 30 | |
| 125 | 14.9† | 35.82 | 1 m., No. 0, horizontal. | 160 | 25 | |
| 250 | ..... | 35.31 | ..... | ..... | ..... |  |
| 450 | 8.0† | 35.03 | ..... | ..... | ..... |  |
| 750 | 4.8† | 34.94 | ..... | ..... | ..... |  |
| 0 | 5.5 | 33.30 | 1 m., No. 6, vertical.... | 600 | 18 | Copepods, all sizes. |
| 50 | 1.7 | 33.65 | ½ m., No. 18, horizontal. | 3-0 | 30 | |
| 125 | 1.2 | ..... | 1 m., No. 0, horizontal. | 190-160 | 30 | |
| 250 | 3.6 | 34.69 | ½ m., No. 6, horizontal. | 95-75 | 28 | |
| 450 | 2.8 | 34.80 | ..... | ..... | ..... |  |
| 750 | 4.4† | 34.96 | ..... | ..... | ..... |  |
| 0 | 4.8 | 33.26 | ½ m., No. 18, horizontal. | 3-0 | 30 | Vertical tow attempted twice—first, net filled with blue black mud; second, apparently struck bottom again. |
| 50 | -0.7 | 33.51 | 1 m., No. 0, horizontal. | 195-170 | 30 | |
| 125 | -1.3 | 33.83 | ½ m., No. 6, horizontal. | 30-18 | 28 | |
| 250 | 0.1* | 34.11 | ..... | ..... | ..... |  |
| 400 | 0.8† | 34.37 | ..... | ..... | ..... |  |
| 550 | 2.7† | 33.61 | ..... | ..... | ..... |  |
| 0 | 5.0 | 32.91 | 1 m., No. 6, vertical.... | 60 | 2 | Aglantha, minute copepods. |
| 10 | 4.2* | 32.83 | ½ m., No. 18, horizontal. | 3-0 | 30 | |
| 20 | 4.2 | 32.74 | 1 m., No. 0, horizontal. | 30 | 35 | |
| 35 | 2.8 | 32.65 | ..... | ..... | ..... |  |
| 50 | -0.6 | 32.45 | ..... | ..... | ..... |  |
| 65 | -0.4† | 32.45 | ..... | ..... | ..... |  |
| 0 | 13.8† | 34.55 | 1 m., No. 6, vertical.... | 600 | 18 | Plankton varied, including salps. |
| 50 | 12.1* | 35.21 | ½ m., No. 18, horizontal. | 3-0 | 40 | |
| 125 | 11.4 | 35.27 | 1 m., No. 0, horizontal. | 180-150 | 35 | |
| 250 | 8.5 | 35.03 | ½ m., No. 6, horizontal. | 90-75 | 32 | |
| 450 | 5.1 | 35.28 | ..... | ..... | ..... |  |
| 750 | 5.3 | 34.93 | ..... | ..... | ..... |  |
| 0 | 19.6 | 36.16 | 1 m., No. 6, vertical.... | 600 | 18 | Salps, chaetognaths. Plankton varied but lacking green. |
| 50 | 15.3* | 35.57 | ½ m., No. 18, horizontal. | 3-0 | 40 | |
| 125 | 14.2 | 35.74 | 1 m., No. 0, horizontal. | 180-140 | 40 | |
| 250 | 11.5 | 35.42 | ½ m., No. 6, horizontal. | 90-70 | 35 | |
| 450 | 7.8 | 35.34 | ..... | ..... | ..... |  |
| 750 | 5.9 | 35.01 | ..... | ..... | ..... |  |
| 0 | 12.6* | 33.42 | 1 m., No. 6, vertical.... | 550 | 18 | Strong current. Stations 234-238, incl., occupied by Tampa, while scientific observer on duty on Modoc. Chaetognaths, copepods, salps. |
| 50 | 12.1* | 34.94 | 1 m., No. 0, horizontal. | 230 | 30 | |
| 125 | 12.4 | ..... | ½ m., No. 18, horizontal. | 3-0 | 30 | |
| 250 | 9.8* | 35.21 | ..... | ..... | ..... |  |
| 450 | 5.5 | 35.10 | ..... | ..... | ..... |  |
| 750 | 4.1† | 34.99* | ..... | ..... | ..... |  |
| 0 | 10.0 | 32.62 | 1 m., No. 6, vertical.... | 580 | 18 | Copepods, schizopods. |
| 50 | 11.9† | 33.08 | 1 m., No. 0, horizontal. | 215 | 30 | |
| 125 | 7.7* | 34.60 | ½ m., No. 18, horizontal. | 3-0 | 30 | |
| 250 | 4.5* | ..... | ..... | ..... | ..... |  |
| 450 | 3.9 | 34.74* | ..... | ..... | ..... |  |
| 750 | 4.1* | 34.94 | ..... | ..... | ..... |  |
| 0 | 10.0 | 32.75 | 1 m., No. 6, vertical.... | 350 | 10 | Do. |
| 25 | 9.7* | 32.86 | 1 m., No. 0, horizontal. | 180-135 | 30 | |
| 75 | 9.7* | ..... | ½ m., No. 18, horizontal. | 3-0 | 30 | |
| 175 | 5.8 | 34.83 | ..... | ..... | ..... |  |
| 275 | 5.7† | 34.64 | ..... | ..... | ..... |  |
| 375 | 4.7 | 34.65 | ..... | ..... | ..... |  |
| 0 | 9.6† | ..... | 1 m., No. 6, vertical.... | 45 | 1 | Minute copepods. |
| 5 | 8.0† | ..... | 1 m., No. 0, horizontal. | 30-25 | 30 | |
| 15 | 6.3* | ..... | ½ m., No. 6, horizontal. | 18-12 | 30 | |
| 25 | 4.6* | ..... | ½ m., No. 18, horizontal. | 3-0 | 30 | |
| 35 | 4.5* | ..... | ..... | ..... | ..... |  |
| 45 | 4.5 | ..... | ..... | ..... | ..... |  |
| 0 | 9.0† | ..... | 1 m., No. 6, vertical.... | 175 | 5 | Copepods, Aglantha. |
| 50 | 5.1† | ..... | 1 m., No. 0, horizontal. | 100-70 | 30 | |
| 75 | 4.8 | ..... | ½ m., No. 6, horizontal. | 50-35 | 30 | |
| 100 | 1.2* | ..... | ½ m., No. 18, horizontal. | 3-0 | 30 | |
| 125 | ..... | ..... | ..... | ..... | ..... |  |
| 175 | 4.8 | ..... | ..... | ..... | ..... |  |

Table of data concerning scientific stations occupied

[See Chart "A".]

| Station No. | Date. | Time of day. | Position. | | Depth of water. | Weather. | |
|-------------|------------------|---------------------|-----------|----------|-----------------|---------------------------------------|-----------------------------|
| | | | Lat. N. | Long. W. | | Wind, direction and force (Beaufort). | Sky. |
| 239 | 1922. June 16 | 4.50-6.20 p. m... | 43 50 | 50 25 | 58 | <i>Meters.</i> SSE.; 4.... | Very foggy..... |
| 240 | June 17 | 1-3.50 p. m..... | 43 10 | 51 07 | Ca. 300 | S.; 3..... | Overcast; hazy..... |
| 241 | June 18 | 8.55-11.05 a. m... | 42 25 | 51 52 | (2,750) | SSW.; 2... | Foggy..... |
| 242 | ...do.... | 2.05-5.50 p. m... | 42 05 | 52 15 | (4,000) | SSW.; 1... | Partly cloudy..... |
| 243 | June 18-19. | 9 p. m.-12.10 a. m. | 41 44 | 52 36 | (4,350) | SSW.; 2... | Clear..... |
| 244 | July 10 | 6-8.05 a. m..... | 43 13 | 50 19 | 72 | SSW.; 2.... | Cloudy..... |
| 245 | ...do.... | 1.20-3.45 p. m... | 42 50 | 49 33 | (1,800) | S.; 2..... | Foggy..... |
| 246 | ...do.... | 7.20-9 p. m..... | 43 10 | 49 52 | 65 | Calm..... | Overcast, foggy; raining... |

by the "Seneca," "Tampa," and "Modoc" during 1922—Continued.

| Water, physical data. | | | Biological collections. | | | Remarks. |
|-----------------------|--------------|--------------------------|---|----------------|-------------|--|
| At depth. | Temperature. | Salinity (‰, by weight). | Nets (size, mesh, and direction of haul). | Depth of haul. | Duration. | |
| <i>Meters</i> | <i>° C.</i> | | | <i>Meters.</i> | <i>Min.</i> | |
| 0 | 6.7† | | 1 m., No. 6, vertical.... | 52 | 2 | Fog made it impossible to determine position within usual margin of error. Correction probably should be to NNW. Aglantha, Tomopteris, minute copepods, no chaetognaths. |
| 10 | 6.7 | 32.30 | 1 m., No. 0, horizontal. | 30-25 | 30 | |
| 20 | 5.7 | 32.47 | ½ m., No. 18, horizontal. | 3-0 | 35 | |
| 35 | -0.2 | 32.94 | ..... | ..... | ..... |  |
| 52 | -0.1 | 32.96 | ..... | ..... | ..... |  |
| 0 | 9.5 | 32.67 | 1 m., No. 6, vertical.... | 260 | 8 | Copepods, schizopods. |
| 50 | 3.2 | 33.42 | ½ m., No. 0, horizontal. | 3-0 | 30 | |
| 100 | 4.2 | 34.13 | 1 m., No. 0, horizontal. | 180-140 | 25 | Copepods. |
| 200 | 5.6 | 34.29 | ½ m., No. 6, horizontal. | 90-70 | 25 | |
| 275 | 3.6 | 34.39 | ..... | ..... | ..... |  |
| 0 | 10.1 | 32.78 | 1 m., No. 6, vertical.... | 600 | 18 | |
| 50 | 9.1† | 34.63 | ½ m., No. 18, horizontal. | 3-0 | 35 | |
| 125 | 3.1 | 34.17 | 1 m., No. 0, horizontal. | 200-150 | 35 | Copepods (all sizes), chaetognaths. |
| 250 | 2.1 | 34.09 | ½ m., No. 6, horizontal. | 100-75 | 30 | |
| 450 | 0.8 | 34.25* | ..... | ..... | ..... |  |
| 750 | 2.9† | 34.65 | ..... | ..... | ..... |  |
| 0 | 19.4* | 35.73* | 1 m., No. 6, vertical.... | 600 | 18 | |
| 50 | 15.3 | 35.91 | ½ m., No. 18, horizontal. | 3-0 | 35 | Hyperiid amphipods (Euthemisto). |
| 125 | 13.0 | 35.55 | 1 m., No. 0, horizontal. | 200-170 | 35 | |
| 250 | 10.9 | 35.30 | ½ m., No. 6, horizontal. | 100-85 | 30 | |
| 450 | 7.3† | 35.17 | ..... | ..... | ..... |  |
| 750 | ..... | 34.96 | ..... | ..... | ..... |  |
| 0 | 17.6 | 34.49 | 1 m., No. 6, vertical.... | 600 | 18 | Minute copepods, Euthemisto. |
| 50 | 14.6 | 35.70 | ½ m., No. 18, horizontal. | 3-0 | 45 | |
| 125 | 12.8 | 35.47 | 1 m., No. 0, horizontal. | 200-170 | 30 | |
| 250 | 11.1 | ..... | ½ m., No. 6, horizontal. | 100-85 | 27 | |
| 450 | 7.0† | 35.08 | ..... | ..... | ..... |  |
| 750 | 7.5 | 34.99 | ..... | ..... | ..... |  |
| 0 | 16.3* | 32.20 | 1 m., No. 6, vertical.... | 60 | 12 | Olive green phytoplankton obscuring rather varied zooplankton. |
| 15 | ..... | 33.30 | ½ m., No. 18, horizontal. | 3-0 | 35 | |
| 30 | 0.6* | 33.41 | 1 m., No. 0, horizontal. | 40-30 | 35 | |
| 45 | -0.2† | 33.53 | ½ m., No. 6, horizontal. | 15-10 | 35 | |
| 62 | -0.1 | 33.46 | ..... | ..... | ..... |  |
| 0 | 9.6† | | 1 m., No. 6, vertical.... | 600 | 18 | Light-green phytoplankton, minute copepods. Many large medusae and sprigs of brown algae seen from deck. |
| 25 | 6.0 | 32.95 | 1 m., No. 0, horizontal. | 200-180 | 25 | |
| 50 | 2.1* | 33.31 | ½ m., No. 6, horizontal. | 60-50 | 25 | |
| 125 | 1.9* | 34.63 | ..... | ..... | ..... |  |
| 250 | 2.3 | 34.66 | ..... | ..... | ..... |  |
| 450 | ..... | 34.89 | ..... | ..... | ..... |  |
| 700 | 3.2 | 34.83 | ..... | ..... | ..... |  |
| 0 | 15.8* | 32.20 | 1 m., No. 0, horizontal. | 40-25 | 30 | Light-green phytoplankton, minute copepods. Many large medusae and sprigs of brown algae seen from deck. |
| 10 | 10.0* | 32.77 | ½ m., No. 6, horizontal. | 15-10 | 30 | |
| 20 | 2.3* | 33.26 | 1 m., No. 18, horizontal. | 3-0 | 30 | |
| 35 | -0.6† | 33.62* | 1 m., No. 6, vertical.... | 60 | 2 | |
| 50 | -0.4* | 33.45* | ..... | ..... | ..... |  |

DISCUSSION OF PROFILES 1-14.

By Lieut. (Junior Grade) EDWARD H. SMITH, Oceanographic Observer.

PROFILE NO. 1. STATIONS 167-170 AND 178.

This section runs from Station "C" (see chart "A") westward to 57° longitude. It was occupied February 13-15, except station 178, which was taken March 16. Unfortunately, it was found impossible to occupy station 178, February 13-15, owing to a gale which had sprung up. A surface dip, however, registered 8.0° C., which agrees closely with the surface temperature found at the same place March 16. Furthermore, the surface temperature charts for both periods, February and March, indicate the presence of warm water at this place. Therefore, noting the presence of a body of warm water and its effect upon the profile in general, we are justified in including station 178, although it should be borne in mind the observation was made nearly a month subsequent.

Salinity.—The characteristic feature of the profile is the column of >35 ‰ salinity water which intruded northward at station 178, separating slope water on either side. Over the Grand Banks fresher water, of 32.57 ‰ salinity, was found; inshore on the banks still fresher water was noted at station 171. Since the Labrador Current is saltier than 32.57 ‰ in the vicinity of the Tail of the Grand Banks, this indicated a dilution by coastal water from the north and west.

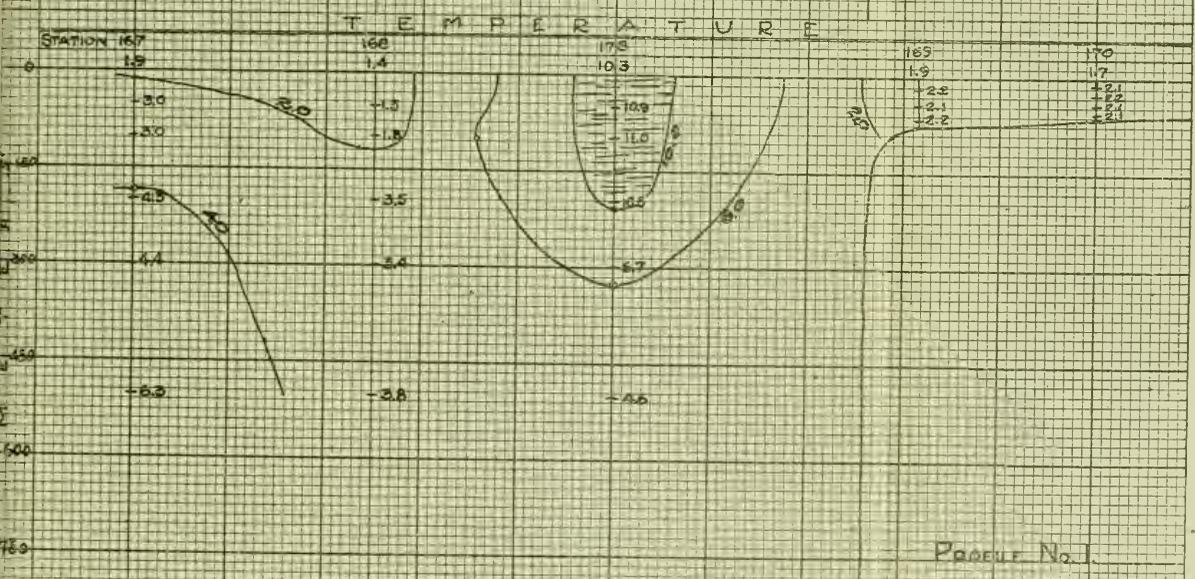
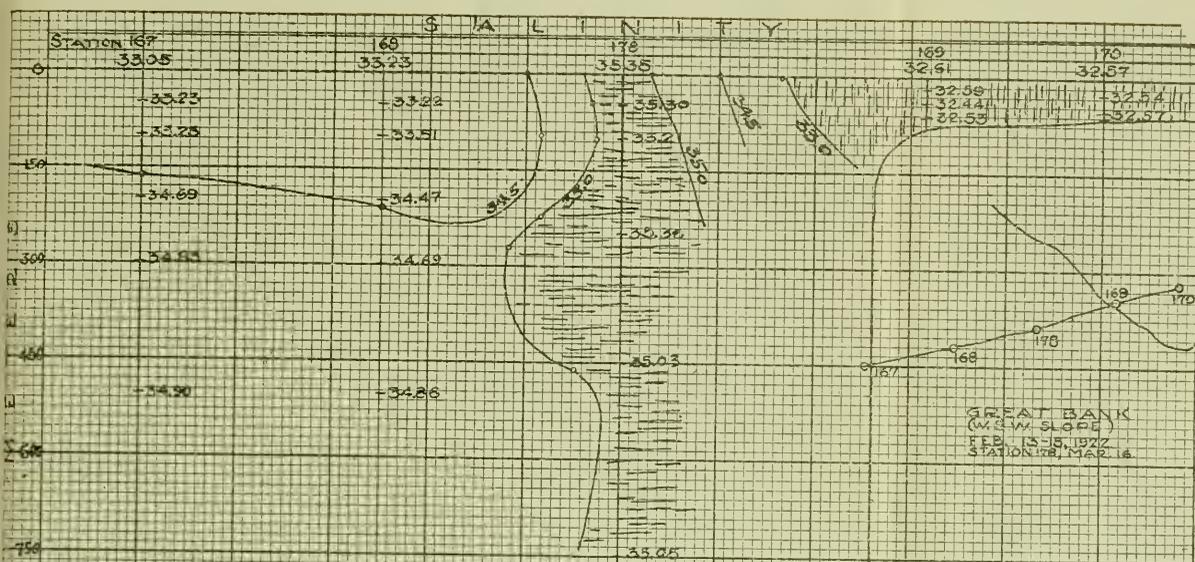
Temperature.—We find that the isotherms are also characterized by the body of warm water at station 178. Cold water, with temperature between 1.9° C. and 1.4° C., extended uniformly over the entire surface, except at station 178. Temperature is a better guide than salinity, at this time of year, in determining the identity of the different kinds of water. It will be noticed that the minimums at each of the stations are in every case at the surface and, with the exception of station 168, are not below 1.7° C. This has not the low temperature characteristic of polar water; in fact it is no colder than may be expected as the general winter temperature for the latitude south of Newfoundland.

Summing up, we can state that on February 15 there was a body of warm salt water extending northward on the surface to 43° 10' N., 53° 00' W. The profiles of both salinity and temperature forbid the presence of any Labrador Current in this vicinity during the period.

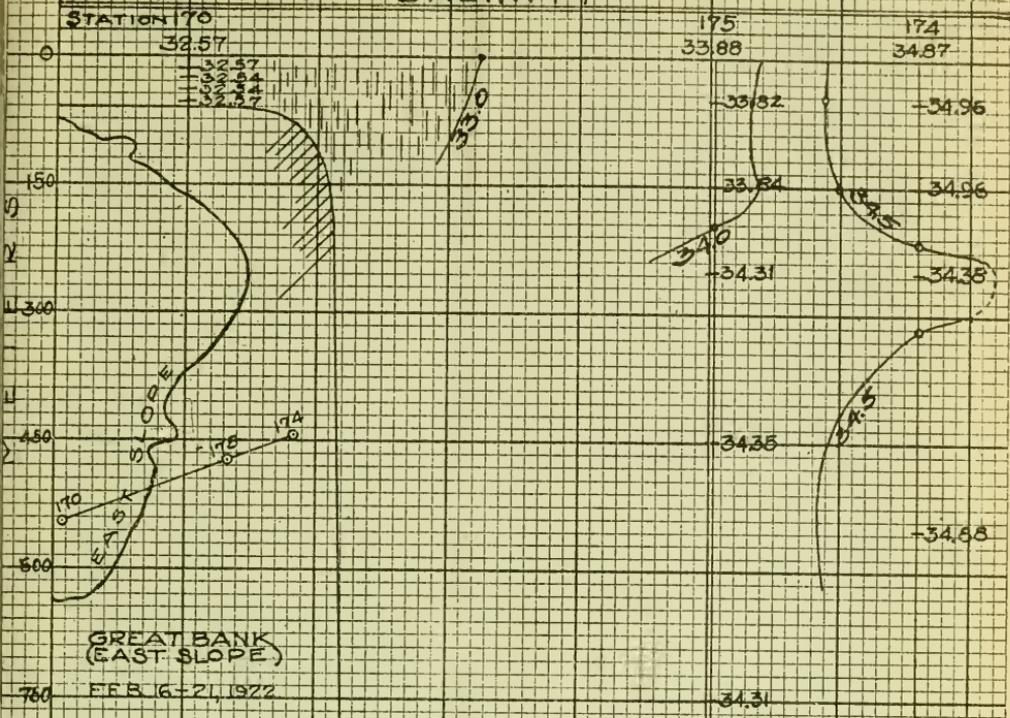
PROFILE NO. 2. STATIONS 170, 174, 175.

This section runs from Station "C" (see chart "A") to the north-eastward diagonally across the east slope of the Grand Banks into deep water. It was occupied February 16-21. The stations are not as numerous as might be wished, but the value of the profile lies in showing certain general conditions.

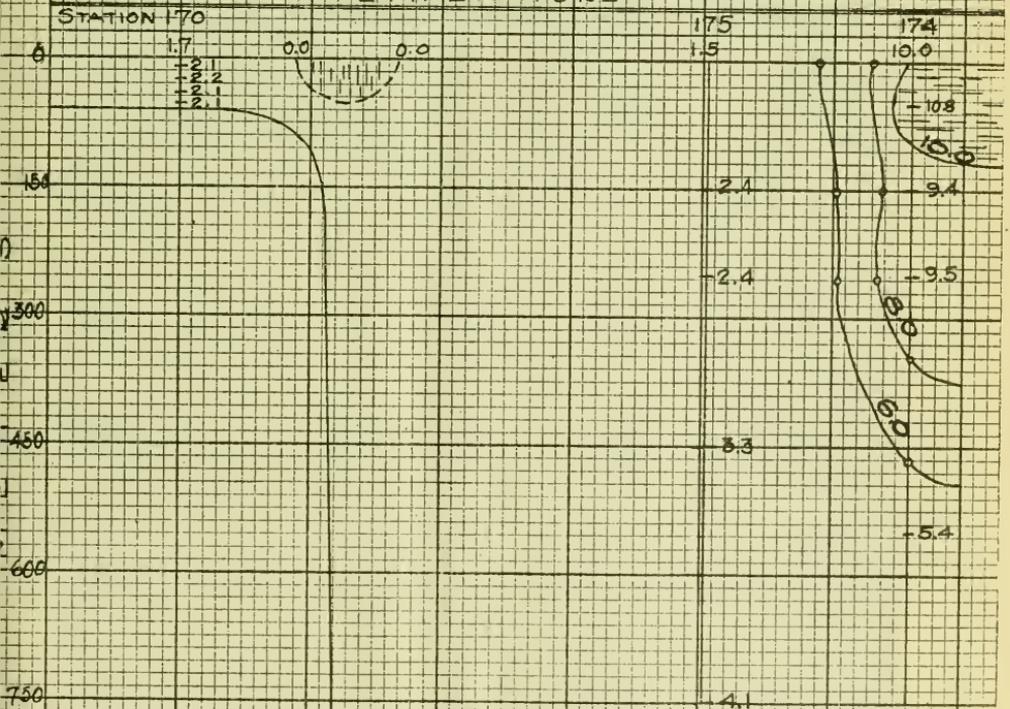
Salinity.—Proceeding eastward from the bank, we come to a sudden change from relatively fresh to salty water. Atlantic water of 34.87 ‰ was found in a surface layer 600 meters thick at station 174. Slope water was found at station 175 and bank water at station 170.



SALINITY

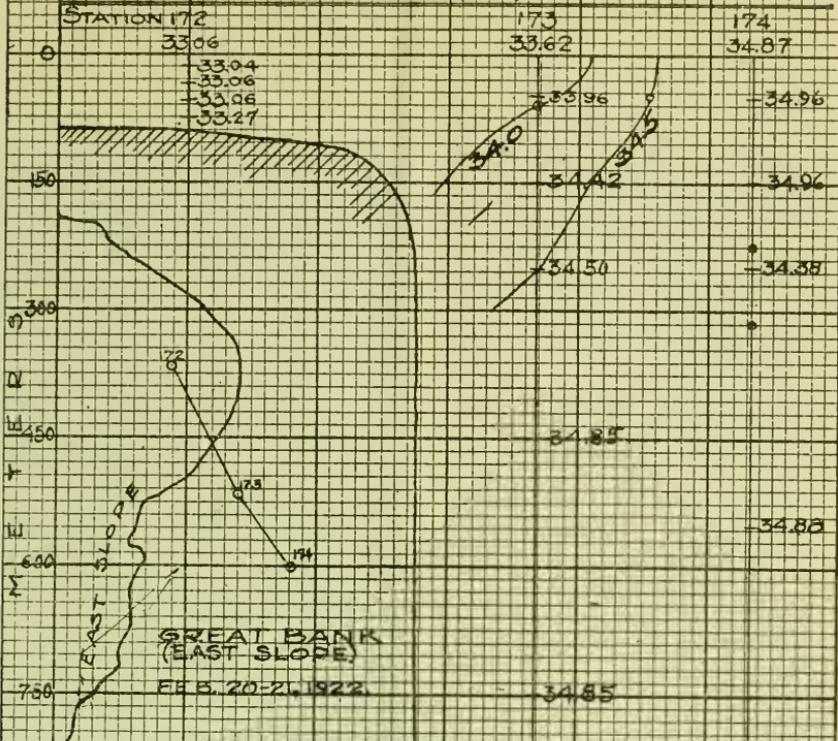


TEMPERATURE

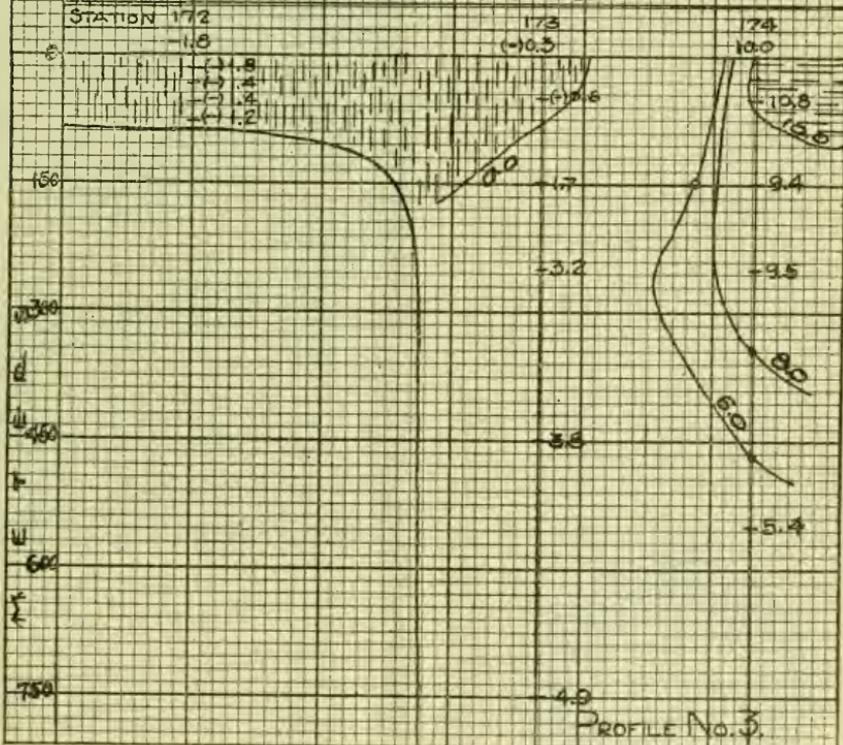


PROFILE No. 2

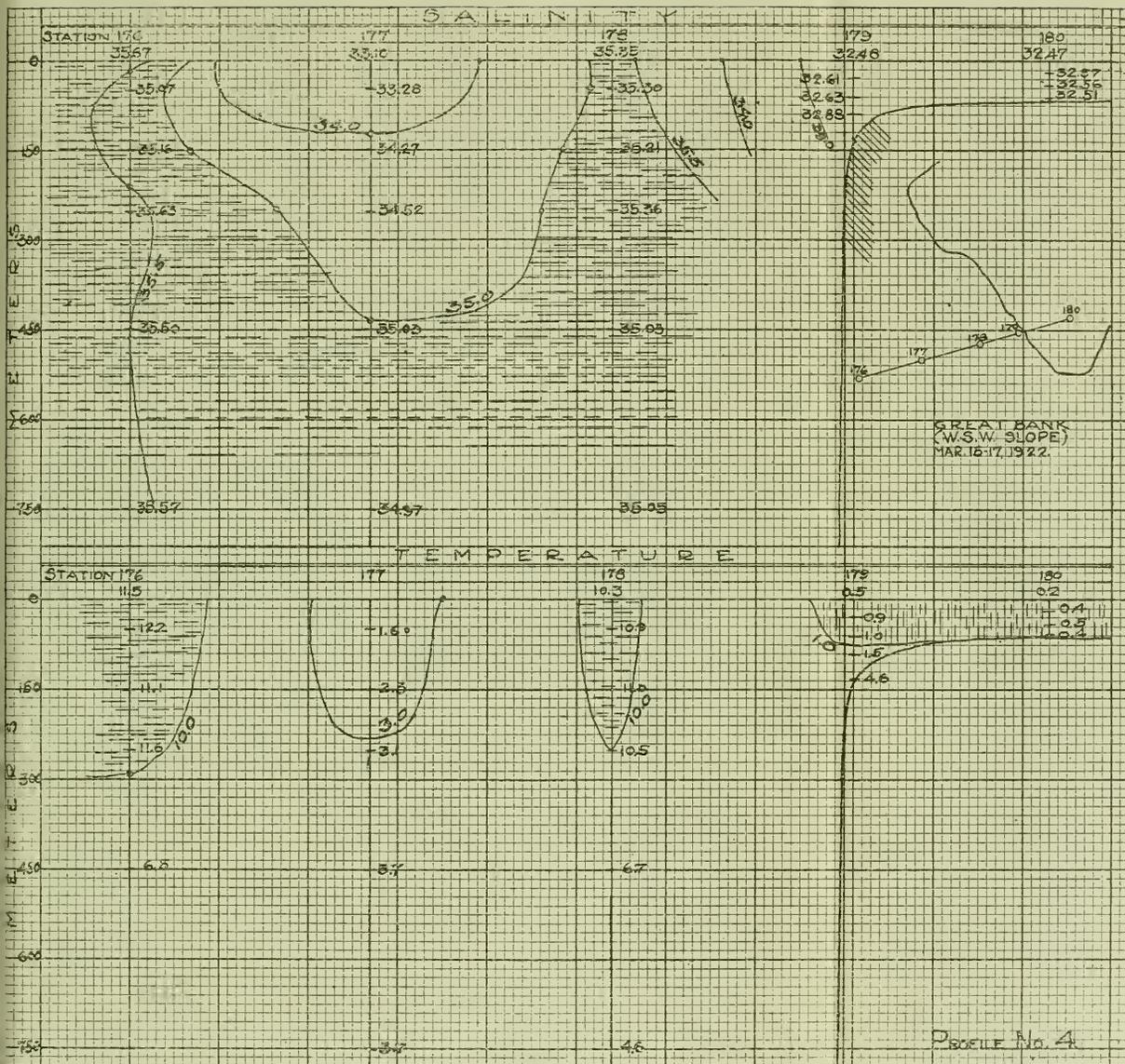
SALINITY



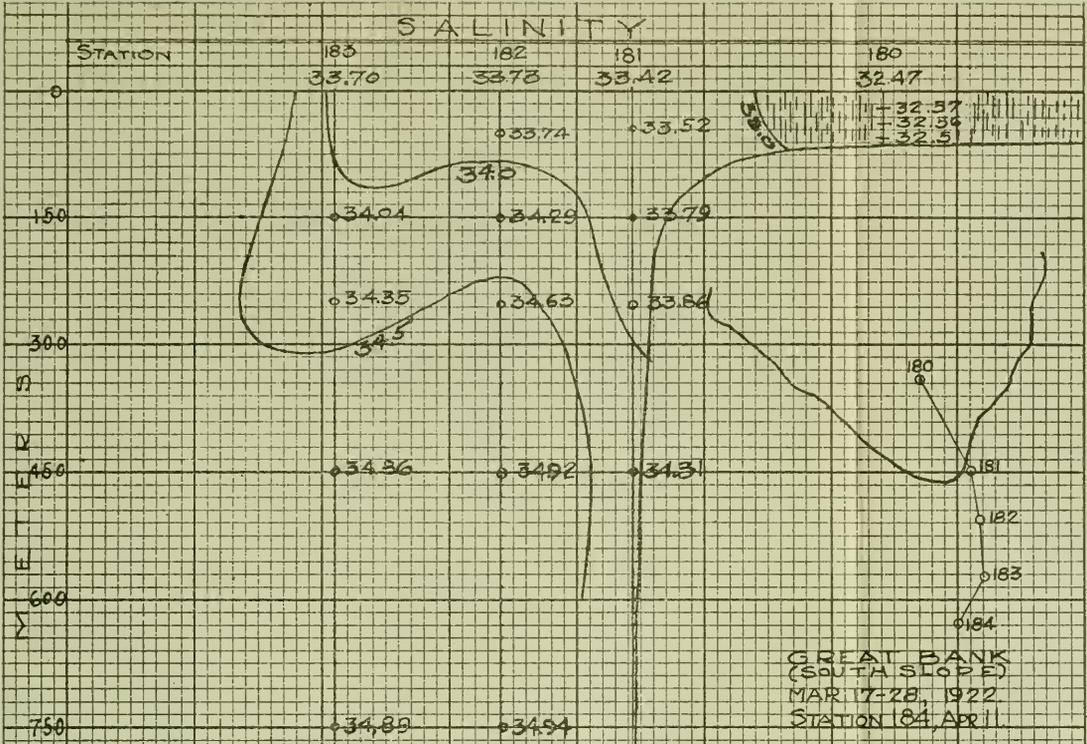
TEMPERATURE



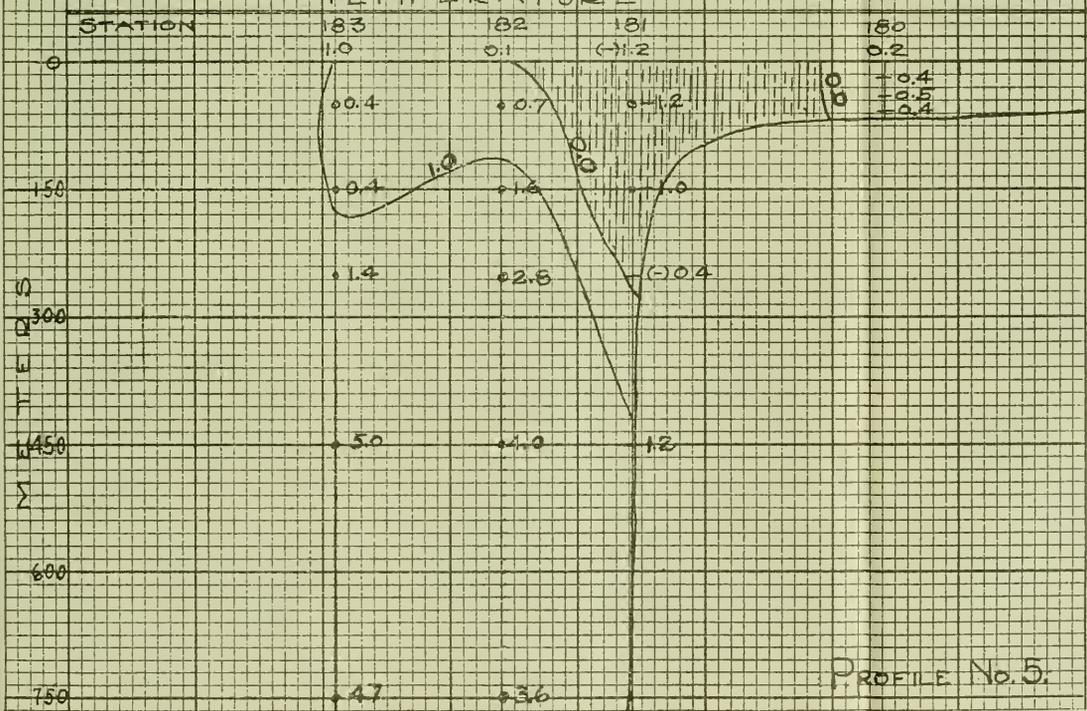
| Date | Description |
|------|-------------|
| 1890 | Jan 1 |
| 1891 | Feb 1 |
| 1892 | Mar 1 |
| 1893 | Apr 1 |
| 1894 | May 1 |
| 1895 | Jun 1 |
| 1896 | Jul 1 |
| 1897 | Aug 1 |
| 1898 | Sep 1 |
| 1899 | Oct 1 |
| 1900 | Nov 1 |
| 1901 | Dec 1 |
| 1902 | Jan 1 |
| 1903 | Feb 1 |
| 1904 | Mar 1 |
| 1905 | Apr 1 |
| 1906 | May 1 |

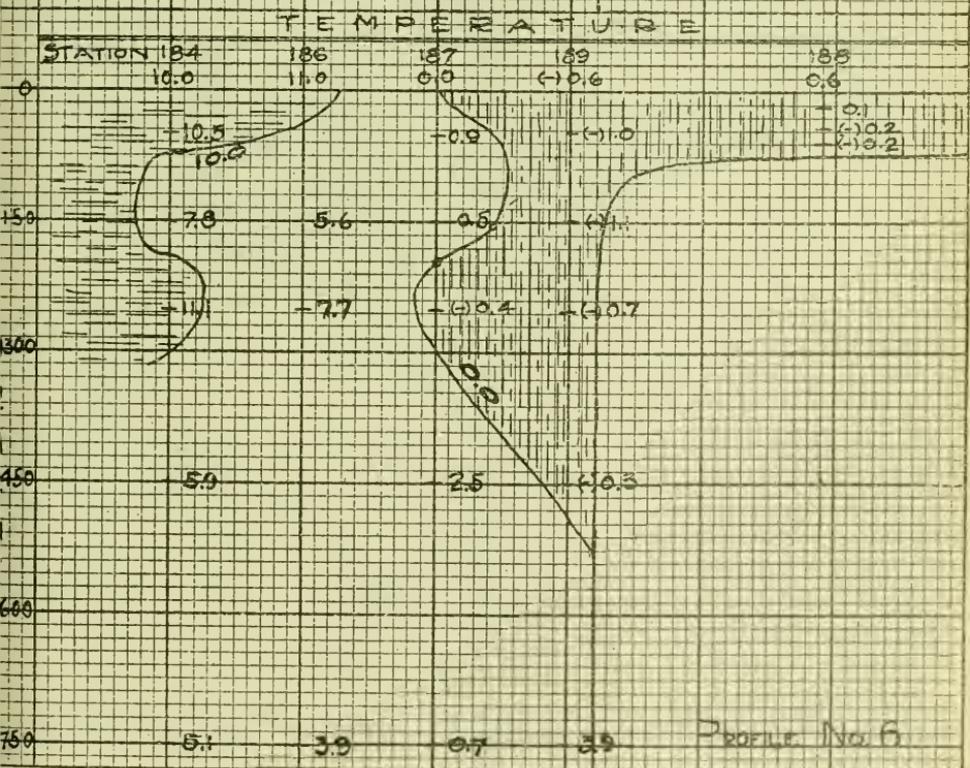
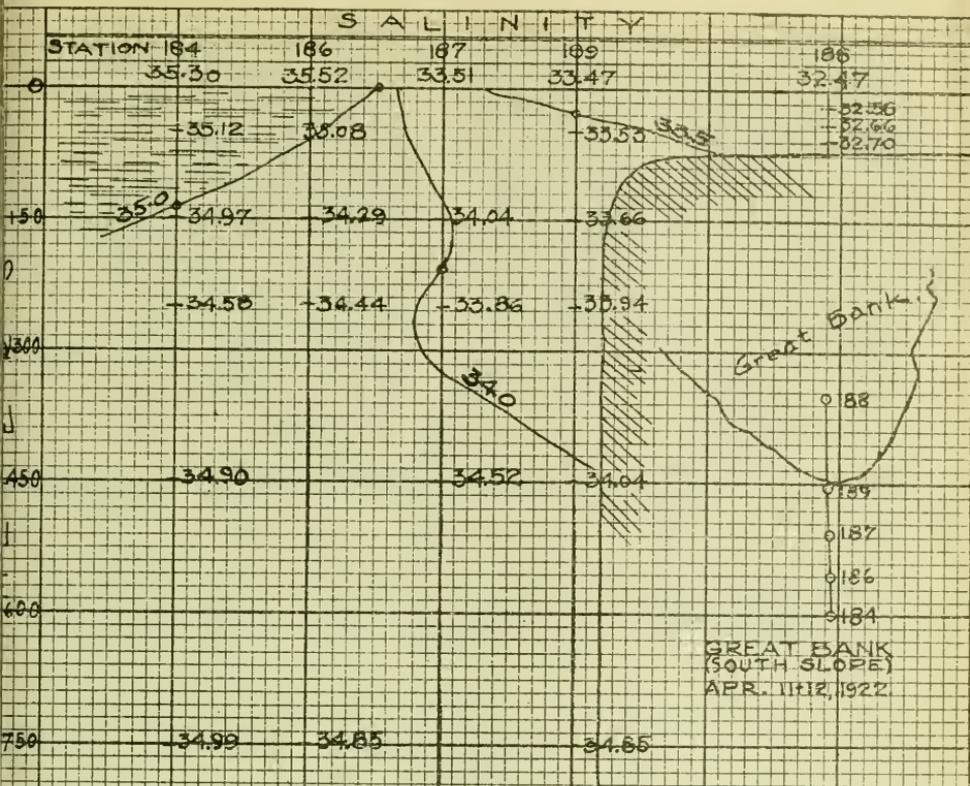


SALINITY

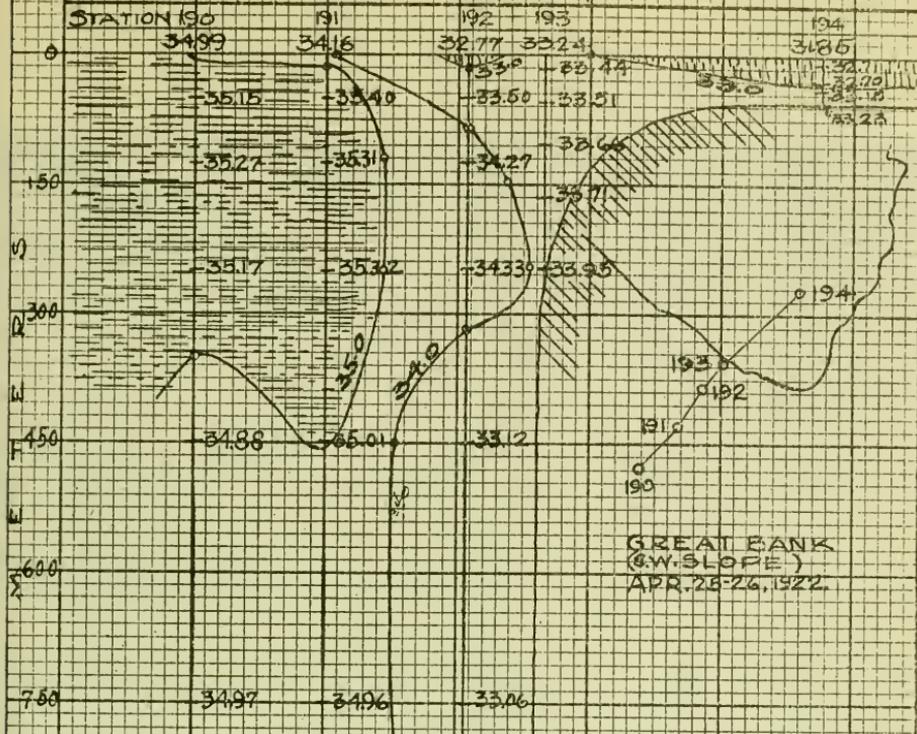


TEMPERATURE

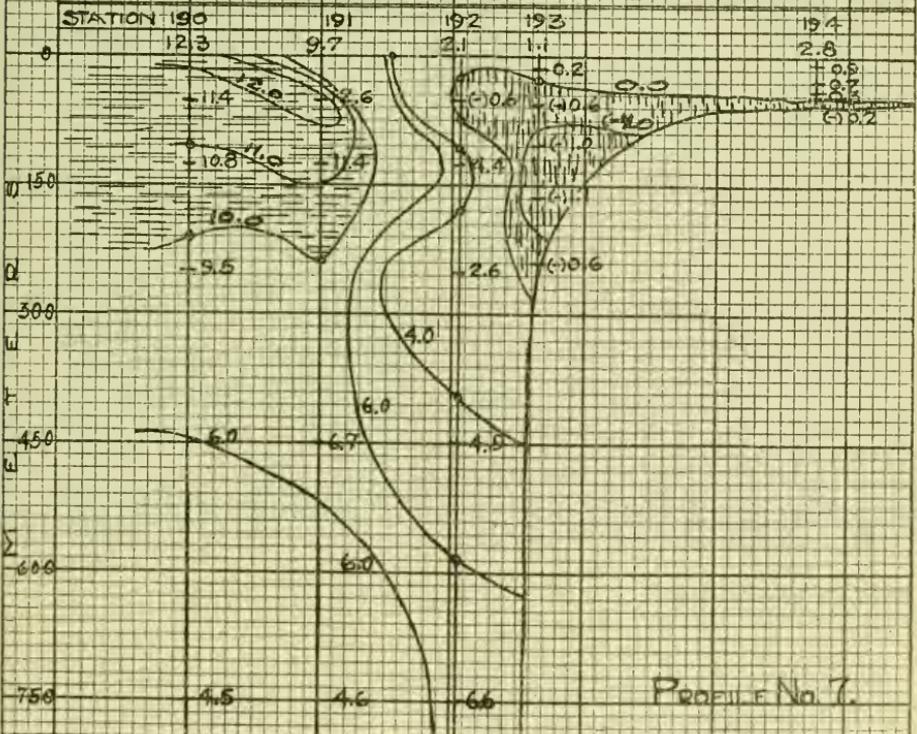


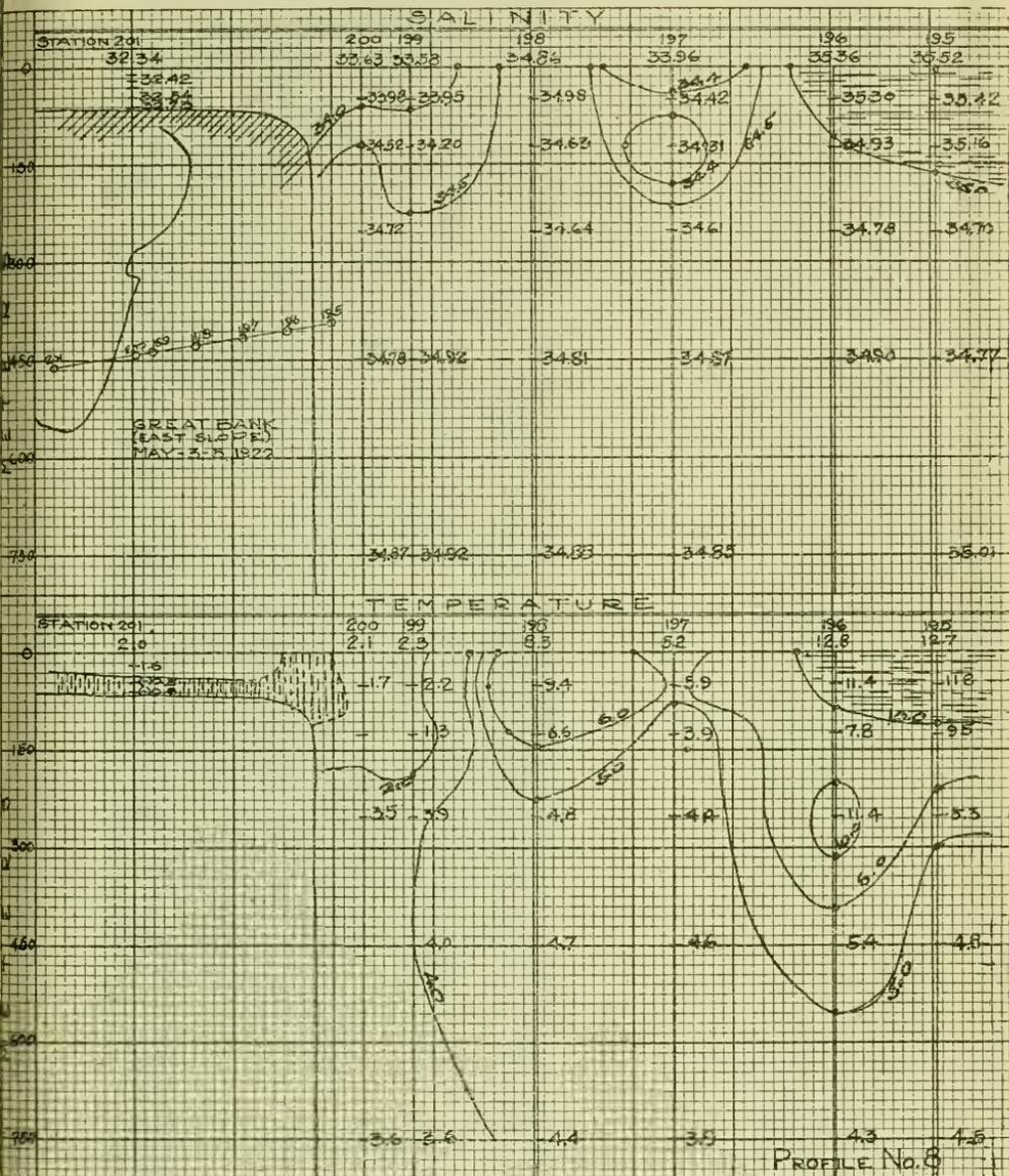


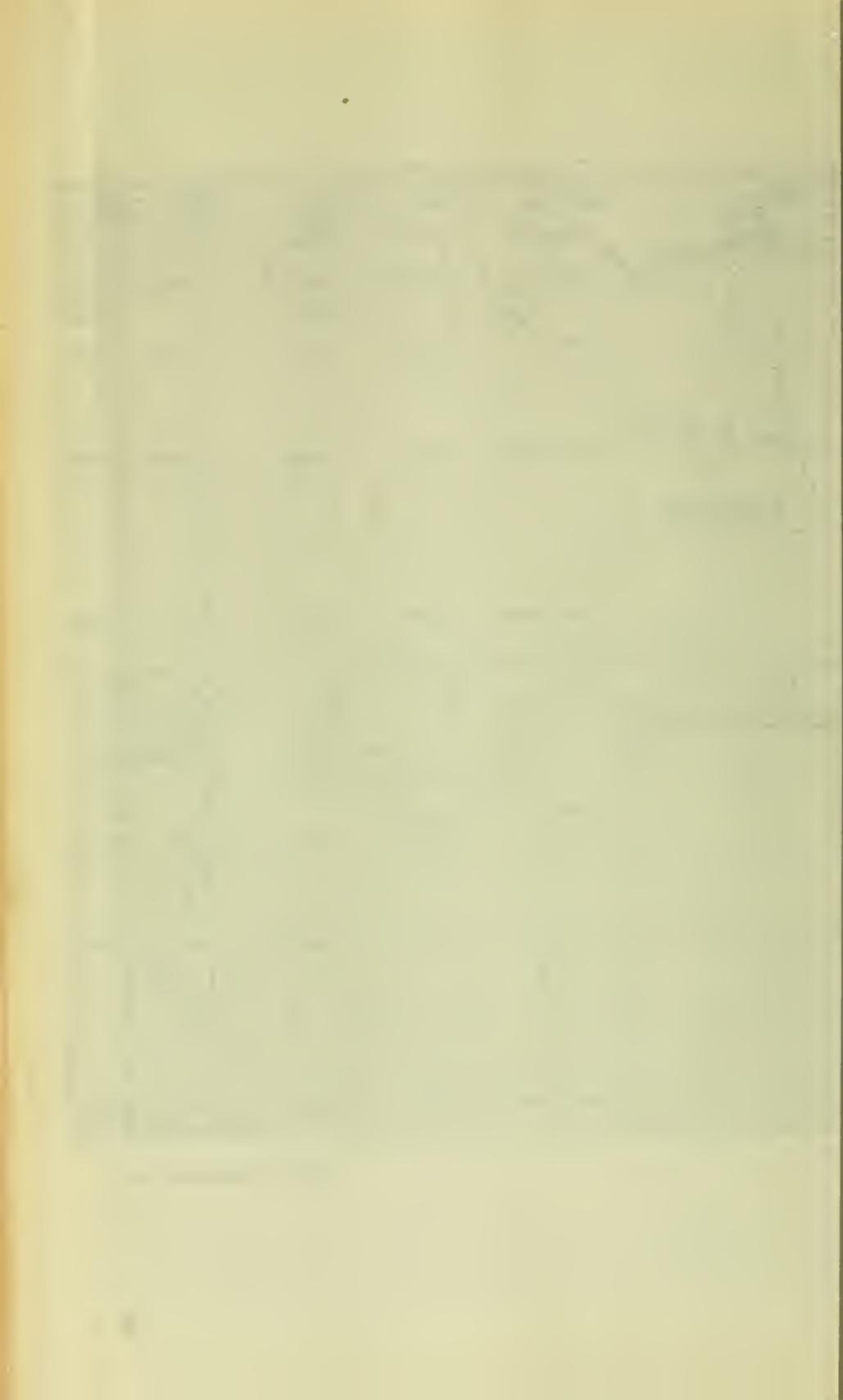
SALINITY

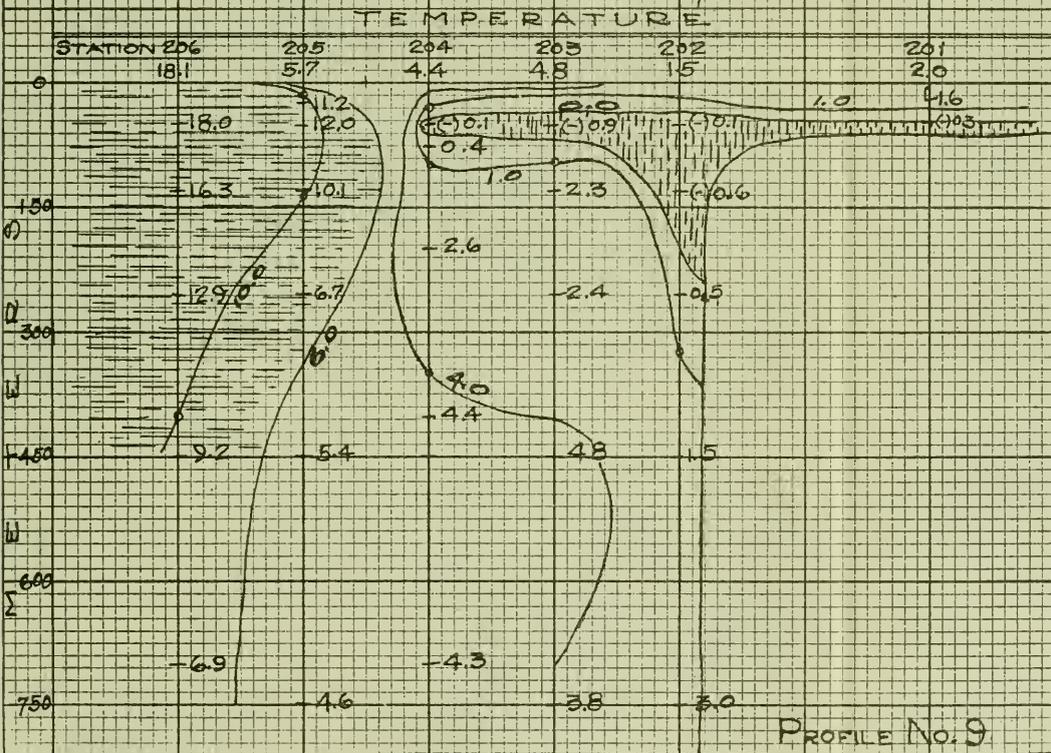
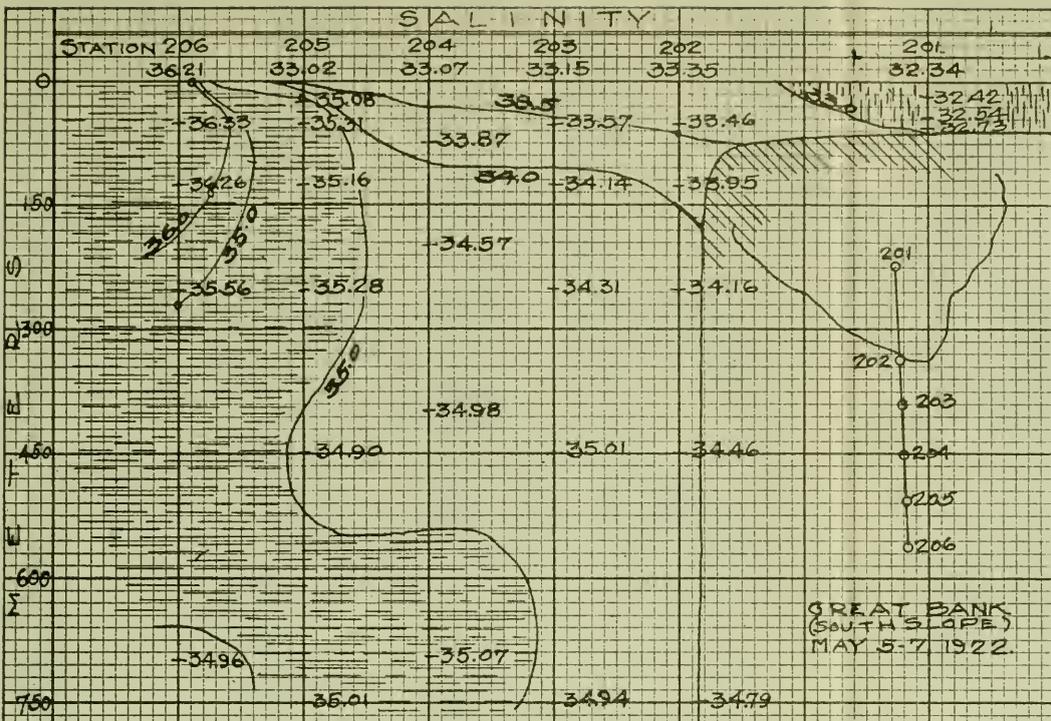


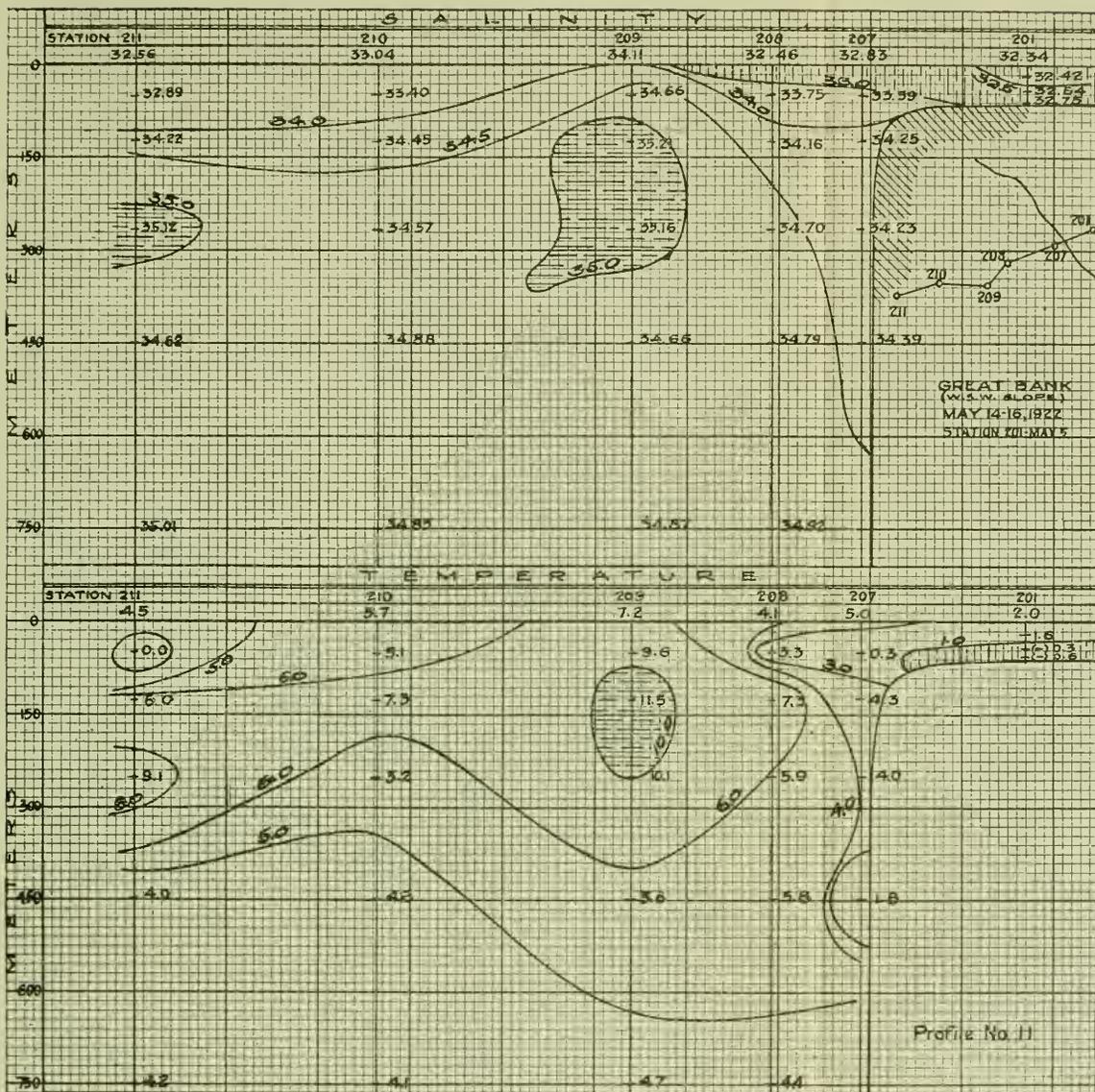
TEMPERATURE

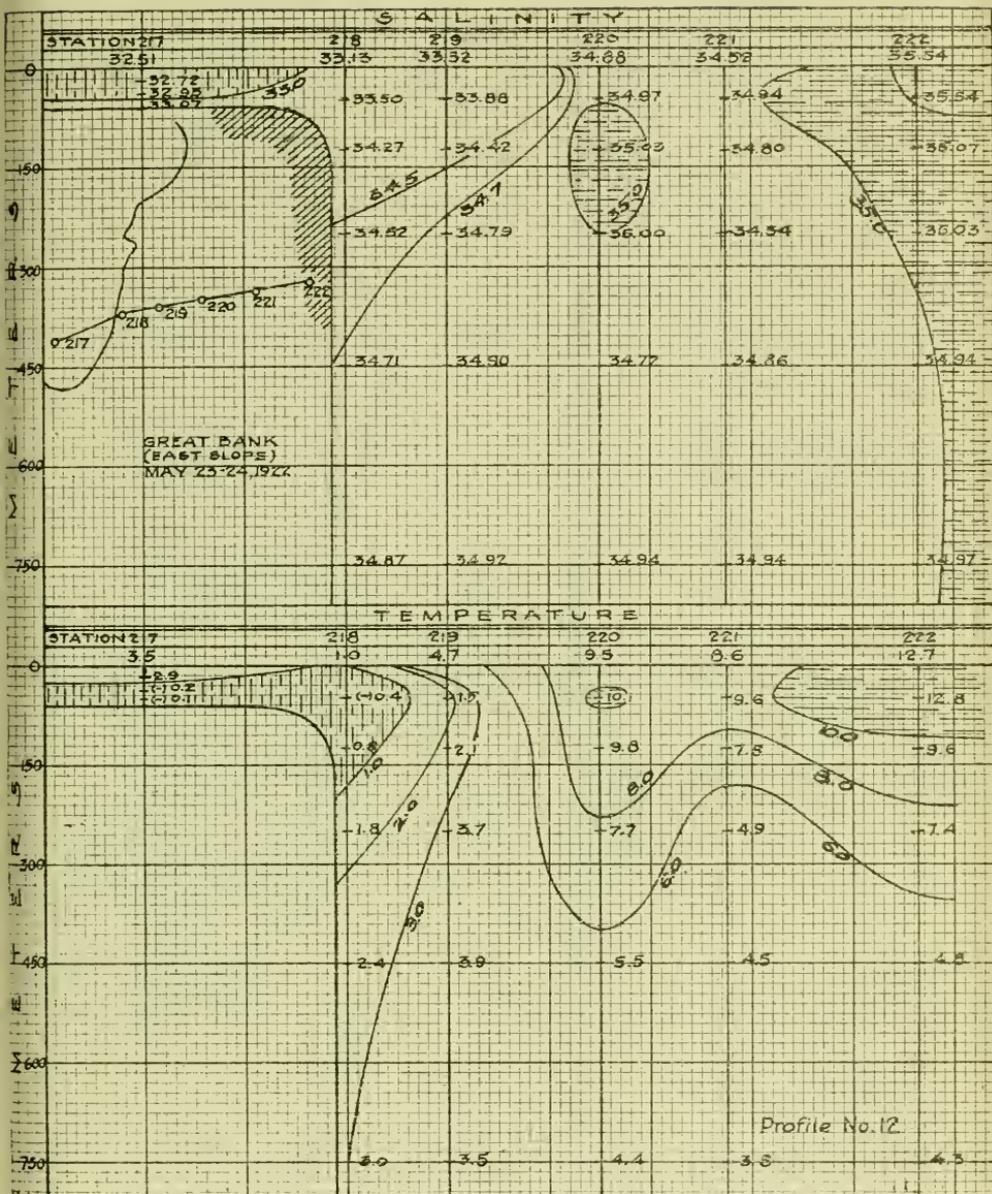




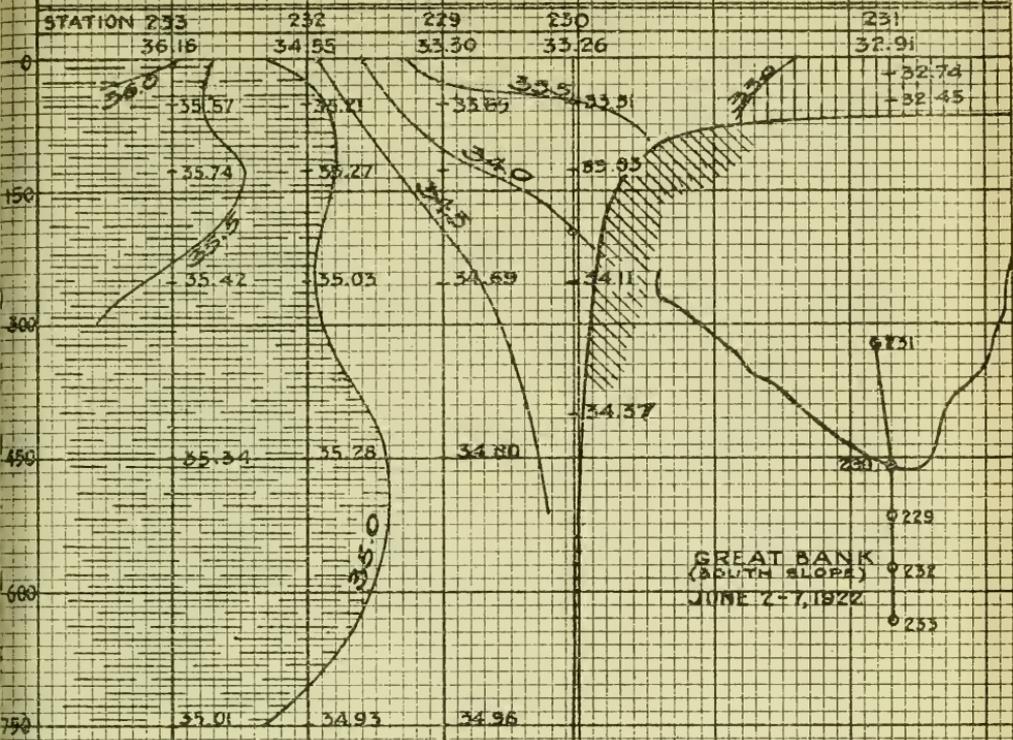




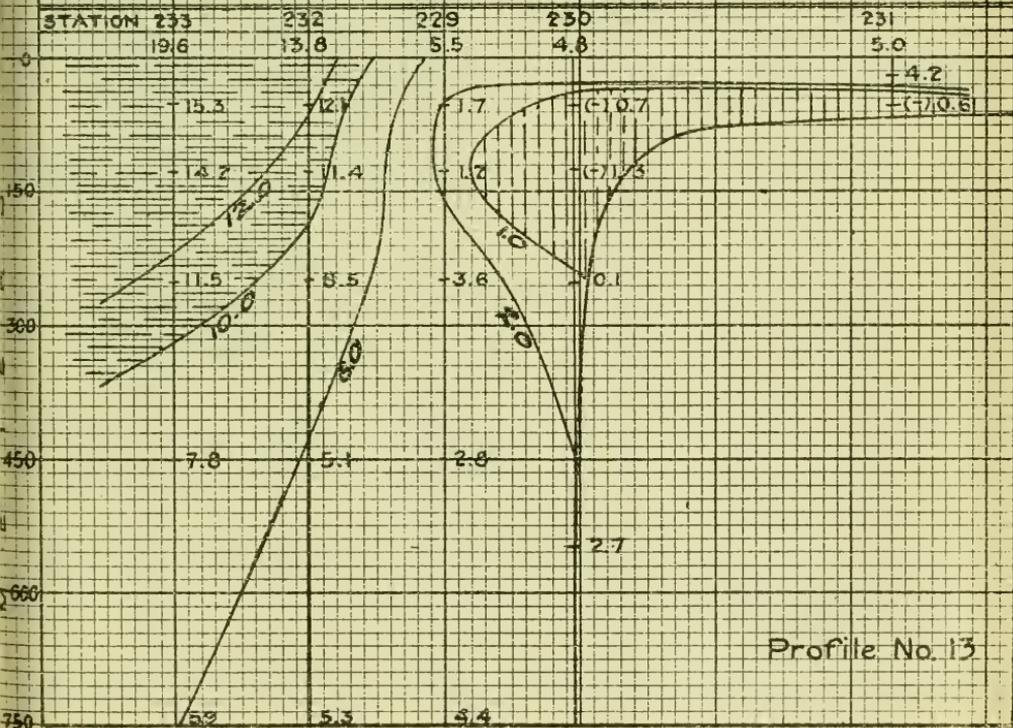




SALINITY



TEMPERATURE



Temperature.—At the outer end of the section we find a surface layer $>10^{\circ}$ C. and 100 meters thick. This is so marked by high salinity and temperature that we can unhesitatingly state it is Gulf Stream drift. Chart "H" of surface temperatures in the vicinity of the Grand Banks precisely agrees with Profile No. 2, showing a rounded area of Gulf Stream water which had intruded westward to $47^{\circ} 30' W.$ between $43^{\circ} 30' N.$ and $44^{\circ} 30' N.$ The current observations from astronomical positions at this point gave evidence of a northeasterly set of 0.8 knot per hour. Note should be taken of the 8° C. and 6° C. isotherms which graphically illustrate the action of heat loss by the Gulf Stream which occurs concurrently with its northern progress. Cold water normal for this latitude was found at stations 167 to 170, to the westward of and on the bank. At station 175 a minimum of 1.5° C. was observed on the surface, warming to 4.1° C. at 750 meters.

The striking feature of the profile is the absence of any evidence indicating the presence of polar water where it is to be expected during the greater part of the year. It is unfortunate that no station was located nearer the slope of the bank, since station 175 may be too far off to detect the presence of an attenuated tongue of Labrador Current lying close to the slope. Examination of the surface temperature chart "H," however, shows a narrow, tapering tongue of 30° F. (1.1° C.) water extending southward on the east slope to $43^{\circ} 15' N., 49^{\circ} 40' W.$ This is sufficient to show that in all probability there was a weak and shallow attenuation of Labrador Current next to the slope, which ceased completely at $43^{\circ} 15' N., 49^{\circ} 40' W.$ It may be added that the navigator found no southerly set from astronomical observations.

PROFILE NO. 3. STATIONS 172, 173, 174.

This section runs SSE. from the NE. extremity of the Grand Banks over the slope into deep water. It was taken February 20–21. (See chart "A.") Very stormy, cold weather was encountered, making the oceanographic work hazardous and difficult. This line of stations was especially sought in an endeavor to obtain a cut across the polar current.

Salinity.—Unlike the preceding profile, no sudden changes of water are met. The saltiest water lies at the outer end of the section; the freshest water is over the bank. The bank station 172 is flooded by water, which on the surface is 33.06 ‰ and at the bottom 33.27 ‰ . This is saltier than characteristic bank water, but, on the other hand, quite typical of water from the north, i. e., the Labrador Current.

Temperature.—The warm surface layer (10° C.) is to be noted at station 174. Station 173 at the surface had a negative temperature, -0.3° C., which fell to a minimum of -0.6° C. at 50 meters; then rose to 4.9° C. at 750 meters depth. This is quite indicative of the presence of polar water, although restricted to a surface layer only 50–75 meters in thickness. On the bank, polar water flooded station 172, causing negative temperatures from surface to bottom.

We may here review conditions in the area at the time of the ice observation cruise, February 8–26. The Labrador Current was found setting diagonally across and around the northeast promontory of the Grand Banks in a weak and shallow flow, the effect of which extended

southward along the slope, in narrow, tapering shape, to about 43° 15' N., 49° 40' W., where it ceased. Off the east side of the Grand Banks the Gulf Stream drift extended west to 47° 30' W., between 43° 30' N. and 44° 30' N. Its presence was noted at station 174, where warm saline surface water, 50 fathoms in depth, was flowing in a swirling northeasterly direction with an estimated velocity of 0.8 knot per hour. Off the west slope of the Grand Banks a warm body of salty water protruded northward in wedgelike shape (see chart "H") to 43° 15' N., 53° 00' W., making its effect felt in over the bank as far as station "C."

PROFILE NO. 4. STATIONS 176-180.

This section runs from station "C" (see chart "A") over the west slope of the Grand Banks to longitude 57° 10' W. It was taken March 15-17 and corresponds in position to profile No. 1, for February 13-15, i. e., a month earlier.

Salinity.—Atlantic water, >35.00 ‰, occupies stations 176 to 178, interrupted by a wide trough of fresher water, 435 meters in depth, at station 177. On the slope of the bank we found fresher water, and in on the bank, at station 180, the freshest water in the profile, "bank water."

Temperature.—Warm water, $>10^{\circ}$ C., at stations 176 and 178 is separated by a trough of colder water. We may state, from the picture given by this profile, that the northern edge of the Gulf Stream is present at both stations 176 and 178 to a depth of 300 meters. The fresher water in the upper 435 meters of station 177 is characteristic of normal water lying south of the Grand Banks of Newfoundland to the westward of the Tail of the Great Bank. Where we had slope water in February, station 167, Profile No. 1, we now find warm salt water, Gulf Stream, which has moved northward, entirely flooding station 176 to 300 meters in depth. In on the bank cold water of 0.4° C. has displaced the 2.1° C. water found there in February.

Due south of the Laurentian Channel the Gulf Stream has moved north from 42° 10' N. to 42° 30' N. South of Cape Race it remains the same as in February. Since the water south of the Grand Banks of Newfoundland has remained quite the same in character over a period of a month, there has been no flow of Labrador Current across the Great Bank during this time. This agrees with previous oceanographical observations in the vicinity of the Grand Banks of Newfoundland. (See Mathews, Report on the Work Carried Out by the S/S. *Scotia*, 1913, p. 31.)

PROFILE NO. 5. STATIONS 180 TO 183.

This section runs south from station "C" (see chart "A") into deep water. It was occupied March 17 to March 28.

Salinity.—There is no outstanding feature to the isohalines. Bank water fresher than 32.6 ‰ is found on the bank, and slope water, 33.0 ‰ to 34.0 ‰, is on the slope; no doubt Atlantic water of 35.0 ‰ would have been found a few miles to the south.

Temperature.—This profile is instructive as being the first for the 1922 season to reveal unmistakably the presence of the Labrador

Current at the Tail of the Bank. This polar water is shown by the shaded area of 0° C. water temperature as bathing the slope from surface to bottom. The temperature of -1.2° C. over the outer parts of the slope (1,100-meter contour) was the lowest encountered off the Tail of the Bank during 1922. This is an icy-cold stream which has flowed direct from Arctic regions without losing any of its negative value, and it was this southern propulsion of the Labrador Current which brought the first bergs of the season and caused the constant patrol to be established March 20.

PROFILE NO. 6. STATIONS 184-188.

This section runs from station "C" (see chart "A") south into warm water. It was taken April 11-12.

Salinity.—At the southern end of the section, stations 184 and 186, we found Atlantic water >35.00 ‰. The mid-stations show 34.00 ‰ to 33.50 ‰ water bathing the slope. In on the bank 32.47 ‰ to 32.70 ‰ water extended from surface to bottom. This is saltier near the bottom than the water found there March 17, being too fresh for polar, and too salt for unadulterated bank water, it is evidently a mixture of the two, hence indicates that there has been an intrusion of the former in over the bottom.

Temperature.—Warm water, $>10^{\circ}$ C., is 300 meters thick at the outer station. But the striking feature in this profile is the negative temperature water which has completely flooded the bank slope; this can be nothing else than the Labrador Current. The characteristic fall in temperature to a minimum below the surface at station 189 is an undeniable sign of water that has drifted from Arctic regions. This is further substantiated by the salinities on the slope and by the chilling of the bank water.

To sum up: February 20 we determined the southern end of the Labrador Current to be $43^{\circ} 15' N.$, $49^{\circ} 40' W.$ March 20, bergs were observed drifting southward around the Tail of the Bank, showing clearly that a great and sudden augmentation to the Labrador Current took place sometime between these dates. April 11-12 we found the Labrador Current at the Tail of the Bank in large volume, extending downward 450 meters (250 fathoms) on the steepest part of the slope, south as far as $42^{\circ} 25' N.$, and west, as shown on surface temperature chart "J," to the 51st meridian. The water at station 188 is not pure Labrador Current but a mixture of bank and polar water, which indicates that there is a tendency upon the part of the Labrador Current to encroach to the westward, especially in over the bottom of the bank.

PROFILE NO. 7. STATIONS 190 TO 194.

This section runs southwesterly from station "C" (see chart "A"). It was occupied April 25-26.

Salinity.—Atlantic water lies on the surface at the outer stations to a depth of 450 meters. A surface film of fresher water, 15 meters in thickness, spreads southward over the Atlantic water. The freshest water so far encountered, 31.85 ‰, lies at the surface on the bank and extends southward. A pool of 32.77 ‰ water lies on the surface at station 192. The bottom layer on the bank is saltier than

normal for bank water unless there has been an intrusion of higher salinity. There are two sources from which such may come, Gulf Stream or Labrador Current, but the low temperatures at once preclude the presence of the former.

Temperature.—Warm water $>10^{\circ}$ C. lies in a surface layer at the offshore stations. Between stations 191 and 192 there is a marked transition from warm tropical water to cold polar water. The striking feature as shown by the temperature profile is the polar water which lies in rounded form over the steeper part of the slope, as shown by the shaded area. This is pure Labrador Current with a salinity of 33.00 ‰ to 34.00 ‰ and a temperature -1.1° C. to 0.5° C. Similar to profile No. 6, the thin bottom layer of negative temperature over the bank denotes an admixture of polar with normal bank water. Examination of the surface temperature chart "K" shows no Labrador Current extending in on the bank so far as station 194, which is further proof that the intrusion of polar water is confined to the bottom on the bank.

Summing up: The close agreement between the isohalines and isotherms, and the clear-cut definition of the boundaries of the different kinds of water, all indicate that the oceanic circulation in the vicinity is strong and of large volume. Conditions then are what has come to be considered normal for the spring of the year, when ice drifts southward in the vicinity of the Grand Banks of Newfoundland. The Gulf Stream is shown flooding the outer stations; the coastal and bank water lies on the surface over the bank; and the Labrador Current with negative temperature flows around the slope and seeps in over the bank on the bottom. A comparison of Profiles 5, 6, and 7 graphically shows how the position of the trunk of the Labrador Current conforms to the contour of the slope of the bank and flows around and not across it in a southwesterly stream.

PROFILE NO. 8. STATIONS 195-201.

The section runs from station "C" to the eastward into deep water. The stations were occupied May 3-5.

Salinity.—At the outer end of the profile, stations 195 and 196, there is a surface layer of water saltier than 35.00 ‰, about 150 meters thick, evidently Gulf Stream. At the inner end, in on the bank, on the other hand, the whole column is fresher than 32.00 ‰. The curves for 34.00 ‰ and 34.50 ‰ suggest an offshore expansion of the slope water. The intermediate stations present a complexity which is not easy to interpret, indicating a mixing and interdigitation of the three kinds of water—Atlantic, polar, and bank.

Temperature.—At the offshore stations, corresponding to the high salinities shown above, we find a surface layer of warm water $>10^{\circ}$ C.; in on the bank a cold bottom layer 30 meters in thickness, with the only negative temperature of the profile. The water of the slope stations has certain polar characteristics, but the minimum temperature of 1.3° C. appears too high for pure polar origin. It may have been warmed enough by interdigitation with the Gulf Stream to lose its normal negative temperature, a possibility corroborated by the salinities of 34.00 ‰ to 34.50 ‰.

The surface temperature chart shows a very narrow belt of water, 0.5° C., lying just inshore of station 200. This area has been in-

closed on the profile by a dotted isotherm and without doubt represents the core of the Labrador Current. Berg track charts "E" and "F" give evidence of a current during this period which drifted bergs down the east side of the Grand Banks, and we found Labrador Current in considerable volume around the Tail of the Bank. (See Profile No. 9.) The failure to locate polar water at station 200 indicates there is a constriction in the current at this place, due to a tendency of the Gulf Stream to intrude westward toward the slope in the form of swirling bands and mixing eddies. (See surface temperature chart "L.")

PROFILE NO. 9. STATIONS 201 TO 206.

This section runs from station "C" (see chart "A") south into deep water. It was occupied May 5-7.

Salinity.—The offshore end of the section, stations 205 and 206, is flooded by a column of water >35.00 ‰, except at the surface of station 205, which is decidedly fresher. The area inclosed by the 33.50 ‰ isohaline extends from the slope of the bank in a gradually thinning surface layer southward to station 205. Below 150 meters the intermediate stations are occupied by water >34.00 ‰. As usual the water in on the bank is the freshest of the profile.

Temperature.—This is the first profile which shows pure tropical water, as warm as 18° C. and saltier than 36.00 ‰, at the outer end. The striking feature, however, is the close agreement in shape between the area inclosed by the 1° C. isotherm and the isohalines of 33.0 ‰– 34.0 ‰. This is pure Labrador Current. Another notable point is the steepness of the isothermic gradient between stations 204 and 205. Warm tropical water >36.0 ‰ salinity and $>18^{\circ}$ C. meets cold polar water of 33.0 ‰ salinity and 1° C., a range in salinity >3.0 ‰ and a range in temperature of 17° C. At no other place in the sea do two such diametrically contrasted bodies of oceanic water abut on each other.

A comparison with Profile No. 6 taken on this same section about a month earlier shows that the Labrador Current has decreased somewhat in volume, but that it extends farther south, i. e., to $41^{\circ} 25' N.$, with a maximum depth of 82 fathoms on the slope of the bank. In this profile there is the same tendency as noted in Profile No. 6 for the Labrador Current to spread out superficially at the Tail of the Bank. It was this same body of water, as shown in Profile No. 7, which drifted bergs "D," "E," and "J" southward around the Tail. (See berg chart "F.")

PROFILE NO. 10. STATIONS 217, 223 TO 228.

This section runs southwesterly from "C" (see chart "A") into deep water. It was occupied May 23-30.

Salinity.—Gulf Stream water saltier than 35.0 ‰ lies at the outer stations to a depth of 450 meters (246 fathoms). Fresh bank water exhibits a tendency to spread south of the slope on the surface. A bottom layer of water >33.0 ‰ lies on the bank.

Temperature.—A head of warm surface water $>10^{\circ}$ C., 425 meters in thickness, is present at the outer stations. Negative temperature water is found on the bottom of the bank. The surface temperature over the bank shows the effect of the increased solar warmth with the

advance of summer. The minimums of 1.6° C. and 0.4° C. at the intermediate stations, 225 and 226, although high for polar water, would lead one to suspect its presence, and salinities further support such a contention. In any case, interdigitation of the slope water is indicated. As for the cold bottom layer over the bank, that is undeniably of Arctic derivation.

A comparison of Profile No. 10 with Profile No. 7 taken a month earlier convinces one that the Labrador Current, which had curled around the Tail and seeped in on the southern part of the bank during April, had weakened and ceased to flow as far west of the Tail as $51^{\circ} 20' W$. Since there is still well-defined Arctic water on the bottom of the bank, this change was due to the Gulf Stream. There is sufficient evidence to show that the latter has grown in strength and is forcing its way northward, swamping the water which was brought here during April by the Labrador Current. This case furnishes a good example of the continual variability in relative strength and, consequently, in the relative positions, of these two ocean currents.

PROFILE NO. 11. STATIONS 201-211.

This section runs from station "C" (see chart "A") westward to longitude $57^{\circ} 10' W$. It was occupied May 14-16.

Salinity.—The feature of the section is the core of Atlantic water at station 209, extending vertically from 100 meters to 330 meters. From a glance at chart "A," it will be noted that station 209 was somewhat south of the straight line connecting the other stations, and this no doubt is the cause for cutting into Atlantic water. It also indicates that the Gulf Stream is near, in longitude $53^{\circ} 20' W$. At the 300-meter level, station 211, another northern extension of Atlantic water is found. The relatively parallel and horizontal positions of the isohalines indicate that this water west of the bank has been quite free from interdigitation. Fresher water, 32.56‰ , lies on the surface at the offshore station 211. Since it is too fresh for Labrador Current so far south, it may be an offshore movement of coastal water.

Temperature.—A core of warm water $>10^{\circ}$ C. occupies the same general position at station 209 as the 35.0‰ water in the salinity profile. There is a bottom layer, 30 meters in thickness, of negative temperature, on the bank. At the deep station, 211, a minimum temperature of 0.0° C. is found at 50 meters. The low salinity and low temperature leads to a conjecture that this water is from the Gulf of St. Lawrence.

Summary.—The area west of the Great Bank is occupied, in the main, by a large body of undisturbed slope water punctured by a head of warm Atlantic water at station 209. At the westernmost station, 211, the surface layers were fresher and colder; evidence that Gulf of St. Lawrence water had projected seaward through the Laurentian Channel. The low bottom temperature on the bank is clear evidence of an admixture of water from the Labrador Current, diluted, as proven by the low salinity, with the bank water which it meets there. This was the most westerly trace of polar water at this time.

PROFILE NO. 12. STATIONS 217-222.

This section runs from station "C" (see chart "A") eastward into deep water. It was occupied May 23-24.

Salinity.—The most easterly station is occupied by a column of Atlantic water, extending west at the 50-meter level to station 221. A core of >35.0 ‰ salinity water is also present at the 150-meter depth, station 220. Slope water occupies station 217. Bank water lies as a surface sheet over the bank, with water salter than 33.0 ‰ on the bottom.

Temperature.—A surface layer $>10^{\circ}$ C., 100 meters thick, lies at the offshore station, 222. Again, a trace of it is noted at the 50-meter level, station 220. The shaded area of water colder than 1° C. is evidence of the Labrador Current flowing along the east slope of the bank and seeping in over the bottom.

A comparison with Profile No. 8, run three weeks earlier, shows that the Labrador Current had increased in volume during the latter part of May. The Gulf Stream also is more evident, especially in the salinity profile. Interdigitation of the salt Gulf Stream with the fresher slope water is noticeable, but not to such an extent as during the first part of the month.

PROFILE NO. 13. STATIONS 233 TO 229.

This section runs south from station "C" (see Chart "A") into deep water. It was occupied June 2-7.

Salinity.—The offshore stations, 232 and 233, are flooded by a column of Atlantic water >35.0 ‰ salinity, which has moved northward closer to the Tail of the Bank than hitherto observed. Slope water is found at the intermediate stations; in on the bank, the freshest water of the profile, i. e., 33.0 ‰ from surface to bottom.

Temperature.—Water warmer than 10° C. extends downward at the outer station to 315 meters (170 fathoms) and at station 232 to 150 meters. This is the highest temperature we have yet observed. A bulge of negative temperature water lies on the steep grade of the slope with a minimum of -1.3° C. at 125 meters at station 230, and -0.6° C. in and on the bottom of the bank. Undeniably this is pure Labrador Current flowing around the Tail of the Great Bank. But the low salinity in the bottom layer over the bank proves that the polar water which spread in over the bottom at an earlier date had freshened, through tidal mixing with the bank water it met there. Surface solar warming is becoming more pronounced as the season advances.

A comparison with profiles of the same section taken April 11 and May 5 shows that the Gulf Stream has advanced northward considerably and also increased in volume. The Arctic current is restricted to the slope and to the bottom of the bank, though so markedly distinct in outline as to show that it has considerable velocity.

PROFILE NO. 14. STATIONS 239 TO 243.

This section runs from station "C" (see Chart "A") southwesterly into deep water. It was occupied June 16 to 17, and is the last of the oceanographic station observations for 1922.

Salinity.—Atlantic water >35.0 ‰ is present at the outer end of the section in large volume. Bank water <33.0 ‰ spreads unusually far southward from the bank in a thin surface layer to station 241. In over the bank we find 32.30 ‰ to 32.96 ‰ water, which is slightly saltier on the bottom than two weeks earlier.

Temperature.—Warm water $>10^{\circ}$ C. occupies station 242 down to 300 meters, and extends northward on the surface to station 241. Solar warming of the surface layers is noticeable; for example, the bank station, 239, registers 6.7° C., where in March it was 0.2° C. A minimum of 3.2° C. below the surface at the slope station, 240, might suggest the Labrador Current, and although this temperature is too high for the latter unadulterated, the negative temperatures on the bottom of the bank point to a drainage of polar water down the slope as the cause of the subsurface minimum at station 240, for the source of the icy water on the banks is undoubtedly the Labrador Current which has spread in over the bottom from the northeast.

Comparing profile No. 14 with profiles Nos. 7 and 10, in the same locality, we may state developments as follows: On April 25 there was a well-defined Labrador Current bathing the southwest slope of the bank. This had ceased to flow by May 23, but the effects of its low temperature remained on the slope where it had been observed in great volume a month earlier.

Since Arctic water brought to the slope of the bank at this place in April has been engulfed by warm, salty water working northward toward the slope, it is fair to assume that the icy cold layer on the bank would have been warmed had it not a source of constant supply, this necessarily being the Labrador Current to the north and east.

OCEANOGRAPHIC SUMMARY.

Lieut. (Junior Grade) EDWARD H. SMITH, detailed as oceanographic observer.

From the preceding detailed discussion of the section profiles, certain facts have been established which now may be summed up in a connective way, thereby giving us a clearer conception of the sequence of developments during the ice season of 1922.

Oceanic circulation¹ is subject to seasonal variations. These variations are exhibited in volume, position, and strength of the currents and are caused by any one or all of the following in combination: (a) Meteorological conditions, (b) dynamic principles of circulation, and possibly (c) variations in solar energy. Local conditions, such as prevailing winds, may set up a temporary surface drift in a limited area, but such a factor is of so slight and temporary a nature that it does not alter the underlying oceanic movement. It is necessary to search farther afield for the fundamental factors which cause the major water movements over large areas, although these may produce local currents apparently inconsistent with the winds at the particular time and place.

This should be borne in mind when discussing the subject of physical phenomena in the vicinity of the Grand Banks of Newfoundland, where for the larger part of the year we have the Labrador Current pressing into the Gulf Stream with continual variations on the part of both in position, volume, and velocity. An example of this occurs every summer in the well-known augmentation of the polar currents caused by the great increase of water from melted ice. Since southerly winds prevail over the Grand Bank area at this time, an observer who confined his observations solely to this region might well be puzzled at finding the southerly Arctic current swelling in opposition to the prevailing wind. But this apparent inconsistency vanishes if one searches for the underlying causes.

The following lines contain a summary of certain facts established by the profiles. Attention will be called to variations in circulation, but no attempt will be made to determine or explain the cause, if not of a local, temporary nature. It is considered sufficient to record these phenomena over a period of years in the vicinity of the Grand Banks of Newfoundland; after the compilation of these data the relationship existing between local currents in the bank area and more general oceanic phenomena may be developed.

The following discussion is based on the observations of 1922. Judging from past ice-patrol records this was, in general, a normal year for amounts of ice, position, and strength of currents, hence it may fairly be used as the basis for describing typical conditions,

¹ Sandstrom, J. W., "Canadian fisheries expedition, 1914-1915," pp. 221-291. Pettersson, O., "Connection between hydrographical and meteorological phenomena," *Quart. Jour. Roy. Met. Soc.*, July, 1912, pp. 123-191. Bjerknes, V. E. K., "Dynamic meteorology and hydrography," *Carnegie Inst.*, Washington, 1910-1911, Pub. No. 88. Dickson, H. N., "The circulation of the surface waters of the North Atlantic," *Phil. Trans., Roy. Soc., London*, 1906, vol. 196A.

though it can not be denied that future experience may call for modification.

The ice-observation vessel on its February cruise succeeded in locating and charting the surface and subsurface shape of the Labrador Current in the vicinity of the Great Bank. We definitely ascertained that this current did not extend south of the Tail of the Bank during February; though at that time it completely flooded the northern and northeastern parts of the bank, and projected out over the slope to the eastward for 40 miles. The Labrador Current was thickest on the rounded northeast promontory of the bank where it extended down the slope 170 meters (93 fathoms). Thence, southward its eastern and western walls quickly converged, forming a narrow fingerlike extension over the 200-fathom contour, reaching southward only to $43^{\circ} 15' N.$, $49^{\circ} 40' W.$

Much to our surprise upon the return of the ice-observation vessel to the Great Bank the middle of March, icebergs were discovered around the Tail. A line of stations run from the Tail to the southeast gave the explanation by showing that during the interval between the two cruises, i. e. February 25 and March 17, a great augmentation of the Labrador Current had taken place, extending south along the slope from its earlier limit, $43^{\circ} 15' N.$, as far as the Tail of the Bank. It was this propulsion of water out of the north which bore the first icebergs down to the Tail.

Two weeks later this northern current had increased to such proportions that it extended on the surface 30 miles south of the Tail and to a maximum depth of 500 meters (255 fathoms) down the slope. Its most striking feature was that it was no longer confined on the west by the slope, but had spread inward over the bank, displacing the bank water. By this process it had not only pushed diagonally across the Tail of the Bank, but it had also sunk down the slope to a depth of 400 meters. The trunk of the current, like other ocean currents, seeks the steepest part of the slope, the excess accumulation of water crowding in over the bank, and curving in a southwest and west flow. Its effect was apparent for 30 miles out over the southwest slope of the bank as far west as $43^{\circ} 00' N.$, $51^{\circ} 00' W.$, beyond which there was no trace of it.

From the middle of April on to the end of the patrol, when observations were necessarily discontinued, the Labrador Current was constantly present in the vicinity of the Grand Banks of Newfoundland; though during this period it was subject to many variations in position, form, and strength. By the first part of May the current exhibited a tendency to spread to the southward in a shallow surface layer around the Tail of the Bank, extending then 70 miles south of the slope and on the average 80 meters (44 fathoms) thick. By the last of May there was a weakening of the Labrador Current west of the Tail. On the southwest slope where it had flowed so strongly in April, it was now no longer apparent. The polar water previously found there had been warmed up beyond recognition by mixture with the local water of higher temperature. By June the Labrador Current was confined to the slope and to the bank, a state of affairs quite similar to that which existed the first part of April, there being in June no Arctic water on the southwest slope. The fact that there was no Arctic water over the southwest slope in June, argues for an actual recession to the eastward.

The eastern boundary of the current from the north is yet to be discussed. There appears to be more mixing and interdigitation of polar and Atlantic water to the eastward of the Great Bank than in any other area. Consequently, the boundary between the two waters is one which is very difficult to determine. The Labrador Current impinges itself at the Tail of the Bank on the northern edge of the Gulf Stream. At times the push is strong enough to split the Labrador Current into an east and west branch; in this case the stronger branch determines the berg drift, the relative strength of the branches probably depending to a great extent on the angle of impingement of the Labrador Current against the Gulf Stream. An illustration of this appears on berg chart "E," showing two bergs, "F" and "G," both of which took the east branch, which was evidently the dominating factor at that time.

The conflict of the two currents, together with the position of the bank produces a frictional arresting of the Gulf Stream on its northern edge, which in turn swings it in sharply to the north and northwest immediately after passing the Tail. This inshore westward swirl of frictional bands of the Gulf Stream sets up an interlacing movement between the two waters. The surface temperature charts "H" to "P" show the curling, eddylike character of the western boundary of the Gulf Stream east of the Great Bank and indicate the general form. But they can not depict the more detailed projections and eddies that must be a constant accompaniment of the active interdigitation. Profiles Nos. 8 and 12 indicate the subsurface mixing.

Unlike the eastern area, the body of water between the Great Bank and the Nova Scotia Bank is comparatively free from disturbing mixings, except just west of the Tail, where the western extension of the Labrador Current is active at times, and also farther south, where heads of Gulf Stream water protrude in undulating form north of the 43° parallel. Their shapes and positions are variable, but they extend farthest north during summer and autumn, when warm tropical water is found close to the Nova Scotia and Newfoundland slopes.

The polar water and Atlantic water as represented by the Labrador Current and the Gulf Stream, respectively, have been discussed. There is a third kind of water present which it is necessary to consider, namely, bank water. The Great Bank extends 250 miles south-southeasterly from Newfoundland. It is the largest bank promontory in the world. Like other banks, it is normally covered by a mass of water which, from its low salinity is known as bank water. This water possesses characteristics which are definite and striking.

The profiles for 1922 show that the bank water is subject to great ranges in temperature. In winter the cold northwest winds from Canada chill it to 0.0° C. from surface to bottom, while in August, under the influence of southwest winds and solar warming, its temperature rises to 12°-14° C. Contrasted with this is the annual range of the Gulf Stream in the locality, which is not greater than 6° C.—less than one-half that of the bank water. The latter is subject to fluctuations in temperature caused by seasonal changes or by water admixtures.

The characterizing feature of this water is the persistence of its low salinity, which even the saltier water from the north, east, or south does not appreciably alter, except near the slopes. It is true that the Labrador Current floods the northern part of the bank most

of the year, but upon the slopes and across the southern end the polar water is subject to variations. There is a well-defined tendency on the part of the polar water, when spreading in over the southern end of the bank, to seek the bottom levels. Attention is called to the position of the Labrador Current in relation to the Great Bank. The subsurface observations for 1922 show no evidence of a general southwesterly set of Labrador Current across the Great Bank in the form of a definite stream.

The freshest water found during 1922 was the upper layers over the bank, which often are of such low salinity that the water is classified as coastal, for in order that water be so fresh it must have coastal connection. Land drainage spreads superficially out over the Great Bank in a slow offshore expansion which is accelerated or retarded by the tides, winds, etc., but is sufficiently constant to maintain the low salinity so permanently a characteristic of the bank area.

Average annual conditions from year to year produce a remarkable constant state of the water over the Great Bank. The encroachments of the Labrador Current on the Gulf Stream in over the bank are to be regarded as abnormalities. Such temporary conditions of oceanic circulation can be traced to an accumulation of water seeking escape in distinction to the stream flow of an ocean current which tends quite consistently to the steepest grade of a continental slope.

Another noticeable and interesting feature was the action of the slope waters during the 1922 season. This consisted of a combination of bank and polar water, which exhibited a marked tendency to spread out to the southward of the Tail on the surface, abutting into the northern edge of the Gulf Stream. There may be several causes for this offshore expansion, such as an escape from the inshore accumulation of coastal water draining off the slopes; it may be the result of a pull from a surface suction induced by an increased density at the juncture of the Gulf Stream and the Labrador Current. The phenomenon with which we are interested, however, is the fact that the slope water (Labrador Current plus bank water) spreads out superficially, as shown by all the profiles, and does not sink. This is convincing proof that the Labrador Current, upon meeting the Gulf Stream south of the Grand Banks of Newfoundland, does not dive beneath the latter to emerge farther south. Ocean currents may exhibit such action at other places in the world, but such certainly is not the case at the Tail of the Great Bank.

If the Labrador Current does not dive beneath the Gulf Stream, what becomes of it? Floating objects furnish us with the most direct information as to the velocity, direction, and limits of a current. Icebergs, because of their size and draft, record a drift which represents the average movement of the body of water as a whole, since the wind seldom influences them. The reader is referred to tracks of the drifts of bergs south of the Tail of the Great Bank for 1922. With the bergs as indicators, it will be seen from charts "D," "F," "G," that the Labrador Current flows around the Tail and southwesterly to about $42^{\circ} 22' N.$, $51^{\circ} 28' W.$ (and as modified by page 95), where it is turned sharply, with varying eddy formations, in a return flow parallel to the Gulf Stream.

Conclusions drawn: 1. The Labrador Current is weak during the winter months, when its southern extension lies near the northern part of the Grand Banks of Newfoundland.

2. The southern extremity of the Labrador Current increases quickly in size and extends around the Tail of the Bank the first part of March.

3. The Labrador Current is present around the bank the entire ice season, but during that time is subject to periodic variations.

4. During the season the Labrador Current floods the northern part of the bank, spreads in over its eastern slope, and encroaches on the southern part of the bank on the bottom.

5. The boundary of the two currents, Labrador and Gulf Stream, on the east side of the Great Bank is variable and difficult to determine, due to excessive interdigitation of the two waters.

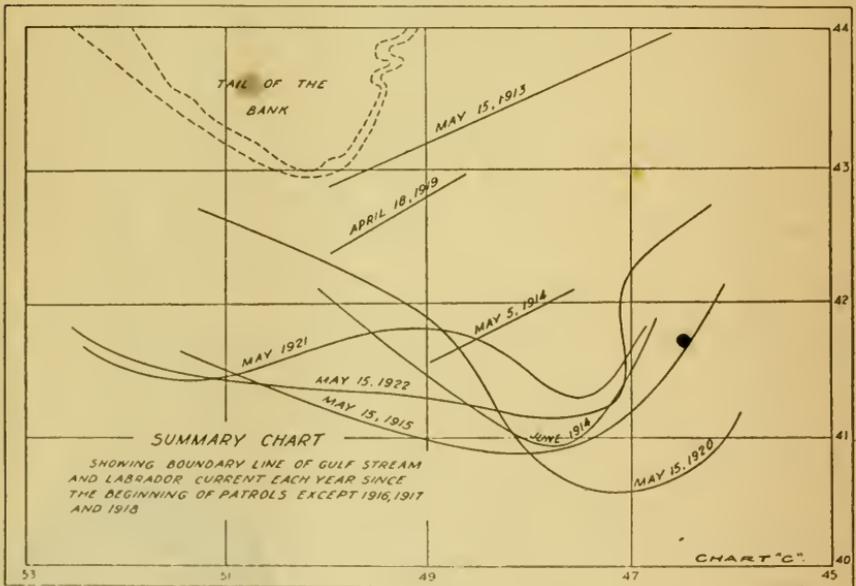
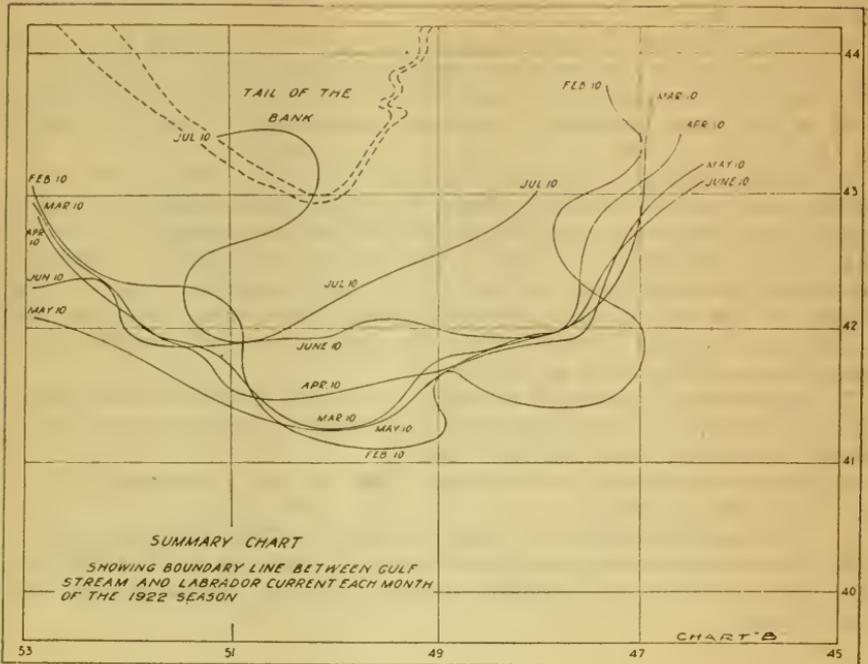
6. The Gulf Stream is characterized by a variable undulated northern boundary west of the Tail, which moves in closer to the slopes of the Grand Banks of Newfoundland during summer and autumn. Just east of the Tail of the Bank the Gulf Stream turns sharply in swirling form to the north.

7. Banks water possesses a striking identity, which is of a prominent character except where temporary encroachments occur on its northern, eastern, and southern sides.

8. There is no southwest stream flow of the Labrador Current across the Great Bank.

9. The Labrador Current, upon meeting the Gulf Stream, does not dive beneath the latter, but turns sharply, between parallels 42 and 43 and meridians 51 and 52, to flow easterly, parallel with the Gulf Stream.





GRAND BANKS

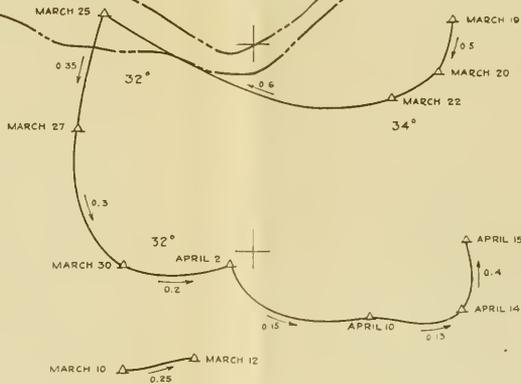
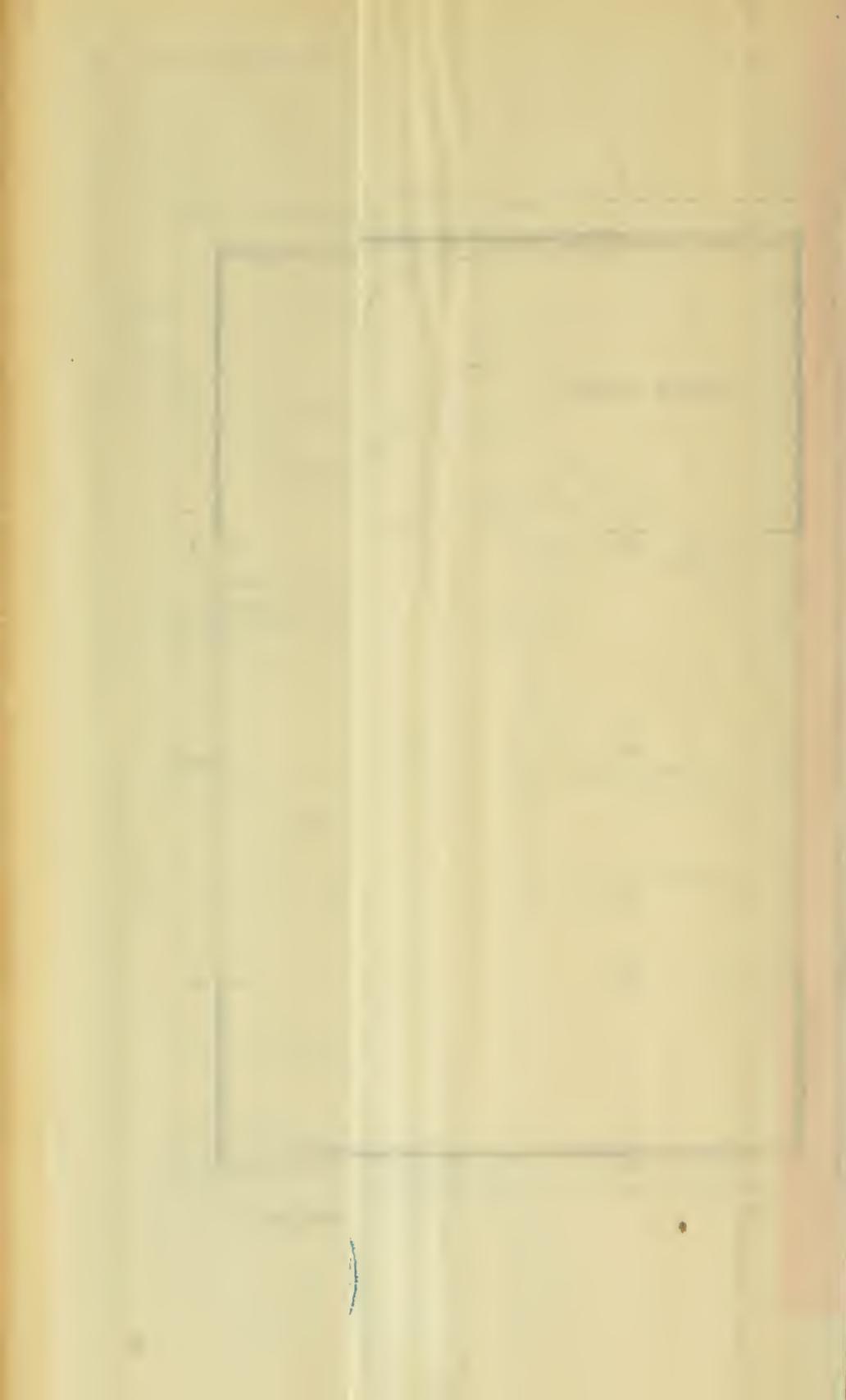
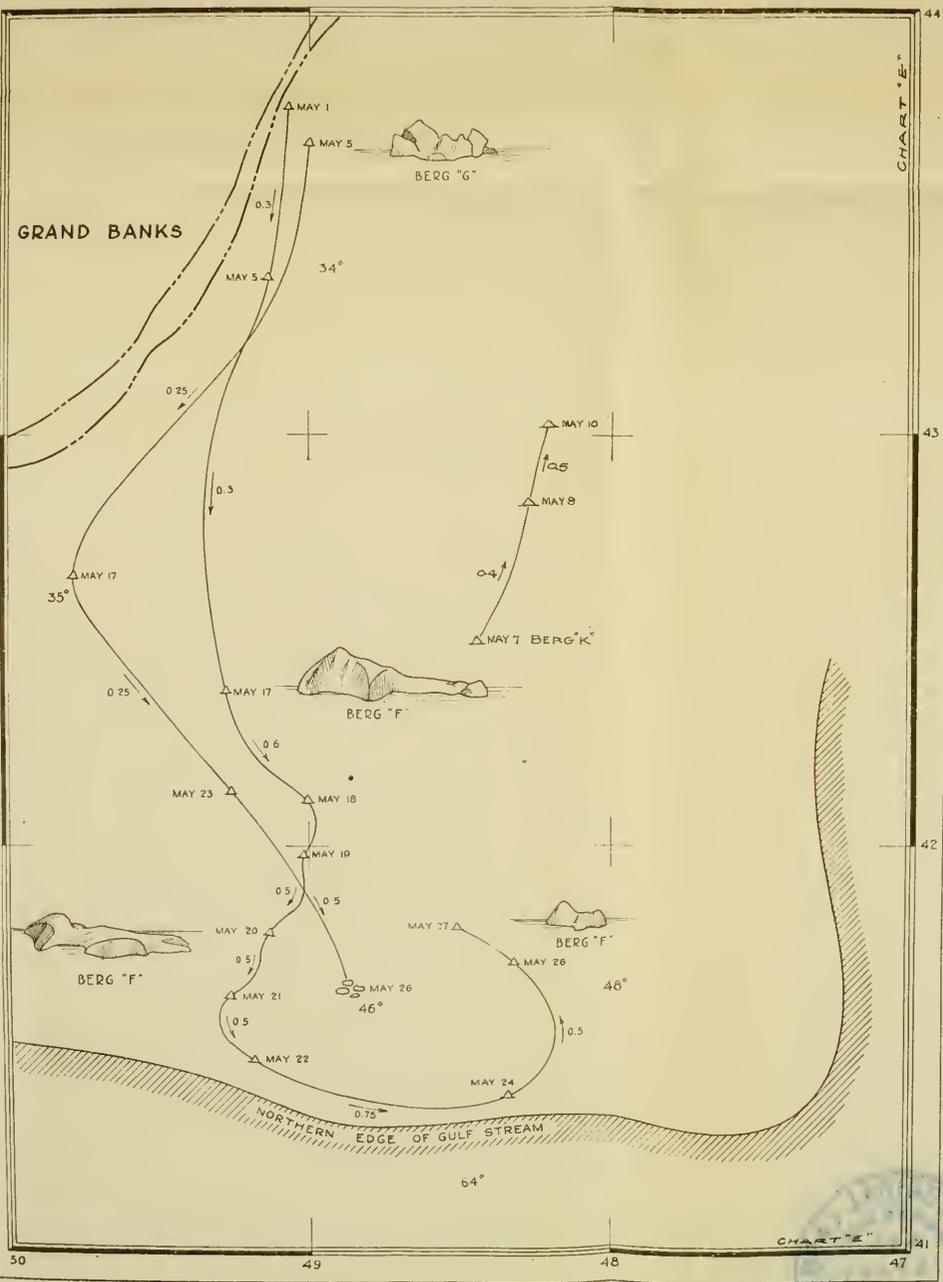


CHART "D"



GRAND BANKS



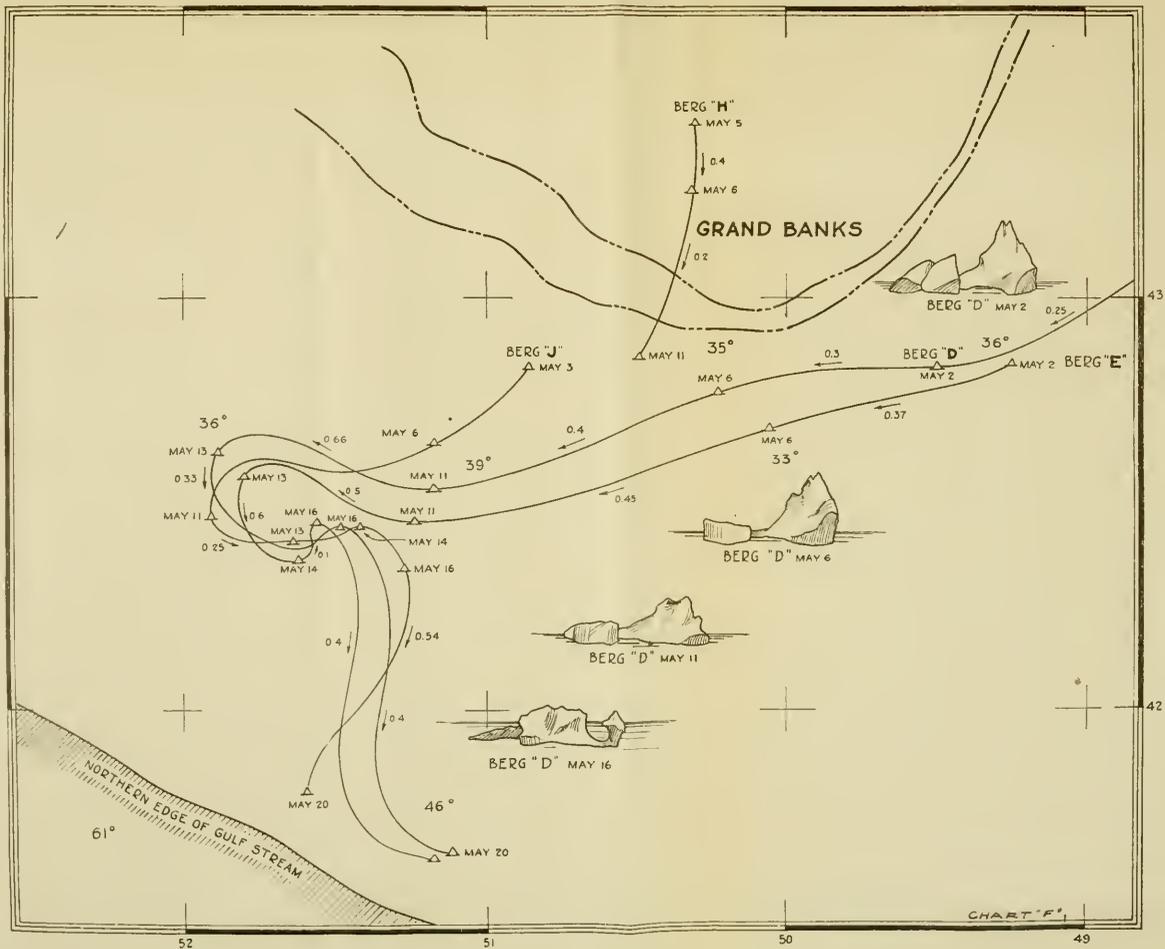
44
43
42
41

50 49 48 47

1971

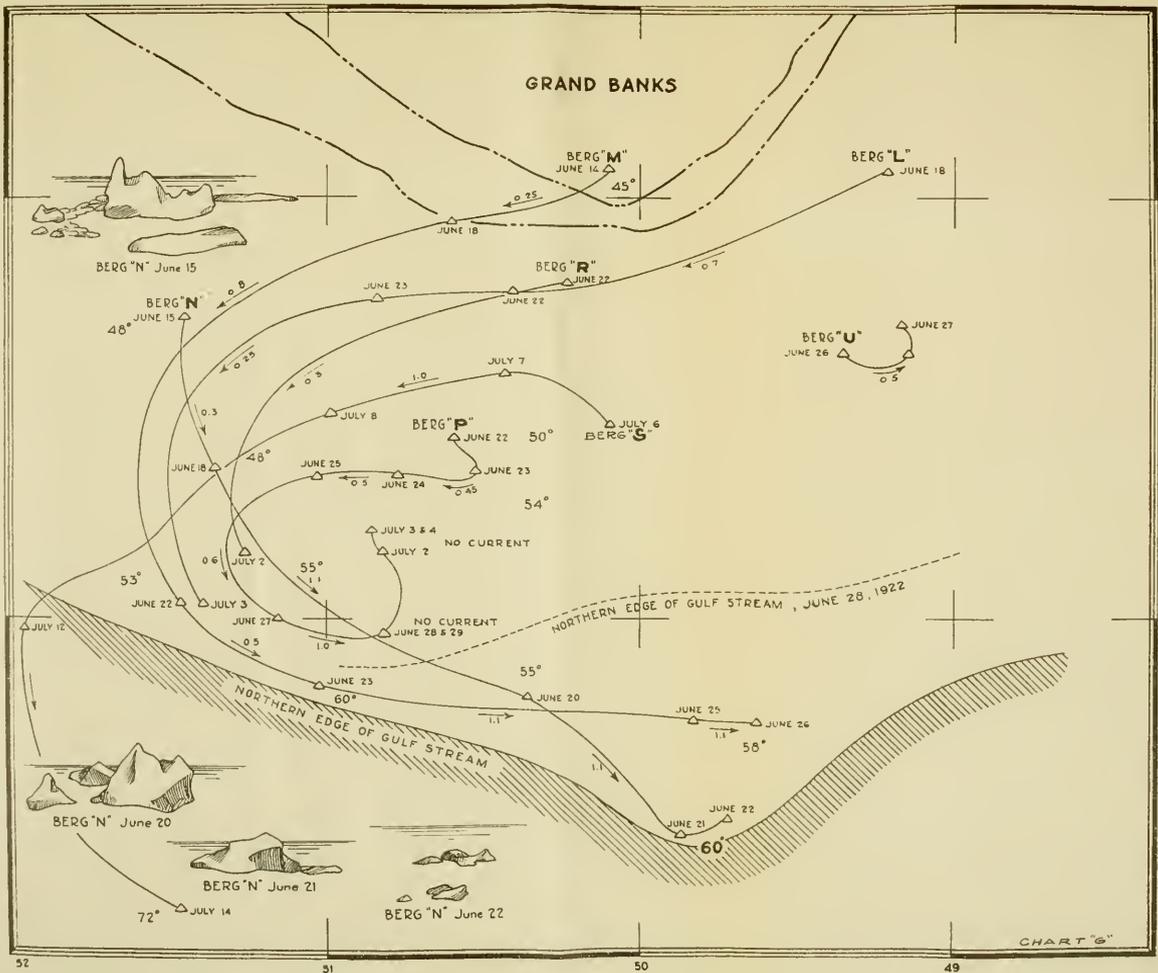


1971

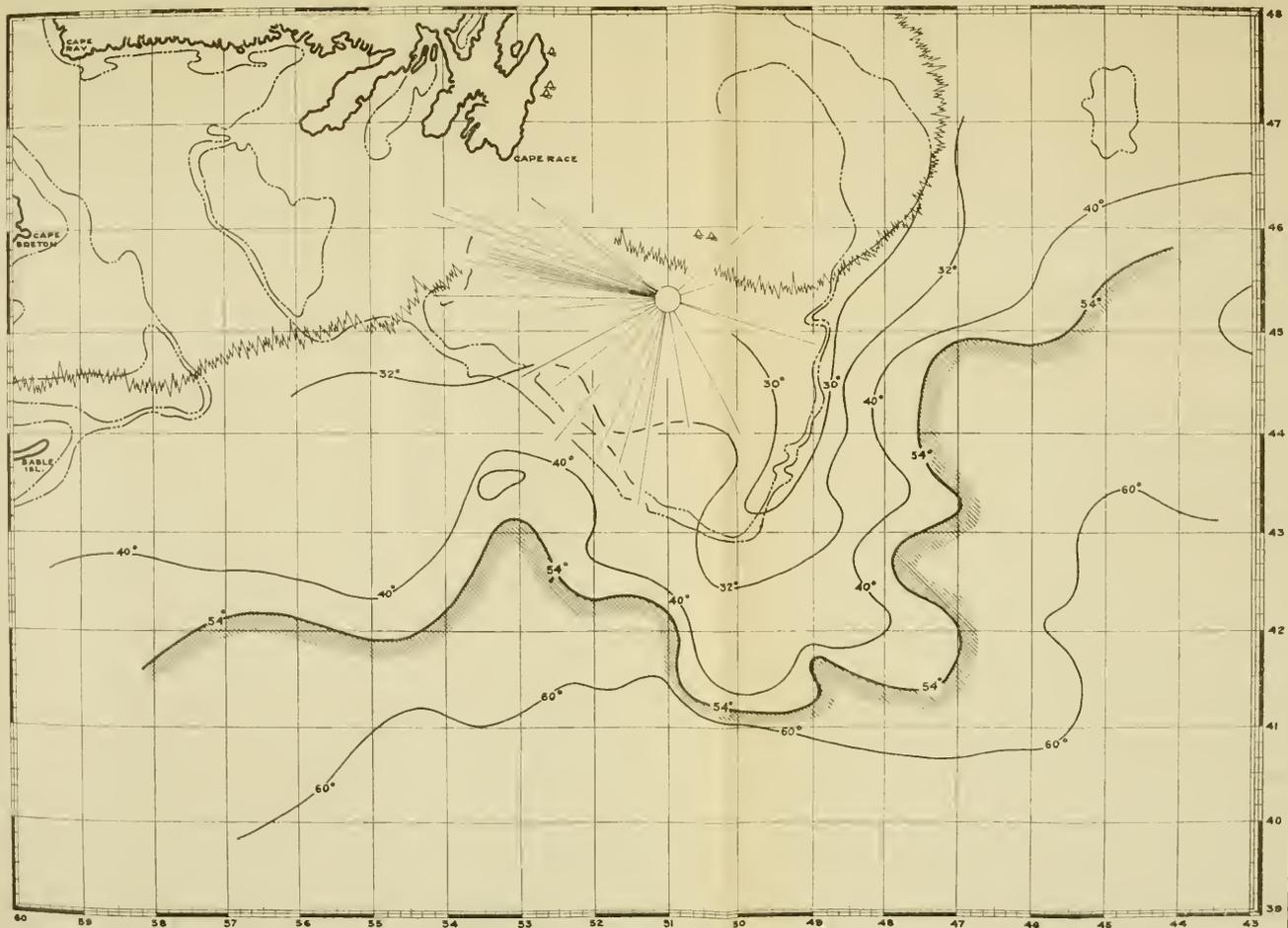




GRAND BANKS







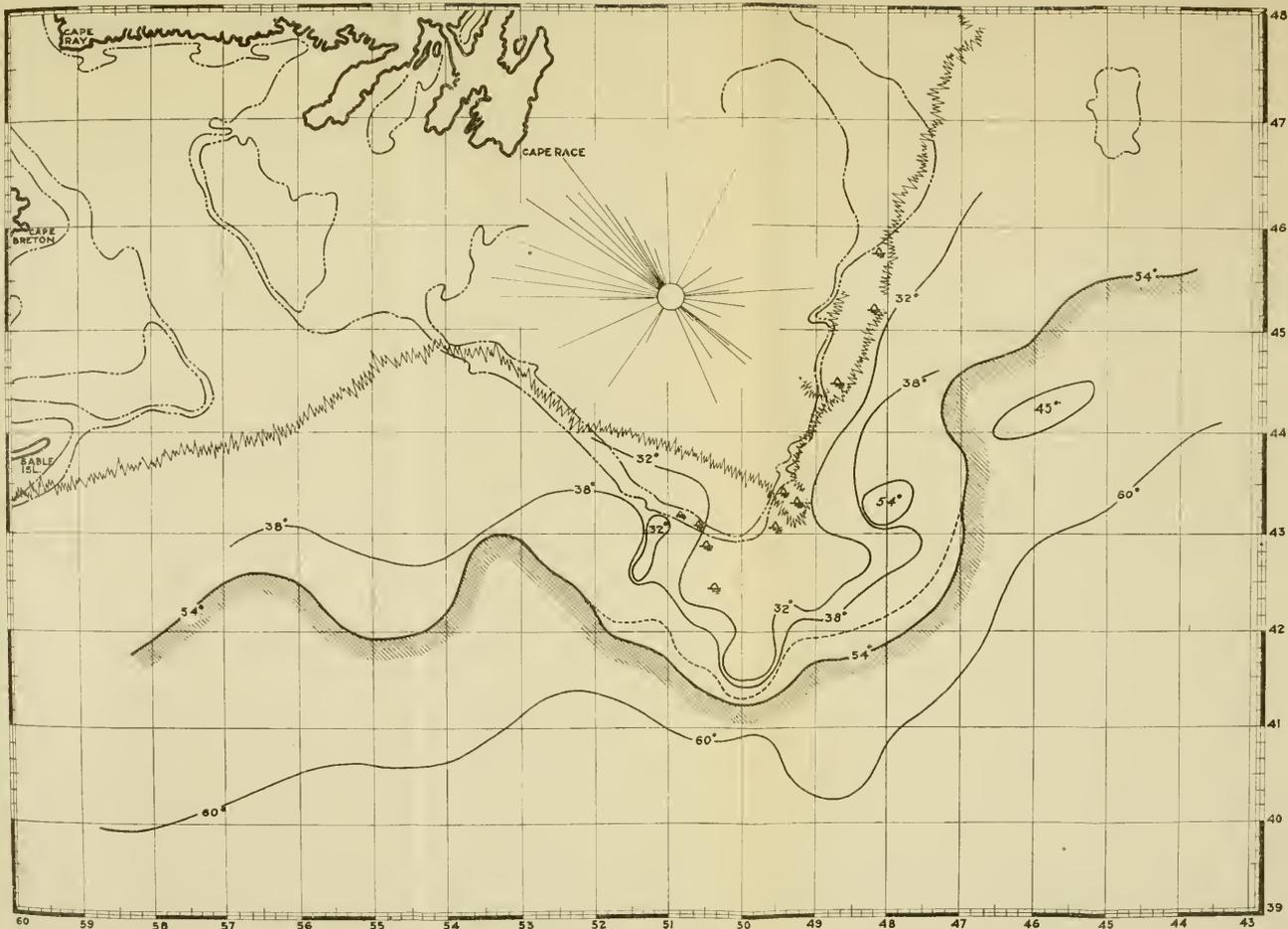
△ BERGS
 --- FIELD ICE, SOUTHERN LIMIT

GENERAL CHART
 COVERING
ICE OBSERVATION
 FEBRUARY 8-26, 1922
 SHOWING SEA-WATER TEMPERATURES AND VARIOUS CONDITIONS IN VICINITY
GRAND BANKS

0 1 2 3 4 5 6 7 8 9 10
 BEAUFORT SCALE FOR WIND DIAGRAM

CHART 'N'





FIRST PART OF MONTH FIELD ICE COVERED GRAND BANKS SOUTH TO 43° 30', 50.00W. FARTHER WEST NEARLY DOWN TO SABLE ISLAND. UNUSUAL AMOUNT OF FIELD ICE. DOTTED ISOOTHERM REPRESENTS CHANGE IN POSITION OF COLD WALL MARCH 25-28.

▲ BERGS
 Wavy FIELD ICE

GENERAL CHART

ICE PATROL

MARCH 15-31, 1922 "SENECA"

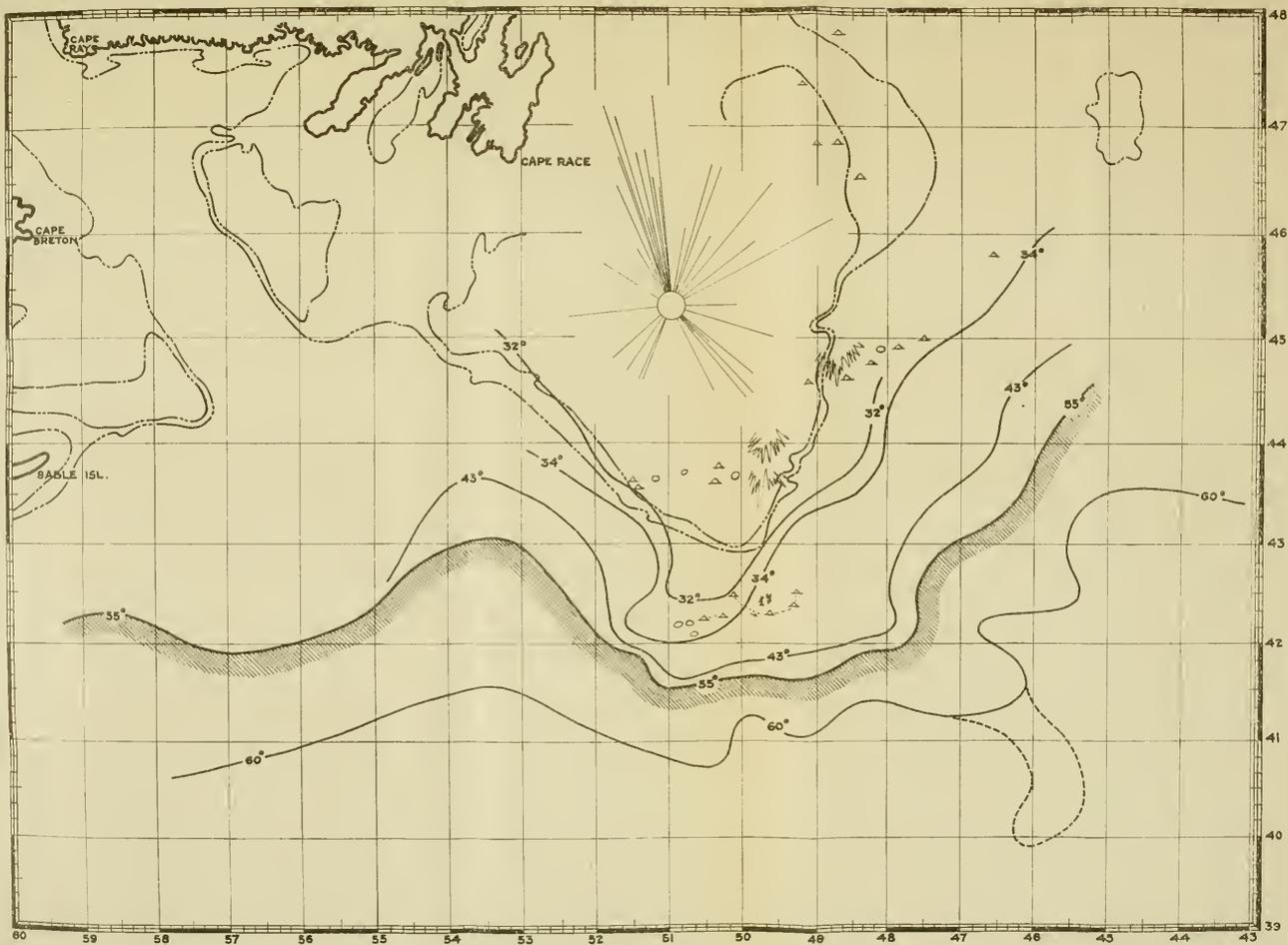
SHOWING SEA-WATER TEMPERATURES AND VARIOUS CONDITIONS IN VICINITY OF GRAND BANKS

BEAUFORT SCALE FOR WIND DIAGRAM

CHART '1'



Faint, illegible text or markings located below the main sketch, possibly bleed-through from the reverse side of the page.



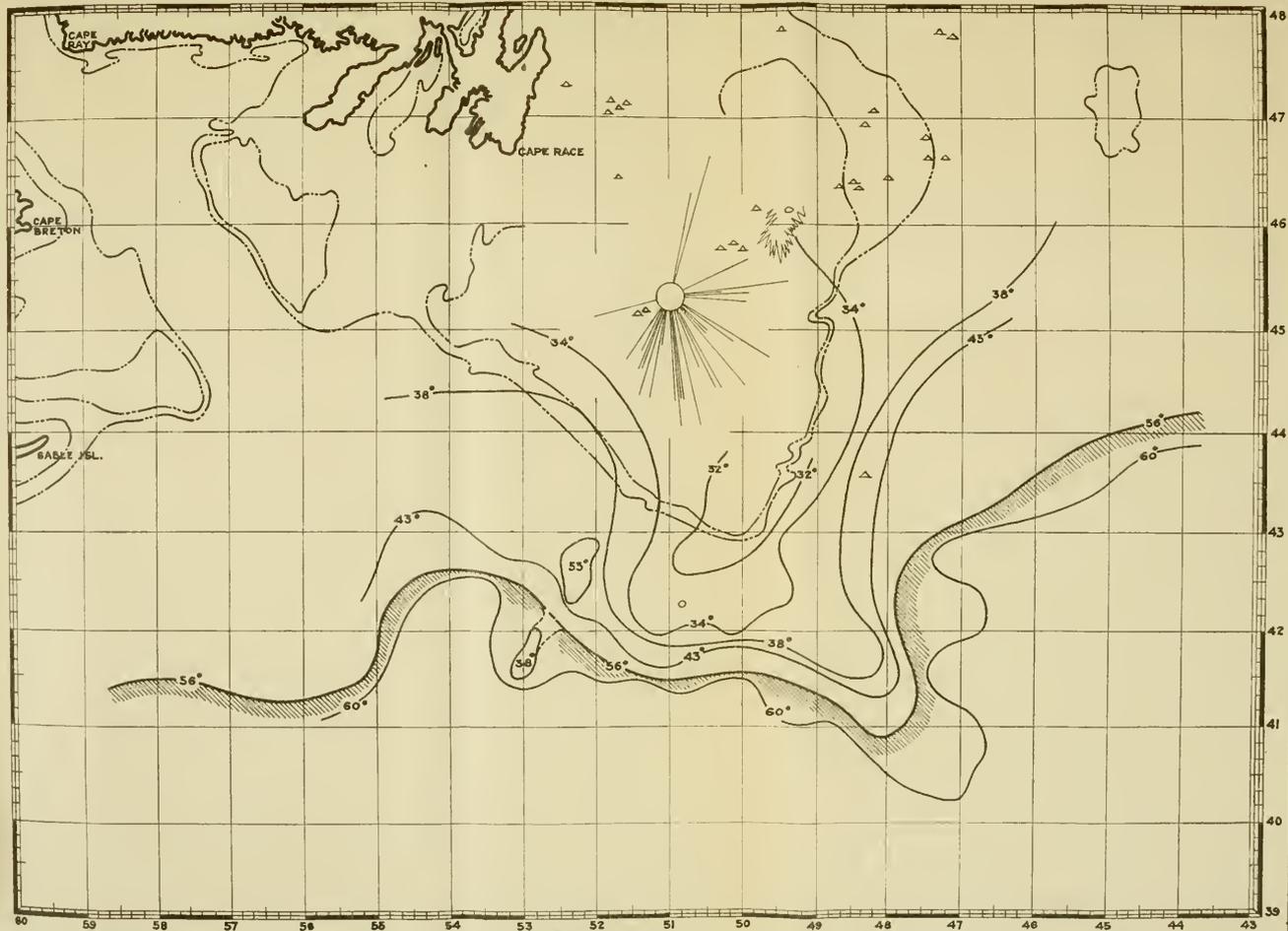
- △ BERGS
- GROWLERS
- ||||| FIELD ICE

GENERAL CHART
 COVERING
ICE PATROL
 APRIL 1-15, 1922 "TAMPA"
 SHOWING SEA-WATER TEMPERATURES AND VARIOUS CONDITIONS IN VICINITY
GRAND BANKS

BEAUFORT SCALE FOR WIND DIAGRAM

CHART 7





GENERAL CHART
COVERING
ICE PATROL

APRIL 16-30, 1922 "SENECA"

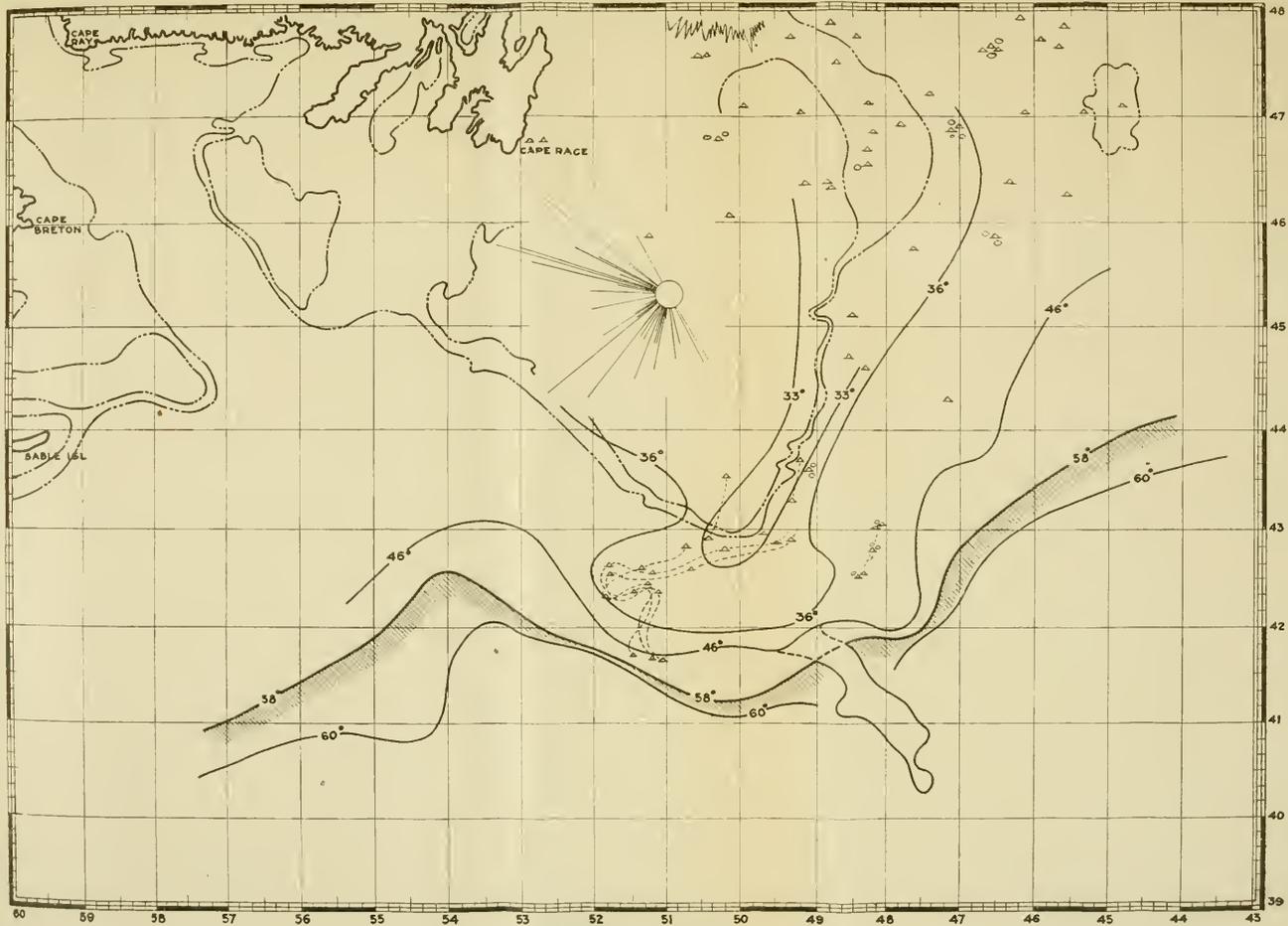
TEMPERATURES AND VARIOUS CONDITIONS IN VICINITY
GRAND BANKS

SHOWING SEA-WATER

- △ - BERGS
- - GROWLERS
- ▨ - FIELD ICE

BEAUFORT SCALE FOR WIND DIAGRAM

CHART "K"



▲ BERGS
 ○ GROWLERS
 ~~~~~ FIELD ICE

**GENERAL CHART  
 COVERING  
 ICE PATROL**

MAY 1-15, 1922 "TAMPA"

TEMPERATURES AND VARIOUS CONDITIONS IN VICINITY

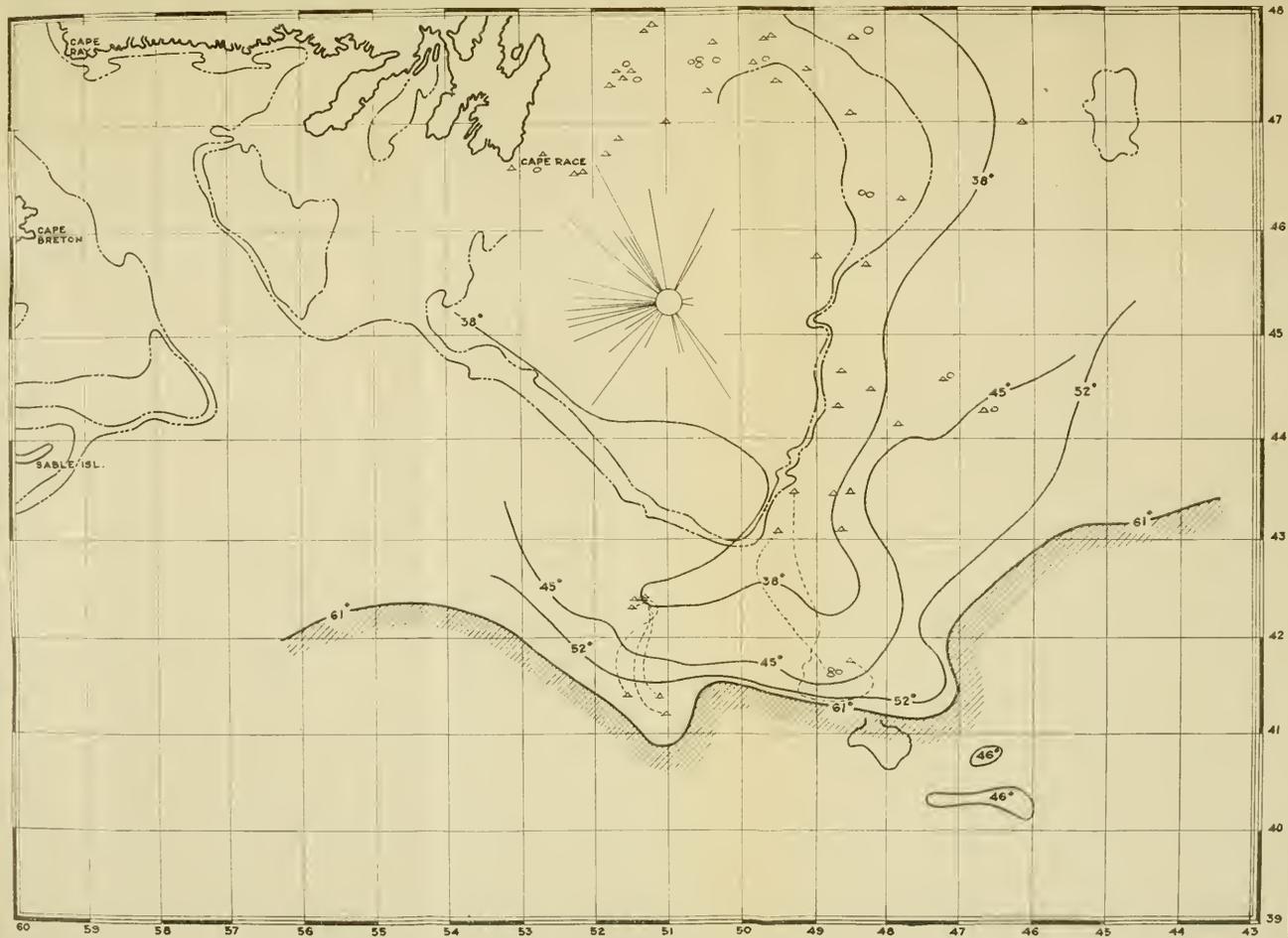
GRAND BANKS

SHOWING SEA-WATER

BEAUFORT SCALE FOR WIND DIAGRAM

CHART



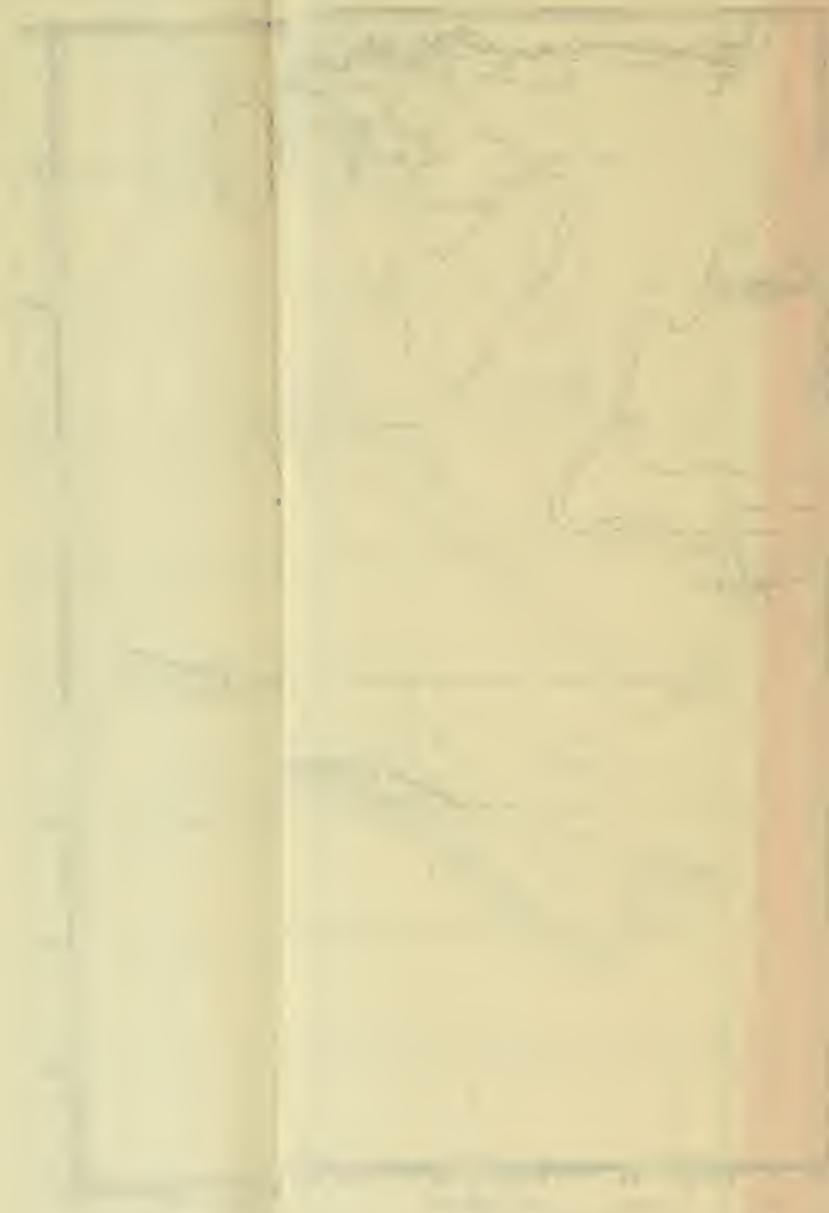


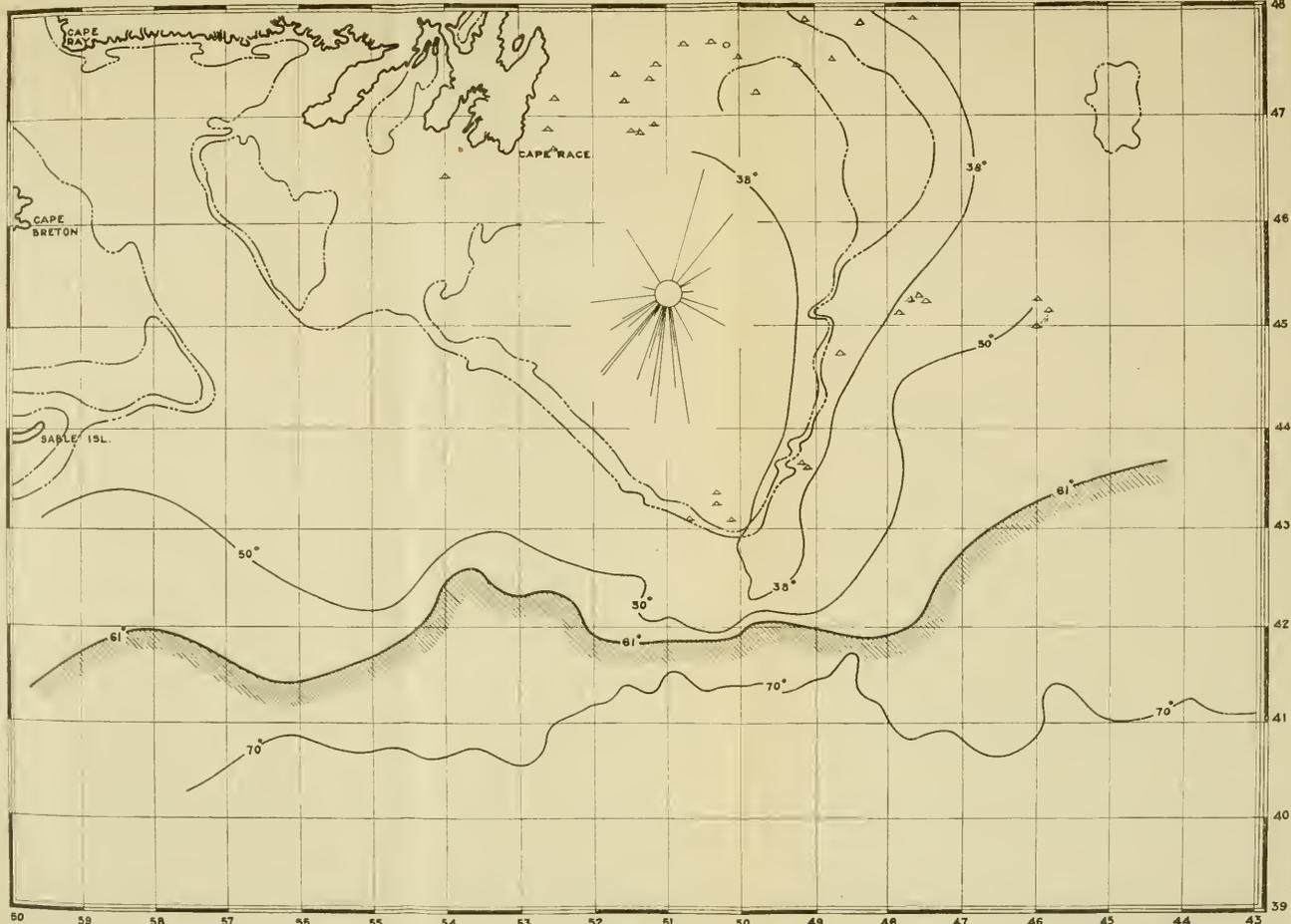
- △ - BERGS
- - GROWLERS
- ▨ - FIELD ICE

**GENERAL CHART**  
 COVERING  
**ICE PATROL**  
 MAY 15 - 30, 1922 "MODOC"  
 SHOWING SEA-WATER TEMPERATURES AND VARIOUS CONDITIONS IN VICINITY  
**GRAND BANKS**

0 1 2 3 4 5 6 7 8 9 10  
 BEAUFORT SCALE FOR WIND DIAGRAM.

CHART 'M'





- △ - BERGS
- - GROWLERS
- ▨ - FIELD ICE

**GENERAL CHART  
COVERING  
ICE PATROL**

MAY 30-JUNE 15, 1922 "TAMPA"

SHOWING SEA-WATER TEMPERATURES AND VARIOUS CONDITIONS IN VICINITY  
**GRAND BANKS**

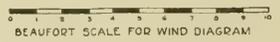
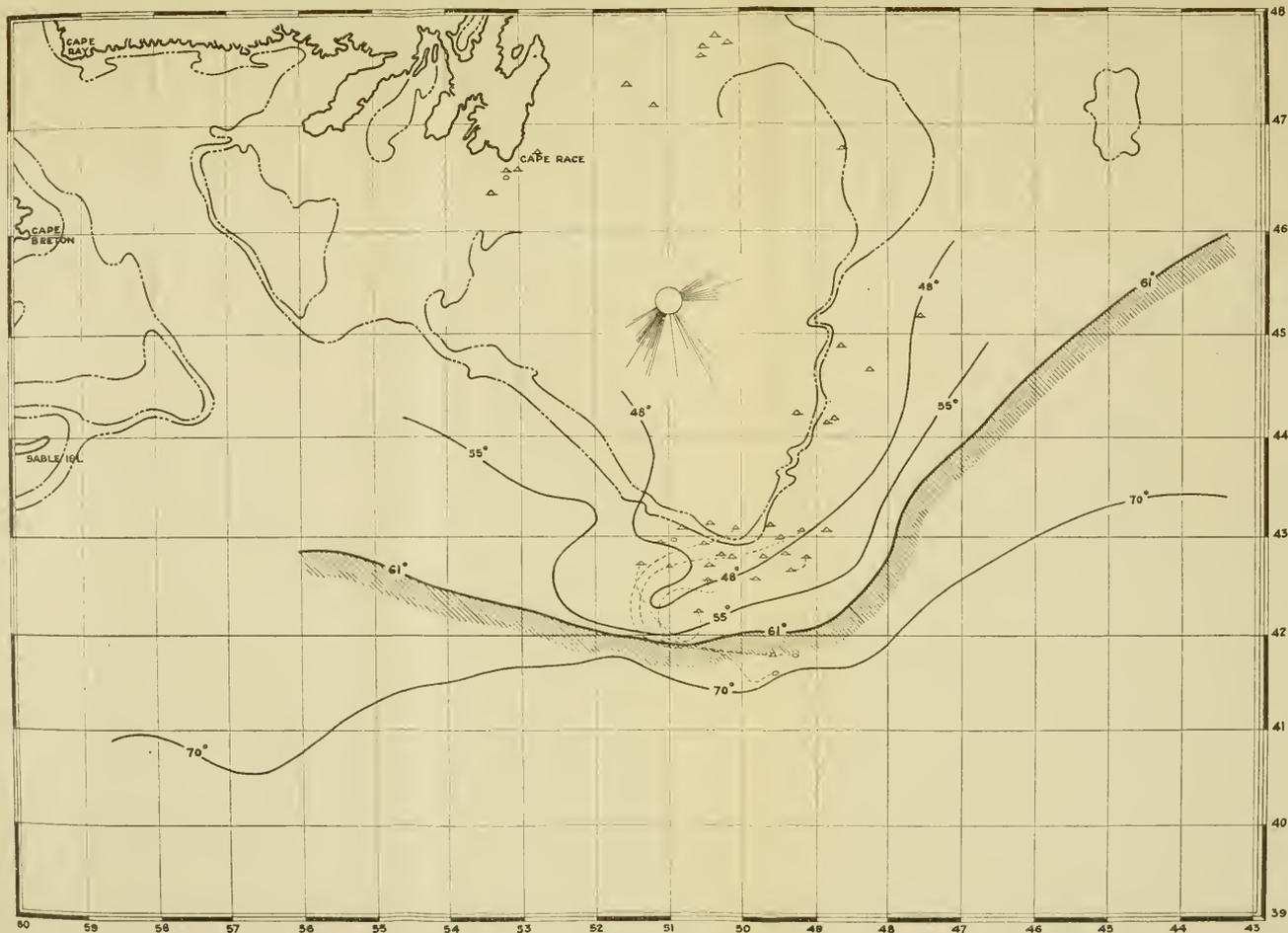


CHART "N"



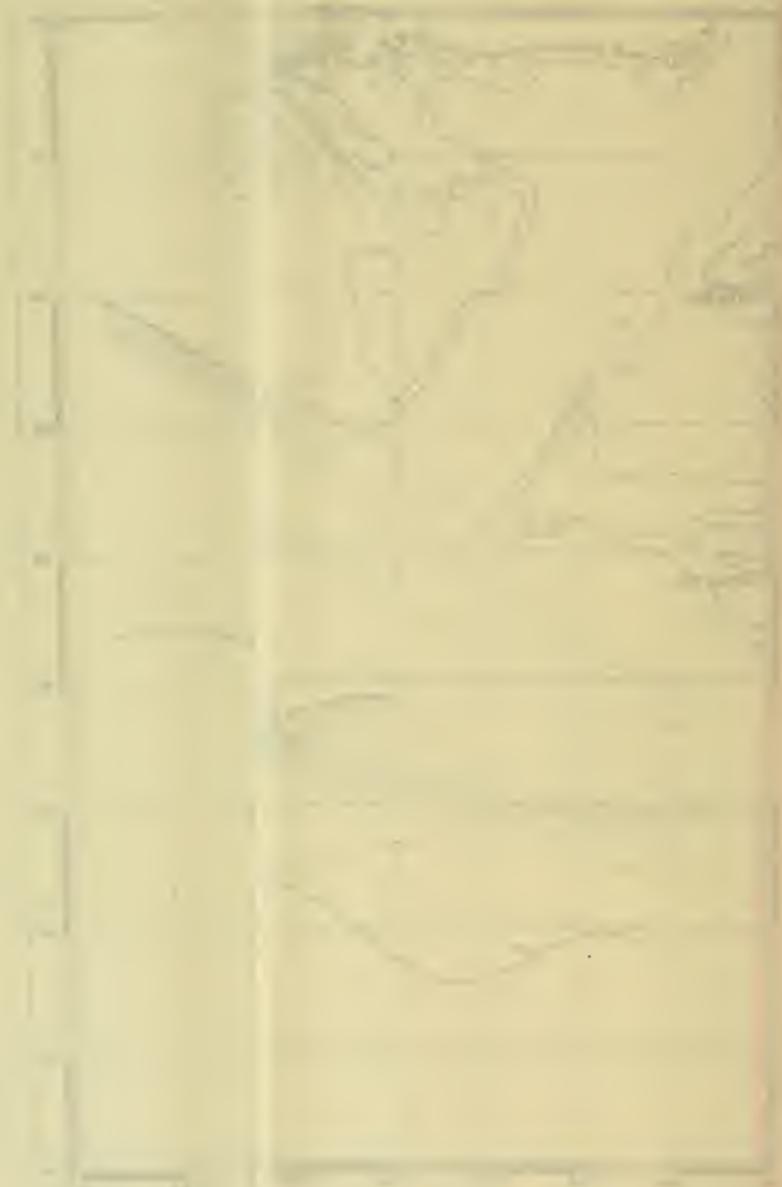


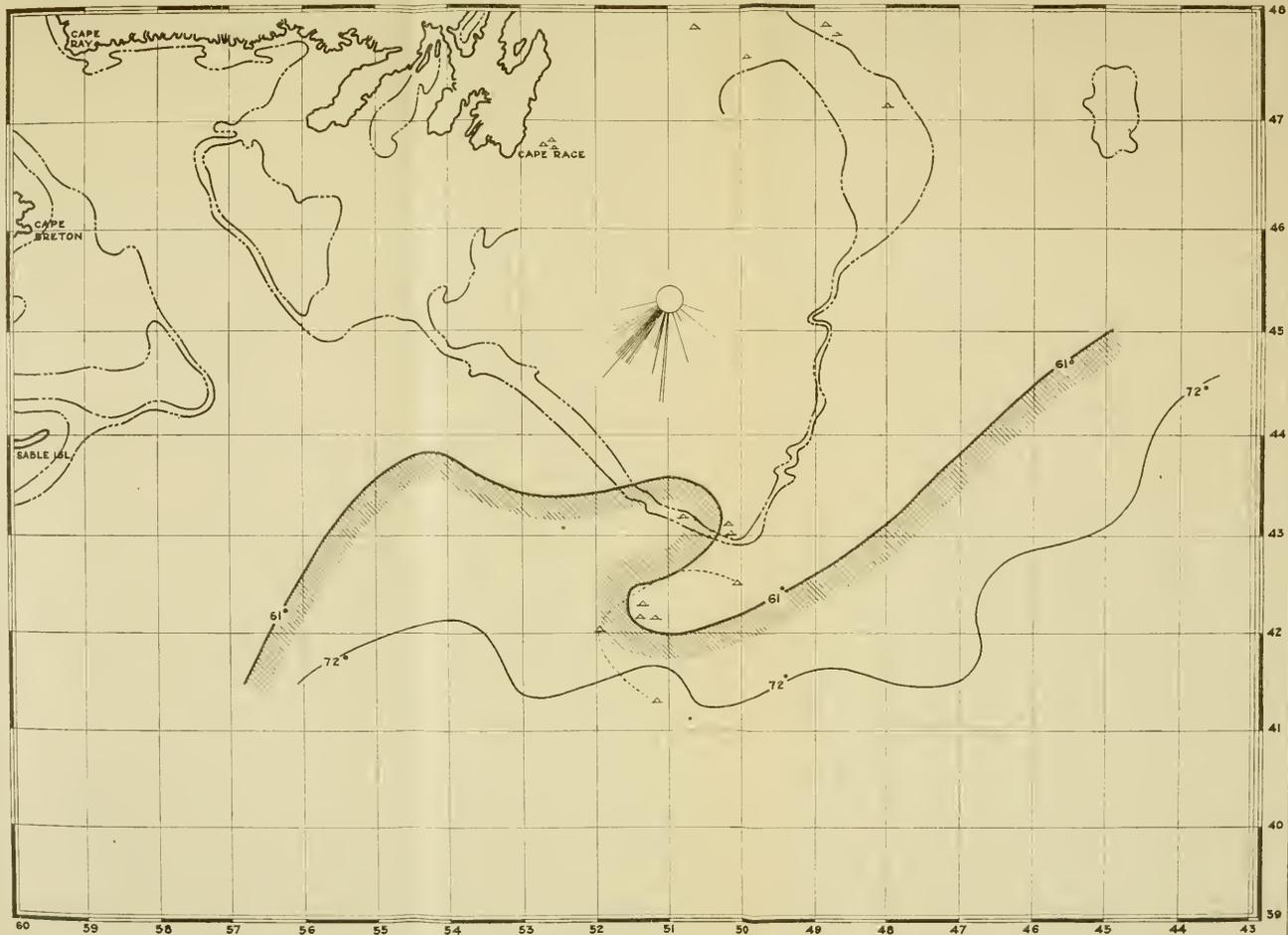
- △ - BERGS
- - GROWLERS
- ▨ - FIELD ICE

**GENERAL CHART**  
 COVERING  
**ICE PATROL**  
 JUNE 15 - 30, 1922 "MODOC"  
 SHOWING SEA-WATER TEMPERATURES AND VARIOUS CONDITIONS IN VICINITY  
**GRAND BANKS**

BEAUFORT SCALE FOR WIND DIAGRAM

CHART "C"





- △ - BERGS
- - GROWLERS
- 〰 - FIELD ICE

**GENERAL CHART**  
COVERING  
**ICE PATROL**

JULY 1 - 14, 1922 "TAMPA"

SHOWING SEA-WATER TEMPERATURES AND VARIOUS CONDITIONS IN VICINITY  
**GRAND BANKS**

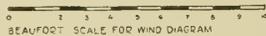


CHART 13



TREASURY DEPARTMENT  
UNITED STATES COAST GUARD

Bulletin No. 11

International  
Ice Observation and Ice Patrol  
Service

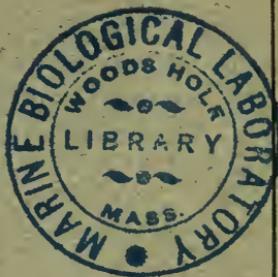
in the  
NORTH ATLANTIC OCEAN



---

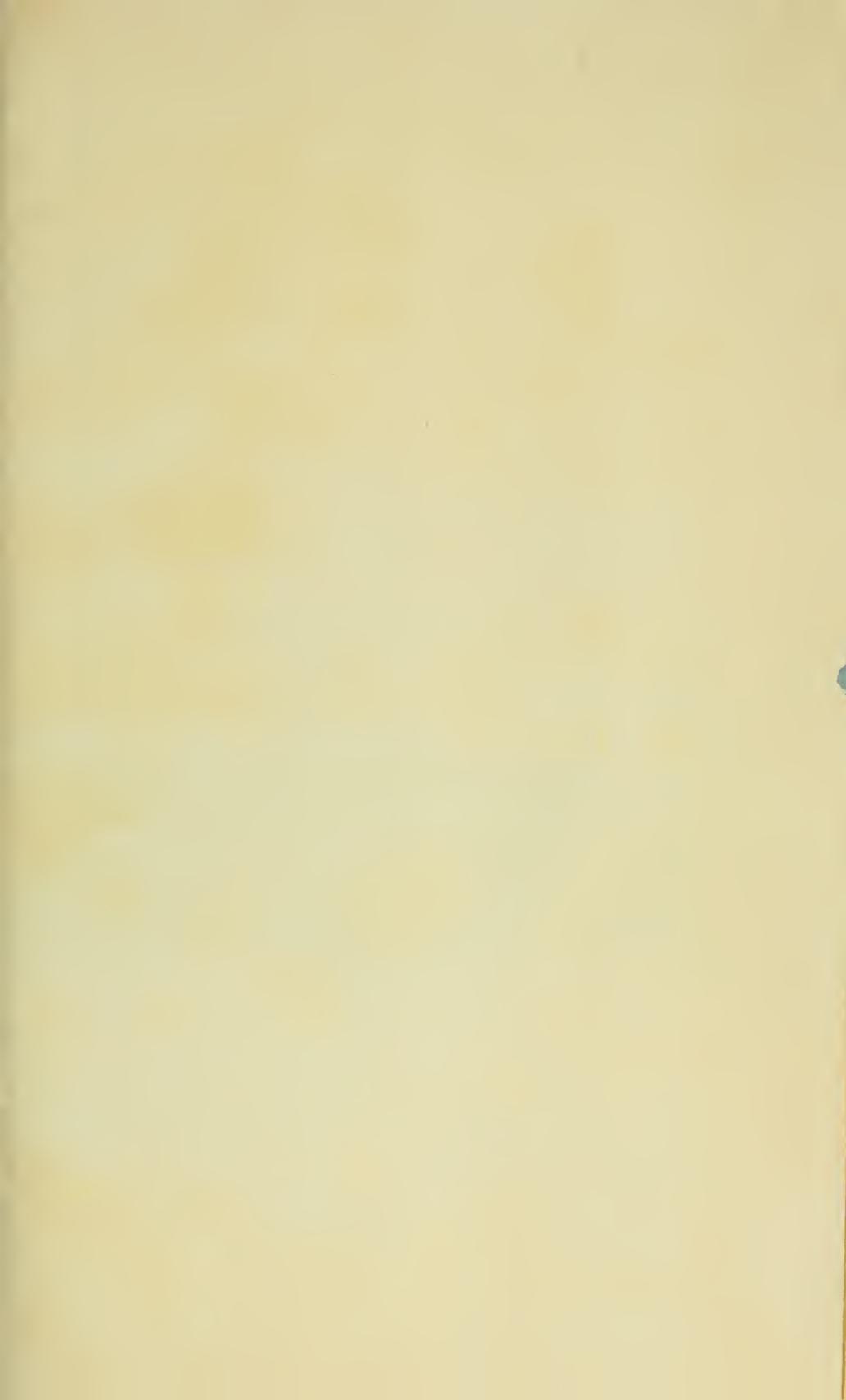
---

Season of 1923

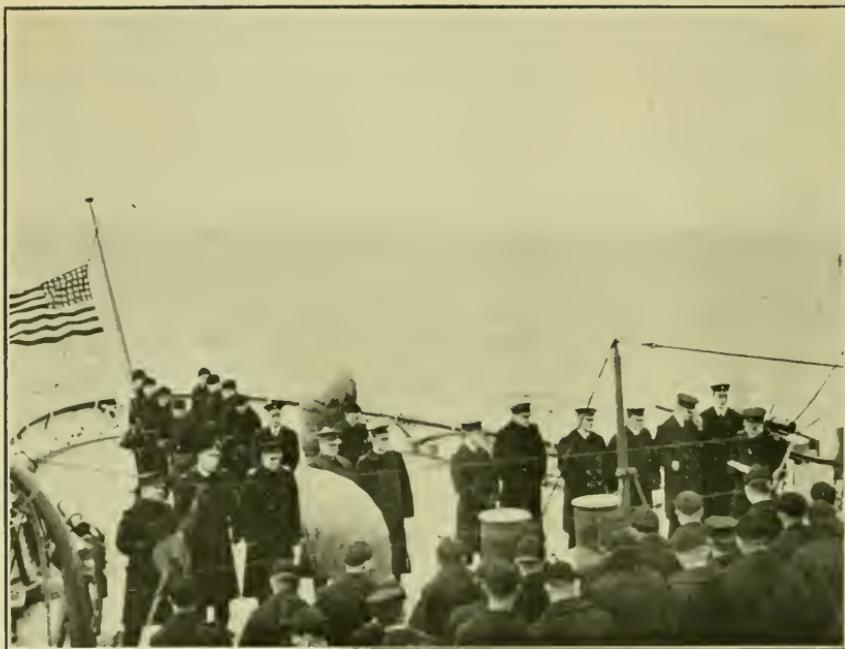


WASHINGTON  
GOVERNMENT PRINTING OFFICE  
1924





FRONTISPIECE.



TITANIC MEMORIAL SERVICE.

TREASURY DEPARTMENT  
UNITED STATES COAST GUARD

Bulletin No. 11

International  
Ice Observation and Ice Patrol  
Service

in the  
NORTH ATLANTIC OCEAN



---

---

Season of 1923



WASHINGTON  
GOVERNMENT PRINTING OFFICE  
1924

International  
Journal of Law and Economics  
and  
Finance

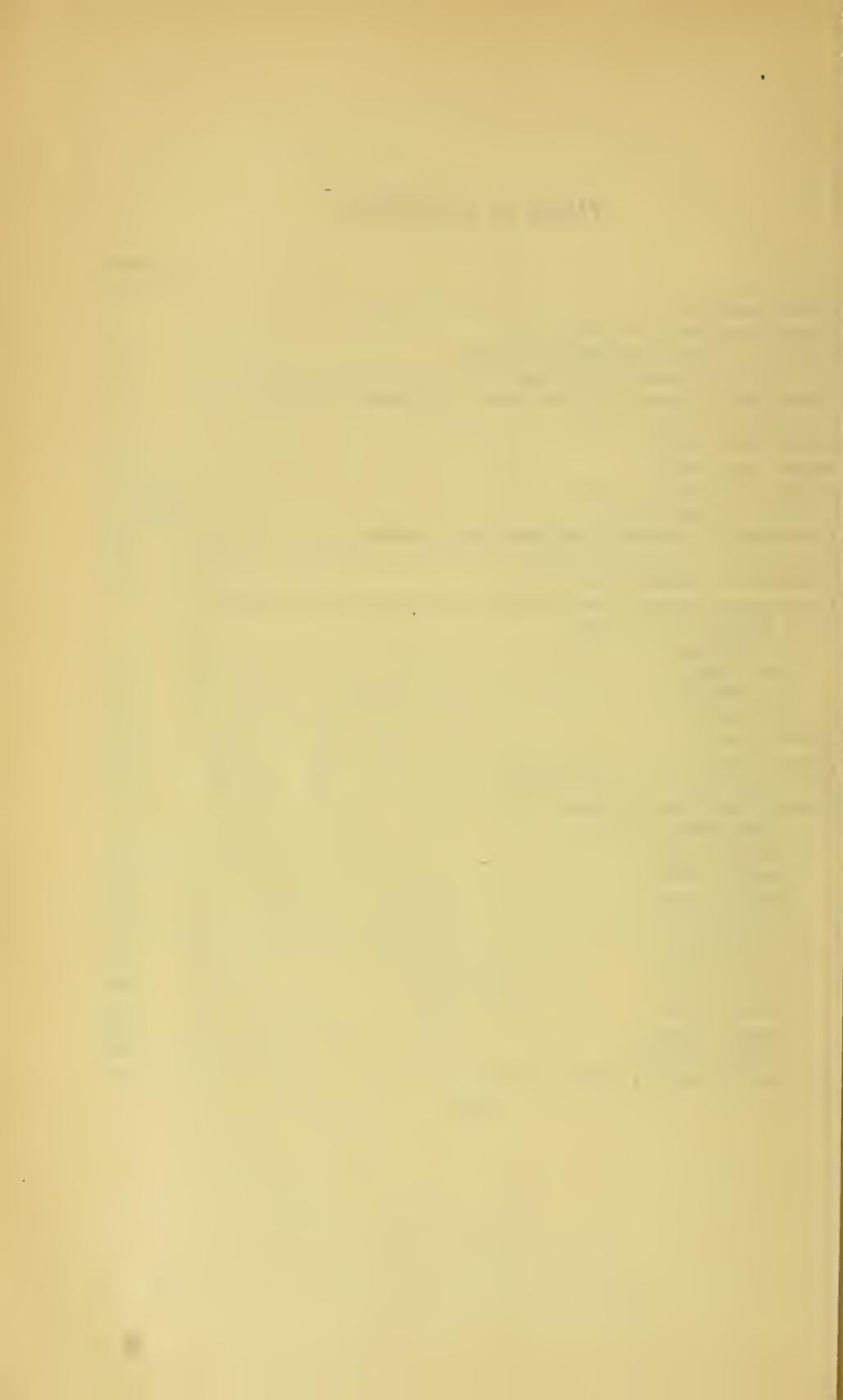
Volume 1, No. 1  
1998



Published by  
[Faint text]

## TABLE OF CONTENTS.

|                                                                             | Page.       |
|-----------------------------------------------------------------------------|-------------|
| Frontispiece .....                                                          | Face title. |
| Orders, ice patrol .....                                                    | 1           |
| Commanding officers' reports .....                                          | 5           |
| Summary report by commander ice patrol .....                                | 61          |
| Table of ice and other obstructions .....                                   | 64          |
| Oceanographer's monthly reports, with two sketches in the text .....        | 70          |
| Oceanographic station Chart A .....                                         | 71          |
| Station table, 1923 .....                                                   | 92          |
| Station table, 1919 .....                                                   | 103         |
| Profiles of subsurface sections (1-19) .....                                | 110-159     |
| Discussion of profiles 1-15 .....                                           | 109-136     |
| Oceanographic summary for ice season, with eight sketches in the text ..... | 139         |
| The October oceanographic cruise .....                                      | 151         |
| Discussion of profiles 16-19 .....                                          | 152         |
| Oceanographic summary for October cruise, with one sketch in text .....     | 160         |
| Wind diagram and fog scale:                                                 |             |
| March, Figure 1 .....                                                       | 73          |
| April, Figure 2 .....                                                       | 75          |
| May, Figure 3 .....                                                         | 80          |
| June, Figure 4 .....                                                        | 87          |
| Iceberg Chart B .....                                                       | 165         |
| Iceberg Chart C .....                                                       | 166         |
| Monthly limits of the "cold-wall" "D" .....                                 | 166         |
| Annual limits of the "cold-wall" "E" .....                                  | 89          |
| Surface temperature charts:                                                 |             |
| Chart F, March .....                                                        | 166         |
| Chart G, March .....                                                        | 166         |
| Chart H, April .....                                                        | 166         |
| Chart I, April .....                                                        | 166         |
| Chart J, May .....                                                          | 166         |
| Chart K, May .....                                                          | 166         |
| Chart L, June .....                                                         | 166         |
| Chart M, June .....                                                         | 166         |
| Chart N, July .....                                                         | 166         |
| Chart O, October .....                                                      | 166         |
| Berg distribution 1911-1923, Chart P .....                                  | 166         |



## INSTRUCTIONS FOR THE ICE PATROL.

---

TREASURY DEPARTMENT,  
UNITED STATES COAST GUARD,  
Washington, February 9, 1923.

To the Commanding Officers of Coast Guard cutters on Ice Patrol, 1923:

1. The *Modoc* and the *Tampa* are designated to carry out the International Ice Patrol during the season of 1923. The *Seneca* is designated as stand-by vessel. The senior line officer present is assigned to command the patrol. The commanding officer of the *Tampa* will command until the arrival on patrol of a senior commanding officer. Vessels concerned will make the necessary preparations to carry out these orders.

2. The object of the patrol is to locate the icebergs and ice fields nearest to the trans-Atlantic steamship lanes. It will be the duty of patrol vessels to determine the southerly, easterly, and westerly limits of the ice and to keep in touch with these fields as they move to the southward, in order that radio messages may be sent out daily, giving the whereabouts of the ice, particularly the ice that may be in the immediate vicinity of the regular trans-Atlantic steamship lanes.

3. The patrol will continue until the ice no longer constitutes a danger to navigation in the trans-Atlantic steamship lanes. The ice season is usually three months—April, May, and June.

4. While on this patrol the *Modoc* and the *Tampa* will base temporarily and obtain fuel and other necessary supplies at Halifax, Nova Scotia. The two vessels will alternate on patrol, making alternate cruises of about 15 days in the ice region, the 15 days to be exclusive of the time occupied in going to and from base. The patrol commander will so regulate the movements of the vessels that on the fifteenth day after reaching the ice region the vessel on patrol will be relieved by the second vessel, if possible, at which time the first vessel will proceed to base, replenish her fuel supply, and return in time to relieve the other vessel at the end of the latter's 15-day cruise. It is important that the patrol be continuous, and the vessel on patrol must not leave her station until relieved by the other vessel, unless it should be absolutely necessary to do so.

5. Having located the ice, the patrol vessel will send the following daily radiograms. All times in radiograms will be in 75th meridian time:

(a) At 6 a. m. and 6 p. m. (75th meridian time) ice information will be sent broadcast for the benefit of vessels, using 600-meter wave length. This message will be sent three times, with an interval of two minutes between each.

(b) At 8 p. m. (75th meridian time) a radiogram will be sent to the Hydrographic Office, Washington, D. C., defining the ice danger zone, its southern limits, or other definite ice news. The telegraphic address of the Hydrographic Office is "Hydrographic, Washington."

(c) Ice information will be given at any time to any ship with which the patrol vessel can communicate

(d) Radio communication shall be carried on by the most practicable and convenient route, having due regard for the economy which may be effected by transmitting through naval radio stations. Bar Harbor has been instructed to give priority to all traffic to and from vessels on ice-patrol duty, and that station should normally be used, if possible. Bar Harbor can receive either day or night from the Canadian radio station at Glace Bay, Cape Breton Island. It is suggested that, whenever the vessel on patrol duty may be unable to communicate directly with Bar Harbor, the station at Glace Bay would provide means of relaying the dispatch more quickly than the station at Cape Race. Headquarters will route all messages for vessels on ice patrol through Bar Harbor. If, for any reason, patrol vessels are unable to receive from Bar Harbor, headquarters shall be advised of that fact by any means available, in order that messages may be routed through Cape Race.

6. Ice information will be given in as plain, concise English as practicable, and will be stated in the following order:

- (a) Position of patrol vessel.
- (b) Location and description of ice.
- (c) Other data as may be necessary.

7. Attention is called to article 3235 (c), Regulations, the provisions of which will be followed in radiograms sent to the Hydrographic Office. (See par. 5-b of this order.) In radiograms sent to vessels other than Coast Guard cutters the words "latitude" and "longitude" will be used.

8. While on this duty the patrol vessels will endeavor by means of daily radio messages to keep ships at sea advised of the limits of the ice fields, etc.

9. The ice patrol vessels' radio call letters are KFOG. This is a special "call" for the vessel actually on patrol, and must not be confounded with the regular "call letters" of the vessels. The patrol vessels shall use a wave length of 600 meters when communicating with passing vessels.

10. The radio messages from the patrol ship will be given publicity immediately upon their receipt by the Hydrographic Office, Wash-

ington, and by the branch Hydrographic offices at Boston, New York, and Norfolk.

11. Each patrol vessel will keep a remark book in which will be entered all data and information concerning the ice that can be collected.

12. Each vessel, on being relieved by the other vessel, will deliver to the relieving vessel a copy of each radiogram sent to or received from the Hydrographic Office during the cruise, and a copy of each instruction received from Headquarters by radio.

13. At the end of each cruise each vessel will forward to Headquarters a full report in triplicate. *These reports should not include any matters of purely ship's business or ship's routine which do not relate to the ice patrol.* Each vessel will send these reports direct to Headquarters and furnish a copy of each report to the other vessel on patrol.

14. Each vessel will plot on tracing paper used in connection with the appropriate plotting sheet, the positions and extent of the ice as located from time to time. Such data will also be plotted on a duplicate tracing paper, and this duplicate will be delivered to the relieving vessel.

15. If, in order to avoid delay in any emergency, it becomes necessary for the junior commanding officer to communicate directly with Headquarters, a copy of each such communication shall be furnished to the patrol commander.

16. Barometers of patrol vessels must be calibrated by the United States Weather Bureau before sailing on patrol duty.

W. E. REYNOLDS, *Commandant.*

---

TREASURY DEPARTMENT,  
UNITED STATES COAST GUARD,  
*Washington, April 21, 1923.*

*To the Commanding Officers of Coast Guard Cutters on Ice Patrol, 1923:*

1. Paragraph 5 of Headquarters' letter of February 9, 1923, is amended to read as follows:

5. Having located the ice, the patrol vessel will send the following daily radiograms. All times in radiograms will be in 75th meridian time:

(a) At 6 a. m. and 6 p. m. (75th meridian time) ice information will be sent broadcast for the benefit of vessels, using 600-meter wave length. This message will be sent three times, with an interval of two minutes between each.

(b) At 8.30 p. m. (75th meridian time) ice information will be sent broadcast for the benefit of vessels, using 2,300-meter wave length. This message will be sent three times, with an interval of two minutes between each.

(c) At 7 p. m. (75th meridian time) a radiogram will be sent to the Hydrographic Office, Washington, D. C., defining the ice danger zone, its southern limits, or other definite ice news. The telegraphic address of the Hydrographic Office is "Hydrographic, Washington."

(d) Ice information will be given at any time to any ship with which the patrol vessel can communicate.

(e) Radio communication shall be carried on by the most practicable and convenient route, having due regard for the economy which may be effected by transmitting through naval radio stations. Bar Harbor has been instructed to give priority to all traffic to and from vessels on ice patrol duty, and that station should normally be used if possible. Bar Harbor can receive either night or day from the Canadian radio station at Glace Bay, Cape Breton Island. It is suggested that whenever the vessel on patrol duty may be unable to communicate directly with Bar Harbor the station at Glace Bay would provide means of relaying the dispatch more quickly than the station at Cape Race. Headquarters will route all messages for vessels on ice patrol through Bar Harbor. If for any reason patrol vessels are unable to receive from Bar Harbor, Headquarters shall be advised of that fact by any means available in order that messages may be routed through Cape Race.

2. The above instructions shall be effective as of the beginning of the day on May 1, 1923.

W. E. REYNOLDS, *Commandant.*

## REPORTS OF COMMANDING OFFICERS.

---

### CRUISE OF COAST GUARD CUTTER "SENECA," COMMANDER A. L. GAMBLE, MARCH 8 TO 19, 1923.

The *Seneca* sailed from New York at 2 p. m., March 8, for the Grand Banks of Newfoundland, to inaugurate the ice patrol for the season of 1923. Moderate to fresh NW. to N. breezes and smooth sea prevailed on the 8th and 9th. The barometer was high and steady until the afternoon of the 10th, when it fell rapidly. On the morning of the 11th the wind had increased to a SW. gale, veering before noon to NW., with heavy westerly swells.

During the forenoon of the 11th an ice report was received from Cape Race, giving the position of the southernmost berg as lat.  $42^{\circ} 49' N.$ , long.  $49^{\circ} 46' W.$  This information was embodied in our first broadcast, the evening of the 11th, and in report to the Hydrographic Office of same date. We later learned that this berg was reported to Cape Race on February 28. It has probably gone to the eastward, as no subsequent reports have been received from the vicinity in which it was first located.

Strong winds with heavy swell from the NW. prevailed on the 12th, with the barometer slowly rising; the temperature of the surface water dropped from  $50^{\circ} F.$  to  $36^{\circ} F.$  and dovekeys were sighted for the first time. The steamer *Weyingham* reported a berg in lat.  $43^{\circ} 20' N.$ , long.  $46^{\circ} 50' W.$  Upon request of the steamer *Ossa*, she was given routing through the ice regions.

The barometer started falling on the 13th. The wind backed from NW. to SE. and at noon hauled to W., with dense fog. The steamer *Lord Dufferin* reported a berg in lat.  $45^{\circ} 53' N.$ , long.  $46^{\circ} 07' W.$ , and one in lat.  $45^{\circ} 35' N.$ , long.  $46^{\circ} 44' W.$  Upon her request, special ice report was furnished the steamer *Asian*. The steamer *West Helix* reported engine trouble in lat.  $41^{\circ} 51' N.$ , long.  $51^{\circ} 26' W.$ , bound west, and requested the positions of westbound vessels. She was given the position of the *Bradclyde* as that nearest to her, but was picked up by the steamer *West Elcasco*. Her plight and position were included in our broadcasts on the 13th and 14th. The *Seneca* arrived off the Tail of the Bank, lat.  $42^{\circ} 49' N.$ , long.  $49^{\circ} 46' W.$ , at 5 p. m. on the 13th.

The 14th continued foggy, with vessel drifting to moderate SW. wind and heavy swell; barometer low and falling slowly, but started

up at 8 p. m. and wind veered and increased to NW. gale, making up a heavy swell. The steamer *Lord Dufferin* reported slob ice in lat.  $42^{\circ} 52' N.$ , long.  $49^{\circ} 25' W.$  The steamer *Canadian Mariner* reported an ice field beginning in lat.  $43^{\circ} 20' N.$ , long.  $48^{\circ} 50' W.$ , and extending south. At the request of the latter vessel, gave her a routing through the ice regions. Kittiwakes and dovekeys were seen this day. The temperature of the surface water was  $30^{\circ} F.$

The moderate NW. gale and heavy swell continued on the 15th, with barometer rising. During daylight hours steamed to the eastward, in search of ice, with snow flurries causing poor visibility. Cape Race reported an ice field over the Grand Bank, extending southward from the Newfoundland shore to lat.  $44^{\circ} 27'$ , long.  $51^{\circ} 16'$ , and bergs as follows: lat.  $44^{\circ} 24'$ , long.  $42^{\circ} 40'$ ; lat.  $44^{\circ} 48'$ , long.  $42^{\circ} 40'$ ; lat.  $47^{\circ} 10'$ , long.  $43^{\circ} 43'$ ; lat.  $46^{\circ} 32'$ , long.  $44^{\circ} 47'$ , and lat.  $43^{\circ} 05'$ , long.  $47^{\circ} 30'$ .

On the 16th the steamer *Gallymere* reported a berg and growlers in lat.  $44^{\circ} 25' N.$ , long.  $43^{\circ} 33' W.$ , and lat.  $44^{\circ} 32' N.$ , long.  $43^{\circ} 02' W.$  Kittiwakes and dovekeys were seen this day. NW. gale and heavy swell continued on this day, with snow flurries; barometer rising. Vessel drifting. Temperature of the surface water  $30^{\circ} F.$  The steamer *Cottage City* reported ice field and growlers in lat.  $43^{\circ} 30' N.$ , long.  $59^{\circ} 05' W.$

The wind fell to a light westerly breeze on the morning of the 17th. Visibility high. At 8.30 a. m., under way and stood to NE. The vessel had drifted 36 miles,  $160^{\circ}$ , in 36 hours, to a position in lat.  $41^{\circ} 52' N.$ , long.  $49^{\circ} 02' W.$  The water temperature had meanwhile risen from  $29^{\circ}$  to  $34^{\circ} F.$  Received radiogram from the *Tampa*, reporting that she was on her way to relieve the *Seneca*. In the afternoon received a radiogram from the steamer *Vittorio Emmanuelle III*, reporting a berg in lat.  $44^{\circ} 37' N.$ , long.  $41^{\circ} 40' W.$  This position is 30 miles from the west bound track from Fastnet. Broadcasted warning to vessels not to go north of west bound track between lat.  $41^{\circ} 30' N.$ , long.  $47^{\circ} 00' W.$ , and lat.  $44^{\circ} 40' N.$ , long.  $40^{\circ} 00' W.$  Gave ice information to steamer *President Garfield*, bound east. The visibility becoming poor, stopped at 5.30 p. m. and drifted to strong SW. wind and swell, with choppy sea.

Early in the morning of the 18th the barometer fell to 29.75. The strong SW. breeze veered to NNW., with heavy rain squall, followed by clearing weather and high visibility. Steamer *Carmania* reported a berg in lat.  $43^{\circ} 20' N.$ , long.  $50^{\circ} 10' W.$  Searched an area 60 by 40 miles, between 47th and 48th meridians and 43d parallel south to lat.  $42^{\circ} 00' N.$  Steamer *Pinemoor* reported a berg in lat.  $43^{\circ} 00' N.$ , long.  $50^{\circ} 24' W.$ , placing it on the extreme tip of the Grand Bank.

During the period of the *Seneca's* patrol daily reports to Hydrographic, Washington, were radioed from March 11 to March 19,

inclusive. Warnings were broadcast at 6 a. m. and at 6 p. m., 75th meridian time, from the night of the 11th to the night of the 19th, inclusive. As the vessel never anchored, no current observations were made and what drift was observed could be accounted for by wind surface set. The prevailing winds were strong SW. to NW., with choppy sea. The following steamers gave us ice reports: *Weyingham*, *Lord Dufferin*, *Canadian Mariner*, *Gallymere*, *Cottage City*, and *Pinemoor*. Sixty-eight vessels contributed 321 surface-water temperature reports, according to which the edge of the Gulf Stream swept in an easy curve through lat. 42° 00' N., long. 55° 00' W., lat. 41° 30' N., long. 50° 00' W., lat. 42° 30' N., long. 46° 00' W.

The *Tampa* was intercepted in lat. 42° 50' N., long. 50° 45' W. at 5 p. m., March 19, when the patrol was taken over by that vessel.

**COAST GUARD CUTTER "TAMPA," LIEUT. COMMANDER W. J. WHEELER, ICE PATROL, FIRST CRUISE, MARCH 15 TO APRIL 3, 1923.**

The *Tampa* left Boston Navy Yard at 1 p. m., March 15, to relieve the *Seneca* on international ice patrol duty. Light airs to gentle breezes were experienced until the early morning of March 16, when the southerly breeze gradually increased to moderate and fresh gale, S. to SW., with falling barometer, which continued from 10 a. m. the 16th until 4 a. m. the 17th. This was followed by a rising barometer, the wind shifting to NW. and falling to gentle and light variable breezes, which continued until the night of the 19th. The southerly gale made up a very heavy sea on the night of the 16th and 17th. Flying fish were observed in the forenoon of the 19th, in lat. 42° 50', indicating that the Gulf Stream was unusually far north. At 12.20 p. m., March 19, a berg, apparently of medium size, was sighted in lat. 43° 00', long. 51° 48'. At 3.30 p. m. the same day a second medium-sized berg was sighted, in lat. 42° 58', long. 50° 52'. The *Tampa* met the *Seneca* at 4.40 p. m., March 19, in lat. 42° 49', long. 50° 39', and relieved her of the ice patrol duty, the *Seneca* leaving for New York. At 6.05 p. m. the *Tampa* stood 65°, true, for a third berg, sighted some 8 miles distant, and at 6.50 p. m. stopped and drifted for the night in the vicinity of the berg. As per arrangement, the routine reports were sent out by the *Seneca* this day.

March 20 began with the vessel drifting. At 5.30 under way to locate the last berg sighted on the previous day. At 7.05 a. m. sighted the berg, distant 6 miles. Stood around berg, photographed it, and ascertained that it was grounded on the Tail of the Bank in lat. 42° 55', long. 50° 21'. Many shearwater, dovebies, and a few sea parrots were in the vicinity of this berg. The following weather

prevailed: Fresh SW. breeze, increasing to moderate gale, SW. to WNW., with partially thick weather first part, mostly clear latter part; very rough sea. Drifted until 4.25 p. m., then anchored on Bank, in 30 fathoms of water, with berg in sight, bearing 235° true.

March 21: Moderate gale to strong breeze, WNW. to NNW.; partly clear; rough sea. The vessel remained at anchor the entire day. Special ice information was sent to three vessels.

March 22 began with the vessel at anchor; moderate gale, NW., falling to moderate and gentle breezes by noon; partly cloudy. At 8.40 a. m. under way; stood to berg and again photographed it. Numerous sea parrots, dovebies, gulls, and shearwater near by. At 9.50 a. m. resumed search for bergs in area not fully covered by reports. At 5.40 p. m. stopped and lay to for the night. Special ice information was sent to the steamship *President Fillmore*. Routine reports were broadcast and sent to Halifax.

March 23 began with the vessel drifting; moderate to light breezes, NNW. to SSE.; mostly cloudy; partially thick first part. Under way at 5.30 a. m., to make search near steamer tracks to eastward. First course north, true, to counteract night drift. At 5.50 a. m. thick snow shut in; stopped and drifted. At 8.05 a. m., clearing, under way, searching for bergs. At 11.45 a. m. stopped because of reduced visibility. At 1.30 p. m. visibility improved and search was resumed. At 5.30 p. m. stopped and lay to for the night. At 7 p. m. a steamer passed near by. Special ice information was sent to the steamships *Scandia*, *Aquitania*, *Cameronia*, and *Way Mehyar*.

March 24 began with the vessel drifting; moderate to gentle breezes, WNW. to NW.; mostly cloudy this day, with fog at intervals during the first part; partially foggy at daybreak, clearing about 6.30 a. m. At 6.50 a. m. under way, to investigate ice conditions near tracks to eastward and to trace out position of Gulf Stream by means of water temperatures. At 8 a. m., fog shutting in, stopped and lay to. At 9.10 a. m., fog clearing, resumed search for bergs until 5.30 p. m., when stopped for the night, having reached water with a temperature of 34° F. Gave ice information to steamships *Alexandria* and *Springfield*.

March 25 began with the vessel lying to. A gentle to moderate E. breeze increased suddenly to a moderate to fresh W. to WNW. gale at 7 a. m., shifted to NNE. at 1.30 p. m., and backed to NNW. at nightfall. Strong WNW. breeze at close. Barometer 29.18 at 7 a. m., rising thereafter. Mostly cloudy; partially thick at intervals. Heavy sea. Lay to throughout the day, the vessel drifting back into the Gulf Stream, as shown by water temperatures in the afternoon. Special ice warnings were sent to the following steamships: *Caucasier*, west bound, lat. 42° 20', long. 48° 30', warned of bergs west of Tail

and advised to proceed to  $41^{\circ} 30'$  track; *Montclair*, east bound, lat.  $42^{\circ} 23'$ , long.  $53^{\circ} 18'$ , informed of bergs and advised to take  $40^{\circ} 30'$  track. Special ice information was sent to the following steamships: *Maiden Creek*, *Morristown*, *Bayano*, *Westwego*, *Ala*, *Zeeland*, and an unlisted vessel whose radio call letters were SMH. A weather report was sent to the steamship *Alabama*.

March 26 began with the vessel lying to. Moderate WNW. gale, rough sea, moderating to strong breeze at 9 a. m. and fresh NW. to W. breeze after noon; mostly cloudy. At 6.23 a. m., under way to scout northern side of steamer lane to eastward and to trace the boundary of the Gulf Stream to the northward and eastward by means of sea-water temperatures. At 11 a. m., observed a berg bearing  $68^{\circ}$ , true, and stood toward it. At 11.45 a. m. stopped to windward of berg, lat.  $44^{\circ} 25'$ , long.  $45^{\circ} 20'$ , and drifted for the remainder of the day. The berg was rather large, and apparently the one reported by the *Sagittaire* in lat.  $44^{\circ} 00'$ , long.  $45^{\circ} 40'$ , on the 23d, having drifted  $30^{\circ}$ , true, for 30 miles, or at the rate of 0.41 mile per hour. A number of kittiwakes accompanied the vessel throughout the day. Special weather reports were given the steamships *Caucasier* and *Alabama*.

March 27 began with the vessel drifting. Fresh to strong breeze, SW. to NW., increasing to NW. gale at 8 a. m. and so continuing until close; mostly cloudy; very rough sea. At 5.30 a. m. under way and stood back toward berg, and en route examined a growler which had broken off from it. At 6.45 a. m. stopped 1 mile to windward of berg and drifted until 3.25 p. m., when we stood back to the berg, which at noon was in lat.  $44^{\circ} 33'$ , long.  $44^{\circ} 44'$ , having drifted  $70^{\circ}$ , true, at rate of 1 knot per hour during the last 24 hours. The strong gale and heavy seas capsized the berg and it was rapidly disintegrating under the influence of the warm water, the sea-water temperatures indicating that it was in the Gulf Stream the latter half of the day. At 6 p. m. secured and lay to for the night near the berg. From 10.40 p. m. to 11 p. m., under way to avoid growler toward which the vessel had drifted. Special ice information was sent to the steamship *West Hadday*.

March 28 began with vessel drifting. Fresh NW. gale throughout forenoon, falling in middle of the afternoon to fresh to gentle breezes, NW. to W. Mostly cloudy. At 7.35 a. m. under way to pick up yesterday's berg. At 10 a. m. raised a second berg, bearing  $223^{\circ}$ , true. At 10.40 a. m. alongside yesterday's berg, which was now in lat.  $44^{\circ} 52'$ , long.  $43^{\circ} 55'$ , having drifted  $60^{\circ}$ , true, 1.8 miles per hour since yesterday noon. This berg was greatly reduced in size and wasting rapidly under the action of the high waves and the warm water, the temperature of the water being  $56^{\circ}$  F. Stood for second berg and at 12.10 p. m. arrived alongside of it and took photographs.

This was a medium-sized berg, some 60 feet in height, with an irregular rectangular base some 200 feet by 50 feet, and was being heavily buffeted by big seas. This berg was in lat.  $44^{\circ} 46'$ , long.  $44^{\circ} 03'$ . At 12.30 p. m. lay to to leeward of berg. At 10.30 p. m. drifted near berg first visited this day. Special ice information was sent to the steamship *West Cohax*.

March 29 began with vessel drifting. Moderate to strong gale first half of day. Afternoon began with strong to fresh NW. breezes, becoming moderate to strong NW. to W. gale, reaching whole gale force in squalls after 8 p. m. Overcast to mostly cloudy, with passing rain and snow squalls. Sea, for most part, very rough. At 5.25 a. m. under way and stood for berg being watched last night. At 6.15 a. m. passed small growler from berg and sighted berg. At 8 a. m. alongside berg, in lat.  $44^{\circ} 55'$ , long.  $43^{\circ} 55'$ . It had drifted, in 24 hours,  $45^{\circ}$ , true, at 0.5 knot per hour, and was disintegrating very rapidly under the action of waves and warm water. Lay to and drifted until 10.55 a. m., then stood back via berg course,  $270^{\circ}$ , true, to investigate to westward. At 11.50 a. m. observed another berg and stood for it. At 12.55 p. m. alongside second berg, which was small and irregular in shape, in lat.  $44^{\circ} 55'$ , long.  $44^{\circ} 27'$ . Stood west, true. At 1.50 p. m. sighted another berg and stood for it. At 3.18 p. m. stopped in lat.  $44^{\circ} 47'$ , long.  $44^{\circ} 35'$ , and lay to to leeward of third berg, which was medium-sized and irregular in shape. Drifted for the night in very rough sea. Gave special ice reports to the steamships *Montcalm*, *Pittsburg*, *Minindora*, *Rapidan* and *Truso City*, and special ice warning to the steamship *Tarantia*.

March 30 began with the vessel drifting. Strong WNW. gale, increasing to whole gale force in squalls. Very rough sea. The wind moderated to moderate gale, W., by noon. Barometer rising rapidly. Strong breezes to moderate W. gale in afternoon; fresh gale at close. At 8.15 a. m. under way to investigate bergs reported yesterday. At 9 a. m. sighted berg ahead. At 10.15 a. m., lat.  $44^{\circ} 38'$ , long.  $44^{\circ} 00'$ , alongside berg, which was a rather large one with steep sides, flat top, and a pinnacle at one end. This was evidently the berg reported by the *Tarantia* yesterday. It had drifted  $45^{\circ}$ , true, at the rate of 0.4 knot per hour. A few kittiwakes were observed. Continued search and at 10.05 a. m. sighted another berg and stood for it. At 2 p. m. alongside berg, which was medium sized and low, with water-washed, rounded top, in lat.  $44^{\circ} 26'$ , long.  $44^{\circ} 17'$ . This berg also was apparently one of those reported by the *Tarantia* yesterday and had drifted  $70^{\circ}$ , true, at the rate of 0.8 knot per hour. At 2.35 p. m. sighted a large berg and stood for it. At 3.45 p. m. alongside berg, in lat.  $44^{\circ} 19'$ , long.  $44^{\circ} 23'$ ; stood to leeward and photographed berg, which had a very large base, some 400 feet by 150 feet, and vertical walls some 60 feet in height, broken down on one

side. Sighted another berg and stood for it. At 5.30 p. m. stopped, in lat.  $44^{\circ} 24'$ , long.  $44^{\circ} 08'$ , and lay to for the night, slightly to windward of the berg, which was a medium-sized one, with a pinnacle that collapsed as the vessel approached. Gave ice information to the steamship *President Polk*.

March 31 began with vessel drifting. Fresh WNW. gale at 4 a. m., falling to light to moderate westerly breezes, which continued until 6 p. m., then fresh gale SW. to WSW. High barometer in forenoon, rapidly falling in afternoon. Overcast; rainy at intervals in afternoon. At 8 a. m. found drift for the night to have been 2 knots per hour,  $70^{\circ}$ , true. At 9.30 a. m. under way, to occupy line of oceanographic stations leading to westward, scouting en route. At 2.50 p. m. passed large berg visited at 4 p. m. yesterday. This berg was now in lat.  $44^{\circ} 26'$ , long.  $44^{\circ} 04'$ , having drifted  $70^{\circ}$ , true, at rate of 1 mile per hour. At 3 p. m. passed a second berg, medium sized and irregular in shape, in lat.  $44^{\circ} 19'$ , long.  $44^{\circ} 39'$ , and at 3.10 p. m. sighted a third berg, medium sized, in lat.  $44^{\circ} 16'$ , long.  $44^{\circ} 45'$ . At 3.25 p. m. stopped at station 247<sup>1</sup> and took water temperatures and samples, completing the work at 4.40 p. m. At 9.40 p. m. stopped at station 248 and attempted to take water samples and temperatures, but found sea too rough. At 10.10 p. m. resumed course,  $260^{\circ}$ , true, and so continued until close of day.

April 1 began with vessel on course on line of oceanographic stations. Fresh SW. gale to strong gale in squalls, hauling to NW. at 9 a. m., and falling to strong breezes at 4 p. m. Barometer falling until 7 a. m., thereafter rising. Rough sea. Mostly cloudy. Sea too rough to permit occupying oceanographic stations. At noon set course for Tail of the Bank, to search for bergs and to meet the *Modoc*. At 5 p. m. sighted a low-lying berg in lat.  $43^{\circ} 37'$ , long.  $47^{\circ} 44'$ , and at 5.50 p. m. stopped and lay to for the night. Special ice information was sent to the steamship *Vennachar*.

April 2 began with the vessel drifting. Strong to moderate and gentle breezes, NW.; NW. swell. At 4 a. m. under way to continue search to the westward and meet the *Modoc*. At 5.45 a. m. sighted a low-lying berg in lat.  $43^{\circ} 21'$ , long.  $47^{\circ} 44'$ , assumed to be the berg sighted at 5 p. m. on the 1st. At 6.40 a. m. sighted a large berg and stood for it, arriving alongside it, in lat.  $43^{\circ} 14'$ , long.  $48^{\circ} 19'$ , at 8.10 a. m. Photographed this berg, which was a very solid one, with a vertical wall on one side, otherwise pyramidal, some 60 feet above water, with a base some 140 feet square. At 1 p. m. set course for appointed rendezvous with the *Modoc* to-night in lat.  $42^{\circ} 50'$ , long.  $52^{\circ} 00'$ . At 5.42 p. m. abeam of berg in approximately lat.  $43^{\circ} 00'$ , long.  $50^{\circ} 20'$ , which was believed to be the berg seen on

<sup>1</sup> For location of all oceanographic stations see station table, page 92.

March 19, grounded on the Tail of the Bank. Gave special ice information to steamship *Missourian*.

The *Modoc* relieved the *Tampa* on ice patrol duty at 12.30 a. m., April 3, in lat.  $42^{\circ} 50'$ , long.  $51^{\circ} 50'$ . The oceanographic observer was transferred from the *Tampa* to the *Modoc*, and the *Tampa* then left for Halifax.

#### SUMMARY.

This cruise has been characterized by remarkably rough weather, the wind being of gale force and higher on 11 of the 15 days of the patrol, this being decidedly higher than the observed average percentage for this season given by the Pilot Charts. The percentage of fogs has been far below the average. The Labrador Current has shown an extraordinary set to the SE., from the region between Flemish Cap and the east slope of the Grand Banks, this being conclusively shown by water temperatures taken. The simultaneous drifting of bergs as far east as the Fastnet steamer tracks confirmed the existence of this current. These bergs were between lats.  $44^{\circ} 20'$  and  $46^{\circ} 00'$ . It was planned to occupy oceanographic stations of the eastern radial line, but the weather permitted the occupation of but one station, No. 247. Far more time than usual was spent east of the Grand Banks near the Fastnet steamer tracks, because of the menace to these tracks. The breaking up and disintegration of bergs buffeted by the heavy to mountainous seas experienced on this cruise was remarkably rapid. In some instances the changes observed in bergs in one, two, or three days would rival the changes shown in as many weeks under other conditions.

Only three bergs came around the Tail of the Bank during this cruise, and these were but little below lat.  $43^{\circ}$ . Field ice was reported a trifle lower than usual, in lat.  $42^{\circ} 20'$ . The transatlantic steamship lanes were ordered shifted during this cruise, the eastbound to take effect on March 30 and the westbound to take effect on April 6.

Ice reports were broadcast twice daily, and a daily report was sent to Hydrographic Office, New York, and to Halifax. Daily weather reports were sent to the Weather Bureau at Washington.

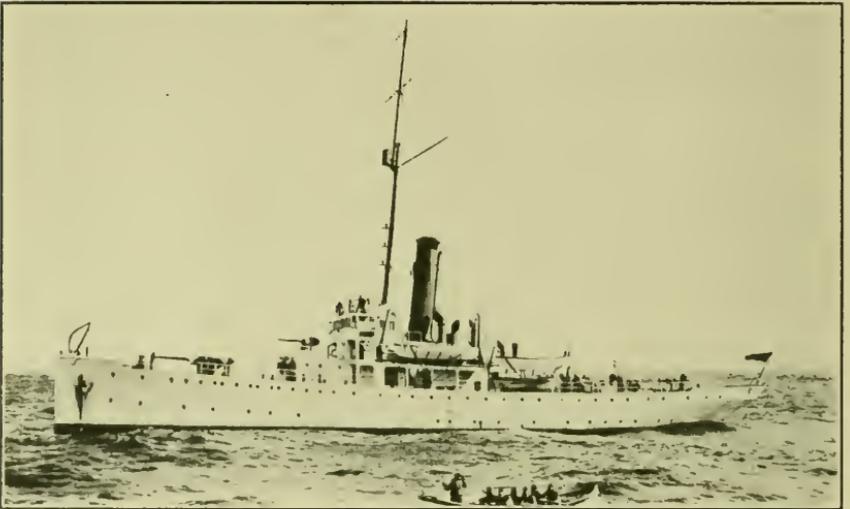
An aggregate of 912 water temperature reports was received during this cruise.

Ice information was received from 10 vessels and special ice information was furnished to 25 vessels.

PLATE I.



AN EARLY SEASON ICEBERG.



THE MODOC RELIEVING THE TAMPA.

COAST GUARD CUTTER "MODOC," COMMANDER B. M. CHISWELL,  
ICE PATROL, FIRST CRUISE, APRIL 3 TO 17, 1923.

At 10.35 a. m., March 30, the *Modoc* sailed from the Boston Navy Yard for the Grand Banks. At 12.35 a. m., April 3, met the *Tampa*, in lat.  $42^{\circ} 50'$ , long.  $51^{\circ} 47'$ . The oceanographic observer was transferred from the *Tampa* to the *Modoc* and the latter vessel took over the duties of the ice patrol, drifting until daylight.

April 3 began with the vessel drifting. Airs and breezes from SW. to S.; smooth sea; barometer from 30.62 to 30.51; weather clear, with excellent visibility. Searched for ice, covering a rectangle bounded by the 42d and 43d parallels and 51st and 49th meridians. No ice was seen. During the day numerous dovekies, a few fulmars, and a school of blackfish were seen. Mirages were observed, giving the eastern horizon the appearance of a long sand beach, backed by high dunes, and dwarf pines appeared and disappeared at regular intervals. At 6.25 p. m. stopped and drifted for the night, in lat.  $42^{\circ} 18'$ , long.  $49^{\circ} 00'$ .

April 4 began with the vessel drifting. Gentle breezes and light airs, shifting from S. to WNW., then back to SE. and ending at SW., with heavy mist and fog from 10 a. m. until sunset. At daylight search was begun for the berg last visited by the *Tampa* at 8 a. m., April 2, in lat.  $43^{\circ} 14'$ , long.  $48^{\circ} 19'$ . The weather having shut in thick with fog and heavy mist, stopped at noon, in lat.  $43^{\circ} 10'$ , long.  $48^{\circ} 10'$ , and drifted for the remainder of the day and for the night. During the day dovekies and fulmars were seen, also one hair seal. Ice information was given the steamships *George Washington* and *Sir Ernest Cassel* and special ice warnings were sent to the steamships *Falls City*, *Drottningholm*, and *Callisto*. Several requests were received relative to harbor ice conditions at Halifax and Louisburg, Nova Scotia, and the authorities at Halifax were requested to furnish this information to the patrol vessel.

April 5 began with the vessel drifting. Light airs and breezes from SW. to NW.; foggy over cold water, clear over warm water. Stood to the eastward, to clear a belt of fog hanging over the cold water of the Labrador Current. On reaching clear weather, in the warm water of the Gulf Stream, set a course to the northward and eastward along the western edge of the Stream. At 5.45 a. m. a large, flat-topped berg was sighted, in lat.  $43^{\circ} 27'$ , long.  $47^{\circ} 00'$ . When within about 3 miles of this berg, the temperature of the surface sea water was found to be  $38^{\circ}$  F. We became enveloped in dense fog and headed back toward warm water. Many small pieces of drift ice trailed off to leeward of this berg for a distance of about 4 miles. The steamship *Sir Ernest Cassel* reported this berg on April 3, in lat.  $43^{\circ} 10'$ , long.  $47^{\circ} 11'$ . It had drifted  $25^{\circ}$ , true, at a speed of 0.4 knot per hour. Dovekies, ful-

mares, and skuas, a school of porpoises, and, in the Gulf Stream, gulf weed and jellyfish, were seen. At dark, lay to and drifted for the night, in lat.  $43^{\circ} 34'$ , long.  $46^{\circ} 28'$ , being enveloped in fog after 9.45 p. m. During darkness, phosphorescent flashes in the water alongside similar to groups of fireflies in size, interval, and color, were noted. The radio officer at Halifax having furnished us information concerning shore and harbor ice conditions for Nova Scotia and Newfoundland, we, on request gave ice and routing advice to the following steamships bound for Nova Scotian and Newfoundland ports: *Elzasier*, *Elizabeth Marie*, *Procyon*, *Callisto*, *Vallratham*, *Liljevalch*, and *Alphard*. Also gave special ice information to the steamships *Columbia* and *Hatteras*.

April 6 began with the vessel drifting. Light SW. to fresh W. winds; barometer falling and sea making up. After running into thick fog, a few miles to the eastward would bring us back into the clear weather prevailing over the warm water of the Gulf Stream. Cruised to the northward along the eastern edge of the fog bank that hung over the cold water, to locate the bergs reported by vessels on April 3 and 4, between the 44th and 45th parallels and the 45th and 43d meridians, and also to cover the northwest edge of the Gulf Stream from lat.  $43^{\circ} 00'$ , long.  $47^{\circ} 00'$ , to lat.  $45^{\circ} 00'$ , long.  $43^{\circ} 00'$ , this season's bergs having been found to be drifting at present to the eastward between these points. No ice was seen during the day. Stopped at 2 p. m., in lat.  $44^{\circ} 00'$ , long.  $44^{\circ} 00'$ , and drifted for the remainder of the day and during the night. While lying to in the early morning fog, the steam whistle gave back a long-drawn-out echo. Murres, puffin, petrel, and dovekeys were observed during the day. The edge of the Gulf Stream was sharply defined. Ice information was given the steamships *Cassandra*, *Hammac*, *Liljevalch*, and *Wekika*, and ice information and warning to the steamship *Lulea*.

April 7 began with the vessel drifting. Search was continued, but because of westerly gale, thick weather, and rough sea, stopped and drifted, at 10.35 a. m., in lat.  $44^{\circ} 13'$ , long.  $44^{\circ} 15'$ . A few murres were seen. Special ice information was furnished the steamships *Olen*, *Delaware*, and *Gloxia*.

April 8 began with the vessel drifting. Fresh WNW. winds, which increased to fresh NW. gale in the forenoon, moderating toward night and becoming moderate N. winds by midnight; rough sea; weather clear, with excellent visibility. Searched north to the 45th parallel and between the 44th and 45th parallels to the eastward of the 44th meridian. At 7.15 G. M. T. passed a large growler in lat.  $44^{\circ} 40'$ , long.  $43^{\circ} 40'$ . Stopped at dark, in lat.  $44^{\circ} 32'$ , long.  $43^{\circ} 45'$ , and drifted for the night. Numerous fulmars, dovekeys, Sabine gulls, and schools of porpoises were noted during the day.

April 9 began with the vessel drifting. During the day the wind hauled from W. through N., E., and S., to SW., with clear weather and excellent visibility until dark. By midnight it was moderate SW., with mist and passing rain squalls. Smooth sea. Searched the area of numerous recent bergs between the 44th and 45th parallels and the 43d and 47th meridians. No ice was found. Occupied station No. 248, lat.  $44^{\circ} 16'$ , long.  $45^{\circ} 20'$ , and station No. 249, lat.  $44^{\circ} 08'$ , long.  $46^{\circ} 30'$ . Water samples and temperatures were taken at each station at depths of 0, 50, 125, 250, 450, and 750 meters. Stopped at 8.20 p. m., in lat.  $43^{\circ} 55'$ , long.  $46^{\circ} 55'$ , and drifted for the remainder of the night. Dovekies, fulmars, and Sabine gulls were seen during the day, and a land bird that flew on board proved to be a horned lark. Phosphorescent water at night indicated that the vessel was still in the Gulf Stream. Special ice information was given the steamships *Newtonhall*, *Lord Downshire*, and *Liljevalch*.

April 10 began with the vessel drifting. Foggy, with moderate SW. winds. Worked to the westward, near the 44th parallel, and occupied station No. 250, lat.  $44^{\circ} 05'$ , long.  $47^{\circ} 30'$ , and station No. 251, lat.  $44^{\circ} 05'$ , long.  $48^{\circ} 13'$ . Samples of sea water and temperatures at various depths down to 750 meters were taken at each station. Stopped for the night at station No. 251. Special ice information was furnished the steamship *Canada*.

April 11 began with the vessel drifting. Fresh to moderate winds from N. and fairly clear weather, with good visibility, after daybreak. Vessel continued search for ice. At 21.35 G. M. T. we passed a berg in lat.  $44^{\circ} 07'$ , long.  $47^{\circ} 43'$ , a second one at 22.25 G. M. T., in lat.  $44^{\circ} 10'$ , long.  $48^{\circ} 00'$ , and a third one at 4 G. M. T., in lat.  $43^{\circ} 47'$ , long.  $48^{\circ} 50'$ ; also a patch of field ice in lat.  $43^{\circ} 47'$ , long.  $48^{\circ} 40'$ . The first berg was approximately 250 feet by 200 feet by 50 feet high; the second was pyramidal in shape, 150 feet by 100 feet by 80 feet high, and the third was a twin berg, two peaks joined under water, the highest being 163 feet, measured by sextant angle, its other dimensions being about 300 feet by 250 feet. Occupied station No. 252, in lat.  $44^{\circ} 00'$ , long.  $48^{\circ} 54'$ . While occupying this station, a French sailing vessel near by requested her longitude, which was given her by International Code signal. Fulmars, dovekies, and one whale were observed. The following message was received from the Wireless Officer, Halifax: "Please discontinue transmitting ice report to Halifax wireless officer, as arrangements have been made to intercept report by our D. F. stations." Special ice information was given the steamship *Texas Maru* and information and routing advice to Louisburg, Cape Breton Island, was given to the steamship *Yildum*. Stopped at dark, in lat.  $43^{\circ} 13'$ , long.  $47^{\circ} 57'$ , and drifted for the night.

April 12 began with the vessel drifting. Weather mild and pleasant, with gentle NE. to SE. wind; clear, with excellent visibility and smooth sea. Ice could be picked up at an unusual distance. Searched from the 48th to 52d meridians to the north and south of the 43d parallel. At 23.15 G. M. T. (11th) a large berg was sighted in lat.  $42^{\circ} 40'$ , long.  $49^{\circ} 55'$ . Another large berg was sighted at 5.20 G. M. T., in lat.  $42^{\circ} 56'$ , long.  $50^{\circ} 17'$ , and a third one at 7.30 G. M. T., in lat.  $42^{\circ} 52'$ , long.  $50^{\circ} 46'$ . The second berg was grounded on the Tail of the Bank and had been reported several times. The third berg was estimated to be 300 feet long by 75 feet high and was reported on the 8th by the steamship *Canadian Mariner*, in lat.  $42^{\circ} 42'$ , long.  $50^{\circ} 28'$ . Occupied station No. 253, on the southwestern radial of oceanographic stations, in lat.  $42^{\circ} 30'$ ; long.  $51^{\circ} 46'$ , after which we stood down along the radial for station No. 254. The following message was received from Halifax: "Disregard our message of yesterday and in future please send daily ice report addressed Agent of Marine, Halifax." In accordance with this message, daily reports to Halifax were resumed this date. Special ice information was sent to the steamship *West Caddoa*. Many murre, fulmars, and dovekies, and one whale were observed during the day.

April 13: Moderate to light SW. and W. winds, with dense fog over the colder water. During the midwatch of this day lightning flashes were seen to the southward. A bird resembling a jaeger and a species of grebe were observed, also jellyfish and several dead fish about 3 inches long. The following oceanographic stations were occupied, Station No. 254, station No. 255, and station No. 256. After completing the work at the last-named station, the vessel drifted for the night. It is deemed worthy of note here that the bergs observed and reported on the western edge of the Gulf Stream, between the 43d and 45th parallels, during the preceding patrol of the *Tampa*, are drifting to the eastward and slowly melting in the warm water, one having been reported on the 6th as far east as long.  $39^{\circ} 42'$  in lat.  $43^{\circ} 05'$ , and the area of their original observation has been left clear of ice, whereas all newly discovered bergs have been in the Labrador Current, drifting slowly in the cold water that sets to the southward along the eastern edge and then westerly around the Tail of the Bank. This seems to indicate that the influences at work earlier in the season, which set the bergs off to the eastward into the Gulf Stream before they had reached the latitude of the Tail of the Bank, no longer prevail. Special ice information was furnished the steamships *Cabotia* and *Hastings County*.

April 14 began with the vessel drifting. During the midwatch the wind shifted suddenly to NW., accompanied by hail and heavy snow, with thunder and lightning to the southward, and continued from fresh to strong NW. and N. during the day, with cloudy weather

and good visibility. Oceanographic stations 257, 258, 259, 260, and 261 were occupied. At 0.50 G. M. T., in lat.  $42^{\circ} 56'$ , long.  $51^{\circ} 06'$ , a long, low berg was passed and photographed. This berg was reported by the steamship *Canadian Mariner*, on the 8th, as being three-fourths of a mile long. It was variously estimated this day as being from 500 to 800 feet long and 50 feet high. It was sighted by the patrol on the 12th, in lat.  $42^{\circ} 52'$ , long.  $50^{\circ} 46'$ , and had drifted  $288^{\circ}$  true, at the rate of 0.5 knot per hour. At 9.35 G. M. T. passed another berg, about 300 feet by 300 feet by 90 feet high, grounded on the Tail of the Bank, in lat.  $43^{\circ} 00'$ , long.  $50^{\circ} 17'$ . A third large berg was sighted, in lat.  $42^{\circ} 50'$ , long.  $50^{\circ} 00'$ . Both the latter bergs had been sighted by the Patrol on the 12th. Fulmars were thick around the bergs and one whale and numerous murrens were noted. A robin lighted on the ship. Special ice information was furnished the steamships *Manchester Hero* and *Bremen*.

April 15: Moderate gale to strong winds from NNW.; cloudy, with good visibility. Occupied station No. 262, and at daybreak arrived at lat.  $41^{\circ} 46'$ , long.  $50^{\circ} 14'$ , where the *Titanic* sank, after colliding with an iceberg, on April 15, 1912. The engines were stopped and at sunrise colors were half-masted. At 10 a. m., 75th meridian time, by request all stations within range observed radio silence for five minutes and the patrol carried out memorial exercises for those who perished on this spot 11 years ago, including a general muster, a memorial address by Lieutenant Smith, prayer by Surgeon Laye, three volleys, and taps. The following message was received from the Agent of Marine, Halifax: "Halifax desires to be associated with you in your memorial service over *Titanic* grave to-day." Upon conclusion of these exercises, the vessel proceeded to occupy oceanographic stations 263 and 264. Special ice information was furnished the steamship *Maryland* and information and warning was furnished the passenger steamship *Montrose*, bound east, whose course was carrying her dangerously close during the night to the three bergs last located by the patrol on the 14th.

April 16: Fresh NNW. winds, falling and backing to WSW., with very good visibility. In the early morning a brilliant meteor was seen to the northward. At 2.35 G. M. T. passed a large berg, in lat.  $42^{\circ} 40'$ , long.  $50^{\circ} 44'$ . This berg was conical in shape, about 110 feet high, with a small peak attached to the main berg below the surface and a long underwater ledge. It was located by the patrol on the 11th, 12th, and 14th, and had drifted, since last observed,  $255^{\circ}$  true, at the rate of 1.5 knots per hour. A second berg was passed at 4 G. M. T., in lat.  $42^{\circ} 48'$ , long.  $50^{\circ} 55'$ . This was the long, low berg sighted on the 14th, since which time it had drifted 12 miles,  $138^{\circ}$ , true. Occupied oceanographic stations 265

and 266. Many fulmars were noted, both near the bergs and out of sight of them.

April 17: Stood to the westward, along the western radial of oceanographic stations, occupying stations 267 and 268. At 2 p. m., met the *Tampa*, in lat.  $43^{\circ} 02'$ , long.  $54^{\circ} 27'$ . The oceanographic observer was transferred from the *Modoc* to the *Tampa* and the latter vessel took over the ice patrol duty, the *Modoc* proceeding to Halifax.

#### ICE INFORMATION AND WARNINGS.

In this report of work performed by the patrol vessel, there is included each day a list of vessels to whom ice information and ice warnings have been sent. The details of some of these cases may prove interesting and are given below.

Steamship *Liljevalch*: The steamer *Liljevalch* at noon, April 5, radioed the patrol that she was stopped in lat.  $49^{\circ}$  N., long.  $49^{\circ}$  W., being held fast by a high and heavy ice field that extended as far as the eye could see. She was on the Cape Race steamer track and asked if it would be possible to attempt further passage past Cape Race. The patrol immediately advised the master that there was little likelihood of making such a passage and sent him the latest ice information, recommending the following route, which would not only guarantee safety from field ice and menacing bergs but would carry him out of the fog into clear weather: "The best practical route for you is from your present position to  $47^{\circ}$  N.,  $45^{\circ}$  W., thence to  $45^{\circ}$  N.,  $44^{\circ}$  W., thence to  $42^{\circ}$  N.,  $47^{\circ}$  W., then steer west until after crossing 52d meridian. Keep patrol advised of your movements." Nothing was heard from her until noon of the 6th, when she sent her position, reported two bergs, stated she was following our previous instructions, and asked for new developments. The patrol replied that it was searching northeastward along the edge of the Gulf Stream, stating that fog was over the cold water, and adding "Advise you steer shortest course to warm water and clear weather. That position for you is  $45^{\circ}$  N.,  $44^{\circ}$  W. Keep in touch with us." The *Liljevalch* proceeded cautiously through the fog and low visibility under the directions as given. April 7 she reported passing close to two bergs at 2.30 p. m. As she approached the warm Gulf Stream the fog became thinner, and at 7.30 p. m., April 8, she had reached lat.  $45^{\circ}$  N., long.  $44^{\circ}$  W., and was in clear weather, comparatively safe from bergs.

Steamship *Lulea*: At 5.20 p. m., April 6, the *Lulea* reported her position in lat.  $46^{\circ} 47'$  N., long.  $42^{\circ} 07'$  W., standing  $209^{\circ}$  true. She was in fog and had slowed to 3 knots. It was immediately observed that she was approaching the berg and growlers reported on the 5th in lat.  $46^{\circ} 02'$  N., long.  $43^{\circ} 19'$  W., therefore the patrol sent

her the following warning: "Bergs reported along your course; dangerous. Advise you steer south true until you cross 44th parallel, then follow prescribed track. By doing this you will avoid both the bergs and the fog." The *Lulea* thanked us and stated that she was following the advice as to route and asked if that would do. April 7, at 10 a. m., she broke out of the fog and passed close to two bergs. April 8, at 8 a. m., she reported her position and course to the patrol and requested new developments. She was now assured that her course was safe.

Steamship *Volbratham*: On April 5 this vessel advised the patrol of her position in lat.  $51^{\circ}$  N., long.  $40^{\circ}$  W., and requested information as to the best route for St. Johns or Halifax. The following reply was sent: "If bound to Halifax, advise steering due south to  $46^{\circ}$  N.,  $40^{\circ}$  W., and then follow the regular steamer track until west of 52d meridian, where it will be safe to haul up for Halifax. If bound to St. Johns direct, you are probably ready to take chances with ice on straight route. One steamer to-day in  $49^{\circ}$  N.,  $49^{\circ}$  W., stopped by heavy ice field." Nothing further was heard from her and it is presumed she took the chances and made St. Johns.

Steamship *Procyon* and steamship *Callisto*: These steamers reported their positions on April 5. The *Procyon* was in lat.  $42^{\circ} 40'$  N., long.  $47^{\circ} 15'$  W., and the *Callisto* in lat.  $41^{\circ} 37'$  N., long.  $47^{\circ} 33'$  W. Both were bound to Louisburg, Cape Breton Island, and requested information regarding ice conditions and the safest route to approach Louisburg. The *Procyon* was advised to get on the westbound steamer track, and the following message was sent to both: "Advise maintain  $41^{\circ} 30'$  track until west of 52d meridian. Will call you tomorrow morning and give you the latest field ice information for approaching the coast. No danger of bergs." A message was sent to the wireless officer, Halifax, stating the patrol had two steamers bound to Louisburg and asking for information relative to ice conditions near the coast. A reply was received and filed for both, as follows: "Ships proceeding Louisburg from Halifax steer 4 or 5 miles off coast. Gulf and entrance of gulf heavy close-packed ice. Flat Point and Point Tupper, no ice in sight." No reply was received from the *Procyon* after several calls. April 15 the latter, bound east, returning from Louisburg, reported to the patrol that through being unable to receive our advice for approaching the coast, she ran into field ice, damaging her propeller.

Steamship *Wekika*: This vessel applied to the patrol on April 5, giving her position as lat.  $42^{\circ} 35'$  N., long.  $43^{\circ} 32'$  W., and asked if her course carried her safely past all menacing bergs. The course given would have taken her uncomfortably close to some reported ice, therefore a reply was sent immediately that a berg and two growlers had been reported that day in lat.  $43^{\circ} 17'$  N., long.  $39^{\circ} 50'$

W. Otherwise her course was clear, but she was advised to keep a careful lookout for the above ice. The master thanked the patrol for its timely warning.

Steamship *Cassandra*: This passenger steamer, bound for Halifax, inquired as to what information the patrol had regarding ice around Sable Island. She was assured that there was little likelihood of her encountering field ice south of Sable Island, but that ice could be expected extending 4 or 5 miles out from the Nova Scotian shore.

Steamship *Hammac*: The case of this vessel was similar to that of the *Wekika*. Being in lat.  $41^{\circ} 25' N.$ , long.  $43^{\circ} 00' W.$ , she was endangered by the same berg as the *Wekika*. A warning was therefore sent her, advising when and where to be on the lookout for a berg and growlers.

Steamship *Columbia*: This steamer, at 7 a. m., April 5, was found to be heading west, at a speed of 7 knots, in lat.  $43^{\circ} 58' N.$ , long.  $47^{\circ} 20' W.$  The following warning was immediately sent: "Your course is liable to take you amongst bergs and field ice. If you will send us your present position and course, the patrol will furnish you with all ice information." The position furnished was lat.  $43^{\circ} 28' N.$ , long.  $48^{\circ} 15' W.$ , and at 12.30 a. m., April 6, the regular broadcast ice warning was specially issued to her, with particular attention called to "Dangerous berg  $43^{\circ} 00' N.$ ,  $50^{\circ} 15' W.$  Bergs may be met as far west as 52d meridian." At 3.24 a. m., April 6, a message was received from her, stating that she had met field ice, as predicted in our broadcast, at lat.  $43^{\circ} 17' N.$ , long.  $48^{\circ} 38' W.$ , and had immediately changed course south.

*Dania*: This motor ship was sighted in lat.  $43^{\circ} 01' N.$ , long.  $47^{\circ} 10' W.$ , by the patrol while scouting for bergs on April 5. She had failed to signal her approach to the ice regions, but upon being seen reported her name. She was warned that she was liable to encounter bergs and fog on her course and advised to go south until after crossing the 42d parallel, before heading west. Nothing further was heard from her.

Steamship *Elizabeth Marie*: This small French trawler, bound to St. Pierre, applied to the patrol for routing advice. She was directed to proceed to the westward until past the 52d meridian, then to haul up for St. Pierre. Probabilities of encountering heavy ice were predicted.

Steamship *Canada*: At 4.10 a. m., April 10, it was noted that this passenger liner was in lat.  $43^{\circ} 14' N.$ , long.  $52^{\circ} 43' W.$ , course  $94^{\circ}$  true, speed 14 knots, dense fog. The patrol immediately sent her the following ice warning: "Your course will carry you near bergs, one grounded on the Tail in  $43^{\circ} 00' N.$ ,  $50^{\circ} 19' W.$ , and another, April 8, in  $42^{\circ} 42' N.$ ,  $50^{\circ} 28' W.$  Advise getting south of 42d parallel." The following reply was received: "Thanks for ice warning. Am

steering clear of positions indicated, following regular Canadian track instructions. It's the field ice reported what to clear. What is your latest position for that? Seen no ice since leaving Portland or Halifax." The patrol sent the following detailed information regarding ice field: "Field ice on 4th,  $43^{\circ} 40' N.$ ,  $48^{\circ} 30' W.$ ; on 6th,  $43^{\circ} 17' N.$ ,  $48^{\circ} 38' W.$ ; on 5th, southern limit patchy field,  $42^{\circ} 50' N.$ ,  $49^{\circ} 00' W.$  You will find cold water and fog over to a line running  $15^{\circ}$  true from  $42^{\circ} 00' N.$ ,  $47^{\circ} 30' W.$ ; east of that, warm water and clear weather." At 4 p. m. she reported that she had slowed down in dense fog in lat.  $43^{\circ} 04' N.$ , long.  $49^{\circ} 55' W.$ , course still  $94^{\circ}$ , and requested information regarding bergs reported in lat.  $43^{\circ} 04' N.$ , long.  $49^{\circ} 55' W.$ , and the field in lat.  $42^{\circ} 50' N.$ , long.  $49^{\circ} 00' W.$  Again she was given all information the patrol possessed and told that she was liable to encounter bergs in that locality at any time.

Steamship *Yildum*: At 2 p. m., April 11, the patrol received the following message from the *Yildum*: "Noon,  $45^{\circ} 16' N.$ ,  $44^{\circ} 43' W.$ , bound to Louisburg, course  $270^{\circ}$  true, speed 8 knots, water  $45.5^{\circ} F.$  Please is there any ice on that course?" Her position was plotted on the ice and water-temperature chart, and it was found that her course would take her into berg areas, and also that field ice would be liable to hold her up. Cape Race had reported the fields southeast of it to be soft but even in that condition it would prevent the passage of a low-powered steamer like the *Yildum*. Accordingly the patrol routed the *Yildum* as follows: "Advise you to come to  $44^{\circ} 25' N.$ ,  $48^{\circ} 00' W.$ , then steer  $270^{\circ}$  true. By following this route you will be free from field ice and bergs. Patrol searched this area this morning. One berg  $44^{\circ} 10' N.$ ,  $48^{\circ} 00' W.$ , another  $44^{\circ} 07' N.$ ,  $47^{\circ} 43' W.$ ; patches of field ice on Banks, but you ought to escape most of it on this route."

Steamship *Montrose*: April 15, about 10 a. m., it was noticed, from plotting a water-temperature report from the Canadian Pacific passenger steamer *Montrose*, that she was in lat.  $42^{\circ} 52' N.$ , long.  $56^{\circ} 06' W.$ , bound  $92^{\circ}$  true on the Canadian steamship track, speed 16.5 knots. It was immediately noticed that this course would carry her close to bergs which had been located around the Tail of the Bank by the patrol on the evening of the 14th. Accordingly an ice warning was dispatched to her, advising her to keep to the southward, as bergs were located along her present course between the 51st and 47th meridians; also to listen in on our regular ice broadcast at 23 G. M. T. The *Montrose* acknowledged the warning and requested time of broadcast. She was again informed and undoubtedly received it and hauled to the southward, as the next water-temperature report placed her in lat.  $42^{\circ} 33' N.$ , long.  $50^{\circ} 19' W.$ , course east. At 9.23 p. m., ship's time, 2 hours 23 minutes after broadcast, the following message was sent to her, the patrol feeling the responsibility of its

position with a passenger ship speeding eastward at 16 knots and night falling: "The berg carried on ice broadcast in  $42^{\circ} 50' N.$ ,  $50^{\circ} 00' W.$ , was last seen evening of 14th. It was drifting  $250^{\circ}$  true, rate 1 knot per hour." It was feared the *Montrose* might not have the latest and most complete information regarding this berg, which, on the chart, laid in her path. This is an example of the duty that falls to the ice patrol, in which no errors must be made, in view of the life and property at stake.

#### SUMMARY.

During the patrol the weather has been unusually good for this season of the year, and the vessel has been quite active, cruising under forced draft whenever visibility and the condition of the sea justified it. During the first few days we scouted along the western and northern edge of the Gulf Stream to lat.  $45^{\circ}$ , long.  $43^{\circ}$ , finding clear weather over the warm water of the Stream and dense fog for the most part over the cold water. This area, which abounded in ice earlier in the season, was found to be clearing up. Later, we investigated conditions over the colder water and around the Tail of the Bank, and occupied oceanographic stations along the eastern, southern, southwestern, and western radials. Ice warnings were broadcast twice daily, with an effective radius of approximately 500 miles. A daily ice report was sent to the Hydrographic Office, Washington, and also to the wireless officer, Dockyards, Halifax, from the 3d to the 10th, and to the Agent of Marine, Halifax, thereafter. A daily weather report was sent to the Observer, Washington. The patrol was furnished with 1,007 sea-water temperatures from 186 different vessels. This hearty cooperation was most encouraging to the oceanographic observer and enabled him to keep well informed on currents over large areas as indicated by temperatures. Special ice information was sent to 35 vessels and ice information was received from 26 vessels.

#### COAST GUARD CUTTER "TAMPA," LIEUT. COMMANDER W. J. WHEELER, ICE PATROL, SECOND CRUISE, APRIL 17 TO MAY 2, 1923.

The *Tampa* sailed from Halifax at 5.10 p. m., April 15, and proceeded by the route south of Sable Island to the relief of the *Modoc* on ice patrol, and met the *Modoc* in lat.  $43^{\circ} 03'$ , long.  $54^{\circ} 28'$ , at 2.40 p. m., April 17, when she assumed the duties of the patrol. Gentle to light southwesterly winds were experienced until noon of the 16th, when a fresh SE. breeze, which later hauled to W., prevailed. A strong to moderate NW. wind was experienced on the 17th. Instead of the SW. current, which is usually encountered in the vicinity of Sable Island, accurate observations showed we had experienced a northerly set of approximately 6 miles since departing from Halifax.

This illustrates the great uncertainty of the current in this region of the "Graveyard of the North Atlantic." Upon assuming the duties of the ice patrol, the following estimate was made of the present ice situation: The southernmost ice consists of a large pinnacle berg, 163 feet high, which was last seen on the afternoon of April 16 in lat.  $42^{\circ} 40'$ , long.  $50^{\circ} 44'$ . This berg had been tracked for several days and was found to be drifting  $250^{\circ}$ , true, at the rate of 1 knot per hour, which would indicate that the Labrador Current is of unusual strength. Another berg, over 1,000 feet long and about 50 feet high, was in lat.  $42^{\circ} 48'$ , long.  $50^{\circ} 55'$ , on April 16. It had been observed for several days and was in a counter eddy current, SW. of the Tail of the Bank. A large berg was grounded on the Tail of the Bank and there were several bergs to the northward, which will probably arrive around the Tail of the Bank in a few days. To the northeastward there were a few bergs drifting to the northeastward along the edge of the Gulf Stream. After a careful review of the ice situation, it was decided to proceed to an advantageous point to commence search at daylight of April 18 for the 163-foot pinnacle berg, so the *Tampa* steamed to the eastward and the *Modoc* proceeded toward Halifax. The steamship *Armach* reported having passed a berg on April 18 in lat.  $44^{\circ} 13'$ , long.  $46^{\circ} 16'$ .

April 18: At 4.45 a. m. we had reached a point to commence search for the pinnacle berg, but were compelled to stop and drift, on account of dense fog, until 6.40 a. m., when the fog cleared and search was commenced to the eastward. The weather was none too favorable, as the wind increased to a moderate gale from SSE. at nightfall and then abated to a fresh SW. breeze at the end of the day. Rain fell at intervals, and a thick fog shut in at 3.30 p. m., at which time the search was discontinued for the day and the vessel permitted to drift. Gave ice warning to the steamship *Ariano*. At 11.35 p. m. received the following broadcast from the steamship *Orduna*: "Barquentine *Clutha* abandoned and in sinking condition and set on fire in latitude 44 N., longitude 47 W., may possibly be a danger to navigation. Crew now on board steamship *Orduna*." Signed Warner, steamship *Orduna*.

April 19: Drifted in dense fog throughout the day. In the forenoon the fresh SW. breeze increased to a moderate SSW. gale. In the afternoon the wind fell to a moderate S. breeze, but increased to a moderate S. gale at the end of the day. Heavy southerly swell; overcast, foggy, and rainy. Gave ice information to the steamship *West Segovia*.

April 20: The day began with a strong S. wind, which in the forenoon moderated and hauled to W. and then NW. In the afternoon gentle to moderate W. to SW. winds prevailed. Overcast to mostly cloudy, with fog first part. At 4.30 a. m., fog partially clearing, stood

S. to fix position. At 7.30 a. m., determined position of ship and found that the current had set us N. 1.5 miles per hour since 3.30 p. m. of the 18th. Resumed search to the southward and eastward for the berg last sighted by the *Modoc* on the 16th inst., and at 2.35 p. m. raised a pinnacle berg bearing  $65^{\circ}$ , true, 11.5 miles distant. Stood for the berg and at 3.50 p. m. took photographs of it, in lat.  $42^{\circ} 55'$ , long.  $50^{\circ} 32'$ . The berg was identified as the one last sighted by the *Modoc* in lat.  $42^{\circ} 40'$ , long.  $50^{\circ} 54'$ , on April 16. It was grounded in 70 fathoms of water and its pinnacle peak was some 160 feet high. A few kittiwakes and shearwater were in the vicinity. Continued scouting to the northward and eastward until dark, in search of the long, low-lying berg sighted by the *Modoc* on April 16, and at 6.55 p. m. anchored for the night, in 30 fathoms of water. Ice warnings were given to the steamships *Cairnvalona*, *Gemma*, and *Brant County*. Routing instructions were given to the steamship *Hickman*.

April 21: Moderate to fresh winds from S. to W. Thick fog during most of day, temporarily clearing during the morning; rain at intervals. Heavy southerly swell. At 4.15 a. m., the fog clearing temporarily, stood N. for an anchorage on the Grand Banks, and at 9 a. m. anchored on the Tail of the Bank, in lat.  $43^{\circ} 05'$ , long.  $50^{\circ} 09'$ .

April 22: Moderate to light winds, WNW. to SW. Moderate SW. swell. Dense fog. Remained at anchor the entire day. Sent special ice information to steamships *Canadian Navigator*, *Bourdonnais*, and *Montcalm*, and sent special ice information and routing instructions to steamship *Capitaine Faure*.

April 23: Fresh to moderate winds, SW. to SSW.; moderate swell. Dense fog. Remained at anchor throughout the day. Ice information and routing instructions were given to the following steamships: *Bolingbroke*, *Mexico*, *Fvredeniberg*, *Marburg*, and *Cymric Queen*, the last named being bound for Louisburg, Cape Breton Island. Received from the steamship *Rosalind* detailed ice information regarding ice fields over the Newfoundland Banks. The following wreck report was received from the steamship *Mabriton*: "Three-masted schooner *Gay Gordon*, of St. Johns, sinking and may be a danger to navigation in latitude 41 55, longitude 41 46, on 21st instant. Crew taken off."

April 24: Moderate to gentle winds, SW. to S.; moderate southerly swell. Remained at anchor on the Tail of the Bank throughout the day on account of dense fog. Routine reports from other vessels indicated that the fog was widespread. Special ice information was given to the U. S. S. *Sapelo*.

April 25: Light to fresh southerly wind; moderate southerly swell; dense fog, with light rain at intervals. Remained at anchor because of dense fog. Occupied oceanographic station 269 at anchorage, lat.  $43^{\circ} 09'$ , long.  $50^{\circ} 05'$ , taking sea-water temperatures and water samples at four depths from surface to bottom. Reports from other

ships indicated that the fog covered a wide area north of the Gulf Stream. Gave special ice information to the steamships *Requisite* and *Cymric Queen*.

April 26: Moderate to gentle SW. to S. winds. Fog prevailed throughout the day, with rain at intervals. At 8.45 a. m. under way and spent the day occupying oceanographic stations on the lower end of the Grand Banks, steaming from station to station at reduced speed through fog. At 12.25 p. m. stopped at station 270. Between 1 p. m. and 7.55 p. m. occupied stations 271 and 272. At 8.25 p. m., on account of increasing darkness and fog, anchored for the night near the eastern edge of the Grand Banks. Gave special ice information and routing instructions to steamships *Megantic*, *Canada*, and *Canadian Squatter*.

At 5 p. m. received the following radiogram via St. Pierre: "American patrol *Tampa*: Three American citizens aboard French trawler *La Provence* from St. Pierre now stuck in outer edge of ice, propeller damaged, coal exhausted. Been aboard 8 days, no accommodations, and sick. Will you take us off for any near port? Our position 59 12 W., Paris meridian, latitude 43 23 N." Communicated by radio with six steamships and replies from the following, each routed to pass near her position, indicated their willingness to assist the *La Provence*: *Rosalind*, *Canada*, and *Knockforna*. Offered to have surgeon prescribe for sick men by radio, but the message was delayed. At 8 p. m. received the following from French cruiser *Regulus*: "Received your signal concerning French trawler *La Provence*. I am steaming to help."

April 27: Gentle S. to SSW. breezes, falling to calm and shifting to SSE. in the afternoon. Overcast, with fog of varying densities until 10 p. m., then clearing. At 4.40 a. m. resumed work of occupying oceanographic stations. The following stations were occupied: Stations 273, 274, 275, 276, and 277. At 1 p. m. passed a barkentine, apparently a French fisherman, westbound. Small flocks of murre and puffin were seen this day. Gave special ice information to the following steamships: *Basis*, *Sachem*, *Ansonia*, *Homer City*, and *Concordia*.

April 28: Light W. to SSW. breezes, increasing to fresh to strong W. winds: cloudy; fog at intervals during first part of day. Westerly swells; rather rough sea at close of day. Occupied oceanographic stations 278, 279, 280, 281, and 282. At 6.55 p. m. set course 223°, true, from station 282, to reach an advantageous position for scouting by daybreak. Gave ice information to the steamship *Seattle Spirit*.

April 29: Strong to fresh winds, W. to N., falling to light breeze at the end of the day; mostly cloudy; clear atmosphere. Ran a line of oceanographic stations to the eastward and searched for ice during the day. About 6.30 p. m. received second request for assistance

from French trawler *La Provence*, fast in the ice and out of fuel in lat.  $45^{\circ} 24'$ , long.  $59^{\circ} 02'$ , Paris meridian, stating that French cruiser *Regulus* had been unable to reach her. Communicated with the *Regulus* and confirmed the report. Sent message to the *Modoc*, via Cape Race, and so advised the *La Provence*; also advised that vessel that the patrol vessel could leave the station only to save life and that *Modoc* was scheduled to leave Halifax on the 30th.

April 30: Light airs to light breezes; partly cloudy, fine weather. At the beginning of the day we were standing on course  $233^{\circ}$ , true, to reach a position south of the Tail of the Bank for daylight scouting, and also searching for ice en route. At 7.30 p. m. stopped and occupied oceanographic station 283, and at 10 p. m. occupied station 284. At 11.15 p. m. sighted an iceberg in the moonlight, bearing  $320^{\circ}$ , true, 5 miles distant. At 12 midnight, alongside of berg, which proved to be of medium size, in lat.  $42^{\circ} 45'$ , long.  $50^{\circ} 30'$ . This appeared to be the berg reported by the steamship *Persier* on the 29th inst. in practically the same position. Later, it was decided that this was also the berg reported by the *Manchester Importer* on April 29, 16 G. M. T., as in lat.  $42^{\circ} 30'$ , long.  $50^{\circ} 13'$ , which position was evidently in error. Flocks of shearwater and petrel were seen this day.

In the early evening communicated with the *Modoc* and was advised that she would relieve the *Tampa* on ice patrol to permit us to go to the assistance of the *La Provence* en route to Halifax. We were also advised that a trawler was proceeding to the assistance of the *La Provence*, which information was communicated to the *La Provence* and the *Regulus*.

May 1: Light to moderate winds, ESE. to E.; mostly clear, fine weather. Occupied oceanographic stations 286 and 285. At 2.30 a. m. sighted a berg in the moonlight, 4 miles distant; steamed to it and made a sketch. Found this berg to be the one grounded in lat.  $43^{\circ} 00'$ , long.  $50^{\circ} 25'$ , which was visited by the *Tampa* on April 20. It was now reduced to about one-fourth the size that it was on that date, and was reported by the steamship *Verdulia* on April 29 and the steamship *Persier* on April 30. At 4 a. m. stood west, true, from station 286, and resumed scouting for bergs. At 4.30 a. m., sighted a large berg, 11 miles distant, and upon arriving alongside photographed it and found it grounded in lat.  $43^{\circ} 06'$ , long.  $50^{\circ} 50'$ . It was some 75 feet in height, with a base 100 by 150 feet, and vertical walls, which were hollow on one side. Small growlers were calving off this berg and drifting to leeward. It was reported by the steamship *Persier* on April 30, but was not sighted by the *Verdulia* on the 29th ultimo, although that vessel reported passing growlers in the fog in its vicinity and must have passed very near to it, with the consequent risk of colliding with it. At 6 a. m. resumed scouting for bergs, and at 9 a. m. sighted growlers not previously reported, in

lat.  $42^{\circ} 40'$ , long.  $50^{\circ} 53'$ . Occupied oceanographic stations 287, 288, 289, and 290 during the day. At 9 p. m., set course west, true, from station 290 for the night. The steamship *Canada* reported that she had reached the distressed trawler *La Provence*, in lat.  $45^{\circ} 30'$ , long.  $56^{\circ} 30'$ , after passing through very heavy ice; that she had taken off the passengers, and that the master and crew had refused to leave the vessel. The master of the *Canada* reported that it was impracticable to tow the *La Provence* and that, in his opinion, a small vessel could not reach her under the prevailing ice conditions.

May 2: Gentle and moderate southerly breezes; mostly clear, with bright moonlight, until daylight, and foggy thereafter. Standing to the westward to meet the *Modoc*.

The steamship *British Vine* reported a large berg in lat.  $43^{\circ} 07'$ , long.  $50^{\circ} 57'$ . This was the berg sighted by the *Tampa* on the 1st inst. Issued ice warning to the *British Vine* of other bergs in her vicinity.

The following radiogram was received this date: "Halifax, via Cape Race, Cutter *Tampa*: Please cancel daily summary ice report addressed to Agent Marine, Halifax, and forward this summary to Officer in Charge, Compass Station, Cape Race, via commercial station Cape Race. Government ice-breaker *Montcalm* now working Gulf and will advise vessels of ice conditions and routes." Signed Halifax.

At 4.45 p. m. we met the *Modoc*, in lat.  $42^{\circ} 56'$ , long.  $55^{\circ} 22'$ , when the oceanographic observer was transferred to that vessel, which thereupon assumed the ice patrol.

In this report of work performed by the patrol vessel there is included each day a list of vessels to which ice information and ice warnings have been sent. The details of some of these cases may prove interesting and are given below.

Steamship *Ariano*: April 18, at 9 a. m., 60th meridian time, the plotting of the reported position of the *Ariano* disclosed the fact that she was standing into danger. At 4 a. m., local time, she had reported in lat.  $42^{\circ} 50'$  N., long.  $56^{\circ} 06'$  W., speed 11 knots, course  $285^{\circ}$ . This would take the ship north of Sable Island. The patrol had previously secured information of field ice north of Sable Island that would cause this passage to be regarded as dangerous to navigation. The *Ariano* was therefore informed of the situation and advised to change course, passing south of Sable Island, and to make considerable westing before hauling to northward. The *Ariano* thanked the patrol for the warning and stated that she had changed course to pass 30 miles south of Sable Island.

Steamship *Gemma*: April 20, about 9 a. m., it was observed, from the water-temperature reports of the *Gemma*, that she was in lat.  $42^{\circ} 30'$  N., long.  $45^{\circ} 22'$  W., speed  $10\frac{1}{2}$  knots, course  $276^{\circ}$ . This

would take her into a position known to contain bergs, and the following message was dispatched at 10.55 a. m.: "There are several bergs south of the 43d parallel and west of the 50th meridian whose exact positions are unknown because of the presence of fog over the region. Your present course is carrying you into danger and you should lay course south of 42d parallel until you are west of 52d meridian." The *Gemma's* master thanked the patrol and immediately changed course as advised.

Steamship *Geboga*: On April 26 the steamship *Geboga* called the patrol and asked: "What is temperature of water surrounding icebergs?" We replied that all the bergs are surrounded by water less than 57° F.; that this water has southern limit of 41° 40' N., eastern limit 47° 30' W., and western limit 52° W.; that local variations in water temperature are no indications of proximity of ice, and referred her to H. O. Pilot Chart for March on Icebergs.

Steamship *Homer City*: The steamship *Homer City* furnishes an example of the important service which is being rendered to trans-Atlantic steamers by the ice patrol. The following message was received about midnight, April 26: "S. S. *Homer City* 45° 25' N., 46° 10' W. Stopped for three days in dense fog. Bound New York. Water 41°. Have you information of bergs near me?" The following reply was sent: "If you will steam to 44° N., 46° W., you will get clear weather. Then steer to 41° 30' N., 47° W., when you can change course for New York. By doing this you will avoid fog and bergs and no need further delay. Send us your address and we will write you instructions how to avoid this next time." In reply the master gave his address, saying he was following our instructions and thanking us. We later sighted the *Homer City*, now inside the warm water, in clear weather, proceeding on her course.

#### INAUGURATION OF ST. LAWRENCE TRAFFIC.

The passage through Cabot Strait to St. Lawrence ports is usually attempted during the latter part of April each year. Due to the suspension of navigation during the winter months, on account of impenetrable ice fields, the resumption of the St. Lawrence navigation is eagerly sought early in the spring. Previous experience has shown that the St. Lawrence ice begins to break up from the middle of April to the first part of May. Many steamers sail from European ports, arriving on the edge of the pack at the entrance to Cabot Strait and forcing their way in as the ice weakens. This year was no exception.

The steamship *Cairivalona* was the first ship to arrive bound to Montreal. On April 20 she was in lat. 48° 13' N., long. 45° 52' W., and reported many bergs and field ice. A message was immediately sent, warning her of the presence of the bergs and fields of ice farther

PLATE 3.



PATROL VESSEL LYING NEAR A LARGE BERG AND BROADCASTING ITS POSITION.



A SMALL BERG WHICH HAS DRIFTED NORTHWESTWARD  
OF THE TAIL OF THE BANK.

west. It was realized that a ship on the St. Lawrence track passing Cape Race expects ice and is prepared to encounter it, therefore no routing instructions were given to assist her to avoid all ice. She was requested to submit a daily report on her progress and success with the ice. She furnished the patrol with a report of ice conditions each day thereafter, until she was past the entrance to the St. Lawrence (west of Cape Ray). In addition to this, the steamship *Rosalind*, which runs between Halifax and St. Johns, submitted a complete and clear report on ice conditions over the Grand Banks on April 23. With the aid of the reports from these two ships the ice patrol was in readiness to furnish the anticipated St. Lawrence steamers with a most accurate summary of ice conditions prevailing ahead of them. The ice message varied somewhat from day to day. Each ship upon coming within radio working distance reported to the patrol for information and advice as to the best route. The following is a typical message sent by the patrol: "April 28: A few scattered bergs on Grand Banks. The Grand Banks field has southern limit in  $47^{\circ} 20'$ ,  $46^{\circ} 40'$ . The ice in which you are most interested is St. Lawrence field. It extends from Cape Breton coast to  $45^{\circ}$  N.,  $54^{\circ}$  W., thence to St. Pierre. It is loose until you reach  $46^{\circ} 30'$ ,  $58^{\circ} 30'$ , when it becomes heavier, with open leads. Farther inside, between Cape North and Cape Ray, it is close packed and necessitates slow speed. Several inbound ships up there now pushing on." Replies of thanks were received in almost all cases. The ships receiving this special ice information were as follows: April 21, steamships *Marloch* and *Crawley*; April 24, steamship *Bolingbroke*; April 25, steamships *Canadian Squatter* and *Montcalm*; April 26, steamships *Metagama*, *Negantic*, *Canada*, *Knockforna*, and *Athenia*, and French cruiser *Regulus*; April 27, steamships *Ansonia*, *Manchester Regime*, *Manchester Spirit*, *Concordia*, *Letitia*, *Canadian Victor*; April 28, steamships *Sachem*, *Manchester Spinner*, and *Canadian Carrier*; May 1, steamship *Minnedosa*.

April 28 the *Seattle Spirit* reported to the patrol, in lat.  $43^{\circ} 20'$  N., long.  $43^{\circ} 02'$  W., bound to Montreal, and requested ice report for her route. This ship was already so far south that it was thought advisable to suggest a route south of the large St. Lawrence ice field. She was informed accordingly and told that it was the belief of the ice patrol that she would make much better time than by following the Cape Race route, as the other St. Lawrence ships were doing. He thanked us and later asked if we would recommend Gut of Causo passage, to which we answered in the negative.

## LOUISBURG STEAMERS.

The port of Louisburg, Cape Breton Island, is frozen in during the winter months, but with early spring it becomes broken out and many steamers are routed to it as a destination. During the recent patrol cruise a number of steamers bound to Louisburg have called for ice information. Wishing to render all possible assistance, our regular ice broadcast carried the following notice: "Louisburg steamers apply to patrol special information."

Four ships, the *Hickman*, *Cymric Queen*, *Capitaine Faure*, and *Ariano*, were all advised as follows: "Advise you to keep south of 42d parallel until after crossing 52° W., then it is safe to haul up for southern end Cape Breton, then follow up coast to Louisburg. Southern limit ice field from Cape Breton to 44° 30' N., 53° W., and over St. Pierre Bank. Heavy ice coming out of Gulf." This information was complete in detail and gave them full instructions, without which they might have been endangered by entering the ice field above described. This year the only ship known to have received damage from ice was caught in this same field through inability to catch the ice patrol's message and suffered damages to her propeller. This occurred the first part of April.

## SUMMARY.

Fog was experienced on each day of this cruise except the last three. The wind reached gale force but once. Pilot charts for this month show an observed average of some 40 per cent of fogs and 13 per cent of gales.

The period of this cruise was marked by a continuous movement of Arctic water along the eastern slope of the Grand Banks to southward and westward around the Tail of the Bank, then NW. bathing the SW. slope. No steamer lanes were threatened during this period. The southernmost berg was in lat. 42° 40', long. 50° 44', this berg being later carried by the cold current to the slope of the Bank and grounded. Twenty oceanographic stations were occupied, these being of four lines, radiating from central station on the Grand Banks, lat. 43° 50', long. 50° 25'. The eastern radial line, the longer one, extended to lat. 44° 43', long. 43° 09', and observations showed that the cold water experienced on the first cruise was not to be found. The absence of bergs was therefore explained. The remaining three lines of stations occupied extended to S., SW., and WSW. from the central station well into deep water. These showed the presence of a large volume of Arctic water W. and NW. of the Tail of the Bank and further demonstrated the association of bergs with Arctic water.

Ice reports were broadcast twice daily and a daily report was sent to Halifax and to Hydrographic Office, New York. A daily weather report was sent to the Weather Bureau, Washington.

Ice information was received from 37 vessels and special ice reports were sent to 29 vessels. Six obstruction reports were received.

An aggregate of 1,228 water temperature reports was received during this cruise.

COAST GUARD CUTTER "MODOC," COMMANDER B. M. CHISWELL,  
ICE PATROL, SECOND CRUISE, MAY 2-17, 1923.

The *Modoc* sailed from Halifax at 1.15 p. m., April 30, to relieve the *Tampa*. The weather was stormy at the time, the wind varying from fresh S. wind to moderate SW. gale, with thick, driving rain. From the time of departure until contact with the *Tampa*, either heavy, driving rain or dense fog prevailed. Without the aid of the radio compass it would have been difficult, if not impossible, to have located that vessel. At 5.20 p. m., May 2, the *Tampa* was relieved of the ice patrol duty, in lat.  $42^{\circ} 56'$ , long.  $55^{\circ} 22'$ , and directed to proceed to Halifax, the oceanographic observer being transferred from the *Tampa* to the *Modoc*, after which the *Modoc* occupied oceanographic station 291, at the point where the relief was effected. At 7.40 p. m. steamed to the eastward. The dense fog cleared at 11 p. m.

May 3: Moderate SSE. to SE. wind, with moderate southerly swell. At 3.30 a. m. dense fog set in and lasted until 8 a. m., when the fog cleared and cloudy weather, with very good visibility, prevailed during the remainder of the day. Oceanographic stations 292, 293, 294, and 295 were occupied. At 9.20 G. M. T. a large, low, irregularly shaped, hummocky berg was located, grounded in 54 fathoms, on the west side of the Tail of the Bank, in lat.  $43^{\circ} 38'$ , long.  $51^{\circ} 51'$ . During the greater part of the day the vessel was in the Labrador Current to the westward of the Grand Banks and experienced a noticeable set to the northward and westward. At 10.50 p. m. the *Modoc* was anchored, to hold her position during the night.

Special ice information was given to the steamships *Strassa*, *Montrose*, *Cabotia*, *Domira*, *Pennsylvania*, and *Catinat*, several of which were bound to St. Lawrence River ports. They were advised that the river was not yet open to navigation. Scattering fulmars and dovekies were noted and many were observed flying about the berg sighted.

May 4: Moderate to fresh SE. to ESE. winds, with falling barometer, and partly clear to overcast weather, with light rain and moderate sea, prevailed during the day. The visibility was good to fair. At

5 a. m., under way, and later occupied oceanographic stations 296 and 297.

At 5.30 G. M. T. a large pinnacle berg was passed in lat.  $43^{\circ} 12'$ , long.  $51^{\circ} 03'$ . This berg was located by the *Tampa*, May 1, in lat.  $43^{\circ} 06'$ , long.  $50^{\circ} 50'$ , and had drifted NW. 11 miles, dragging along the bottom of the SW. slope of the Bank during the interval. At 7 G. M. T. a small berg was observed, grounded in lat.  $43^{\circ} 04'$ , long.  $50^{\circ} 55'$ . The present tendency of the berg drift seems to be from the north along the east side of the Bank to between the 42d and 43d parallels, then to the westward until the 50th meridian is passed, after which the set is rather sharply to the north and the bergs ground on the Bank between the 50th and 52d meridians, which shows that the Labrador Current is flowing strongly around the Tail of the Bank and up toward Cabot Straits.

Special ice information was furnished the steamships *Thyra*, *Catinat*, *Drottningholm*, and *Canadian Mariner*, and the *Drottningholm* was also warned. Bird life was plentiful and fulmars, jaegers, murrees, and dovekies were seen.

At 8.35 p. m. anchored on the Banks for the night.

May 5: Gentle to moderate SE. wind, with falling barometer; moderate southerly sea and swell, and dense fog prevailed throughout the day. The *Modoc* remained at anchor, in lat.  $43^{\circ} 11'$ , long.  $50^{\circ} 14'$ . A few whales and blackfish played about the ship and a number of fulmars were seen during the day.

Special ice information and routing advice was furnished the steamships *Appalachee*, *Loyal Devonian*, *Comanche*, and *Pennsylvania*.

May 6: Fresh to gentle SE. wind, hauling to S. at the end of the day; dense fog, lifting in the late afternoon and closing again at dark. The vessel remained at anchor. At 5.30 p. m. a berg was sighted, bearing  $168^{\circ}$ , true. Fulmars, jaegers, and a few jellyfish were observed, and a sea cucumber was brought up from the bottom on a fishhook.

Special ice information was furnished the steamships *Wallsum*, *United States*, *Valacia*, *Manchester Shipper*, *Ballygally Head*, and *Empress of Scotland*. Upon request routing advice was given the *Wallsum*, *Manchester Shipper*, and *Valacia*. The steamship *Sahale* was warned.

May 7: Light W. winds during the day, backing to SSE. by night; foggy. At 8.50 a. m. weighed anchor and steamed slowly through the fog along the Cape Race radial of oceanographic stations, later occupying station 298. A few fulmars and dovekies were seen during the day.

Special ice information was furnished the steamships *Alfred Nobel*, *Cassandra*, *Fort McHenry*, and *Ansonia*. The widespread prevalence

of fog over the Grand Banks makes effective scouting for icebergs almost impossible.

May 8: Gentle wind, hauling from SSE. around to NW. during the day; thick fog until 8 p. m. At 7.10 a. m. weighed anchor and stood to the northward at reduced speed along the Cape Race radial of oceanographic stations, the thick fog making scouting for ice impracticable. The following stations were occupied: Stations 299, 300, and 301. Fulmars, dovebies, murrees, and one stormy petrel were seen. A faint display of the aurora borealis was observed from 8 p. m. until 11 p. m.

Special ice information was furnished the steamships *Thurban*, *Cassandra*, *Cedric*, and *Tuscania*. As many steamships are now asking for ice conditions and routing instructions for the St. Lawrence River, the patrol endeavors to keep posted on these matters from all available sources and furnishes them with the latest information obtainable.

May 9: Gentle wind from WNW. to NW., falling to light NE. wind at the end of the day; fog throughout the day. Barometer rising slowly. Oceanographic stations 303, 304, and 305 were occupied. In the gully south of Cape Race a marked set of current to the westward was experienced. After completing observations at station 305, course was set for the eastern edge of the Banks, lat.  $45^{\circ} 30'$ , to investigate ice conditions in the Labrador Current and along that parallel and to the southward. Many murrees and dovebies were sighted.

Special ice information was given to the steamships *Bothwell*, *Recca*, *St. Jehanne*, *Andania*, *Montcalm*, *Canada*, *Ballygally Head*, and *Rathland Head*. The *Montcalm* and *Canada* were warned that their respective courses were carrying them into danger.

May 10: Moderate to fresh variable winds, between NE. and NW.; overcast and cloudy; fair to good visibility. The fog lifted shortly after daybreak and was followed by light, drizzling rain. During the day scouted to the southward along the eastern edge of the Grand Banks, and at 5.15 p. m. passed a large, table-topped berg, with many blue diagonal veins, grounded in 65 fathoms, in lat.  $43^{\circ} 55'$ , long.  $49^{\circ} 03'$ . Fulmars, murrees, jaegers, dovebies, and petrel were plentiful, and a large school of whales was seen near the berg. At 6 p. m. dense fog closed in and continued until the end of the day. At 6.55 p. m. anchored in lat.  $44^{\circ} 00'$ , long.  $49^{\circ} 17'$ . From 8.25 p. m. until 11 p. m. a steamer, apparently a trawler, identity unknown, cruised about in the vicinity of our anchorage.

Special ice information was furnished the steamships *Orduna*, *Waimate*, and *Metagama*. The *Metagama* was warned that her course was taking her near the berg we had sighted in the afternoon. The following interesting and instructive report, dated May 10, was re-

ceived from the steamship *Empress of Scotland*: "5 a. m., off Cape Ray at edge of ice field. Excepting for loose fringe of heavy pack ice, no break visible from masthead. Positions of vessels located in ice field yesterday remained unchanged. Ships which entered the field p. m. yesterday only penetrated beyond the fringe and remain there. Regarding best route to approach this position, would advice passing Miquelon 6 miles, Rose Blanche and Port Basque at 2 miles. Area of several miles open water off these points between 58 40 W. and 59 10 W. Have cruised around this area and find the field solid to the southward. Gillies, Commander." The steamship *Cassandra*, on May 10, reported as follows: "Entered open ice St. Pierre bearing 318°, 18 miles. Now passing through heavy open ice, Platte Point, Miquelon, 68°, 14 miles."

May 11: Gentle to light northerly winds. When the vessel left her anchorage, at 5.20 a. m., the weather was clear, but within a half hour we ran into a path of dense fog, and later into clear, pleasant weather, for a short spell, which was followed by almost constant light fog, with poor visibility, until in the late afternoon, when, the wind having backed to WNW., the fog settled very low. During the day we scouted along the east side of the Grand Banks, between lats. 44° 00', and 43° 09', and at 9 p. m. anchored in lat. 43° 09', long. 49° 50'. A large berg of most irregular shape, consisting of three ice masses resting on one common base and connected above water by what appeared to be comparatively soft snow ice, through which the sea had carved several picturesque arches, was passed at 7.15 p. m., in lat. 43° 10', long. 49° 34'. Two medium-sized growlers were seen to the southward of this berg, and the usual bird life was observed; also a few "hell-divers," a species of grebe, and several hair seal.

Special ice information was given the steamship *Bothwell*. It was noticed from water temperature reports received from the steamships *Celtic* and *Orduna* that their respective courses would carry them very close to the line of drift of a berg reported by the *Alki* on the 9th instant in lat. 40° 42', long., 48° 55'. As they had clear weather, with excellent visibility, they were requested to keep a sharp lookout for bergs. The following dispatch was received from the *Celtic*: "No sign of berg reported 40° 42', 48° 55', on 9th."

May 12: The day began with a gentle SE. wind and falling barometer, the wind hauling through W. to N. and reaching fresh gale force by night. A heavy cold rain and moderate to rough sea prevailed during most of the day. At 5.10 a. m. weighed anchor and searched an area off the southeastern edge of the Grand Banks, the visibility ranging from good to poor. The berg sighted the previous evening was visited in the early morning, when it was found that it had not noticeably changed its location. At 10.25 p. m. anchored on the Banks, in lat. 43° 15', long. 50° 39'.

Ice information was sent to the steamship *Belvidere* and to a steamship whose radio call letters were "FZB." An ice warning was sent to the steamship *War Nazan*. The usual bird life was in evidence during the day, and a number of murre, fulmars, and stormy petrel were seen.

May 13: At the beginning of the day wind was strong to fresh from NW., and later hauled to NNE., and moderated until at night light airs and calms prevailed. Beginning with overcast and rainy, the weather finally settled into thick, low fog, which cleared away toward midnight. The vessel remained at anchor throughout the day, on account of unfavorable conditions for scouting. Special ice information was furnished the steamships *Sinasta* and *Olympic*.

May 14: The day began with light southerly airs and winds, hauling to NW. and N.; weather clear, with good visibility, but shutting in dense fog at 8 a. m. and continuing thick throughout the day. At 5.05 a. m. weighed anchor and began search for ice south of the Grand Banks. At 12.50 p. m., while steaming slowly in the thick fog, some drift ice was sighted, which, upon being followed up, led to the location of a large berg, at 1.30 p. m., in lat.  $42^{\circ} 52'$ , long.  $50^{\circ} 42'$ . Fulmars, jaegers, "hell-divers," murre, petrel, and tern were observed in the vicinity of the berg, and a small flock of fulmars was perched on it.

Ice information was furnished the steamships *Majestic*, *Carrigan Head*, *Bolingbroke*, and *Sinasta*. The steamship *Bolingbroke* reported that she was from Montreal and that she had come "via Gut of Canso and Northumberland," and the steamship *Montrose* reported that she had "from 20 miles east of Rosier skirted field ice in clear water to 14 miles north of Bird Rock; then heavy pack ice to Cape Ray; then clear water passing 10 miles off Platte Point, having kept well north of track to clear ice field."

May 15: Gentle to fresh NW. to NE. winds, falling to light airs at the close of the day; foggy, clearing by daylight. At 4.45 a. m. weighed anchor and cruised along the southwestern edge of the Grand Banks. At 7.15 a. m. and 10.55 a. m., in lat.  $43^{\circ} 07'$ , long.  $51^{\circ} 04'$ , and lat.  $43^{\circ} 21'$ , long.  $51^{\circ} 40'$ , respectively, sea-water temperatures were taken at various depths, to determine the prevalence of the Labrador Current. The temperatures indicated that the Current was nonexistent. Several small fishing schooners were seen during the day. At 3 p. m. we passed a long, low, flat-topped berg, grounded in 56 fathoms in lat.  $43^{\circ} 48'$ , long.  $51^{\circ} 52'$ . Fulmars, jaegers, and tern were plentiful and a large flock of tern was resting on the berg. This berg was first reported by the steamship *Canadian Mariner*, on April 8, in lat.  $42^{\circ} 42'$ , long.  $50^{\circ} 28'$ , and it was located by the *Modoc*, on April 16, in lat.  $42^{\circ} 48'$ , long.  $50^{\circ} 55'$ , and was last seen by an ice-patrol vessel on May 3, 5 miles south of its present

position. At 3.35 p. m. we passed a small, U-shaped berg, in lat.  $43^{\circ} 47'$ , long.  $51^{\circ} 42'$ , which was reported by the *Tampa* on May 1, in lat.  $43^{\circ} 06'$ , long.  $50^{\circ} 50'$ , and by the *Modoc* on May 4, in lat.  $43^{\circ} 12'$ , long.  $51^{\circ} 03'$ . Since May 4 it had drifted  $320^{\circ}$ , true, 46 miles. It was full of cavities, crumbling, and surrounded by a considerable field of loose ice, and will probably not last long. At 9.15 p. m. anchored in lat.  $43^{\circ} 08'$ , long.  $50^{\circ} 20'$ .

Ice information was sent to the steamships *Ryufuku Maru* and *Aledo*, and the steamship *Dania* was warned.

May 16: Light airs to fresh wind, NW. to NE.; moderate sea; weather clear, with excellent visibility. At 4.50 a. m. weighed anchor and made a search of a rectangular area south of the Grand Banks. No ice was seen. At dark we stopped and drifted for the night. The usual bird life, including fulmars, murre, petrel, and jaegers, was seen.

Special ice information was furnished the steamship *Ryufuku Maru*.

May 17: Moderate to light NE. winds; clear. At 4.30 a. m. the rectangular search south of the Banks was resumed, and at 6.20 a. m. a medium-sized berg, which showed signs of disintegration, was passed in lat.  $42^{\circ} 28'$ , long.  $51^{\circ} 31'$ . At 10 a. m. course was laid to the westward, and at 3 p. m. contact was made with the *Tampa*, in lat.  $43^{\circ} 05'$ , long.  $53^{\circ} 08'$ , when the oceanographic observer was transferred to that vessel, which relieved us of patrol duty. The *Modoc* then proceeded to Halifax.

Special ice information was furnished the steamships *Melita*, *Marburn*, *Montclair*, *Teespool*, *Cameronia*, *Baltic*, and *Alexandra*.

In this report of work performed by the patrol vessels there is included each day a list of vessels to which ice information and ice warnings have been sent. The details of some of these cases may prove interesting and are given below.

May 4 the steamship *Drottningholm* was found to be heading rather close to previously located bergs and was advised to maintain a good lookout until she got west of long.  $52^{\circ}$  W. The steamship *Cubotia* also came under the notice of the patrol as a possible risk and the following warning was sent to her: "Advise you to stand 90 until east of 47. Stand by for our regular broadcast 11 p. m. G. M. T." The steamship *Thyra* inquired as follows: "Is it advisable to pass through Gut of Canso and the Strait of Northumberland?" We replied: "No; it is not advisable. You will probably meet delay by so doing."

May 5 the patrol received the following message from the steamship *Comanche*: "11.30, lat. 43-12, long. 46-03, course S. 64 W. Is that safe course or would you recommend farther south?" We advised him that his present course was safe. On the same day

the steamship *Loyal Devonian* was found to be standing toward bergs in foggy weather, with night approaching. The patrol advised her to change course to 180° to avoid ice and get into warm water and clear weather. The master acknowledged this message as follows: "Now steering S. 10 W. true to avoid dangers advised by you. Have you any warnings for my present course? Dense fog prevails." She was carefully watched and alterations of course were advised until she reached a region of safety.

May 6 the steamship *Pennsylvania*, after being furnished with the latest advice for passage to Montreal, asked the patrol as follows: "Will it be advisable to call for an anchorage at St. Pierre if I can't get past, owing to ice? Are pilots obtainable there?" We replied: "Pilots obtainable St. Pierre. Send service message 'FIT' and he will give you local information." On this day the steamships *Suwanee* and *Sahale* were observed, by means of their water temperature reports, to be standing into danger, with night approaching. The *Suwanee* was warned as follows: "Advise you steer 90° until after you cross 47 W." The following message was sent to the *Sahale*: "Advise you steer due south until you cross 42 N., then 270° until you cross 52 W." Both messages were acknowledged with thanks. This is an illustration of the constant alert watch that has to be maintained, especially in fog and darkness, as then the passage of the ice regions becomes more dangerous.

On the occasion of an erroneous report of a berg near the westbound steamer track, inquiries were received from several ships, including the *Orduna*, *Olympic*, *Cedric*, *Tuscania*, and *United States*, asking us to "Please confirm," "Verify immediately," etc. These big ships were worried about the possibility of a berg being in the locality reported. The patrol was prepared and at once reassured them, advising them that their courses were clear. Such replies as "Thanks. Knew you would be cognizant," etc., indicated a confidence and dependency that is quite gratifying.

May 11 we were anchored 11 miles west of a large berg grounded on the east slope of the Banks. It was calm, with dense fog, and the night was dark. The lights of the passenger steamship *Metagama* could be seen as she passed near us, bound to the eastward. Our broadcast time was an hour away. By quick work we were able to advise her of the danger in her path, with the following message: "Large berg grounded 11 miles east of us. See your lights. Advise cautious lookout to-night."

May 14 the Japanese steamship *Ryufuku Maru*, evidently a stranger in this region, was heard calling Cape Race, asking for ice information for vessels bound for Montreal. The patrol gave her its special St. Lawrence information, kept on file and corrected to date. The

master requested to know the charges and was surprised to learn that the service was free.

#### ST. LAWRENCE RIVER, SYDNEY, AND LOUISBURG.

The St. Lawrence and Louisburg traffic was one of the features of the cruise. The patrol, having in mind its international aspect, believed it could render valuable service to the steamers making the St. Lawrence this spring; therefore special efforts have been made to give these ships the very latest information. Accordingly a special "sheet" has been made up from reports received from ships as they worked their way through the entrance and into the Gulf. That our efforts have not gone unappreciated is evidenced by the response from the ships. Many well into the Gulf and out of communication have taken pains to relay information through shore stations to the patrol. Also St. Lawrence ships recently bound out have submitted detailed reports of ice conditions in Cabot Strait and to the westward. The patrol finds this useful in keeping up to date its special "sheet" for inbound traffic. Skirting the fields and working through open waters may mean the saving of several days' time, not to mention the dangers that attend navigation through heavy ice floes.

Our daily Atlantic ice broadcast has carried the following: "St. Lawrence, Sydney, and Louisburg ships apply patrol special information." Upon request, we furnish them a report. As an illustration, the report of May 12 is quoted as follows: "A few scattered bergs on northern part of Grand Banks. At least 40 bergs between Flemish Cap and Banks. St. Lawrence field is growing smaller to-day. It extends Breton to 46 N., 57 W., thence to north and westward. Advise keeping on the Newfoundland side Cabot Strait. Steamers will find open water by laying course 10 miles off Miquelon, then hold up for Cape Ray, thence to 48-30. 62-00; Cape Ray to Bird Rock heavy packed ice. Keep north of line connecting Bird Rock and Cape Rosier and you will have open water."

The following ships have acknowledged our work, with thanks: *Pennsylvania*, *Domira*, *Thyra*, *Manchester Shipper*, *Valacia*, *Ballygully Head*, *Bothwell*, *Recco*, *Andania*, *Megantic*, *Empress of Scotland*, *Carrigan Head*, *Sinasta*, *Aledo*, *Ryufuku Maru*, *Melita*, *Marburn*, *Montclair* and *Teespool*. Similar service has been supplied the following Sydney and Louisburg steamers, with special reference to approaching the coast and condition of ice in the harbors: *Strassa*, *Catinat*, *Alfred Nobel*, *Thurban*, *Ste. Jehanne*, *Waimate*, and *Blackheath*.

The large percentage of fog and rain that has prevailed during this patrol cruise has handicapped our efforts to locate bergs. It may be stated with confidence, however, that there is no ice south of

lat.  $42^{\circ} 15'$  at the present time and the drift tendency is around the Tail of the Bank and thence to the northward and westward. An unusual number of bergs are grounded.

A line of oceanographic stations from the central station to Cape Race was occupied. Ice warnings were broadcast twice daily on 600-meter and once daily on 2,300-meter wave lengths. A daily ice report was sent to the Hydrographic Office, Washington, and after the 9th two daily weather reports were sent to the Observer, Washington.

We were furnished with 1,017 water temperature reports by 185 vessels, 33 vessels reported ice, and 66 vessels were given special ice information, several of them being warned. Montreal-bound steamers regularly asked for and received routing advice.

**COAST GUARD CUTTER "TAMPA," LIEUT. COMMANDER W. J. WHEELER,  
ICE PATROL, THIRD CRUISE, MAY 17 TO JUNE 1, 1923.**

The *Tampa* sailed from Halifax at 1 p. m., May 15, and relieved the *Modoc* on ice patrol at 3.10 p. m., May 17, in lat.  $43^{\circ} 08'$ , long.  $53^{\circ} 05'$ , the oceanographic observer being transferred to the *Tampa*. Fine weather with slight southerly airs and breezes was experienced. On the morning of the 17th a drifting bell buoy was destroyed by gunfire.

The following summary of the ice situation was made by the oceanographic observer: There are to-day only five bergs south of the 44th parallel. Their positions are as follows: One berg is grounded on the east slope of the Grand Banks in lat.  $43^{\circ} 58'$ , long.  $49^{\circ} 20'$ ; another berg was last seen May 14, west of the Tail, in lat.  $42^{\circ} 57'$ , long.  $50^{\circ} 50'$ ; two bergs lie well to the northwestward on the southwest slope of the Grand Banks in lat.  $43^{\circ} 45'$ , long.  $51^{\circ} 50'$ , are disintegrating rapidly, and will entirely melt in this locality; the only other berg in the area was observed by the *Modoc* this morning, in lat.  $42^{\circ} 28'$ , long.  $51^{\circ} 35'$ , and may be expected to assume what has been found to be the normal drift of bergs south of the Tail of the Bank. In the early season the Arctic Current was found to be drifting the bergs abnormally to the eastward between the 44th and 46th parallels. About the middle of April this movement ceased and the Labrador Current was found running around the Tail of the Bank and drifting the ice to the northwestward onto the southwest slope of the Grand Banks. Within the last week it has been found that this northwesterly current extension has ceased and we now may expect a southwesterly current past the Tail of the Bank. Since the berg in lat.  $42^{\circ} 28'$ , long.  $51^{\circ} 35'$ , is the southernmost berg and the situation is so clearly defined, it would seem advisable to relocate this berg and lie near by, observing its drift southward and eastward.

At 3.35 p. m. stood on course to reach point for beginning scouting at daybreak to-morrow. Fog set in after sunset, and at 9.50 p. m. we stopped and drifted for the night. Ice information was furnished the steamships *Alexandra* and *Baltic*.

May 18: Light easterly airs and breezes; foggy at intervals. At 4.50 a. m. under way for starting point of search. At 5.50 a. m. stopped on account of fog. At 8.20 a. m. fog partially clearing, stood east, true, scouring area south of Trail of the Bank and investigating drift of berg sighted by the *Modoc* on the 17th, believed to be the southernmost berg. At 11.20 a. m. sighted berg, bearing  $139^{\circ}$  true, distant 12 miles, and identified it as the one sighted by the *Modoc* on the 17th. Estimated that it had drifted  $162^{\circ}$ , true, at the rate of 1 mile per hour. Scouting was resumed in a southerly direction. At 2.45 p. m. received the following radiogram: "Western Spirit on fire, lat.  $40^{\circ} 22'$ , long.  $54^{\circ} 26'$ , course 271; trying to get fire under control; not succeeded as yet." Headed for position given and sent following radiogram: "We are heading toward you, course 239 true, 150 miles distant, 13 knots. Advise how serious emergency. If you desire our assistance, suggest you head toward us." At 3.35 p. m. received the following radiogram: "Thank you very much. Have fire under control now. Expect to have it out in half an hour. Think we can manage by ourselves now." Changed course to return to southernmost berg for the night. At 6.30 p. m. stopped and drifted for the night in dense fog, at an estimated distance of 4 miles from the berg. Kittiwakes and stormy petrel were seen this day. Ice information was sent to the steamships *Loriston*, *Atlanta*, and *Pearlmore*.

May 19: Light easterly airs to light and gentle southerly breezes. Dense fog over water of Labrador Current; clear in Gulf Stream. At 8.35 a. m. stood at moderate speed through fog area, to occupy southernmost station. Emerged from fog when well clear of Labrador Current at about 10.30 a. m. At 12.45 p. m. sighted two bergs bearing  $18^{\circ}$  true, 14 miles distant, the changing visibility conditions having brought them into view well abaft beam. Stood for bergs and identified the larger as the southernmost berg last seen on the 18th, its present position being lat.  $41^{\circ} 28'$ , long.  $50^{\circ} 38'$ . The second berg, a small, low-lying one, had manifestly calved from the first. The first berg was hollowed in center, with a base, partly submerged, approximately 450 feet square. A pinnacle about 170 feet in height stood toward one corner. A horizontal egg-shaped mass, some 50 feet high, was on the opposite side of the base from the pinnacle, to which irregular, vertical walls, about 100 feet high, were partly attached. Stood around the larger berg and photographed it. A water temperature of  $60^{\circ}$  F. was found at a depth of 750 meters. At 5.50 p. m. stood for southernmost oceanographic station, No. 309,

which was occupied at 10.30 p. m. Dolphin were observed in the Gulf Stream and fulmars and stormy petrel were seen.

May 20: Fog at intervals, becoming dense at times and clearing at 6 p. m. Vessel standing back to bergs left the evening before, the larger one being sighted at 3.40 a. m. We stood near to it and drifted, occasionally steaming back to it through the fog. This berg was melting and calving from the action of the warm water. Occasion was taken to try the effect of guncotton mines in destroying the berg, and, from the difficulty experienced in placing the mine and the negligible results obtained, it was concluded that only in unusual cases of disintegrating bergs threatening the steamship lanes was an attempt to destroy them by the use of mines justified. Noon observation showed this larger berg to be in lat.  $41^{\circ} 28'$ , long.  $49^{\circ} 50'$ , it having drifted  $90^{\circ}$ , true, at the rate of 1.8 miles per hour, since noon of the 19th. At 7.20 p. m. stood to small berg, 4 miles distant from larger berg, and lay to for the night. Sent out two special broadcasts regarding these southernmost bergs. Special ice information was given the steamships *Innoko*, *Burgerdyk*, and *Glox-ania*.

May 21: Light E. airs and breezes; mostly clear, fine weather; fog on horizon toward Labrador Current. Vessel drifting, standing by bergs for the night. At 4.45 a. m. stood back to small berg, distant 7 miles; large berg bearing from this  $65^{\circ}$ , true, some 5 miles distant. Ascertained that bergs had drifted  $123^{\circ}$ , true, at rate of 2 knots per hour since yesterday. At 9.45 a. m. under way to make rectangular search between meridians 49 and 50 and south of lat.  $41^{\circ} 40'$ , planning to return to bergs for the night. At 10.15 p. m. lay to near position of bergs. Because of proximity of bergs to westbound track, sent out special ice warnings to following vessels approaching from the eastward: *Reliance*, *Taxandria*, *West Celina*, *Montamban*, and *Fanahead*.

May 22: Light airs to light and gentle breezes, easterly. Mostly clear, with light passing fog banks in afternoon. At daybreak larger of two bergs visible, 8 miles distant. Stood to it and lay to. The second berg was approximately 2 miles distant, and a third berg, small one, calved off the large berg, was some 4 miles distant. Indications were that the wind had more effect on the large berg and retarded its drift to some extent. This berg was melting rapidly under the action of the warm water and atmosphere. Cracking sounds showed decided tension both under water and above. Noon position lat.  $40^{\circ} 34'$ , long.  $48^{\circ} 15'$ , showing drift of berg in 24 hours to be  $130^{\circ}$ , true, at rate of 1.5 knots per hour. This is the lowest latitude in which a large berg has been sighted for several years. Special warnings were sent out every two hours and special information furnished the steamships *Idaho*, *Lapland*, *West Lashaway*, *Bellasco*, *George Wash-*

*ington, Tabisman, Nieuw Amsterdam, Mauretania, and Olympic.* The first three passed very near during daylight; the others were on courses which would take them very near during the night.

May 23: Gentle breezes to light airs, easterly. Clear, fine weather. Day began with vessel drifting. At 5.25 a. m. under way and stood back to berg bearing  $65^{\circ}$ , true, distant 5 miles. Small bergs 4 miles and 10 miles distant, respectively. At 2.35 p. m. stood for small berg to eastward and at 4.10 p. m. stopped alongside and found it to be reduced to a mere growler. Took water temperatures to a depth of 750 meters and found warm water the entire depth. Returned to large berg and then examined the nearer small berg, which was reduced to approximately half of its size this morning and was rising and falling with each swell. Returned to large berg and lay to for the night. A school of blackfish and a few Wilson petrel and fulmars were seen. The noon position of the large berg was lat.  $40^{\circ} 10'$ , long.  $49^{\circ} 00'$ . Its 8 p. m. position was lat.  $39^{\circ} 57'$ , long.  $48^{\circ} 53'$ . The drift from noon on the 22d to noon on the 23d was in a curve to the SW. at the rate of 1.4 knots per hour. From noon on the 23d to 8 p. m. the drift was SE. at the rate of 1.2 knots per hour.

Because of the menace to steamship lanes, a special ice broadcast was sent every two hours. The steamships *Delaware* and *McKeesport* were given special ice information.

May 24: Light airs to light and gentle breezes, E. to SSW. Clear to overcast and rainy at close. Day began with vessel standing close by largest berg, so as to be in advantageous position for warning vessels passing in steamer lane. At 6.30 a. m. under way and stood  $16^{\circ}$ , true, for 5 miles to search for the growler we left yesterday.

It could not be discovered from aloft and manifestly had disintegrated. Returned to largest berg. A remnant of a small berg was visible, distant about 5 miles. The larger berg was rapidly disintegrating, the smaller portion drifting clear as a large growler. At 4 p. m. stood toward smaller berg and found it practically disintegrated and no longer a menace. Noon observation, lat.  $39^{\circ} 22'$ , long.  $48^{\circ} 20'$ , showed larger berg drifting SE. at rate of 2 miles per hour. Stood by the larger berg for the night, keeping it close aboard by occasionally steaming back as vessel drifted away. Special broadcasts were sent every two hours, owing to position of bergs and growlers. Special ice information was furnished the steamships *Mojave, Ohio, and Samanger.*

May 25: Light and gentle N. breezes, becoming fresh for a few hours at midday; calm at close. Rain at beginning; partly clear, with excellent visibility, the remainder of the day. Day began with vessel standing by remnant of berg, which was rapidly disintegrating under action of the waves and rain. Steaming at intervals at slow speed to keep position near berg. Successfully used searchlight

from 2 a. m. until daybreak to keep berg in sight. At daybreak it was manifest that the berg would not last many hours nor be a menace by nightfall of this date. The last position of this berg was lat.  $39^{\circ} 08'$ , long.  $48^{\circ} 30'$ , drift 1.3 knots per hour,  $160^{\circ}$  true. At 5 p. m. under way to scout for berg twice reported yesterday in approximately lat.  $41^{\circ} 00'$ , long.  $49^{\circ} 00'$ . At dark, vessel lay to for the night. Many stormy petrel and some blackfish and porpoises were seen this day. Special broadcasts were sent out every two hours.

May 26: Clear with light W. airs and breezes, changing to moderate to fresh SSW. gale, with passing rain squalls, for some four hours at midday, followed by fresh to light WNW. breezes and calms. Heavy SW. swell. At 5.10 a. m. under way to scout for berg last reported on the 24th. At 12.40 p. m. lay to temporarily in passing squalls and thick weather. At 4.07 p. m. under way. At 8.30 p. m. lay to for the night in lat.  $41^{\circ} 08'$ , long  $48^{\circ} 11'$ . Special inquiries were frequently broadcast but received no news of the berg. The following vessels passed through the area of this berg's probable drift during daylight this day: *President Monroe*, *Allaquash*, and *Mongolia*. By nightfall we felt justified in assuming that the berg had melted. Many stormy petrel were seen this day. Special ice information was sent to the steamships *Melita*, *Steadfast*, and *President Garfield*.

May 27: Light W. breezes, increasing to strong breezes at 11 a. m. and so continuing throughout the day. Rough sea in afternoon. Clear to overcast; rainy at intervals in afternoon. At 4 a. m. under way to resume scouting in area extending WNW., covering probable drift of berg from vicinity of Tail of the Bank. Scouted this day an area some 30 miles wide, beginning in lat.  $41^{\circ} 00'$ , long.  $48^{\circ} 00'$ , and ending in lat.  $41^{\circ} 30'$ , long.  $50^{\circ} 00'$ . No bergs were sighted and none reported south of the Banks by passing steamers. Occupied station 310. Blackfish and many stormy petrel were seen.

May 28: Strong breezes to moderate gale WSW., coming out fresh NW. breeze at 10 a. m. and falling to calm at close. Clear to overcast, with heavy passing rain squalls. At 4 a. m. under way and continued scouting, covering area between meridians  $50^{\circ}$  and  $51^{\circ}$  and parallels  $41^{\circ} 30'$  and  $42^{\circ}$ . Unable to secure observations for latitude until evening, when intersection of lines of position showed a set of some 40 miles to southward in approximately 30 hours. At 8 p. m. stopped and lay to. At 10 p. m. received a report from the steamship *Etna Maru*, stating that at 7.20 p. m. she had passed an iceberg in lat.  $41^{\circ} 42'$ , long.  $49^{\circ} 39'$ . At 10.15 p. m. under way. Secured radio bearings of the *Etna Maru* and stood NE. and then E. to intercept her course and definitely establish the position of the berg, because of the amazing drift. At 11.50 p. m. raised the *Etna Maru* dead ahead, her position accurately agreeing

with ours and apparently guaranteeing the finding of the berg. Many petrel and a few flying fish were seen this day.

May 29: Light and gentle breezes throughout the day. Partly clear to overcast and rainy. Vessel standing E. to locate berg reported by the *Etna Maru*. At 8 a. m. reached reported position of berg. Visibility good, but berg not found. Started rectangular search. No information was received from vessels passing through area of possible drift, and therefore concluded that the report was a mistake and that thick clouds observed on the horizon at the time the report was made had been mistaken for a berg. At 12.20 p. m. set course to continue scouting for possible bergs drifting down from the vicinity of the Tail of the Bank. Noon position, lat.  $42^{\circ} 00'$ , long.  $49^{\circ} 05'$ . Occupied station 312. At 4.45 p. m. stopped and lay to for the night. At 9 p. m. received the following radiogram from the steamship *Passenger*: "Bound east; passed one small iceberg in  $42 10 N.$ ,  $49 20 W.$ " At 9.20 p. m. under way to reach reported position by daybreak. Many stormy petrel and a few kittiwakes were seen this day. During the day communicated with the *Etna Maru* and was advised that further observations placed the alleged berg farther north and east than first reported. Gave special ice information to the steamship *Capulin*.

May 30: Gentle E. increasing to moderate and strong E. breezes at close. Partly clear to overcast; foggy at close. Vessel standing course to reach at daybreak position of small berg reported by the *Passenger*. At 4.50 a. m. passed through reported position of berg. Made rectangular search to eastward, southward, and westward, to cover area of probable drift. At 2 p. m. steamship *Ivar* reported a berg in lat.  $41^{\circ} 50'$ , long.  $49^{\circ} 35'$ . Stood for position given. At 3 p. m. sighted a growler 8 miles distant and stood for it, arriving alongside at 4.10 p. m. in lat.  $42^{\circ} 04'$ , long.  $49^{\circ} 29'$ . This growler was rapidly disintegrating and broke in two just before our arrival; manifestly it would cease to be a menace in a few hours. At 10 p. m. under way, to reach position for beginning search by daybreak. Stormy petrel and kittiwakes were seen this day. The second engineer of the steamship *Westlake* was treated by radio by our surgeon.

May 31: Moderate to strong breezes, shifting from ESE. to WSW. Overcast; foggy in forenoon. Heavy W. swell in afternoon. Heavy weather reported N. and W. Vessel standing W. to take up at daybreak search N. of  $42^{\circ}$  and W. of  $50^{\circ}$ . At 4.50 a. m., fog shutting in, utilized thick weather to complete occupation of line of stations running S. from central station. Occupied station 313, then stood for station 314. At 1.20 p. m. sighted berg and at 2 p. m. arrived alongside it, in lat.  $42^{\circ} 49'$ , long.  $50^{\circ} 05'$ . This berg consisted of two irregular shaped parts, each some 60 feet high, connected by a

submerged base; extreme length of base 300 feet. Two growlers of insignificant bulk were floating to leeward. At 2.40 p. m. resumed course for station 314, which was occupied at 5.25 p. m. At 6 p. m. under way to scout for other bergs near Tail of the Bank, and later to reach position by daybreak to-morrow for beginning a search to westward from meridian  $53^{\circ}$ , between parallels  $42^{\circ} 30'$  and  $43^{\circ} 30'$ , for berg reported on the 29th in lat.  $43^{\circ} 26'$ , long.  $54^{\circ} 07'$ . Kittiwakes and petrel were seen this day. Special ice information was sent to the steamship *Lord Kelvin*. The second engineer of the steamship *Westlake* received further treatment by radio from our surgeon.

June 1: Fresh W. to NW. gale to fresh breeze. Rough to moderately rough sea. Vessel on course to reach point for beginning search. At 7.50 a. m. set course S. on first leg of search. At 8.15 a. m. sighted berg sought, 11 miles distant, and stood to same. Its position was lat.  $43^{\circ} 01'$ , long.  $53^{\circ} 38'$ , showing a strong southern set since yesterday. This was a very solid berg, about 35 feet high and 140 feet long. Communicated with the *Modoc*, which had planned to commence searching for this berg from meridian  $55^{\circ} 30'$  eastward. At 11.45 a. m. stood W. and at 5.30 p. m. met the *Modoc*, in lat.  $43^{\circ} 04'$ , long.  $54^{\circ} 16'$ . The oceanographic observer was transferred to the *Modoc* and that vessel then relieved the *Tampa* on the ice patrol.

#### SUMMARY.

The outstanding feature of this cruise was the extremely low latitude reached by one berg, the remnant of which was left by us, in lat.  $39^{\circ} 08'$ , long.  $48^{\circ} 30'$ , at daybreak on May 25. It is believed that this is the lowest latitude in which a berg has been observed since the establishment of the International Ice Patrol. The Labrador Current formed a wedge farther to the southeastward than usual at this season and was doubtless primarily responsible for the situation of this berg, but temperatures twice taken to depths of some 700 meters showed no evidence of cold water in the vicinity of the berg after it had reached this unusually low latitude.

The number of bergs south of the Tail of the Bank was only four during the period of this cruise; a smaller number than usual at this season.

The pilot charts predicted 8 per cent of gales for this season, and this was the amount experienced. Fogs experienced were about the amount predicted, some 20 to 30 per cent.

Five regular oceanographic stations were occupied and two special stations in the vicinity of bergs.

Ice information was broadcast twice daily at 600 meters and once daily at 2,300 meters. Special broadcasts were sent every two

hours when the steamship lanes were menaced. A daily ice report was sent to the Hydrographic Office, and weather reports were made twice daily to the Weather Bureau at Washington.

During this cruise an aggregate of 1,316 water temperature reports were received.

**COAST GUARD CUTTER "MODOC," COMMANDER B. M. CHISWELL, ICE PATROL, THIRD CRUISE, JUNE 1-16, 1923.**

The *Modoc* sailed from Halifax at 11.45 a. m., May 30, and met the *Tampa* at 5.20 p. m., June 1, in lat.  $43^{\circ} 04'$ , long.  $54^{\circ} 16'$ . The oceanographic observer was transferred to the *Modoc*, which then relieved the *Tampa* on the ice patrol.

During the night of May 30 the wind, which had been moderate SE., backed into NE. and N. and increased to moderate gale force on the 31st, with rough sea. On the night of the 31st it continued backing, going to WNW, and then to SW., decreasing in force to strong and fresh breezes on June 1.

On June 1, having relieved the *Tampa*, at 5.55 p. m. we headed for the berg that she had passed in the morning in lat.  $43^{\circ} 01'$ , long.  $53^{\circ} 38'$ , and at 9.05 p. m. stopped to leeward of same to drift during darkness. Ice information was furnished the steamship *Bremen*.

After conferences with the wireless officer, Department of Marine and Fisheries, Halifax, Nova Scotia, relative to duplication and confusion resulting from broadcasting North Atlantic ice information by the ice patrol vessels and Cape Race, a satisfactory agreement was reached by which duplication of effort would be avoided for the remainder of the season.

June 2: Wind WSW. to W., of moderate gale force decreasing to fresh breezes by night, with rough sea. Barometer falling until 5 p. m., when it stood at 29.59, after which it rose slowly to 29.68 by midnight. Weather was overcast and cloudy, with poor visibility. The sea was heavier than the force of the wind would lead one to expect, indicating a heavy blow to the westward. The vessel drifted to leeward of the berg of last night, awaiting an opportunity to determine its line and rate of drift. About 5 p. m. a rather large piece broke off from one end of the berg, resulting in one large growler and several small ones. One of the small growlers drifted to leeward faster than the ship. This is difficult to understand, as the ship and the growler must have been approximately equal as to depth in the water and therefore actuated by the same surface current, if any, but the growler's exposure to the wind was less than 10 per cent of the ship's. The large growler, on the other hand, remained in the vicinity of the berg. The ship's drift to leeward from the berg was approximately 1 knot per hour

June 3: Light airs and breezes from NW. to WSW. Clear weather and excellent visibility. The berg showed the results of the pounding it had received during the gale, the rough seas, at temperatures between 40° and 50° F., having materially reduced its bulk. It appeared to be not more than half as large as on the evening of the 1st. At 9.50 a. m. proceeded to the westward to occupy oceanographic stations along the WSW. radial. Our noon sight, worked back by dead reckoning, placed the berg in lat. 43° 05', long. 53° 03', with a drift of 85°, true, 25 miles since it was located by the *Tampa* on the morning of the 1st. The following oceanographic stations were occupied: Stations 315, 316, and 317. Fulmars and petrel were seen and a brown thrush flew on board. Plentiful gulf weed and phosphorescence at night indicated Gulf Stream influences. Special ice information was furnished the steamships *Olympic* and *Waukegan*. The steamship *Winifredian* transmitted the following report: "19.30 G. M. T. 41-34 N., 55-06 W., steering 277, 12 knots, water 54, air 59, wind north 3, partly cloudy, visibility good; experienced 2 knot easterly current from noon 2d to noon 3d."

June 4: Light airs and breezes from NW., backing to SE.; weather clear. At 8.30 a. m., in lat. 43° 37', long. 51° 01', passed a grounded berg with a growler about 5 miles N. This berg, which consisted of three rather large ice hummocks attached to a common underwater base, was identified as one sighted by the *Modoc* on May 11 in lat. 43° 09', long. 49° 40'. Oceanographic stations 318, 319, 320, 321, 322, 323, and 324 were occupied. Traces of Arctic water were found on the WSW. radial, indicating considerable mixing. On the SW. radial temperatures showed Arctic water extending for 35 miles from the SW. slope of the Bank. As long as this is present in such strong character we may expect bergs south of the Tail. Jaegers, fulmars, dovebies, Leach petrel, blackfish, jellyfish, and Portuguese men-of-war were seen this day. A mirage gave the illusion of a large sea plane rising from the water and another that of a steamer upside down above the horizon. Special ice information was furnished the steamships *Wekika* and *Loki*.

June 5: Light S. winds to fresh SW. breezes. Overcast and cloudy, with good to fair visibility, followed by dense fog after 11.25 a. m. In the morning we searched between the 50th and 52d meridians to lat. 42° 40'. At 11.25 a. m., dense fog shutting in and continuing for the remainder of the day, a course was laid for station 225, where the vessel anchored at 8.40 p. m., lat. 43° 20', long. 50° 22'. Special ice information was given the steamship *Hickman*.

June 6: Fresh SW. moderating to light W. breezes prevailed, with fog in the early morning, followed by heavy haze, with occasional light rainfall; visibility fair to poor. At 6 a. m. under way and began search for the bergs reported by the *Manchester Importer* on the 4th.

At 4.15 p. m., lat.  $42^{\circ} 54'$ , long.  $49^{\circ} 27'$ , stopped and drifted for the night near a small berg about 75 feet long and 30 feet high, having the general shape of a saddle, with a small growler to the SW. Oceanographic station 326, near the berg, was occupied. Fulmars and Leach petrel were plentiful and one gannet and two blackfish also were seen. Special ice information was sent to the steamships *Hickman*, *Eisenach*, and *Carlsholm*.

June 7: Light S. airs, backing and ending with gentle NE. breezes. Overcast, cloudy, and foggy, with frequent periods of drizzling rain, accompanied by sharp lightning in the early morning, clearing at dark. At 6.25 a. m. search was started for the other bergs reported by the *Manchester Importer* on the 4th, but poor visibility making the search futile we turned back and at 10.35 a. m. stopped and drifted for the remainder of the day and night near the berg which we had left. At 8 p. m. this berg, located by Cape Race radio bearing, was in lat.  $42^{\circ} 48'$ , long.  $49^{\circ} 41'$ , having drifted 13 miles,  $225^{\circ}$  true, since noon of the 6th. It was disintegrating rapidly and probably would cease to be a menace within the next 24 hours. Just before dark, as the weather cleared, a growler was sighted to the SW.,  $3\frac{1}{2}$  miles distant. Fulmars, tern, Leach petrel, and blackfish were seen, and a sanderling was observed hopping about the decks. Special ice information was furnished the steamships *Scottish Maiden*, *Berengia*, and *Thomas Haaland* and warnings were sent to the steamships *Rovanitza* and *Atlantehavit*.

June 8: Gentle to light breezes, beginning at NE. and veering to ESE. Clear until 7.30 a. m., when fog shut in; thereafter alternating between fog and thick haze. The berg with which we had been drifting was now but a small growler, in lat.  $42^{\circ} 46'$ , long.  $49^{\circ} 49'$ . It was first sighted by the *Manchester Importer* on the 4th and had been under observation of the patrol since the 6th. From this latter date its drift had been  $252^{\circ}$ , true, at the rate of 0.4 knot per hour. Search was started at daylight. At 7.30 a. m. fog shut in and at 8.45 a. m. we stood for a berg which had been located at 5.45 a. m., in lat.  $42^{\circ} 38'$ , long.  $49^{\circ} 37'$ . This berg was of medium size, consisting of two ice hillocks separated by a deep gully. The water temperature near by was  $37^{\circ}$  F. It was reported by the *Manchester Importer* on the 4th and had since drifted  $230^{\circ}$ , true, at the rate of 0.4 knot per hour. The bergs seen during the last few days appear to be under intensified melting influences, probably due to rainfall and wash of unusually heavy seas and swells. At 1.05 p. m. stopped and drifted near the berg. Special ice information was furnished the steamship *Teespool*.

June 9: Gentle ESE., veering and increasing to fresh S. and ending with moderate SW. breezes. Overcast and cloudy at daylight, with very good visibility until late afternoon, when thick, foggy, rainy,

stormy weather set in and continued to end of the day. The barometer dropped rapidly from 30.12 at midnight to 29.69 twenty-four hours later. At 6.40 a. m. started search to the NE., and continued until thick weather set in, about 4.50 p. m. At 6.45 p. m. stopped and drifted. Five bergs were located this day. One, the largest, was pyramidal in shape, approximately 85 feet high and 350 feet long, with a brown, earthy streak; one was pyramidal in shape, with low projections on each of two opposite sides, also with earthy streaks; one was small; one was calving fast, with spray dashing over it on all sides and many blue streaks, a few growlers being near by; one was picturesque, having a natural cave in the center and numerous blue streaks down its sides. All were drifting around the Tail of the Bank at the rate of about 0.4 knot per hour. A large flock of fulmars, also dovebies, Leach petrel, and blackfish were seen. Ice warnings were sent to the steamships *Hatteras* and *Eskbridge*.

June 10: Moderate to fresh SW. and SSW. winds, with dense fog. The barometer fell to 29.63 and then began rising very slowly to 29.74 at end of the day. The vessel drifted until 9.40 a. m., when we stood in on the Banks and at 11.05 anchored at oceanographic station 327, lat.  $43^{\circ} 06'$ , long.  $50^{\circ} 05'$ . The steamship *American Press*, in lat.  $39^{\circ} 40'$ , long.  $46^{\circ} 41'$ , reported having been set ENE. 18 miles in the last 24 hours.

June 11: Moderate to light SSW. to WSW. winds, falling to light airs and backing to S., with fog until 10 a. m.; foggy and hazy after 6 p. m. The barometer rose from 29.76 to 30.12. A small berg was sighted from the anchorage, in approximately lat.  $43^{\circ} 08'$ , long.  $50^{\circ} 18'$ . At 4 p. m. under way and steamed slowly to the southward, to begin search near the 42d parallel at daylight. About 4.30 p. m. a berg was sighted in approximately lat.  $42^{\circ} 54'$ , long.  $49^{\circ} 47'$ , but was enveloped in dense fog before we reached it. Special ice information was furnished the steamship *Graysport*.

June 12: Light to gentle S. breezes, with dense fog over the colder water. Clear weather and good visibility S. of  $42^{\circ} 20'$  N. lat. We searched between the 50th and 52d meridians from lat.  $42^{\circ} 00'$  to lat.  $42^{\circ} 20'$  and saw no ice. At 4 p. m. stopped in lat.  $42^{\circ} 20'$ , long.  $51^{\circ} 20'$ , and drifted for the remainder of the day. In the early morning two brilliant meteors were seen to the westward. Echoes from the whistle while in fog were distinct and prolonged. Blackfish, gulf weed, fulmars, and Leach petrel were noted. Special ice information was furnished the steamships *Sinasta* and *Tunisian*, and ice warning was furnished the steamship *Levenpool*.

June 13: Gentle to moderate S. winds, with dense fog over the colder water; overcast with light, drizzling rain to the southward. At 8.25 a. m. laid course to occupy oceanographic stations along the



southern radial. Occupied stations 328 and 329. A few Leach petrel, fulmars, murres, and Portuguese men-of-war were noted, also much gulf weed. Special ice information was furnished the steamships *Koranna* and *Levenpool*.

June 14: Moderate to gentle winds, beginning at SSW. and veering to WNW., with dense fog throughout the day. Occupied oceanographic stations 330, 331, 332, 333, and 334. Temperatures indicated an extension of Arctic water to the southward since this radial was last occupied. At 8.10 p. m. anchored in lat.  $43^{\circ} 13'$ , long.  $50^{\circ} 27'$ . Special ice information was furnished the steamship *Saxilby* and the steamship *Idelfjord* was warned.

June 15: Gentle to moderate SSE. and S. winds, with dense fog. The barometer fell from 29.93 at 1 a. m. to 29.74 at midnight. At 5 a. m. began search for bergs last seen on the 9th, but dense fog closing in, returned to the Banks and at 9.40 a. m. anchored in lat.  $43^{\circ} 05'$ , long.  $50^{\circ} 04'$ .

June 16: Gentle to fresh winds from SW., veering to NW. and then backing to SW. Dense fog over the Banks in the morning, clearing as we passed into the warmer water at about 11 a. m. At 5 a. m., left anchorage and set course to intercept the *Tampa*. At 7.20 a. m., lat.  $42^{\circ} 56'$ , long.  $50^{\circ} 30'$ , passed close to a small growler, indicating a berg to windward which could not be seen in the dense fog. At 6.50 p. m., contact was made with the *Tampa* in lat.  $42^{\circ} 49'$ , long.  $53^{\circ} 09'$ . After transferring the oceanographic observer to the *Tampa*, that vessel took over the patrol duty and the *Modoc* proceeded to Halifax.

#### SUMMARY.

The oceanographic observer states that during the first week in April the southern extension of the Labrador Current around the Tail of the Grand Banks attained a maximum velocity of 1.2 knots per hour. May 31 a vertical plane section taken off the Tail at right angles to the current indicated a very small amount of Arctic water running around the Tail. June 4 to 8, with the bergs as indicators, the strength of the Labrador Current was determined at 0.4 knot per hour. This indicates a considerable dwindling and recession in the Labrador Current around the Tail at the present as compared with April 10. This is the keynote of the situation and, unless another flood wave occurs in the Labrador stream, forecasts the termination of the ice season this year. Such a phenomenon, however, even as late in the season as the present time, is possible. Last year, for example, during the first part of May the Labrador Current had a velocity of 0.3 knot per hour, but as late as the latter part of June the current swelled to 0.7 knot per hour past the Tail, bringing with it several bergs. It is believed the causes of these variations are funda-

mental ones, determined months previously in the Arctic regions. The variations are intensified or ameliorated by meteorologic and hydrographic forces as they react over this time and space.

With only three days of good visibility during this entire cruise, it was not possible to make a comprehensive, thorough search. Of the 11 bergs sighted, probably not more than two remained as a potential menace to the steamer lanes at the end of the patrol period, and it is believed they are north of lat.  $42^{\circ} 30'$ . Ice warnings were broadcast twice daily on 600-meter and once daily on 2,300-meter wave lengths. A daily ice report was sent to the Hydrographic Office and a morning and evening weather report to the Weather Bureau, Washington; 236 vessels furnished the patrol with 1,112 water temperature reports and 26 vessels reported ice; special ice information was furnished to 19 vessels and 6 were warned.

**COAST GUARD CUTTER "TAMPA," LIEUT. COMMANDER W. J. WHEELER,  
ICE PATROL, FOURTH CRUISE, JUNE 16 TO JULY 2, 1923.**

The *Tampa* sailed from Halifax at 11.10 a. m., June 14, to relieve the *Modoc* on ice patrol. Light to moderate NNE. to SSE. breezes were experienced during the trip, with fog at intervals on the 15th.

June 16: Contact was made with the *Modoc* at 6.45 p. m., in lat.  $42^{\circ} 48'$ , long.  $53^{\circ} 15'$ . The oceanographic observer was transferred to the *Tampa*, which then took over the ice patrol, the *Modoc* proceeding to Halifax. At 7.35 p. m. stood a course for lat.  $42^{\circ} 00'$ , long.  $51^{\circ} 30'$ , to commence search from that position at daybreak next morning to long.  $50^{\circ} 20'$ , thence to northward.

The following summary of the ice situation was made by the oceanographic observer: During the past two weeks there have been only two days on which it was not foggy. June 9 a total of eight bergs were found bunched in deep water off the Tail of the Bank. They were drifting SW. at the rate of 0.4 knot per hour, in the axis of the Labrador Current. Since then they have not been sighted south of the fog line (parallel  $42^{\circ}$  N.), therefore it is believed that they have been set in on the SW. slope of the Bank. There are two bergs to the W. and NW. of the Tail, which will probably disintegrate there. The Arctic Current has increased during the past two weeks and is now in large volume around the Tail and extending to the southward.

June 17: Moderate to gentle SSW. breezes in forenoon, falling to light S. airs in afternoon. Vessel on course to arrive at starting point of search by daybreak. At 4.15 a. m., fog shutting in, stopped and drifted. At 5.45 a. m., fog clearing, proceeded on course. At 7.35 a. m., fog again shutting in, stopped and drifted. At 8.10 a. m., fog clearing, again stood on course, until again in fog at 8.55 a. m. Stood S. until clear of fog, at 10.15 a. m., then E. until again in fog at

11 a. m. Stood S. until again clear of fog, at 11.25 a. m., then E. until 12.30 p. m., when, being enveloped in fog which appeared likely to continue, stopped and lay to for the remainder of the day. Noon position, lat.  $41^{\circ} 45'$ , long.  $50^{\circ} 35'$ . Water temperature  $62^{\circ}$  F. Later we drifted into cold water. Ice warnings were sent to the steamships *Ampetco* and *Glenluss*.

June 18: Light to gentle breezes, shifting from SSW. to NW. and N. Foggy, partially clearing at intervals; passing rain showers about daybreak. At 7.45 a. m., under way for Tail of Bank, to utilize foggy weather for taking oceanographic observations. At 6.10 p. m. anchored for the night, in lat.  $43^{\circ} 05'$ , long.  $50^{\circ} 03'$ . Occupied anchorage site at station, designating it No. 335, at 9. p. m., and as No. 336 at midnight, taking temperatures to the bottom. Found decided difference in temperatures at same depth on the two observations, indicating daily change in current. Ice information was furnished the steamship *Bellasco* and ice warning was given the steamship *Kiruna*.

June 19: Light to gentle N. breezes. Overcast; foggy at intervals. At 4 a. m., occupied anchorage site as station 337. Again found temperatures at various depths to differ from those previously taken. At 4.25 a. m. under way for small berg just sighted 3 miles distant. At 4.50 a. m. rounded berg and photographed it, lat.  $43^{\circ} 08'$ , long.  $50^{\circ} 03'$ . This was a small, solid berg, of pyramidal cross-section some 125 feet in length by 35 feet in height, completely water washed and apparently afloat. Began rectangular search of area E. and S. of Tail of the Bank. At 2 p. m. sighted a small berg, in lat.  $42^{\circ} 45'$ , long.  $49^{\circ} 55'$ , and at 2.15 p. m. stood around same. This berg was very similar in size and appearance to the one examined this morning. Continued search until 9 p. m., when we lay to for the night off the last berg sighted. At 10 p. m. fog again shut in. Occupied station 338 near berg, lat.  $42^{\circ} 45'$ , long.  $49^{\circ} 58'$ , this being in the axis of the Labrador Current near the Tail of the Bank, where this current is most pronounced. The temperatures recorded at the various depths were as follows:

|                              |                              |
|------------------------------|------------------------------|
| Surface, $6.3^{\circ}$ C.    | 250 meters, $6.2^{\circ}$ C. |
| 50 meters, $4.3^{\circ}$ C.  | 450 meters, $4.7^{\circ}$ C. |
| 125 meters, $2.3^{\circ}$ C. | 750 meters, $3.4^{\circ}$ C. |

It is to be observed that the water in which this berg floated is of positive temperature (above freezing). Unadulterated Labrador Current is of negative temperature at this time and place below the surface. This is an indication, therefore, that the Labrador Current at this point was weak and that unusual mixing with warm Atlantic water had occurred. It is further interesting to compare the above

subsurface temperatures with the following taken at a similar berg and position on June 6:

|                       |                     |
|-----------------------|---------------------|
| 50 meters, 1.3° C.    | 450 meters, 0.5° C. |
| 125 meters, - 0.8° C. | 750 meters, 3.3° C. |
| 250 meters, - 0.4° C. |                     |

The temperatures taken June 6 indicate a characteristic Labrador Current, which has since dwindled considerably, as shown by to-day's investigations. Unless a swelling of the current from the north occurs, the end of the season is forecasted.

June 20: Light to gentle NE. breezes, hauling to SSE. in afternoon. Overcast, misty, and foggy, partially clearing at intervals in forenoon. At 4.15 a. m., partially clearing at intervals, stood 223°, true, for 35 miles, planning to start search at extreme southern point of probable drift, clearer weather being expected there. At 7.45 a. m. stopped and lay to on account of fog. At 9.10 a. m., fog increasing, stood for anchorage on Tail of the Bank. At 5.55 p. m. anchored for the night in lat. 43° 10', long. 49° 52'.

June 21: Light breezes to light airs, ESE. to SE. Overcast; dense fog, becoming lighter at intervals. At 4.30 a. m. under way. At 11.15 a. m., stopped and occupied central station 339. At 11.40 a. m. resumed course to occupy line of stations to Cape Race. The present time is considered propitious for this trip because of slacking of the Labrador Current and the absence of ice in the vicinity of the steamship lanes, confirmatory evidence of which is furnished by cargo vessels passing N. of present steamship tracks daily reporting water temperatures but making no ice reports. At 5.45 p. m. stopped and occupied station 340. Resumed course at 6 p. m. and at 7.30 p. m. stopped and anchored for the night, because of dense fog. Several flocks of sooty shearwater were seen this day.

June 22: Light SE. breezes, becoming northerly at noon and increasing to fresh breeze at close, with rather rough sea. Fog generally dense until 8 p. m.; thereafter overcast, with fair visibility. At anchor in fog for the night. At 10.50 a. m. under way, across Grand Banks, on line of stations to Cape Race. Occupied stations 341 and 342. At 10.40 p. m. stood on course for Cape Race. Ice information was furnished the steamship *New Brighton* and ice warning was given the steamship *Suwanee*.

June 23: Strong NE. breeze with rough sea at beginning, soon increasing to strong NNE. gale, which became whole gale for a period shortly after noon. Wind backed to NNW. at 3 p. m., to WNW. at 8 p. m., and continued as fresh to strong gale. Very rough sea during the greater part of the day. Vessel steaming on line of stations for Cape Race. A heavy westerly current was experienced. At 10 a. m. stopped and occupied station 343, lat. 46° 22', long. 52° 48', this

being in the axis of the gulley. Owing to strong head gale and sea, decided to omit the remaining less important station off Cape Race. At 10.35 a. m. stood toward SE. edge of Grand Banks.

June 24: Strong breezes, NNW. backing to SW. and becoming moderate S. breeze at close. Rough to moderate sea. Clear to cloudy, with passing rain squalls in afternoon. Vessel standing across Grand Banks. Meridian position, lat.  $43^{\circ} 50'$ , long.  $51^{\circ} 32'$ . At 12.30 p. m. received Headquarters' radiogram requesting investigation of bergs reported southward of our position. At 12.45 p. m. set course to scout for bergs reported on 21st instant, lat.  $42^{\circ} 44'$ , long.  $51^{\circ} 34'$ , from which position drift to NW. was deemed more probable than toward the steamship lanes. At 1.30 p. m. received radiogram from steamship *West Kebar*, lat.  $47^{\circ} 47'$ , long.  $48^{\circ} 47'$ , stating that she was disabled by slacking of propeller on shaft and drifting to eastward at the rate of 2 or 3 knots per hour. She requested that arrangements be made for assistance by Coast Guard cutter or westbound Shipping Board vessel. Broadcast inquiries for available Shipping Board vessel and this was answered by the *Chickasaw*, which vessel arranged to render the required assistance. At 10 p. m. lay to for the night, in lat.  $42^{\circ} 30'$ , long.  $51^{\circ} 48'$ , having seen nothing of the bergs sought.

June 25: Light to gentle SE. breezes, shifting to NW., then backing to WSW. Light fog first part, clearing at 5.30 a. m. At 5.40 a. m. under way to scout for bergs SW. of Tail of the Bank. At 3.15 p. m. sighted a berg 16 miles distant. Stood for this berg and at 5.15 p. m. stood around and photographed it, lat.  $42^{\circ} 44'$ , long.  $50^{\circ} 55'$ . This was a medium-sized berg of pyramidal shape, some 80 feet in height, the greatest dimension of its base being some 200 feet. Continued scouting until 10.10 p. m., when we stopped near the berg and drifted for the night. Ice information was furnished the steamship *Chickasaw*.

June 26: Gentle to light S. breezes, shifting to WSW. at close. Cloudy to overcast; rainy in afternoon, followed by fog. Vessel standing by berg for the night. At 4.25 a. m. under way to scout area S. of Tail of the Bank. At 7.15 a. m. sighted a berg 15 miles distant. Stood for this berg and at 7.45 a. m. passed and photographed it close aboard, lat.  $42^{\circ} 48'$ , long.  $50^{\circ} 19'$ . This berg was 180 feet high and pyramidal in shape, with a base projecting under water, attached to which was another wall some 40 feet high, water washed and rounded. One face of the pyramid was a nearly vertical triangular plane. The berg left at 4.25 a. m. to-day had drifted  $20^{\circ}$ , true, at the rate of 0.8 knot per hour since the previous night, its position this morning being lat.  $42^{\circ} 52'$ , long.  $50^{\circ} 52'$ . The indications were that both bergs would drift to the SW. slope of the Tail of the Bank. Continued scouting. At 11.55 a. m. set course for

position of berg reported by an unidentified Norwegian motor vessel, "AQBT" (not listed), 8.40 a. m., as follows: "Just passed large berg 41-54 N., 49-52 W.; 8. a. m. position, 41-55 N., 49-52 W." Every effort was made to immediately secure confirmatory details, but without success. The steamship *Liljevalch*, passing near the reported position about this time, did not see the berg nor hear radio signals of "AQBT." About 3.30 p. m. succeeded in getting in touch with "AQBT," and she repeated position of berg, but gave no details as to her last observations as requested. Signals sounded far away, those of the afternoon being slightly the louder. At 5.55 p. m. reached reported position of berg and searched for same without success. Continued course for oceanographic station 345. Ice information was given to the steamships *Alcor* and *Ocean* and ice warning was sent to the steamship *Ombla*.

June 27: Light WSW. breezes to light variable airs and breezes, becoming gentle SSW. breezes. Fog throughout, generally dense. At 12.20 a. m. stopped and occupied station 345, lat.  $41^{\circ} 20'$ , long.  $50^{\circ} 18'$ . At 10.05 a. m. under way to occupy oceanographic stations of southern radial line and occupied stations 346, 347, 348, 349 and 350. Received, via steamship *Stockholm*, Headquarters' radiogram inquiring if the resuming of normal tracks on July 1 was recommended. Replied as follows: "Normal tracks considered safe except for very questionable report berg 41 54, 49 52, on 26th. Dense fog over area. Recommend brief delay shifting tracks until further advice from patrol." At 8.40 p. m. under way, to utilize hours of darkness for run to vicinity of reported position of southernmost berg.

June 28: Gentle to light breezes SSW. to WSW. Dense fog throughout. Vessel on course to reach position of reported southernmost berg of 26th instant, lat.  $41^{\circ} 54'$ , long.  $49^{\circ} 50'$ . At 9 a. m., having reached this position, lay to for the remainder of the day to await clearing of fog. The steamship *Sonora* passed near our position, sounding her fog whistle. Ice information was furnished the steamships *Bergenfjord* and *Cochrane* and ice warnings were given the steamships *Ariano*, *Sonora*, *Narvie*, *Tilthorn*, *Bradvon*, and *Heathfield*.

June 29: Light SW. breezes to calm. Continuous dense fog. Radio reports from steamers indicated fog over a widespread area. The vessel lay to throughout the day. Ice information was furnished the steamship *Sahalie* and ice warnings were given the steamships *Camberly* and *Brothing*.

June 30: Light SW. airs to calm. Dense fog, partially clearing in afternoon. Vessel lying to, awaiting opportunity to search for berg reported on the 26th. Observations showed a surface current of 0.5 knot per hour. At 9.45 a. m. received report from steamship *Es-*

*thonia* of a berg sighted in lat.  $41^{\circ} 17'$ , long.  $50^{\circ} 38'$ , at 8 a. m., the weather there having just cleared. At 10.05 a. m. under way for reported position. The *Esthonia* later verified position by observations and gave corrected position of the berg as lat.  $41^{\circ} 42'$ , long.  $50^{\circ} 32'$ . At 5.20 p. m., having passed position of estimated drift of berg, made search in an approximately rectangular pattern, to N. and E. until 8.05 p. m., then lay to for the night. Visibility varying greatly from about 2 p. m. until sunset. From about 5 p. m. until dark, observed a series of remarkable cloud formations resting on the horizon around western half. Small detached clouds of various shapes bore remarkable resemblance to icebergs, so much so that in more than one case the heading of the vessel was changed toward the object before the delusion was discovered. A water temperature of  $58^{\circ}$  F. to  $56^{\circ}$  F. and the appearance of seaweed after 2 p. m. indicated the edge of the Gulf Stream. Warning of the berg reported in lat.  $41^{\circ} 42'$ , long.  $50^{\circ} 32'$ , was sent to the steamships *Arioa*, *Boden*, *Lord Antrim*, *Blair*, *Wekika*, *Breedyk*, and *Oscar II*.

July 1: Calm to light variable airs. Dense fog, with very high and steady barometer and no immediate prospect of change. Vessel lying to, awaiting opportunity to search for southernmost reported bergs. At noon received radiogram from the *Modoc*, advising that a child on Sable Island was in urgent need of surgical assistance and inquiring as to feasibility of the *Tampa* coming at once to meet the *Modoc* and visiting Sable Island en route to Halifax. At 12.15 p. m. under way on course to meet the *Modoc*. At 6.50 p. m. received message via the *Modoc*, to the effect that the child on Sable Island had greatly improved and that surgeon would probably not be required. Stopped and lay to, awaiting possible clearing weather for searching to-morrow. All reports indicated fog covering wide area. Radio bearings showed an easterly drift of 0.5 knot per hour.

July 2: The day began with dense fog, slightly clearing at intervals. High barometer and no indications of early change or opportunity to search vicinity. At 9.10 a. m. stood on course to meet the *Modoc*. Farther west found a tendency to clear, with passing fogs. Light to gentle NW. breezes latter part. At 11.45 p. m. met the *Modoc*, in lat.  $41^{\circ} 51'$ , long.  $53^{\circ} 54'$ . The oceanographic observer was transferred to the *Modoc*, which then took over the duties of the ice patrol. Ice information was furnished the steamship *Dallas* and ice warning was sent to the steamship *Kristiansfjord*.

#### SUMMARY.

This cruise was characterized by a very large percentage of fogs, 70 per cent of the period being foggy, while the Pilot Chart gave 40 to 50 per cent as the average for this month. The 5 per cent of gales given on the chart was fully realized by some 24 hours of moderate

to strong and whole gale on the northern part of the Grand Banks on the 23d instant. Temperatures taken indicated a larger volume of Arctic water around the Tail of the Bank than at the same season last year. Icebergs actually seen by the patrol vessel menaced the steamship lanes less than at this season last year, the lowest actually seen being near the 43d parallel and apparently setting in on SW. slope of the Bank. The berg reported by an unidentified Norwegian motor ship as in lat.  $41^{\circ} 54'$ , long.  $49^{\circ} 52'$ , on the 26th, was not found by the patrol vessel nor seen by another vessel which passed near that position about the time of the report. The berg reported by the steamship *Esthonia* in lat.  $41^{\circ} 42'$ , long.  $50^{\circ} 32'$ , on the 30th, also could not be found by the patrol vessel. In neither case, however, did the weather afford the opportunity of making a thorough search. Either or both reports may have been erroneous, but the possible danger to the normal westbound steamship track was too serious to be disregarded, and no pains were spared to secure confirmatory evidence.

On this cruise 15 oceanographic stations were occupied, including a line of stations as far north as the axis of the Gully off Cape Race. Eleven ice reports were received from steamships and four bergs were sighted by the patrol vessel. In the aggregate, 28 vessels were warned or given ice information, and 871 water temperature reports were received.

Ice information was broadcast twice daily on 600-meter wave length and once daily on 2,300-meter wave length, each warning being repeated three times. Ice information was sent daily to the Hydrographic Office and weather reports were sent twice daily to the Weather Bureau, Washington.

COAST GUARD CUTTER "MODOC," COMMANDER B. M. CHISWELL,  
ICE PATROL, FOURTH CRUISE, JUNE 30 TO JULY 12, 1923.

The *Modoc* left Halifax at 10 a. m., June 30, and met the *Tampa* at 11.45 p. m., July 2, in lat.  $41^{\circ} 50'$ , long.  $52^{\circ} 50'$ . The oceanographic observer was transferred to the *Modoc*, which then took over the duties of the ice patrol. The *Modoc* left Halifax in thick weather and experienced WSW. to SSW. airs and breezes, with dense fog, until midnight of July 1. On July 2 we were in the warm water of the Gulf Stream, with clear weather. Thick fog prevailed at the time of meeting the *Tampa*.

July 3: Light E. airs and breezes. Clear weather with excellent visibility and intervals of fog. We ran to the position of the berg reported by the *Esthonia* on June 30 in lat.  $41^{\circ} 42'$ , long.  $50^{\circ} 32'$ , and searched along its line of probable drift. About 12.45 p. m. the vessel crossed the line separating the Gulf Stream from Arctic waters. This line was quite distinct and could be seen for miles in either

direction. A sunfish (*mola mola*) was observed. At 6 p. m. arrived alongside a derelict capsized schooner, with stern out of water and bow submerged, in lat.  $41^{\circ} 11'$ , long.  $48^{\circ} 47'$ . If this is the derelict reported by the *President Van Buren* on June 3 in lat.  $40^{\circ} 38'$ , long.  $59^{\circ} 50'$ , which seems likely, it has drifted in the past 30 days  $87^{\circ}$  true, 500 miles. Guncotton mines were secured under the stern of the wreck and exploded. Unfortunately darkness, accompanied by a dense fog, closed in a few minutes before the explosion, and it could not be determined definitely whether or not the wreck was completely destroyed, but it was believed to have ceased to be a menace to navigation. The name of the derelict was well under water and could not be read distinctly. It appeared to be *F. W. Lunden*, home port not deciphered, or it may have been *Lunenburg, N. S.*, and name not decipherable. The cargo was small planking. During the night the vessel drifted to leeward in a dense fog.

July 4: Light E. airs and NE. breezes, with fog over the colder water and clear weather over the warm. An intensive search was made for the wreck of last night. Visibility poor. Some inconsequential flotsam was sighted, but nothing that constituted a menace to navigation. At 11.15 a. m. the search was abandoned and vessel headed to the southward. By noon we had reached warm water and clear, pleasant weather, after which search to the westward was prosecuted for the berg reported by the *Esthonia* on June 30. At dark we stopped and drifted for the night.

July 5: Calm, followed by W. airs increasing to fresh SW. breeze. Partly clear to overcast and cloudy. Barometer falling. Searched possible ice areas to the westward. Received the following radiogram from the steamship *West Calumb*: "Lat. 40-38, long. 46-05, passed bottom part of wreck about 160 feet long awash at 7.05 G. M. T." This was believed to be the derelict that we had attempted to destroy on the night of the 3d and were unable to relocate on the morning of the 4th because of thick weather. We headed for the position given in the latest report, for the purpose of finding it and again attempting its destruction. Special ice information was furnished the steamship *Bremerton*.

July 6: Moderate to light breezes, beginning WSW., backing to SSW., and ending W., with passing rain squalls at night. Partly cloudy with very good visibility during daylight. In the midwatch a brilliant meteor, having a long, fiery tail, was observed to the southward and vivid lightning to the westward. We stood to the eastward to search for the wreckage reported yesterday. Special ice information was furnished the steamship *Federica*.

July 7: Light airs and breezes, mostly westerly, with partly clear to hazy weather. Vessel searching for wreckage reported on the 5th. With the assistance of the steamship *Edyphill*, which reported

passing it at 6:15 a. m., a piece approximately 50 ft. by 20 ft. was found at 4:10 p. m., in lat.  $40^{\circ} 30'$ , long.  $44^{\circ} 25'$ . This consisted of a part of the stern of the derelict destroyed by the *Modoc* on the 3d, frames with planking attached extending from rail to keel, evidently a two-masted vessel of the fishing schooner type. Exploded two guncotton mines under the wreckage, leaving no piece large enough to constitute a menace to navigation. We then stood back for the Tail of the Bank. While searching this day the vessel experienced a set almost due E. of about 2.5 knots per hour. Special ice information was furnished the steamships *Mesaba* and *Majestic*.

July 8: Light SW. airs, increasing to SW. gale by 11 a. m. Fog in the early morning; overcast and cloudy during remainder of the day. Steamed to the westward for the vicinity of the Tail of the Bank and stopped at dark, in lat.  $41^{\circ} 25'$ , long.  $49^{\circ} 38'$ , to drift for the night. The following message was relayed to the *Modoc* through a Shipping Board vessel, as we were unable to communicate with Bar Harbor direct: "9907. Release *Tampa* from patrol. Direct her proceed Boston. *Modoc* will continue the patrol present. 1215. Coast Guard," and the following message was sent to the *Tampa*, via Ste. Pierre radio station: "1008. Proceed Boston report Eastern Division. 0920." By request, information regarding the steamship tracks was furnished the steamships *Miami* and *Tungus*.

July 9: Moderate to light SW. and WSW. winds. Mostly clear to overcast and cloudy; mist and rain at night; fog to the N. over the Banks. We scouted to the westward S. of the Banks and at dark stopped to drift for the night, in lat.  $41^{\circ} 58'$ , long.  $50^{\circ} 17'$ . About 5 p. m. a berg was reported and the ship headed for it. All who observed it were certain that it was a very large berg. After covering 5 or 6 miles toward it, however, its change both in shape and bearing, and its final disappearance, left no doubt that it was an unusually deceptive appearing cloud form resting on the water, or, in other words, a small, detached patch of fog. Something similar was undoubtedly mistaken for a berg by the *Esthonia* on June 30. Special ice information was furnished the steamship *Hjalmoren*, and, by request, the steamship *President Arthur* was advised concerning steamship tracks.

July 10: Light to moderate SW. winds. Overcast and cloudy in the forenoon; mostly clear during the remainder of the day. Scouted to the westward until dark, then stopped and drifted. The oceanographic observer stated that between July 6 and 10 there has been a noticeable movement of warm surface water toward the N. The northern edge of the Gulf Stream was observed to be along the 41st parallel SE. of the Tail of the Bank during the first few days in July. This day it lies N. to  $41^{\circ} 50'$  on the surface. The probability of bergs drifting S. of the 42d parallel again this year is very slight.

Should such an unexpected thing occur, the danger of the berg's presence would be minimized by the absence of fog over the warm water. The medical officer prescribed treatment by radio for an engineer on the steamship *Evergreen City*, whose illness was diagnosed as lumbago. The following radiogram was received from Coast Guard at 7.50 p. m.: "9910. Discontinue patrol on July 12. Proceed Bath, Me., stopping en route Halifax if necessary. 1205." Ice information was furnished the steamship *Hjalmoren*.

July 11: Moderate to light WSW. and SW. breezes. Partly clear to cloudy; barometer falling. Search for ice was continued between lats.  $42^{\circ} 00'$  and  $42^{\circ} 30'$ , E. to the 51st meridian. Special ice information was furnished the steamship *Navarra*.

July 12: The patrol was discontinued and the vessel sailed for Halifax to refuel. Special ice information was furnished the steamship *Sinasta*. The following message was received from the steamship *Mauretania*: "Your work and reports while on ice patrol greatly appreciated. As you leave patrolling may I wish you all a well-earned vacation and happy spell on shore. Best regards. Rostron."

#### SUMMARY.

Ice warnings were broadcast twice daily on 600-meter and once daily on 2,300-meter wave lengths. A daily ice report was sent to the Hydrographic Office and a morning and evening weather report to the Weather Bureau, Washington. Eighty-two vessels furnished the patrol with 306 surface-water temperature reports, 4 vessels reported ice, and 7 were given special ice information.

## SUMMARY OF ICE PATROL, SEASON OF 1923.

By Commander B. M. CHISWELL, Senior Officer.

---

The patrol was inaugurated by the *Seneca*, which arrived off the Tail of the Grand Bank March 13, when she was relieved by the *Tampa*. Thereafter the *Tampa* and *Modoc* alternated on ice patrol duty every 15 days until the discontinuance of the patrol on July 12.

The month of March was characterized by unusually stormy weather, the wind reaching gale force on 3 of the 6 days of the *Seneca's* patrol and 11 of the 13 of the *Tampa's*. All gales were from SW. to NW. Only about 9 per cent of fog and reduced visibility was experienced for this period. Water temperatures showed that the Labrador Current had assumed an unusual drift to the SE. between Flemish Cap and the east slope of the Grand Banks. This was further shown by the drift of numerous bergs, as far east as the steamer tracks to northern European ports, between lats.  $44^{\circ} 20'$  and  $46^{\circ} 00'$ , which led the patrol to spend more time than usual east of the Grand Banks in the vicinity of the steamer tracks mentioned. The breaking up and disintegration of bergs was remarkably rapid and was caused by the high sea-water temperatures and the buffeting they received from the tempestuous seas. In one instance a large berg wholly disintegrated in three days, which is most unusual. Only three bergs drifted around the Tail of the Bank during the month, and these but little south of the 43d parallel. Field ice was reported as far south as  $42^{\circ} 20'$ , which is somewhat farther south than it is usually seen. The trans-Atlantic steamer tracks were shifted 60 miles to the southward, effective March 30 for eastbound vessels and April 6 for those westbound.

During the month of April fog and low visibility prevailed approximately 51 per cent of the time, and three gales were encountered. The tendency of the bergs to drift off to the eastward before reaching the Tail of the Bank, observed in March, continued during the first half of April, one being reported on April 13 as far east as  $39^{\circ} 42'$  W. and  $43^{\circ} 05'$  N. By the middle of the month, however, this easterly drift had ceased and subsequent drift was to the southward along the east side of the Banks, then to the westward around the Tail of the Bank, and finally to the NW., many of them grounding along the SW. slope of the Bank. No steamer lanes were threatened during the month and the southernmost berg observed was in  $42^{\circ} 40'$  N.,

50° 44' W., later being carried by the cold current to the northwestward and finally grounding. Many vessels sought advice from the patrol regarding ice conditions along the shores and in the harbors of Nova Scotia and Newfoundland and much useful information was furnished them. Thirty-five oceanographic stations were occupied during the month, at which sea-water temperatures and water samples were taken at various depths, samples to be analyzed in a laboratory after the end of the patrol for determination of salinity. These stations were located on radials projecting from a central station on the Grand Banks, in 43° 50' N., 50° 25' W., the radial lines extending E., S., SW. and WSW. from the central station. Temperatures obtained indicated the presence of Arctic water over a large area W. and NW. of the Tail of the Bank.

During the month of May there was 39 per cent of fog and poor visibility, and the wind reached gale force on but two days, the 12th and 28th. There was a smaller number of bergs south of the Tail of the Bank than usual at this season, and the general trend of the drift was around the Tail and up the SW. slope, but there was one notable exception to this general tendency, as one berg drifted as far south as 39° 08' N., 48° 30' W., where it was left by the patrol in the last stages of disintegration at daybreak of May 25. Twenty-six regular oceanographic stations and some special ones in the vicinity of bergs were occupied. One run was made during the month from the central station along the northern radial to the vicinity of Cape Race, to determine the temperatures and characteristics of the water over the Grand Banks. The Labrador Current formed a wedge farther to the southeastward than usual at this season. On the 14th the first vessel of the season came through from St. Lawrence River ports, and shortly thereafter one or more Canadian patrol vessels were stationed in Cabot Straits to furnish ice information to vessels bound to Canadian ports, relieving the patrol of the work of furnishing ice information to vessels bound to the St. Lawrence River, which had been done theretofore.

During June fog and low visibility prevailed during 71 per cent of the month and gales were experienced on the 2d and 23d, the wind reaching whole gale force on the latter date. The bergs sighted by the patrol were considered not to constitute a real menace to the normal steamer tracks, as the southernmost one, sighted on June 8, in 48° 32' N., 49° 37' W., was not sufficiently massive and hard to last more than a few days in warm water. The berg reported by an unidentified Norwegian motor ship in 41° 54' N., 49° 52' W., on the 26th, was not found by the patrol, nor was it seen by another vessel that passed near this position about the time of the report. Neither could the one reported by the *Esthonia* on the 30th, in 41° 42' N., 50° 32' W., be found. After due investigation, it was confidently believed that both

reports were in error. During the season many other reports were found to be undoubtedly in error. Thirty-five oceanographic stations, including the stations along the radial extending across the Grand Bank to Cape Race, were occupied during the month. The sea-water temperatures taken indicated a larger volume of Arctic water around the Tail of the Bank than at the same season last year.

The patrol was discontinued on July 12, the period from the 1st to the 12th being devoted to a search of the area of possible drift of the southernmost bergs reported on June 26 and 30, and to destroying a derelict and some wreckage in the vicinity of the patrol grounds. The reports referred to above were undoubtedly in error, as no ice was found by the patrol nor reported by the many steamers that traversed this area subsequent to the receipt of the reports. Surface temperatures of the sea water taken between July 1 and 10 showed that the Gulf Stream had advanced from  $41^{\circ} 00' N.$  to  $41^{\circ} 50' N.$  in the longitude of the Grand Banks.

During the season 46 vessels were warned of the presence of ice on or near their tracks, 195 were furnished special ice information, approximately 8,500 water temperature reports were received, 416 reports of ice sighted were received, 4 steamships were given medical advice by radio, and 4 were furnished weather reports.

Attention is invited to the important oceanographic work carried on this year. The oceanographic observer is compiling a record of all oceanographic observations taken and a discussion of the data. It is realized that no true picture of oceanographic circulation and the movement of ice in the North Atlantic can be obtained from observations restricted to the surface of the sea. Recognizing the value to be derived from investigation of the subsurface waters, the Interdepartmental Board of the Ice Patrol laid down a program of oceanographic work which has been considerably developed in the last few years. It is believed that the records of the ice patrol constitute the most complete and systematic study of hydrographical conditions in the vicinity of the Grand Banks yet obtained. This year it was decided to suspend further collection of biological specimens pending analysis of the material collected during previous seasons. The investigation of physical oceanography was continued as formerly, salinities and temperatures having been ascertained at various levels to a depth of 750 meters at frequent intervals. A total of 103 stations was occupied, which exceeds the number for any previous ice season. The failure of the salinity apparatus installed on the *Tampa* to furnish data of salinities was disappointing. It is hoped this apparatus will be in working order for next year's patrol. Practical use was made of the subsurface temperature readings in determining in advance the general drift of bergs in the vicinity of the Tail of the Bank.

An illustration of the practical value of the oceanographic work was furnished during April, when stations occupied off the SW. slope of the Grand Banks disclosed the presence of polar water over a relatively large area in that vicinity, which it is believed was the major extension of the Labrador Current reaching out northwestward from the Tail of the Bank. This led to the assumption that icebergs arriving at the Tail of the Bank would tend to drift to the northwestward parallel to the SW. slope of the Grand Bank, and subsequent developments seemed to indicate the correctness of this assumption. The characteristic drift of bergs since the middle of April has been around the Tail and up onto the SW. slope of the Grand Bank. It has long been the hope of the patrol to forecast advance information regarding the movements of ice.

Surface temperature conditions in the vicinity of the Grand Banks have been carefully watched and recorded, as shown on the surface temperature charts. These are based upon the thousands of reports received from passing steamships and upon hourly records kept on board the patrol vessel. Detailed wind and fog information was also collected, from which wind diagrams and fog scales will be prepared.

*Ice and obstructions reported, season of 1923.*

| Date    | Vessel reporting.            | Position. |          | Nature of ice or obstruction.                 |
|---------|------------------------------|-----------|----------|-----------------------------------------------|
|         |                              | N. lat.   | W. long. |                                               |
| 1923.   |                              | ° /       | ° /      |                                               |
| Feb. 27 | Via Cape Race.....           | 42 33     | 51 05    | Berg (first berg of the season).              |
| 28      | do.....                      | 43 00     | 51 10    | Do.                                           |
| Mar. 1  | do.....                      | 42 28     | 41 10    | Do. (See report of the 27th ult.)             |
|         | Niels Nielson.....           | 42 35     | 48 23    | Field ice extending 10 miles N.               |
| 2       | Via Cape Race.....           | 42 49     | 49 46    | Berg and growlers.                            |
| 3       | West Kebar.....              | 41 59     | 59 48    | Field ice.                                    |
| 5       | do.....                      | 43 15     | 48 11    | Medium-sized berg.                            |
|         | Venusia.....                 | 41 58     | 59 30    | Field ice extending W. 60 miles.              |
|         | do.....                      | 42 54     | 48 42    | Field ice.                                    |
| 7       | do.....                      | 45 49     | 44 00    | Berg.                                         |
| 9       | do.....                      | 47 25     | 41 26    | Do.                                           |
| 11      | Weyingham.....               | 43 20     | 46 50    | Do.                                           |
|         | do.....                      | 42 52     | 49 25    | Slob ice.                                     |
| 13      | Lord Dufferin.....           | 45 53     | 46 07    | Berg.                                         |
|         | do.....                      | 45 35     | 46 44    | 5 large bergs.                                |
|         | do.....                      | 46 32     | 44 47    | Berg.                                         |
|         | do.....                      | 47 10     | 43 43    | Do.                                           |
|         | do.....                      | 43 05     | 47 30    | Do.                                           |
| 14      | Canadian Mariner.....        | 43 20     | 48 50    | Field ice extending S.                        |
|         | Via Cape Race.....           | 41 27     | 51 16    | Field ice from Newfoundland to this position. |
|         | do.....                      | 44 24     | 42 40    | Berg.                                         |
|         | do.....                      | 44 48     | 42 40    | Do.                                           |
| 15      | Gallymede.....               | 44 25     | 43 33    | Do.                                           |
|         | do.....                      | 44 32     | 43 02    | Do.                                           |
|         | Cottage City.....            | 43 30     | 59 05    | Field ice and growlers.                       |
| 16      | Vittorio Emmanuelle III..... | 44 37     | 41 40    | Berg.                                         |
| 18      | Pinemore.....                | 43 00     | 51 48    | Medium-sized berg.                            |
| 19      | Patrol vessel.....           | 43 00     | 51 48    | Do.                                           |
|         | do.....                      | 42 58     | 50 52    | Do.                                           |
|         | do.....                      | 42 55     | 50 21    | Do.                                           |
|         | Eastern City.....            | 44 20     | 44 27    | Do.                                           |
| 20      | do.....                      | 43 12     | 48 13    | Do.                                           |
| 21      | Afel.....                    | 43 50     | 38 42    | Floating mine.                                |
| 22      | Sagittaire.....              | 44 30     | 42 25    | 3 bergs.                                      |
|         | do.....                      | 43 36     | 50 47    | Southern boundary ice field.                  |
| 23      | do.....                      | 44 00     | 45 40    | Large berg.                                   |
| 24      | do.....                      | 43 40     | 48 20    | Ice field.                                    |
|         | do.....                      | 43 25     | 48 50    | Do.                                           |
| 26      | Patrol vessel.....           | 44 25     | 45 20    | Berg.                                         |

## Ice and obstructions reported, season of 1923—Continued.

| Date    | Vessel reporting.       | Position. |          | Nature of ice or obstruction. |    |                                            |
|---------|-------------------------|-----------|----------|-------------------------------|----|--------------------------------------------|
|         |                         | N. lat.   | W. long. |                               |    |                                            |
| 1923.   |                         | °         | '        | °                             | '  |                                            |
| Mar. 28 | Patrol vessel.....      | 44        | 46       | 44                            | 03 | Berg, medium size.                         |
|         | Stagpool.....           | 42        | 20       | 50                            | 10 | Ice field, crescent shape, 10 miles long.  |
| 29      | Patrol vessel.....      | 44        | 55       | 44                            | 27 | Berg, small.                               |
|         | do.....                 | 44        | 47       | 44                            | 35 | Berg, medium size.                         |
|         | Tarantia.....           | 44        | 07       | 45                            | 02 | Berg.                                      |
|         | do.....                 | 44        | 23       | 44                            | 29 | Do.                                        |
|         | do.....                 | 44        | 33       | 44                            | 09 | Do.                                        |
| 30      | Patrol vessel.....      | 44        | 38       | 44                            | 00 | Do.                                        |
|         | do.....                 | 44        | 26       | 44                            | 17 | Berg, medium size.                         |
|         | do.....                 | 44        | 19       | 44                            | 23 | Berg, large.                               |
|         | Canada.....             | 42        | 23       | 49                            | 20 | Beginning of field ice.                    |
|         | do.....                 | 42        | 27       | 50                            | 08 | Ending of field ice.                       |
| 31      | Patrol vessel.....      | 44        | 19       | 44                            | 39 | Berg, medium size.                         |
|         | do.....                 | 44        | 16       | 44                            | 35 | Do.                                        |
| Apr. 1  | do.....                 | 43        | 37       | 47                            | 44 | Berg, low lying.                           |
| 2       | do.....                 | 43        | 14       | 48                            | 19 | Berg, large.                               |
| 3       | Orca.....               | 39        | 55       | 55                            | 51 | Schooner Rita N. Cluett on fire.           |
|         | Drottningholm.....      | 45        | 55       | 41                            | 35 | Berg, medium size.                         |
|         | Marloch.....            | 44        | 01       | 44                            | 22 | Berg, large.                               |
|         | Cameronia.....          | 40        | 58       | 49                            | 01 | Small piece of ice.                        |
|         | Sir Ernest Cassel.....  | 43        | 10       | 47                            | 11 | Berg, large.                               |
|         | Trolleholm.....         | 45        | 48       | 42                            | 11 | Berg.                                      |
| 4       | Drottningholm.....      | 44        | 10       | 43                            | 45 | 2 bergs, one large, one small.             |
|         | Falls City.....         | 43        | 40       | 48                            | 30 | Heavy field ice.                           |
|         | Trolleholm.....         | 44        | 15       | 44                            | 29 | Berg, medium size.                         |
|         | do.....                 | 44        | 29       | 44                            | 08 | 2 small bergs.                             |
|         | Elazasier.....          | 44        | 45       | 43                            | 40 | Berg, large.                               |
|         | do.....                 | 44        | 33       | 44                            | 06 | Growlers.                                  |
| 5       | Comino.....             | 43        | 26       | 40                            | 05 | Berg.                                      |
|         | Columbia.....           | 46        | 02       | 43                            | 19 | Berg and 2 growlers.                       |
|         | Liljevalch.....         | 49        | 00       | 49                            | 00 | Heavy field ice.                           |
|         | Patrol vessel.....      | 43        | 27       | 47                            | 00 | Berg, large.                               |
|         | Londonier.....          | 42        | 50       | 49                            | 00 | Tail of ice field.                         |
| 6       | Regina.....             | 43        | 17       | 39                            | 53 | Small growlers.                            |
|         | do.....                 | 43        | 12       | 39                            | 53 | Berg, medium size.                         |
|         | Columbia.....           | 43        | 17       | 48                            | 38 | Loose field ice.                           |
|         | President Garfield..... | 43        | 15       | 39                            | 45 | Berg.                                      |
|         | Liljevalch.....         | 47        | 41       | 46                            | 30 | Field ice and growlers.                    |
|         | Wekika.....             | 42        | 36       | 43                            | 25 | Spar 40 feet long.                         |
|         | Blydendyk.....          | 43        | 05       | 39                            | 42 | Berg.                                      |
| 7       | Lulea.....              | 45        | 40       | 43                            | 00 | Berg, small.                               |
|         | Liljevalch.....         | 46        | 27       | 44                            | 20 | Berg and growlers.                         |
|         | do.....                 | 46        | 03       | 44                            | 16 | Berg, large.                               |
| 8       | Canadian Mariner.....   | 42        | 42       | 50                            | 28 | Berg, very large.                          |
|         | Patrol vessel.....      | 44        | 40       | 43                            | 40 | Growler.                                   |
| 9       | Indian.....             | 39        | 58       | 48                            | 05 | Yard 90 feet long.                         |
| 11      | Patrol vessel.....      | 44        | 07       | 47                            | 43 | Berg, large.                               |
|         | do.....                 | 44        | 10       | 48                            | 00 | Do.                                        |
|         | Liss.....               | 43        | 53       | 43                            | 09 | Berg.                                      |
|         | Marburn.....            | 45        | 26       | 41                            | 03 | Do.                                        |
|         | Liss.....               | 44        | 04       | 42                            | 09 | Do.                                        |
| 12      | Patrol vessel.....      | 43        | 19       | 49                            | 00 | Berg, large.                               |
|         | do.....                 | 42        | 56       | 50                            | 17 | Do.                                        |
|         | do.....                 | 42        | 52       | 50                            | 46 | Do.                                        |
|         | Yildum.....             | 44        | 10       | 48                            | 42 | Ice field.                                 |
|         | do.....                 | 44        | 23       | 50                            | 30 | Berg, large.                               |
| 13      | Stockholm.....          | 45        | 50       | 41                            | 25 | Do.                                        |
|         | Wearbridge.....         | 39        | 50       | 45                            | 00 | Large piece ice.                           |
| 14      | Patrol vessel.....      | 42        | 56       | 51                            | 06 | Berg.                                      |
|         | do.....                 | 43        | 00       | 50                            | 17 | Berg (sighted by patrol on 12th).          |
|         | do.....                 | 42        | 50       | 50                            | 00 | Do.                                        |
| 16      | do.....                 | 42        | 40       | 50                            | 44 | Berg (sighted by patrol on 11th and 12th). |
|         | do.....                 | 42        | 48       | 50                            | 55 | Do.                                        |
| 18      | Orduna.....             | 44        | 00       | 47                            | 00 | Schooner Rita N. Cluett on fire.           |
| 19      | Mertaines.....          | 44        | 32       | 43                            | 44 | Berg, large.                               |
|         | do.....                 | 46        | 43       | 41                            | 42 | Do.                                        |
| 20      | Cairnvalonia.....       | 47        | 58       | 46                            | 46 | Edge ice field.                            |
|         | Arcturus.....           | 43        | 07       | 49                            | 37 | Berg.                                      |
|         | Bodin.....              | 42        | 57       | 48                            | 58 | Berg, large.                               |
|         | Patrol vessel.....      | 42        | 55       | 50                            | 32 | Large berg, grounded.                      |
| 21      | Marloch, from.....      | 47        | 02       | 44                            | 50 |                                            |
|         | Marloch, to.....        | 46        | 40       | 45                            | 48 | 7 bergs and 4 growlers.                    |
|         | Cairnvalonia.....       | 47        | 31       | 46                            | 48 | Outer edge huge ice field.                 |
| 22      | Marloch.....            | 46        | 33       | 46                            | 00 | Berg, large.                               |
|         | do.....                 | 46        | 33       | 46                            | 03 | Do.                                        |
|         | do.....                 | 46        | 23       | 46                            | 20 | Do.                                        |
| 23      | Cranley, from.....      | 47        | 40       | 48                            | 50 |                                            |
|         | Cranley, to.....        | 47        | 35       | 49                            | 20 | 3 bergs.                                   |
|         | Mabriton.....           | 41        | 55       | 41                            | 46 | Schooner Gay Gordon sinking.               |

## Ice and obstructions reported, season of 1923—Continued.

| Date.    | Vessel reporting.              | Position. |          | Nature of ice or obstruction. |
|----------|--------------------------------|-----------|----------|-------------------------------|
|          |                                | N. lat.   | W. long. |                               |
| 1923.    |                                | ° /       | ° /      |                               |
| April 24 | Eastern King .....             | 39 30     | 52 15    | Black can buoy.               |
|          | Cairnvalonia .....             | 46 10     | 55 50    | Passing through ice field.    |
| 26       | Canadian Squatter .....        | 45 05     | 46 15    | Berg, large.                  |
|          | Montealm .....                 | 48 31     | 44 02    | Several growlers.             |
|          | do .....                       | 48 05     | 45 21    | Berg.                         |
|          | do .....                       | 47 20     | 46 42    | Met ice field.                |
| 27       | Letitia .....                  | 46 54     | 44 42    | 2 bergs.                      |
|          | Cairnvalonia .....             | 47 21     | 59 22    | Surrounded by ice field.      |
|          | Basis .....                    | 46 00     | 43 42    | Berg, large.                  |
|          | Canada .....                   | 47 24     | 50 18    | Do.                           |
|          | do .....                       | 46 55     | 50 23    | Do.                           |
|          | Canadian Victor .....          | 48 23     | 46 23    | Patches field ice.            |
|          | Manchester Regime .....        | 47 30     | 46 48    | Southern edge ice field.      |
| 28       | Verdulia .....                 | 43 04     | 50 51    | Berg.                         |
|          | do .....                       | 42 57     | 50 26    | Do.                           |
|          | Tronjinfjord .....             | 48 24     | 49 16    | Southern edge ice field.      |
|          | Canadian Carrier .....         | 48 02     | 45 08    | 3 bergs.                      |
|          | Manchester Spinner .....       | 47 45     | 44 40    | Berg.                         |
|          | do .....                       | 48 10     | 44 15    | Do.                           |
|          | Ansonia .....                  | 46 54     | 45 51    | Do.                           |
|          | Bosworth .....                 | 42 48     | 50 24    | Berg, large.                  |
|          | Sachem .....                   | 46 30     | 43 38    | 3 bergs.                      |
|          | do .....                       | 46 02     | 44 50    | 2 bergs.                      |
|          | Basis .....                    | 44 30     | 45 23    | Berg.                         |
|          | do .....                       | 44 10     | 45 30    | Growler.                      |
|          | Canadian Victor .....          | 48 10     | 48 25    | Field ice.                    |
|          | Athena .....                   | 46 48     | 45 39    | Berg.                         |
|          | do .....                       | 46 40     | 45 38    | Do.                           |
|          | do .....                       | 46 31     | 46 30    | Do.                           |
|          | do .....                       | 46 34     | 46 40    | Do.                           |
|          | do .....                       | 46 46     | 45 45    | Growler.                      |
| 29       | Verdulia .....                 | 43 04     | 50 51    | Large growlers.               |
|          | do .....                       | 42 57     | 50 26    | Berg, large.                  |
|          | do .....                       | 43 09     | 48 33    | Berg, low.                    |
|          | Manchester Importer .....      | 42 30     | 50 13    | Berg, medium size.            |
|          | "ZMC" .....                    | 47 05     | 44 50    | Ice field.                    |
| 30       | Benquella .....                | 47 26     | 43 57    | Berg.                         |
|          | do .....                       | 47 08     | 45 05    | Do.                           |
|          | do .....                       | 47 02     | 45 15    | Do.                           |
|          | do .....                       | 47 10     | 45 35    | Do.                           |
|          | do .....                       | 46 55     | 45 35    | Do.                           |
|          | West Saginaw .....             | 39 03     | 48 12    | Conical buoy.                 |
|          | Sanfelix .....                 | 39 05     | 48 16    | Conical buoy (same).          |
|          | Hastings County .....          | 42 45     | 50 24    | 2 bergs, 1 large, 1 small.    |
|          | Mexican .....                  | 45 20     | 48 10    | Berg, large.                  |
|          | Persier .....                  | 42 59     | 50 30    | 3 bergs                       |
|          | do .....                       | 43 01     | 50 45    | Growlers.                     |
|          | do .....                       | 42 45     | 50 29    | Do.                           |
|          | Ala .....                      | 41 04     | 43 58    | Nun buoy.                     |
|          | Patrol vessel .....            | 42 45     | 50 30    | Berg, medium size.            |
| May 1    | Minnedosa .....                | 46 35     | 46 26    | 2 bergs.                      |
|          | do .....                       | 46 28     | 46 30    | Berg.                         |
|          | do .....                       | 46 18     | 46 35    | Do.                           |
|          | do .....                       | 46 36     | 46 38    | Do.                           |
|          | do .....                       | 46 36     | 46 46    | Do.                           |
|          | do .....                       | 46 16     | 46 57    | Do.                           |
|          | do .....                       | 46 32     | 47 14    | Small ice field.              |
|          | do .....                       | 46 55     | 47 01    | Berg.                         |
|          | do .....                       | 46 50     | 44 39    | 7 bergs, 3 growlers.          |
|          | do .....                       | 46 29     | 45 53    | Berg.                         |
|          | do .....                       | 46 25     | 46 00    | 2 bergs.                      |
|          | Patrol vessel .....            | 43 00     | 50 25    | Berg.                         |
| 2        | British Vine .....             | 43 07     | 50 57    | Do.                           |
|          | Sachem .....                   | 45 44     | 55 34    | Entered heavy ice field.      |
|          | Regina .....                   | 47 37     | 45 26    | 11 bergs.                     |
|          | do .....                       | 48 21     | 44 17    | 3 bergs.                      |
|          | Montrose .....                 | 47 31     | 44 37    | Several bergs. (See above.)   |
| 3        | Strassa .....                  | 44 05     | 48 55    | Berg.                         |
|          | Cabotin .....                  | 42 56     | 49 43    | Berg, small.                  |
|          | Patrol vessel .....            | 43 38     | 51 51    | Berg, large.                  |
| 4        | Thyra .....                    | 45 40     | 47 00    | Berg.                         |
|          | Shelley .....                  | 43 10     | 50 30    | Berg, large.                  |
|          | Pennsylvania .....             | 43 58     | 49 00    | Berg.                         |
|          | Patrol vessel .....            | 43 12     | 51 03    | Berg, large.                  |
|          | do .....                       | 43 04     | 50 55    | Berg.                         |
| 5        | Loyal Devonian .....           | 44 22     | 48 42    | Berg, large.                  |
|          | Manchester Shipper .....       | 47 13     | 45 16    | Berg and 6 growlers.          |
|          | Manchester Shipper, from ..... | 46 50     | 46 33    |                               |
|          | Manchester Shipper, to .....   | 46 30     | 47 40    | 14 bergs and growlers.        |

## Ice and obstructions reported, season of 1923—Continued.

| Date  | Vessel reporting.     | Position. |          | Nature of ice or obstruction.                                                  |
|-------|-----------------------|-----------|----------|--------------------------------------------------------------------------------|
|       |                       | N. lat.   | W. long. |                                                                                |
| 1923. |                       | ° /       | ° /      |                                                                                |
| May 6 | Valacia .....         | 46 57     | 46 44    | 3 growlers.                                                                    |
|       | Unknown vessel .....  | 38 47     | 50 55    | Log 30 feet long.                                                              |
| 8     | Thurban .....         | 48 55     | 45 29    | Berg, large.                                                                   |
|       | do .....              | 47 30     | 47 40    | Field ice.                                                                     |
|       | Cassandra .....       | 45 44     | 46 50    | 2 growlers.                                                                    |
| 9     | do .....              | 45 44     | 48 21    | Berg, large.                                                                   |
|       | Canada .....          | 46 29     | 47 52    | Berg.                                                                          |
|       | do .....              | 46 35     | 47 29    | Berg, small.                                                                   |
|       | Ballygally Head ..... | 46 33     | 55 36    | Ice field.                                                                     |
|       | Berengaria .....      | 40 29     | 47 51    | Buoy.                                                                          |
| 10    | Otarama .....         | 49 00     | 48 30    | Berg.                                                                          |
|       | Metagama .....        | 43 18     | 51 21    | Berg, large.                                                                   |
|       | do .....              | 43 22     | 50 41    | Large growler.                                                                 |
|       | Megantic .....        | 47 32     | 45 49    | Large berg and several growlers.                                               |
|       | Alki .....            | 40 42     | 48 55    | Berg.                                                                          |
|       | Bothwell .....        | 46 30     | 47 51    | Berg, large.                                                                   |
|       | do .....              | 46 26     | 47 57    | Small bergs.                                                                   |
|       | do .....              | 46 24     | 47 59    | Growlers.                                                                      |
|       | Andania .....         | 46 29     | 48 20    | Berg, large.                                                                   |
|       | Cassandra .....       |           |          | Entered open field ice 10 miles off St. Pierre.                                |
|       | Patrol vessel .....   | 43 55     | 49 03    | Berg, large.                                                                   |
| 11    | Allegheny .....       | 42 36     | 50 30    | Berg, small.                                                                   |
|       | Larenberg .....       | 45 44     | 47 52    | Berg, large.                                                                   |
|       | Patrol vessel .....   | 43 10     | 49 34    | Do.                                                                            |
| 12    | War Nizam .....       | 43 00     | 50 00    | Berg.                                                                          |
|       | Potomac .....         | 40 05     | 45 50    | Spar 15 by 2 feet.                                                             |
| 14    | Renogdet .....        | 44 02     | 49 20    | Berg.                                                                          |
|       | Patrol vessel .....   | 42 52     | 50 42    | Berg, large.                                                                   |
| 15    | Montrose .....        | 45 55     | 48 27    | Do.                                                                            |
|       | do .....              | 46 01     | 47 54    | Berg.                                                                          |
|       | do .....              | 46 22     | 46 59    | Do.                                                                            |
|       | do .....              | 46 25     | 46 15    | Do.                                                                            |
|       | do .....              | 46 18     | 45 43    | Do.                                                                            |
|       | Renogdet .....        | 43 43     | 51 35    | 2 bergs.                                                                       |
|       | Patrol vessel .....   | 43 48     | 51 52    | Berg.                                                                          |
|       | do .....              | 43 47     | 51 42    | Do.                                                                            |
| 16    | Blackheath .....      | 43 46     | 55 32    | Large buoy.                                                                    |
|       | Regulus .....         | 43 45     | 52 04    | Berg.                                                                          |
|       | do .....              | 43 40     | 52 04    | Do.                                                                            |
|       | Thurban .....         | 46 00     | 57 58    | Ice field, Gulf of St. Lawrence.                                               |
|       | Melita .....          | 46 33     | 38 45    | Berg, small.                                                                   |
| 17    | Regina .....          | 47 28     | 45 23    | Do.                                                                            |
|       | Lord Kelvin .....     | 48 55     | 51 20    | About 50 growlers.                                                             |
|       | Patrol vessel .....   | 42 28     | 51 31    | Berg, large.                                                                   |
| 18    | Scythia .....         | 41 50     | 51 46    | Do.                                                                            |
|       | Regina .....          | 47 28     | 45 23    | Berg, small.                                                                   |
|       | Parthenia .....       | 47 55     | 49 53    | 3 bergs.                                                                       |
|       | Patrol vessel .....   | 42 06     | 51 17    | Berg.                                                                          |
| 19    | do .....              | 41 28     | 50 38    | 2 bergs.                                                                       |
| 20    | do .....              | 41 28     | 49 50    | Do.                                                                            |
| 21    | Belgian .....         | 41 06     | 48 41    | Large berg 15 miles N.                                                         |
|       | do .....              | 41 04     | 48 56    | Berg.                                                                          |
|       | Patrol vessel .....   | 42 06     | 51 17    | 2 bergs. (Previously located; had drifted 2 knots per hour.)                   |
| 22    | Ansonia .....         | 48 07     | 45 55    | Berg, large.                                                                   |
|       | Talisman .....        | 42 52     | 49 51    | Berg.                                                                          |
|       | West Nosska .....     | 42 42     | 49 44    | Do.                                                                            |
|       | Patrol vessel .....   | 40 34     | 48 15    | 3 bergs, 1 large, 2 small.                                                     |
| 23    | Concordia .....       | 45 49     | 48 58    | Berg, large.                                                                   |
|       | do .....              | 45 55     | 48 49    | Berg.                                                                          |
|       | do .....              | 45 58     | 48 43    | Growlers.                                                                      |
|       | do .....              | 46 04     | 48 20    | Berg.                                                                          |
|       | Darien .....          | 40 06     | 48 55    | Do.                                                                            |
|       | Alaska .....          | 40 25     | 49 03    | Small bergs.                                                                   |
|       | do .....              | 40 20     | 49 10    | Berg, large.                                                                   |
|       | Patrol vessel .....   | 39 57     | 48 53    | 3 bergs.                                                                       |
| 24    | Sorland .....         | 41 00     | 49 05    | Berg.                                                                          |
|       | Aquitania .....       | 39 33     | 49 04    | 3 small growlers.                                                              |
|       | Caronia .....         | 40 55     | 49 15    | Berg, medium size.                                                             |
|       | Patrol vessel .....   | 39 22     | 48 20    | Large berg and remnant of small berg.                                          |
| 25    | Hammershus .....      | 48 26     | 49 45    | 2 bergs.                                                                       |
|       | Patrol vessel .....   | 39 08     | 48 30    | Small berg.                                                                    |
| 26    | Tyrhenia .....        | 39 52     | 66 22    | Mast attached to wreckage about 10 feet out of water; dangerous to navigation. |
|       | Melita .....          | 48 03     | 49 14    | Berg.                                                                          |
|       | do .....              | 47 57     | 50 10    | Small berg.                                                                    |
|       | do .....              | 47 26     | 51 55    | Berg.                                                                          |
|       | do .....              | 47 50     | 51 27    | Do.                                                                            |
|       | do .....              | 47 47     | 51 28    | Berg, large                                                                    |

## Ice and obstructions reported, season of 1923—Continued.

| Date.  | Vessel reporting.   | Position. |          | Nature of ice or obstruction.            |
|--------|---------------------|-----------|----------|------------------------------------------|
|        |                     | N. lat.   | W. long. |                                          |
| 1923.  |                     | °         | '        |                                          |
| May 26 | Melita              | 47 48     | 51 27    | Large berg and several growlers.         |
|        | do                  | 47 43     | 51 01    | Berg.                                    |
| 28     | Hvidehavet          | 39 56     | 43 52    | Large can buoy painted red               |
|        | Hirtk town          | 45 00     | 49 07    | Berg, large.                             |
|        | Montelaire          | 47 50     | 50 18    | 2 bergs in sight.                        |
|        | Mayburn             | 47 10     | 51 46    | Berg, medium size.                       |
|        | do                  | 47 21     | 51 23    | Do.                                      |
|        | do                  | 47 55     | 50 15    | Do.                                      |
|        | do                  | 48 00     | 50 15    | Do.                                      |
|        | do                  | 48 26     | 48 57    | Do.                                      |
|        | do                  | 48 29     | 48 52    | Do.                                      |
|        | Montelaire          | 50 48     | 50 18    | Bergs.                                   |
|        | do                  | 48 17     | 49 13    | Berg.                                    |
|        | do                  | 48 31     | 48 47    | Berg, small.                             |
|        | Etna Maru           | 41 42     | 49 39    | Berg, large.                             |
|        | Malacca Maru        | 43 17     | 51 09    | Berg, about 135 feet high.               |
| 29     | Passenger           | 42 10     | 49 20    | Berg, small.                             |
|        | Grangeberg          | 43 26     | 54 07    | Berg, large.                             |
|        | Unknown vessel      | 46 00     | 48 38    | Berg.                                    |
|        | do                  | 48 26     | 48 45    | 2 bergs.                                 |
|        | do                  | 48 10     | 50 14    | Berg, large.                             |
|        | do                  | 47 50     |          | Do.                                      |
|        | Ala                 | 43 19     | 54 05    | Berg, 500 feet long, 140 feet high.      |
| 30     | West Lake           | 46 49     | 49 10    | Small berg 5 miles to N.                 |
|        | do                  | 47 06     | 48 22    | Large growler.                           |
|        | do                  | 47 02     | 48 12    | Berg.                                    |
|        | Ivar                | 41 50     | 49 35    | Do.                                      |
|        | Patrol vessel       | 42 04     | 49 29    | Growler.                                 |
| 31     | Minnedosa           | 48 15     | 46 02    | Berg.                                    |
|        | do                  | 48 18     | 47 21    | Berg and growler.                        |
|        | do                  | 48 11     | 47 37    | Berg.                                    |
|        | Patrol vessel       | 42 49     | 50 05    | Do.                                      |
| June 1 | do                  | 43 01     | 53 38    | Berg, medium size.                       |
| 2      | Caucasier           | 41 26     | 51 28    | Wreckage dangerous to navigation.        |
|        | Patrol vessel       | 42 50     | 53 12    | Berg.                                    |
| 3      | Metagama            | 48 12     | 49 26    | Large growler.                           |
|        | President Van Buren | 40 38     | 59 50    | Derelet, apparently schooner bottom up   |
| 4      | Marloch             | 48 12     | 48 48    | Berg, small.                             |
|        | do                  | 48 30     | 48 08    | Berg, large.                             |
|        | Empress of Scotland | 47 30     | 50 56    | Berg.                                    |
|        | do                  | 47 31     | 51 15    | Do.                                      |
|        | do                  | 48 07     | 49 45    | Growlers.                                |
|        | do                  | 46 59     | 52 00    | Berg.                                    |
|        | Athenia             | 47 21     | 51 01    | Berg, large.                             |
|        | do                  | 47 23     | 51 16    | Berg, small.                             |
|        | Manchester Importer | 43 15     | 48 24    | Do.                                      |
|        | do                  | 43 11     | 49 00    | Berg, large.                             |
|        | do                  | 43 01     | 49 15    | Small berg and growlers.                 |
|        | do                  | 43 01     | 49 15    | Large berg considerable distance N.      |
|        | Minnie de Larrinaga | 43 12     | 53 00    | Berg.                                    |
|        | Patrol vessel       | 43 37     | 51 01    | Do.                                      |
|        | do                  | 43 42     | 51 01    | Growler.                                 |
| 5      | Ansonia             | 46 51     | 51 43    | Berg.                                    |
|        | Canada              | 48 11     | 48 50    | Large growler.                           |
|        | Singapore Maru      | 41 21     | 43 39    | White buoy.                              |
| 6      | Ansonia             | 49 00     | 45 00    | Berg, large.                             |
|        | do                  | 48 32     | 46 35    | Large berg and 6 growlers.               |
|        | Ornela              | 47 38     | 50 45    | Large berg and growler.                  |
|        | do                  | 47 38     | 50 45    | Several small pieces ice 3 miles SSE.    |
|        | Patrol vessel       | 42 54     | 49 27    | Small berg and growler.                  |
| 7      | Ansonia             | 48 18     | 47 27    | Large growler.                           |
|        | do                  | 48 03     | 48 09    | Small berg and growlers.                 |
|        | do                  |           |          | Berg 223° 164 miles from Cape Race.      |
|        | Megantle            | 47 39     | 50 54    | Berg, large.                             |
|        | Istar               | 43 28     | 41 07    | Gas buoy.                                |
|        | Elmsport            | 39 53     | 54 37    | Spar 40 feet long by 18 inches diameter. |
| 8      | Saturnian           | 46 36     | 50 36    | Berg, large.                             |
|        | Eidsfield           | 43 40     | 47 55    | Berg, small.                             |
|        | Teespool            | 43 48     | 53 29    | Berg.                                    |
|        | Patrol vessel       | 42 38     | 49 37    | Do.                                      |
| 9      | Eskbridge           | 44 02     | 53 06    | Floating mine.                           |
|        | Borglum             | 46 15     | 47 08    | Small berg and growlers.                 |
|        | Minnedosa           |           |          | Berg 157° 13 miles from Cape Pine.       |
|        | do                  | 47 46     | 49 01    | Berg.                                    |
|        | do                  | 47 47     | 48 58    | Berg, small.                             |
|        | do                  | 47 40     | 48 22    | Berg, large.                             |
|        | do                  | 48 00     | 48 17    | Do.                                      |
|        | do                  | 48 00     | 48 12    | Growler.                                 |
|        | Conqueror           | 48 47     | 45 08    | Do.                                      |

## Ice and obstructions reported, season of 1923—Continued.

| Date.          | Vessel reporting.        | Position.          |          | Nature of ice or obstruction.                                                                       |
|----------------|--------------------------|--------------------|----------|-----------------------------------------------------------------------------------------------------|
|                |                          | N. lat.            | W. long. |                                                                                                     |
| 1923.          | Pencisely.....           | 46 03              | 47 40    | Berg, small.                                                                                        |
|                | do.....                  | 46 18              | 48 11    | Do.                                                                                                 |
|                | Patrol vessel.....       | 42 39              | 50 01    | Berg.                                                                                               |
|                | do.....                  | 43 00              | 48 45    | Do.                                                                                                 |
|                | do.....                  | 43 00              | 49 16    | Do.                                                                                                 |
| June 10        | do.....                  | 43 16              | 48 51    | Do.                                                                                                 |
|                | do.....                  | 43 19              | 49 09    | Do.                                                                                                 |
|                | Alness.....              | 40 24              | 48 30    | Small piece detached ice.                                                                           |
|                | Homeric.....             | 40 31              | 50 11    | Spar 70 feet long, dangerous to navigation.                                                         |
|                | Montrose.....            | 48 08              | 49 02    | Berg and several growlers.                                                                          |
|                | Stanmore.....            | 42 44              | 49 11    | Berg.                                                                                               |
|                | do.....                  | 42 49              | 49 22    | Do.                                                                                                 |
|                | do.....                  | 42 54              | 48 38    | Berg N. 25° W. 6 miles.                                                                             |
|                | British Vine.....        | 45 14              | 48 18    | Berg.                                                                                               |
|                | Patrol vessel.....       | 43 08              | 50 18    | Berg, small.                                                                                        |
| 12             | do.....                  | 42 54              | 49 47    | Berg.                                                                                               |
|                | Empress of Scotland..... | 48 11              | 46 48    | Berg, large.                                                                                        |
|                | Levenpool.....           | 44 33              | 53 51    | Berg.                                                                                               |
|                | Kastalia.....            | 45 33              | 48 25    | Berg, large.                                                                                        |
|                | Kastalia, from.....      | 45 37              | 48 40    | 3 medium-sized bergs and numerous growlers.                                                         |
|                | Kastalia, to.....        | 45 37              | 48 50    |                                                                                                     |
|                | Melita.....              | 48 17              | 47 50    | Berg, large.                                                                                        |
|                | Regina.....              | 48 35              | 47 43    | Berg, medium.                                                                                       |
|                | do.....                  | 48 20              | 48 03    | Large berg and growler.                                                                             |
|                | Saccarappa.....          | 37 39              | 42 14    | Vertical spar 2 feet in diameter attached to submerged wreckage; dangerous to navigation.           |
| 14             | Melita.....              |                    |          | Berg 3½ miles off Cape Pine.                                                                        |
|                | Marburn.....             | 48 54              | 48 05    | Growlers.                                                                                           |
|                | do.....                  | 48 50              | 48 15    | Berg, small.                                                                                        |
| 15             | do.....                  | 48 38              | 48 42    | Berg.                                                                                               |
|                | Andania.....             | 47 48              | 49 09    | Berg, large.                                                                                        |
|                | Hog Island.....          | 40 21              | 41 46    | Num buoy.                                                                                           |
| 16             | Patrol vessel.....       | 42 56              | 50 30    | Berg and growler.                                                                                   |
| 18             | Glenluss.....            | 44 36              | 54 33    | Large berg and growler, small growler 2 miles north.                                                |
|                | Wyncote.....             | 47 54              | 50 20    | Berg, large.                                                                                        |
|                | do.....                  | 47 55              | 50 19    | Growler.                                                                                            |
|                | do.....                  | 47 56              | 50 19    | 4 small growlers.                                                                                   |
|                | Johie.....               | 40 17              | 41 56    | Log 25 by 2 feet covered with marine growth.                                                        |
|                | Kronborg.....            | 42 20              | 48 40    | Bergs NE. about 15 miles distant                                                                    |
| 19             | do.....                  | 42 20              | 48 40    | Berg, small.                                                                                        |
|                | "SDK".....               | 45 18              | 49 57    | Berg, large.                                                                                        |
|                | Patrol vessel.....       | 43 08              | 50 03    | Berg, small.                                                                                        |
|                | do.....                  | 42 45              | 49 55    | Do.                                                                                                 |
| 21             | Regulus.....             | 45 08              | 54 30    | Berg, large.                                                                                        |
| 22             | Tiger.....               | 49 16              | 51 04    | Berg, with growler 2 miles W.                                                                       |
|                | Lord Londonderry.....    | 42 44              | 51 34    | One large and two smaller bergs.                                                                    |
|                | Tuscania.....            | 41 02              | 51 05    | Red can buoy.                                                                                       |
| 24             | Carso.....               | 45 34              | 49 15    | Large berg about 5 miles NE.                                                                        |
| 25             | Montclair.....           | 47 37              | 51 04    | Berg.                                                                                               |
|                | do.....                  | 47 46              | 50 46    | Berg, small.                                                                                        |
|                | do.....                  | 48 30              | 48 29    | 2 bergs.                                                                                            |
|                | do.....                  | 48 48              | 47 40    | Berg, small.                                                                                        |
|                | Patrol vessel.....       | 42 44              | 50 55    | Berg, medium size.                                                                                  |
| 26             | "AQB".....               | 41 54              | 49 52    | Berg, large.                                                                                        |
|                | Patrol vessel.....       | 42 52              | 50 52    | Berg, medium size.                                                                                  |
|                | do.....                  | 42 48              | 50 19    | Berg, large.                                                                                        |
| 30             | Esthonia.....            | 41 42              | 50 30    | Do.                                                                                                 |
|                | Manx Isles.....          | 44 15              | 43 00    | Wreckage dangerous to shipping.                                                                     |
|                | Patrol vessel.....       | 41 11              | 48 17    | Derelict capsized schooner (destroyed).                                                             |
|                | Marloch.....             | 48 41              | 47 40    | Berg, small.                                                                                        |
|                | do.....                  | 48 42              | 47 30    | Berg, large.                                                                                        |
|                | do.....                  | 48 04              | 48 55    | Berg.                                                                                               |
|                | do.....                  | 48 05              | 48 58    | Do.                                                                                                 |
|                | do.....                  | 48 05              | 48 50    | Growlers.                                                                                           |
|                | do.....                  | 48 10              | 48 47    | Berg.                                                                                               |
|                | do.....                  | 48 12              | 48 45    | Do.                                                                                                 |
|                | do.....                  | 48 11              | 48 30    | Berg, large.                                                                                        |
|                | do.....                  | 48 17              | 48 51    | Do.                                                                                                 |
|                | West Calumb.....         | 40 38              | 46 05    | Bottom part of wreck 160 feet long.                                                                 |
|                | Elmsport.....            | 40 30              | 46 56    | Wreckage awash and floating barrels; main part of wreck ribs exposed; very dangerous to navigation. |
|                | 7                        | Patrol vessel..... | 40 30    | 44 25 | Wreckage (destroyed). |
| Vennonnia..... |                          | 42 54              | 41 22    | Fragment of ice.                                                                                    |
| 8              | Melita.....              | 48 55              | 45 12    | Large growler.                                                                                      |
| 10             | Parray.....              | 49 31              | 45 53    | Large berg breaking up; many large pieces stretching NE.                                            |

## OCEANOGRAPHER'S REPORTS.

Lieut. EDWARD H. SMITH, U. S. Coast Guard.

---

### MARCH.

Bergs were reported around the Tail of the Grand Bank the first part of March, and the ice patrol was inaugurated on the 13th instant.

Upon sorting, assembling, and plotting the positions of icebergs that had been reported since the one reported February 27, it was noted that the majority of bergs were drifting southeastward from the region between Flemish Cap and the Grand Banks. They continued to be set in a general southeasterly direction down on to the northern edge of the Gulf Stream, where they assumed an east-northeasterly drift, due to the set of the Gulf Stream. The region most infested by bergs was between parallels 44 and 46 and meridians 44 and 46. (See charts "F" and "G".) This uncommon easterly set of the bergs could not be attributed to the prevailing northwesterly gales, since as great a number of gales of similar direction and intensity blew last year and caused no such marked drift to the ice. Observations obtained at station 247 (see station table, p. 92), lat.  $44^{\circ} 17'$ , long.  $44^{\circ} 37'$ , indicated the presence of presumably Arctic water and established a southeasterly current which accounted for the drift of these bergs. This current was accelerated, no doubt, by the northwesterly gales, but the fact that it existed in the subsurface layers, and that the surface was covered by warm tropical water, indicates that the wind was not the controlling factor in this movement of the water masses and of the bergs. The above observations agree with previous ones relative to the small effect of wind upon icebergs, and emphasize the fact that the drift of bergs is controlled by relatively deep-seated major circulatory movements in the sea.

A few of the bergs were found to be drifting down along the east side of the Grand Banks and around the Tail (what has come to be regarded as the normal track). Three bergs, which had followed this course, were sighted at intervals on March 19 in an east and west line, due west of the Tail for 40 miles. Consideration of subsequent developments leads to the belief that these bergs were set in on the southwest slope of the Grand Bank and there disintegrated. Surface evidence, i. e., low temperatures, of the southern-



most extension of the Labrador Current, the latter part of March, was found as far southwest of the Tail as lat.  $42^{\circ} 00'$ , long.  $51^{\circ} 00'$ .

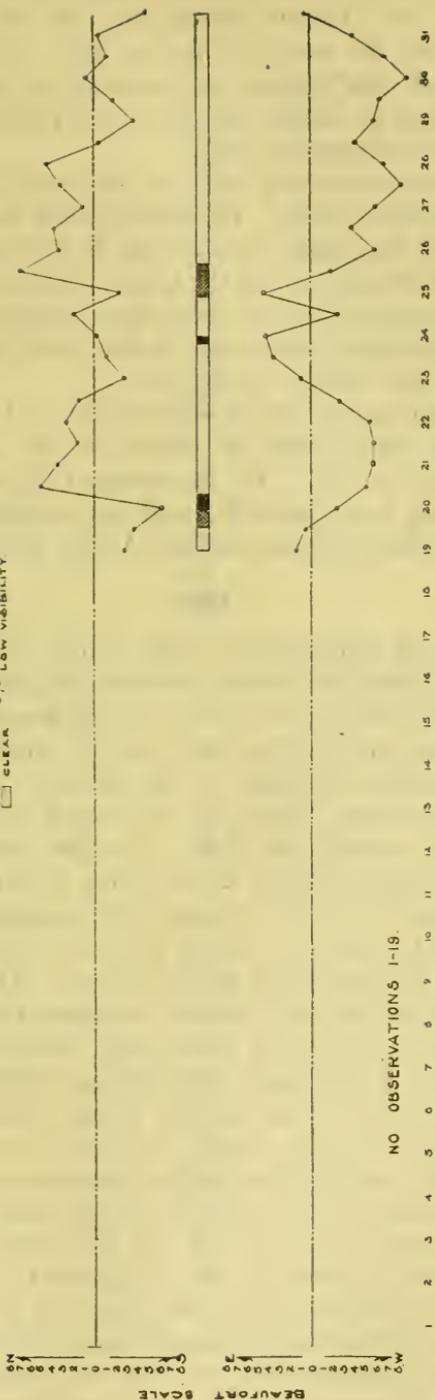
Surface thermal conditions in the ice regions are shown on charts "F" and "G." A comparison of the 1922 and 1923 charts for this period indicates that there was a larger volume of Arctic water around the Grand Bank in 1923 than in 1922. In 1923 the  $30^{\circ}$  water occupied an area extending 60 miles south of the Tail, while in 1922 water of that temperature was confined to a narrow finger-like extension along the east slope of the Bank. (See Ice Patrol Bulletin No. 10, chart "H," facing p. 98.) The area of warm water for the two years also invites comparison. From February 8 to 26, 1922, its edge ran nearly north and south, approximating the 47th meridian. This vast head of warm water extended northward nearly to the 45th parallel before it swerved eastward. In 1923 the warm water boundary ran from lat.  $42^{\circ} 00'$ , long.  $47^{\circ} 00'$ , to lat.  $44^{\circ} 00'$ , long.  $46^{\circ} 00'$ , which shows a difference of 40 miles in position for the two years. In 1922 there was an area of 1,000 square miles which contained water with a temperature higher than  $54^{\circ}$ , all of which lay to the westward of the  $54^{\circ}$  boundary in 1923. Estimating this surface layer to have had a thickness of 100 meters, there were 585 cubic miles of sea water  $16^{\circ}$  warmer than the water at that same location in 1923. The enormous amount of heat units represented by such a body of water indicates the great annual variations to which this region is subjected. Such variations as these are bound to have a great and far-reaching climatic effect, especially upon the countries of northern Europe.

Characteristic frigid water of a temperature of  $30^{\circ}$  to  $32^{\circ}$  was found in over the Grand Bank throughout March, 1923, being uniform from Cape Race to the Tail of the Bank. This cold water extended 30 to 35 miles out over the eastern and southern slopes. No sea-water temperatures were obtained north of the Tail except by the patrol vessels, owing to the absence of steamers in that region.

Twenty bergs came south of the 45th parallel from March 15 to April 1. As previously stated, most of these were located between the 44th and 46th parallels and between the 44th and 46th meridians. The majority of the bergs after entering the confines of the Gulf Stream assumed a northeasterly drift. An exception to this was noted on the 22d instant, when two bergs were reported in lat.  $44^{\circ} 30'$ , long.  $42^{\circ} 25'$ , the most easterly bergs observed during the month. Only 3 out of the 20 bergs drifted down around the Tail of the Bank while all the others drifted southeasterly on to the edge of the Gulf Stream between the 44th and 45th parallels. On March 24 field ice was reported in the vicinity of the Tail of the Bank, its southern limit being lat.  $43^{\circ} 30'$ , long.  $50^{\circ}$ . Field ice also was reported south of Sable Island. (See charts "F" and "G.") March 28 and 30 patches

WIND DIAGRAM AND FOG SCALE

- ☐ FOG
- ▨ 4% FOG
- ▩ MAXE 9% FOG AND
- ☐ CLEAR



of ice, which had broken off from the main field, to the northward, were reported in lat.  $42^{\circ} 30'$ , from long.  $49^{\circ} 10'$  to long.  $50^{\circ} 10'$ . This ice was within the area bounded by the  $32^{\circ}$  isotherm. Unlike the bergs, the field ice showed no tendency to assume an unusual easterly drift, since it melted rapidly in the relatively warm Atlantic water off the continental shelf.

Seven bergs were observed south of the 45th parallel in March, 1922, and 20 in March, 1923. The Gulf Stream was 60 miles farther north on the 53d meridian, west of the Tail of the Bank, in 1922 than in 1923. South of the Tail the boundary between the warm and the cold water occupied about the same position for both years. The velocity of the Gulf Stream east of the Grand Banks was approximately 0.8 knot per hour for both years.

The patrol ship was in the neighborhood of lat.  $44^{\circ}$ , long.  $45^{\circ}$ , except for a few days spent at anchor on the Tail of the Bank, lat.  $43^{\circ} 10'$ , long.  $50^{\circ} 10'$ . We experienced 4 per cent hours with fog and 9 per cent hours with fog and low visibility. The average winds were from the west and northwest with a force of 6 (Beaufort scale).

#### APRIL.

The easterly and southeasterly drift which was imparted to the icebergs by the Labrador Current between the northern part of the Grand Bank and Flemish Cap, the striking feature for the month of March, continued during the first part of April. After the 10th, however, the number of bergs in the eastern theater diminished. At the same time bergs began to drift down the east side of the Grand Banks and around the Tail. The first berg sighted around the Tail, since those of March 19, was one reported on April 8 in lat.  $42^{\circ} 42'$ , long.  $50^{\circ} 28'$ . During the remainder of the patrol bergs continued to assume normal drifts, in distinction to those recorded during the early part of the season. The drifts taken by a few of the bergs in the early season are shown on chart "G."

The first week in April the patrol ship searched in the eastern theater and found a gradually diminishing number of bergs, and was preparing to return to the vicinity of the Tail of the Bank when the berg of April 8 was reported. Attention should be called to a small berg that attained the farthest eastern drift of the season. It was reported in lat.  $43^{\circ} 26'$ , long.  $40^{\circ} 05'$  on April 5; in lat.  $43^{\circ} 15'$ , long.  $39^{\circ} 48'$  on the 6th; and in lat.  $43^{\circ} 05'$ , long.  $39^{\circ} 42'$  again the same day. The temperature of the surface water in the vicinity of this berg was  $61^{\circ}$  and the set of the berg was  $135^{\circ}$  at the rate of 1.5 knots per hour, which is an unusual easterly drift.

Such drifts emphasize the fact that the Gulf Stream, or any other ocean current in the deep ocean basins, uninfluenced by continental



contours, does not travel in simple stream flow, but is influenced by the many varied factors which establish oceanic circulation, resulting in a complexity of motion which can be represented in a general way only. Local temporary movements are ever enlarging or contracting in a maze of eddy-like and tongue-shaped formations,<sup>1</sup> one of which undoubtedly caused the extraordinary easterly drift of the aforementioned berg. For this reason, and contrary to popular conception, a berg drifting exceptionally far to the south does not necessarily mean an unusual invasion by a cold current from the north. A certain momentum imparted to the berg, sufficient to carry it into the region of warm water, is all that is required to originate an extrasoutherly or extraeasterly berg drift. Provided one of the varied temporary local movements of a certain water mass is in progress, the berg will be borne along with it. These continual interdigitations of water masses in the open ocean set up currents which are termed "local." This should not mislead the uninitiated, since the magnitudes involved may cause these eddies and tongues to extend 200 or 300 miles. Consequently any attempt to chart the surface plane of offshore oceanic circulation can be a figurative representation only.

From April 1 to 15 there were 24 bergs south of the 45th parallel, and from April 15 to 30, 33 south of the 48th parallel and 10 south of the 45th parallel. The positions of these bergs are shown on charts "H" and "L." On the 16th a berg was observed in lat. 42° 42', long. 50° 14'. (See chart "B," berg 14.) None of the bergs that arrived at the Tail of the Bank during April exhibited any tendency to drift to the southward; on the contrary, after passing the Tail they were set in on the southwest slope of the Bank. The drift of berg 14 (chart "B") is an example of this, the cause of which may be disclosed when we study the subsurface records for the season. The force which caused this berg to change the direction of its drift so abruptly on April 16 must have been of great magnitude, since the velocity of the current which bore it down the east side of the Grand Bank, April 11 to 14, was 1.2 knots per hour.

This is the greatest strength ever observed for the Labrador Current in this vicinity, and it is stated with some confidence, because good atmospheric conditions permitted excellent astronomical observations. The latter half of the month was foggy and necessarily the patrol ship was handicapped in locating bergs. A "light-up" on the last two days of the month disclosed a small berg (berg 15, chart "B"), subsequent observations of which showed it to drift in on the southwest slope of the Bank. Therefore, it is fair to assume

<sup>1</sup> Holland-Hansen and Nansen: "Temperature Variations in the North Atlantic Ocean and Atmosphere." Smithsonian Miscellaneous Collections, Vol. 70, No. 4, p. 11, 1920.

PLATE 5.



BERG NO. 17, MAY 21, 1923. (See p. 78.)



that the currents continued to maintain the previously described set around the Tail and on to the southwest slope.

The period of fog mentioned in the preceding paragraph might suggest the following questions to one not thoroughly acquainted with the ice patrol work: "How complete is the ice report broadcast by the patrol ship?" "Can steamships approaching the ice regions rely confidently on the patrol's report as being final?" "Does the ice patrol know the location of all of the icebergs in the North Atlantic?" The essence of the idea which suggested a patrol of the ice regions is based upon the theory that a ship could maintain continuous contact with the western, southern, and eastern iceberg limits during the ice season. It is believed that, with few exceptions, caused by unusually protracted periods of fog, the patrol, as at present organized, is cognizant of all ice that drifts south of the Tail of the Grand Bank. In other words, it is rare for the passing steamer to report a berg south of the 43d parallel the presence of which is not known to the ice patrol. A year in which there is an abnormal number of bergs may require modification of this statement. It is the policy of the patrol, however, to keep informed regarding the position of all bergs in the North Atlantic south of the 43d parallel. In order to accomplish this, diligent search of this area is made at frequent intervals, except when handicapped by fogs. North of the 43d parallel the patrol is forced to rely upon the reports of passing ships, except when able to make an occasional excursion into that region. All reports received are compiled and a daily broadcast made up for the area northward to the 48th parallel.

The boundary between the warm and the cold water during the first part of April followed an undulating line between the 42d and 43d parallels south of the Grand Banks. The last half of the month its contour assumed a less swirling form 20 miles southward in lat.  $41^{\circ} 20'$ , long.  $50^{\circ} 00'$ . It also assumed a wedge-shaped form which, extended southeastward to lat.  $41^{\circ} 00'$ , long.  $47^{\circ} 30'$  (see charts "H" and "I"), corresponding to the bathymetrical contour of the Grand Banks in its deeper soundings (see chart "E"). Such wedge-shaped form for the cold water was observed by the patrol in 1921 and 1922 (Treasury Department Bulletins Nos. 9 and 10, "International Ice Observation and Ice Patrol Service"), and also is mentioned by Helland-Hansen and Nansen: "Temperature Variations in the North Atlantic Ocean and in the Atmosphere." Smithsonian Miscellaneous Collections, vol. 70, No. 4, 1920.

The head of warm water usually encountered in long.  $53^{\circ} 00'$ , west of the Tail of the Bank, was not as prominent as usual this year, and the southerly position of the "cold wall" during the latter half of the month indicated an influx of cold water around the Tail.

Mention should be made of the field ice for April. The location of the main ice field was not determined due to the fact that neither steamers nor the patrol crossed to the northward over the Grand Banks. But there is little doubt that the southern edge of the field was near the 44th parallel on the Grand Banks, while to the westward it ran just north of Sable Island. On April 3, a small piece of ice, 8 feet in diameter, was sighted in lat.  $40^{\circ} 58'$ , long.  $49^{\circ} 01'$ , in water of a temperature of  $60^{\circ}$ . Since there had been no bergs in this vicinity, it was no doubt the last vestige of a field that had been blown offshore by the prevailing northwesterly winds. And since it was probably identical with a pan reported in lat.  $42^{\circ} 27'$ , long.  $50^{\circ} 08'$ , on March 30, it had drifted 80 miles in three days; approximately 1 knot per hour.

A comparison of April 1923 with 1922 shows that there were a few more bergs in 1923. In 1922 there were two bergs south of the Tail; in 1923, there were five. In 1922, however, the southernmost berg, on April 10, was in lat.  $42^{\circ} 30'$ , long.  $49^{\circ} 45'$ , while the southernmost berg in 1923, April 16, was in lat.  $42^{\circ} 42'$ , long.  $50^{\circ} 28'$ . During April there were 33 per cent hours with fog and 51 per cent hours of fog and low visibility, a trifle more than in 1922. The patrol ship was in the vicinity of the Tail of the Grand Bank, lat.  $43^{\circ}$ , long.  $50^{\circ}$ , most of the month. There was a decided change in direction of the winds from the northwest quadrant to the southern semicircle. The force of the wind averaged less than 4, which was somewhat less than during March.

#### MAY.

The accompanying sketch (sketch No. 1) shows all the bergs that were south of the 43d parallel during the first half of the month. The patrol ship was absent from the vicinity of the Tail of the Bank, May 17 to 25, following berg No. 17 in its extrasoutherly drift. (See charts "J" and "K.")

The sketch indicates that the currents around the Tail and along the southwest slope of the Grand Bank which had been observed during the latter half of April continued without slackening the first half of May. In fact, the tendency of the bergs this year to set to the northward and westward along the southwest slope of the Bank has been the outstanding feature of the ice drift.

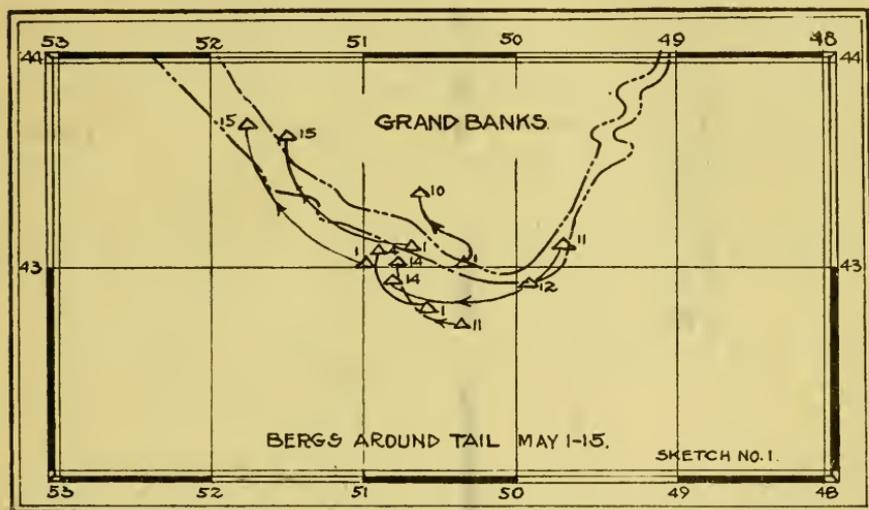
The one notable exception to the above was the drift of berg 17 (see chart "C"), which was first sighted May 17 in lat.  $42^{\circ} 28'$ , long.  $51^{\circ} 29'$ , and last seen May 25, in lat.  $39^{\circ} 08'$ , long.  $48^{\circ} 30'$ , when it was no larger than a ship's boat. It drifted 287 miles in 8 days, or 34.6 miles per day, approximately 1.5 knots per hour. For a few hours it drifted at the rate of 3 knots per hour. May 19 it calved a small berg and May 22 it calved another berg. This gave the patrol

three bergs to watch as they drifted across the extrasoutherly steamship tracks. This berg drifted farther south than any of which the ice patrol has made a record.

In order to determine whether or not it was a cold current from the north that caused this berg to assume such a southerly drift, a series of observations on the temperature of the water were made to the depth of 750 meters. The results obtained at station 308, lat.  $41^{\circ} 28'$ , long.  $50^{\circ} 38'$ , taken May 19 near the berg, which was drifting  $135^{\circ}$ , true, at the rate of 1.8 knots per hour at the time, are given below.

|                 |           |                 |           |
|-----------------|-----------|-----------------|-----------|
| Surface.....    | 15. 9° C. | 250 meters..... | 15. 7° C. |
| 50 meters.....  | 15. 0° C. | 450 meters..... | 12. 6° C. |
| 125 meters..... | 14. 1° C. | 750 meters..... | 15. 2° C. |

The temperatures, obviously, negate the presence of any Arctic water, but are, on the other hand, proof that berg 17 was floating well within the limits of the Gulf Stream.

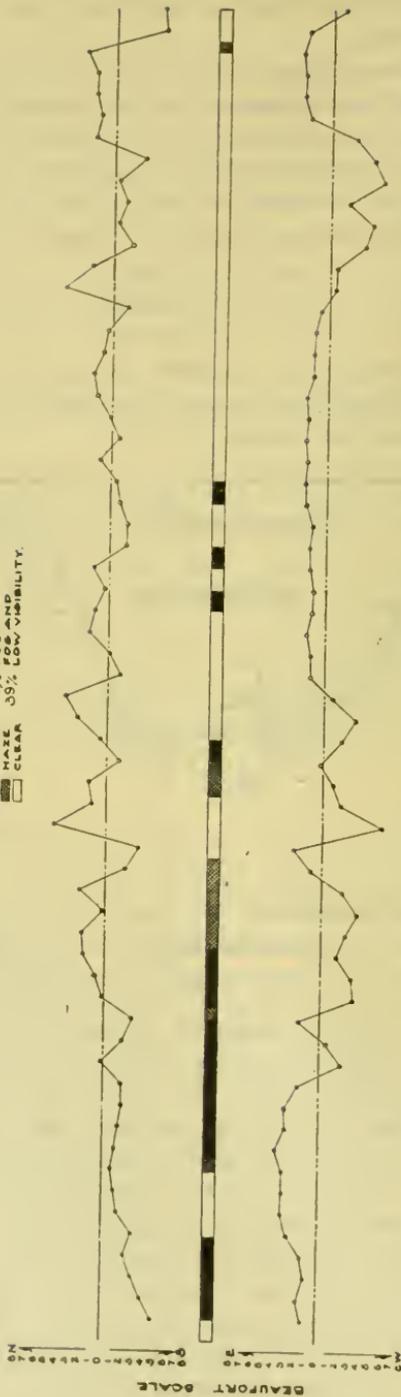


It was noted that the sounding wire at station 308 had a decided slant, when lowered to the 800 meter depth, the plane of which ran  $225^{\circ}$ , true. The current causing this slant was of considerable strength, as the sounding wire was carried well under the ship's keel. The wind factor can be eliminated, since light variable airs prevailed.

The upper layers of water in which the berg floated, to a depth of 180 to 200 meters, were known to be carrying berg 17 southeasterly at this time. It is believed, therefore, that the  $225^{\circ}$  set observed by the slant of the sounding wire was the direction of flow of the water layers 200 to 800 meters below the surface. This difference in direction of flow between the surface layers and the deeper layers is interesting in that it calls attention to the complexity of the circulation involved at times in this part of the ocean. The cause of the south-

WIND DIAGRAM AND FOG SCALE

- FOG 50% FOG AND
- HAZE 37% FOG AND
- CLEAR 0% LOW VISIBILITY.



MAY-1923.

FIG. 3.

westerly set of the deeper water layers is not known, but it may have been that these layers are affected to a greater degree by the rotation of the earth.

Another observation of the subsurface temperature was made May 23 at station 310, in lat.  $40^{\circ} 10'$ , long.  $48^{\circ} 50'$ . Berg 17, which was nearby was drifting  $170^{\circ}$ , true, at the rate of 1.4 knots per hour. The following temperatures were recorded:

|                 |           |                 |           |
|-----------------|-----------|-----------------|-----------|
| Surface.....    | 18. 6° C. | 250 meters..... | 15. 4° C. |
| 50 meters.....  | 17. 2° C. | 450 meters..... | 10. 2° C. |
| 125 meters..... | 18. 0° C. | 750 meters..... | 15. 0° C. |

No traces of cold current from the north appear at any depth. On the contrary, the high temperatures recorded show that Gulf Stream water entirely surrounded berg 17.

From this it will be seen that berg 17 had been drifting in the Gulf Stream since May 19. When last seen May 25 (see chart "C"), it was in lat.  $39^{\circ} 08'$ , having drifted in the interim, in a general southerly direction, more or less at right angles to the flow of the Gulf Stream, as it is ordinarily found in this part of the North Atlantic. The phenomenal drift of this berg corroborates the statement regarding off-shore oceanic circulation that <sup>2</sup> "the extraordinary drift of ice to low latitudes in the North Atlantic, is probably due to temporary surface branches of warm water moving south in contradistinction to an abnormal polar current." Also in April, when discussing an abnormal berg drift (see p. 76): "such tracks emphasize the fact that the Gulf Stream or any other ocean current, uninfluenced by continental contours, travels in no simple stream flow movement."

Wrecking mines were employed in hastening the destruction of berg 17. The results of the demolition work are best told in the following report of operations:

May 20: Berg very solid. One peak about 170 feet high. Two mines lashed together and suspended about 6 feet under water from a float were used. As it was not deemed safe to approach the berg closely on account of overhanging ledges, went to windward of berg and about 50 feet from it lowered mines and float into water, hoping it would drift down on the ice. A small "sail" had been rigged on the float to facilitate this. The mine, evidently caught by the back lash of the sea breaking on the face of the berg, went off to one side. Then attempted to tow mine against berg by towing across its face, but was unable to accomplish anything. It should be mentioned that the lines attached to the float and to the firing cable were buoyed at frequent intervals. Picked up mines and backed in close to berg, lowered them into the water, and, pulling away, attempted to fire: mines did not explode due to water splashed on batteries in maneuvering. Picked up mines and returned to ship. In the afternoon, there being a fog so dense that the peak of the berg was not visible when almost alongside it, made another attempt. Placed mines attached to float over a ledge projecting under water, pulled away and fired. On account of fog little could

<sup>2</sup> Smith, Edward H. International Ice Observation and Ice Patrol Service. U. S. Coast Guard Bulletin No. 10, page 65, 1922.

be seen. Considerable ice came down, however. In about 20 minutes the berg could be heard calving repeatedly. Much ice was brought down by the explosion. Three growlers, the result of this calving, and much loose ice, were seen later when the fog cleared.

May 21, a. m.: The berg being appreciably smaller and presenting in one place a sheer wall without overhang about 15 feet high, succeeded in casting a grapnel in a small crevasse in the top of this wall, after several attempts. Suspended mine about 10 feet below water and fired. Much loose ice came down, as well as several growlers. The water line of the berg was considerably changed.

May 21, p. m.: On this occasion a grapnel was cast upon an overhanging ledge covered with broken ice and about 10 feet above the water. The mine was lowered about 20 feet below the surface of the sea and fired, doing the greatest damage as yet observed to the berg.

May 24, a. m.: On this occasion, profiting by previous experience, exceptionally smooth sea, and the further reduced size of the berg, a very careful examination was made, the under-water form and approximate center of gravity of the berg were roughly determined, and from this the best location for the mine. This was under a smooth wall of ice, slightly overhanging and from 15 to 35 feet high. Grapnels could not be made to catch in the ice. A 14-pound lead was hove over the wall, but it did not offer sufficient resistance to counterbalance the weight of the mine. A loop was gotten around the most prominent knob of ice available, but slipped off. Then proceeded to other side of berg, and with shoulder gun shot a line across, so that the projectile fell where it was desired to plant the mine. Two oars and a sounding lead were now attached to the shot line and the boat returned and picked up the projectile, pulling in on the shot line until the oars held on the other side of the wall. The mine was attached to the shot line so that it would hang about 30 feet under water and then exploded. Much ice came off the berg, which rose considerably out of water on the side facing the boat and then broke squarely in two where the mine had been placed.

On May 20 berg 17 was observed well within the Gulf Stream. Instead of floating in water of  $38^{\circ}$ , it was now nearly immersed in water warmer than  $60^{\circ}$ . Under such circumstances various stresses and strains are set up which react in an accelerated calving and general disintegration. It is not long before a bulky berg becomes furrowed, pinacled, and quite irregular in shape. The weather to the southward of the 41st parallel within the bounds of the Gulf Stream permits work with small boat with gentle breezes and a smooth sea. Such a condition in respect to berg 17, on May 20, offered excellent opportunities to test the efficacy of explosive demolition of a menacing iceberg in the steamship lanes. The result of this work from May 20 to May 24, in which four explosive charges were fired, has been described. It is believed that the employment of explosives to hasten the disintegration of bergs is restricted in its practical application to those bergs which are observed drifting south of the 41st parallel. Bergs in this location are a distinct danger not only to cargo steamers, but also to the passenger liners plying between Europe and the United States. True, the drift of berg 17 was extraordinary. Records show that on the average one iceberg drifts south of the 40th parallel every four and one-half years, but

PLATE 6.



MINING OPERATIONS CONDUCTED MAY 20-24, 1923

PLATE 7.



AN ICEBERG AFTER HAVING BEEN MINED. (See p. 83.)

there has been no instance of another berg south of the 41st parallel during the past four years. The fact that extraordinary southerly drifts of icebergs are so rare, there being none other recorded since the establishment of the patrol, may have caused us to lose sight of the fact that the employment of high explosives in the destruction of a berg is entirely practical. It brings to light a latent ability possessed by the International Ice Patrol. This in no manner minimizes the menace of icebergs north of the 41st parallel, where they exist during the ice season ready to drift southward without warning on to the extra-southerly passenger steamship tracks. When such a dangerous situation exists, threatening passenger ships, as shown by drift of berg 17 (see chart "C"), the patrol ship which is standing by the berg should immediately commence demolition operations. This work is not only justified as practical, but is demanded in view of the danger to lives and property which are hazarded in this busy lane.

It is considered that the result of the four experiments outlined above was quite favorable under the circumstances then existing.

It is believed that the life of this berg was certainly shortened by more than one day, possibly two days, and the vessel released earlier by that period for other important duty in connection with the patrol. Moreover, the menace of a berg so situated in the event of fog can not be overestimated. While the *Tampa* stood by, passing rifts of fog frequently concealed the berg and the *Mauretania*, *Lapland*, *Olympic*, and other large liners passed within a short distance.

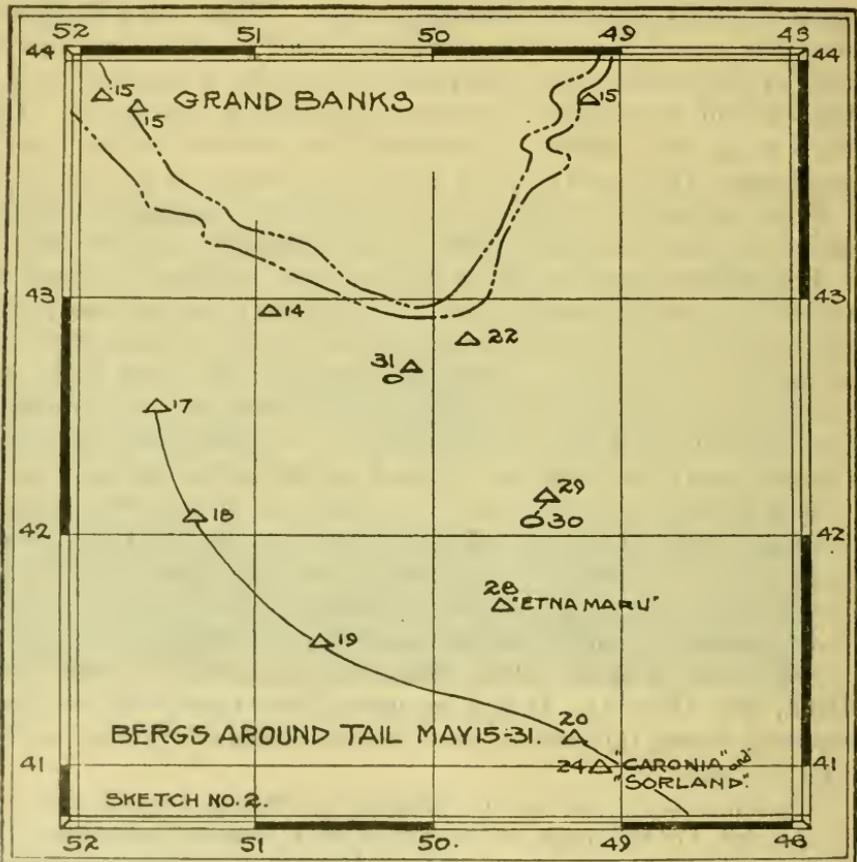
It is thought, however, that the possible use of wrecking mines is limited to cases of bergs in or near the steamer lanes. Only in such cases where the weather is sufficiently smooth for operations and the berg's disintegration far enough advanced for it to feel the effect of the explosives would the expense and effort be justified.

Sketch No. 2 shows all the bergs around the Tail of the Grand Bank, May 15 to 31. It will be noticed that there were two bergs reported during this period, the positions of which were not verified by the patrol.

The small berg reported by both the steamships *Caronia* and *Sorland* in lat. 41° 00', long. 49° 05', May 24, is believed authentic. Its life was short in the warm water. May 28 the Japanese steamer *Etna Maru* reported passing 10 miles north of a large berg about the hour of sunset. The patrol ship made contact with the *Etna Maru* and ran back her course. At daylight the next morning, with excellent visibility, there was no sign of ice, hence we are convinced the report was in error.

The foregoing incident is cited in order to point out to those assigned the responsibilities of the patrol in future years that it has been found necessary to question *carefully* the authenticity of every message reporting a berg south of the 43d parallel. In determining the

value of such a report one must be guided by previous experiences; distance of the reporting ship from the berg; radio transmission; visibility at the time; water temperature at the berg; familiarity of the particular steamer with the ice regions (that is, whether she is a frequent passer or a stranger); accuracy of the position of the reporting steamer as determined by recent astronomical observations; time of day. Near sunset clouds and fog often create fantastic shapes, which, under certain atmospheric conditions, may mislead



even one accustomed to the ice regions. Every year there are a number of these mistaken reports, which, unless carefully analyzed, will lead the patrol ship on "wild goose" searches.

*Surface temperature conditions.*—The cold wall during the first half of the month ran from lat. 43°, long. 53° 10', to lat. 40° 50', long. 48°, when it turned sharply northward and thence in a northeasterly direction. The suggestion of the southeast wedge-shaped form of the cold water during the first part of the month became a well-developed condition by May 20. (See chart "K.") It is be-

lieved that this particular shape of the "cold wall" played no small part in the extra-southerly drift of berg 17. (See chart "C.")

To sum up: May 1 to 15 there were 6 bergs south of the 43d parallel, 8 south of the 44th parallel, 9 south of the 45th parallel, and 55 south of the 48th parallel. May 15 to 31 there were 7 bergs south of the 43d parallel, 9 south of the 45th parallel, and 35 south of the 48th parallel. In 1922 there were 8 bergs south of the 43d parallel and 16 south of the 45th parallel during the entire month; a few more around the Tail in 1922 than in 1923. There were 27 per cent hours of fog and 39 per cent hours of fog and low visibility. There was a marked drop in the force of the wind during the last half of the month, the average force being  $1\frac{3}{4}$ , Beaufort scale.

#### JUNE.

Ice patrol records show that June brings more fog than any other month. This year was no exception to the rule, there being 51 per cent hours of fog and 71 hours of fog and low visibility. Such a protracted period handicapped the patrol vessel in its duty of locating bergs south of the 43d parallel. The drifts of the bergs during June indicated the velocity of the Labrador Current around the Tail of the Bank as approximately 0.5 knot per hour. This is only one-third the strength of the current found at the same place in April.

Berg No. 11a (see chart "C") followed an interesting drift, being entirely confined to the area west and northwest of the Tail of the Grand Bank. It was sighted by the patrol May 3 in lat.  $43^{\circ} 38'$ , long.  $51^{\circ} 51'$ , grounded on the southwest slope of the Bank in 56 fathoms of water, and was so distinctive in shape and in markings that there was no doubt of its identification when it was further observed on May 29, June 1, 2, 3, 4, 8, 12, and finally June 18. Thus we have a track of its drift over a period of six weeks. The average velocity of the current on the west side of the Grand Banks during this period was between 0.4 and 0.6 knot per hour. Berg 11a drifted under the influence of a large ocean eddy between May 3 and June 8, making a complete loop with a diameter of about 50 miles.

In 1921<sup>3</sup> there is a record of a berg following a similar elliptical-shaped drift, at the same time of the year, in the same locality, and at approximately the same rate of speed, similarly carried by a large ocean eddy on the west side of the Grand Banks. Berg 11 (see chart "B") also drifted under the influence of this same eddy.

All this furnishes evidence toward our knowledge regarding the circulation of the water masses west and northwest of the Tail of

<sup>3</sup> 1921. Smith, Edward H.: International Ice Observation and Ice Patrol Service, U. S. Coast Guard, Bulletin No. 9, chart "H."

the Grand Bank. Attention is drawn to the fact that in all three of these drifts the movement of the bergs was counter-clockwise. Conclusions based upon the distribution of the surface water, as regards temperature, caused this statement last year: "It would seem fair to assume that a great eddy exists on the west side of the Tail of the Grand Bank at this season." The circulation in this area probably is not restricted to one eddy only, but the tendency for eddies to form to the westward and northwestward, off the southwest slope of the Grand Bank, is a well established fact.

Very little has been written regarding the effect of wind upon the drift of icebergs. It is intended to present several cases of bergs the drifts of which, with the prevailing direction and force of wind, are known. The wind action is of two kinds—(a) the direct force of the wind as applied to the exposed surface of the berg and (b) the indirect effect of the wind as applied through its frictional action in setting up a current in the water mass in which the berg floats. The effect of (a) under this classification is greatest on the "sailer" berg, which, by virtue of its lofty sides and shallow draft, is popularly supposed to spread its wings and schoon off before the gale.

With regard to the action of the wind upon the berg, attention is called to the close similarity between the drift of the berg west of the Grand Bank, as shown on chart "H," 1921,<sup>5</sup> and the drifts of bergs 11 and 11a on charts "B" and "C." During the period May 24 to June 4, 1921,<sup>6</sup> which covers the drift of the berg on chart "H," the winds were south-southeasterly and southwesterly, force 4 to 5. April 8 to May 15, 1923, the winds were divided between the southeast and northwest quadrants, force  $3\frac{1}{2}$ . This covered the period of berg 11. May 3 to June 18, 1923, the winds were easterly and southerly, force 3, and this covers the period of berg 11a. Consideration of the great similarity of the three drifts and the dissimilarity of the winds forbids any relationship between the wind and the drifts in the above cases.

Similarly, several bergs in the eastern theater during the early part of the season of 1923 (see chart "G") drifted in a northeasterly direction for several days, while the wind blew from the northwest quadrant with a force of 6, part of the time with a force of 8 and 10. In spite of this gale the bergs drifted at right angles to the wind at the rate of 0.6 knot per hour, following the flow of the Gulf Stream.

The drifts assumed by 9 bergs from May 2 to July 14, 1922,<sup>6</sup> afford another excellent opportunity to observe the effect of wind upon ice-

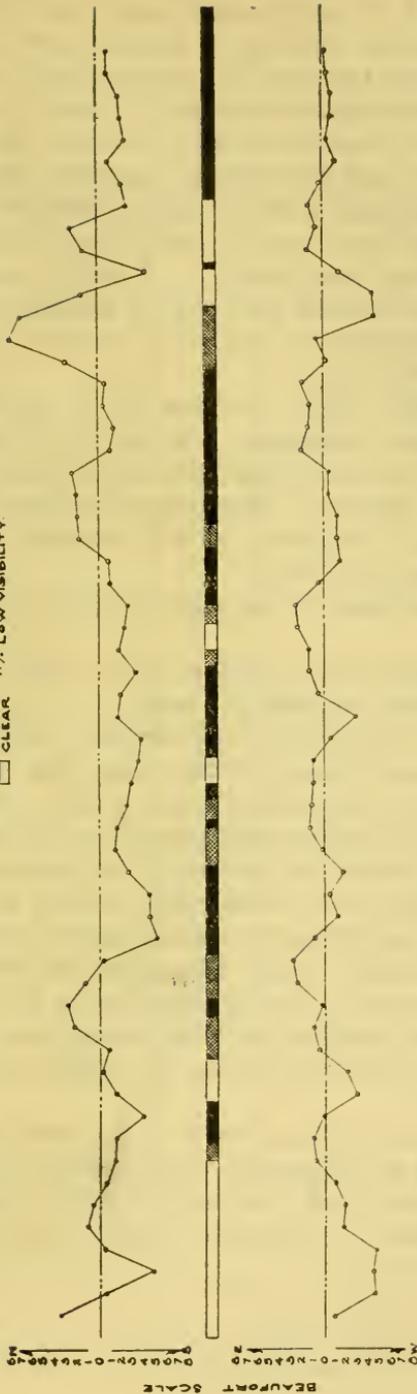
<sup>4</sup> 1922. Smith, Edward H.: International Ice Observation and Ice Patrol Service, U. S. Coast Guard Bulletin No. 10, p. 55.

<sup>5</sup> 1921. Smith, Edward H.: Ice Observ., etc., Bull. No. 9, chart "H."

<sup>6</sup> 1922. Smith, Edward H.: Ice Observ. and Ice Patrol Serv., U. S. C. G. Bull. No. 10, charts "F" and "O" facing p. 98 and pp. 61 and 63.

WIND DIAGRAM AND FOG SCALE

FOG 51% FOG AND  
HAZE 1 1/2% LOW VISIBILITY.  
CLEAR



JUNE -1923.

FIG. 4.

bergs. Charts "F" and "G" show that the drift tracks of the 9 bergs (J, D, E, M, N, L, R, S, and P) were similar, yet occurring at different times during a period covering 2 months and 12 days. In May the winds were from the west and northwest, the average strength being 4 and 5. During the first half of June the winds became southerly and their average intensity was not over 4, while during the second half of June light breezes, equally divided between the SE. and SW. quadrants, with an average strength of  $2\frac{1}{2}$ , prevailed.

July 1 to 15 the wind was confined almost entirely to the SW. quadrant, its average force being 4. It will be seen from this that the winds<sup>7</sup> did not remain the same in direction and force during this period, yet the bergs (see charts "F" and "G") followed approximately similar drift tracks.

May 2 to 13, 1922, bergs "D" and "E"<sup>8</sup> drifted westward from the Tail of the Bank, a distance of 90 miles, although the wind during this time was constantly blowing from the west against the bergs. One of the days, May 4, it blew west-northwest, force 6, yet the bergs "D" and "E" continued to drift into the face of the wind at the rate of 0.3 knot per hour.

The direction and force of the wind for 1923 is indicated on charts "B" and "C."

Since 1921 the patrol has observed only one case in which the wind appeared to influence the drift of a berg.

It is generally conceded that the frictional effect of wind sets up currents in the upper layers of the ocean, the magnitude of the current set up, i. e., the velocity and volume of the water mass set in motion, being directly proportional to the strength and duration of the wind, though not necessarily in the same direction. The phase of the subject most immediately bearing on the drift of icebergs is, to what depth does the wind impart motion to the water particles in the ocean? Some information is obtainable from the subsurface sections taken at right angles to the cold wall during June and July, when the prevailing southerly winds tend to blow a surface layer of warm tropical water over the colder mixed water to the northward.

The average height of a berg south of the 45th parallel is 75 to 100 feet. Such a berg would possess a mean draft of 300 to 400 feet or more. It can be seen from this that the drift of bergs is necessarily controlled by relatively deep-seated, major circulatory movements

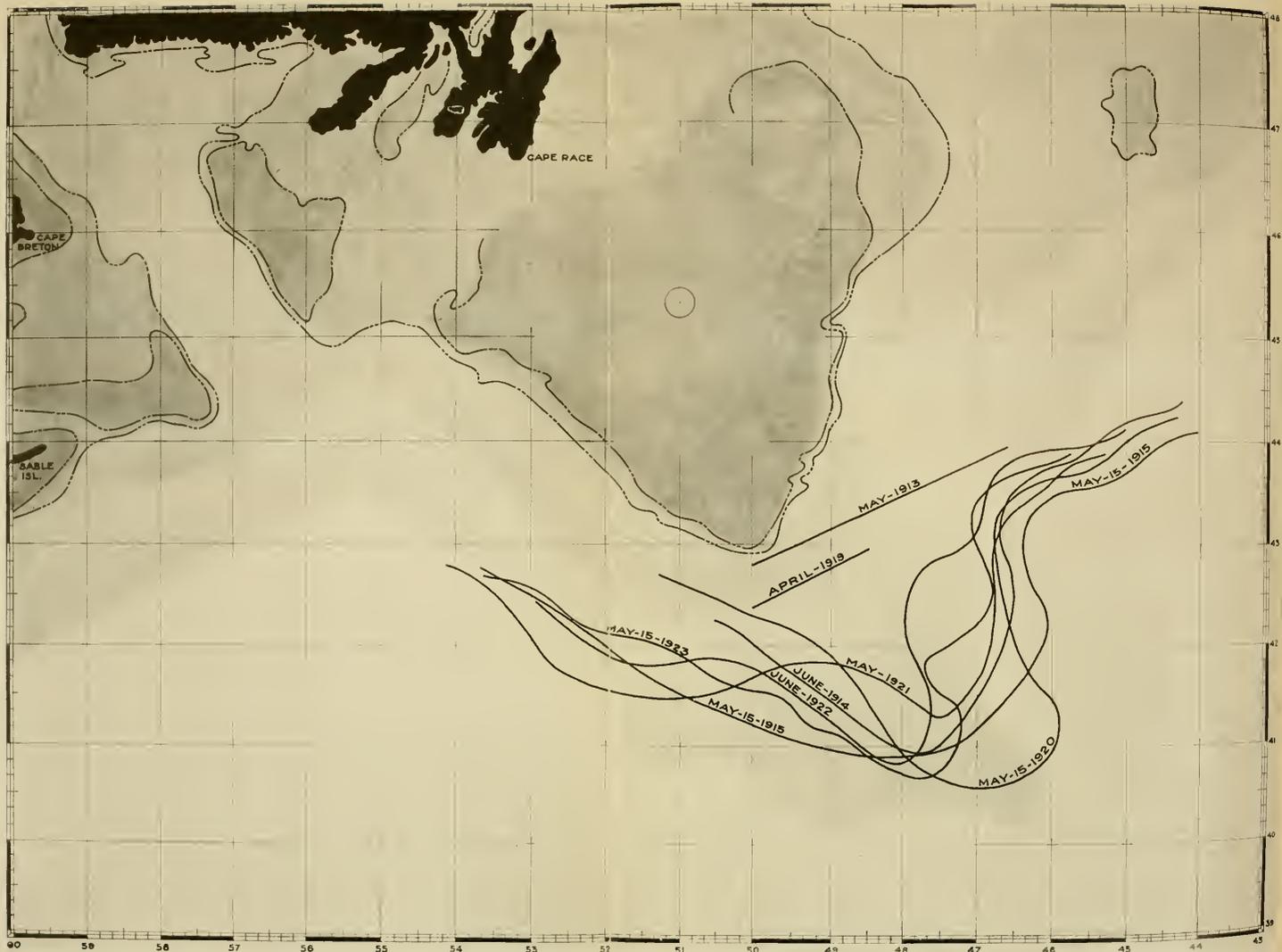
<sup>7</sup> 1901. Dickson, N. H.; "The Circulation of the Surface Waters of the North Atlantic," Phil. Trans. Roy. Soc. London. Ser. A. Vol. 196.

1920. Helland-Hansen & Nansen; "Temperature Variations in the No. Atlantic and in the Atmosphere" Smithsonian Miscellaneous Collections, vol. 70, No. 4.

1915. Sandstrom, J. W.; "Canadian Fisheries Expedition 1914-15," Bull. Dept. Marine and Fisheries, Ottawa.

<sup>8</sup> 1922. Treasury Department Bulletin No. 10, chart "F."





GENERAL CHART  
COVERING  
ICE PATROL  
ANNUAL LIMITS "COLD-WALL"  
GRAND BANKS  
BATHYMETRICAL CHART.

CHART "E."

in the sea, but very few observations bearing on this subject have ever been made.

June 26, a berg was reported in lat.  $41^{\circ} 54'$ , long.  $49^{\circ} 52'$ , by an unknown Norwegian steamer. Little information could be obtained except the supposed position of the berg. The patrol searched for but was unable to find it. For several reasons the report was considered erroneous. June 30, a berg was reported in lat.  $41^{\circ} 42'$ , long.  $50^{\circ} 32'$ . The patrol searched for this berg, but did not find it. The report located it on the southern edge of the fog sheet, pieces of which were found to be detaching in various forms and shapes that were deceptive even to those on the patrol ship who were accustomed to the appearance of icebergs. The report was undoubtedly erroneous.

June 22, while at anchor on the Grand Bank, in lat.  $41^{\circ} 40'$ , long.  $51^{\circ} 18'$ , current observations were made by hourly readings of the ship's head, and, in addition, a drift stick was thrown every hour to determine the strength of the current. The wind at the time was southeast; light airs; smooth sea; dense fog.

| Time (G. M. T.). | Ship's head. | Time (G. M. T.). | Ship's head. |
|------------------|--------------|------------------|--------------|
| 1 a. m. ....     | 118°         | 8 a. m. ....     | 163°         |
| 2 a. m. ....     | 100°         | 9 a. m. ....     | 183°         |
| 3 a. m. ....     | 113°         | 10 a. m. ....    | 193°         |
| 4 a. m. ....     | 128°         | 11 a. m. ....    | 213°         |
| 5 a. m. ....     | 143°         | Noon .....       | 246°         |
| 6 a. m. ....     | 153°         | 1 p. m. ....     | 73°          |
| 7 a. m. ....     | 158°         |                  |              |

The foregoing observations indicate that the surface current in this place was of a rotary tidal character veering in a clockwise direction. This agrees with previous current observations obtained on the Grand Banks. The strength of the current, as shown by the drift stick, was 0.25 knot per hour.

Discussing surface thermal conditions (see charts "E," "L" and "M"), the wedge of cold water observed in May had extended south-eastward and increased in area to the maximum for the year. There was more cold water south of the Grand Banks in 1923 than in 1922. Subsurface observations also showed a great volume of Arctic water around the Tail in 1923.

An interesting feature was the development of a finger-shaped body of cold water which curved back southwestward from the main cold water mass around the Tail of the Bank, marked "A" on chart "L." The presence of this tongue extending toward the southwest throws a light upon the oceanographic observations made in 1910 by the steamer *Michael Sars*, which found a similar body of water in this same locality, believed by Murray and Hjort<sup>9</sup> to be a current of

<sup>9</sup> 1912 Murray and Hjort: "Depths of the Ocean," London, 1912.

cold water flowing toward the southwest. The presence of this phenomenon has puzzled oceanographers, since no such current had previously been found in that locality. The detailed surface temperature chart "L" conclusively explains the cause as the tendency of oceanic circulation to proceed by means of complex eddy-like tongues, which are ceaselessly changing in size and position. Apparently the oceanographic section which the *Michael Sars* took crossed a tongue of cold water, similar in position and size to that shown for June 1-15, on chart "L." The following quotation from Helland-Hansen and Nansen<sup>10</sup> will further emphasize this point:

The progress of water masses through the ocean does not proceed by any such simple lines as schematic current charts represent. It proceeds more by monster moving eddy currents on the surface of the ocean and in the deeper layers. These whirlpools are in a great measure the cause of the extraordinary tongue-like projections of the isotherms, not only at the surface of the ocean but in the underlying deeper layers.

Attention is called to the icebergs in the Gulley. (See chart "L.") They drifted south in the Labrador Current, rounded Cape Race, and one was seen west as far as Cape Pine, grounded near the lighthouse. This drift agrees with previous observations<sup>11</sup> that a branch of the Labrador Current flows in the relatively deep Gulley between Cape Race and the shoaler part of the Grand Bank to the southward. The drift of the patrol ship in this locality during May indicated a 1-knot current, setting southwest.

To sum up: June 1 to 15 there were 12 bergs south of the 43d parallel; June 15 to 30, 6 were south of the 43d parallel, 7 south of the 45th parallel, and 19 south of the 48th parallel. There were 51 per cent hours of fog and 71 per cent hours of fog and low visibility. The central point of observations was lat. 43° 00', long. 50° 00'. The winds for the month were variable, of an average force of 3, but with one gale, force 10, from the north, on the 23d instant. (See wind and fog scale, fig. 4, page 87.)

#### JULY.

There were no bergs reported or sighted around the Tail of the Bank during this period of the patrol. A few were located on the northern part of the Banks. (See chart "N.") Consequently the ice patrol was discontinued on the 12th.

Although there were no bergs sighted, the drift of the derelict destroyed on July 7 affords added information regarding the currents of this region. June 3 she was reported bottom up by the steamer *President Van Buren*, in lat. 40° 38', long. 59° 50'. July 3 the ice patrol ship found her in lat 41° 11', long. 48° 41', having drifted 500

<sup>10</sup> 1920. Helland-Hansen and Nansen: "Temperature Variations in the North Atlantic Ocean and in the Atmosphere," Smithsonian Miscellaneous Collections, vol. 70, No. 4, pp. 11-12.

<sup>11</sup> 1914. Mathews, J. D.: "Report on the Work Carried out by the Steamship *Scotia*, 1913," pp. 31-32

miles in 30 days. This indicates an easterly current between these two points of 0.8 to 0.9 knot per hour. The drift track is shown on chart "C." From July 3 to 4, when under observation of the patrol, she traveled eastward at the very rapid rate of 2.5 knots per hour. This high-drift rate was certainly not due to favoring winds, both because little of the derelict was exposed above the surface and because light southerly airs prevailed during this period.

The appearance of a berg at night in the light of a full moon on April 30 was interesting. The sky and the moon were entirely covered by a thin film of cirrus stratus clouds, when a berg was sighted 8 miles away, bearing  $330^\circ$ , true; the moon at the time bore  $165^\circ$  and its altitude was  $35^\circ$ . This was about the maximum of visibility since the berg was barely discernible as a white, luminous spot. It assumed a glistening white appearance at 5 miles, plain to the naked eye, and similar to a berg in the sunshine. The patrol ship passed close to the berg and then changed course to  $0^\circ$ . After proceeding 8 miles, the berg could be seen as a mere white place on the horizon.

The limit of visibility of a berg, with clear atmospheric conditions at night in the moonlight, depends upon (a) the altitude of moon, (b) the size of the moon, and (c) the relative position of moon, berg, and ship. Other things being equal, the limit of visibility is, of course, directly proportional to the size of the moon and its altitude. Another important factor is represented by (c). If the berg is between the ship and the moon, the likelihood of seeing it is less than if the berg and moon bear in widely different directions from the ship. The effect of position (c) is minimized as the altitude of the moon increases and vice versa. A low moon, behind a berg, gives the poorest conditions for visibility. The experience with the berg just discussed shows that given a full moon, at an altitude of  $35^\circ$ , covered by a thin film of cirrus stratus clouds, a berg is clearly visible to the naked eye at a distance of 5 miles, irrespective of the relative positions of berg, moon, and ship.

*Temperature.*—The cold water area, as shown on the surface temperature chart "N," was much less extensive in July than in June, due to the prevailing southerly winds, which blew the warmer surface layers northward, overriding this area. The same condition was observed in 1912; as shown by charts "O" and "P,"<sup>12</sup> bringing out the fact that warm surface water flooded northward and restricted the surface signs of the Labrador Current to a small tongue extending only 60 miles southwest of the Tail. This same seasonal change, which is characteristic of the approach of the end of the ice season, was underway July 6 to 10, 1923. Bergs which might be borne southward around the Tail at this time would tend to remain north-

<sup>12</sup> 1922. Smith, Edward H.: International Ice Observation and Ice Patrol Service, U. S. Coast Guard Bulletin No. 10. Charts "O" and "P."

ward of the boundary of warm water. Since the fog sheet is found habitually lying over the cold-water area, any contraction of the latter means less fog south of the Grand Banks. Stripped of fog, the bergs lose much of their danger. The fact that there is less fog in late summer and autumn, as shown by the U. S. Pilot Chart of the North Atlantic, points toward less Arctic water around the Grand Banks. Other causes for less fog are the northern drift of the warm surface layers under the impetus of the southerly winds, and the general solar warming of the surface of the ocean, which becomes more pronounced at this period.

Table of data concerning scientific stations occupied by the "Tampa" and "Modoc."

[See Chart "A."]

| Station No. | Date.   | Time of day.               | Position. |          | Depth of water.   | Wind direction and force (Beaufort). | Sky.            | Water, physical data. |              |                        |
|-------------|---------|----------------------------|-----------|----------|-------------------|--------------------------------------|-----------------|-----------------------|--------------|------------------------|
|             |         |                            | Lat. N.   | Long. W. |                   |                                      |                 | Depth.                | Temperature. | Salinity (‰ by weight) |
| 247         | Mar. 31 | 3.30-4.30 p. m.            | 44 17     | 44 37    | Fathoms.<br>2,599 | W.; 3-----                           | Partly cloudy.. | Meters.               | ° C.         |                        |
|             |         |                            |           |          |                   |                                      |                 | 0                     | 6.9          | 34.45                  |
|             |         |                            |           |          |                   |                                      |                 | 50                    | 2.6          | 34.13                  |
|             |         |                            |           |          |                   |                                      |                 | 125                   | .0           | 34.49                  |
|             |         |                            |           |          |                   |                                      |                 | 250                   | 0.2          | 34.85                  |
| 248         | Apr. 9  | 11.40 a. m.<br>12.10 p. m. | 44 12     | 44 20    | 2,210             | S.; 2-----                           | do-----         | 450                   | 3.9          | 34.13                  |
|             |         |                            |           |          |                   |                                      |                 | 750                   | 3.6          | 34.32                  |
|             |         |                            |           |          |                   |                                      |                 | 0                     | 11.9         | 35.32                  |
|             |         |                            |           |          |                   |                                      |                 | 50                    | 11.2         | 35.37                  |
|             |         |                            |           |          |                   |                                      |                 | 125                   | 8.0          | 34.87                  |
| 249         | do----- | 4.05-4.55 p. m.            | 44 07     | 46 30    | 2,250             | SSW.; 2-----                         | do-----         | 250                   | 7.2          | 34.88                  |
|             |         |                            |           |          |                   |                                      |                 | 450                   | 6.0          | 34.97                  |
|             |         |                            |           |          |                   |                                      |                 | 750                   | 4.45         | 34.92                  |
|             |         |                            |           |          |                   |                                      |                 | 0                     | 10.9         | 35.32                  |
|             |         |                            |           |          |                   |                                      |                 | 50                    | 5.95         | 34.60                  |
| 250         | Apr. 10 | 12-1 p. m.                 | 44 12     | 47 30    | 2,048             | W.; 5-----                           | Overcast-----   | 125                   | 6.0          | 34.56                  |
|             |         |                            |           |          |                   |                                      |                 | 250                   | 7.0          | 34.47                  |
|             |         |                            |           |          |                   |                                      |                 | 450                   | 6.0          | 34.87                  |
|             |         |                            |           |          |                   |                                      |                 | 750                   | 3.95         | 34.91                  |
|             |         |                            |           |          |                   |                                      |                 | 0                     | 11.9         | 35.41                  |
| 251         | do----- | 5.15-6 p. m.               | 44 08     | 47 48    | 2,000             | SW.; 4-----                          | do-----         | 50                    | 11.35        | 35.44                  |
|             |         |                            |           |          |                   |                                      |                 | 125                   | 11.0         | 35.26                  |
|             |         |                            |           |          |                   |                                      |                 | 250                   | 11.0         | 34.76                  |
|             |         |                            |           |          |                   |                                      |                 | 450                   | 7.05         | 34.96                  |
|             |         |                            |           |          |                   |                                      |                 | 750                   |              |                        |
| 252         | Apr. 11 | 9.15-10.30 p. m.           | 44 00     | 48 54    | 984               | N.; 4-----                           | do-----         | 0                     | 3.0          | 33.80                  |
|             |         |                            |           |          |                   |                                      |                 | 50                    | 2.95         | 33.98                  |
|             |         |                            |           |          |                   |                                      |                 | 125                   | 2.05         | 33.96                  |
|             |         |                            |           |          |                   |                                      |                 | 250                   | 2.0          | 34.27                  |
|             |         |                            |           |          |                   |                                      |                 | 450                   | 5.1          | 34.72                  |
| 253         | Apr. 12 | 8-8.50 p. m.               | 42 30     | 51 46    | 1,420             | SSW.; 2-----                         | Mostly cloudy.. | 750                   | 4.25         | 34.97                  |
|             |         |                            |           |          |                   |                                      |                 | 0                     | 0.1          | 33.19                  |
|             |         |                            |           |          |                   |                                      |                 | 50                    | -1.25        | 33.37                  |
|             |         |                            |           |          |                   |                                      |                 | 125                   | -1.7         | 34.04                  |
|             |         |                            |           |          |                   |                                      |                 | 250                   | 0.0          | 34.70                  |
| 254         | Apr. 13 | 12.45-1.35 a. m.           | 42 00     | 52 15    | 2,340             | SSW.; 3-----                         | Mostly clear... | 450                   | 3.8          | 34.87                  |
|             |         |                            |           |          |                   |                                      |                 | 750                   | 3.3          | 33.73                  |
|             |         |                            |           |          |                   |                                      |                 | 0                     | 0.1          | 33.19                  |
|             |         |                            |           |          |                   |                                      |                 | 50                    | -1.25        | 33.37                  |
|             |         |                            |           |          |                   |                                      |                 | 125                   | 7.0          | 33.85                  |
|             |         |                            |           |          |                   |                                      |                 | 250                   | 3.45         | 34.65                  |
|             |         |                            |           |          |                   |                                      |                 | 450                   | 3.6          | 34.87                  |
|             |         |                            |           |          |                   |                                      |                 | 750                   | 3.7          | 34.97                  |
|             |         |                            |           |          |                   |                                      |                 | 0                     | 13.9         | 36.04                  |
|             |         |                            |           |          |                   |                                      |                 | 50                    | 14.9         | 35.86                  |
|             |         |                            |           |          |                   |                                      |                 | 125                   | 16.15        | 35.61                  |
|             |         |                            |           |          |                   |                                      |                 | 250                   | 12.80        | 35.41                  |
|             |         |                            |           |          |                   |                                      |                 | 450                   | 13.2         | 35.48                  |
|             |         |                            |           |          |                   |                                      |                 | 750                   | 11.2         | 34.96                  |

Table of data concerning scientific stations occupied by the "Tampa" and "Modoc"—Continued.

| Station No. | Date.   | Time of day.      | Position. |          | Depth of water.   | Wind direction and force (Beaufort). | Sky.          | Water, physical data.                          |                                                       |                                                    |
|-------------|---------|-------------------|-----------|----------|-------------------|--------------------------------------|---------------|------------------------------------------------|-------------------------------------------------------|----------------------------------------------------|
|             |         |                   | Lat. N.   | Long. W. |                   |                                      |               | Depth.                                         | Temperature.                                          | Salinity (‰ by weight).                            |
| 255         | Apr. 13 | 4.50-5.30 a. m.   | 41 36     | 52 38    | Fathoms.<br>1,874 | SSW; 3                               | Partly cloudy | Meters.<br>0<br>50<br>125<br>250<br>450<br>750 | ° C.<br>16.3<br>17.05<br>17.0<br>16.8<br>16.2<br>8.65 | 36.29<br>36.29<br>36.29<br>35.79<br>35.39<br>34.99 |
| 256         | do      | 4.50-5.30 p. m.   | 42 50     | 51 25    | 1,060             | SW.; 1                               | Foggy         | 0<br>50<br>125<br>250<br>450<br>750            | 0.2<br>-1.65<br>0.2<br>1.45<br>0.00<br>-0.15          | 33.33<br>33.33<br>33.48<br>34.27<br>34.11<br>34.90 |
| 257         | Apr. 14 | 7.10-7.50 a. m.   | 43 03     | 51 14    | 580               | NW.; 5                               | Overcast      | 0<br>50<br>125<br>250<br>450<br>750            | -1.3<br>-1.05<br>-0.35<br>-0.9<br>-1.20<br>-0.75      | 33.28<br>33.33<br>33.49<br>33.46<br>33.73<br>34.72 |
| 258         | do      | 12.30-1 p. m.     | 43 31     | 50 50    | 48                | NW.; 5                               | do            | 0<br>10<br>25<br>40<br>55<br>750               | 0.1<br>0.6<br>1.15<br>0.8<br>0.45<br>-0.1             | 32.84<br>32.83<br>32.83<br>32.92<br>32.90<br>32.92 |
| 259         | do      | 3-3.25 p. m.      | 43 21     | 50 24    | 38                | NNW.; 2                              | do            | 0<br>15<br>30<br>45<br>60<br>750               | 0.1<br>0.45<br>0.1<br>0.3<br>0.45<br>-0.5             | 32.90<br>33.13<br>33.24<br>33.46<br>33.37<br>33.60 |
| 260         | do      | 6.45-8.30 p. m.   | 42 52     | 50 28    | 983               | NW.; 2                               | do            | 50<br>125<br>250<br>450<br>750                 | -0.1<br>-1.15<br>-0.8<br>-0.7<br>1.05                 | 33.60<br>34.60<br>34.97<br>33.44<br>33.55          |
| 261         | do      | 11.20-12.20 a. m. | 42 25     | 50 20    | 1,557             | NW.; 3                               | do            | 0<br>50<br>125<br>250<br>450<br>750            | 0.4<br>0.35<br>0.25<br>3.2<br>1.1<br>4.5              | 33.58<br>34.78<br>32.88<br>34.94<br>33.22<br>35.03 |
| 262         | Apr. 15 | 3.50-4.30 a. m.   | 41 55     | 50 19    | 2,034             | NW.; 3                               | do            | 0<br>50<br>125<br>250<br>450<br>750            | 0.3<br>1.4<br>1.05<br>4.1<br>4.1<br>4.45              | 34.97<br>34.99<br>34.60<br>34.85<br>33.64<br>35.50 |
| 263         | do      | 12.30-1.30 p. m.  | 41 25     | 50 18    | 2,113             | SW.; 1                               | do            | 0<br>50<br>125<br>250<br>450<br>750            | 13.9<br>15.4<br>12.85<br>13.7<br>11.8<br>8.50         | 34.22<br>36.27<br>36.27<br>35.53<br>32.84<br>32.86 |
| 264         | do      | 4.50-5.30 p. m.   | 40 55     | 50 17    | 2,439             | SSW.; 3                              | Mostly cloudy | 0<br>50<br>125<br>250<br>450<br>750            | 11.9<br>12.6<br>9.7<br>10.45<br>10.2<br>10.55         | 35.57<br>35.05<br>35.53<br>35.50<br>35.14<br>35.52 |
| 265         | Apr. 16 | 4.30-5.25 p. m.   | 43 10     | 51 25    | 447               | WNW.; 5                              | do            | 0<br>50<br>125<br>250<br>450<br>750            | -0.6<br>-0.8<br>-0.35<br>-0.8<br>2.4<br>3.25          | 33.44<br>33.39<br>33.48<br>35.17<br>34.81<br>33.77 |
| 266         | do      | 8.30-9.20 p. m.   | 43 30     | 52 00    | 565               | WSW.; 1                              | Overcast      | 0<br>50<br>125<br>250<br>450<br>750            | 0.9<br>-1.5<br>0.15<br>-1.0<br>1.0<br>3.35            | 32.99<br>33.28<br>33.46<br>33.68<br>34.60<br>34.97 |

Table of data concerning scientific stations occupied by the "Tampa" and "Modoc"—Continued.

| Sta. tion No. | Date.     | Time of day.      | Position. |          | Depth of water. | Wind direction and force (Beaufort). | Sky.          | Water, physical data. |                |                        |
|---------------|-----------|-------------------|-----------|----------|-----------------|--------------------------------------|---------------|-----------------------|----------------|------------------------|
|               |           |                   | Lat. N.   | Long. W. |                 |                                      |               | Depth.                | Tempera- ture. | Salinity (‰ by weight) |
| 267           | Apr. 17   | 1-1.50 a. m.      | 43 25     | 52 40    | 1,235           | WSW.; 2.                             | Overcast..... | <i>Meters.</i>        | ° C.           |                        |
|               |           |                   |           |          |                 |                                      |               | 0                     | -0.3           | 33.49                  |
|               |           |                   |           |          |                 |                                      |               | 50                    | -0.5           | 33.53                  |
|               |           |                   |           |          |                 |                                      |               | 125                   | -0.75          | 33.91                  |
|               |           |                   |           |          |                 |                                      |               | 250                   | 2.8            | 34.65                  |
| 268           | ...do.... | 8.20-9.15 a. m.   | 43 15     | 53 40    | 2,141           | NW.; 6.                              | ...do.....    | 450                   | 2.9            | 34.72                  |
|               |           |                   |           |          |                 |                                      |               | 750                   | 3.15           | 35.03                  |
|               |           |                   |           |          |                 |                                      |               | 0                     | 0.9            | 39.87                  |
|               |           |                   |           |          |                 |                                      |               | 50                    | 0.3            | 33.53                  |
|               |           |                   |           |          |                 |                                      |               | 125                   | 0.3            | 33.49                  |
| 269           | Apr. 25   | 6-6.30 p. m.      | 43 05     | 50 09    | 44              | S.; 4.                               | Foggy.....    | 250                   | -0.4           | 33.40                  |
|               |           |                   |           |          |                 |                                      |               | 450                   | 0.2            | 34.51                  |
|               |           |                   |           |          |                 |                                      |               | 750                   | 0.8            | 34.54                  |
|               |           |                   |           |          |                 |                                      |               | 0                     | 0.9            | 32.84                  |
|               |           |                   |           |          |                 |                                      |               | 15                    | 2.0            | 32.83                  |
| 270           | Apr. 26   | 12.30-1 p. m.     | 43 29     | 50 16    | 33              | ...do.....                           | ...do.....    | 30                    | 0.95           | 32.79                  |
|               |           |                   |           |          |                 |                                      |               | 40                    | 1.0            | 33.62                  |
|               |           |                   |           |          |                 |                                      |               | 0                     | 1.2            | 32.81                  |
|               |           |                   |           |          |                 |                                      |               | 10                    | 0.4            | 32.81                  |
|               |           |                   |           |          |                 |                                      |               | 25                    | 0.55           | 32.51                  |
| 271           | ...do.... | 4-4.30 p. m.      | 43 54     | 50 25    | 32              | S.; 3.                               | ...do.....    | 40                    | 0.5            | 32.83                  |
|               |           |                   |           |          |                 |                                      |               | 55                    | -0.2           | 32.81                  |
|               |           |                   |           |          |                 |                                      |               | 0                     | 0.1            | 33.94                  |
|               |           |                   |           |          |                 |                                      |               | 15                    | 0.2            | 32.94                  |
|               |           |                   |           |          |                 |                                      |               | 30                    | 0.35           | 32.92                  |
| 272           | ...do.... | 8-8.30 p. m.      | 43 57     | 49 45    | 27              | ...do.....                           | ...do.....    | 40                    | 0.4            | 32.90                  |
|               |           |                   |           |          |                 |                                      |               | 50                    | -0.2           | 32.88                  |
|               |           |                   |           |          |                 |                                      |               | 0                     | 0.9            | 33.03                  |
|               |           |                   |           |          |                 |                                      |               | 10                    | 0.6            | 33.04                  |
|               |           |                   |           |          |                 |                                      |               | 20                    | 0.7            | 32.61                  |
| 273           | Apr. 27   | 6.20-6.50 a. m.   | 44 00     | 49 04    | 27              | ...do.....                           | ...do.....    | 30                    | 0.6            | 32.99                  |
|               |           |                   |           |          |                 |                                      |               | 45                    | 0.4            | 33.04                  |
|               |           |                   |           |          |                 |                                      |               | 0                     | 0.4            | 32.95                  |
|               |           |                   |           |          |                 |                                      |               | 15                    | 0.15           | 33.26                  |
|               |           |                   |           |          |                 |                                      |               | 25                    | -0.8           | 33.24                  |
| 274           | ...do.... | 10.30-11.30 a. m. | 44 05     | 48 20    | 1,530           | ...do.....                           | ...do.....    | 40                    | -1.0           | 33.68                  |
|               |           |                   |           |          |                 |                                      |               | 0                     | 0.1            | 33.31                  |
|               |           |                   |           |          |                 |                                      |               | 50                    | 1.2            | 33.30                  |
|               |           |                   |           |          |                 |                                      |               | 125                   | 1.2            | 33.30                  |
|               |           |                   |           |          |                 |                                      |               | 250                   | 1.35           | 33.57                  |
| 275           | ...do.... | 3-3.50 p. m.      | 44 10     | 47 37    | 2,500           | S.; 2.                               | ...do.....    | 450                   | 2.1            | 33.48                  |
|               |           |                   |           |          |                 |                                      |               | 750                   | 2.95           | 34.92                  |
|               |           |                   |           |          |                 |                                      |               | 0                     | 4.7            | 33.77                  |
|               |           |                   |           |          |                 |                                      |               | 50                    | 8.65           | -----                  |
|               |           |                   |           |          |                 |                                      |               | 125                   | 7.3            | -----                  |
| 276           | ...do.... | 7.30-8.20 p. m.   | 44 15     | 46 56    | 2,500           | S.; 1.                               | ...do.....    | 250                   | 5.6            | 34.74                  |
|               |           |                   |           |          |                 |                                      |               | 450                   | 5.7            | -----                  |
|               |           |                   |           |          |                 |                                      |               | 750                   | 6.5            | -----                  |
|               |           |                   |           |          |                 |                                      |               | 0                     | 6.7            | -----                  |
|               |           |                   |           |          |                 |                                      |               | 50                    | 7.3            | 34.74                  |
| 277           | ...do.... | 11.50-12.40 p. m. | 44 22     | 46 14    | 2,500           | SSE.; 3.                             | Overcast..... | 125                   | 7.5            | 34.81                  |
|               |           |                   |           |          |                 |                                      |               | 250                   | 6.5            | 34.76                  |
|               |           |                   |           |          |                 |                                      |               | 450                   | 6.95           | -----                  |
|               |           |                   |           |          |                 |                                      |               | 750                   | 7.6            | 34.96                  |
|               |           |                   |           |          |                 |                                      |               | 0                     | 9.1            | -----                  |
| 278           | Apr. 28   | 3.50-4.30 a. m.   | 44 32     | 45 30    | 2,500           | SW.; 2.                              | ...do.....    | 50                    | 9.1            | 34.97                  |
|               |           |                   |           |          |                 |                                      |               | 0                     | 9.4            | 33.62                  |
|               |           |                   |           |          |                 |                                      |               | 50                    | 5.5            | 34.11                  |
|               |           |                   |           |          |                 |                                      |               | 125                   | 6.1            | 34.58                  |
|               |           |                   |           |          |                 |                                      |               | 250                   | 5.6            | 34.74                  |
| 279           | ...do.... | 7.50-8.20 a. m.   | 44 35     | 44 48    | 2,500           | W.; 2.                               | Foggy.....    | 450                   | 5.25           | 34.72                  |
|               |           |                   |           |          |                 |                                      |               | 750                   | 3.05           | 34.51                  |
|               |           |                   |           |          |                 |                                      |               | 0                     | 7.7            | -----                  |
|               |           |                   |           |          |                 |                                      |               | 50                    | 6.9            | -----                  |
|               |           |                   |           |          |                 |                                      |               | 125                   | 7.25           | -----                  |
|               |           |                   |           |          |                 |                                      |               | 250                   | 7.0            | 34.79                  |
|               |           |                   |           |          |                 |                                      |               | 450                   | 6.35           | 33.95                  |
|               |           |                   |           |          |                 |                                      |               | 750                   | 6.35           | 34.99                  |

Table of data concerning scientific stations occupied by the "Tampa" and "Modoc"—Continued.

| Station No. | Date.   | Time of day.       | Position. |          | Depth of water.        | Wind direction and force (Beaufort). | Sky.          | Water, physical data. |              |                         |
|-------------|---------|--------------------|-----------|----------|------------------------|--------------------------------------|---------------|-----------------------|--------------|-------------------------|
|             |         |                    | Lat. N.   | Long. W. |                        |                                      |               | Depth.                | Temperature. | Salinity (‰ by weight). |
| 280         | Apr. 28 | 11.30-12.30 p. m.  | 44 40     | 44 09    | Fath-<br>oms.<br>2,549 | W.; 5                                | Overcast      | Meters.               | ° C.         |                         |
|             |         |                    |           |          |                        |                                      |               | 0                     | 11.9         | 35.41                   |
|             |         |                    |           |          |                        |                                      |               | 50                    | 13.1         | 35.52                   |
|             |         |                    |           |          |                        |                                      |               | 125                   | 6.95         | 35.28                   |
|             |         |                    |           |          |                        |                                      |               | 250                   | 8.3          | 34.83                   |
|             |         |                    |           |          |                        |                                      |               | 450                   | 5.15         | 34.83                   |
|             |         |                    |           |          |                        |                                      |               | 750                   | 11.1         |                         |
| 281         | do      | 3.25 - 4.20 p. m.  | 44 41     | 43 25    | 2,500                  | do                                   | do            | 0                     | 5.0          | 33.82                   |
|             |         |                    |           |          |                        |                                      |               | 50                    | 7.3          | 35.08                   |
|             |         |                    |           |          |                        |                                      |               | 125                   | 9.65         | 34.90                   |
|             |         |                    |           |          |                        |                                      |               | 250                   | 7.8          | 35.08                   |
|             |         |                    |           |          |                        |                                      |               | 450                   | 6.75         | 34.79                   |
|             |         |                    |           |          |                        |                                      |               | 750                   | 6.05         | 34.76                   |
| 282         | do      | 6.10-7 p. m.       | 44 43     | 43 09    | 2,500                  | S.; 5                                | Clear         | 0                     | 11.9         | 35.77                   |
|             |         |                    |           |          |                        |                                      |               | 50                    | 14.1         | 35.77                   |
|             |         |                    |           |          |                        |                                      |               | 125                   | 13.55        | 35.68                   |
|             |         |                    |           |          |                        |                                      |               | 250                   | 12.0         | 35.19                   |
|             |         |                    |           |          |                        |                                      |               | 450                   | 8.9          | 34.99                   |
|             |         |                    |           |          |                        |                                      |               | 750                   | 13.15        | 34.87                   |
| 283         | Apr. 30 | 7.30 - 8.20 p. m.  | 42 23     | 50 20    | 2,300                  | NE.; 2                               | do            | 0                     | 0.9          | 33.31                   |
|             |         |                    |           |          |                        |                                      |               | 50                    | 0.8          | 33.68                   |
|             |         |                    |           |          |                        |                                      |               | 125                   | 1.85         | 34.20                   |
|             |         |                    |           |          |                        |                                      |               | 250                   | 2.85         | 34.67                   |
|             |         |                    |           |          |                        |                                      |               | 450                   | 3.55         | 34.88                   |
|             |         |                    |           |          |                        |                                      |               | 750                   | 3.95         | 34.88                   |
| 284         | do      | 10-10.50 p. m.     | 42 38     | 50 20    | 1,246                  | do                                   | do            | 0                     | 1.3          | 33.17                   |
|             |         |                    |           |          |                        |                                      |               | 50                    | -0.5         | 33.30                   |
|             |         |                    |           |          |                        |                                      |               | 125                   | 4.0          | 34.23                   |
|             |         |                    |           |          |                        |                                      |               | 250                   | 2.3          | 33.13                   |
|             |         |                    |           |          |                        |                                      |               | 450                   | 0.2          | 34.85                   |
|             |         |                    |           |          |                        |                                      |               | 750                   | 3.1          | 34.87                   |
| 285         | May 1   | 12.30 - 1.40 a. m. | 42 52     | 50 20    | 983                    | E.; 1                                | Mostly clear  | 0                     | 1.4          | 33.08                   |
|             |         |                    |           |          |                        |                                      |               | 50                    | -0.9         | 33.24                   |
|             |         |                    |           |          |                        |                                      |               | 125                   | -1.35        | 33.30                   |
|             |         |                    |           |          |                        |                                      |               | 250                   | -0.95        | 33.49                   |
|             |         |                    |           |          |                        |                                      |               | 450                   | -0.5         | 33.22                   |
|             |         |                    |           |          |                        |                                      |               | 750                   | 2.0          | 34.16                   |
| 286         | do      | 3.30-4 a. m.       | 43 08     | 50 20    | 44                     | ESE.; 2                              | Mostly cloudy | 0                     | 2.0          | 32.83                   |
|             |         |                    |           |          |                        |                                      |               | 25                    | 3.8          | 32.83                   |
|             |         |                    |           |          |                        |                                      |               | 50                    | 3.35         | 33.04                   |
|             |         |                    |           |          |                        |                                      |               | 70                    | -1.2         | 33.55                   |
| 287         | do      | 1.45 - 2.30 p. m.  | 42 41     | 51 34    | 1,415                  | SE.; 4                               | Mostly clear  | 0                     | 3.5          | 33.15                   |
|             |         |                    |           |          |                        |                                      |               | 50                    | 1.75         | 33.53                   |
|             |         |                    |           |          |                        |                                      |               | 125                   | 0.8          | 33.89                   |
|             |         |                    |           |          |                        |                                      |               | 250                   | (?)          | 34.65                   |
|             |         |                    |           |          |                        |                                      |               | 450                   | 3.65         | 33.53                   |
|             |         |                    |           |          |                        |                                      |               | 750                   | 4.65         | 34.92                   |
| 288         | do      | 4-4.50 p. m.       | 42 53     | 51 23    | 1,060                  | SSE.; 3                              | do            | 0                     | 1.8          | 33.19                   |
|             |         |                    |           |          |                        |                                      |               | 50                    | 4.1          | 33.13                   |
|             |         |                    |           |          |                        |                                      |               | 125                   | 3.05         | 33.17                   |
|             |         |                    |           |          |                        |                                      |               | 250                   | 0.9          | 33.69                   |
|             |         |                    |           |          |                        |                                      |               | 450                   | -0.5         | 34.69                   |
|             |         |                    |           |          |                        |                                      |               | 750                   | 0.6          | 34.87                   |
| 289         | do      | 6.45 - 7.30 p. m.  | 43 05     | 51 11    | 580                    | SE.; 3                               | Mostly cloudy | 0                     | 1.7          | 33.17                   |
|             |         |                    |           |          |                        |                                      |               | 50                    | 0.75         | 33.19                   |
|             |         |                    |           |          |                        |                                      |               | 125                   | -1.35        | 33.42                   |
|             |         |                    |           |          |                        |                                      |               | 250                   | -1.15        | 33.64                   |
|             |         |                    |           |          |                        |                                      |               | 450                   | 3.15         | 33.37                   |
|             |         |                    |           |          |                        |                                      |               | 750                   | (?)          | 34.31                   |
| 290         | do      | 9-9.30 p. m.       | 43 15     | 50 57    | 47                     | do                                   | do            | 0                     | 2.3          | 32.95                   |
|             |         |                    |           |          |                        |                                      |               | 15                    | 1.85         | 32.75                   |
|             |         |                    |           |          |                        |                                      |               | 30                    | 5.3          | 32.81                   |
|             |         |                    |           |          |                        |                                      |               | 45                    | -0.95        |                         |
|             |         |                    |           |          |                        |                                      |               | 65                    | -1.85        | 32.94                   |
|             |         |                    |           |          |                        |                                      |               | 85                    | 0.5          | 32.75                   |
| 291         | May 2   | 6.30-7.20 p. m.    | 42 56     | 55 12    | 2,332                  | S.; 2                                | Foggy         | 0                     | 3.0          | 32.99                   |
|             |         |                    |           |          |                        |                                      |               | 50                    | 1.2          | 33.01                   |
|             |         |                    |           |          |                        |                                      |               | 125                   | 2.15         | 33.48                   |
|             |         |                    |           |          |                        |                                      |               | 250                   | 4.5          | 34.00                   |
|             |         |                    |           |          |                        |                                      |               | 450                   | 4.1          | 34.92                   |
|             |         |                    |           |          |                        |                                      |               | 750                   | 3.9          | 35.41                   |

Table of data concerning scientific stations occupied by the "Tampa" and "Modoc"—Continued.

| Sta. tion No. | Date. | Time of day.      | Position. |          | Depth of water.   | Wind direction and force (Beaufort). | Sky.          | Water, physical data. |                |                         |
|---------------|-------|-------------------|-----------|----------|-------------------|--------------------------------------|---------------|-----------------------|----------------|-------------------------|
|               |       |                   | Lat. N.   | Long. W. |                   |                                      |               | Depth.                | Tem- perature. | Salinity (‰ by weight). |
| 292           | May 3 | 6.30-7.20 a. m.   | 43 15     | 53 30    | Fath- oms. 2, 141 | SSE.; 4                              | Overcast      | Meters.               | ° C.           |                         |
|               |       |                   |           |          |                   |                                      |               | 0                     | 3.2            | 33.01                   |
|               |       |                   |           |          |                   |                                      |               | 50                    | 0.1            | 33.78                   |
|               |       |                   |           |          |                   |                                      |               | 125                   | 2.7            | 33.96                   |
|               |       |                   |           |          |                   |                                      |               | 250                   | 4.05           | 34.05                   |
| 293           | do    | 11.15-12.15 a. m. | 43 25     | 52 35    | 1, 235            | do                                   | Mostly cloudy | 450                   | 3.15           | 34.90                   |
|               |       |                   |           |          |                   |                                      |               | 750                   | 3.15           | 35.07                   |
|               |       |                   |           |          |                   |                                      |               | 0                     | 3.8            | 33.35                   |
|               |       |                   |           |          |                   |                                      |               | 50                    | -0.4           | 33.42                   |
|               |       |                   |           |          |                   |                                      |               | 125                   | 0.3            | 34.00                   |
| 294           | do    | 3-4.05 p. m.      | 43 32     | 52 00    | 565               | do                                   | Partly cloudy | 250                   | 3.8            | 34.40                   |
|               |       |                   |           |          |                   |                                      |               | 450                   | 2.8            | 34.76                   |
|               |       |                   |           |          |                   |                                      |               | 750                   | 3.4            | 34.96                   |
|               |       |                   |           |          |                   |                                      |               | 0                     | 2.8            | 33.15                   |
|               |       |                   |           |          |                   |                                      |               | 50                    | -0.2           | 34.74                   |
| 295           | do    | 8.30-9 p. m.      | 43 41     | 51 12    | 44                | SE.; 4                               | Mostly clear  | 125                   | -1.2           | 33.51                   |
|               |       |                   |           |          |                   |                                      |               | 250                   | -0.4           | 33.80                   |
|               |       |                   |           |          |                   |                                      |               | 450                   | 0.4            | 33.26                   |
|               |       |                   |           |          |                   |                                      |               | 750                   | 3.9            | 34.72                   |
|               |       |                   |           |          |                   |                                      |               | 0                     | 3.7            | 32.84                   |
| 296           | May 4 | 7-7.20 a. m.      | 43 50     | 50 25    | 35                | SE.; 3                               | do            | 15                    | 2.4            | 32.75                   |
|               |       |                   |           |          |                   |                                      |               | 35                    | 1.05           | 32.79                   |
|               |       |                   |           |          |                   |                                      |               | 55                    | -0.35          |                         |
|               |       |                   |           |          |                   |                                      |               | 75                    | -0.6           | 33.06                   |
|               |       |                   |           |          |                   |                                      |               | 0                     | 2.3            | 32.88                   |
| 297           | do    | 10.30-11 a. m.    | 43 30     | 50 45    | 37                | SE.; 4                               | Overcast      | 10                    | 1.8            | 32.92                   |
|               |       |                   |           |          |                   |                                      |               | 20                    | 1.25           | 32.97                   |
|               |       |                   |           |          |                   |                                      |               | 35                    | -0.6           | 33.17                   |
|               |       |                   |           |          |                   |                                      |               | 55                    | -0.45          | 33.01                   |
|               |       |                   |           |          |                   |                                      |               | 0                     | 3.4            | 32.72                   |
| 298           | May 7 | 5.20-5.40 p. m.   | 44 15     | 50 39    | 35                | W.; 2                                | Foggy         | 15                    | 2.8            | 32.72                   |
|               |       |                   |           |          |                   |                                      |               | 30                    | 1.3            | 32.75                   |
|               |       |                   |           |          |                   |                                      |               | 45                    | -0.5           | 32.84                   |
|               |       |                   |           |          |                   |                                      |               | 60                    | -0.6           | 32.86                   |
|               |       |                   |           |          |                   |                                      |               | 0                     | 2.7            | 32.79                   |
| 299           | May 8 | 11.30-11.55 a. m. | 44 40     | 51 12    | 38                | W.; 3                                | do            | 15                    | 2.8            | 32.77                   |
|               |       |                   |           |          |                   |                                      |               | 25                    | 2.95           | 32.79                   |
|               |       |                   |           |          |                   |                                      |               | 40                    | -0.7           | 32.92                   |
|               |       |                   |           |          |                   |                                      |               | 60                    | -1.15          | 32.97                   |
|               |       |                   |           |          |                   |                                      |               | 0                     | 3.0            | 31.62                   |
| 300           | do    | 2.20-2.50 p. m.   | 45 05     | 51 36    | 38                | N.; 3                                | do            | 15                    | 2.1            | 32.77                   |
|               |       |                   |           |          |                   |                                      |               | 25                    | -0.05          | 32.95                   |
|               |       |                   |           |          |                   |                                      |               | 40                    | -0.9           | 33.03                   |
|               |       |                   |           |          |                   |                                      |               | 60                    | -1.1           | 33.03                   |
|               |       |                   |           |          |                   |                                      |               | 0                     | 2.5            | 32.88                   |
| 301           | do    | 7.30-7.50 p. m.   | 45 28     | 52 02    | 41                | NW.; 4                               | do            | 15                    | 1.8            | 32.94                   |
|               |       |                   |           |          |                   |                                      |               | 30                    | 0.7            | 33.01                   |
|               |       |                   |           |          |                   |                                      |               | 45                    | -0.9           | 33.03                   |
|               |       |                   |           |          |                   |                                      |               | 65                    | 1.0            | 33.04                   |
|               |       |                   |           |          |                   |                                      |               | 0                     | 1.1            | 32.90                   |
| 302           | do    | 10.55-11.15 p. m. | 45 51     | 52 48    | 44                | NW.; 3                               | Mostly clear  | 15                    | 1.3            | 32.94                   |
|               |       |                   |           |          |                   |                                      |               | 30                    | 0.7            | 33.01                   |
|               |       |                   |           |          |                   |                                      |               | 45                    | -1.0           | 33.01                   |
|               |       |                   |           |          |                   |                                      |               | 60                    | -1.55          | 33.08                   |
|               |       |                   |           |          |                   |                                      |               | 0                     | 1.8            | 32.92                   |
| 303           | May 9 | 1.40-2 a. m.      | 46 05     | 52 51    | 55                | WNW. 3                               | Foggy         | 15                    | -0.5           | 32.95                   |
|               |       |                   |           |          |                   |                                      |               | 30                    | -0.5           | 33.04                   |
|               |       |                   |           |          |                   |                                      |               | 50                    | -1.3           | 33.08                   |
|               |       |                   |           |          |                   |                                      |               | 70                    | -1.75          | 33.17                   |
|               |       |                   |           |          |                   |                                      |               | 0                     | 1.4            | 33.04                   |
| 304           | do    | 5.40-6.20 a. m.   | 46 16     | 53 07    | 74                | NW.; 3                               | do            | 20                    | 0.4            | 32.95                   |
|               |       |                   |           |          |                   |                                      |               | 40                    | -1.25          | 32.99                   |
|               |       |                   |           |          |                   |                                      |               | 60                    | -1.9           | 33.24                   |
|               |       |                   |           |          |                   |                                      |               | 90                    | -1.75          |                         |
|               |       |                   |           |          |                   |                                      |               | 0                     | 1.1            | 33.12                   |
| 305           | do    | 9-9.20 a. m.      | 46 29     | 53 00    | 44                | WNW.; 3                              | Foggy         | 30                    | -1.3           | 32.90                   |
|               |       |                   |           |          |                   |                                      |               | 60                    | -1.35          | 32.35                   |
|               |       |                   |           |          |                   |                                      |               | 90                    | -1.3           | 33.19                   |
|               |       |                   |           |          |                   |                                      |               | 120                   | -1.4           | 33.24                   |
|               |       |                   |           |          |                   |                                      |               | 0                     | 1.3            | 32.92                   |
|               |       |                   |           |          |                   |                                      |               | 15                    | 0.8            | 32.92                   |
|               |       |                   |           |          |                   |                                      |               | 35                    | 0.15           | 33.01                   |
|               |       |                   |           |          |                   |                                      |               | 55                    | -1.1           | 33.12                   |
|               |       |                   |           |          |                   |                                      |               | 75                    | -1.35          |                         |

Table of data concerning scientific stations occupied by the "Tampa" and "Modoc"—Continued.

| Sta.<br>tion<br>No. | Date.  | Time of day.         | Position.  |            | Depth<br>of<br>water. | Wind<br>direction<br>and force<br>(Beaufort). | Sky.          | Water, physical data. |                   |                               |
|---------------------|--------|----------------------|------------|------------|-----------------------|-----------------------------------------------|---------------|-----------------------|-------------------|-------------------------------|
|                     |        |                      | Lat.<br>N. | Long<br>W. |                       |                                               |               | Depth.                | Tempera-<br>ture. | Salinity<br>(‰ by<br>weight). |
| 306                 | May 15 | 7.30-8 a. m.         | 43 07      | 51 04      | Fath-<br>oms.<br>560  | N.; 4                                         | Overcast      | Meters.               | ° C.              |                               |
|                     |        |                      |            |            |                       |                                               |               | 0                     | 3.6               | -----                         |
|                     |        |                      |            |            |                       |                                               |               | 50                    | 1.25              | -----                         |
|                     |        |                      |            |            |                       |                                               |               | 125                   | -1.0              | -----                         |
|                     |        |                      |            |            |                       |                                               |               | 250                   | 1.35              | -----                         |
|                     |        |                      |            |            |                       |                                               |               | 450                   | 3.1               | -----                         |
|                     |        |                      |            |            |                       |                                               |               | 750                   | 2.05              | -----                         |
| 307                 | do     | 11-11.45 a. m.       | 43 16      | 51 38      | 900                   | N.; 4                                         | do            | 0                     | 5.0               | -----                         |
|                     |        |                      |            |            |                       |                                               |               | 50                    | 2.0               | -----                         |
|                     |        |                      |            |            |                       |                                               |               | 125                   | 2.5               | -----                         |
|                     |        |                      |            |            |                       |                                               |               | 250                   | 2.25              | -----                         |
|                     |        |                      |            |            |                       |                                               |               | 450                   | 3.0               | -----                         |
|                     |        |                      |            |            |                       |                                               |               | 750                   | 3.2               | -----                         |
| 308                 | May 19 | 5-5.50 p. m.         | 41 28      | 50 38      | 2,100                 | S.; 2                                         | Mostly clear  | 0                     | 15.9              | -----                         |
|                     |        |                      |            |            |                       |                                               |               | 50                    | 15.0              | -----                         |
|                     |        |                      |            |            |                       |                                               |               | 125                   | 14.2              | -----                         |
|                     |        |                      |            |            |                       |                                               |               | 250                   | 15.65             | -----                         |
|                     |        |                      |            |            |                       |                                               |               | 450                   | 12.6              | -----                         |
|                     |        |                      |            |            |                       |                                               |               | 750                   | 15.2              | -----                         |
| 309                 | do     | 10.30-11.30<br>p. m. | 40 56      | 50 17      | 2,100                 | S.; 2                                         | do            | 0                     | 17.8              | 36.44                         |
|                     |        |                      |            |            |                       |                                               |               | 50                    | 17.85             | 36.45                         |
|                     |        |                      |            |            |                       |                                               |               | 125                   | 17.1              | 36.36                         |
|                     |        |                      |            |            |                       |                                               |               | 250                   | 18.1              | 35.81                         |
|                     |        |                      |            |            |                       |                                               |               | 450                   | 18.2              | 36.40                         |
|                     |        |                      |            |            |                       |                                               |               | 750                   | 18.0              | 36.42                         |
| 310                 | May 23 | 3.40-4.40 p.<br>m.   | 40 10      | 48 50      | 2,197                 | W.; 3                                         | Overcast      | 0                     | 18.7              | 36.08                         |
|                     |        |                      |            |            |                       |                                               |               | 50                    | 17.2              | 36.02                         |
|                     |        |                      |            |            |                       |                                               |               | 125                   | 18.1              | 35.70                         |
|                     |        |                      |            |            |                       |                                               |               | 250                   | 15.4              | 36.06                         |
|                     |        |                      |            |            |                       |                                               |               | 450                   | 10.05             | 35.19                         |
|                     |        |                      |            |            |                       |                                               |               | 750                   | 14.05             | 34.70                         |
| 311                 | May 27 | 3.45-4.30 a.<br>m.   | 41 32      | 50 18      | 2,000                 | W.; 6                                         | do            | 0                     | 19.8              | 36.35                         |
|                     |        |                      |            |            |                       |                                               |               | 50                    | 19.3              | 36.44                         |
|                     |        |                      |            |            |                       |                                               |               | 125                   | 19.6              | 36.09                         |
|                     |        |                      |            |            |                       |                                               |               | 250                   | 20.0              | 36.08                         |
|                     |        |                      |            |            |                       |                                               |               | 450                   | 17.45             | 35.23                         |
|                     |        |                      |            |            |                       |                                               |               | 750                   | 18.3              | 36.08                         |
| 312                 | May 29 | 3.45-4.30 p.<br>m.   | 42 04      | 50 18      | 2,034                 | E.; 3                                         | do            | 0                     | 11.4              | 34.92                         |
|                     |        |                      |            |            |                       |                                               |               | 50                    | 11.0              | 34.56                         |
|                     |        |                      |            |            |                       |                                               |               | 125                   | 10.9              | 34.51                         |
|                     |        |                      |            |            |                       |                                               |               | 250                   | 10.65             | 34.81                         |
|                     |        |                      |            |            |                       |                                               |               | 450                   | 10.6              | 35.50                         |
|                     |        |                      |            |            |                       |                                               |               | 750                   | 5.5               | 35.32                         |
| 313                 | May 31 | 10.25-11.25<br>a. m. | 42 38      | 50 15      | 976                   | SW.; 4                                        | Partly cloudy | 0                     | 3.1               | 33.17                         |
|                     |        |                      |            |            |                       |                                               |               | 50                    | 1.8               | 34.14                         |
|                     |        |                      |            |            |                       |                                               |               | 125                   | 1.6               | 34.85                         |
|                     |        |                      |            |            |                       |                                               |               | 250                   | 1.1               | 33.26                         |
|                     |        |                      |            |            |                       |                                               |               | 450                   | -0.4              | 33.51                         |
|                     |        |                      |            |            |                       |                                               |               | 750                   | 0.6               | 34.07                         |
| 314                 | May 31 | 4.30-5.30 p.<br>m.   | 42 47      | 50 12      | 440                   | SW.; 4                                        | do            | 0                     | 3.5               | 33.10                         |
|                     |        |                      |            |            |                       |                                               |               | 50                    | 1.3               | 33.42                         |
|                     |        |                      |            |            |                       |                                               |               | 125                   | 1.5               | 34.04                         |
|                     |        |                      |            |            |                       |                                               |               | 250                   | 0.0               | 34.40                         |
|                     |        |                      |            |            |                       |                                               |               | 450                   | 1.5               | 34.40                         |
|                     |        |                      |            |            |                       |                                               |               | 750                   | 1.5               | 33.35                         |
| 315                 | June 3 | 2.30-3.40 p.<br>m.   | 43 10      | 54 00      | 1,500                 | NW.; 3                                        | Mostly clear  | 0                     | 10.6              | 33.98                         |
|                     |        |                      |            |            |                       |                                               |               | 50                    | 10.85             | 33.96                         |
|                     |        |                      |            |            |                       |                                               |               | 125                   | 10.1              | 34.90                         |
|                     |        |                      |            |            |                       |                                               |               | 250                   | 9.8               | 34.72                         |
|                     |        |                      |            |            |                       |                                               |               | 450                   | 9.8               | 34.94                         |
|                     |        |                      |            |            |                       |                                               |               | 750                   | 3.75              | 34.87                         |
| 316                 | do     | 6-6.45 p. m.         | 43 17      | 53 21      | 2,141                 | NW.; 1                                        | do            | 0                     | 7.2               | 33.19                         |
|                     |        |                      |            |            |                       |                                               |               | 50                    | 0.0               | 33.43                         |
|                     |        |                      |            |            |                       |                                               |               | 125                   | 6.2               | 34.02                         |
|                     |        |                      |            |            |                       |                                               |               | 250                   | 4.3               | 34.79                         |
|                     |        |                      |            |            |                       |                                               |               | 450                   | 4.8               | 34.97                         |
|                     |        |                      |            |            |                       |                                               |               | 750                   | 3.7               | 34.96                         |
| 317                 | do     | 10-10.45 p.<br>m.    | 43 24      | 52 42      | 1,235                 | WNW.; 1                                       | Clear         | 0                     | 10.6              | 34.88                         |
|                     |        |                      |            |            |                       |                                               |               | 50                    | 12.1              | 35.26                         |
|                     |        |                      |            |            |                       |                                               |               | 125                   | 10.8              | 35.19                         |
|                     |        |                      |            |            |                       |                                               |               | 250                   | 6.7               | 34.58                         |
|                     |        |                      |            |            |                       |                                               |               | 450                   | 4.0               | 34.40                         |
|                     |        |                      |            |            |                       |                                               |               | 750                   | 4.7               | 35.01                         |

Table of data concerning scientific stations occupied by the "Tampa" and "Modoc"—Continued.

| Station No. | Date.   | Time of day.      | Position. |          | Depth of water. | Wind direction and force (Beaufort). | Sky.         | Water, physical data. |              |                         |
|-------------|---------|-------------------|-----------|----------|-----------------|--------------------------------------|--------------|-----------------------|--------------|-------------------------|
|             |         |                   | Lat. N.   | Long. W. |                 |                                      |              | Depth.                | Temperature. | Salinity (‰ by weight). |
| 318         | June 4  | 2.30-4.30 a. m.   | 43 32     | 52 00    | Fathoms.<br>565 | NNW.; 1.                             | Clear        | Meters.               | ° C.         |                         |
|             |         |                   |           |          |                 |                                      |              | 0                     | 5.55         | 33.15                   |
|             |         |                   |           |          |                 |                                      |              | 50                    | 4.3          | ---                     |
|             |         |                   |           |          |                 |                                      |              | 125                   | 4.0          | 33.58                   |
|             |         |                   |           |          |                 |                                      |              | 250                   | 5.8          | 34.54                   |
| 319         | do      | 6.30-7 a. m.      | 43 40     | 51 15    | 39              | W.; 1                                | do           | 450                   | 3.9          | 34.51                   |
|             |         |                   |           |          |                 |                                      |              | 750                   | 0.25         | 34.85                   |
|             |         |                   |           |          |                 |                                      |              | 0                     | 4.8          | 32.68                   |
|             |         |                   |           |          |                 |                                      |              | 15                    | 4.85         | 32.68                   |
|             |         |                   |           |          |                 |                                      |              | 30                    | 5.2          | 32.68                   |
| 320         | do      | 10-10.30 a. m.    | 43 29     | 50 46    | 35              | do                                   | do           | 50                    | 0.4          | 32.97                   |
|             |         |                   |           |          |                 |                                      |              | 70                    | 0.25         | 33.06                   |
|             |         |                   |           |          |                 |                                      |              | 0                     | 5.65         | 32.70                   |
|             |         |                   |           |          |                 |                                      |              | 10                    | 5.4          | 32.70                   |
|             |         |                   |           |          |                 |                                      |              | 25                    | 3.8          | 32.70                   |
| 321         | do      | 1.35-2.30 p. m.   | 43 04     | 51 10    | 580             | SSW.; 1                              | do           | 40                    | 2.6          | 32.79                   |
|             |         |                   |           |          |                 |                                      |              | 60                    | 1.65         | 32.99                   |
|             |         |                   |           |          |                 |                                      |              | 0                     | 7.1          | 33.13                   |
|             |         |                   |           |          |                 |                                      |              | 50                    | 0.6          | 33.35                   |
|             |         |                   |           |          |                 |                                      |              | 125                   | -1.45        | 33.53                   |
| 322         | do      | 5-5.40 p. m.      | 42 44     | 51 30    | 1,096           | S.; 1                                | do           | 250                   | -0.35        | 33.75                   |
|             |         |                   |           |          |                 |                                      |              | 450                   | 1.3          | 33.77                   |
|             |         |                   |           |          |                 |                                      |              | 750                   | 3.0          | 34.74                   |
|             |         |                   |           |          |                 |                                      |              | 0                     | 6.1          | 33.13                   |
|             |         |                   |           |          |                 |                                      |              | 50                    | 1.4          | 33.28                   |
| 323         | do      | 8.15-9 p. m.      | 42 24     | 51 50    | 1,826           | SE.; 1                               | Partly clear | 125                   | -1.3         | 33.53                   |
|             |         |                   |           |          |                 |                                      |              | 250                   | -0.35        | 33.87                   |
|             |         |                   |           |          |                 |                                      |              | 450                   | 3.0          | 34.83                   |
|             |         |                   |           |          |                 |                                      |              | 750                   | 3.4          | 34.90                   |
|             |         |                   |           |          |                 |                                      |              | 0                     | 15.4         | 35.43                   |
| 324         | do      | 11.30-12.30 a. m. | 42 03     | 52 10    | 2,340           | SSE.; 2                              | Mostly clear | 50                    | 14.5         | 35.48                   |
|             |         |                   |           |          |                 |                                      |              | 125                   | 12.25        | 35.37                   |
|             |         |                   |           |          |                 |                                      |              | 250                   | 10.2         | 35.14                   |
|             |         |                   |           |          |                 |                                      |              | 450                   | 6.6          | 34.92                   |
|             |         |                   |           |          |                 |                                      |              | 750                   | 5.5          | 34.78                   |
| 325         | June 5  | 8.45-9.20 p. m.   | 43 20     | 50 22    | 38              | SSW.; 3                              | Foggy        | 0                     | 15.7         | 35.61                   |
|             |         |                   |           |          |                 |                                      |              | 50                    | 14.6         | 35.46                   |
|             |         |                   |           |          |                 |                                      |              | 125                   | 12.7         | 35.46                   |
|             |         |                   |           |          |                 |                                      |              | 250                   | 10.4         | 35.16                   |
|             |         |                   |           |          |                 |                                      |              | 450                   | 10.8         | 34.94                   |
| 326         | June 6  | 4.30-5.10 p. m.   | 42 54     | 49 27    | 845             | W.; 2                                | Overcast     | 750                   | 4.7          | 34.99                   |
|             |         |                   |           |          |                 |                                      |              | 0                     | 5.2          | 32.88                   |
|             |         |                   |           |          |                 |                                      |              | 10                    | 5.5          | 32.88                   |
|             |         |                   |           |          |                 |                                      |              | 25                    | 3.6          | 32.88                   |
|             |         |                   |           |          |                 |                                      |              | 40                    | 1.2          | 32.08                   |
| 327         | June 10 | 11-11.30 a. m.    | 43 06     | 50 08    | 39              | SE.; 4                               | Foggy        | 60                    | -0.25        | 32.12                   |
|             |         |                   |           |          |                 |                                      |              | 0                     | 2.3          | ---                     |
|             |         |                   |           |          |                 |                                      |              | 50                    | 1.25         | ---                     |
|             |         |                   |           |          |                 |                                      |              | 125                   | -0.9         | ---                     |
|             |         |                   |           |          |                 |                                      |              | 250                   | -0.5         | ---                     |
| 328         | June 13 | 4.20-5 p. m.      | 41 25     | 50 25    | 2,000           | S.; 3                                | Overcast     | 450                   | 0.55         | ---                     |
|             |         |                   |           |          |                 |                                      |              | 750                   | 3.3          | ---                     |
|             |         |                   |           |          |                 |                                      |              | 0                     | 5.8          | 32.94                   |
|             |         |                   |           |          |                 |                                      |              | 20                    | 5.4          | 33.19                   |
|             |         |                   |           |          |                 |                                      |              | 40                    | 0.5          | 33.21                   |
| 329         | do      | 8.10-9.10 p. m.   | 40 55     | 50 15    | 2,000           | SW.; 4                               | Foggy        | 70                    | 0.0          | 32.97                   |
|             |         |                   |           |          |                 |                                      |              | 0                     | 17.3         | 35.73                   |
|             |         |                   |           |          |                 |                                      |              | 50                    | 15.8         | 35.68                   |
|             |         |                   |           |          |                 |                                      |              | 125                   | 15.1         | 35.14                   |
|             |         |                   |           |          |                 |                                      |              | 250                   | 12.0         | 35.21                   |
| 330         | June 14 | 2.45-3.40 a. m.   | 41 55     | 50 19    | 2,034           | SW.; 4                               | Overcast     | 450                   | 9.0          | 34.83                   |
|             |         |                   |           |          |                 |                                      |              | 750                   | 4.6          | 35.62                   |
|             |         |                   |           |          |                 |                                      |              | 0                     | 17.6         | 35.77                   |
|             |         |                   |           |          |                 |                                      |              | 50                    | 16.45        | 35.68                   |
|             |         |                   |           |          |                 |                                      |              | 125                   | 14.4         | 35.25                   |
|             |         |                   |           |          |                 |                                      |              | 250                   | 14.0         | 35.90                   |
|             |         |                   |           |          |                 |                                      |              | 450                   | 11.7         | 35.70                   |
|             |         |                   |           |          |                 |                                      |              | 750                   | 7.0          | 35.01                   |
|             |         |                   |           |          |                 |                                      |              | 0                     | 7.05         | ---                     |
|             |         |                   |           |          |                 |                                      |              | 50                    | 2.5          | 33.55                   |
|             |         |                   |           |          |                 |                                      |              | 125                   | 2.1          | 33.96                   |
|             |         |                   |           |          |                 |                                      |              | 250                   | 1.0          | 34.61                   |
|             |         |                   |           |          |                 |                                      |              | 450                   | 1.7          | 34.07                   |
|             |         |                   |           |          |                 |                                      |              | 750                   | 3.8          | 34.92                   |
|             |         |                   |           |          |                 |                                      |              |                       |              |                         |

Table of data concerning scientific stations occupied by the "Tampa" and "Modoc"—Continued.

| Station No. | Date.   | Time of day.      | Position. |          | Depth of water.   | Wind direction and force (Beaufort). | Sky.     | Water, physical data. |              |                        |
|-------------|---------|-------------------|-----------|----------|-------------------|--------------------------------------|----------|-----------------------|--------------|------------------------|
|             |         |                   | Lat. N.   | Long. W. |                   |                                      |          | Depth.                | Temperature. | Salinity (‰ by weight) |
| 331         | June 14 | 6-6.35 a. m.      | 42 17     | 50 20    | Fathoms.<br>1,750 | SW.; 4                               | Foggy    | Meters.               | ° C.         |                        |
|             |         |                   |           |          |                   |                                      |          | 0                     | 5.8          | 33.08                  |
|             |         |                   |           |          |                   |                                      |          | 50                    | 0.5          | 33.51                  |
|             |         |                   |           |          |                   |                                      |          | 125                   | 0.7          | 33.95                  |
|             |         |                   |           |          |                   |                                      |          | 250                   | 0.9          | 34.51                  |
| 332         | do      | 10.20-11.10 a. m. | 42 34     | 50 27    | 1,081             | SW.; 4                               | do       | 450                   | 0.7          | 34.85                  |
|             |         |                   |           |          |                   |                                      |          | 750                   | 2.6          | 34.94                  |
|             |         |                   |           |          |                   |                                      |          | 0                     | 4.5          | 33.15                  |
|             |         |                   |           |          |                   |                                      |          | 50                    | -1.6         | 34.25                  |
|             |         |                   |           |          |                   |                                      |          | 125                   | 0.7          | 34.76                  |
| 333         | do      | 3.30-4.30 p. m.   | 42 48     | 50 27    | 101               | SW.; 4                               | do       | 250                   | -1.6         | 33.48                  |
|             |         |                   |           |          |                   |                                      |          | 450                   | -0.6         | 33.60                  |
|             |         |                   |           |          |                   |                                      |          | 750                   | 3.2          | 34.87                  |
|             |         |                   |           |          |                   |                                      |          | 0                     | 4.3          | 32.79                  |
|             |         |                   |           |          |                   |                                      |          | 20                    | 3.7          | 33.48                  |
| 334         | do      | 8.30-8.50 p. m.   | 43 13     | 50 27    | 39                | WNW.; 3                              | do       | 70                    | 0.5          | 33.21                  |
|             |         |                   |           |          |                   |                                      |          | 120                   | -1.7         | 33.75                  |
|             |         |                   |           |          |                   |                                      |          | 170                   | 1.75         | 33.19                  |
|             |         |                   |           |          |                   |                                      |          | 0                     | 6.1          | 32.70                  |
|             |         |                   |           |          |                   |                                      |          | 15                    | 6.3          | 33.06                  |
| 335         | June 18 | 8.45-9.10 p. m.   | 43 05     | 50 03    | 41                | NNW.; 2                              | do       | 25                    | 5.2          | 33.04                  |
|             |         |                   |           |          |                   |                                      |          | 40                    | -1.3         | 32.68                  |
|             |         |                   |           |          |                   |                                      |          | 60                    | 0.25         | 32.75                  |
|             |         |                   |           |          |                   |                                      |          | 0                     | 7.6          | -----                  |
|             |         |                   |           |          |                   |                                      |          | 15                    | 7.5          | -----                  |
| 336         | do      | 12-12.30 a. m.    | 43 05     | 50 03    | 41                | N.; 2                                | do       | 30                    | 5.2          | -----                  |
|             |         |                   |           |          |                   |                                      |          | 45                    | 3.2          | -----                  |
|             |         |                   |           |          |                   |                                      |          | 60                    | 0.9          | -----                  |
|             |         |                   |           |          |                   |                                      |          | 0                     | 6.8          | -----                  |
|             |         |                   |           |          |                   |                                      |          | 15                    | 5.5          | -----                  |
| 337         | June 19 | 4-4.20 a. m.      | 43 05     | 50 03    | 41                | NNE.; 2                              | do       | 30                    | 4.2          | -----                  |
|             |         |                   |           |          |                   |                                      |          | 45                    | 0.3          | -----                  |
|             |         |                   |           |          |                   |                                      |          | 60                    | -0.7         | -----                  |
|             |         |                   |           |          |                   |                                      |          | 0                     | 7.2          | -----                  |
|             |         |                   |           |          |                   |                                      |          | 15                    | 7.0          | -----                  |
| 338         | do      | 10.30-11.20 p. m. | 42 45     | 50 00    | 976               | NE.; 2                               | do       | 30                    | 1.7          | -----                  |
|             |         |                   |           |          |                   |                                      |          | 45                    | 0.8          | -----                  |
|             |         |                   |           |          |                   |                                      |          | 60                    | -0.6         | -----                  |
|             |         |                   |           |          |                   |                                      |          | 0                     | 6.3          | -----                  |
|             |         |                   |           |          |                   |                                      |          | 50                    | 4.4          | -----                  |
| 339         | June 21 | 11.20-11.40 a. m. | 43 50     | 50 25    | 35                | SE.; 1                               | do       | 125                   | 2.4          | -----                  |
|             |         |                   |           |          |                   |                                      |          | 250                   | 6.25         | -----                  |
|             |         |                   |           |          |                   |                                      |          | 450                   | 4.6          | -----                  |
|             |         |                   |           |          |                   |                                      |          | 750                   | 3.4          | -----                  |
|             |         |                   |           |          |                   |                                      |          | 0                     | 8.9          | 32.52                  |
| 340         | do      | 5.40-6.10 p. m.   | 43 31     | 51 04    | 38                | SE.; 2                               | do       | 15                    | 7.95         | 32.94                  |
|             |         |                   |           |          |                   |                                      |          | 25                    | 7.3          | 32.56                  |
|             |         |                   |           |          |                   |                                      |          | 35                    | 3.75         | 32.72                  |
|             |         |                   |           |          |                   |                                      |          | 50                    | 3.2          | 32.52                  |
|             |         |                   |           |          |                   |                                      |          | 0                     | 8.8          | 32.61                  |
| 341         | June 22 | 3.40-4.05 p. m.   | 45 12     | 51 41    | 31                | SE.; 1                               | do       | 15                    | 7.45         | 32.66                  |
|             |         |                   |           |          |                   |                                      |          | 25                    | 5.0          | 32.79                  |
|             |         |                   |           |          |                   |                                      |          | 45                    | 5.7          | 32.94                  |
|             |         |                   |           |          |                   |                                      |          | 60                    | 7.1          | 32.66                  |
|             |         |                   |           |          |                   |                                      |          | 0                     | 0.4          | 32.79                  |
| 342         | do      | 10.20-10.40 p. m. | 45 53     | 52 20    | 38                | SE.; 1                               | do       | 15                    | 4.9          | 32.81                  |
|             |         |                   |           |          |                   |                                      |          | 25                    | 5.3          | 32.83                  |
|             |         |                   |           |          |                   |                                      |          | 35                    | 3.15         | 32.92                  |
|             |         |                   |           |          |                   |                                      |          | 50                    | -1.3         | -----                  |
|             |         |                   |           |          |                   |                                      |          | 0                     | 6.8          | -----                  |
| 343         | June 23 | 10.05-10.55 a. m. | 46 22     | 52 48    | 99                | NNE.; 8                              | Overcast | 10                    | 6.0          | -----                  |
|             |         |                   |           |          |                   |                                      |          | 20                    | 4.7          | -----                  |
|             |         |                   |           |          |                   |                                      |          | 40                    | 7.1          | -----                  |
|             |         |                   |           |          |                   |                                      |          | 60                    | 5.8          | -----                  |
|             |         |                   |           |          |                   |                                      |          | 0                     | 4.6          | 33.04                  |
|             |         |                   |           |          |                   |                                      |          | 20                    | -1.4         | 33.19                  |
|             |         |                   |           |          |                   |                                      |          | 50                    | 4.65         | 32.97                  |
|             |         |                   |           |          |                   |                                      |          | 80                    | 1.7          | 33.24                  |
|             |         |                   |           |          |                   |                                      |          | 110                   | 4.9          | 33.22                  |
|             |         |                   |           |          |                   |                                      |          | 140                   | -0.5         | 33.24                  |
| 170         | -1.15   | 33.26             |           |          |                   |                                      |          |                       |              |                        |

Table of data concerning scientific stations occupied by the "Tampa" and "Modoc"—Continued.

| Station No. | Date.     | Time of day.      | Position. |          | Depth of water. | Wind direction and force (Beaufort). | Sky.            | Water, physical data. |              |                         |
|-------------|-----------|-------------------|-----------|----------|-----------------|--------------------------------------|-----------------|-----------------------|--------------|-------------------------|
|             |           |                   | Lat. N.   | Long. W. |                 |                                      |                 | Depth.                | Temperature. | Salinity (‰ by weight). |
| 344         | June 25   | 10.30-11.20 p. m. | 42 46     | 50 55    | Fathoms.<br>983 | WSW.; 2.                             | Partly cloudy.. | Meters.               | ° C.         |                         |
|             |           |                   |           |          |                 |                                      |                 | 0                     | 3.5          | -----                   |
|             |           |                   |           |          |                 |                                      |                 | 50                    | 2.35         | -----                   |
|             |           |                   |           |          |                 |                                      |                 | 125                   | 1.05         | -----                   |
|             |           |                   |           |          |                 |                                      |                 | 250                   | 0.8          | -----                   |
| 450         | 0.15      | -----             |           |          |                 |                                      |                 |                       |              |                         |
| 345         | June 27   | 12.10-1.10 a. m.  | 41 20     | 50 18    | 2,034           | WSW.; 2.                             | Foggy.....      | 0                     | 12.1         | 34.40                   |
|             |           |                   |           |          |                 |                                      |                 | 50                    | 7.2          | 35.32                   |
|             |           |                   |           |          |                 |                                      |                 | 125                   | 11.35        | 34.83                   |
|             |           |                   |           |          |                 |                                      |                 | 250                   | 8.5          | 34.38                   |
|             |           |                   |           |          |                 |                                      |                 | 450                   | 6.8          | 35.01                   |
| 346         | ...do.... | 5.05-6 a. m.      | 41 55     | 50 19    | 2,034           | W.; 1.....                           | ...do.....      | 750                   | 5.15         | 34.29                   |
|             |           |                   |           |          |                 |                                      |                 | 0                     | 5.5          | 33.17                   |
|             |           |                   |           |          |                 |                                      |                 | 50                    | 0.9          | 34.23                   |
|             |           |                   |           |          |                 |                                      |                 | 125                   | 1.9          | 34.67                   |
|             |           |                   |           |          |                 |                                      |                 | 250                   | 2.4          | 34.81                   |
| 347         | ...do.... | 10.30-11.40 a. m. | 42 15     | 50 15    | 1,557           | W.; 1.....                           | ...do.....      | 450                   | 4.0          | 34.92                   |
|             |           |                   |           |          |                 |                                      |                 | 750                   | 3.9          | 35.34                   |
|             |           |                   |           |          |                 |                                      |                 | 0                     | 9.1          | 33.24                   |
|             |           |                   |           |          |                 |                                      |                 | 50                    | 0.2          | 34.02                   |
|             |           |                   |           |          |                 |                                      |                 | 125                   | 1.45         | 34.65                   |
| 348         | ...do.... | 1.10-2.05 p. m.   | 42 30     | 50 15    | 1,246           | S.; 2.....                           | ...do.....      | 250                   | 2.65         | 34.92                   |
|             |           |                   |           |          |                 |                                      |                 | 450                   | 4.2          | 34.94                   |
|             |           |                   |           |          |                 |                                      |                 | 850                   | 3.65         | 33.58                   |
|             |           |                   |           |          |                 |                                      |                 | 0                     | 7.4          | 33.21                   |
|             |           |                   |           |          |                 |                                      |                 | 50                    | 1.5          | 32.95                   |
| 349         | ...do.... | 4-5.25 p. m.      | 42 44     | 50 06    | 983             | SW.; 2.....                          | ...do.....      | 250                   | 5.4          | 34.25                   |
|             |           |                   |           |          |                 |                                      |                 | 450                   | 2.55         | 35.05                   |
|             |           |                   |           |          |                 |                                      |                 | 750                   | 3.8          | 33.55                   |
|             |           |                   |           |          |                 |                                      |                 | 0                     | 8.2          | 33.33                   |
|             |           |                   |           |          |                 |                                      |                 | 50                    | -1.2         | 34.36                   |
| 350         | ...do.... | 8-8.25 p. m.      | 42 58     | 50 12    | 59              | SW.; 2.....                          | ...do.....      | 125                   | -1.25        | 33.71                   |
|             |           |                   |           |          |                 |                                      |                 | 250                   | 1.05         | 34.87                   |
|             |           |                   |           |          |                 |                                      |                 | 450                   | 2.6          | 34.90                   |
|             |           |                   |           |          |                 |                                      |                 | 750                   | 3.0          | 33.77                   |
|             |           |                   |           |          |                 |                                      |                 | 0                     | 6.6          | -----                   |
| 351         | Oct. 21   | 2.50-3.55 p. m.   | 43 11     | 53 50    | 2,140           | SW.; 3.....                          | Clear.....      | 25                    | 6.25         | -----                   |
|             |           |                   |           |          |                 |                                      |                 | 50                    | 0.9          | -----                   |
|             |           |                   |           |          |                 |                                      |                 | 75                    | -0.85        | -----                   |
|             |           |                   |           |          |                 |                                      |                 | 90                    | -1.3         | -----                   |
|             |           |                   |           |          |                 |                                      |                 | 0                     | 19.8         | 35.23                   |
| 352         | ...do.... | 7.15-7.45 p. m.   | 43 19     | 53 06    | 2,140           | SW.; 4.....                          | ...do.....      | 50                    | 18.4         | 35.44                   |
|             |           |                   |           |          |                 |                                      |                 | 125                   | 16.6         | 36.09                   |
|             |           |                   |           |          |                 |                                      |                 | 250                   | 15.85        | 35.53                   |
|             |           |                   |           |          |                 |                                      |                 | 450                   | 8.45         | 34.94                   |
|             |           |                   |           |          |                 |                                      |                 | 750                   | 4.75         | 34.87                   |
| 353         | Oct. 21   | 11.10-11.45 p. m. | 43 20     | 52 22    | 2,200           | SW.; 2...                            | Foggy.....      | 0                     | 14.2         | 33.21                   |
|             |           |                   |           |          |                 |                                      |                 | 50                    | 15.2         | 34.85                   |
|             |           |                   |           |          |                 |                                      |                 | 125                   | 10.2         | 34.99                   |
|             |           |                   |           |          |                 |                                      |                 | 250                   | 8.4          | 34.94                   |
|             |           |                   |           |          |                 |                                      |                 | 450                   | 5.7          | 34.85                   |
| 354         | Oct. 22   | 3.30-3.48 a. m.   | 43 35     | 51 50    | 150 m.          | W.; 2.....                           | ...do.....      | 750                   | 4.4          | 34.96                   |
|             |           |                   |           |          |                 |                                      |                 | 0                     | 8.3          | 32.72                   |
|             |           |                   |           |          |                 |                                      |                 | 30                    | 7.9          | 33.17                   |
|             |           |                   |           |          |                 |                                      |                 | 60                    | 2.7          | 33.51                   |
|             |           |                   |           |          |                 |                                      |                 | 100                   | -0.4         | 33.78                   |
| 355         | ...do.... | 7.15-7.33 a. m.   | 43 41     | 51 11    | 75              | Calm....                             | Clear-fog.....  | 140                   | +0.4         | 33.96                   |
|             |           |                   |           |          |                 |                                      |                 | 0                     | 13.6         | 32.57                   |
|             |           |                   |           |          |                 |                                      |                 | 15                    | .0           | 32.65                   |
|             |           |                   |           |          |                 |                                      |                 | 30                    | 10.05        | 32.94                   |
|             |           |                   |           |          |                 |                                      |                 | 45                    | 5.2          | 33.15                   |
| 356         | ...do.... | 10-10.23 a. m.    | 43 28     | 50 46    | 73 m.           | S.; 1.....                           | Foggy.....      | 65                    | 0.85         | 33.48                   |
|             |           |                   |           |          |                 |                                      |                 | 0                     | 12.8         | 32.74                   |
|             |           |                   |           |          |                 |                                      |                 | 15                    | 9.8          | 33.03                   |
|             |           |                   |           |          |                 |                                      |                 | 30                    | 6.3          | 33.26                   |
|             |           |                   |           |          |                 |                                      |                 | 50                    | 0.2          | 33.58                   |
| 70          | 0.1       | 33.60             |           |          |                 |                                      |                 |                       |              |                         |

Table of data concerning scientific stations occupied by the "Tampa" and "Modoc"—Continued.

| Sta. No. | Date.   | Time of day.     | Position. |          | Depth of water. | Wind direction and force (Beaufort). | Sky.          | Water, physical data.                        |                                                      |                                                             |
|----------|---------|------------------|-----------|----------|-----------------|--------------------------------------|---------------|----------------------------------------------|------------------------------------------------------|-------------------------------------------------------------|
|          |         |                  | Lat. N.   | Long. W. |                 |                                      |               | Depth.                                       | Temperature.                                         | Salinity (% by weight).                                     |
|          |         |                  | ° ' "     | ° ' "    | Fathoms.        |                                      |               | Meters.                                      | ° C.                                                 |                                                             |
| 357      | Oct. 22 | 1.05-1.24 p. m.  | 43 20     | 50 24    | 40              | S.; 1                                | Foggy         | 0<br>15<br>30<br>45<br>65                    | 12.9<br>11.0<br>6.35<br>0.7<br>0.65                  | 32.72<br>32.90<br>33.13<br>33.51<br>33.55                   |
| 358      | do      | 5.15-6.00 p. m.  | 42 54     | 50 22    | 122             | SW.; 4                               | do            | 0<br>40<br>80<br>120<br>160<br>200           | 7.4<br>1.85<br>-0.15<br>0.0<br>0.4<br>1.0            | 33.39<br>33.62<br>33.86<br>33.96<br>34.00<br>34.16          |
| 359      | do      | 8-9 p. m.        | 42 37     | 50 22    | 1,240           | S.; 4                                | do            | 0<br>50<br>125<br>250<br>450<br>750          | 7.4<br>11.85<br>3.35<br>3.8<br>3.55<br>3.35          | 33.28<br>33.75<br>33.26<br>34.78<br>34.87<br>34.88          |
| 360      | do      | 11.55-1.00 p. m. | 52 11     | 50 20    | 2,000           | SW.; 3                               | Overcast; fog | 0<br>50<br>125<br>250<br>550<br>750          | 14.1<br>10.85<br>-0.4<br>1.95<br>3.7<br>3.7          | 32.77<br>34.07<br>33.68<br>34.09<br>34.76<br>34.87          |
| 361      | Oct. 23 | 4.40-5.23 a. m.  | 41 42     | 50 18    | 2,200           | W.; 3-4                              | Overcast      | 0<br>50<br>125<br>250<br>450<br>750          | 21.9<br>20.55<br>15.5<br>11.35<br>7.3<br>3.98        | 35.77<br>35.62<br>35.93<br>35.37<br>34.96<br>34.85          |
| 362      | Oct. 23 | 9-10.20 a. m.    | 41 10     | 50 17    | 2,200           | W.; 4                                | Overcast      | 0<br>50<br>125<br>250<br>450<br>700<br>1,000 | 22.6<br>18.15<br>16.9<br>14.3<br>9.05<br>4.65<br>4.5 | 35.93<br>35.28<br>36.38<br>35.90<br>35.16<br>34.85<br>34.94 |
| 363      | Oct. 24 | 4.35-5.10 p. m.  | 43 53     | 47 10    | 2,000           | NNW.; 2                              | Clear         | 0<br>50<br>125<br>250<br>450<br>750          | 14.3<br>13.8<br>12.0<br>7.15<br>4.5<br>4.4           | 33.69<br>35.41<br>35.12<br>34.85<br>34.83<br>34.96          |
| 364      | do      | 9.07-9.35 p. m.  | 43 58     | 48 00    | 2,000           | NW.; 4                               | do            | 0<br>50<br>125<br>250<br>450<br>750          | 14.4<br>11.2<br>8.7<br>6.1<br>4.3<br>4.0             | 33.96<br>35.16<br>34.96<br>34.83<br>34.88<br>34.97          |
| 365      | do      | 11-11.35 p. m.   | 43 54     | 48 15    | 2,200           | NW                                   | do            | 0<br>50<br>125<br>250<br>450<br>750          | 15.1<br>8.55<br>2.8<br>4.55<br>4.3<br>3.8            | 33.95<br>33.96<br>34.31<br>34.78<br>34.96<br>34.97          |
| 366      | Oct. 25 | 12.55-1-25 a. m. | 43 55     | 48 30    | 2,200           | WNW.; 3-4                            | do            | 0<br>50<br>25<br>250<br>450<br>750           | 14.7<br>9.95<br>2.4<br>4.0<br>3.8<br>3.6             | 33.68<br>33.57<br>34.33<br>34.81<br>34.92<br>34.94          |
| 367      | do      | 7.17-7.30 a. m.  | 43 57     | 49 24    | 50              | WNW.; 3                              | Partly cloudy | 0<br>50<br>125<br>250<br>450<br>750          | 11.3<br>5.4<br>3.15<br>3.85<br>3.7<br>3.7            | 33.19<br>33.77<br>34.45<br>34.76<br>34.88<br>34.94          |
| 368      | do      | 5-5.30 a. m.     | 43 56     | 49 03    | 330             | Calm; 0                              | Overcast      | 0<br>100<br>200<br>300<br>400<br>800         | 8.4<br>-0.45<br>0.65<br>2.05<br>2.0<br>2.0           | 32.81<br>33.82<br>34.07<br>34.42<br>34.42<br>34.43          |



Table of data concerning scientific stations occupied by the "Tampa" and "Modoc"—Continued.

| Sta. tion No | Date.   | Time of day.      | Position. |          | Depth of water. | Wind direction and force (Beaufort). | Sky.             | Water, physical data |               |                        |
|--------------|---------|-------------------|-----------|----------|-----------------|--------------------------------------|------------------|----------------------|---------------|------------------------|
|              |         |                   | Lat. N.   | Long. W. |                 |                                      |                  | Depth.               | Temper-ature. | Salinity (‰ by weight) |
| 369          | Oct. 25 | 7.17-7.30 a. m.   | 43 57     | 49 24    | Fath-oms. 50 m. | WNW.; 2                              | Partly cloudy..  | Meters.              | ° C.          |                        |
|              |         |                   |           |          |                 |                                      |                  | 0                    | 8.9           | 32.86                  |
|              |         |                   |           |          |                 |                                      |                  | 15                   | 8.8           | 32.84                  |
|              |         |                   |           |          |                 |                                      |                  | 30                   | 5.0           | 33.19                  |
| 370          | do      | 10.17-10.55 a. m. | 43 37     | 49 03    | 500             | S; 2                                 | Overcast         | 45                   | 2.15          | 33.33                  |
|              |         |                   |           |          |                 |                                      |                  | 0                    | 8.8           | 33.13                  |
|              |         |                   |           |          |                 |                                      |                  | 50                   | 2.6           | 33.93                  |
|              |         |                   |           |          |                 |                                      |                  | 125                  | 2.2           | 34.43                  |
| 371          | do      | 2.30-3 p. m.      | 43 10     | 49 21    | 567             | S; 2                                 | Foggy            | 250                  | 2.65          | 34.52                  |
|              |         |                   |           |          |                 |                                      |                  | 450                  | 3.1           | 34.69                  |
|              |         |                   |           |          |                 |                                      |                  | 750                  | 3.55          | 34.85                  |
|              |         |                   |           |          |                 |                                      |                  | 0                    | 7.1           | 33.19                  |
| 372          | do      | 11.45-12.40 a. m. | 43 05     | 51 10    | 425             | SW.; 2                               | do               | 50                   | 5.6           | 33.42                  |
|              |         |                   |           |          |                 |                                      |                  | 125                  | 0.6           | 34.05                  |
|              |         |                   |           |          |                 |                                      |                  | 250                  | 1.6           | 34.29                  |
|              |         |                   |           |          |                 |                                      |                  | 450                  | 3.4           | 34.83                  |
| 373          | Oct. 26 | 2-2.30 a. m.      | 42 56     | 51 19    | 1,540           | W.; 2                                | do               | 750                  | 3.55          | 34.81                  |
|              |         |                   |           |          |                 |                                      |                  | 0                    | 7.7           | 33.33                  |
|              |         |                   |           |          |                 |                                      |                  | 50                   | 3.7           | 33.58                  |
|              |         |                   |           |          |                 |                                      |                  | 125                  | (1.0)         | 34.09                  |
| 374          | do      | 5.22-5.52 a. m.   | 42 39     | 51 42    | 1,350           | S.; 2                                | do               | 250                  | 2.05          | 34.34                  |
|              |         |                   |           |          |                 |                                      |                  | 450                  | 3.45          | 34.76                  |
|              |         |                   |           |          |                 |                                      |                  | 750                  | 3.55          | 34.83                  |
|              |         |                   |           |          |                 |                                      |                  | 0                    | 6.4           | 33.40                  |
| 375          | do      | 8.45-9.15 a. m.   | 42 20     | 52 05    | 1,828           | S; 2                                 | Foggy, clearing. | 50                   | 0.4           | 33.95                  |
|              |         |                   |           |          |                 |                                      |                  | 125                  | 2.8           | 34.74                  |
|              |         |                   |           |          |                 |                                      |                  | 250                  | 3.65          | 34.85                  |
|              |         |                   |           |          |                 |                                      |                  | 450                  | 3.8           | 34.87                  |
| 376          | do      | Noon              | 42 00     | 52 28    | 2,150           | SW.; 3                               | Overcast         | 750                  | 3.6           | 32.75                  |
|              |         |                   |           |          |                 |                                      |                  | 0                    | 13.1          | 32.75                  |
|              |         |                   |           |          |                 |                                      |                  | 50                   | 8.95          | 33.68                  |
|              |         |                   |           |          |                 |                                      |                  | 125                  | 3.2           | 34.07                  |
|              |         |                   |           |          |                 |                                      |                  | 250                  | 1.4           | 34.16                  |
|              |         |                   |           |          |                 |                                      |                  | 450                  | 3.6           | 34.72                  |
|              |         |                   |           |          |                 |                                      |                  | 750                  | 4.2           | 34.92                  |
|              |         |                   |           |          |                 |                                      |                  | 0                    | 18.0          | 34.92                  |
|              |         |                   |           |          |                 |                                      |                  | 50                   | 15.1          | 35.39                  |
|              |         |                   |           |          |                 |                                      |                  | 125                  | 11.75         | 35.37                  |
|              |         |                   |           |          |                 |                                      |                  | 250                  | 8.25          | 35.03                  |
|              |         |                   |           |          |                 |                                      |                  | 450                  | 5.65          | 34.99                  |
|              |         |                   |           |          |                 |                                      |                  | 750                  | 4.4           |                        |

Table of data concerning oceanographic stations occupied in the vicinity of the Grand Banks during the ice season, 1919.

[NOTE.—Upon examining the records of the international ice patrol it was discovered that the station data of the oceanographic work carried out during the 1919 ice patrol was not carried in the printed reports of that year (Treasury Bulletin No. 7). They are printed herewith, immediately after the station records for 1923. No attempt has been made to discuss the information which these 1919 data contain but it is believed important that the records be placed in print without further delay. At some future date it is hoped they will be examined and conclusions of practical value be obtained.]

1919.

[Fathom×1.83=meters.]

| Station No. | Date.   | Time of day. | Position. |          | Depth of water. | Wind direction and force (Beaufort). | Sky. | Water, physical data. |              |                         |
|-------------|---------|--------------|-----------|----------|-----------------|--------------------------------------|------|-----------------------|--------------|-------------------------|
|             |         |              | Lat. N.   | Long. W. |                 |                                      |      | Depth.                | Temperature. | Salinity (‰ by weight). |
| 1           | Mar. 28 | 8 p. m.      | 42 06     | 69 52    | Fathoms.<br>60  |                                      |      | Meters.               | ° C.         |                         |
|             |         |              |           |          |                 |                                      |      | 0                     | 4.5          | 32.43                   |
|             |         |              |           |          |                 |                                      |      | 27                    | 3.65         | 32.29                   |
|             |         |              |           |          |                 |                                      |      | 55                    | 2.9          | 32.48                   |
|             |         |              |           |          |                 |                                      |      | 77                    | 3.75         | 32.61                   |
| 2           | Mar. 29 | 2 a. m.      | 42 23     | 69 03    | 90              |                                      |      | 101                   | 3.7          | 32.66                   |
|             |         |              |           |          |                 |                                      |      | 0                     | 4.7          | 32.72                   |
|             |         |              |           |          |                 |                                      |      | 40                    | 3.9          | 32.68                   |
|             |         |              |           |          |                 |                                      |      | 80                    | 3.05         | 32.66                   |
|             |         |              |           |          |                 |                                      |      | 121                   | 4.45         | 32.77                   |
| 3           | do      | 1 p. m.      | 42 51     | 67 32    | 120             |                                      |      | 161                   | 5.25         | 33.46                   |
|             |         |              |           |          |                 |                                      |      | 0                     | 0            | 31.87                   |
|             |         |              |           |          |                 |                                      |      | 55                    | 3.7          | 32.68                   |
|             |         |              |           |          |                 |                                      |      | 110                   | 4.75         | 33.58                   |
|             |         |              |           |          |                 |                                      |      | 165                   | 4.75         | 33.84                   |
| 4           | Mar. 30 | 5 p. m.      | 44 24     | 63 21    | 35              |                                      |      | 216                   | 4.75         | 33.37                   |
|             |         |              |           |          |                 |                                      |      | 0                     | -0.2         | 31.13                   |
|             |         |              |           |          |                 |                                      |      | 15                    | -0.7         | 31.20                   |
|             |         |              |           |          |                 |                                      |      | 29                    | -0.65        | 31.24                   |
|             |         |              |           |          |                 |                                      |      | 44                    | -0.8         | 31.36                   |
| 5           | do      | 9 p. m.      | 44 10     | 62 40    | 80              |                                      |      | 59                    | -0.8         | 31.32                   |
|             |         |              |           |          |                 |                                      |      | 0                     | 1.8          | 31.96                   |
|             |         |              |           |          |                 |                                      |      | 37                    | 4.1          | 32.07                   |
|             |         |              |           |          |                 |                                      |      | 73                    | 1.5          | 33.30                   |
|             |         |              |           |          |                 |                                      |      | 110                   | 1.5          | 34.23                   |
| 6           | Mar. 31 | 3 a. m.      | 43 50     | 61 50    | 45              |                                      |      | 146                   | 5.6          | 33.84                   |
|             |         |              |           |          |                 |                                      |      | 0                     | 2.2          | 32.09                   |
|             |         |              |           |          |                 |                                      |      | 20                    | 1.9          | 32.10                   |
|             |         |              |           |          |                 |                                      |      | 40                    | 1.75         | 32.16                   |
|             |         |              |           |          |                 |                                      |      | 60                    | 1.75         | 33.21                   |
| 7           | do      | 12 p. m.     | 43 16     | 60 27    |                 |                                      |      | 80                    | 4.3          | 33.21                   |
|             |         |              |           |          |                 |                                      |      | 0                     | 0.0          | 32.83                   |
|             |         |              |           |          |                 |                                      |      | 46                    | 1.45         | 33.19                   |
|             |         |              |           |          |                 |                                      |      | 92                    | 4.1          | 33.71                   |
|             |         |              |           |          |                 |                                      |      | 137                   | 3.55         | 34.07                   |
| 8           | Apr. 1  | 7 a. m.      | 41 58     | 57 07    |                 |                                      |      | 183                   | 3.55         | 34.18                   |
|             |         |              |           |          |                 |                                      |      | 366                   | 4.15         | 34.69                   |
|             |         |              |           |          |                 |                                      |      | 0                     | 11.0         | 35.46                   |
|             |         |              |           |          |                 |                                      |      | 46                    | 11.5         | 35.45                   |
|             |         |              |           |          |                 |                                      |      | 92                    | 12.0         | 35.44                   |
| 9           | do      | 3 p. m.      | 42 42     | 56 10    |                 |                                      |      | 137                   | 12.0         | 35.44                   |
|             |         |              |           |          |                 |                                      |      | 183                   | 10.0         | 35.44                   |
|             |         |              |           |          |                 |                                      |      | 366                   | 10.2         | 35.44                   |
|             |         |              |           |          |                 |                                      |      | 550                   |              |                         |
|             |         |              |           |          |                 |                                      |      | 0                     | 1.1          | 33.03                   |
| 10          | Apr. 4  | 5 p. m.      | 46 30     | 53 03    | 40              |                                      |      | 46                    | 1.85         | 33.31                   |
|             |         |              |           |          |                 |                                      |      | 92                    | 0.8          | 33.75                   |
|             |         |              |           |          |                 |                                      |      | 137                   | 1.25         | 34.00                   |
|             |         |              |           |          |                 |                                      |      | 183                   | 1.9          | 34.20                   |
|             |         |              |           |          |                 |                                      |      | 366                   | 3.95         | 34.72                   |
| 11          | do      | 8 p. m.      | 46 15     | 52 42    | 70              |                                      |      | 550                   | 3.90         | 34.96                   |
|             |         |              |           |          |                 |                                      |      | 0                     | -1.0         | 32.06                   |
|             |         |              |           |          |                 |                                      |      | 18                    | -1.45        | 32.01                   |
|             |         |              |           |          |                 |                                      |      | 35                    | -1.35        | 32.30                   |
|             |         |              |           |          |                 |                                      |      | 53                    | -1.6         | 32.68                   |
| 12          | do      | 8 a. m.      | 45 40     | 51 56    | 45              |                                      |      | 0                     | -0.7         | 32.32                   |
|             |         |              |           |          |                 |                                      |      | 27                    | -1.1         | 32.66                   |
|             |         |              |           |          |                 |                                      |      | 55                    | -1.65        | 32.66                   |
|             |         |              |           |          |                 |                                      |      | 82                    | -1.5         | 32.95                   |
|             |         |              |           |          |                 |                                      |      | 110                   | -1.5         | 33.06                   |
|             |         |              |           |          |                 |                                      |      | 0                     | 2.3          | 32.86                   |
|             |         |              |           |          |                 |                                      |      | 18                    | 0.9          | 32.92                   |
|             |         |              |           |          |                 |                                      |      | 37                    | 0.55         | 32.95                   |
|             |         |              |           |          |                 |                                      |      | 55                    | -0.1         | 33.06                   |
|             |         |              |           |          |                 |                                      |      | 73                    | -0.25        | 33.04                   |

Table of data concerning oceanographic stations occupied in the vicinity of the Grand Banks during the ice season, 1919—Continued.

| Sta. No. | Date.   | Time of day. | Position. |          | Depth of water. | Wind direction and force (Beaufort). | Sky. | Water, physical data. |              |                         |
|----------|---------|--------------|-----------|----------|-----------------|--------------------------------------|------|-----------------------|--------------|-------------------------|
|          |         |              | Lat. N.   | Long. W. |                 |                                      |      | Depth.                | Temperature. | Salinity (‰ by weight). |
| 13       | Apr. 5  | 2 p. m.      | 44 54     | 51 20    | Fathoms.<br>38  |                                      |      | Meters.               | ° C.         |                         |
|          |         |              |           |          |                 |                                      |      | 0                     | 3.4          | 32.95                   |
|          |         |              |           |          |                 |                                      |      | 16                    | 1.3          | 32.90                   |
|          |         |              |           |          |                 |                                      |      | 33                    | 1.2          | 32.86                   |
|          |         |              |           |          |                 |                                      |      | 49                    | 0.95         | 32.86                   |
| 14       | do      | 12 a. m.     | 44 20     | 51 12    | 28              |                                      |      | 64                    | -0.05        | 33.03                   |
|          |         |              |           |          |                 |                                      |      | 0                     | 2.8          | 33.26                   |
|          |         |              |           |          |                 |                                      |      | 11                    | 1.5          | 33.30                   |
|          |         |              |           |          |                 |                                      |      | 22                    | 1.4          | 33.26                   |
|          |         |              |           |          |                 |                                      |      | 33                    | 1.35         | 33.26                   |
| 15       | Apr. 6  | 4 p. m.      | 44 05     | 49 22    | 25              |                                      |      | 44                    | 1.4          |                         |
|          |         |              |           |          |                 |                                      |      | 0                     | 0.5          | 33.17                   |
|          |         |              |           |          |                 |                                      |      | 11                    | 0.45         | 33.15                   |
|          |         |              |           |          |                 |                                      |      | 22                    | 0.2          | 33.15                   |
|          |         |              |           |          |                 |                                      |      | 33                    | 0.15         | 33.15                   |
| 16       | Apr. 8  | 10 p. m.     | 44 27     | 48 16    |                 |                                      |      | 44                    | 0.15         | 33.17                   |
|          |         |              |           |          |                 |                                      |      | 0                     | 3.8          | 33.93                   |
|          |         |              |           |          |                 |                                      |      | 46                    | 6.9          |                         |
|          |         |              |           |          |                 |                                      |      | 92                    | 6.85         | 34.51                   |
|          |         |              |           |          |                 |                                      |      | 137                   | -1.65        | 34.65                   |
| 17       | Apr. 11 | 11 a. m.     | 44 40     | 48 19    |                 |                                      |      | 183                   | 6.25         |                         |
|          |         |              |           |          |                 |                                      |      | 0                     | 1.8          | 33.21                   |
|          |         |              |           |          |                 |                                      |      | 46                    | 4.35         | 33.82                   |
|          |         |              |           |          |                 |                                      |      | 92                    | 3.2          | 34.18                   |
|          |         |              |           |          |                 |                                      |      | 137                   | 2.55         | 34.51                   |
| 18       | Apr. 14 | 3 p. m.      | 44 58     | 53 32    | 46              |                                      |      | 183                   | 3.8          | 34.74                   |
|          |         |              |           |          |                 |                                      |      | 306                   | 4.35         | 34.97                   |
|          |         |              |           |          |                 |                                      |      | 550                   | 4.15         | 34.99                   |
|          |         |              |           |          |                 |                                      |      | 0                     | 2.4          |                         |
|          |         |              |           |          |                 |                                      |      | 50                    | 1.9          | 32.79                   |
| 19       | Apr. 28 | 3 a. m.      | 42 06     | 69 52    | 60              |                                      |      | 40                    | 1.65         | 32.84                   |
|          |         |              |           |          |                 |                                      |      | 60                    | 0.9          | 32.92                   |
|          |         |              |           |          |                 |                                      |      | 80                    | -0.85        | 33.26                   |
|          |         |              |           |          |                 |                                      |      | 0                     | 4.7          | 31.29                   |
|          |         |              |           |          |                 |                                      |      | 27                    | 5.15         | 31.71                   |
| 20       | do      | 8 a. m.      | 42 23     | 69 03    | 85              |                                      |      | 64                    | 3.75         | 31.76                   |
|          |         |              |           |          |                 |                                      |      | 101                   | 3.75         | 32.09                   |
|          |         |              |           |          |                 |                                      |      | 0                     | 4.9          | 32.27                   |
|          |         |              |           |          |                 |                                      |      | 37                    | 4.85         | 32.18                   |
|          |         |              |           |          |                 |                                      |      | 73                    | 4.85         | 32.57                   |
| 21       | do      | 3 p. m.      | 42 51     | 67 32    | 125             |                                      |      | 110                   | 4.8          | 32.23                   |
|          |         |              |           |          |                 |                                      |      | 146                   | 4.35         | 32.41                   |
|          |         |              |           |          |                 |                                      |      | 0                     | 4.6          | 31.98                   |
|          |         |              |           |          |                 |                                      |      | 55                    | 3.65         | 32.38                   |
|          |         |              |           |          |                 |                                      |      | 110                   | 4.45         | 32.14                   |
| 22       | do      | 10 p. m.     | 43 17     | 66 20    | 38              |                                      |      | 165                   | 4.4          | 32.92                   |
|          |         |              |           |          |                 |                                      |      | 220                   |              |                         |
|          |         |              |           |          |                 |                                      |      | 0                     | 2.7          | 31.71                   |
|          |         |              |           |          |                 |                                      |      | 18                    | 2.9          | 31.71                   |
|          |         |              |           |          |                 |                                      |      | 37                    | 2.7          |                         |
| 23       | Apr. 29 | 3 p. m.      | 44 24     | 63 21    | 46              |                                      |      | 55                    | 2.75         | 31.71                   |
|          |         |              |           |          |                 |                                      |      | 0                     | 1.3          | 31.27                   |
|          |         |              |           |          |                 |                                      |      | 20                    | 1.45         | 31.09                   |
|          |         |              |           |          |                 |                                      |      | 40                    | 0.55         | 31.15                   |
|          |         |              |           |          |                 |                                      |      | 60                    | 0.55         |                         |
| 24       | do      | 7 p. m.      | 44 10     | 62 40    | 120             |                                      |      | 80                    | -0.05        | 31.12                   |
|          |         |              |           |          |                 |                                      |      | 0                     | 1.1          | 31.26                   |
|          |         |              |           |          |                 |                                      |      | 60                    | 1.8          | 31.92                   |
|          |         |              |           |          |                 |                                      |      | 121                   | 3.9          | 33.40                   |
|          |         |              |           |          |                 |                                      |      | 181                   | 6.2          | 34.23                   |
| 25       | Apr. 30 | 12 p. m.     | 43 50     | 61 50    | 58              |                                      |      | 0                     | 3.2          | 32.23                   |
|          |         |              |           |          |                 |                                      |      | 53                    | 3.35         | 32.25                   |
|          |         |              |           |          |                 |                                      |      | 70                    | 4.3          | 33.35                   |
|          |         |              |           |          |                 |                                      |      | 106                   | 4.9          | 33.48                   |
|          |         |              |           |          |                 |                                      |      | 0                     | 6.6          | 33.83                   |
| 26       | do      | 9 a. m.      | 43 16     | 60 27    | 100             |                                      |      | 40                    | 7.4          | 33.93                   |
|          |         |              |           |          |                 |                                      |      | 80                    | 6.5          | 34.02                   |
|          |         |              |           |          |                 |                                      |      | 121                   | 6.25         | 34.38                   |
|          |         |              |           |          |                 |                                      |      | 161                   | 6.2          | 34.31                   |
|          |         |              |           |          |                 |                                      |      | 0                     | 0.9          | 31.18                   |
| 27       | May 4   | 3 p. m.      | 47 00     | 52 45    | 75              |                                      |      | 44                    | -1.4         | 32.32                   |
|          |         |              |           |          |                 |                                      |      | 88                    | -1.7         | 32.97                   |
|          |         |              |           |          |                 |                                      |      | 132                   | -1.6         | 32.99                   |

Table of data concerning oceanographic stations occupied in the vicinity of the Grand Banks during the ice season, 1919—Continued.

| Station No. | Date.  | Time of day. | Position. |          | Depth of water. | Wind direction and force (Beaufort). | Sky. | Water, physical data. |              |                         |
|-------------|--------|--------------|-----------|----------|-----------------|--------------------------------------|------|-----------------------|--------------|-------------------------|
|             |        |              | Lat. N.   | Long. W. |                 |                                      |      | Depth.                | Temperature. | Salinity (‰ by weight). |
|             |        |              | ° ,       | ° ,      | Fathoms.        |                                      |      | Meters.               | ° C.         |                         |
| 28          | May 4  | 9 p. m.      | 47 00     | 51 43    | 52              |                                      |      | 0                     | 0.4          | 32.30                   |
|             |        |              |           |          |                 |                                      |      | 29                    | -0.1         | 32.61                   |
|             |        |              |           |          |                 |                                      |      | 59                    | -1.25        | 33.01                   |
|             |        |              |           |          |                 |                                      |      | 88                    | -0.5         | 33.17                   |
| 29          | May 5  | 4 a. m.      | 47 00     | 50 35    | 56              |                                      |      | 0                     | 0.9          | 32.83                   |
|             |        |              |           |          |                 |                                      |      | 24                    | 0.9          | 32.88                   |
|             |        |              |           |          |                 |                                      |      | 48                    | -0.45        | 33.04                   |
|             |        |              |           |          |                 |                                      |      | 71                    | 0.25         | 33.35                   |
|             |        |              |           |          |                 |                                      |      | 95                    | 0.6          | 33.26                   |
| 30          | do     | 7 p. m.      | 47 00     | 48 20    | 56              |                                      |      | 0                     | 1.7          | 32.95                   |
|             |        |              |           |          |                 |                                      |      | 34                    | 1.6          | 32.94                   |
|             |        |              |           |          |                 |                                      |      | 48                    | 0.8          | 32.94                   |
|             |        |              |           |          |                 |                                      |      | 71                    | -0.65        | 33.04                   |
|             |        |              |           |          |                 |                                      |      | 95                    | -1.05        | 33.31                   |
| 31          | May 6  | 8 p. m.      | 47 00     | 47 14    |                 |                                      |      | 0                     | 0.0          | 32.66                   |
|             |        |              |           |          |                 |                                      |      | 55                    | -0.4         | 33.13                   |
|             |        |              |           |          |                 |                                      |      | 119                   | -0.25        | 33.71                   |
|             |        |              |           |          |                 |                                      |      | 165                   | 0.4          | 33.08                   |
|             |        |              |           |          |                 |                                      |      | 366                   | 2.55         | 33.51                   |
|             |        |              |           |          |                 |                                      |      | 550                   | 3.6          | 34.85                   |
| 32          | May 8  | 8 a. m.      | 45 29     | 43 34    |                 |                                      |      | 0                     | 9.9          | 34.56                   |
|             |        |              |           |          |                 |                                      |      | 46                    | 11.5         | 34.96                   |
|             |        |              |           |          |                 |                                      |      | 92                    | 12.0         | 35.05                   |
|             |        |              |           |          |                 |                                      |      | 137                   | 12.0         | 35.55                   |
|             |        |              |           |          |                 |                                      |      | 183                   | 12.0         | 35.57                   |
|             |        |              |           |          |                 |                                      |      | 366                   | 9.0          | 35.46                   |
|             |        |              |           |          |                 |                                      |      | 550                   | 6.9          | 34.72                   |
| 33          | do     | 1 p. m.      | 43 53     | 45 35    |                 |                                      |      | 0                     | 8.9          | 34.27                   |
|             |        |              |           |          |                 |                                      |      | 46                    | 9.1          | 34.31                   |
|             |        |              |           |          |                 |                                      |      | 92                    | 9.0          | 34.96                   |
|             |        |              |           |          |                 |                                      |      | 137                   | 8.35         | 34.72                   |
|             |        |              |           |          |                 |                                      |      | 183                   | 9.65         | 34.80                   |
|             |        |              |           |          |                 |                                      |      | 366                   | 5.75         | 34.60                   |
|             |        |              |           |          |                 |                                      |      | 550                   | 4.95         | 34.72                   |
| 34          | May 12 | 4 p. m.      | 44 03     | 49 18    | 22              |                                      |      | 0                     | 0.3          | 32.95                   |
|             |        |              |           |          |                 |                                      |      | 9                     | 0.45         | 32.97                   |
|             |        |              |           |          |                 |                                      |      | 18                    | 0.5          | 32.94                   |
|             |        |              |           |          |                 |                                      |      | 27                    | 0.55         | 32.94                   |
|             |        |              |           |          |                 |                                      |      | 37                    | 0.4          | 32.95                   |
| 35          | May 29 | 5 a. m.      | 42 06     | 69 52    | 80              |                                      |      | 0                     | 9.3          | 31.53                   |
|             |        |              |           |          |                 |                                      |      | 35                    | 6.05         | 31.80                   |
|             |        |              |           |          |                 |                                      |      | 70                    | 4.3          | 32.02                   |
|             |        |              |           |          |                 |                                      |      | 104                   | 4.0          | 32.48                   |
|             |        |              |           |          |                 |                                      |      | 139                   | 4.05         | 32.68                   |
| 36          | do     | 11 a. m.     | 42 23     | 69 03    | 130             |                                      |      | 0                     | 9.0          | 31.80                   |
|             |        |              |           |          |                 |                                      |      | 55                    | 4.6          | 33.16                   |
|             |        |              |           |          |                 |                                      |      | 110                   | 4.75         | 33.16                   |
|             |        |              |           |          |                 |                                      |      | 165                   | 5.4          | 33.48                   |
|             |        |              |           |          |                 |                                      |      | 220                   | 5.6          | 33.91                   |
| 37          | do     | 7 p. m.      | 42 51     | 67 32    | 136             |                                      |      | 0                     | 7.8          | 31.96                   |
|             |        |              |           |          |                 |                                      |      | 60                    | 4.3          | 32.49                   |
|             |        |              |           |          |                 |                                      |      | 121                   | 4.95         | 33.50                   |
|             |        |              |           |          |                 |                                      |      | 181                   | 6.05         | 34.29                   |
|             |        |              |           |          |                 |                                      |      | 242                   | 6.15         |                         |
| 38          | May 30 | 3 a. m.      | 43 17     | 66 20    | 48              |                                      |      | 0                     | 4.2          | 31.67                   |
|             |        |              |           |          |                 |                                      |      | 27                    | 4.2          | 31.71                   |
|             |        |              |           |          |                 |                                      |      | 55                    | 4.2          | 31.76                   |
|             |        |              |           |          |                 |                                      |      | 82                    |              | 31.80                   |
| 39          | do     | 11 p. m.     | 44 24     | 63 21    | 45              |                                      |      | 0                     | 5.2          | 30.51                   |
|             |        |              |           |          |                 |                                      |      | 26                    | 4.95         | 30.83                   |
|             |        |              |           |          |                 |                                      |      | 51                    | 1.85         | 31.60                   |
|             |        |              |           |          |                 |                                      |      | 77                    | 0.6          | 32.25                   |
| 40          | May 31 | 3 a. m.      | 44 10     | 62 40    | 108             |                                      |      | 0                     | 5.5          | 32.07                   |
|             |        |              |           |          |                 |                                      |      | 48                    | 4.6          | 32.88                   |
|             |        |              |           |          |                 |                                      |      | 95                    | 2.3          | 32.77                   |
|             |        |              |           |          |                 |                                      |      | 143                   | 4.85         | 33.83                   |
|             |        |              |           |          |                 |                                      |      | 190                   | 6.1          | 34.21                   |
| 41          | do     | 8 a. m.      | 43 50     | 61 50    | 85              |                                      |      | 0                     | 5.4          | 32.42                   |
|             |        |              |           |          |                 |                                      |      | 37                    | 5.1          | 32.45                   |
|             |        |              |           |          |                 |                                      |      | 73                    | 2.75         | 33.09                   |
|             |        |              |           |          |                 |                                      |      | 110                   | 3.15         | 33.37                   |
|             |        |              |           |          |                 |                                      |      | 146                   | 4.1          | 33.68                   |

Table of data concerning oceanographic stations occupied in the vicinity of the Grand Banks during the ice season, 1919—Continued.

| Sta-<br>tion<br>No. | Date.  | Time of day | Position.  |             | Depth<br>of<br>water. | Wind<br>direction<br>and force<br>(Beaufort). | Sky. | Water, physical data. |                        |                               |
|---------------------|--------|-------------|------------|-------------|-----------------------|-----------------------------------------------|------|-----------------------|------------------------|-------------------------------|
|                     |        |             | Lat.<br>N. | Long.<br>W. |                       |                                               |      | Depth.                | Tem-<br>pera-<br>ture. | Salinity<br>(‰ by<br>weight). |
| 42                  | June 2 | 4 p. m.     | 44.30      | 57.19       | Fath-<br>oms.<br>42   |                                               |      | Meters.               | ° C.                   |                               |
|                     |        |             |            |             |                       |                                               |      | 0                     | 7.7                    | 33.67                         |
|                     |        |             |            |             |                       |                                               |      | 24                    | 7.45                   | 33.62                         |
|                     |        |             |            |             |                       |                                               |      | 48                    | 5.9                    | 33.51                         |
| 43                  | do     | 9 p. m.     | 44.30      | 56.30       |                       |                                               |      | 71                    | 2.15                   | 33.80                         |
|                     |        |             |            |             |                       |                                               |      | 0                     | 6.0                    | 33.42                         |
|                     |        |             |            |             |                       |                                               |      | 60                    | 7.2                    | 34.30                         |
|                     |        |             |            |             |                       |                                               |      | 121                   | 6.85                   | 34.65                         |
|                     |        |             |            |             |                       |                                               |      | 181                   | 7.7                    | 34.87                         |
|                     |        |             |            |             |                       |                                               |      | 366                   | 4.15                   | 34.71                         |
| 44                  | June 3 | 3 a. m.     | 44.32      | 55.33       | 99                    |                                               |      | 550                   | 4.0                    |                               |
|                     |        |             |            |             |                       |                                               |      | 0                     | 6.4                    | 33.37                         |
|                     |        |             |            |             |                       |                                               |      | 60                    | 2.85                   | 33.70                         |
|                     |        |             |            |             |                       |                                               |      | 121                   | 4.05                   | 34.27                         |
|                     |        |             |            |             |                       |                                               |      | 181                   | 4.85                   | 34.52                         |
| 45                  | do     | 9 a. m.     | 44.37      | 55.07       |                       |                                               |      | 366                   | 3.7                    | 34.69                         |
|                     |        |             |            |             |                       |                                               |      | 0                     | 7.3                    | 33.71                         |
|                     |        |             |            |             |                       |                                               |      | 60                    | 6.25                   | 34.17                         |
|                     |        |             |            |             |                       |                                               |      | 121                   | 6.95                   | 35.05                         |
| 46                  | do     | 1 p. m.     | 44.39      | 54.48       |                       |                                               |      |                       | or                     | 34.60                         |
|                     |        |             |            |             |                       |                                               |      | 181                   | 6.85                   | 34.71                         |
|                     |        |             |            |             |                       |                                               |      | 366                   | 5.1                    |                               |
|                     |        |             |            |             |                       |                                               |      | 0                     | 7.3                    | 33.15                         |
|                     |        |             |            |             |                       |                                               |      | 46                    | 4.25                   | 33.55                         |
|                     |        |             |            |             |                       |                                               |      | 92                    | 6.6                    | 34.56                         |
|                     |        |             |            |             |                       |                                               |      | 137                   | 6.1                    | 34.58                         |
| 183                 | 4.85   | 34.52       |            |             |                       |                                               |      |                       |                        |                               |
| 47                  | June 3 | 5 p. m.     | 44.52      | 53.52       | 48                    |                                               |      | 0                     | 3.8                    | 34.73                         |
|                     |        |             |            |             |                       |                                               |      | 29                    | 5.1                    | 33.01                         |
|                     |        |             |            |             |                       |                                               |      | 59                    | 1.2                    | 33.21                         |
|                     |        |             |            |             |                       |                                               |      | 88                    | -0.95                  | 33.41                         |
| 48                  | June 4 | 3 a. m.     | 46 07      | 53 00       | 48                    |                                               |      | 0                     | 2.9                    | 32.61                         |
|                     |        |             |            |             |                       |                                               |      | 27                    | 3.25                   | 32.61                         |
|                     |        |             |            |             |                       |                                               |      | 55                    | -0.5                   | 32.79                         |
| 49                  | do     | 6 a. m.     | 46 22      | 53 10       | 78                    |                                               |      | 82                    | -1.25                  | 33.25                         |
|                     |        |             |            |             |                       |                                               |      | 0                     | 1.5                    | 32.55                         |
|                     |        |             |            |             |                       |                                               |      | 35                    | 1.8                    | 32.55                         |
|                     |        |             |            |             |                       |                                               |      | 70                    | 0.95                   | 32.60                         |
|                     |        |             |            |             |                       |                                               |      | 104                   | 1.15                   | 32.60                         |
|                     |        |             |            |             |                       |                                               |      | 139                   | -1.4                   | 32.99                         |
| 50                  | June 5 | 7 p. m.     | 46 23      | 52 51       | 88                    |                                               |      | 0                     | 3.2                    | 32.47                         |
|                     |        |             |            |             |                       |                                               |      | 38                    | 1.9                    | 33.08                         |
|                     |        |             |            |             |                       |                                               |      | 77                    | -1.35                  | 33.40                         |
|                     |        |             |            |             |                       |                                               |      | 115                   | -1.6                   | 33.60                         |
|                     |        |             |            |             |                       |                                               |      | 154                   | -1.45                  | 33.68                         |
| 51                  | do     | 9 p. m.     | 46 09      | 52 28       | 48                    |                                               |      | 0                     | 3.7                    | 33.36                         |
|                     |        |             |            |             |                       |                                               |      | 27                    | 3.05                   | 33.37                         |
|                     |        |             |            |             |                       |                                               |      | 55                    | 1.25                   | 33.48                         |
|                     |        |             |            |             |                       |                                               |      | 82                    | -0.55                  | 33.70                         |
| 52                  | June 6 | 4 a. m.     | 45 49      | 51 57       | 46                    |                                               |      | 0                     | 4.2                    | 33.05                         |
|                     |        |             |            |             |                       |                                               |      | 27                    | 3.65                   | 33.07                         |
|                     |        |             |            |             |                       |                                               |      | 55                    | 2.1                    | 33.13                         |
|                     |        |             |            |             |                       |                                               |      | 82                    | 0.4                    | 33.13                         |
|                     |        |             |            |             |                       |                                               |      | 0                     | 4.4                    | 33.13                         |
| 53                  | do     | 11 a. m.    | 45 42      | 51 29       | 42                    |                                               |      | 24                    | 4.2                    | 33.13                         |
|                     |        |             |            |             |                       |                                               |      | 48                    | 2.05                   | 33.13                         |
|                     |        |             |            |             |                       |                                               |      | 71                    | 1.05                   | 33.21                         |
|                     |        |             |            |             |                       |                                               |      | 0                     | 3.8                    | 33.01                         |
|                     |        |             |            |             |                       |                                               |      | 24                    | 3.95                   | 33.03                         |
| 54                  | do     | 7 p. m.     | 45 47      | 51 43       | 40                    |                                               |      | 48                    | 1.4                    | 33.09                         |
|                     |        |             |            |             |                       |                                               |      | 71                    | 1.2                    | 33.07                         |
|                     |        |             |            |             |                       |                                               |      | 0                     | 3.7                    | 33.01                         |
|                     |        |             |            |             |                       |                                               |      | 22                    | 4.0                    | 33.03                         |
|                     |        |             |            |             |                       |                                               |      | 44                    | 1.75                   |                               |
| 55                  | June 7 | 4 a. m.     | 46 05      | 49 51       | 38                    |                                               |      | 66                    | 1.65                   | 33.05                         |
|                     |        |             |            |             |                       |                                               |      | 0                     | 2.1                    | 33.28                         |
|                     |        |             |            |             |                       |                                               |      | 26                    | 2.3                    | 33.28                         |
|                     |        |             |            |             |                       |                                               |      | 51                    | -0.7                   | 33.15                         |
|                     |        |             |            |             |                       |                                               |      | 77                    | -1.4                   | 33.64                         |
| 56                  | June 8 | 4 a. m.     | 45 20      | 48 56       | 44                    |                                               |      | 0                     | 2.1                    | 33.28                         |
|                     |        |             |            |             |                       |                                               |      | 26                    | 2.3                    | 33.28                         |
|                     |        |             |            |             |                       |                                               |      | 51                    | -0.7                   | 33.15                         |
|                     |        |             |            |             |                       |                                               |      | 77                    | -1.4                   | 33.64                         |

Table of data concerning oceanographic stations occupied in the vicinity of the Grand Banks during the ice season, 1919—Continued.

| Station No. | Date.   | Time of day. | Position. |          | Depth of water. | Wind direction and force (Beaufort). | Sky. | Water, physical data. |              |                         |
|-------------|---------|--------------|-----------|----------|-----------------|--------------------------------------|------|-----------------------|--------------|-------------------------|
|             |         |              | Lat. N.   | Long. W. |                 |                                      |      | Depth.                | Temperature. | Salinity (‰ by weight). |
| 57          | June 8  | 9 a. m.      | 45 27     | 48 39    | Fathoms.        |                                      |      | Meters.               | ° C.         |                         |
|             |         |              |           |          |                 |                                      |      | 0                     | 1.6          | 32.89                   |
|             |         |              |           |          |                 |                                      |      | 46                    | -0.7         | 33.09                   |
|             |         |              |           |          |                 |                                      |      | 92                    | -1.45        | 33.33                   |
|             |         |              |           |          |                 |                                      |      | 137                   | -1.3         | 33.41                   |
|             |         |              |           |          |                 |                                      |      | 183                   | -0.65        | 33.61                   |
|             |         |              |           |          |                 |                                      |      | 366                   | 1.3          | 33.84                   |
|             |         |              |           |          |                 |                                      |      | 550                   | 2.95         | 34.65                   |
| 58          | do      | 1 p. m.      | 45 42     | 48 02    |                 |                                      |      | 0                     | 2.1          |                         |
|             |         |              |           |          |                 |                                      |      | 46                    | 0.9          | 33.07                   |
|             |         |              |           |          |                 |                                      |      | 92                    | -0.95        | 33.59                   |
|             |         |              |           |          |                 |                                      |      | 137                   | -0.75        | 33.62                   |
|             |         |              |           |          |                 |                                      |      | 183                   | 0.85         | 34.00                   |
|             |         |              |           |          |                 |                                      |      | 366                   | 3.4          | 34.71                   |
|             |         |              |           |          |                 |                                      |      | 550                   | 3.65         | 34.82                   |
| 59          | do      | 5 p. m.      | 45 59     | 47 19    |                 |                                      |      | 0                     | 2.6          | 33.35                   |
|             |         |              |           |          |                 |                                      |      | 46                    | 4.15         | 34.17                   |
|             |         |              |           |          |                 |                                      |      | 92                    | 3.05         | 34.30                   |
|             |         |              |           |          |                 |                                      |      | 137                   | 3.75         | 34.51                   |
|             |         |              |           |          |                 |                                      |      | 183                   | 3.3          | 34.73                   |
|             |         |              |           |          |                 |                                      |      | 366                   | 3.7          | 34.87                   |
|             |         |              |           |          |                 |                                      |      | 550                   | 3.7          | 34.87                   |
| 60          | June 9  | 11 a. m.     | 44 13     | 48 22    |                 |                                      |      | 0                     | 8.6          | 33.33                   |
|             |         |              |           |          |                 |                                      |      | 60                    | 3.6          | 33.77                   |
|             |         |              |           |          |                 |                                      |      | 121                   | 2.95         |                         |
|             |         |              |           |          |                 |                                      |      | 191                   | 3.0          | 34.55                   |
|             |         |              |           |          |                 |                                      |      | 366                   | 4.3          | 34.87                   |
|             |         |              |           |          |                 |                                      |      | 550                   | 3.9          | 34.91                   |
| 61          | do      | 2 p. m.      | 44 11     | 49 03    | 62              |                                      |      | 0                     | 1.6          | 35.89                   |
|             |         |              |           |          |                 |                                      |      | 27                    | 0.6          | 32.99                   |
|             |         |              |           |          |                 |                                      |      | 55                    | -0.85        | 33.11                   |
|             |         |              |           |          |                 |                                      |      | 82                    | -0.7         | 33.11                   |
|             |         |              |           |          |                 |                                      |      | 110                   | -1.2         | 33.27                   |
| 62          | June 10 | 4 a. m.      | 43 52     | 49 28    | 25              |                                      |      | 0                     | 2.7          | 32.87                   |
|             |         |              |           |          |                 |                                      |      | 15                    | 3.25         | 32.87                   |
|             |         |              |           |          |                 |                                      |      | 29                    | 0.6          | 32.99                   |
|             |         |              |           |          |                 |                                      |      | 44                    | 0.45         | 32.99                   |
| 63          | do      | 6 a. m.      | 43 52     | 49 13    | 120             |                                      |      | 0                     | 2.2          | 32.90                   |
|             |         |              |           |          |                 |                                      |      | 53                    | 0.7          | 33.16                   |
|             |         |              |           |          |                 |                                      |      | 106                   | 1.15         | 33.34                   |
|             |         |              |           |          |                 |                                      |      | 159                   | 0.95         | 33.42                   |
|             |         |              |           |          |                 |                                      |      | 212                   | 0.8          | 33.54                   |
| 64          | do      | 8 a. m.      | 43 52     | 48 59    |                 |                                      |      | 0                     | 2.6          | 32.90                   |
|             |         |              |           |          |                 |                                      |      | 46                    | 1.4          | 32.99                   |
|             |         |              |           |          |                 |                                      |      | 96                    | 4.2          | 33.78                   |
|             |         |              |           |          |                 |                                      |      | 137                   | 2.15         | 34.16                   |
|             |         |              |           |          |                 |                                      |      | 183                   | 1.1          | 34.46                   |
|             |         |              |           |          |                 |                                      |      | 366                   | 3.45         | 34.72                   |
|             |         |              |           |          |                 |                                      |      | 550                   | 3.75         | 34.82                   |
| 65          | do      | 10 a. m.     | 43 54     | 48 44    |                 |                                      |      | 0                     | 9.0          | 33.31                   |
|             |         |              |           |          |                 |                                      |      | 46                    | 4.85         | 34.10                   |
|             |         |              |           |          |                 |                                      |      | 92                    | 2.65         | 34.23                   |
|             |         |              |           |          |                 |                                      |      | 137                   | 3.0          | 34.47                   |
|             |         |              |           |          |                 |                                      |      | 183                   | 3.0          | 34.53                   |
|             |         |              |           |          |                 |                                      |      | 366                   | 3.85         | 34.85                   |
|             |         |              |           |          |                 |                                      |      | 550                   | 3.9          | 34.88                   |
| 66          | do      | 2 p. m.      | 43 56     | 48 15    |                 |                                      |      | 0                     | 11.9         | 34.20                   |
|             |         |              |           |          |                 |                                      |      | 46                    | 13.2         | 35.78                   |
|             |         |              |           |          |                 |                                      |      | 92                    | 12.7         | 35.68                   |
|             |         |              |           |          |                 |                                      |      | 137                   | 12.2         | 35.58                   |
|             |         |              |           |          |                 |                                      |      | 183                   | 9.25         | 35.05                   |
|             |         |              |           |          |                 |                                      |      | 366                   | 6.05         | 34.88                   |
|             |         |              |           |          |                 |                                      |      | 550                   | 4.7          | 35.00                   |
| 67          | June 12 | 9 a. m.      | 4 13      | 49 42    | 36              |                                      |      | 0                     | 3.3          | 32.81                   |
|             |         |              |           |          |                 |                                      |      | 22                    | 1.8          | 32.99                   |
|             |         |              |           |          |                 |                                      |      | 44                    | 0.35         | 33.01                   |
|             |         |              |           |          |                 |                                      |      | 66                    | -0.7         | 33.15                   |
| 68          | do      | 11 a. m.     | 43 07     | 49 50    | 45              |                                      |      | 0                     | 2.7          | 32.85                   |
|             |         |              |           |          |                 |                                      |      | 27                    | 0.75         | 32.99                   |
|             |         |              |           |          |                 |                                      |      | 55                    | -0.85        | 33.17                   |
|             |         |              |           |          |                 |                                      |      | 82                    | -1.0         | 33.23                   |

Table of data concerning oceanographic stations occupied in the vicinity of the Grand Banks during the ice season, 1919—Continued.

| Sta-<br>tion<br>No. | Date.    | Time of day  | Position.  |             | Depth<br>of<br>water. | Wind<br>direction<br>and force<br>(Beaufort). | Sky. | Water, physical data. |                        |                              |
|---------------------|----------|--------------|------------|-------------|-----------------------|-----------------------------------------------|------|-----------------------|------------------------|------------------------------|
|                     |          |              | Lat.<br>N. | Long.<br>W. |                       |                                               |      | Depth.                | Tem-<br>pera-<br>ture. | Salinity<br>(‰ by<br>weight) |
| 69                  | June 12  | 2 p. m. .... | 42 58      | 49 53       | Fath-<br>oms.<br>116  |                                               |      | Meters.               | ° C.                   |                              |
|                     |          |              |            |             |                       |                                               |      | 0                     | 3.7                    | 32.93                        |
|                     |          |              |            |             |                       |                                               |      | 53                    | -1.0                   | 33.37                        |
|                     |          |              |            |             |                       |                                               |      | 106                   | -1.05                  | 33.41                        |
|                     |          |              |            |             |                       |                                               |      | 159                   | -1.0                   | 33.43                        |
| 70                  | do. .... | 4 p. m. .... | 42 48      | 49 59       |                       |                                               |      | 212                   | -0.6                   | 33.55                        |
|                     |          |              |            |             |                       |                                               |      | 0                     | 8.4                    | 33.27                        |
|                     |          |              |            |             |                       |                                               |      | 46                    | 1.75                   | 33.29                        |
|                     |          |              |            |             |                       |                                               |      | 92                    | 2.35                   | 34.02                        |
|                     |          |              |            |             |                       |                                               |      | 137                   | 1.8                    | 34.25                        |
| 71                  | do. .... | 7 p. m. .... | 42 42      | 50 02       |                       |                                               |      | 183                   | 2.0                    | 34.02                        |
|                     |          |              |            |             |                       |                                               |      | 366                   | 2.55                   | 34.49                        |
|                     |          |              |            |             |                       |                                               |      | 550                   | 3.1                    | 34.69                        |
|                     |          |              |            |             |                       |                                               |      | 0                     | 9.5                    | 33.15                        |
|                     |          |              |            |             |                       |                                               |      | 60                    | 1.8                    | 33.50                        |
| 72                  | June 13  | 4 a. m. .... | 42 03      | 50 21       |                       |                                               |      | 121                   | 5.0                    | 34.40                        |
|                     |          |              |            |             |                       |                                               |      | 181                   | 3.55                   | 34.23                        |
|                     |          |              |            |             |                       |                                               |      | 366                   | 4.25                   | 34.95                        |
|                     |          |              |            |             |                       |                                               |      | 550                   | 4.35                   | 34.95                        |
|                     |          |              |            |             |                       |                                               |      | 0                     | 17.7                   | 35.80                        |
|                     |          |              |            |             |                       |                                               |      | 60                    | 17.55                  | 36.06                        |
|                     |          |              |            |             |                       |                                               |      | 121                   | 16.15                  | 36.03                        |
|                     |          |              |            |             |                       |                                               |      | 181                   | 15.0                   | 35.79                        |
|                     |          |              |            |             |                       |                                               |      | 366                   | 12.4                   | 35.45                        |
|                     |          |              |            |             |                       |                                               |      | 550                   | 8.3                    | 35.08                        |

## DISCUSSION OF PROFILES 1-15.

Lieut. EDWARD H. SMITH, U. S. Coast Guard.

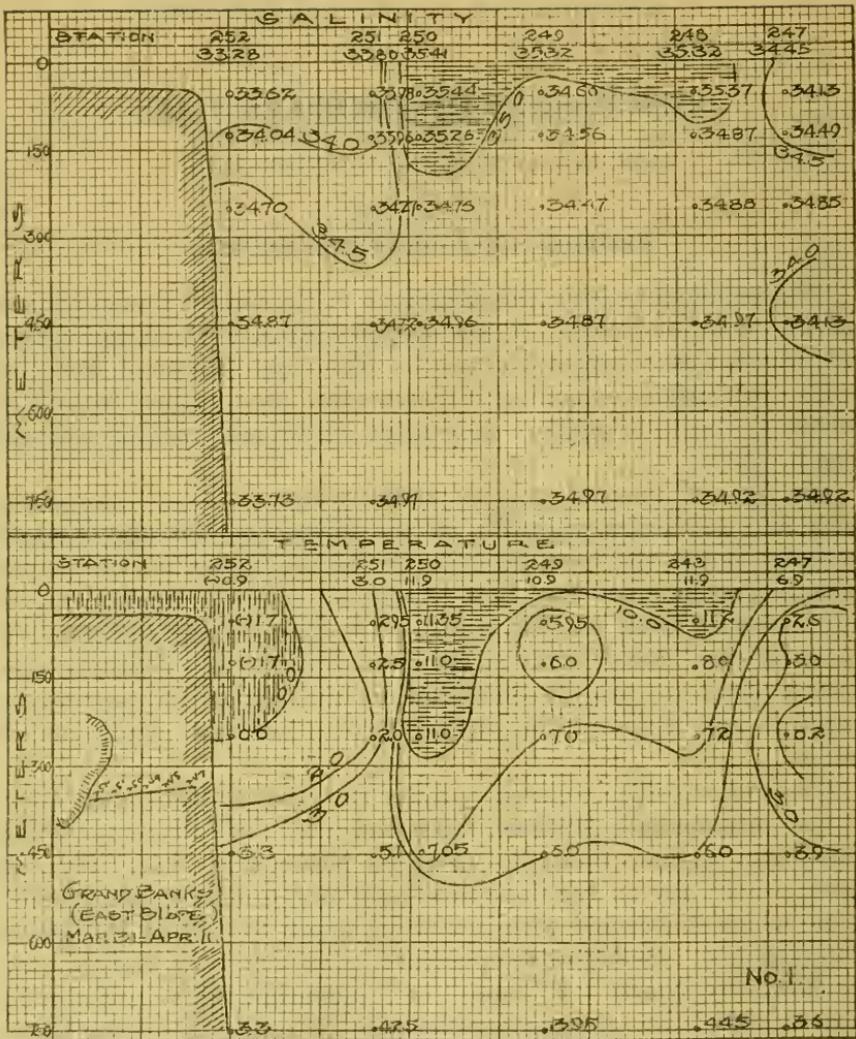
---

### PROFILE NO. 1—STATIONS 247-252.

This section runs from the east slope of the Grand Banks offshore into the Atlantic Basin. It was occupied April 9-11, except station 247, which was occupied March 31. The chief interest in this particular subsurface examination centers on the possible factors involved in the wide offshore movement of the early season icebergs. (See p. 70.)

*Salinity.*—A floating pool of saline water  $>35\text{‰}$ , 100 meters thick and 110 miles wide, lay on the surface at the mid stations, 250-248, and is the most noteworthy feature shown on the profile. Such a phenomenon has been observed in this locality before. (See Treasury Bull. No. 10, p. 88.) On approaching the slope the water became fresher, while at the outer station, 247, salinities lower than  $34.5\text{‰}$  are also to be noted in the upper 150 meters (82 fathoms) and again at the 450-meter (246 fathoms) depth on the profile.

*Temperature.*—The isolated body of salty water mentioned above at the intermediate stations, registered over  $10^{\circ}$  in temperature, which was warmer than the water on either side of it. Icy cold water,  $-1.7^{\circ}$ , lay on the slope to a depth of 150 meters (82 fathoms), below which it warmed with increasing depth to  $3.8^{\circ}$  at 450 meters (246 fathoms). Such low temperature,  $-1.7^{\circ}$ , and the drift of bergs as shown by charts "F" and "G," identifies this as Labrador Current, which was flowing parallel with the east side of the Grand Bank at this time. At the outer station, 247, we found water not so cold as that on the slope, but colder than that directly inshore of it. Although the temperature and salinity were higher than water unmodifiedly polar, yet the latter easily could have become warmed and salted, and thus disguised, through admixture with offshore Atlantic water, and this is probably what happened. Another noteworthy feature is the sudden transition which occurred 65 miles seaward of the slope, where saline water above  $35\text{‰}$  and warmer than  $10^{\circ}$  abutted water fresher than  $33\text{‰}$  and colder than  $3^{\circ}$ , a range of  $2\text{‰}$  in salinity and  $7^{\circ}$  in temperature. This is graphically illustrated on profile No. 1, in the compactness and verticality of the isohalines and isotherms between stations 259 and 251.

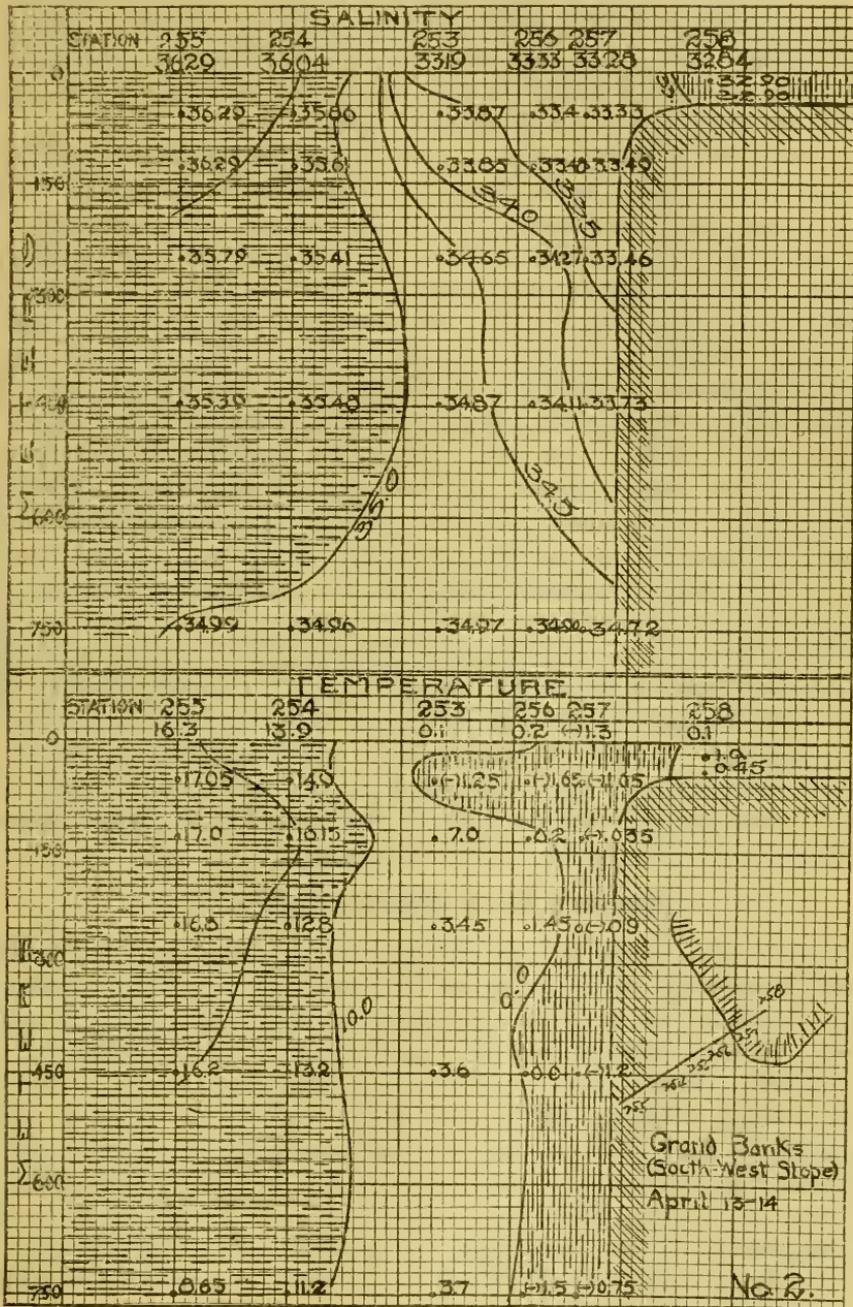


PROFILE NO. 2—STATIONS 253-258.

This section starts in on the southwest slope of the Bank and runs southwesterly, offshore, into the Gulf Stream. It was occupied April 13-14, immediately after the completion of the eastern investigation shown in profile No. 1, and it inaugurates the beginning of the subsurface examinations in the mixing zone around the Tail of the Bank for 1923. From this time on, at frequent intervals, until the termination of the ice season, in July, continual watch was maintained on oceanographical developments in this region.

*Salinity.*—In this section we found the water freshest on the Bank, suggestive of coastal character, with a salinity  $< 33^{\circ}_{00}$ . For

a distance of 55 miles offshore from the slope, and to a depth of 175 meters (96 fathoms), we encountered a water mass of unusually



uniform salinity, the precise figure, 33.15‰–33.45‰, being that characteristic of the most southerly extension of the Labrador Cur-

rent. Sixty miles from the continental edge we suddenly entered much more saline water  $>35\text{‰}$ , the northern outline of this body of water, as shown in profile, being a vertical face extending downward to a depth of 750 meters (410 fathoms). At the outer station, 255, water  $>36\text{‰}$  was encountered in the upper 150 meters (82 fathoms), a salinity which, in this region, unmistakably marks the water in question as Gulf Stream in origin.

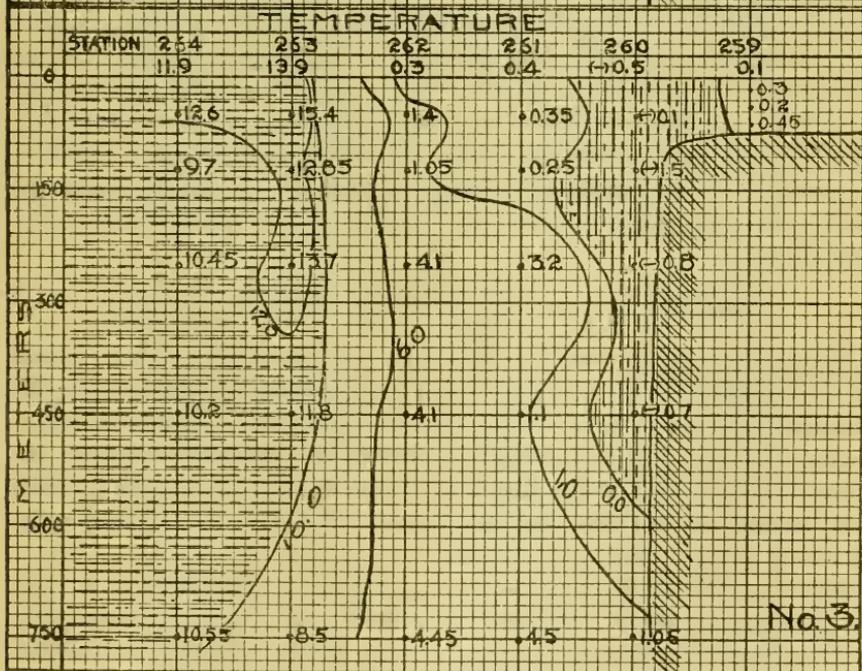
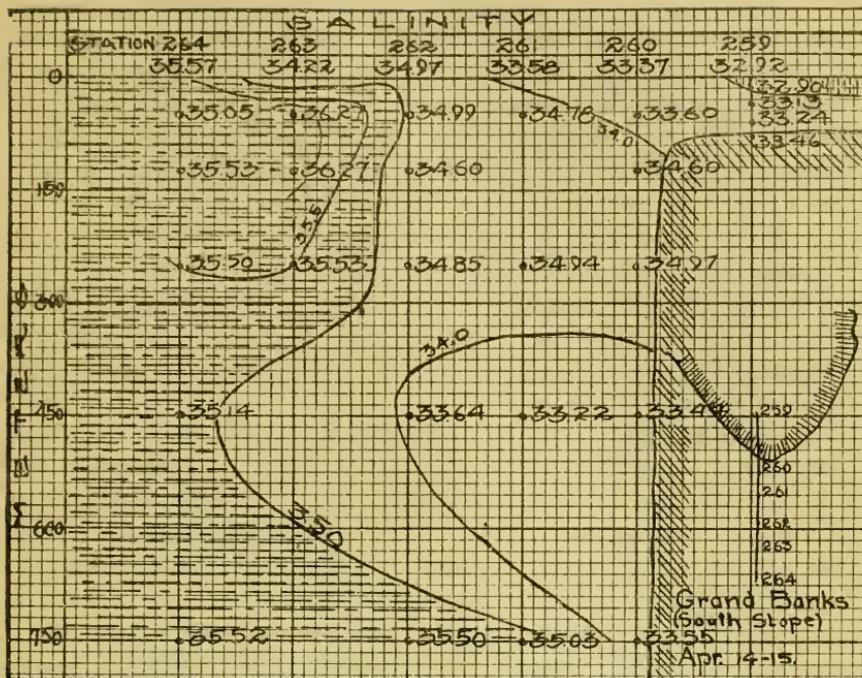
*Temperature.*—Warm water  $>10^\circ$ , corresponding in its general bounds to the most saline water mentioned above, extended from the surface downward to a depth of 700 meters (383 fathoms), at the outer end of the section, 80 miles seaward from the slope. Water colder than  $0^\circ$  bathed the slope, while in over the Bank the temperature was slightly higher. The temperatures found on the slope,  $-1.2^\circ$  to  $-0.35^\circ$ , could not have been attained locally, as the average minimum winter temperature of the water on the Grand Bank is about  $0^\circ$ , and by April this temperature has already begun to rise. Subsurface minimum temperatures at the 50-meter (27 fathoms) depth at the slope stations, together with the salinities of  $33\text{‰}$  to  $34\text{‰}$ , all support the conclusion that this water must have a northern origin. Bergs drifting southward in this region (see iceberg chart "B") are additional proof that the Labrador Current was present on the east slope of the Grand Bank and offshore to a distance of 68 miles on the surface. The lower salinity and higher temperature of the inshore station precludes the possibility of Labrador Current in any quantity having been projected in on the Bank. The profile also indicates, through its wide range of salinity and temperature, a more active state of circulation than at the same time of year for 1922, with greater volumes both of Arctic and Gulf Stream water west and southwest of the Tail at this period.

#### PROFILE NO. 3—STATIONS 259-264.

This section, starting in on the Tail of the Bank, runs southerly with its offshore end crosscutting the Gulf Stream. The stations were occupied April 14-15, contemporary with the southwest and west sections. (See profiles No. 2 and No. 3a.)

*Salinity.*—Water salter than  $35\text{‰}$  lay offshore at stations 263 and 264. Water between  $33.5\text{‰}$  and  $34.5\text{‰}$  bathed the slope at the midstations and crept inshore on the bottom of the Bank. The freshest water found lay on the surface in over the Bank. The bottom cover of  $33.24\text{‰}$ - $33.46\text{‰}$  is salter than had been found on the Bank to the westward a few days earlier (see profile No. 2) and is salter than is usually the case over the Banks in this region, plainly indicating that a flooding from offshore had occurred.

*Temperature.*—A column of warm water  $>10^\circ$ , which occupied the outer stations, 263 and 264, is so warm and saline that it must be



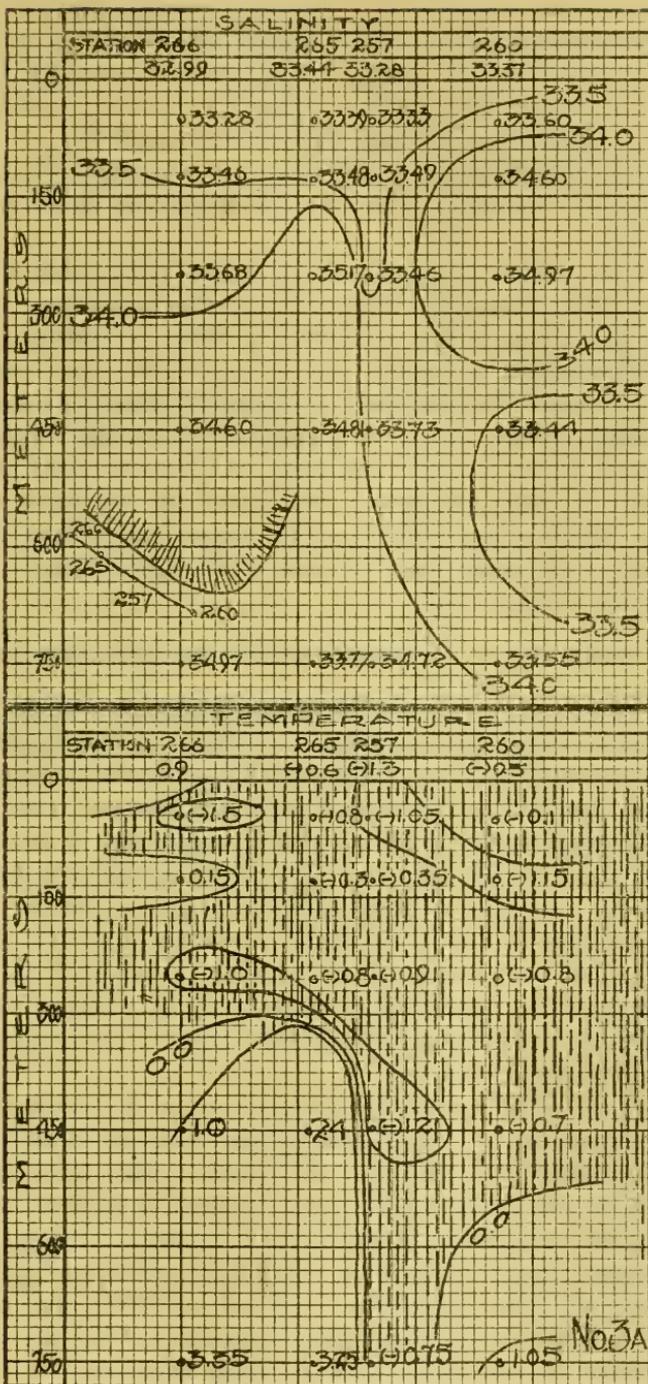
classified as belonging to the Gulf Stream. Its northern face presented a nearly vertical temperature boundary, a phenomenon which is characteristic of late winter and early spring when convectional circulation has attained its maximum influence, and a state which is strikingly illustrated by vertical profile No. 3. At the time this section was made, the "cold wall" was approximately 90 miles south of the Grand Bank, which is 10 miles farther from the slope than west of the Tail. (See profile No. 2.) Water colder than  $0^{\circ}$  lay on the slope and downwards to a depth of 650 meters (350 fathoms). Its low temperature of  $-1.5^{\circ}$  and its high salinity of  $34^{\circ}/_{00}$ , further substantiated by a minimum temperature below the surface followed by a successive rise, identifies this water as Labrador Current which was washing the Tail of the Bank at this time both down the slope and in over the bottom.

A comparison with profile No. 2, taken normal to the continental edge two days earlier and at a point 30 miles to the westward of the Tail, portrays a greater range and degree of contrast of isohalines and isotherms than that noted in profile No. 3. Such a condition signifies intense activity of the water masses and permits us to state that at this time there was much more circulatory activity on the southwest slope of the Bank than at the Tail. Further comparison discloses a greater volume of Arctic water to the westward than at the Tail and, since it is well established that the direction of flow is from the Tail to the westward (see Treasury Bull. No. 10), we are justified in concluding that a maximum flow of Arctic water occurred at a date prior to April 14-15, and when this investigation was made there had been a slackening in the current from the north around the Tail. This is an example of the irregular variations manifested by the southern extensions of the Labrador Current in the vicinity of the Tail of the Grand Bank.

**PROFILE NO. 3a.—STATIONS 257, 260, 265, AND 266.**

This section runs parallel to the southwest slope of the Grand Bank and at a distance of 10 miles out from the continental edge, where the maximum volume of polar water is usually situated. The section was occupied April 14-16 and gives a picture of the extreme extension, in longitudinal section, of the Labrador Current, in this direction, after it has curled around the Tail and flowed to the northwest along the southwest slope of the Grand Bank.

*Salinity.*—Water  $33.28^{\circ}/_{00}$  to  $33.5^{\circ}/_{00}$  lay on the surface as a mere surface film, 20 meters (11 fathoms) thick at the Tail, but increasing to 135 meters (74 fathoms) at the station farthest to the northwest, 266. All depths below the 300 meter (164 fathoms) plane are flooded by  $34^{\circ}/_{00}$  water, except around the Tail, where the  $34^{\circ}/_{00}$  water has overridden the fresher  $33.5^{\circ}/_{00}$  water, which is to be seen at all depths



below the 450 meter (246 fathoms), at station 260. This suggests an intrusion in the intermediate levels, just south of the Tail of the Bank, by a body of saltier water whose source necessarily is the south. (See discussion of profile No. 3.) The area to the northwest and below the 300 meter (164 fathoms) plane was flooded by water saltier than  $34\text{‰}$ , which from its high salinity identifies this as Atlantic water, on top of which the Arctic water has spread in a gradually thinning surface stream northwestward along the slope and away from the Tail.

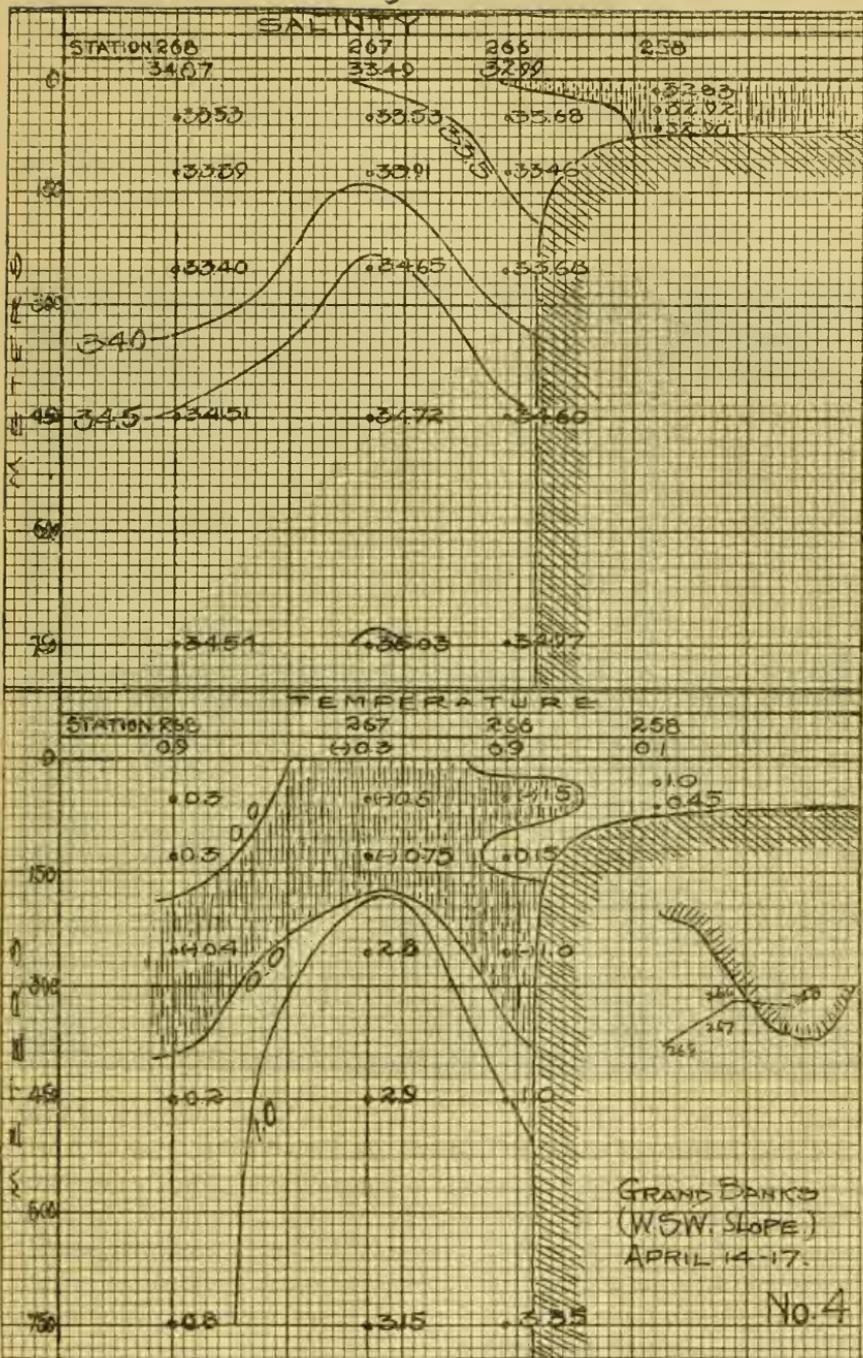
*Temperature.*—The predominance of water colder than  $0^{\circ}$  is the most noteworthy feature of this profile. The salinity of less than  $34\text{‰}$  and the temperature below  $0^{\circ}$  incloses a section of water in the profile which is chiefly Arctic in origin. (See page 112.) The correspondence between these two bounds attracts attention and, like the salinity profile, it shows a gradually thinning volume of icy water from the Tail to the northwest. At several levels at station 266, farthest to the northwest, was found the warmest water of the section, which suggests that had the investigation been extended a little farther we would have run out of all Arctic water in a gradually thinning surface pool.

#### PROFILE NO. 4—STATIONS 258, 266, 257, AND 268.

The section runs from station 258, located in on the southwest slope of the Bank, westerly into deep water. It was occupied April 14–17, one of the objects being the location of the northwestern extension of polar water, provided it had flowed to such a distance from the Tail.

*Salinity.*—Fresh water  $<33\text{‰}$  salinity was found in on the Bank from the surface to the bottom. The isohalines in the deep water off the Bank assumed a more horizontal position than they do farther southward around the Tail, where normally the lines are more vertical. The fact that there is no  $34\text{‰}$  water above the 250-meter (137 fathoms) plane, even at the offshore station, 268, would lend support to the belief that the Gulf Stream lay a considerable distance to the southward.

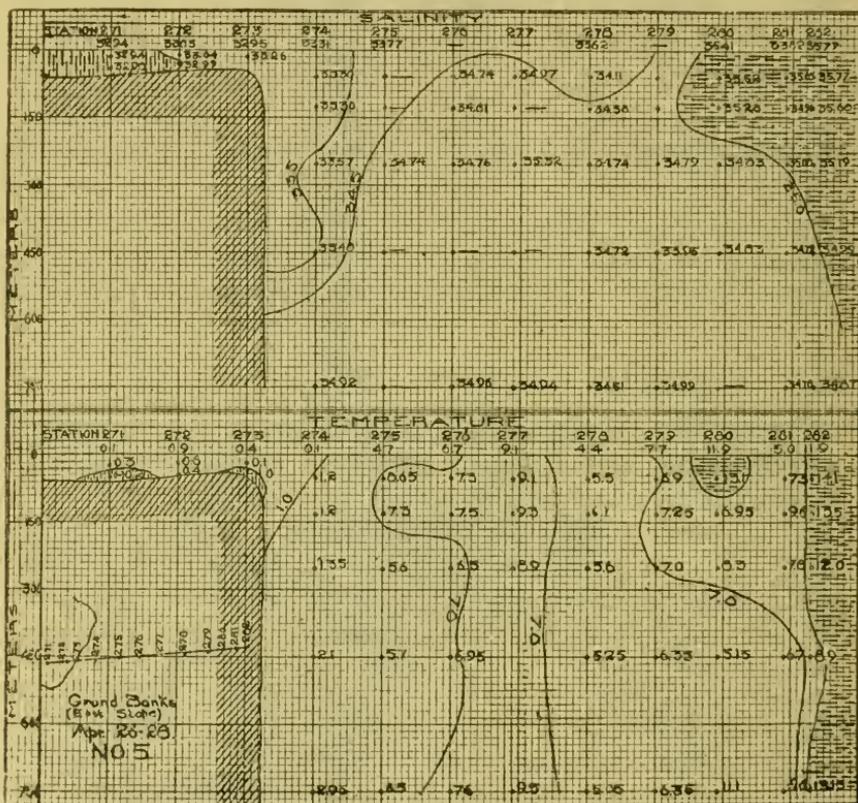
*Temperature.*—Inshore on the Bank we found no water as cold as  $0^{\circ}$ , hence consideration of both salinity and temperatures forbid the presence of Arctic water in over the Bank at this time and place. (See p. 146.) The water colder than  $0^{\circ}$ , shown shaded in the profile, clearly reveals the presence and defines the bounds of a large quantity of polar water, for water to be so cold and so salt,  $33.5\text{‰}$  to  $34\text{‰}$ , must have come from the Arctic. It was mostly restricted to the upper 250 meters (137 fathoms), but it spread out for the unusually great distance of 120 miles seaward from the edge of the Bank. Since no polar water was found in on the Bank, it must have been transported to this locality, 120 miles west-northwest of the Tail,



in the form of an extension of the Labrador Current, and this is the farthest to the west and northwest of the Tail of the Grand Bank that the ice patrol has ever found it in subsurface examination in such large volume.

PROFILE NO. 5—STATIONS 271-282.

The section runs from station "C" (see chart "A") eastward out over the slope, across the zone of mixed water, and into the Gulf Stream, extending farther into the Atlantic than any previously



taken by the patrol. The easterly drift of the bergs which had been the striking feature of the early season, slackened by the 1st of April, and by the time this particular section was made no bergs were being carried offshore into the northeasterly moving waters of the Gulf Stream. Such a change in the courses of the bergs must necessarily be foreshadowed by a change in oceanographical conditions, which in turn are bound to show in vertical cross section. The above stations were occupied April 26-28.

*Salinity.*—Atlantic water  $>35\text{‰}$  extended inshore of station 279, about 215 miles seaward of the slope. It had a thickness of nearly

211 meters (110 fathoms) at station 280 and increased to a depth of 450 meters (246 fathoms) at the outer station, 282. The mid stations were flooded by water between 34.5 ‰–35 ‰, except on the surface, where 33.5 ‰–34.5 ‰ water spread 180 miles out from the slope. On the Bank, 30 miles inshore from the continental edge, water fresher than 33 ‰ was found from surface to bottom. The slope stations were flooded by a body of water 33.5 ‰, which extended down to the 450-meter (246 fathom) level.

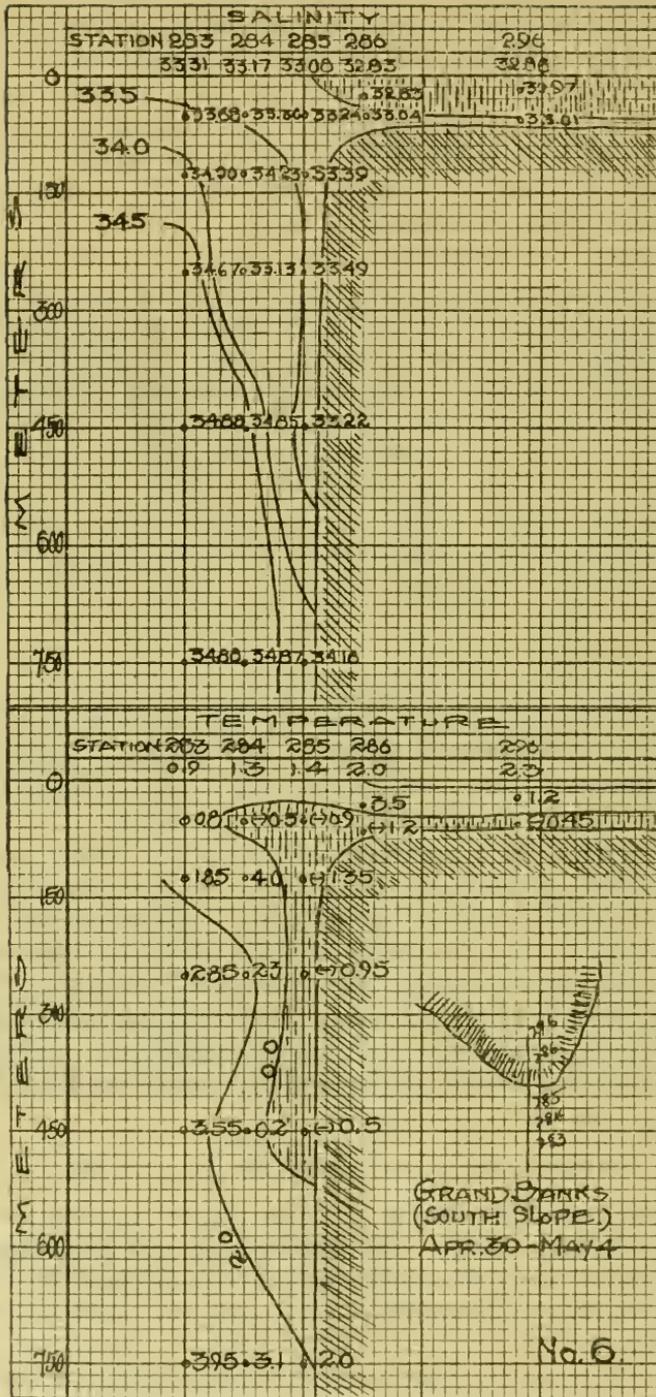
*Temperature.*—We found the outer station to be in warm water  $>10^{\circ}$ , the inshore boundary of this body being located between stations 281 and 282 in the form of a precipitous wall, which extended vertically downward to our maximum depth, 750 meters. A small surface pool of warm water was found at station 280, it having become disconnected from the main offshore body. Proceeding in toward the Bank a strip of cool water was encountered 40 miles in width and extending vertically downward for 750 meters (410 fathoms), and inshore of this lay a belt warmer than  $7^{\circ}$  and of about equal width. Inshore of this latter, in turn, the temperature fell rapidly as we entered the cold water lying next to the slope. The only subzero water was a small patch lying on the slope at the 75 meter (41 fathom) depth.

Summing up: Warm salt water (Gulf Stream) lay 180 to 200 miles off the east continental edge of the Grand Bank, which is farther offshore than it was found earlier in the season or during 1922. In mid section we failed to find the shoulder of the Gulf Stream which was charted there a month earlier. (See profile No. 1.) The warm streak which was found separating cooler water on either side of it, must by virtue of its high temperature and salinity, have been related to the Gulf Stream at some time, which is sufficient for the profile to illustrate the interlacing activity which has been observed so often on the east side of the Grand Banks at this place. The fact that we did not find such extremely contrasted water masses adjacent to each other as observed earlier in the month (see profile No. 1) would indicate that the circulation was less active April 26–28 than April 11 (see discussion of profile No. 3).

#### PROFILE NO. 6—STATIONS 283–286 AND 296.

The section runs from station "C" (see chart "A") south out over the slope into deep water. The offshore end was not carried into the Gulf Stream since the object sought was to chart the size and position of the Labrador Current only. The stations were occupied April 30–May 4.

*Salinity.*—In over the Bank was found water fresher than 33 ‰ except on the bottom, where it was 33.01 ‰. Off the slope, and as far seaward as the outer station, 283, the water was 33.08 ‰—



33.31 ‰, 500 meters (273 fathoms) thick on the slope but flattening out into a surface film only 30 meters (16 fathoms) thick offshore, where water salter than 34.5‰ occupied the depths.

*Temperature.*—Co-limital with the water of 33‰, the temperature was colder than 0°, except on the surface where it had been warmed by the sun. The depth of penetration of the sun's heat is shown by the 2° isotherm, which lies only 10 meters (5 fathoms) below the surface. The freshness of this water eliminates any possibility of its having been heated through admixture with warm saline Atlantic water. Both salinity and temperature, viz, 33.2‰ to 34‰ and -0.5° to -1.3° (see p. 146), warrant the conclusion that the water on the slope and, to a lesser degree, in over the bottom of the Bank, is Labrador Current. But the latter was not so strong here at the Tail on April 30–May 4, or in such large volume, as it had been two weeks earlier, as shown by profile No. 3, though the Arctic water had crept in on the bottom during that interval.

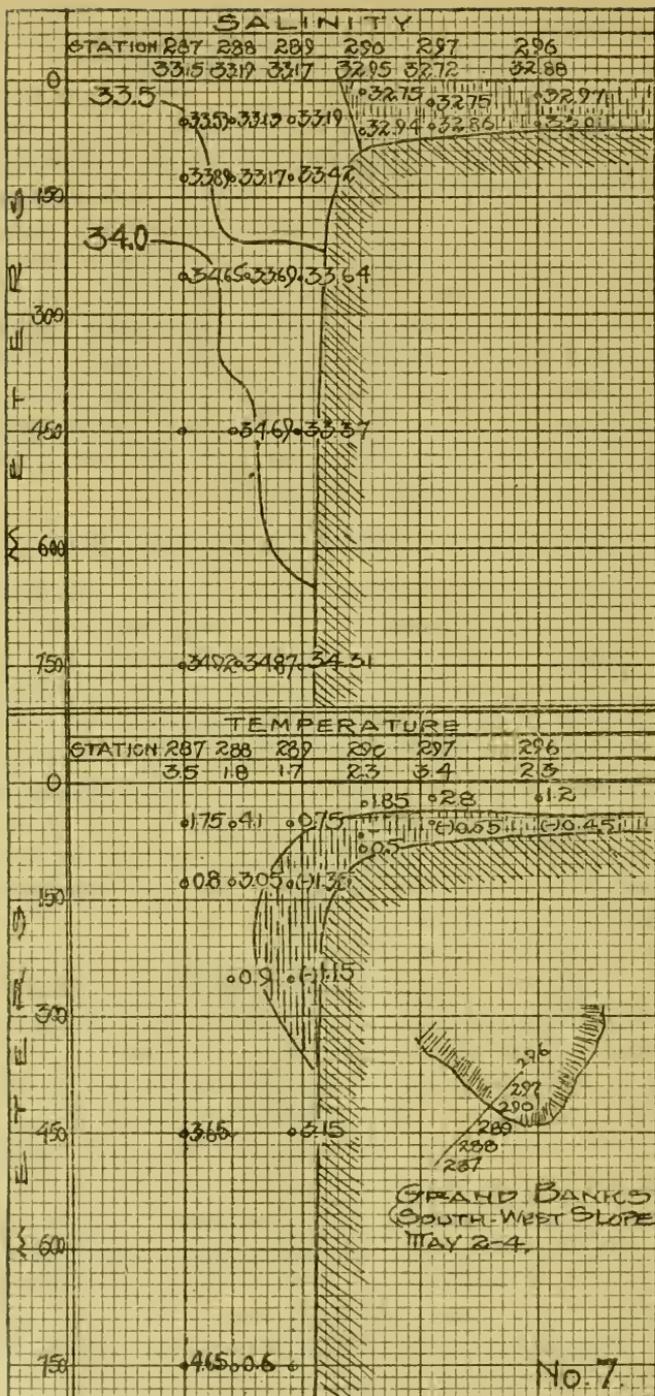
#### PROFILE NO. 7—STATIONS 287-289 AND 296-297.

The section runs southwest from station "C" (see chart "A") across the slope into deep water. No attempt was made to extend the oceanographic investigation south to the Gulf Stream, as time was limited and data were desired immediately regarding the Labrador Current in order to predict the probable movement of certain bergs which were floating around the Tail at the time. The stations were taken May 2-4. It may be added that finding subsurface conditions unchanged from those prevailing during April, it was predicted that the bergs would continue to drift as they had been doing, viz, around the Tail and on to the southwest slope. The prediction was verified by the drifts of bergs as shown on chart "B."

*Salinity.*—The Bank was flooded by a column of water fresher than 33‰. Offshore conditions were closely in agreement with those at the Tail at this time. (See salinity profile No. 6.)

*Temperature.*—Cold water below 0°, in rounded form, lay on the slope and in over the Bank as an icy bottom cover. Since this water of 33.20‰ and -1.35° exactly corresponds in salinity and temperature to the Arctic water found 35 miles southeastward around the Tail at this time, it indicates a connection which is traced in the form of an extension of the Labrador Current, which had flowed around the Tail and westward along the southwest slope.

A comparison of profiles Nos. 2 and 7 shows that there was less Arctic water on the southwest slope early in May than during the middle of April, which points to a slackening in the flow of the current from the north around the Tail and along the southwest slope during the interval.

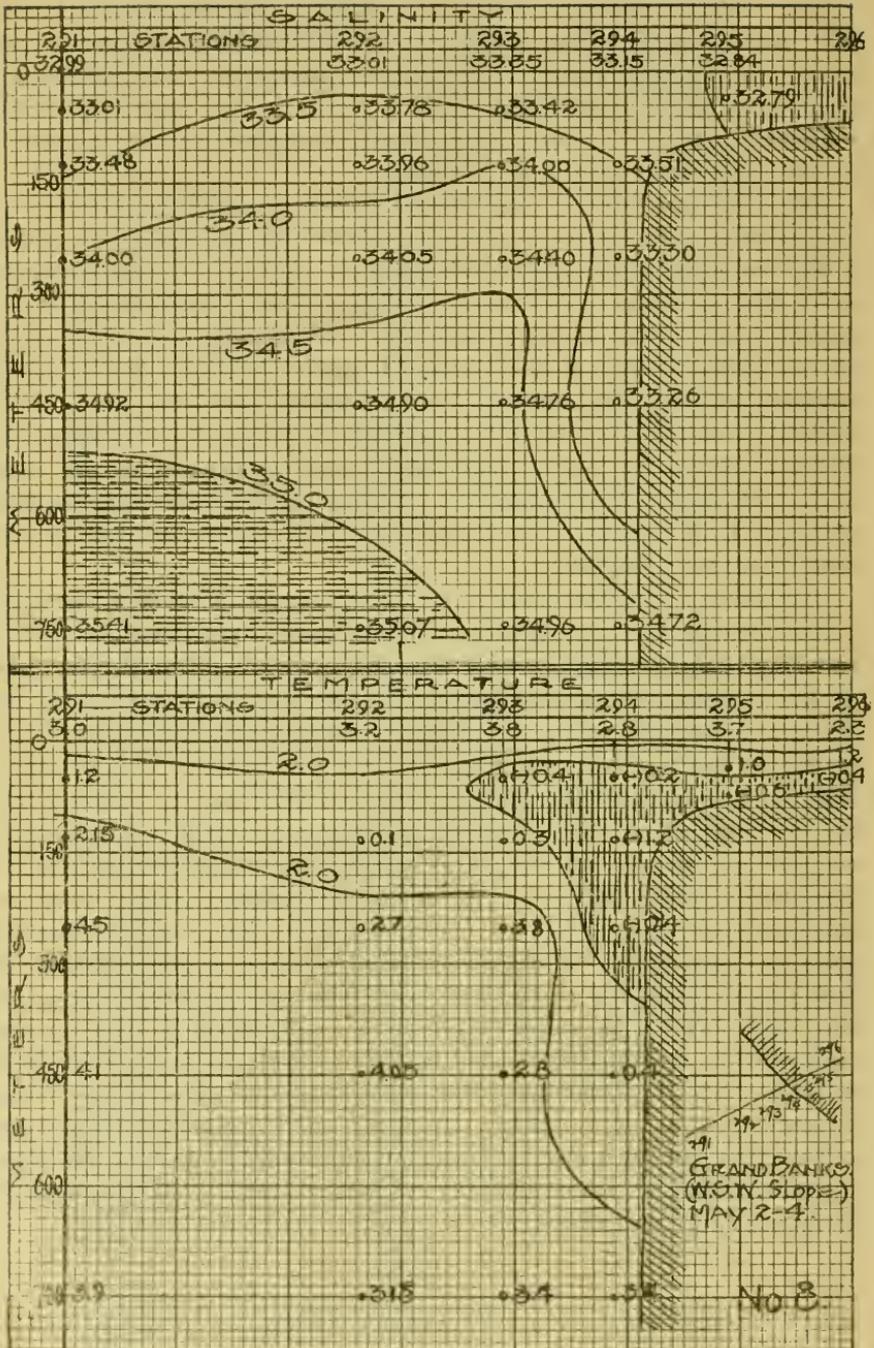


## PROFILE NO. 8—STATIONS 291-295.

The section, starting on the west side of the Grand Bank, runs 420 miles westerly into deep water. The stations were occupied May 2-4. Information was desired concerning the subsequent movement of the large mass of Arctic water which was found in this vicinity April 14-17, when it extended along the slope for a distance of 120 miles northwest from the Tail.

*Salinity.*—Like the corresponding section in April (profile No. 4), the parallel and nearly horizontal positions of the isohalines denote a uniform state of the water mass this far west of the Tail, excepting in on the slope where the sudden dipping of the isohalines for 34.5 ‰ and 34 ‰ mark an abrupt transition from the saltier water offshore to the fresher water of the Bank. In over the Bank we found the freshest water of the section with a salinity less than 33 ‰, while Atlantic water saltier than 35 ‰ lay in the depths of the outer stations, 291 and 292. In none of the subsurface investigations this year, and contrary to the experience of other years, did we note the presence of saline Gulf Stream water intruded northward into the oceanic triangle west of the Tail.

*Temperature.*—Water colder than 0° lay on the bottom of the Bank and extended 42 miles offshore just below the surface. Except on the slope, the isotherms, like the isohalines, furnish further proof of the freedom of the water west of the Tail from intrusions and disturbed mixings. The similarity between the position of the isohalines and the isotherms is especially well marked in this profile. The general form of the shaded area of frigid water, together with the position of the 2° isotherm, suggests an offshore spreading in the surface layers, but density profiles alone could prove this. A comparison with profile No. 4, taken two weeks earlier, brings out the fact that there was less Arctic water in this vicinity May 2-4 than on April 14-17, which points to a decrease, or cessation, in the flow of the extension of the Labrador Current this far northwest of the Tail. The cold water which was transported to this locality earlier in the season had worked inshore over the bottom of the Bank, as shown by the lower temperatures recorded in profile No. 8 than in profile No. 4. At no time in 1922 was the Labrador Current found so far from the Tail on the western slope, while on the other hand the Gulf Stream often flooded the outer stations of the sections along this line in that year.



## PROFILE NO. 9—STATIONS 296-305.

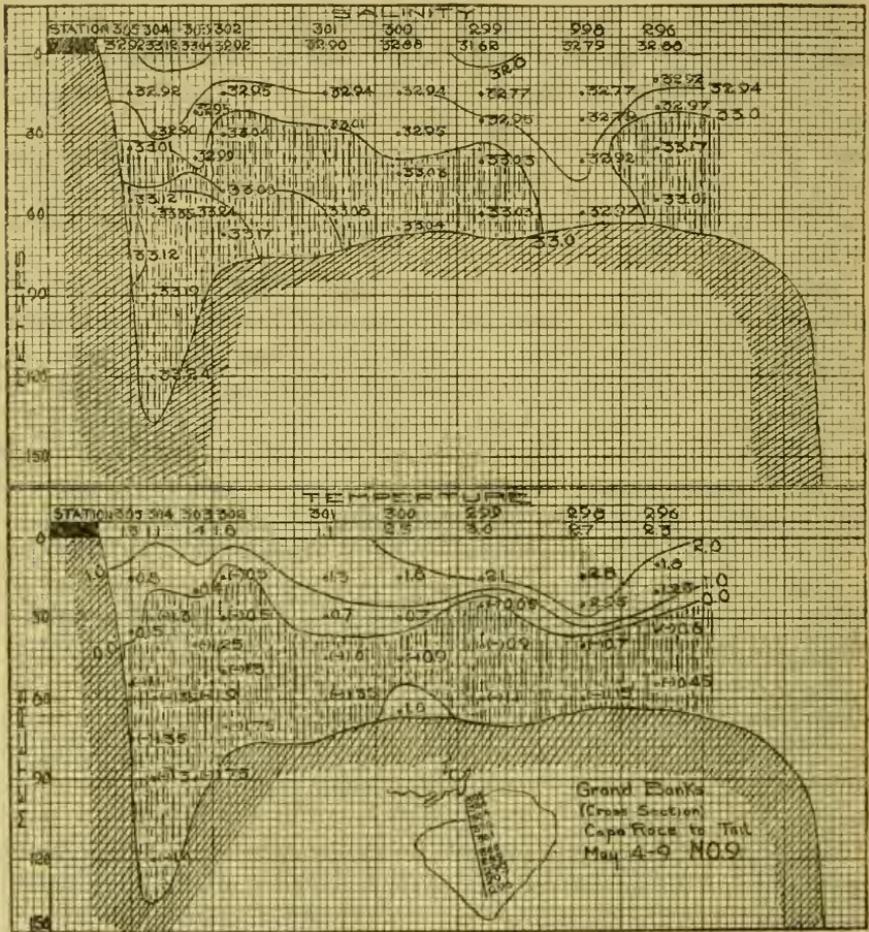
The section runs from station "C" (see chart "A") northerly to within 15 miles of Cape Race, Newfoundland. It gives a north and south vertical section of the water column on the Grand Bank and also cross-cuts the gulley which separates Newfoundland from the shoaler portion of the continental shelf lying to the southward. The stations were taken during the period May 4-9, the first time this region of the Grand Bank has been investigated by the ice patrol since July 16, 1914. The investigation was made for information relative to the extent of the influence of the Labrador Current over the Grand Banks. The value of the section lies in the frequency of stations, there being 9.

*Salinity.*—A layer of water fresher than 32.94‰, 20 meters (11 fathoms) in thickness, extended on the surface from Cape Race to the Tail of the Grand Bank. Water salter than 33‰ flooded the northern part of the Bank in the deeper water and overflowed over the bottom of the shoaler bank to the southward, a distance of 150 miles from Cape Race. Southward, on the Atlantic side, was found water of similar salinity which had encroached inshore on the Tail for a distance of 70 miles. The remaining water, the freshest of the section, 31.62‰, lay as a surface pool at station 299, in the central part of the Bank. The saltiest water lay in the deepest part of the gulley, the maximum reading of 33.24‰ being obtained at station 304 as close to the bottom as it was prudent to lower the thermometers.

*Temperature.*—Water colder than 0° bathed the bottom of the Bank from Cape Race to the Tail. This icy bottom cover was, on the average, 30 meters (16 fathoms) thick, the contour of its upper boundary being roughly horizontal except near the Newfoundland coast. The coldest water of the entire section was found just south of Cape Race on the south side of the gulley, where the thermometer registered -1.9°, the lowest temperature ever recorded by the patrol. This water with a temperature of -1.9° and a salinity 33.24‰ is pure Arctic, free from adulterations, and similar to that found by the steamship *Scotia*, June 28, 1913, much farther north off the coast of Labrador in the heart of the Labrador Current (-1.85°, salinity 33.24‰). The warmest water was a surface pool >2°, which lay on the south central part of the Bank exactly corresponding in position with the freshest water.

Summing up: A careful examination of the profile indicates that cold Arctic water flooded the northern part of the Grand Bank in the form of a branch of the Labrador Current (see p. 146), which set around Cape Race, completely filling the gulley and overflowing southward over the bottom of the Bank to a distance of 150 miles

south of Cape Race. On the Newfoundland coast a certain amount of land drainage had diluted the inshore side of the Labrador Current, apparent in the salinities to a distance of 10 miles seaward and to a



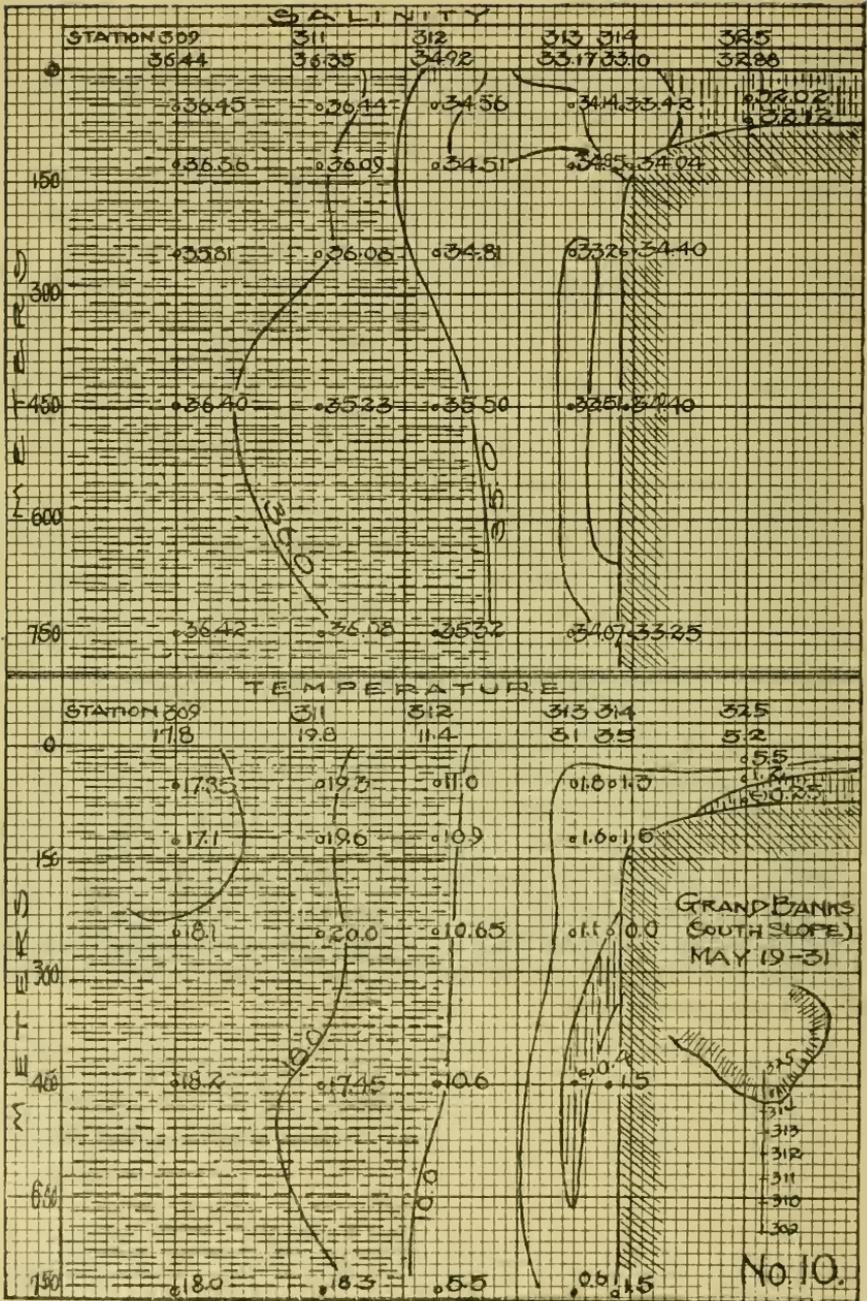
depth of 15 meters (8 fathoms). Slightly fresher and warmer water flooded the surface layers south of the gully, especially in the south central part of the Bank, where water fresher than 32.88 ‰ and warmer than 2.5° spread out in a surface pool 75 miles across.

## PROFILE NO. 10—STATIONS 309, 311-314, AND 325.

The section, starting in on the Tail of the Bank, runs southward well into the confines of the Gulf Stream. The stations were occupied May 19-31.

*Salinity.*—Inshore on the Bank was found water fresher than  $33\text{‰}$ . There was a sudden transition on the continental edge from water of  $33\text{‰}$  to water of  $34\text{‰}$ , restricting the Labrador Current, if present at all, to a very narrow zone. Just south of station 312, only 60 miles from the Tail, we met salty Atlantic water  $>35\text{‰}$ , the northern face of which, as outlined by the  $35\text{‰}$  isohaline, was nearly vertical in position and extended from the surface to the limit of investigation, 750 meters (410 fathoms). This water mass, represented by the shaded area in profile No. 10, occupying two-thirds of the picture, grew saltier as we proceeded south, with the highest salinity yet met on patrol,  $36.45\text{‰}$ , near the surface at the outer station. This is pure tropical water, identical to that in the heart of the Gulf Stream off the coast of Florida.

*Temperature.*—A thin bottom layer of icy water lay on the Bank and extended as a thin attenuation down the slope to a depth of 600 meters (328 fathoms). Station 312 and southward was flooded by an immense volume of warm water higher than  $10^{\circ}$  in temperature, extending from the surface to the 750 meter level. A maximum reading of  $20^{\circ}$  was obtained at the 250 meter (137 fathoms) level at station 311. This body of extremely salt and warm water lay only 60 miles south of the continental edge. Profile No. 10 shows a decided encroachment of the Gulf Stream since the previous observations made April 30-May 4 (profile No. 6), and furthermore indicates sufficient strength on the part of the Gulf Stream nearly to efface the presence of the Labrador Current at the Tail. The fact that a great diminution in the volume of Arctic water in this vicinity occurred between May 4 and May 30 (see profiles No. 6 and No. 10) may be attributable to Gulf Stream encroachment or to dwindling Labrador Current, or to both.



## PROFILE NO. 11—STATIONS 320-324.

The section runs from in on the Bank southwesterly offshore into the warm salt water of the Gulf Stream. It was occupied June 4.

*Salinity.*—Water less than  $33\text{‰}$  lay in over the Bank. Water between  $33\text{‰}$  and  $34\text{‰}$  extended 45 miles off the slope and to a mean depth of 450 meters (246 fathoms). Proceeding offshore a sudden transition was found from  $33\text{‰}$  to much more saline water  $> 35\text{‰}$ . These two water masses, so diametrically opposed physically, abutted each other with a sudden transition and a well-defined boundary, as shown by the  $34.9\text{‰}$  isohaline, 60 miles seaward from the slope.

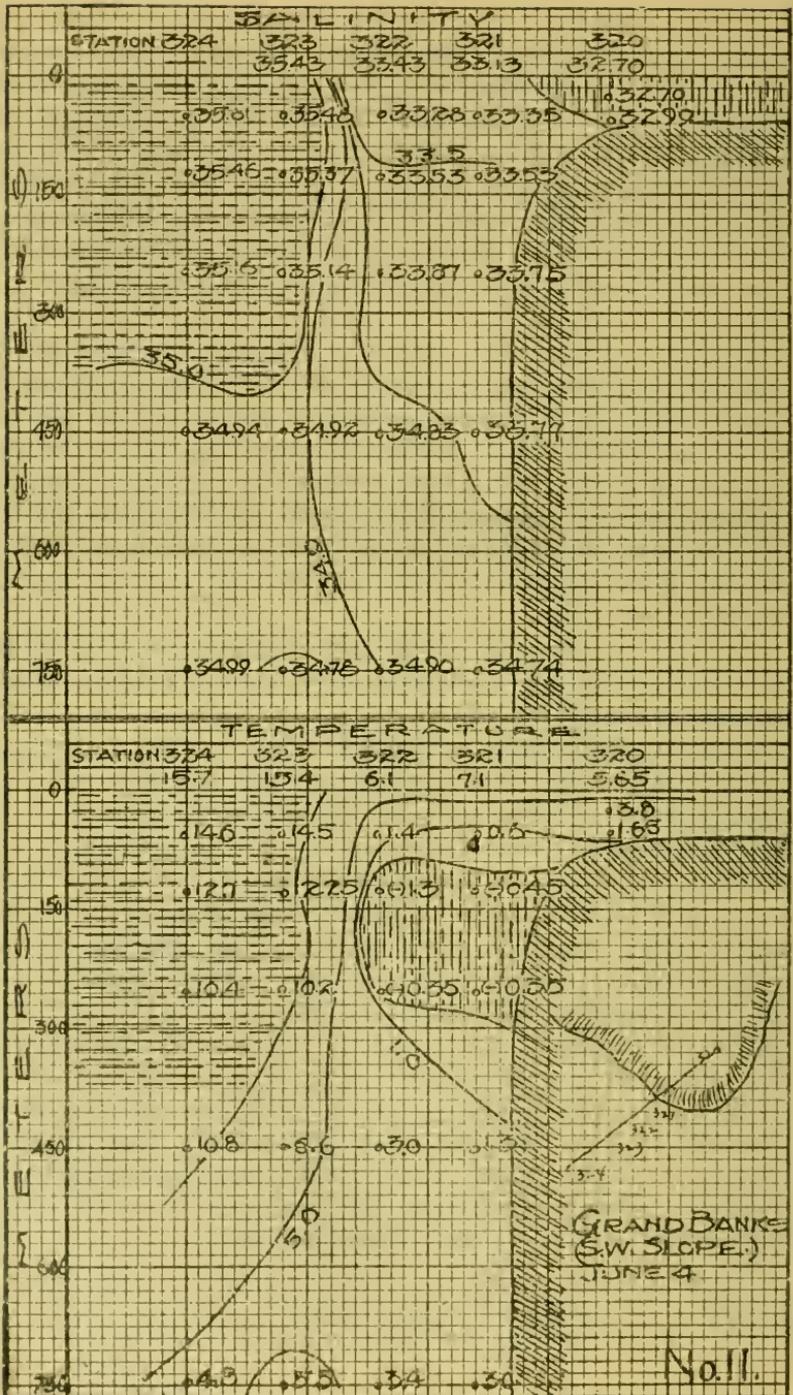
*Temperature.*—The coldest water was found on the slope between the 100 and 300 meter depths (55 and 164 fathoms), projecting seaward as a shelf, with its base resting on the slope and its outer bounds extending 42 miles offshore, abutting against the mass of warm salt water which completely flooded the outer two stations. The saltness and the warmth of the latter identifies it as the inner edge of the Gulf Stream, which had worked inshore toward the slope, west of the Tail, during the interim since the last investigation on May 2-4.

Since profile No. 11 represents the last of three sections which were taken in this locality for the ice season of 1923, it is appropriate to review the data thus secured.

April 14: A large amount of Arctic water was found on the southwest slope, which extended 68 miles out from the slope and downward to the depth of investigation, 750 meters (410 fathoms).

May 4: A decided shrinkage had occurred in the amount of frigid water on the slope, it now extending offshore a distance of only 50 miles and downward 350 meters (191 fathoms), adjacent to the Bank.

June 4: There was very little change in the amount of Arctic water at this place on the southwest slope over an interval of one month, but its position had changed. It was restricted to the 100-300 meter (55-164 fathoms) levels, extended offshore 42 miles, and had become effaced in over the bottom of the Bank. These successive observations taken at frequent intervals furnish conclusive evidence, with respect to both salinities and temperatures (see p. 146), of the presence of the Labrador Current, which was continually bathing the southwest slope of the Grand Bank, 50 miles west of the Tail, throughout the months of April, May, and June.



## PROFILE NO. 12—STATIONS 315-319.

The section runs from station 319, in on the Bank, 100 miles offshore to the westward. It was taken June 3-4.

*Salinity.*—The water inshore on the Bank was fresher than 33.0‰. Proceeding offshore increasingly saltier water was passed through out to station 317, 30 miles off the slope, where the salinity was at a maximum for the entire section. But this saltiest water was in the form of a wall, only some 15 miles wide at the surface with decidedly lower salinities offshore, in a surface pool 75 to 100 meters (41-55 fathoms) deep at the outer stations, 315 and 316. Below 250 meters (137 fathoms) the whole breadth of the section cut water of a comparatively uniform salinity, 34.5‰-35‰.

*Temperature.*—The coldest water in the section was on the bottom of the Bank at the inner station, 319, but even this minimum, being above 0°, was not so low as the bottom temperature on the Bank a month previously. (See profile No. 8.) The striking feature of the profile, however, is the trough of warm water, >10°, 150 meters (82 fathoms) deep and 11 miles wide, lying 30 miles off the slope at station 317 and occupying the same general position as the wall of saline water shown in the salinity profile. At the outer station, 315, warm water >10° was again found, but restricted to the upper 200 meters (109 fathoms), and separated from the trough of still higher temperature just mentioned by a cooler band. The presence of warm saline water, in trough form at station 317 and in rounded form offshore, has been observed before in this locality and, as now, was held to be attributable to the northern edge of the Gulf Stream, which tends to work northward in the surface layers of the oceanic triangle west of the Tail. (See Treasury Bull. No. 10, profile No. 1.)

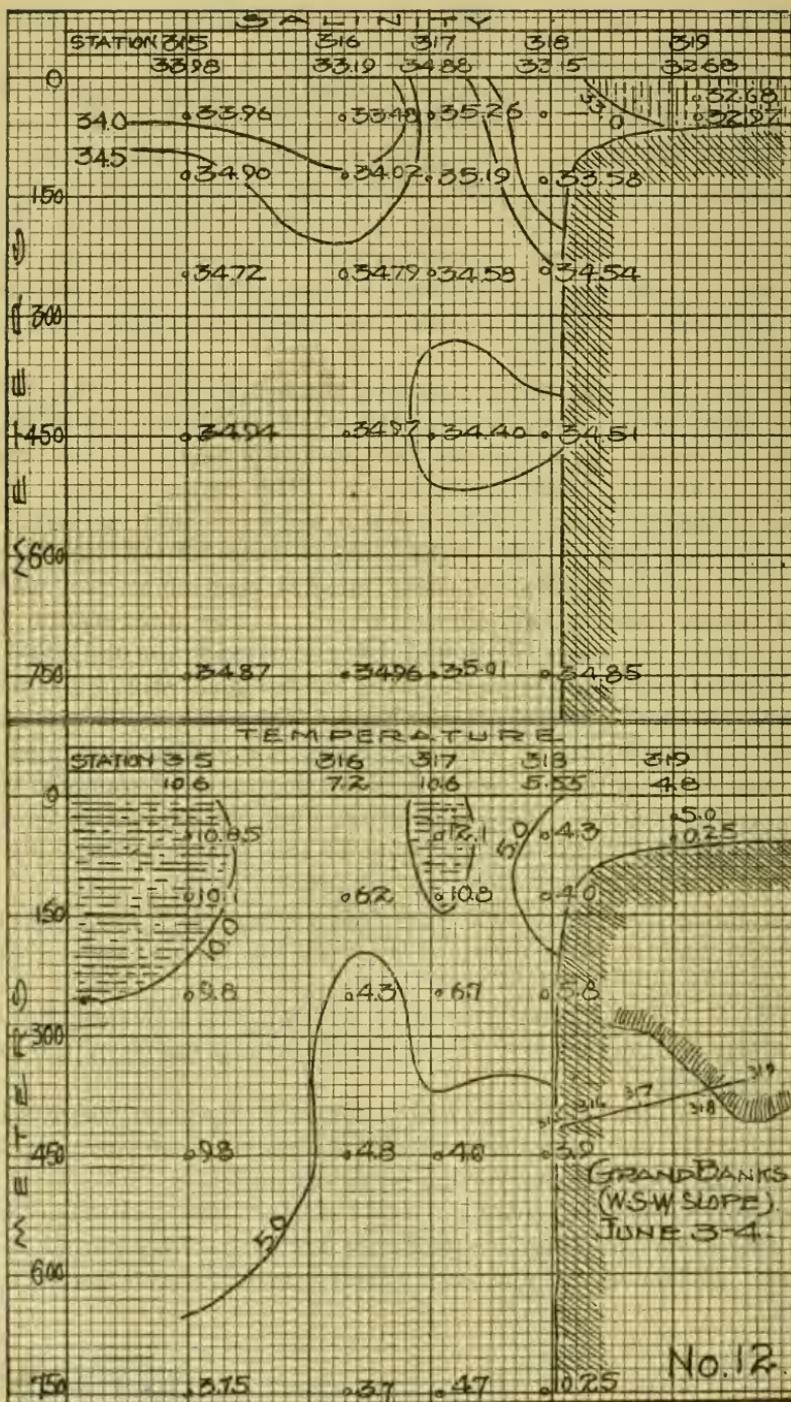
Comparing his section with those taken at the same place, 90 miles from the Tail, at three different times during the ice season, brings out the following facts:

April 17: An unusual amount of Arctic water was spread out in the upper 260 meters (142 fathoms) and to a distance of 120 miles from the slope.

May 4: A great shrinkage had occurred in the polar water, which now extended only 42 miles seaward from the slope and to a depth of 350 meters (191 fathoms) on the continental edge.

June 4: Continued shrinkage in the Arctic water had taken place, resulting in its complete disappearance during the brief period of one month. Evidence of the arrival of Gulf Stream water is found in the profile.





## PROFILE NO. 13—STATIONS 329-333 AND 339.

The section runs from station 339, on the southern part of the Grand Bank, southward into deep water, with its offshore end cross-sectioning the northern part of the Gulf Stream. The stations were occupied June 13-14.

*Salinity.*—The freshest water found, less than 33‰, occupied all Bank depths, surface to bottom, inshore of the continental edge, while a large body of water of salinity similar to that of the Labrador Current, 33‰ to 34‰, lay on the slope to a depth of 600 meters (328 fathoms) and extended offshore 65 miles in the upper 150 meters (82 fathoms). Atlantic water 35‰, with its inner boundary a vertical wall 68 miles south of the Tail, flooded the two outer stations to the maximum depth of investigation, 750 meters (410 fathoms).

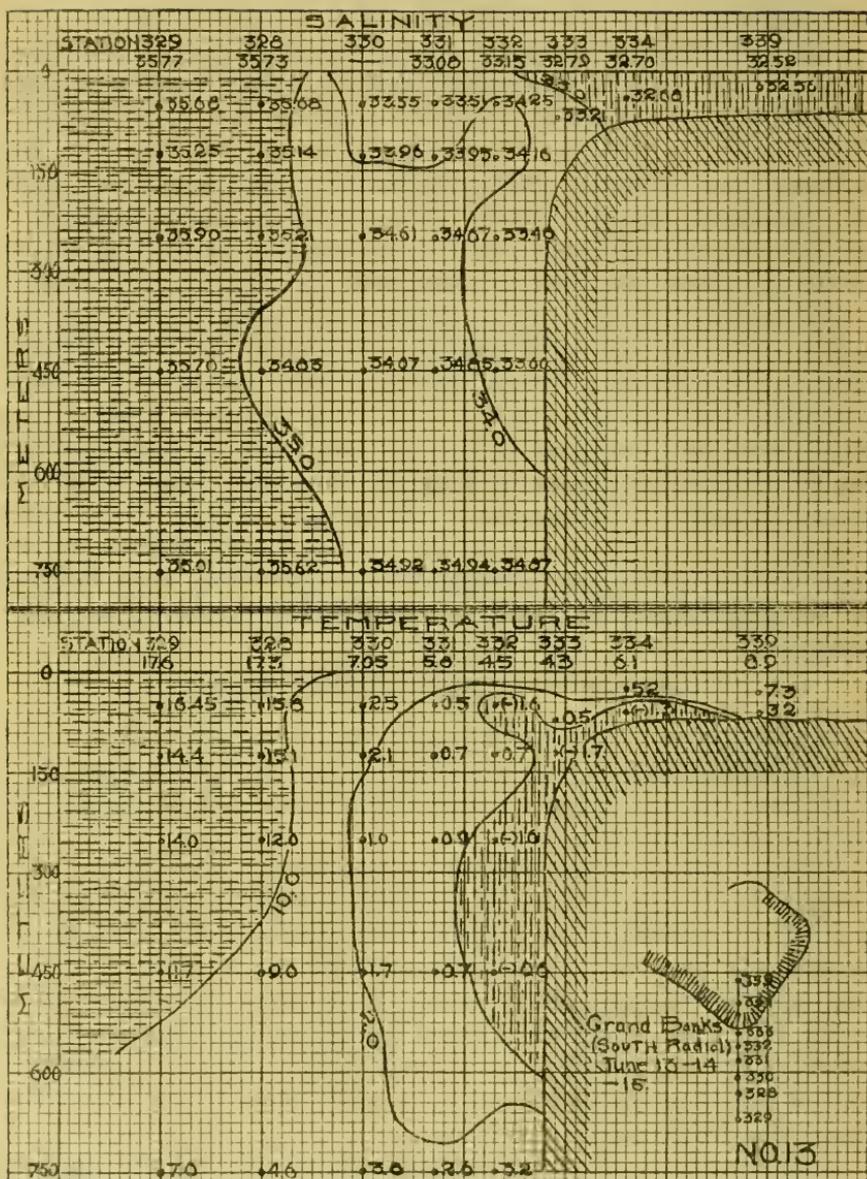
*Temperature.*—Cold water  $< 0^{\circ}$  was found washing the slope to a depth of 600 meters (328 fathoms), extending 30 miles offshore, and spreading 35 miles northward in over the bottom of the Bank. Colimital with the salinities of 33‰ and upwards, temperatures higher than  $10^{\circ}$  were found at the outer stations, physical characters which identified this mass of water as the inner edge of the Gulf Stream. Below the 450-meter (246-fathom) depth at the outer stations we found a cooling in the bottom layers of the northern edge of the Gulf Stream, occasioned no doubt by the icy cold water on the deeper part of the slope, assisted by normal abyssal temperatures.

## PROFILE NO. 14—STATIONS 338-343.

The section was taken in the same locality as profile No. 9, May 4-9, see page 125. It runs from the Tail of the Bank northward to Cape Race, giving a vertical section of the water column lying on the Bank. It was taken June 19-23.

*Salinity.*—Water salter than 33‰ (the saltiest water of the profile) occupied the whole depth of the gully, surface to bottom, and encroached southward on the Bank a distance of 69 miles on the surface and 100 miles on the bottom from Cape Race. South of this, salinities were uniformly below 33‰ across the whole breadth of the Bank, but the profile did not run far enough south to cut the salter water which usually lies over the Atlantic slope. The southern half of the Bank was occupied by a water mass which was fresher than 33‰ from surface to bottom.

*Temperature.*—Two bodies of cool water, one on the northern part of the Bank, in the gully, as shown by the readings below zero at 50 meters (27 fathoms) and on the bottom, and the other at the Tail on the continental edge, were separated by a greater mass of warmer water which flooded the entire central part of the Bank. The positions of the two cold masses correspond roughly to the





for small bands on the bottom and at the 25-meter (14-fathom) depth in the gully, and on the slope at the Tail. This change points to a very active state of circulation prevailing over the Grand Bank's column. The increasing influence of warm fresh water supply to the surface layers is now clearly noted over the entire southern half of the Grand Bank and also northward into the area usually occupied by the western branch of the Labrador Current. This appeared to accumulate quite consistently over the central part of the Bank where, being lighter than the surrounding water, it spread out on all sides in the surface layers. The reason why, and the manner in which, warm fresh water spreads out over the central part of the Grand Bank may be explained by the well known expansion of low salinity water seaward from land areas, a general condition which is functioning throughout the year but attains a maximum during summer.

**PROFILE NO. 15—STATIONS 345-350.**

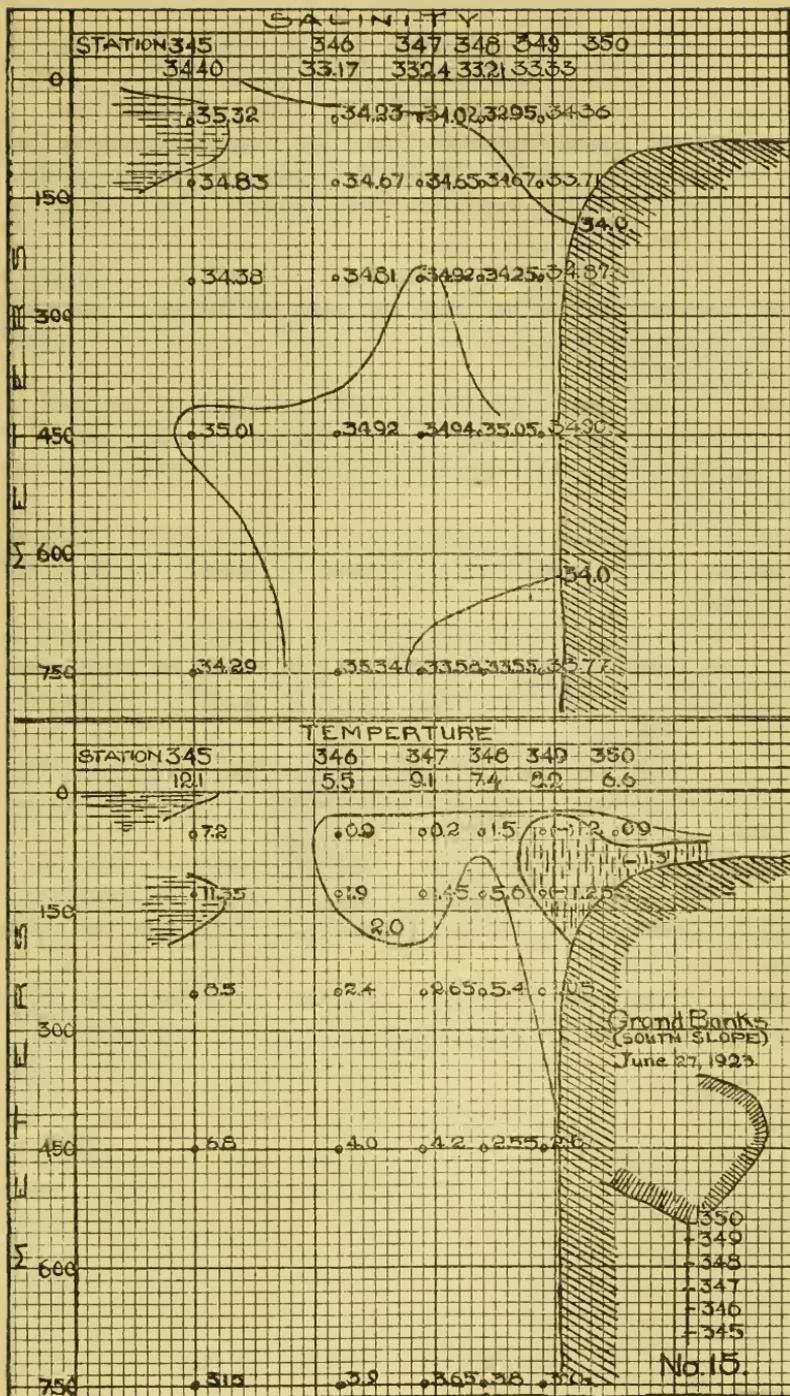
The section runs from in on the Tail of the Bank southward into the Atlantic. The stations were taken June 27.

*Salinity.*—Water less saline than  $34\text{‰}$  extended 80 miles out from the slope on the surface. On the other hand, the outermost station cut the inner edge of the Gulf Stream, which intruded northward as a thin shelf at the 50-meter level, as evidenced by the high salinity of  $35.32\text{‰}$ .

*Temperature.*—The section cuts bands of water colder than  $0^\circ$  along the continental edge and in on the Bank at 50 and 200 meters (29–109 fathoms), and shows the influence of these bands for 60 miles offshore as a cool shelf, outlined by the  $2.0^\circ$  isotherm, with its axis about the 100-meter (55-fathom) level. At the outer station the first sign of the Gulf Stream was found in the surface and the 125-meter (68-fathom) readings of  $10^\circ$  and  $12^\circ$ , which further corroborates the evidence of salinity.

Attention was called in profile No. 6 to the depth of penetration of the sun's heat in the water lying over the slope at the Tail. Since this water has been shown to have a constant salinity and temperature, viz,  $33\text{‰}$  to  $34\text{‰}$  and less than  $0^\circ$  (Labrador Current) throughout the ice season, it follows that any warming must have been caused by the sun. The following data are taken from profiles Nos. 6, 10, 13, and 15:

| Date.         | Surface temperature. | Depth of penetration of $2^\circ$ isotherm. |
|---------------|----------------------|---------------------------------------------|
|               | $^\circ\text{C.}$    |                                             |
| May 4 .....   | 2                    | 10 meters (5 fathoms).                      |
| May 31 .....  | 4                    | 30 meters (16 fathoms).                     |
| June 14 ..... | 6                    | 30 meters (16 fathoms).                     |
| June 27 ..... | 8                    | 25 meters (14 fathoms).                     |



A summary of comparisons in this locality south of the Tail brings out the following facts:

*The Labrador Current.*—April 15: The first profile at the Tail showed the Labrador Current extending out 40 miles from the slope and downward to a maximum depth of 275 meters (150 fathoms).

May 4: The Labrador Current spread 55 miles seaward on the surface, rested on the slope to a depth of 500 meters (275 fathoms), and had crept in over the bottom of the Bank as an icy covering 8 fathoms thick.

May 31: A shrinkage had occurred in the Labrador Current, leaving only a small band based on the slope, which projected shelflike out into warmer water a distance of 15 miles and as a bottom layer in on the Bank.

June 14: A notable increase had taken place in the volume of the current from the north, which now spread 60 miles offshore from the continental edge and bathed the slope down to a depth of 604 meters (330 fathoms).

June 27: A shrinkage of the volume of the Labrador Current had taken place, with a tendency of the surface layers to spread offshore for 60 miles.

*The Gulf Stream.*—April 15: The Gulf Stream was found in unusually large volume and strength for the season 90 miles south of the Tail, with its northern face a vertical wall in the upper 400 fathoms.

May 31: It had increased in volume and strength and had advanced northward as a sheer vertical wall to within 58 miles of the Tail of the Bank.

June 4: Not so prominent as in the preceding section and evidently affected by a temporary swelling which occurred in the Labrador Current. The inner edge of the Gulf Stream lay 70 miles south of the Bank.

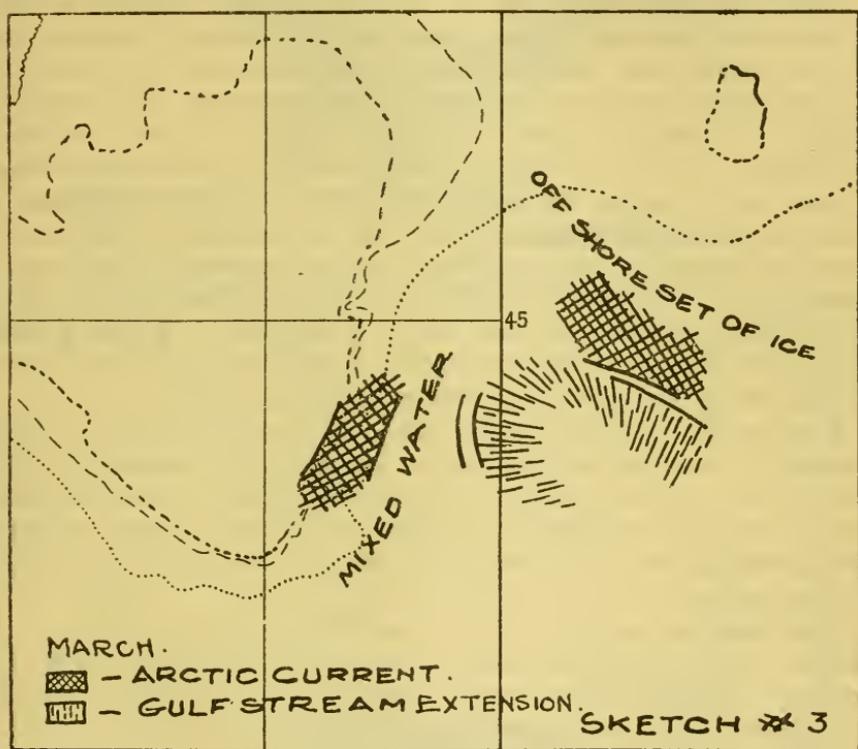
June 27: Apparently a further retreat of the edge of the Gulf Stream to 85 miles from the Tail.

## OCEANOGRAPHIC SUMMARY.<sup>1</sup>

Lieut. EDWARD H. SMITH, *U. S. Coast Guard.*

We are now prepared to sum up the history of oceanographic events for the ice season of 1923 in the vicinity of the Grand Bank, based upon profiles 1-15. In general, 1922 was considered a normal year and 1923, in most respects, corresponded, especially as regards number of bergs.

It was noticed by the ice-patrol vessel on her initial appearance in the region of the Grand Bank, March 13, that the majority of bergs



were following courses which carried them offshore and that scarcely any were taking the path which had come to be regarded as normal, southward along the eastern continental edge of the Grand Bank. Such berg drift being unusual, an examination was made which gives a picture of oceanographic conditions prevailing below the surface at that time and place, the results of which can best be illustrated by a sketch of the horizontal plane at the 100-meter (55-fathom) depth.

<sup>1</sup> All temperatures are centigrade.

Sometime prior to March 31 warm, saline water, a dilation of the northern side of the Gulf Stream, had shouldered northwestward up the submarine valley which indents the continental slope in lat.  $43^{\circ} 40'$ , long.  $47^{\circ} 15'$ . This invasive swerve tended to work inshore, and to deflect a large proportion of the south-flowing water masses offshore to the eastward. Whether this movement was sufficient to explain the corresponding offshore drift of the icebergs at this time, it is difficult to say. Such drifts, on the other hand, which are characteristic of the early season (February and March), have been attributed to the field ice farther north, which may act to fend the bergs offshore.

The encroachment of the warm saline water shoreward in the topographical depression east of the Grand Bank develops chiefly in the winter and early spring, when the Gulf Stream is more active in this region than at other times. Several factors are involved, which include the attractive force existing between two bodies of water of extremely opposite character, caused by the so-called "cabeling" along the boundary of their meeting.<sup>2</sup> Another probable factor centers around the elevation in the ocean floor, which is a southeastward continuation of the Tail of the Bank. The movement of the water masses eastward, over and around this rise, combined with the frictional arresting of opposite currents which takes place along the zone of their mixture, all enter into the mutual interaction between these two waters of contrasting physical character in this region during the late winter and early spring.

Early in April the offshore movement of the bergs ceased and they began to follow courses more or less parallel to the eastern edge of the Bank. Another vertical section of these waters made the latter part of April also indicates a slacking of the warm-water invasion and a decreased tendency toward an offshore movement of the south-flowing masses.

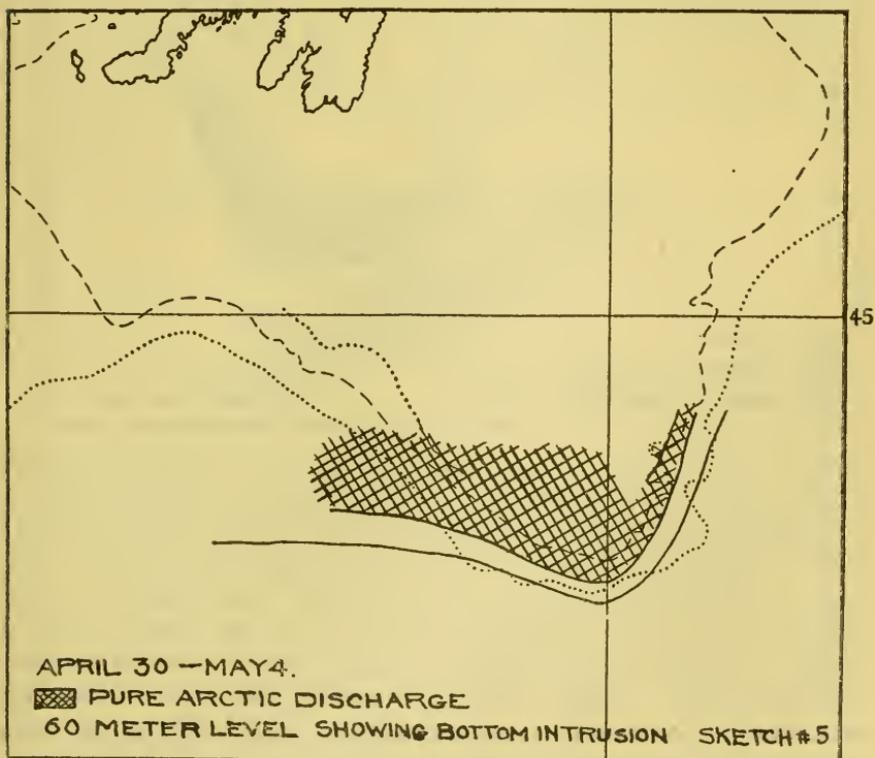
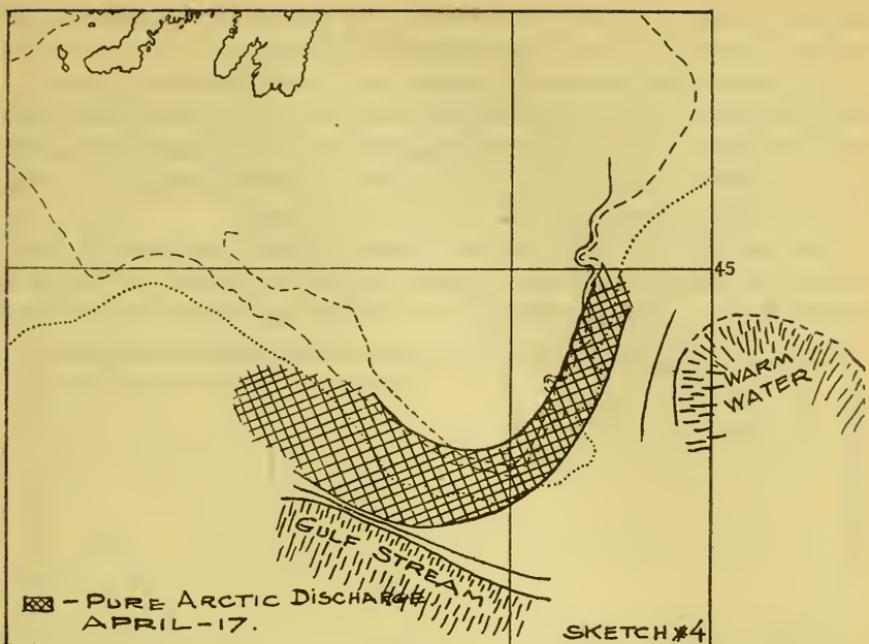
Conditions around the Tail the middle of April are shown in a sketch of the horizontal plane 60 meters (33 fathoms) below the surface. The cold current was flowing southward at a record breaking velocity of 1.2 knots per hour, just north of the Tail (p. 74),

<sup>1</sup> The reader is referred to Prof. Emil Witte's clear and simple treatment of the subject in the *Geogr. Anzeiger*, October, 1910:

"When, on the boundary of an ocean current, warm water of high salinity is brought into contact with colder water of less saline character, but having approximately the same specific gravity, then the resulting mixture will, as may easily be proved by the Knudsen tables, be of greater density than either of its component parts. It will consequently sink down, giving rise to the peculiar phenomenon known as *cabeling*.

"Obviously, this tendency in the water will likewise produce horizontal currents; as the mixed water sinks down surface water must flow in from either side to take its place. By way of example, we may take the waters in the vicinity of the Newfoundland Bank, where the Gulf Stream encounters the cold current flowing down from the Greenland seas. Throughout the wide extent of the boundary surface between these two mixed water is constantly being formed, sinking down, and thus drawing in a continual further supply of surface water from either side."

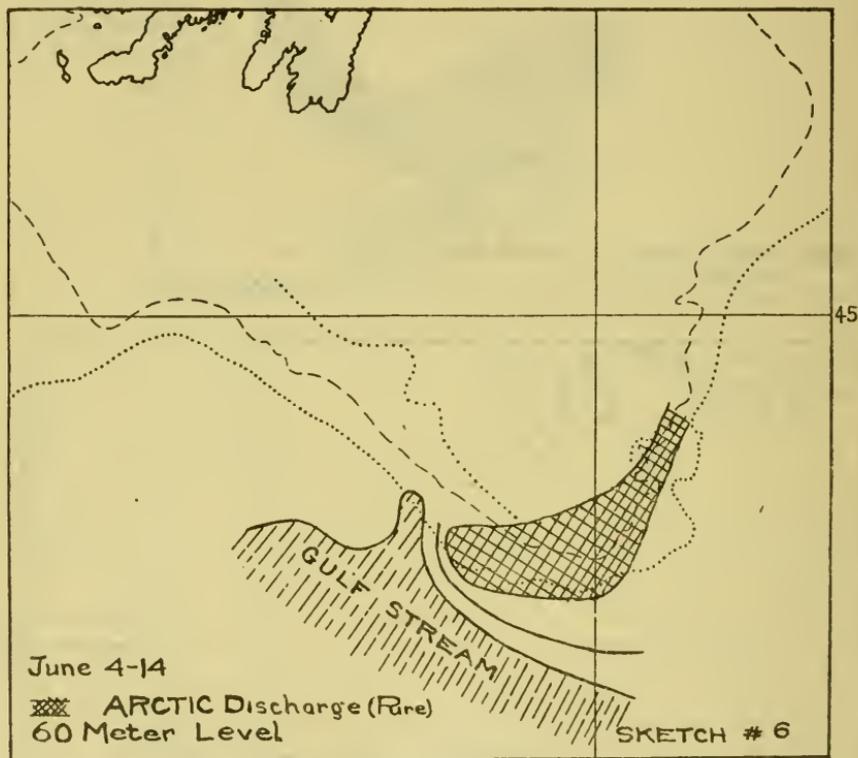
It is this perpetual sinking of the water, of course, which renders the oceanic boundary line here so vertical.



curling around and across the latter, and extending westward along the slope for a distance of more than 120 miles.

No examination was made farther to the northwestward; yet it is probable that Arctic water did not extend much farther west than this beyond the Tail. There it spread out in a pool 250 meters (137 fathoms) deep and 120 miles wide, connected with the more active supply around the Tail by an icy cold neck.

Two weeks later, May 2-4, we observed that this mass of Arctic water had shrunk noticeably in size from its outline as shown in sketch No. 4. (See profile No. 8.) On the east slope the cold cur-



rent from the north had been reduced to a narrow stream restricted to the continental edge about the 100 meter (55 fathoms) depth.

A proportional shrinkage from the April state was noted at the Tail, and especially 30 miles to the westward along the slope. There was an unmistakable movement of the Arctic water inshore over the bottom of the Bank during this period. On the south, the Gulf Stream had increased in strength as shown by the increase in temperature and salinity. This conclusion is based upon the general assumption that in a continuous transference of water such as an ocean current the rate at which changes take place in the physical character

of the water, considering its contact with other waters, and on atmospheric influences, depends largely on the time interval.

The highest temperature and salinity ever recorded by the patrol was observed May 27, 75 miles south of the Tail, where water of 20° and of 36.44 salinity was found, which would be normal for the water between Bahama and Florida, one of the fountain heads of the Gulf Stream.<sup>3</sup>

The latter part of May the Labrador Current extension had dwindled to its lowest ebb for the season. It was instructive to observe such a contrast between its size on May 27-30—a weak, attenuated extension—and on April 13-14, when it was a voluminous current flowing at record strength.

Early in June the cold current exhibited a tendency to swell from its low ebb just mentioned. The pool of water left on the southwest slope by the failure of the northern supply was, by June 4, entirely absorbed by warm saline intrusions in the deep oceanic triangle west of the Tail. This was the first appearance of Gulf Stream water this far north and this far inshore for 1923.

The boundary of the cold Arctic discharge, on June 4-14, curled around and somewhat across the Tail of the Bank, extending about 60 miles to the westward and 48 miles to the southward. Several bergs were freighted southward by it around the Tail, and set in on the southwest slope during this period as shown by chart "C."

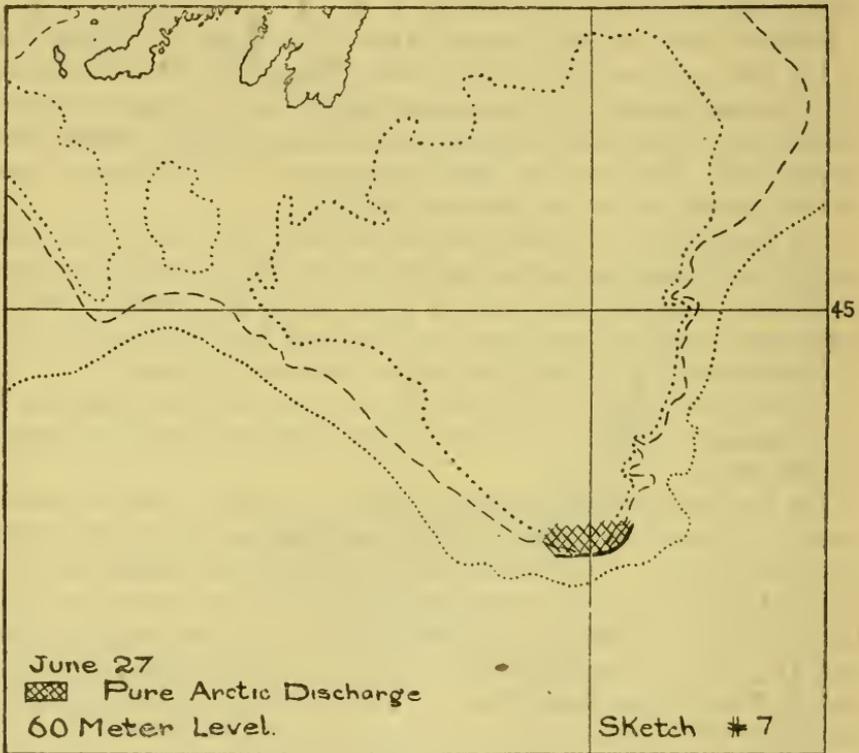
During the latter part of June the cold current again weakened to an attenuated streak across the extreme edge of the Tail as shown by Sketch No. 7.

The circulation of the water over the Grand Bank itself was subjected to examination during May and June, as shown by profiles No. 9 and No. 14. Early in May icy water was found filling the gulley south of Cape Race and completely flooding the northern part of the Grand Bank to a distance of 150 miles from Cape Race on the surface, and 110 miles on the bottom, the latter condition being shown on sketch No. 8. The water over the south central part of the Bank, especially in the surface layers, was constantly too warm and of too low a salinity to have had a far northern source. A decided shrinkage in volume of the Arctic water occurred between May 9 and June 19, when it completely receded from the south central part of the Bank, where it had been replaced by decidedly warmer and fresher water, a change especially well marked in the surface layers.

Several interesting facts have been brought out in connection with oceanographic developments as disclosed by the series of observations carried out during the ice season of 1923, one of the most

<sup>3</sup> Bigelow (1917), on an exploration of the western Atlantic on Mar. 21, 1914, midway between Bahama and Florida, found the water to be 20.13° in temperature and 36.55 in salinity. Although separated by several years, the time interval of two months is approximately the period required to transport any individual water mass from Florida to the Tail of the Grand Bank.

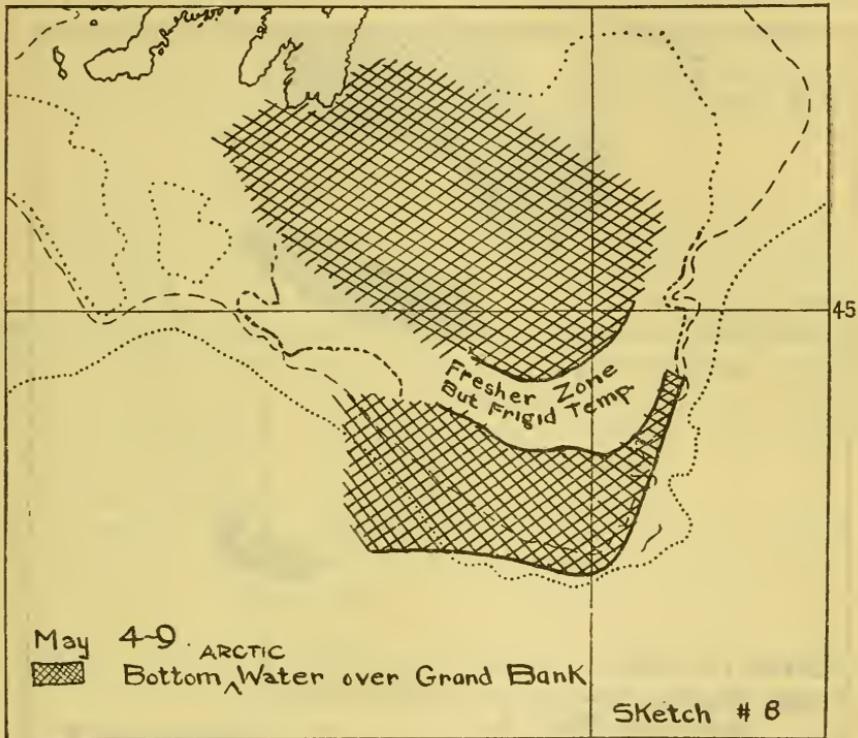
important being the noteworthy variations in the size and strength of the Arctic discharge into the area around the Tail. We are now speaking about the current which runs around the seaward edge of the Grand Bank. This current quite consistently (as in previous years) hugged the continental edge, i. e., the steepest part of the slope as bounded by the 100 to 200 meter (55 to 110 fathoms) depths, continually flooding and ebbing on this base line. It exhibited a tendency at times to encroach over the Bank, but this movement was always on the bottom and more marked at the Tail and for some distance northwestward along the southwest slope than elsewhere.



In the main this may be attributed to the effect of the rotation of the earth which swings moving objects in the northern hemisphere to the right of their paths.

In as brief a period as two weeks a great variation was noted in the size and strength of the current from the north. These pulsations of the cold current, from whatever cause, react on the extreme southern extensions of Arctic water around the Tail, and revive its influence from time to time, even many miles to the northwest along the southwest slope. Being the extreme southern extension of the cold polar water, any variation in the movement of the major masses

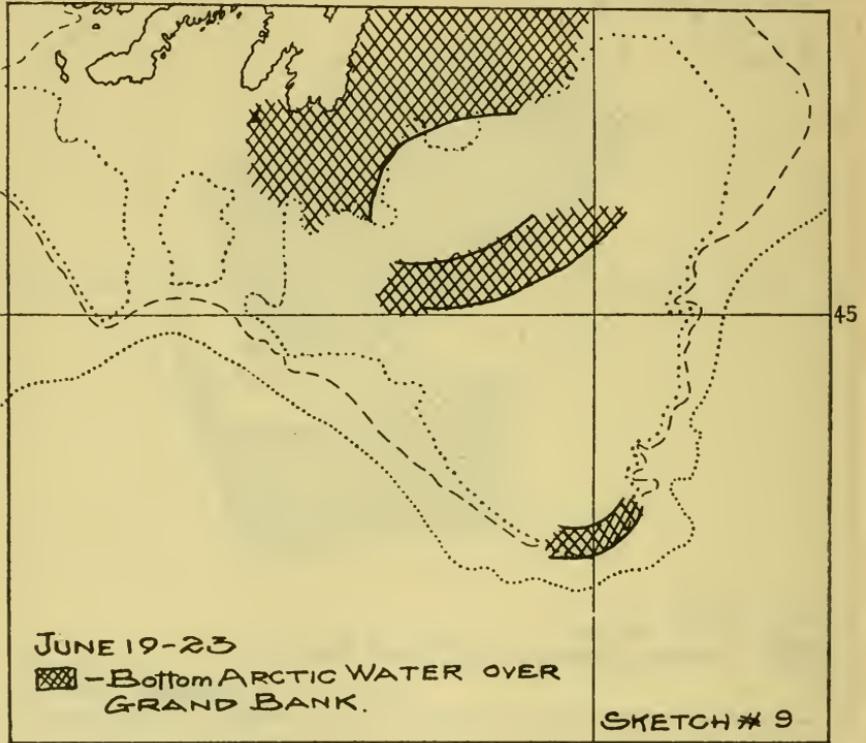
farther north is bound to be reflected in wider swings and fluctuations in the region around the Tail where its complexion continually glows and fades. A dwindling in the flow may leave isolated patches of polar water, which have been freighted here during a flood period. Such icy pools left along the southwest slope become engulfed and finally absorbed by the warmer, saltier Atlantic water. In the deeper layers such Arctic relics appear to work westward more or less, following around the continental edge, as evidenced by records which sometimes show extreme westerly drifts to bergs in the oceanic triangle west of the Tail of the Grand Bank.



Attention has been called to the size and position of the cold northern current throughout the ice season around the Atlantic side of the Grand Bank. It is impossible to set definite bounds as to salinity and temperature within which the water from the north will fall. At times the mixture is in such proportion along the zone of transition which lies both inshore and offshore of the Labrador Current that it is quite impossible to determine water bounds. The water, however, which is to be found every ice season around the continental edge of the Grand Bank is too salt for Bank water and too fresh for Atlantic water. That it is not indigenous, inactive slope water (i. e., a transitional stage in offshore expansion) is

shown by its extreme coldness, especially below the surface ( $0^{\circ}$  to  $-1.9^{\circ}$ ). Such temperatures never could be produced locally during the ice season and are comparable only with those of the discharge from the far north, the salinity of which corresponds to that found along the continental edge of the Grand Bank. Such water, therefore, must have been transported to the Grand Banks region from elsewhere.

There is a cold, icy current flowing clockwise around the Atlantic faces of the Grand Bank, more clearly defined along the east side and around the Tail than elsewhere, which we call an extension of



the Labrador Current in the absence of a better name. But it does not follow a continuous stream flow (riverlike) from its source, the Arctic, to the Tail of the Bank at all times throughout the year. In summer, when this current becomes weak, the continental edge from the Labrador coast to the 43d parallel is the seat of regional circuits of circulation. The well-known augmentation occurring in the northern current every spring results in a more continuous flow made visible by the transference of Arctic freight in the form of icebergs.

It is well established that the water masses from the north flood the northern part of the Grand Bank, where the current forms two

branches—the eastern branch we have just discussed, and we will now speak of the western branch and the circulation over the Grand Bank. The Arctic water becomes accelerated as it floods in over the broad continental shelf and pours southwestward through the gulley between Newfoundland and the Grand Bank proper. Much of this water swings to the right as an indraught along the south coast of Newfoundland as far west as Cape Pine, while the offshore water, following the bottom configuration, swerves to the left and eddies eastward. During the period, March to May, the cold Arctic water is at a maximum here and it spreads southward, enveloping the entire Grand Bank's column, for a brief period in the surface layers, and for more extended periods on the bottom. As summer advances the influence of the northern icy waters becomes less obvious and late season investigations find it restricted to the bottom, where intermittently throughout the summer irregular, but short-lived, intrusions may occur.

The south central part of the Grand Bank is least affected by Arctic influences and as summer advances the effects of freshening and warming in this region become more and more emphasized, more especially in the surface layers. In order that such water be progressively freshened and warmed, it must receive a coastal supply. This may be attributed to the general seaward expansion and eastward movement of the surface layers of low salinity to the Grand Bank, interacting with the intermittent expansions of the northern current from the gulley southward over the Bank.

The picture certainly is complex. In addition to the mixing of water masses over the Bank, we must not forget to take account of the effects of seasonal cooling and warming which acts equally on all water masses in a given region. The first signs of cooling of the surface layers in the central part of the Bank is detected in autumn, and from then on progressively lower temperatures are observed which reach a minimum in February and March, when from surface to bottom the convectional currents produce a uniform water column,  $0^{\circ}$  to  $-0.5^{\circ}$ . The following results of investigations by months of the years for which we have record is given for the south central part of the Bank, lat.  $44^{\circ} 00'$ , long.  $50^{\circ} 50'$ , which designates the center of a region least affected by intrusions, and which therefore most nearly approaches a purely tidal reservoir.

## South Central Grand Bank.

| Month.         | Year. | Temperature. |         | Salinity. |         |
|----------------|-------|--------------|---------|-----------|---------|
|                |       | Surface.     | Bottom. | Surface.  | Bottom. |
| February.....  | 1921  | -0.3°C       | -0.4°C  | 32.97     | 32.96   |
|                | 1922  | 0.7°         | 0.6°    | 32.54     | 32.55   |
| Do.....        | 1921  | 0.0°         | -0.8°   | 33.23     | 33.30   |
|                | 1922  | 0.2°         | 0.4°    | 32.47     | 32.50   |
| March.....     | 1921  | 0.9°         | 0.6°    | 32.90     | 33.04   |
|                | 1914  | 0.7°         | 0.3°    | 32.94     | 32.94   |
| April.....     | 1919  | 2.4°         | 0.0°    | 32.95     | 33.08   |
|                | 1920  | 2.0°         | 1.0°    | 32.47     | 32.50   |
| May.....       | 1921  | 2.4°         | 0.4°    | 33.25     | 33.46   |
|                | 1922  | 0.6°         | -0.2°   | 32.47     | 32.72   |
| June.....      | 1923  | 0.1°         | -0.2°   | 32.94     | 32.88   |
|                | 1914  | 0.6°         | 0.8°    | 32.83     | 32.85   |
| July.....      | 1915  | 2.8°         | 2.5°    | 32.10     | 33.10   |
|                | 1920  | 3.5°         | 2.25°   | 32.05     | 32.44   |
| August.....    | 1921  | 6.0°         | 4.9°    | 32.94     | 33.10   |
|                | 1922  | 2.0°         | -0.6°   | 32.34     | 33.73   |
| September..... | 1923  | 2.3°         | -0.45°  | 32.88     | 33.01   |
|                | 1910  | 11.0°        | 2.1°    | 32.70     | 32.79   |
| October.....   | 1914  | 4.5°         | -1.0°   | 32.77     | 32.86   |
|                | 1919  | 4.4°         | 1.05°   | 32.13     | 33.21   |
| November.....  | 1920  | 5.1°         | -0.3°   | 32.71     | 33.00   |
|                | 1921  | 11.0°        | 2.1°    | 32.98     | 33.26   |
| December.....  | 1922  | 6.7°         | -0.1°   | 32.28     | 32.86   |
|                | 1923  | 8.9°         | 3.2°    | 32.52     | 32.52   |
| January.....   | 1913  | 11.0°        | 0.8°    | 32.60     | 33.19   |
|                | 1914  | 9.2°         | 0.3°    | 32.68     | 33.01   |
| February.....  | 1914  | 9.2°         | 0.3°    | 32.68     | 33.01   |
|                | 1923  | 13.2°        | 0.85°   | 32.60     | 33.45   |

Evidently, from these data, there are sufficient intrusions of icy water to maintain the bottom of the Bank in a more or less frigid condition, even in August—this in the latitude of Paris and Boston.

The mixing between the water masses of dissimilar physical character over the Grand Bank is extremely active. It is necessary to speak of this in order to show that the low bottom temperatures of summer given in the table are not reminiscent of winter chilling, but are maintained at these low levels by Arctic intrusions. In proof of the activity of circulation over the Grand Bank, the following is submitted:

First: Wave action alone produces considerable mixing, the effects of which extend downward to astonishing depths as pointed out by several writers. Krummel (1911) states that waves have been known to break in 25 fathoms (47 meters). Agassiz (1888) writes that off the northeast coast of New England disturbances due to waves and tide may extend to a depth of 300 fathoms (558 meters). Bigelow (1905) attributes the spherical form of nullipore masses which he dredged from Challenger Bank, off Bermuda, to the effects of wave action. This bank has a depth of 30-40 fathoms (56-74 meters) and is exposed to oceanic influences, in which respects it corresponds to the Grand Bank.

Second: Tidal currents and oscillations have been recorded of a velocity of 0.56 knot per hour by the Patrol in 1915 and 1921 on the Grand Bank, which is bound to react in active mixings. Tide rips have often been observed in calm weather clearly outlining the

contour of the eastern edge of the Bank. It seems probable that this is the diurnal tidal wave (which extends to the bottom) meeting the obstacle of the Bank; the former is accelerated so much that it becomes visible in the form of rips on the surface.

Third: Three observations at four-hour intervals in lat.  $43^{\circ} 05'$ , long.  $50^{\circ} 03'$ , near the Tail of the Bank, in 75 meters (41 fathoms) of water, gave the following data:

| Station 335, 8-9.10<br>P. M., June 18. |                   | Station 336, 12-12.30<br>A. M., June 19. |                   | Station 337, 4-4.20<br>A. M., June 19. |                   |
|----------------------------------------|-------------------|------------------------------------------|-------------------|----------------------------------------|-------------------|
| Depth.                                 | Tempera-<br>ture. | Depth.                                   | Tempera-<br>ture. | Depth.                                 | Tempera-<br>ture. |
| <i>M.</i>                              | $^{\circ}$ C.     | <i>M.</i>                                | $^{\circ}$ C.     | <i>M.</i>                              | $^{\circ}$ C.     |
| 0                                      | 7.6               | 0                                        | 6.8               | 0                                      | 7.2               |
| 15                                     | 7.5               | 1.5                                      | 5.5               | 1.5                                    | 7.0               |
| 30                                     | 5.0               | 3.0                                      | 4.2               | 3.0                                    | 1.7               |
| 45                                     | 3.2               | 4.0                                      | 0.3               | 4.5                                    | 0.8               |
| 60                                     | 1.0               | 6.0                                      | (-)0.7            | 6.0                                    | (-)0.6            |

A comparison of the temperatures in the above table indicates a rapid change of measurable magnitude, all of which is further evidence that an active mixing occurs in the water on the Grand Bank.

Fourth: A comparison of profiles No. 9 and No. 14, the vertical sections which run from the Tail to Cape Race, shows that a great change in temperature and salinity occurred May 9 to June 23 in the water lying over the Bank. Attention is called to the effects of changes in barometric pressure, and wind friction of the surface layers, both of which undoubtedly play a very important rôle in the movements of this very interesting body of water. All this accumulation of evidence justifies the statement that the water over the Grand Bank is in a continuous lively state of circulation.

More Arctic water was transported around the Tail and to the northwestward along the southwest slope of the Bank in 1923 than in any previous year since the inauguration of the patrol, a statement substantiated by the record of bergs, more being set in on the southwest slope and to the northwestward, under the control of this circulation, than in any previous year. In all cases during 1923 the cold water distribution and the berg distribution corresponded closely.

*Summary of the features of 1923.*—(1) Invasive shoulder of Gulf Stream east of Bank.

(2) Offshore movement to south-flowing waters on east side of Bank.

(3) Variations in the size and velocity of the Labrador Current.

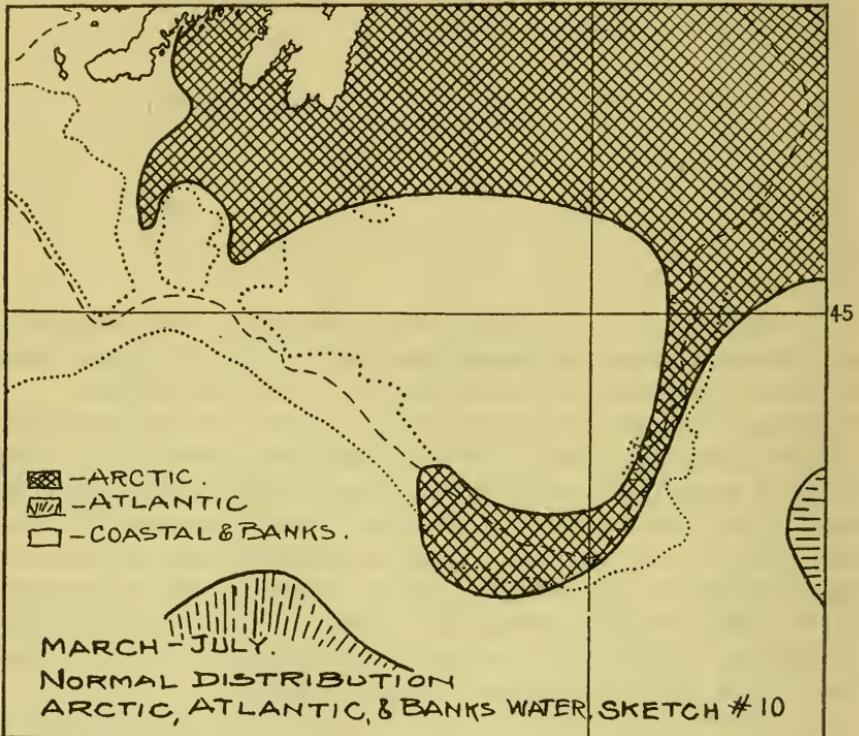
(4) Movement of Arctic water westward along southwest slope.

(5) Tendency of Labrador Current to spread in on bottom of Bank.

(6) Progressive freshening and warming over central part of Bank, especially well marked in the surface layers, with the advance of the season.

(7) Greater intensity of circulation in 1923 than in 1922.

The following sketch illustrates the normal distribution of the three main classified types of water, Arctic, Atlantic, and coastal, and the manner in which the Arctic water floods the northern part of the Grand Bank and extends down and around the Atlantic faces of the latter. The drift and distribution of icebergs in general corresponds to the distribution of the above types of water.



## OCEANOGRAPHIC CRUISE, OCTOBER 21-26, 1923.

Lieut. EDWARD H. SMITH., U. S. Coast Guard.

---

At its twelfth annual meeting, September 28, 1923, the Interdepartmental Board on International Ice Observation and Ice Patrol and Derelict Destruction considered the advisability of having a vessel make a cruise to the Grand Banks during the fall season of 1923 for the purpose of collecting oceanographic data. It was explained that while an exhaustive study had been made of oceanography and ice conditions in this region during the ice season, March-July, no oceanographic observations had ever been made either by the patrol or by any other expedition during the autumn.

The first oceanographic observations were made by the ice patrol during the spring and summer of 1914. They corroborated previous evidence that the Labrador Current, or one extension of it, flowed southward along the east side of the Grand Bank and to a variable distance around the Tail. But subsequent observations made in February, 1922, brought out the fact that the cold current from the north, heretofore found on the east side of the Grand Bank, was at this time a weak, shallow attenuation which ceased altogether in lat.  $43^{\circ} 15'$ ,<sup>1</sup> and this led to the belief that the ice-laden current is subject to seasonal variations. In view of the foregoing it was pointed out that autumnal records would prove of great value in the study of ice conditions in the North Atlantic Ocean and assist in the construction of a picture of seasonal events in the region of the Grand Banks. As a result of such discussion it was decided to send a vessel sometime during the autumn, whose mission would be to locate, if possible, the cold current from the north in the vicinity of the Tail of the Bank at this period of the year, and, furthermore, to determine its exact size, position, and rate of flow. In compliance with orders, the Coast Guard cutter *Seneca* sailed from Boston at 1 p. m., October 17, for the Grand Banks of Newfoundland.

The program of oceanographic work, similar to that adopted during the last few ice seasons, contemplated the making of vertical sections which would run in four radiating directions from a point in on the south central part of the Bank and at right angles to the slope. Stations were occupied along these radials according to the importance

---

<sup>1</sup> 1922. Smith, Edward H.: "International Ice Observation and Ice Patrol Service," Treasury Bulletin No. 10, p. 94.

of circulation at each particular place. (See oceanographic station chart "A.")

A severe gale was experienced on the passage eastward, but the *Seneca* arrived without noteworthy event at station 351, lat.  $43^{\circ} 11'$ , long.  $53^{\circ} 50'$ , at 2.15 p. m., October 21. Favorable weather conditions prevailed, affording an opportunity for accurate and rapid work, and the entire investigation was completed at 12.50 p. m., October 26. The *Seneca* cruised about 850 miles and occupied 26 stations, at which 151 records for both salinity and temperature were secured to a depth of 750 meters (410 fathoms).

The *Seneca* collected the only oceanographic data ever secured at this time of year—October—in the region of the Grand Banks. These data are available for the use of scientists, and also are of practical use to the ice patrol, as they increase its general knowledge of the ice regions. A detailed discussion with reference to the salinity and temperature of the profiles of the four radial sections taken October 21–26 follows:

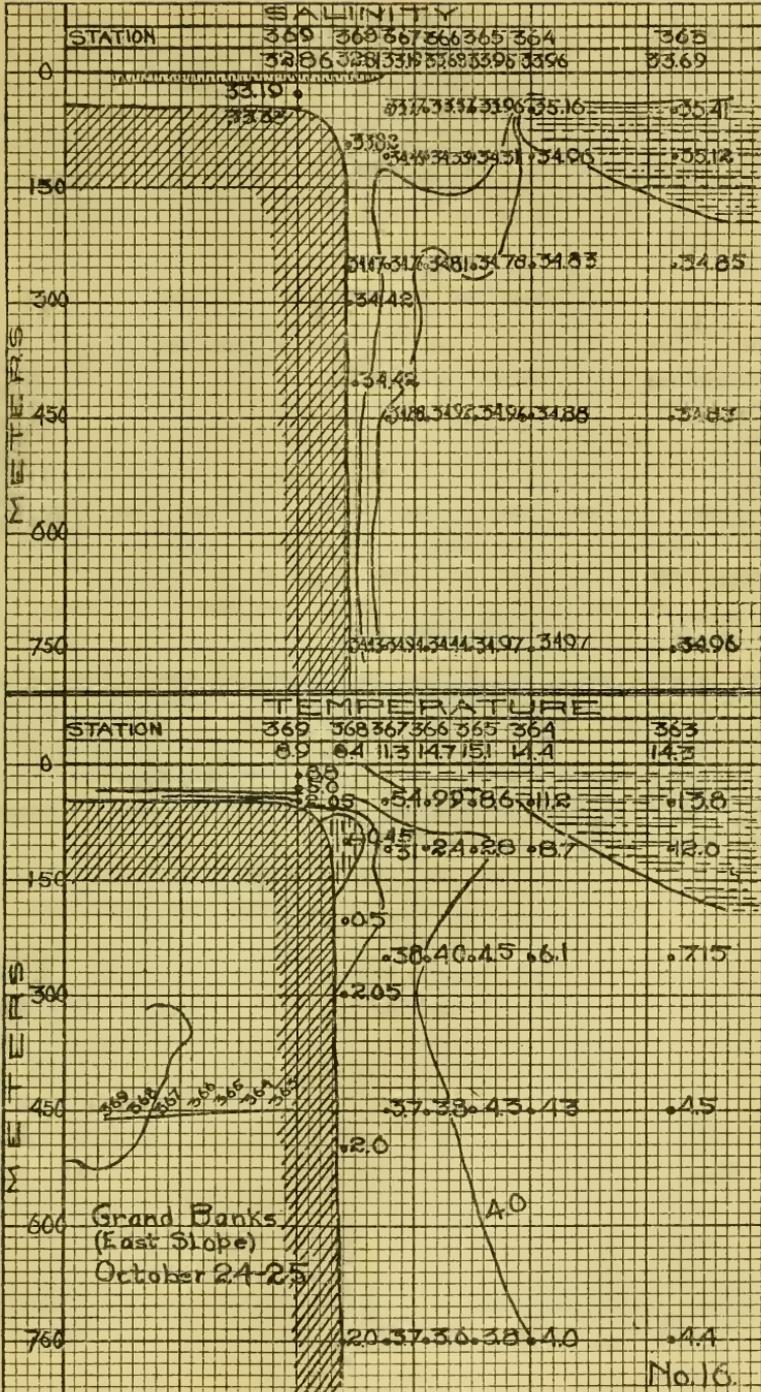
## DISCUSSION OF PROFILES 16–19.

### PROFILE NO. 16—STATIONS 363–369.

The section runs from just inside the continental edge across the slope and eastward into deep water. The stations were taken October 24–25.

*Salinity.*—A shelf of water salter than  $35\text{‰}$  lay between the 45 and 150 meter (25–82 fathoms) depths at the outer stations, but it did not reach to station 365. At this point, 70 miles seaward from the slope, an abrupt transition occurred in the intermediate layers from the highly saline water offshore to decidedly lower salinities,  $<34\text{‰}$ , which occupied the remainder of the section above the 125-meter (68 fathoms) depth. Water between  $34\text{‰}$  and  $33.5\text{‰}$  bathed the slope and the bottom of the Bank. A still fresher surface film,  $32.8\text{‰}$ , 15 meters (8 fathoms) in thickness, spread 12 miles seaward from the edge, and right across the whole section in the upper 30 meters (18 fathoms) the water was fresher than  $34\text{‰}$ .

*Temperature.*—The most interesting feature of the profile is the demonstration of the presence of a narrow band of water of Arctic temperature,  $-0.4^{\circ}$ , hugging the upper part of the slope between the 60 and 160 meter (33–86 fathoms) levels, but not encroaching at all on the bottom of the Bank, nor more than 9 miles in width. The bottom water on the Bank was more than  $2^{\circ}$  warmer ( $2.05^{\circ}$ ) than that on the slope. The curve for  $4^{\circ}$  at the 150-meter (82 fathoms) depth suggests that the temperature at this level had been influenced by this Arctic band 44 miles out, but somewhere between stations 365 and 364 there was a sudden transition between temperature



colder than  $3^{\circ}$  and warmer than  $8^{\circ}$ , which, it should be noted, coincides exactly in location with the corresponding transition from low to high salinities described in the preceding paragraph.

Offshore water warmer than  $10^{\circ}$  lay to a depth of 150 meters (82 fathoms) at the outer station and extended inshore, gradually thinning to a surface film which could be traced no farther inshore than station 367. The coldest water found on the surface was directly over the band of icy water 50 meters (27 fathoms) on the continental edge.

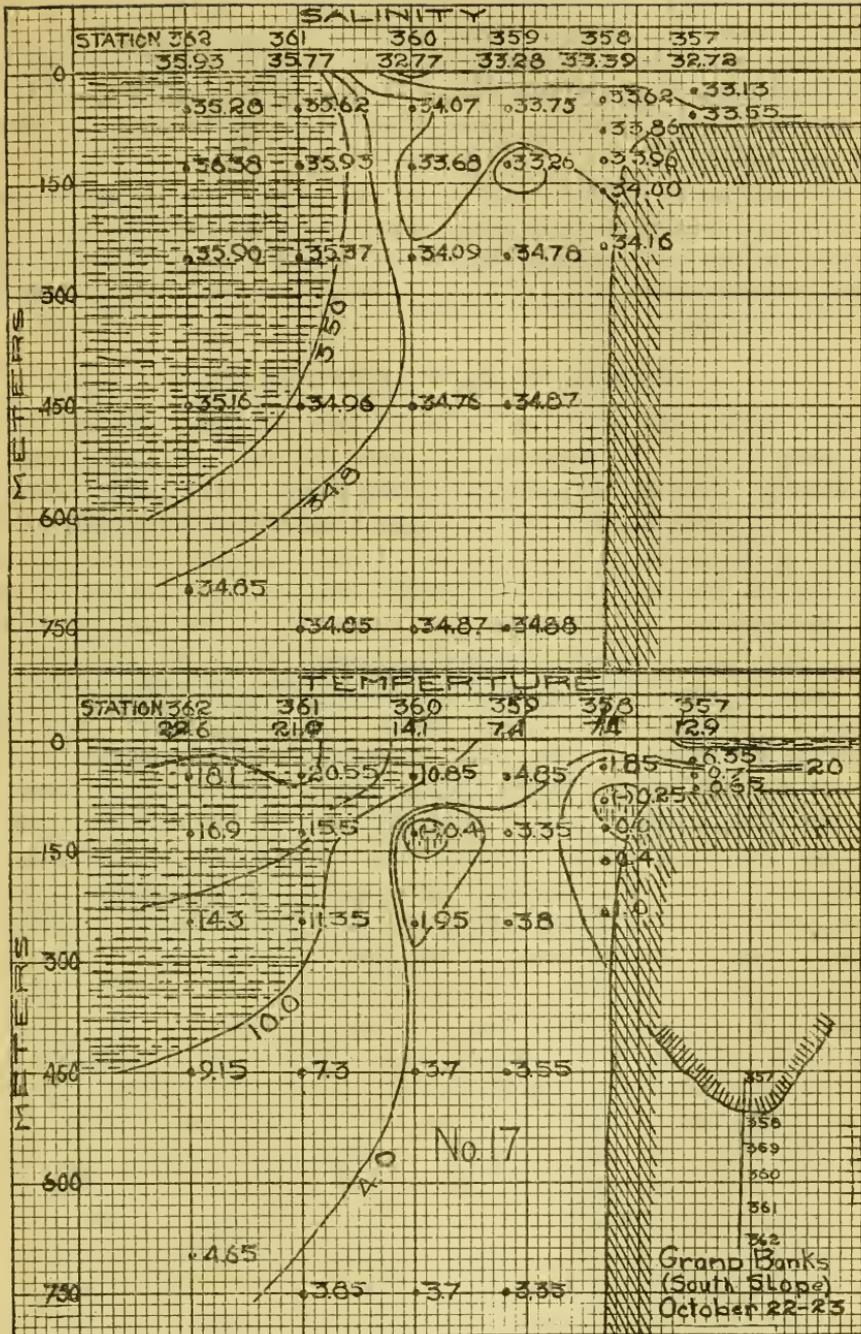
#### PROFILE NO. 17—STATIONS 357-362.

The section runs from in on the Tail of the Bank southward out over the slope and into the deep water. The stations were occupied October 22-23.

*Salinity.*—A body of water salter than  $35\text{‰}$  was found flooding all depths to 600 meters (328 fathoms) and 450 meters (246 fathoms) at stations 362 and 361, respectively. The northern face of this water, as bounded by the curve  $35\text{‰}$ , was of slightly convex form, the upper 300 meters (164 fathoms) being nearly vertical and lying 78 miles from the continental edge. The transition zone from  $35\text{‰}$  to  $34\text{‰}$  water was encountered between station 361 and station 360. Water salter than  $33\text{‰}$  flooded the whole column in on the Bank, except at the surface, which was  $32.72\text{‰}$ . Water of a salinity less than  $33.5\text{‰}$  spread seaward from the edge for more than 60 miles. The water immediately on the slope at the 80-meter (44-fathom) level registered  $33.86\text{‰}$ , an important fact in connection with the discussion of the circulation.

*Temperature.*—Similar to the band of cold water found northward on the east slope (see profile No. 16), and without doubt a southern extension of the latter were the two bands of water colder than  $0^{\circ}$ , which are the most striking features of the section. One band was found lying on the slope between the 60-meter (33-fathom) and 135-meter (74-fathom) depths; a shelf projecting offshore 12 miles from the continental edge. The second band or core of  $-0.4^{\circ}$  water lay at the 125-meter (68-fathom) depth of station 360. Probably these two bodies of cold water had become disconnected some time shortly prior to October 22-23. The bottom of the Bank was covered to a thickness of 30 meters (16 fathoms) by water colder than  $0.7^{\circ}$ , which is much colder than the water on the east side of the Bank ( $2.05^{\circ}$ ) at station 369, several miles to the northward. But this water in over the bottom,  $0.6^{\circ}$ , is considerably warmer than the Arctic bands aforementioned.

At the outer station water warmer than  $10^{\circ}$  and with  $18^{\circ}$  at surface occupied the upper 150 meters (82 fathoms). But shoreward the isotherm for  $10^{\circ}$  rose to the surface somewhere between stations



375 and 374. The surface was likewise warmer than  $10^{\circ}$  over the Bank but cooler over the intermediate portion of the section, in which respect it corresponds to profile No. 16.

It may be added that the temperature of the surface at station 362, 120 miles south of the Tail, was the highest recorded for the cruise and higher than any ever taken during previous ice seasons by the patrol.

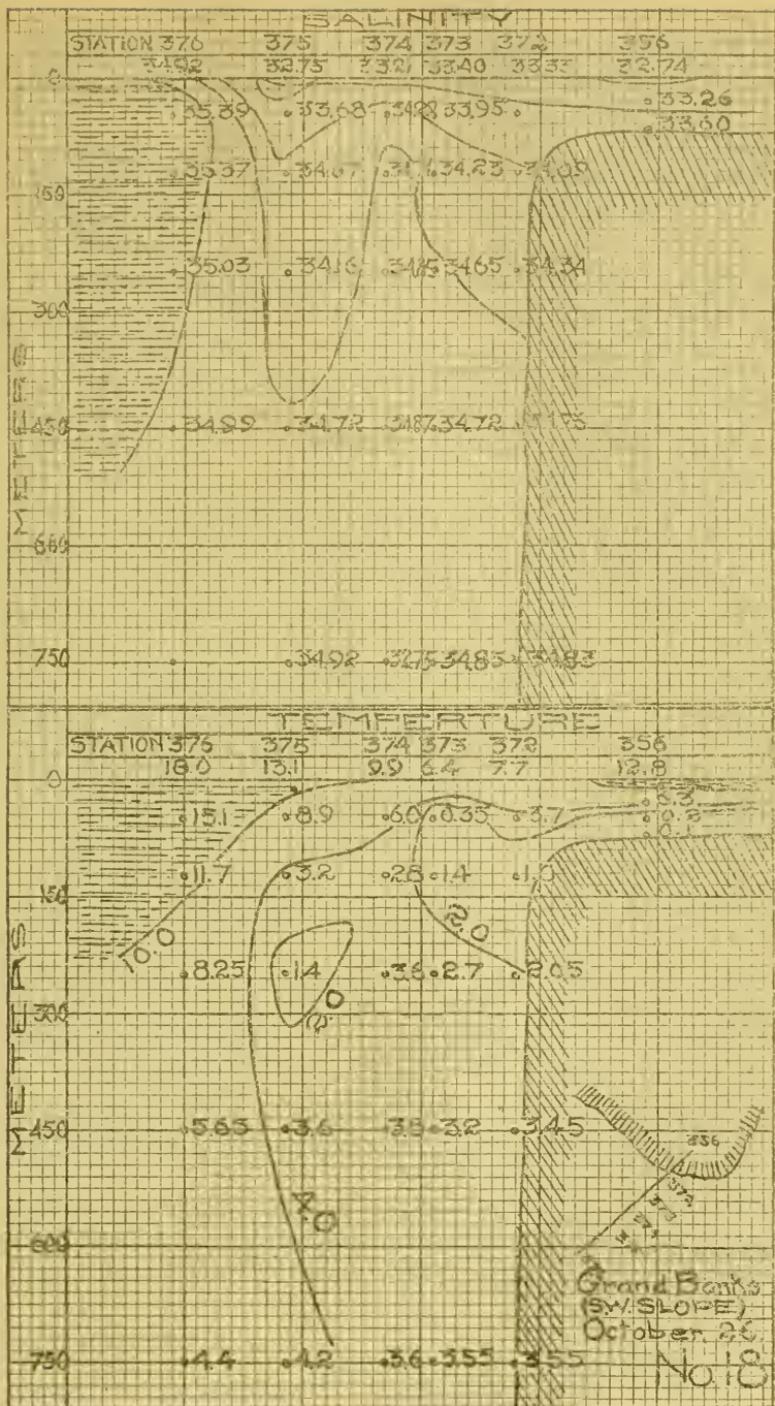
A comparison of the salinity and the temperature suggests an offshore movement in the surface layers from the continental edge but a sinking near station 360, at the location of the outer cold band, substantiated by the course of both the  $34\text{‰}$  isohaline and the  $20^{\circ}$  isotherm.

#### PROFILE NO. 18—STATIONS 356-376.

The section runs from in on the southwest slope offshore into the deep water of the Atlantic. The stations were taken October 26.

*Salinity.*—The saltiest water,  $35\text{‰}$ , was found at the outer station, 376, its northern face, of convex contour, extending downward to a depth of 600 meters (328 fathoms). It lay 85 miles seaward from the edge of the Bank at a point farther offshore than at the Tail or to the westward. (See profiles Nos. 16 and 19.) The isohalines for  $34\text{‰}$  and  $35\text{‰}$  follow a roughly horizontal course at the 15 and 45 meter (8 and 25 fathom) depths, respectively. Two disconnected shallow surface pools of water fresher than  $33\text{‰}$  were found at stations 375 and 356. There was no abrupt wall or zone of transition from high to low salinity to be found in this section, which thereby differs from former sections taken by the Patrol in the regions where the highly contrasted waters lie adjacent to each other. Isohaline  $34.5\text{‰}$  and isotherm  $2.0^{\circ}$  suggest a sinking of the water mass, at station 375, 60 miles from the slope, but without consideration of relative densities such a statement is unwarranted.

*Temperature.*—The most noteworthy feature of this section was the absence of any water colder than  $0^{\circ}$ , where we naturally expected to find such water on the continental edge. The lowest temperature at this spot, in the location similar to the icy cold band observed on the slope either side of this section, was  $1^{\circ}$ . A core of cold water,  $1.4^{\circ}$ , lay offshore at the 250-meter (137-fathom) level, station 375, and probably represents traces of the extreme extension of the offshore icy band found off the Tail, profile No. 17. The coldest water of the section,  $0.1^{\circ}$ , was found in on the bottom of the Bank, being the coldest bottom water found in October. It is worth remarking that the only section not exhibiting below zero temperatures had the lowest bottom temperature in over the Bank, and the largest area of cool water off the slope.



## PROFILE NO. 19—STATIONS 351-355.

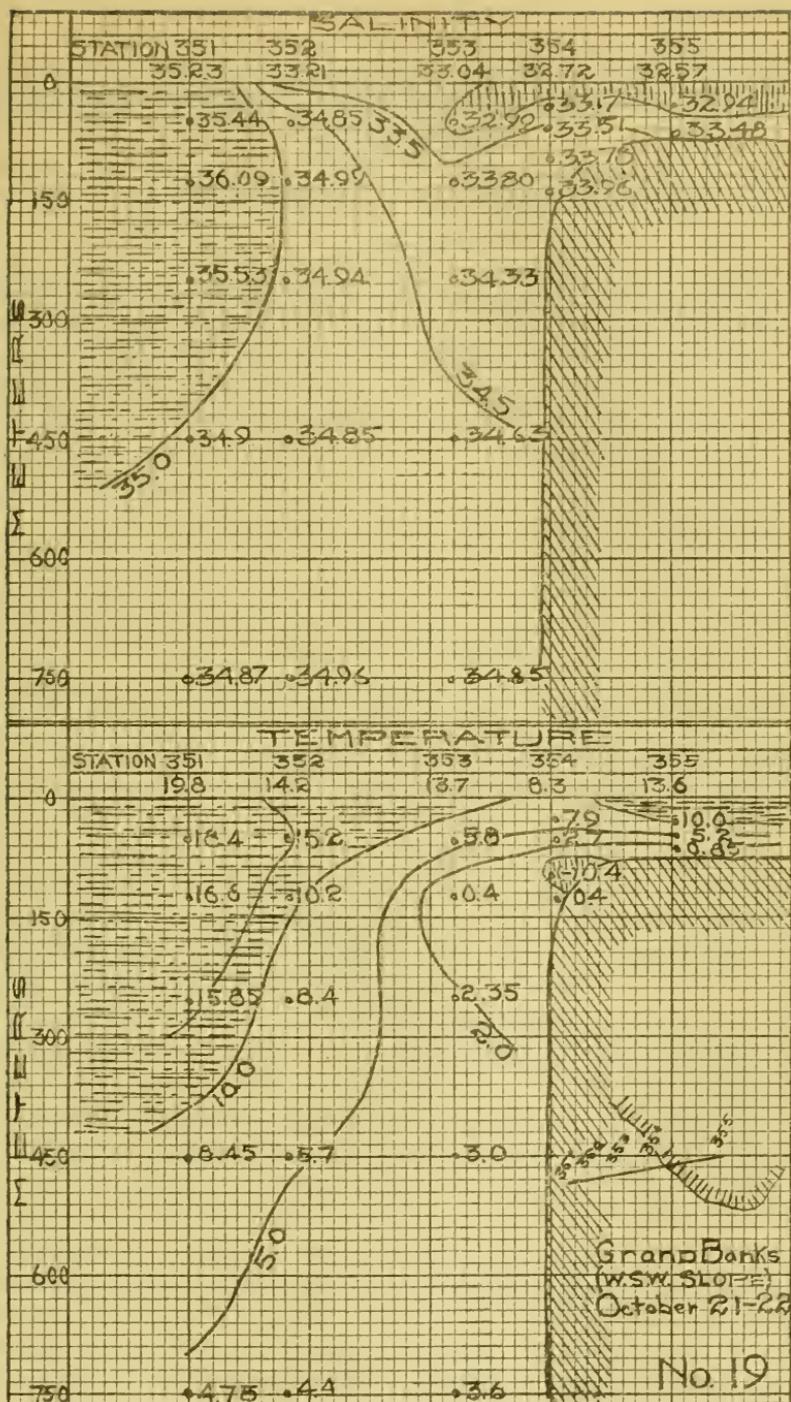
The section runs from in on the Bank west-southwesterly across the southwest slope and offshore into deep water. The stations were taken October 21-22.

*Salinity.*—Water of 35 ‰ was found at the outer station extending downward 450 meters (246 fathoms). The general shape of its northern boundary corresponded closely to water of this same character at the Tail on profile No. 17; and similarly a salinity of over 36 ‰ was found at the 125-meter (68-fathom) level, 68 miles seaward of the slope, which identifies this as Gulf Stream. Water of 34.5 ‰ to 33.5 ‰ lay on the slope and in over the bottom of the Bank, while a surface film of water fresher than 33 ‰ spread nearly 30 miles seaward from the edge—the largest quantity of water of such low salinity found in any of the sections for October.

*Temperature.*—Again we found a band of water colder than 0°, presumably a connection with those which we had previously observed on the east slope and at the Tail. It lay on the slope between the 75 and 120 meter (41 and 66 fathom) levels, and extended only 8 miles offshore, which is a decrease in size from that around the Tail and northward. The bottom water in on the Bank was 0.85°, which is colder than that found on the Bank to the eastward but not so cold as the water which lay in over the southwest slope and at the Tail.

The influence of the band of icy water on the slope was reflected in the temperatures on the surface, which, being colder than the water on either side of it, and despite the influence of solar warmth, retained its Arctic character. These two bodies of warmer water separated by the cold band correspond in temperatures higher than 10°, but are quite dissimilar in physical character. Inshore over the Bank a fresh surface layer 30 meters (16 fathoms) thick attained a temperature higher than 10° through solar warming. Offshore at the outer stations, on the other hand, we find water with temperatures higher than 15°, which water can have only one source, the Tropics, and in this region is referred to as Gulf Stream.

Consideration of the relatively high state of salinity (except on the surface, where diluted by water fresher than 33 ‰), combined with the relatively high temperature of the two bodies of warm water (except where the section was punctured by the icy band), suggests that this locality may bound the extreme northwestern extension of frigid Arctic water along the western slope of the Grand Bank.



## SUMMARY OF OCEANOGRAPHIC CRUISE OCTOBER 21-26, 1923.

Lieut. EDWARD H. SMITH, U. S. Coast Guard.

---

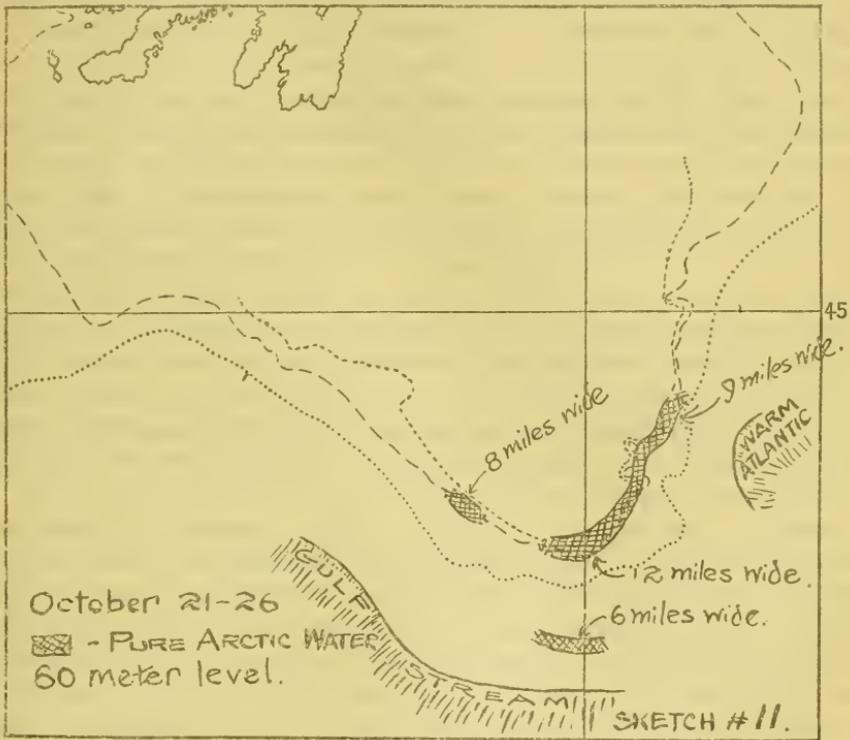
A general consideration of all sections emphasizes above all else that oceanographical conditions around the Tail of the Grand Bank in the autumn are quite different, in the main, from what they have been found to be in the spring. The standards upon which comparisons are based, naturally, must be different in October from in May, for in the first instance the water mass has been under the influence of an entire summer's warmth, while in the second the water is just beginning to acquire warmth after a full winter's chilling. Yet, fundamentally, it was found that the two periods corresponded in one very important respect: water of unmistakable Arctic origin was bathing the east slope and southward around the Tail of the Bank during the period October 21-26, 1923.

The proof for this statement rests on the presence of a band of icy cold water of temperature below zero which was found in all the sections, except the mid one on the southwest slope, 45 miles west of the Tail, where no water colder than zero degrees was found. The temperatures of  $-0.4^{\circ}$  to  $-0.25^{\circ}$ , existing around the Atlantic faces of the Grand Bank, could not have been produced locally, or even earlier in the season, as pointed out on page 146, and therefore they could only have been the result of cooling somewhere in the regions farther north. The salinity of this band of extremely cold water,  $33.86\text{‰}$  to  $33.78\text{‰}$ , also accords with the salinity of the northern discharge; consequently this water in question must have been transported to the Grand Bank by a current from the north.

As pointed out above, the recognition of Arctic water depends on rather different criteria of salinity and temperature in autumn than in spring, this frigid water being about  $0.8\text{‰}$  saltier and about  $1^{\circ}$  warmer at the same locality in October than in the spring, when the icy current is flowing at its maximum. This salting from spring to summer has been brought about through a more extended period of exposure to Atlantic adulterations, from which a slow, occasionally interrupted, flow from the north must suffer. The warming is attributable to two factors: (1) the heat derived from the summer's sun and (2) heat transference through mixture with the much warmer offshore Atlantic.

The proof that such icy water masses found along the southwest slope, 90 miles west of the Tail, were transported clockwise around the Atlantic faces of the Grand Bank, instead of across it, is furnished by the decidedly higher temperatures in over the Bank.

The Arctic water in October was in the form of a narrow streak bathing the 90 meter (49 fathoms) contour southward as far as the Tail, and again an isolated patch, probably a disconnected extension, 90 miles northwest of the Tail at the same depth on the slope. This body was 9 miles wide and 90 meters (49 fathoms) deep on the east slope, 12 miles wide and 75 meters (41 fathoms) deep at the Tail, 12 miles wide and 75 meters (41 fathoms) deep at the Tail,



and 8 miles wide and 45 meters (25 fathoms) deep farthest west on the slope, plainly showing that it was becoming narrower and shallower as we proceeded westward. An isolated core of icy water offshore of the Tail will be discussed later.

Although the axis of the Arctic water occupied about the same location relative to the slope in October as is usually the case in the spring, its volume was much smaller. A comparison between the size of the Arctic current during the spring when it was at a maximum (sketch No. 4) with its dimensions in June and October (sketches 7 and 11) brings out this fact. At the Tail of the Bank in April it had a width of 30 miles and a depth greater than 750 meters (410 fathoms);

in June it had shrunk to a breadth of 20 miles and a depth of 160 meters (86 fathoms), while in October it was only 12 miles across and 75 meters (41 fathoms) deep.

The fact that there was less Arctic water around the Grand Bank's slopes in October than in April or June lends support to the theory that the cold northern discharge is subject to seasonal variations of measurable proportions, flooding to a maximum during spring and dwindling in summer. It may cease altogether temporarily in autumn or winter (Treasury Bull. No. 10), leaving behind patches of Arctic water (relics), which would be recognizable by their low temperatures until absorbed in the general system of eddylike mixings which are constantly in process around the Grand Banks (p. 146). In October, when these observations were made, the volume of the Arctic water was near the minimum. The only winter observations in the vicinity of the Grand Bank were made by the ice patrol in February, 1921 and 1922 (Treasury Bulls. No. 9 and No. 10), when there proved to be no Arctic water either on the southwest slope or even on the eastern, except north of latitude  $43^{\circ} 15'$ , February, 1922. This might point to a progressive dwindling of the current in late summer and in the fall, which possibly culminates in its complete cessation, but in any event the minimum strength of the discharge from the north occurs in late fall and winter. But even then temporary pulsations probably occur, a belief based upon the observations during the period March-July, 1923, when fluctuations in the strength and volume of the Arctic current around the Tail were frequent and irregular.

It will be noticed on sketch No. 11 that a patch of isolated icy water was found 90 miles northwest of the Tail on the southwest slope, having the same physical character as the Arctic band at the Tail, and was no doubt a part of the latter, which had been pinched off and moved to the westward along the slope. This corresponds to conditions in the previous May (p. 146), when, during short periods of alternate flooding and ebbing of the northern current, isolated patches of polar water were left along the southwest slope, to be engulfed and finally absorbed by mixing with Atlantic water. In the deeper layers, on the contrary, such icy relics tend to work to the westward around the continental slope, as shown by the drifts of bergs. (See charts "B" and "C.")

The absence of icy water colder than  $0^{\circ}$  along the mid section on the southwest slope in October is attributable to the mixing process between cold northern water and warm Atlantic water. The equalization of temperatures suggested by the section at this place indicates that immediately prior to the taking of the observations a very active interdigitation took place, leaving a water mass completely

mixed and altered in character. It is difficult to state why such a lively mixing should occur at this precise place.

The presence of an apparently isolated core of icy water 6 miles wide and 60 miles seaward from the Tail on the south section (profile No. 17) is also difficult to account for satisfactorily. It may have been a recurling finger actually connected with icy water on the slope, or may have set offshore from the main supply at the Tail.

While navigating through the streak of northern water lying on the east continental edge of the Grand Bank in October, careful and frequent astronomical observations were taken, but no set or drift could be detected. Hence, either the current was very weak or it was so narrow that it did not affect the ship appreciably. It is believed both factors were involved. Two whales and several shearwaters were seen feeding in this band of coldest water, which is a characteristic sight in the spring of the year, when the Arctic current teems with all sorts of marine life. If this water was not flowing south along the eastern edge at that particular time, October 25, it certainly had been freighted to this locality, since it still held abundant northern fauna.

October 25 was a calm day, with smooth sea, when we steamed on a course parallel with, and nearly over, the edge of the Bank. A well-marked rip was visible running in a general north and south direction and outlining the contour of the Bank as exactly as it could be marked on a chart. The phenomenon may have been attributable partly to the diurnal tidal wave meeting the obstacle of the Bank.

It will be noticed by sketch No. 11 that warm Atlantic water occupied the submarine valley which indents the east continental slope of the Grand Bank at lat.  $43^{\circ} 40'$ , long.  $47^{\circ} 15'$  and extended well inshore just below the surface. This condition was not so well defined as during early spring, as evidenced by the salinity of 35.4 ‰ to 35.12 ‰ and the temperature of  $12^{\circ}$  to  $14^{\circ}$ , but the fact that such a tendency existed in October demonstrates that this state is not characteristic of spring only.

By contrast the Gulf Stream water (salinity 36.09 ‰ and temperature  $18.4^{\circ}$ ) in the surface layers of the deep oceanic triangle west of the Tail had worked farther north by October than we have ever found it at any time during the spring or early summer. The last observations, made June 3-4 (see profile No. 12), mark the beginning of this movement, which had been assisted throughout the summer by the prevailing southerly winds frictionally urging the surface layers toward the continental slope.

During the period between June and October water of low salinity but comparatively high temperature had continued to spread offshore in the surface layers. This movement was most noticeable on the west slope of the Bank, when water fresher than 33 ‰ formed a

surface layer 45 meters (25 fathoms) in thickness 30 miles out from the edge. Another surface film of water of low salinity, much thinner than the above, was found on the east side of the Bank. Curiously enough this tendency toward offshore expansion was confined entirely to the surface, and the water in the deeper layers over the Bank was more saline in October than during the previous spring. The only source from which this water could have received salty adulterations is to the southward—the offshore Atlantic. All this suggests a continuous and extensive expansion of warm surface water of low salinity from the coast seaward; and progressive mixing on the slope and on the bottom of the Bank, whereby salinity and temperature were raised by the warm salt Atlantic influence.

It might be added that the two northern Banks' stations, one on the west side and one on the east side, were warmer and fresher in the surface layers than those farther south around the Tail, and moreover the westernmost of these stations was fresher on the surface, but not warmer, than the eastern one. This points to an easterly progress of the fresh surface layers which is freshest on the west side of the Bank, because it is nearest the source of supply, and warmer on the east because warmed by solar heat as it progresses across the shallows.

#### SUMMARY.

The following conclusions are reached as a result of the fall oceanographic cruise:

(a) Arctic water was present along the Atlantic faces of the Grand Bank.

(b) The head of northern water around the Tail had warmed by  $1^{\circ}$  and salted by 0.8 ‰ since spring.

(c) The northern water was a very shallow and narrow band as compared with that of June.

(d) Isolated cold patches were present on the southwest slope which had originally been connected with a northern supply.

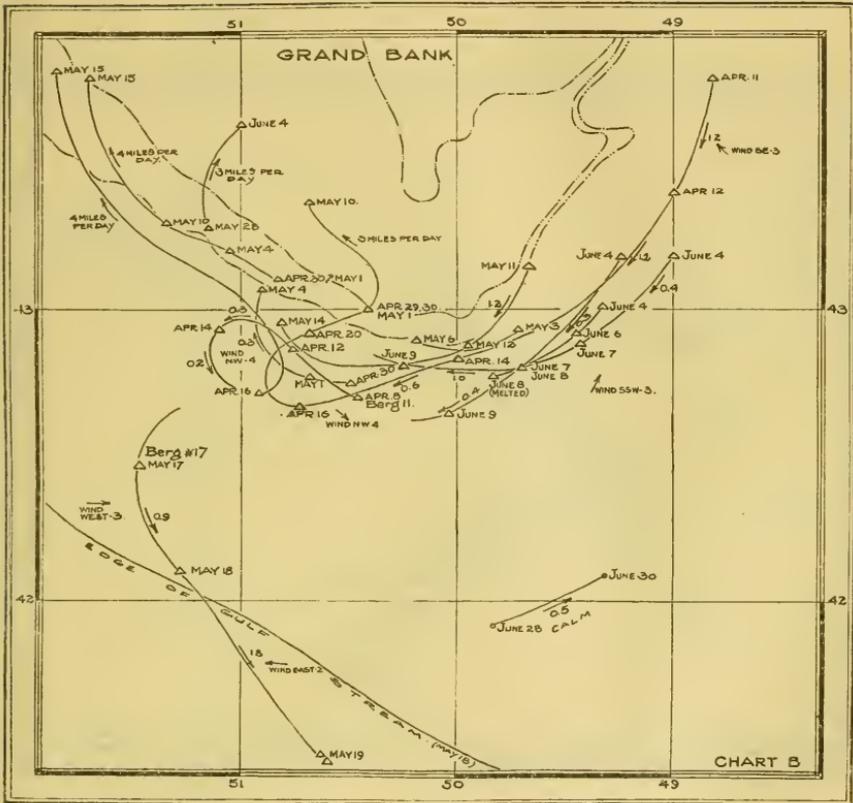
(e) The narrowness and shallowness of the icy water (yet existing) was a feature of the fall observations.

(f) No appreciable southerly set was noticeable while navigating in this cold water.

(g) An increase since spring was noticed in the quantity of offshore expansion of low salinity water in the surface layers.

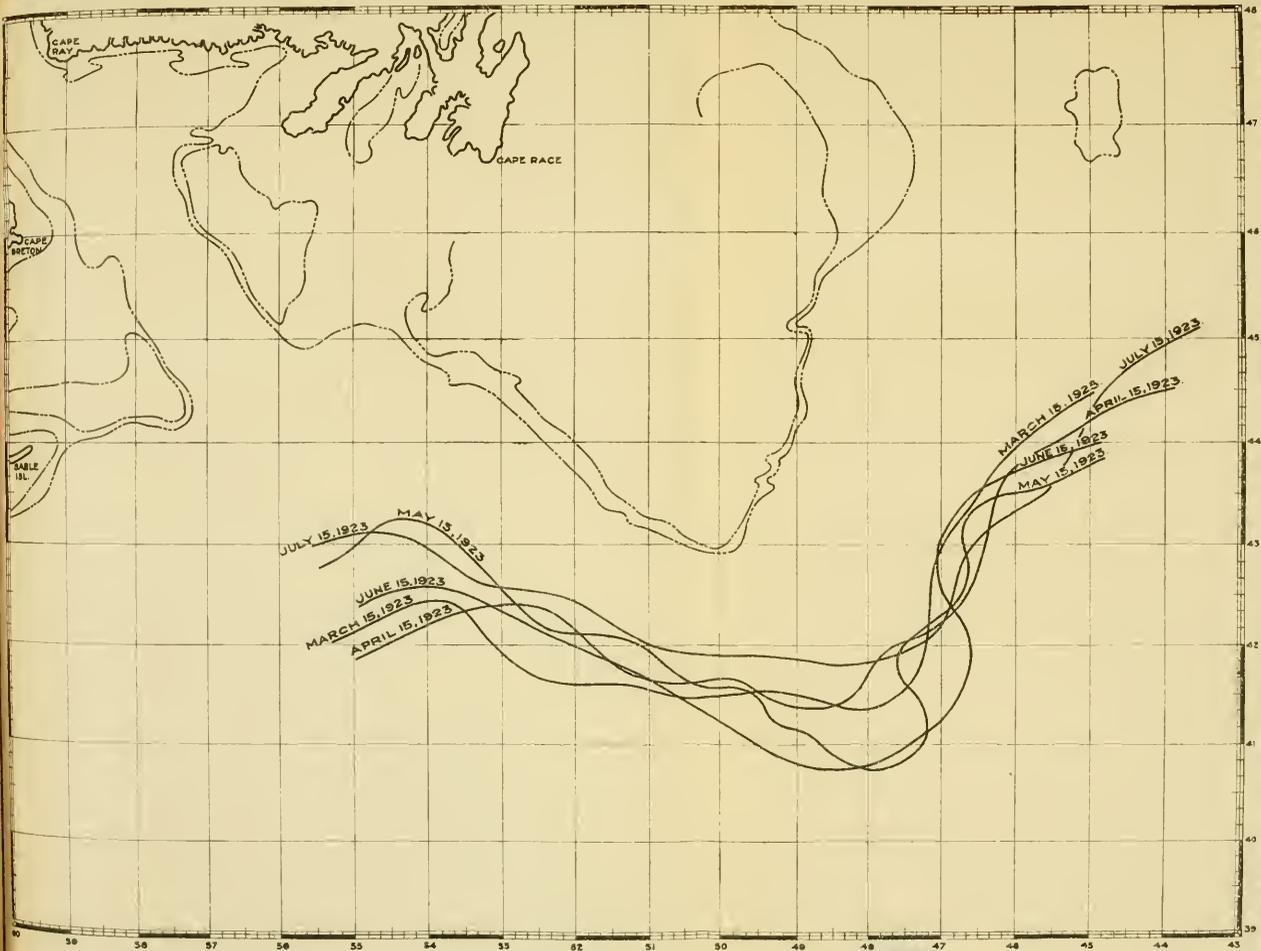
(h) The eastward movement of this water across the Grand Banks was also observed at stations 355 and 369.

(i) Evidence was gathered which indicates a seasonal variation in the current from the north.



88124-24-12





GENERAL CHART  
COVERING  
ICE PATROL  
MONTHLY LIMITS "COLD-WALL".

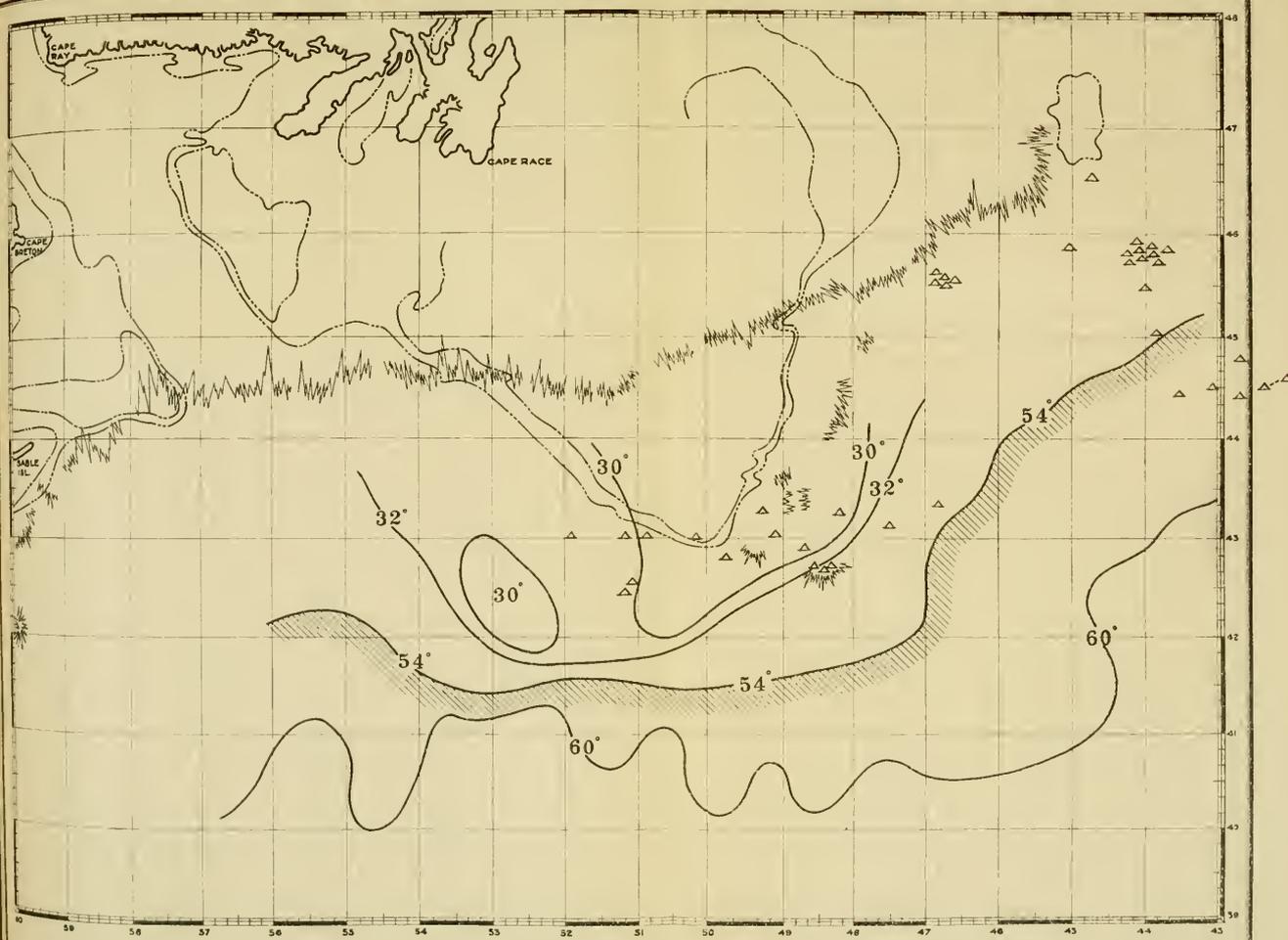
GRAND BANKS  
1923.

CHART "D"

Handwritten text at the top of the page, possibly a title or header.



Small handwritten text or notes located at the bottom left corner of the page.



▲ BERGS  
 ○ GROWLERS  
 ▨ FIELD ICE

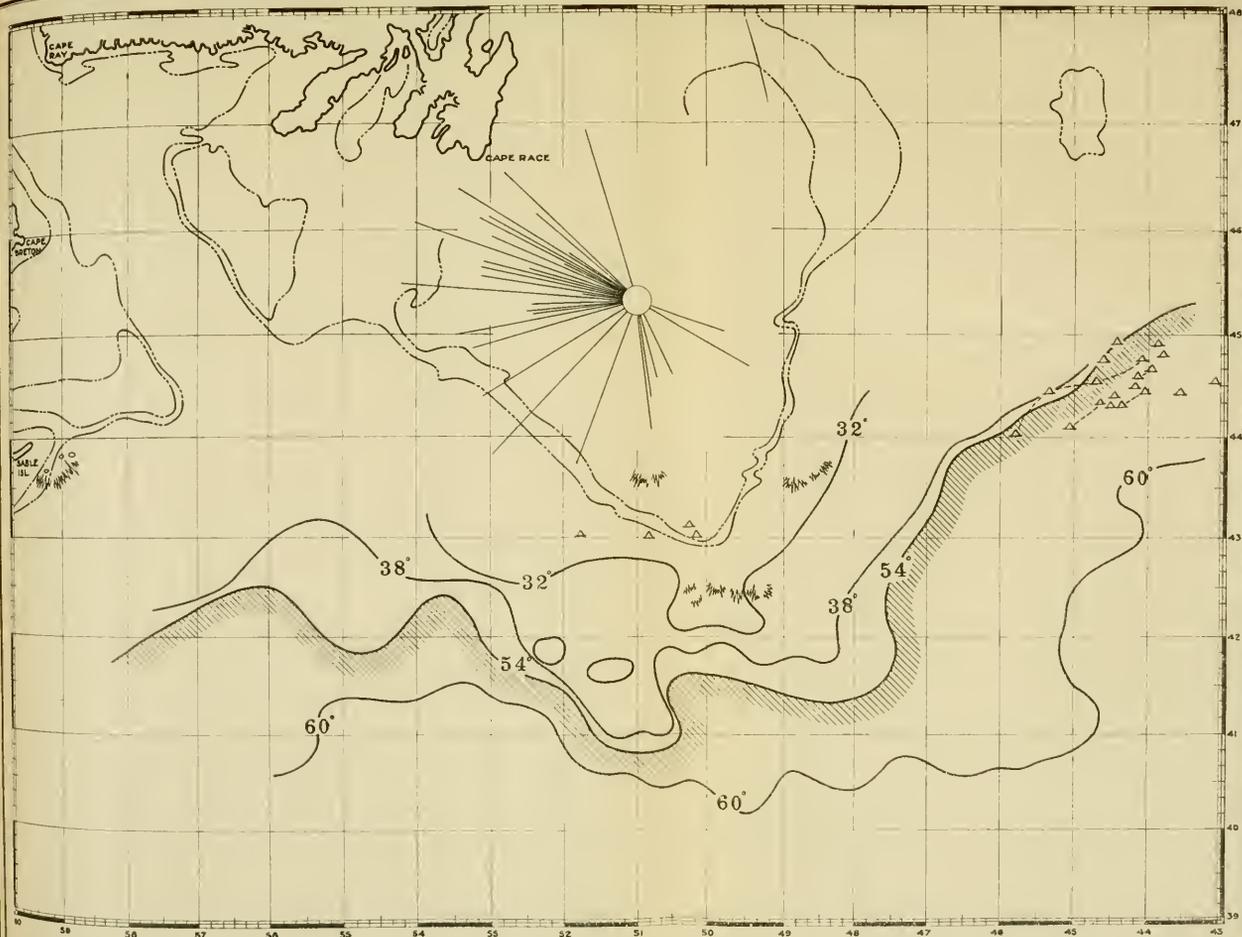
BASED ON 321 WATER  
 TEMPERATURE REPORTS

GENERAL CHART  
 COVERING  
**ICE PATROL**  
 FEB. 27 - MAR. 15, 1923  
 SHOWING SEA-WATER TEMPERATURES AND VARIOUS CONDITIONS IN VICINITY  
 GRAND BANKS

BEAUFORT SCALE FOR WIND DIAGRAM.

CHART 'F'





▲-BERGS  
 □-CROWLERS  
 ---FIELD ICE

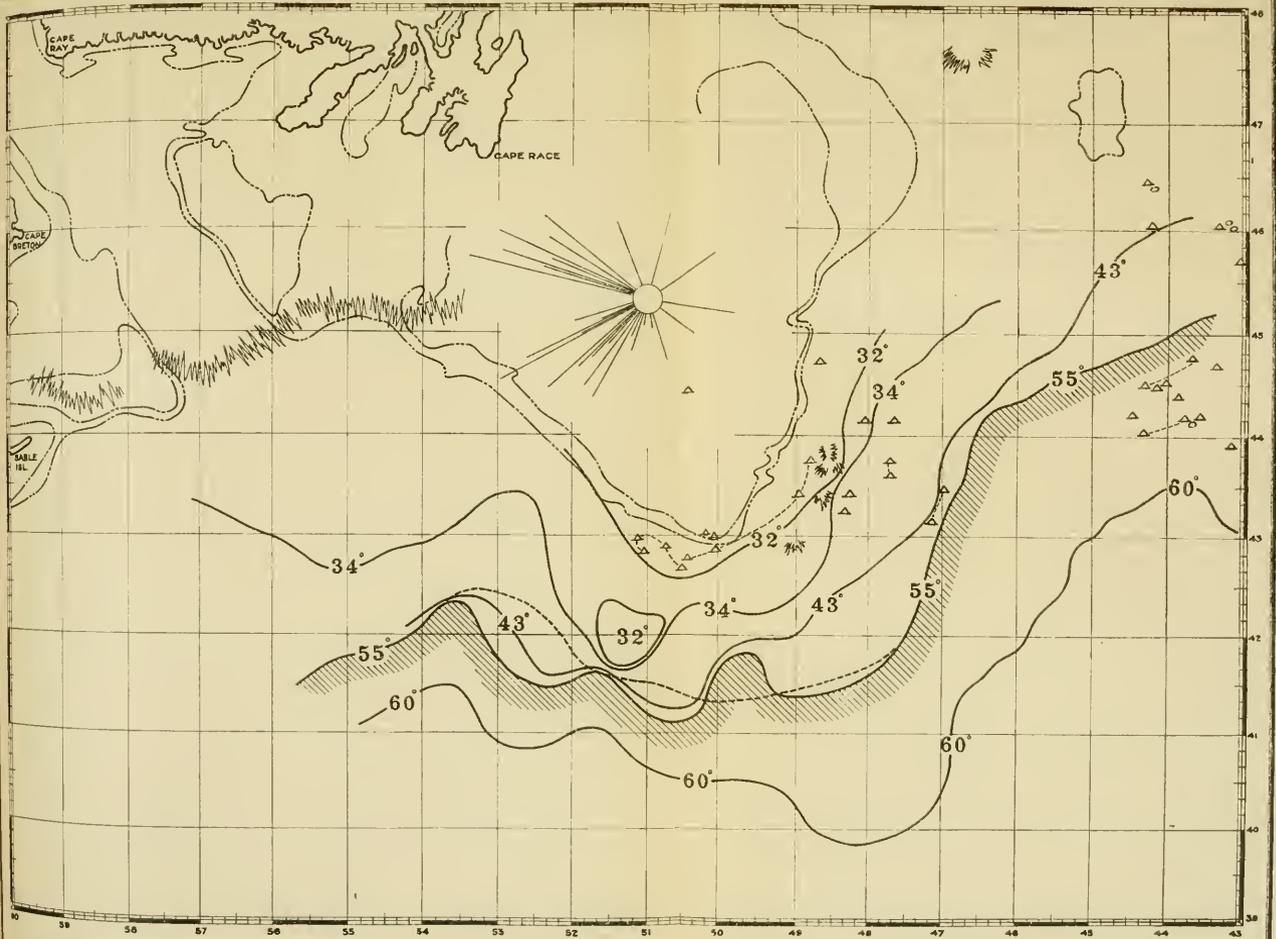
NOTE: ICE FIELD COVERED GRAND BANKS  
 AND WESTWARD TO NOVA SCOTIA COAST  
 BASED ON SIZ WATER  
 TEMPERATURE REPORTS

GENERAL CHART  
 COVERING  
**ICE PATROL**  
**MARCH 15-31, 1923**  
 SHOWING SEA-WATER TEMPERATURES AND VARIOUS CONDITIONS IN VICINITY  
**GRAND BANKS**

BEAUFORT SCALE FOR WIND DIAGRAM.

CHART "C"





▲ - BERGS  
 ○ - GROWLERS  
 ▨ - FIELD ICE

NOTE: DOTTED ISOTHERM SHOWS  
 CHANGE COLD-WALL APRIL 10-15  
 BASED ON 1007 WATER  
 TEMPERATURE REPORTS

GENERAL CHART  
 GOVERNING  
 ICE PATROL  
 APRIL 1-15, 1923.

SHOWING SEA-WATER TEMPERATURES AND VARIOUS CONDITIONS IN VICINITY  
 GRAND BANKS



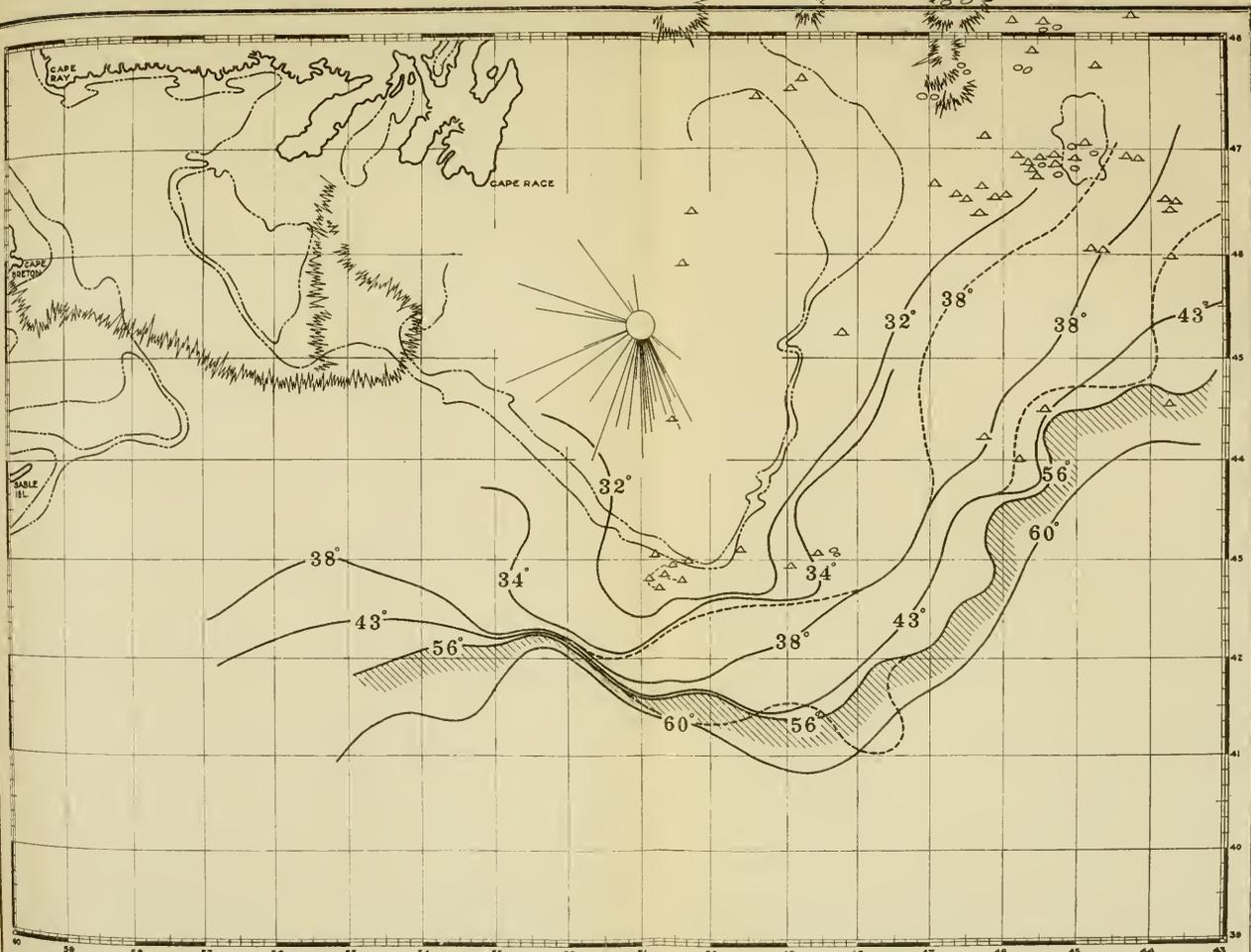
CHART "H"

U.S. PHOT. CO. 5511

1911  
L. J. ...



OFFICE OF THE  
COMMISSIONER OF THE GENERAL LAND OFFICE  
WASHINGTON, D. C.



▲-BERGS.  
 ○-GROWLERS.  
 ---FIELD ICE.

NOTE: DOTTED LINES SHOW CHANGES IN  
 POSITION OF ISOTHERMS THE LATTER  
 PART OF THE MONTH  
 BASED ON 1226 WATER  
 TEMPERATURE REPORTS.

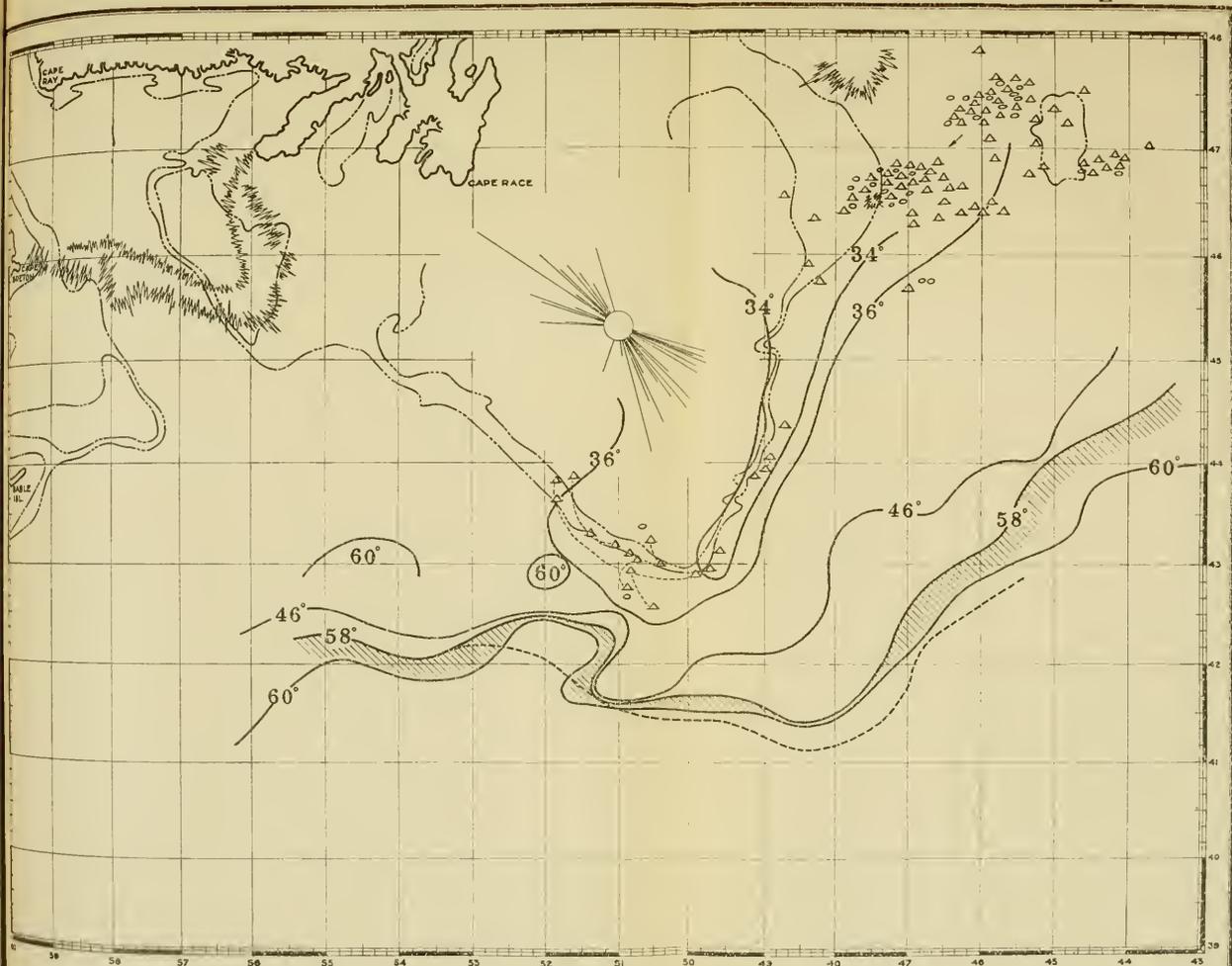
**GENERAL CHART**  
 COVERING  
**ICE PATROL**  
**APRIL 15-30, 1923**  
 SHOWING SEA-WATER TEMPERATURES AND VARIOUS CONDITIONS IN VICINITY  
**GRAND BANKS**

BEAUFORT SCALE FOR WIND DIAGRAM.

CHART "I"  
U.S. Hydrographic Office



1. *[Faint handwritten text]*  
 2. *[Faint handwritten text]*  
 3. *[Faint handwritten text]*  
 4. *[Faint handwritten text]*  
 5. *[Faint handwritten text]*  
 6. *[Faint handwritten text]*  
 7. *[Faint handwritten text]*  
 8. *[Faint handwritten text]*  
 9. *[Faint handwritten text]*  
 10. *[Faint handwritten text]*



4-BERGS.  
 1-BROWLERS  
 1-PELLED ICE.

BASED ON 1125 WATER  
 TEMPERATURE REPORTS

GENERAL CHART  
 COVERING  
 ICE PATROL

MAY 1-15, 1923

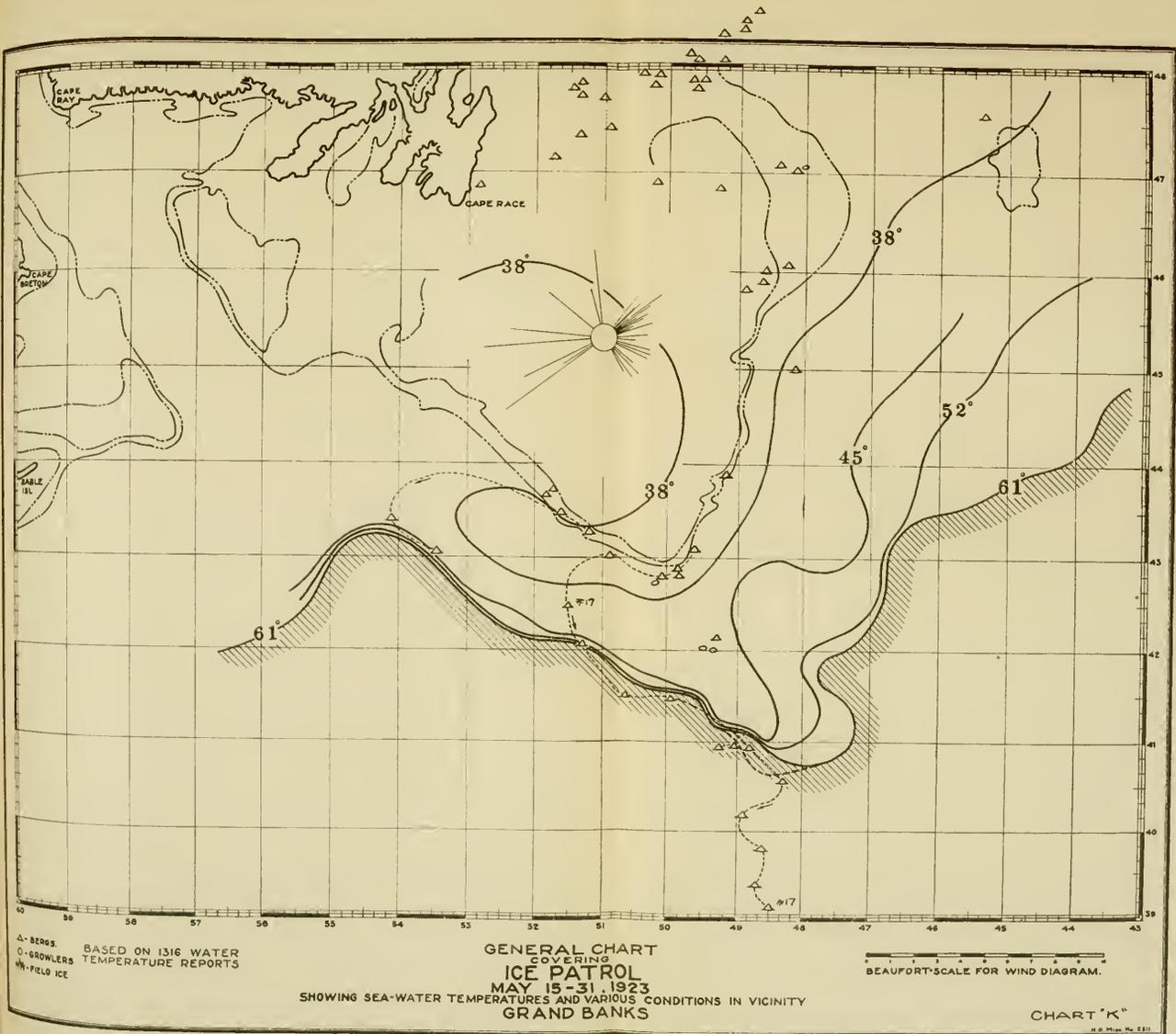
SHOWING SEA-WATER TEMPERATURES AND VARIOUS CONDITIONS IN VICINITY  
 GRAND BANKS

BEAUFORT SCALE FOR WIND DIAGRAM.

CHART "J".

U.S. GOVERNMENT PRINTING OFFICE: 1923





BASED ON 1316 WATER  
 TEMPERATURE REPORTS

△ BEARS  
 ○ GROWLERS  
 ▨ FIELD ICE

GENERAL CHART  
COVERING

ICE PATROL  
MAY 15-31, 1923

SHOWING SEA-WATER TEMPERATURES AND VARIOUS CONDITIONS IN VICINITY  
GRAND BANKS

BEAUFORT-SCALE FOR WIND DIAGRAM.

CHART "K"

H. O. P. M. N. E. S. I.

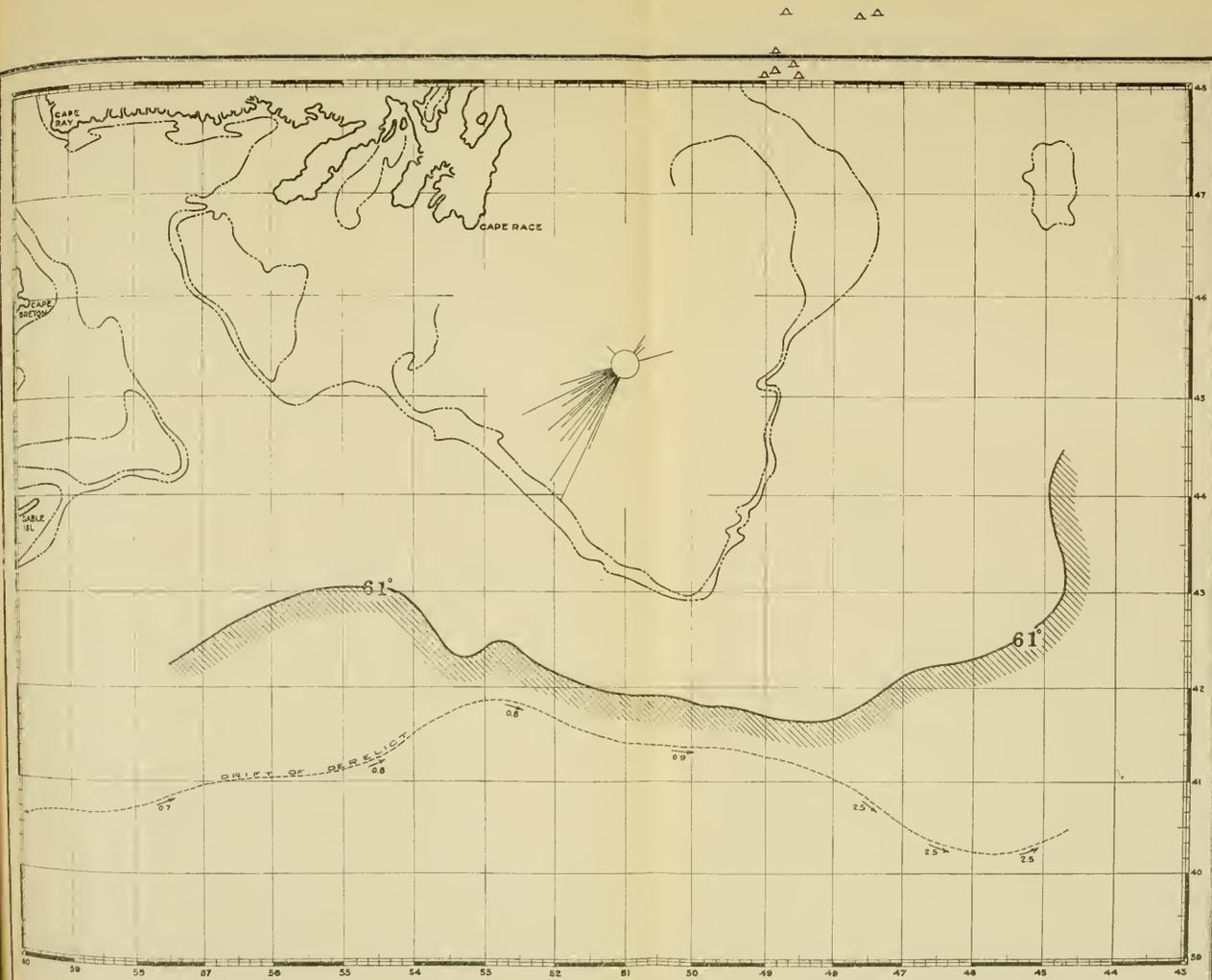












△ - BERGS  
 ○ - GROWLERS  
 ▨ - FIELD ICE

BASED ON 306 WATER  
 TEMPERATURE REPORTS

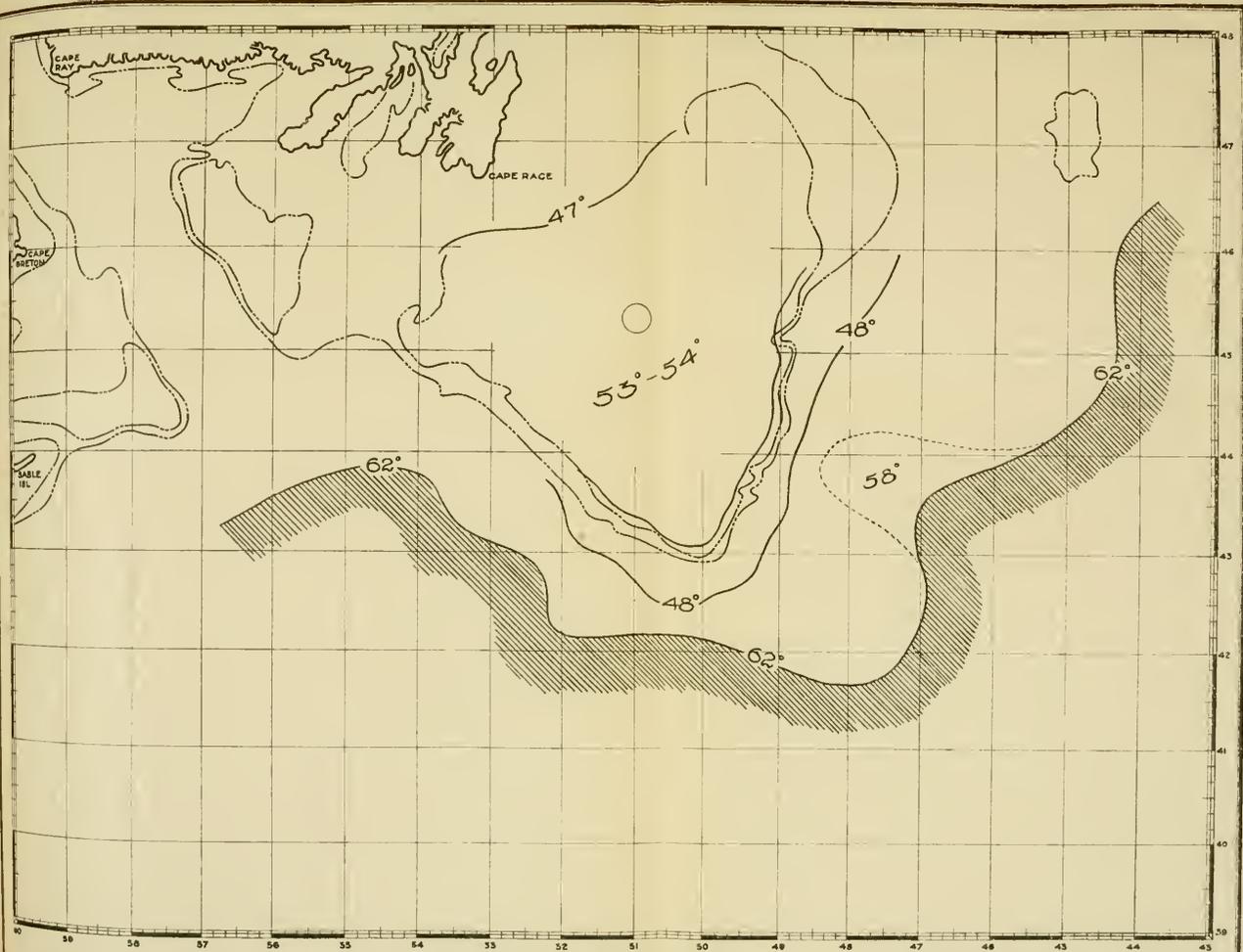
GENERAL CHART  
 COVERING  
**ICE PATROL**  
 JULY 1-12, 1923  
 SHOWING SEA-WATER TEMPERATURES AND VARIOUS CONDITIONS IN VICINITY  
**GRAND BANKS**

BEAUFORT SCALE FOR WIND DIAGRAM.

CHART "N"

H.O. PUBL. No. 1511





▲ - BERGS.  
 ○ - GROWLERS  
 ▨ - FIELD ICE.

BASED ON 210 WATER  
 TEMPERATURE REPORTS

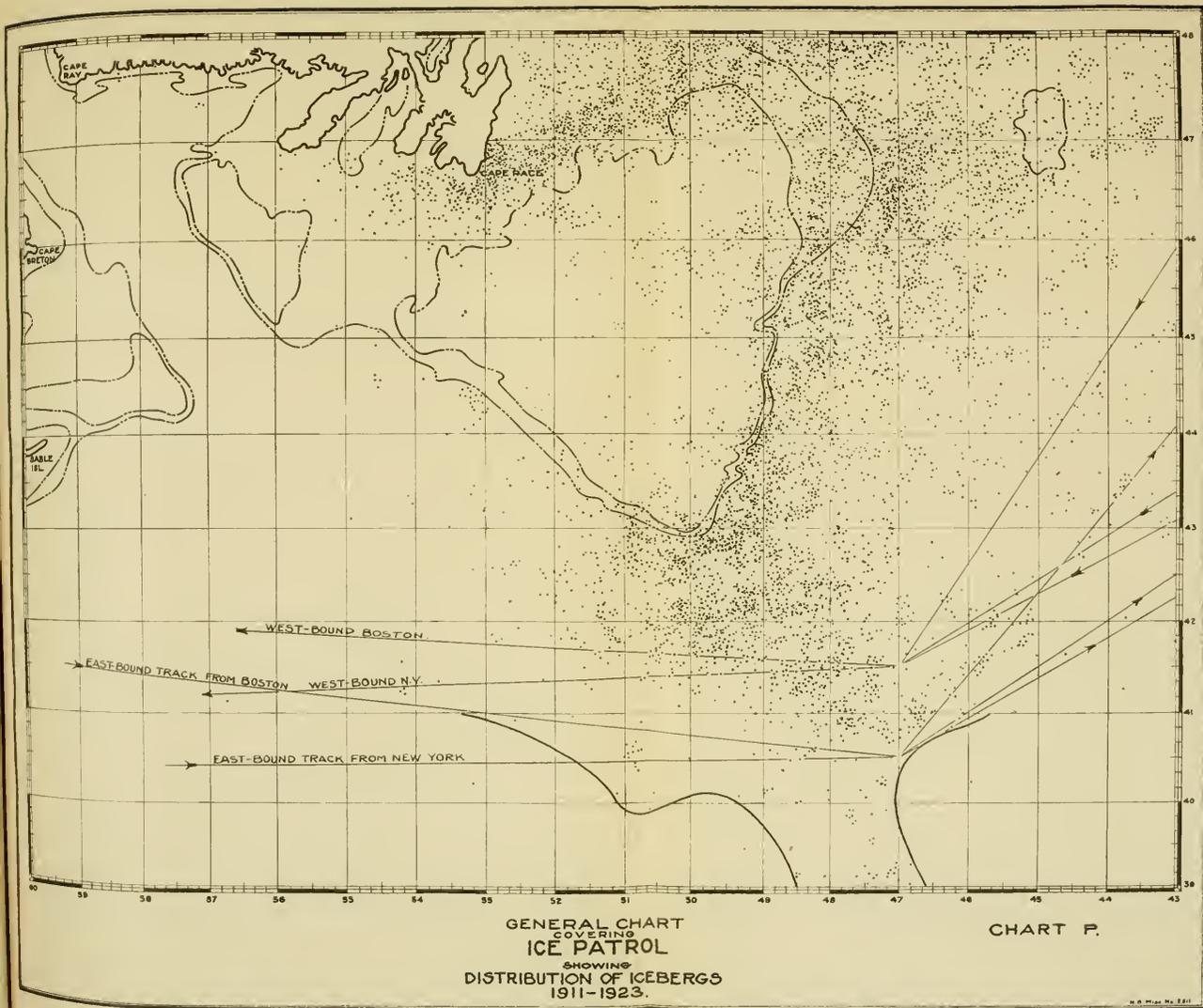
GENERAL CHART  
 COVERING  
 OCEANOGRAPHIC CRUISE  
 OCTOBER 21-26

SHOWING SEA-WATER TEMPERATURES AND VARIOUS CONDITIONS IN VICINITY  
 GRAND BANKS

BEAUFORT SCALE FOR WIND DIAGRAM.

CHART "O"



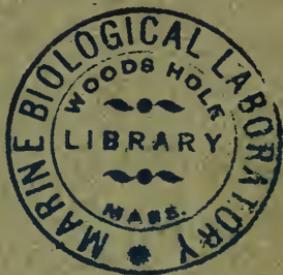




TREASURY DEPARTMENT - UNITED STATES COAST GUARD

BULLETIN No. 12

INTERNATIONAL ICE OBSERVATION  
AND ICE PATROL SERVICE IN THE  
NORTH ATLANTIC OCEAN - [SEASON of  
1924]









June 5, Coast Guard cutter "Modoc" explodes four guncotton mines suspended 60 feet under water from berg No. 3. The berg was seen to quiver perceptibly the instant of the explosion, and several large pieces of ice were detached from its side. See sketch No. 4

TREASURY DEPARTMENT  
UNITED STATES COAST GUARD

Bulletin No. 12

International  
Ice Observation and Ice Patrol  
Service

in the  
NORTH ATLANTIC OCEAN



---

---

Season of 1924



WASHINGTON  
GOVERNMENT PRINTING OFFICE  
1924



## TABLE OF CONTENTS

---

|                                                           | Page |
|-----------------------------------------------------------|------|
| Frontispiece-----                                         | I    |
| Orders, ice patrol-----                                   | 1    |
| Commanding officer's reports, ice patrol-----             | 5    |
| Summary report by commander, ice patrol-----              | 59   |
| Photographs (two plates, one on either side of page)----- | 62   |
| Oceanographer's monthly reports (March to June)-----      | 63   |
| Table of ice and obstructions-----                        | 84   |
| Oceanographic station chart A-----                        | 86   |
| Table of oceanographic stations-----                      | 87   |
| Profiles of subsurface sections (1-10)-----               | 88   |
| Discussion of subsurface investigations-----              | 98   |
| Iceberg chart B-----                                      | 99   |
| Oceanographic summary-----                                | 129  |
| Composite iceberg chart, 1913-1924, chart C-----          | 131  |
| Photographs (two plates, one on either side of page)----- | 135  |
| Description salinity apparatus with five figures-----     | 136  |
| Wind diagram and fog scale:                               |      |
| March (fig. 1)-----                                       | 148  |
| April (fig. 2)-----                                       | 149  |
| May (fig. 3)-----                                         | 150  |
| June (fig. 4)-----                                        | 151  |
| Monthly limits of "Cold-Wall" (chart D)-----              | 151  |
| Annual limits of "Cold-Wall" (chart E)-----               | 151  |
| Surface temperature charts:                               |      |
| Chart F (March 15-31)-----                                | 151  |
| Chart G (April 1-15)-----                                 | 151  |
| Chart H (April 15-30)-----                                | 151  |
| Chart I (May 1-15)-----                                   | 151  |
| Chart J (May 15-31)-----                                  | 151  |
| Chart K (June 1-15)-----                                  | 151  |
| Chart L (June 15-30)-----                                 | 151  |
| Iceberg distribution chart, 1911-1924, chart M-----       | 151  |



## INSTRUCTIONS FOR THE ICE PATROL

---

TREASURY DEPARTMENT,  
UNITED STATES COAST GUARD,  
Washington, February 4, 1924.

To commanding officers, "*Modoc*," "*Tampa*," and "*Ossipee*":

1. The *Modoc* and the *Tampa* are designated to carry out the international ice patrol during the season of 1924. The *Ossipee* is designated as stand-by vessel. The senior line officer present is assigned to command the patrol. The commanding officer of the *Tampa* will command until the arrival on patrol of a senior commanding officer. Vessels concerned will make the necessary preparations to carry out these orders.

2. The object of the patrol is to locate the icebergs and ice fields nearest to the trans-Atlantic steamship lanes. It will be the duty of patrol vessels to determine the southerly, easterly, and westerly limits of the ice and to keep in touch with these fields as they move to the southward, in order that radio broadcasts may be sent out daily, giving the whereabouts of the ice, particularly the ice that may be in the immediate vicinity of the regular trans-Atlantic steamship lanes.

3. The patrol will continue until the ice no longer constitutes a danger to navigation in the trans-Atlantic steamship lanes. The ice season is usually three months, April, May, and June.

4. While on this patrol the *Modoc* and the *Tampa* will base temporarily and obtain fuel and other necessary supplies at Halifax, Nova Scotia. The two vessels will alternate on patrol, making alternate cruises of about 15 days in the ice region, the 15 days to be exclusive of the time occupied in going to and from base. The patrol commander will so regulate the movements of the vessels that on the fifteenth day after reaching the ice region the vessel on patrol will be relieved by the second vessel, if possible, at which time the first vessel will proceed to base, replenish her fuel supply, and return in time to relieve the other vessel at the end of the latter's 15-day cruise. It is important that the patrol be continuous, and the vessel on patrol must not leave her station until relieved by the other vessel, unless it should be absolutely necessary to do so.

## RADIO BROADCASTS AND COMMUNICATIONS

(a) Having located the ice, the patrol vessel will send the following daily dispatches and radio broadcasts. All dispatches will refer to seventy-fifth meridian time.

- (1) At 0600 seventy-fifth meridian time, and 1800 seventy-fifth meridian time, ice information will be sent broadcast by radio on 600 meters (spark). These broadcasts will be sent three times, with an interval of 2 minutes between each.

(NOTE.—*It is the intention to eliminate spark broadcasts as soon as possible and all shipping should be so advised in order that they may equip themselves with receivers capable of CW reception.*)

- (2) At 0700 seventy-fifth meridian time, and 1900 seventy-fifth meridian time, ice information will be broadcast by radio on 1,621 meters (185 kilocycles) CW. These broadcasts will be sent three times, with an interval of 2 minutes between each.

- (3) At 2000 seventy-fifth meridian time, a dispatch will be sent to the Hydrographic Office, Washington, D. C., defining the danger zone, its southern limits, or other definite ice news, and an additional dispatch will be sent during the night if any important information is obtained later. The telegraphic address of the Hydrographic Office is "Hydrographic, Washington." To be of value for broadcasting from Annapolis, Arlington, and other shore radio stations, this dispatch must be in the Hydrographic Office before 0900 the following day.

(b) Ice information will be given by radio at any time to any ship with which the patrol vessel can communicate. Such information will be furnished as regular radio traffic (without charge) on commercial traffic frequencies (wave lengths).

(c) The following should be observed as closely as possible:

- (1) Use 600-meter wave length (spark) only for broadcasting on schedule, calling, answering, and traffic incident to SOS.
- (2) Use commercial-traffic wave lengths (except 600 meters when possible) for handling traffic other than Government.
- (3) Use CW transmission whenever practicable (except for broadcasting on 600 meters and traffic on 706 meters) and request stations to transmit on CW when known to be so equipped. Reduce to a minimum radio work on spark.

(d) Ship-to-shore radio traffic shall be carried on by the most practicable and convenient route, having due regard for the economy which may be effected by transmitting through naval radio stations. Bar Harbor has been instructed to give priority to all traffic to and from vessels on ice patrol duty, and that station should normally be used, if possible. Headquarters will route all messages for vessels on ice patrol through Bar Harbor. Should it develop that communication through Bar Harbor will be impracticable for an extended period, headquarters should be so advised by the most practicable means in order that dispatches may be routed accordingly.

(e) Ice information will be given in as plain concise English as practicable, and will state in the following order:

- (1) Position of patrol vessel.
- (2) Location and description of ice.
- (3) Other data.

(f) In order that there may not arise any doubt as to the position of the patrol vessel, the number and position of bergs reported or sighted and other obstructions found necessary to report, the following points should be emphasized:

- (1) The message to be made up of short sentences, each followed by the word "stop."
- (2) The latitude and longitude positions to consist of four words each and the latitude be separated from the longitude by the word "dash" and after the longitude position the word "stop" shall be used, viz., latitude 40° 00', longitude 50° 00' should be written "Four zero zero zero dash five zero zero zero stop."
- (3) Distinction should be made clearly whether one berg was *sighted* or *reported* or more than one berg.
- (4) Clearly define whether the patrol vessel sighted the ice or obstructions or whether the patrol vessel received the report of ice or obstructions from a passing vessel.
- (5) The message to be complete in itself, not referring to previous reports.

(g) Messages broadcast to other vessels should never contain such phrases as "No ice south of —," etc.

6. Attention is called to article 3235 (c), Regulations, the provisions of which will be followed in radiograms sent to the Hydrographic Office. (See paragraph 5 (a) (3) of this order.) In radiograms sent to vessels other than Coast Guard cutters the words "latitude" and "longitude" will be used.

7. The ice patrol vessels' radio call letters are NIDK. This is a special "call" for the vessels actually on patrol, and must not be confounded with the regular "call letters" of the vessels.

8. The radio messages from the patrol ship will be given publicity immediately upon their receipt by the Hydrographic Office, Washington, and by the branch hydrographic offices at Boston, New York, and Norfolk.

9. Each patrol vessel will keep a remark book in which will be entered all data and information that can be collected concerning the ice.

10. Each vessel, on being relieved by the other vessel, will deliver to the relieving vessel a copy of each radiogram sent to or received from the Hydrographic Office during the cruise, and a copy of each instruction received from headquarters.

11. At the end of each cruise each vessel will forward to headquarters a full report in triplicate. Each vessel will send these reports direct to headquarters and furnish a copy of each report to the other vessel on patrol.

12. Each vessel will plot on tracing paper used in connection with the appropriate plotting sheet the positions and extent of the ice as located from time to time. Such data will also be plotted on a duplicate tracing paper, and this duplicate will be delivered to the relieving vessel.

13. If, in order to avoid delay in any emergency, it becomes necessary for the junior commanding officer to communicate directly with headquarters, a copy of each such communication shall be furnished to the patrol commander.

14. Barometers of patrol vessels must be calibrated by the United States Weather Bureau before sailing on patrol duty.

F. C. BILLARD.

## REPORTS OF COMMANDING OFFICERS

---

COAST GUARD CUTTER "TAMPA," LIEUT. COMMANDER W. J. WHEELER, ICE PATROL, FIRST CRUISE, MARCH 20 TO APRIL 5, 1924

The *Tampa* left Boston Navy Yard at 10.45 a. m., March 18, and proceeded to the Tail of Grand Banks by direct route north of George's Bank. Light to fresh northwesterly winds and unusually fine weather prevailed until forenoon of 20th, when wind increased to strong breeze and moderate gale, NNW., hauling to NNE., which continued until night of 22d., though moderating at intervals to fresh breezes. Fog was experienced at intervals on 22d.

On 19th we sent the following message to wireless officer, Halifax: "International ice patrol will be fully inaugurated March 22. Patrol will be continuous until end of ice season, probably early in July. Agreeably to understanding of last year patrol will broadcast all ice and obstruction information for the Atlantic area. Ice patrol call this year—NIDK—TAMPA." Similar messages were sent to officer in charge station at St. Pierre and to commercial station and compass station at Cape Race.

At 5.50 p. m., 21st, latitude  $42^{\circ} 42'$ , longitude  $54^{\circ} 21'$ , the vessel was stopped for some five hours, partly to adjust air pump and partly to avoid reaching possible ice area before daybreak would give an opportunity for efficient search with masthead lookout. An unimportant obstruction report (spar) was also received this day from steamship *Canadian Ranger*, and communication was received from French radio station, St. Pierre, expressing their intention to fully cooperate with patrol for the season.

Masthead lookout was established at daybreak 22d, and at 9 a. m. course was set  $57^{\circ}$  true to reach southwest slope of bank, partly for purpose of searching and partly for anchorage in event of continuance of fog.

At 2 p. m., 22d, stopped and occupied station No. 377; depth of water 105 fathoms. Temperatures at four depths were all above  $0^{\circ}$  C, showing no arctic water, therefore no indications of ice. At 3.25 ahead on course  $57^{\circ}$  true and at 6 anchored for the night in 45 fathoms port chain, Tail of Bank; latitude  $43^{\circ} 34'$ , longitude  $51^{\circ} 15'$ . Sent out first broadcasts for season and made other routine reports.

Received message from wireless officer, Halifax, assuring us of cooperation for season along lines of last year. Gave ice information to steamship *Cairntorr*.

March 23: Strong to fresh NE. to NNE. breezes, with overcast sky, prevailed for the day. Rather rough sea, north. Hove up anchor and at 6.45 stood east 20 miles to eastern edge Tail of Bank; then  $115^{\circ}$  true for 70 miles to skirt this edge, scouting for possible ice and investigating current conditions. From 11.55 to 12.30 stopped and occupied station 378, finding arctic water below surface, which we later concluded may have been a pool from current earlier in season rather than prevailing Labrador current. From 5.17 to 6.25 stopped and occupied station 378, where no arctic water was found. At 6.25 stood north true and so continued for 18 miles, sounding at intervals for anchorage for night. At 9.15 came to anchor in 40 fathoms of water, with 100 fathoms of chain. Latitude  $43^{\circ} 08'$ , longitude  $50^{\circ} 09'$ .

March 24: Again strong to fresh NNE. breezes, with sky overcast. Heavy swell to rather rough sea, north. At 5.45 up anchor and stood east true for 25 miles to eastern edge of Bank; then skirted same on courses  $16^{\circ}$  true to  $40^{\circ}$  true for 63 miles, scouting for possible bergs, but none were seen. Sea too rough for occupying station for water temperatures. At 6 p. m. stood west true, and later  $285^{\circ}$  true, sounding at intervals for anchorage for the night. At 7.30 anchored in 24 fathoms, 75 fathoms of chain. Latitude  $43^{\circ} 55'$ , longitude  $49^{\circ} 14'$ .

Special ice information given to the following steamships this day: *Alexandra*, *Amsterdam*, *Marburn*.

March 25: Day begins with fresh NNE. breezes, falling to light breezes at close; overcast throughout; snow flurries in early morning and at close. At 5.25 up anchor and stood  $48^{\circ}$  true for 35 miles, scouting eastern edge of Banks for possible bergs. At 8.45 occupied station 380, finding Arctic water. At 12.20 stood  $16^{\circ}$  true for 35 miles. At 4.10 occupied station 381, finding no Arctic water. At 5.45 stood  $280^{\circ}$  true for anchorage for the night. Received report of berg, latitude  $45^{\circ} 18'$ , longitude  $49^{\circ} 36'$ . At 7.15 set course  $314^{\circ}$  true for this berg, then 40 miles distant. At 9.15 stopped and anchored because of snow squall; 37 fathoms of water, 100 fathoms of chain.

Gave ice information this day to steamships *Hastings County* and *West Comas*. Received ice information from steamship *Lituania*.

March 26: Day begins with light NW. breezes and smooth sea, increasing to moderate NW. breeze with moderate swell in midday, falling to light breeze at close. Overcast; passing snow squall, 6 a. m. At 5.20 up anchor and stood  $314^{\circ}$  true for position of berg reported yesterday. At 7.39 sighted berg bearing  $32^{\circ}$  true and at

9.05 stopped alongside of it; latitude  $45^{\circ} 35'$ , longitude  $49^{\circ} 28'$ . Found this first berg of the season to be of medium size, composed of two parallel walls, the larger of which was some 250 feet in length, some 100 feet in height, and perhaps 60 feet thick at base, tapering to jagged edge on top. The smaller wall was similar to the larger and approximately two-thirds its size in each dimension. The swell pulsating through the open space some 50 feet wide between the walls showed depth of some 10 feet over the base.

Lieutenant Von Paulsen requested permission to try one of the 150-pound T.N.T. wrecking mines sent on board for experimenting in destruction of bergs. This request was granted, and that officer, with surfboat crew, lowered a mine alongside base of berg, secured by means of grapnel hooked in ice crevice above water. The mine failed to explode and was hoisted up and brought back to the vessel. Examination showed that one wire of detonator had been broken. At 11 stood to windward of berg and anchored in 37 fathoms of water (90 fathoms chain) to observe drift of berg for the day. Berg drifted to southward about one-fourth mile per hour.

Received ice report from steamship *Gorm*. (Growler.)

March 27: Day begins with light north airs and breezes, hauling to east and increasing to fresh breeze by noon and moderate gale SE. at close. Mostly cloudy to overcast. At 5.35 up anchor and stood to berg, which had drifted to southward distance of some 5 miles in 18 hours. Lieutenant Von Paulsen, with surfboat crew, placed another 150-pound depth charge mine on base of berg, and again it failed to explode. Hoisted mine and examined it aboard and decided that detonator designed for smaller mine was not sufficiently in contact with T.N.T. Made adjustments accordingly and lowered another mine alongside base of berg at depth of some 17 fathoms. This was successfully exploded at 8.30. Many tons of ice was brought down from both walls of the berg. The entire berg rocked back and forth, but did not capsize, evidently being partly sustained by proximity to bottom. Broken ice drifted off in form of small growlers and slush.

At 9.05 stood  $165^{\circ}$  true to investigate report just received from *West Quechee* of berg to southward. At 1.40 sighted berg bearing  $143^{\circ}$ , distance 19.5 miles, and stood for it. At 4 stood around berg and photographed it (latitude  $44^{\circ} 31'$ , longitude  $49^{\circ} 05'$ ); then stood  $265^{\circ}$  true for anchorage on edge of bank. At 4.50 anchored, with 100 fathoms chain, in 35 fathoms of water, with sand and shell bottom; latitude  $44^{\circ} 25'$ , longitude  $49^{\circ} 20'$ . Tried fishing, without success; evidently too early in season.

Ice reports received this day from steamships *West Quechee* and *Rosalind*. Derelict report from steamship *Ben Neckom*.

March 28: Moderate to fresh SE. to SSW. breezes until 4 p. m., then falling to fresh and gentle SW. to WNW. breezes; heavy swell

to rather rough sea. Overcast, mostly foggy and rainy throughout day. Vessel remained at anchor because of weather.

March 29: Begins with moderate W. by S. breezes backing to SSE. in afternoon and increasing to moderate gale, which hauled to NW. and became fresh gale. Rather rough sea throughout. Began clear and became overcast, with fog at intervals. At 5.30 hove up anchor and stood  $136^{\circ}$  true, 12.5 miles, to the southernmost berg last sighted on 27th; occupied station alongside of it. Found this to be in latitude  $44^{\circ} 18'$ , longitude  $49^{\circ} 08'$ , having dragged along bottom in 38 fathoms,  $190^{\circ}$  true, 0.3 knot per hour since last sighted.

Lowered surfboat; stood around berg and photographed it with film camera. The rough sea breaking against this berg and swells pulsating through open space between the two walls made this quite spectacular in clear weather then prevailing. Stood back on Bank proper for anchorage, passing and sighting some eight French fishing vessels, among the first of the fleet. Of these the barque *La Angelin* set international code signal as *Tampa* passed requesting that we take mail. To this we acquiesced and *Tampa* stopped and received letters via dory from *La Angelin*. We were also requested to report this vessel in Halifax. Photographs with film camera were also taken of this vessel and of French hermaphrodite brig *La Motte Picquet*. At 3.15 anchored in 33 fathoms, 100 fathoms of chain. Latitude  $44^{\circ} 27'$ ; longitude  $50^{\circ} 12'$ . Tried fishing, without success. Shearwaters and murrens observed this day.

March 30. Begins moderate to fresh NW. to WNW., gale, with rough sea falling to light and moderate breezes and backing to SE. Strong SE. breeze at close. Mostly cloudy to overcast. Remained at anchorage for the day. At 9.25 tripped anchor and let vessel drift approximately one mile to leeward hoping to find shell bottom for possible fishing. Failed to find shell bottom, and at 10.25 again let go anchor, 33 fathoms water, 100 fathoms chain. Tried fishing, without success, at various times in the day. Gave special ice information to Steamship *American Farmer*.

Received special ice information from cable ship *John W. Mackay*.

March 31: Fresh to gentle SE. to WSW.; breezes; overcast and foggy for most part throughout the day. Remained at anchor because of fog.

April 1: Begins with light and gentle SW. breezes, later hauling and increasing to moderate and fresh NW. to N. gale. Foggy at intervals first part. At 9.30 under way, stood  $116^{\circ}$  true, to visit southernmost berg, last seen on 29th, and investigate current on east side of Bank. A number of French fishermen observed ahead and on either side, a portion of which had dories in water, apparently season not fully opened. Exchanged international code signals with French

barkentines *Benegalia* and *Noell* both requesting that they be reported as all well. At 1.10 course  $152^{\circ}$  true. At 3.15 sighted berg 13 miles distant and at 5 came alongside of it; latitude  $43^{\circ} 43'$ ; longitude  $49^{\circ} 15'$ . This berg had drifted approximately south at rate of 0.5 mile per hour since last sighted by *Tampa* 29th instant. Occupied station 384 alongside of berg and found arctic water at depths of 50 meters and 125 meters.

At 6.20 stood  $226^{\circ}$  true for anchorage on edge of bank. At 8.20 changed course to  $252^{\circ}$  true, sounding at intervals to locate anchorage. At 10.45 soundings showing 45 fathoms. Stopped and lowered anchor, with windlass paying out 100 fathoms of chain. Soundings after anchor had taken bottom showed 58 fathoms, indicating that we were exactly on edge of bank. Flocks of murre seen this day.

Special ice information given to steamship *America*.

April 2: Strong to moderate breezes hauling from N. to SE. Sky overcast to partly clear at midday. Vessel remained at anchorage on southeast edge of bank throughout the day, observing the southernmost berg. This berg in sight from 9 a. m. until dark, drifting estimated speed of 0.8 knot per hour,  $190^{\circ}$  true. At 1 hove up anchor to allow east wind to drift vessel slightly farther on bank. Drifted slowly with wind and current in general southwest direction, using rudder. At 6.30 anchored in 43 fathoms of water, 100 fathoms of chain.

Received ice information from steamship *Sachem*. Gave special ice information to steamship *Cody*.

April 3: Strong breezes to moderate S. to SSE. gale, moderating to light and gentle breezes at close and hauling to SSW. Overcast and rainy, with dense fog in afternoon and evening; rather rough sea. Vessel remained at anchor throughout day.

Gave special ice information to steamships *Andania* and *Mount Carroll*. Received ice information from steamship *Sachem*.

April 4: Day begins with gentle ESE. breeze, backing to N. and increasing to fresh and strong breezes, falling to gentle N. breeze at close. Overcast, foggy, and rainy first part; hazy thereafter, with visibility some 4 miles.

At 9.50 up anchor and under way to scout for berg last seen on 2d instant. Stood S. true 12 miles; then began rectangular search to southward, extending from edge of bank to some 20 miles east. At 1.48 received report from steamship *Cameronia* that berg 185 feet high was sighted in latitude  $42^{\circ} 34'$ , longitude  $50^{\circ} 03'$ . Stood  $221^{\circ}$  true for same and at 3.55 sighted berg, 2.5 miles distant, bearing  $247^{\circ}$  true. At 4.11 stopped alongside berg and occupied station No. 385, latitude  $42^{\circ} 44'$ , longitude  $49^{\circ} 56'$ . Found no arctic water.

This berg, since last sighted, April 2, had drifted parallel with 50-fathom contour of bank, in general direction  $210^{\circ}$  true, 0.9 mile per hour. From close aboard its present height was estimated as some 80 feet, showing overrating of height by the *Cameronia*, as usually is the case of estimates made from vessel at distance. The discrepancy of some 11 miles in estimated position is also very common.

After nightfall haziness increased and we kept position in sight of berg by means of searchlights. The vessel drifted to leeward at rate of some 1 or 1.5 knots per hour, and occasional backing was generally found to be the best way to keep position. Mother Carey's chickens were found in the vicinity of the berg and a number flew on board, blinded by the searchlights, disabling themselves by collision with rigging or structural parts of ship.

Ice report received this day from steamship *Cameronia*. Obstruction report received from steamship *Vendome*.

April 5: Moderate to fresh N. to NNW. breezes; overcast; moderate sea. Standing by southernmost berg, keeping it constantly in sight by means of searchlight and keeping position by occasionally steaming as necessary. At 6 left berg, latitude  $42^{\circ} 37'$ ; longitude  $50^{\circ} 18'$ , and proceeded west true to meet *Modoc*.

At 4.30 p. m. met *Modoc*, latitude  $42^{\circ} 30'$ , longitude  $52^{\circ} 43'$ . Lieut. E. H. Smith, oceanographer, and Yeoman R. W. Lewis, assistant, transferred to *Modoc*, which vessel took over ice patrol relieving *Tampa* for refueling, etc., in Halifax.

#### SUMMARY

The weather experienced this cruise has been decidedly better than the average for the season as shown by pilot chart, since we have had only 20 per cent of fogs and some 13 per cent of gales. This is in marked contrast to the weather of last year, since we then had gales for 9 of the 15 days for the same period. The mild winter was reflected in the surface temperature found on the Banks, this being  $37$  to  $38^{\circ}$  F.,  $6^{\circ}$  warmer than normal. There has also been a pronounced prevalence of warm water over localities where arctic water might be expected. The absence of field ice on the Grand Banks is also a notable feature. The effect of the unusual features on the number of bergs to be expected later in the season can not be positively foretold, but it would appear that less ice than usual might be predicted.

As a logical result of the absence of arctic water there has thus far been decidedly a smaller number of bergs than usual for the season, only three having been reported south of Newfoundland since March 13. Two of these have been sighted by the *Tampa* and

the only one that showed disposition to drift south was tracked by the *Tampa* from March 27 to April 5, during which period it drifted 141 miles, and it was left at 6 a. m., April 5, in latitude  $42^{\circ} 37'$ ; longitude  $50^{\circ} 18'$ .

During the period of this first patrol, ice reports were received from 34 vessels; obstruction reports from 5 vessels, and 804 water-temperature reports were received.

Daily dispatches and radio broadcasts have been sent out as follows:

(a) At 6 a. m., and 6 p. m., seventy-fifth meridian time (7 p. m., sixtieth meridian time) ice information has been broadcasted on 600-meter wave length (spark), and one hour later the same information has been broadcasted on 1,621 CW.

(b) Daily at 8 p. m., seventy-fifth meridian time, ice information has been sent to Hydrographic Office, Washington.

(c) Daily weather reports have been sent to Washington.

**COAST GUARD CUTTER "MODOC," COMMANDER B. M. CHISWELL,  
ICE PATROL, FIRST CRUISE, APRIL 5 TO APRIL 19, 1924**

The *Tampa* having inaugurated the ice patrol season, sailing from Boston, March 18, 1924, the *Modoc* left 15 days later from the same port at 10.05 a. m., April 2, 1924. Contact was made with the *Tampa* in  $42^{\circ} 30'$  north latitude,  $52^{\circ} 46'$  west longitude, at 4.30 p. m., April 5. Lieut. E. H. Smith, observer, and Yeoman R. W. Lewis, his assistant, transferred from *Tampa* to *Modoc*. Mail for *Tampa* was delivered and, having relieved her of patrol duty, the *Modoc* at 7.05 p. m. stood slowly to the eastward to begin scouting for ice at daybreak and to relocate the berg last seen by the *Tampa* in  $42^{\circ} 35'$  north latitude,  $50^{\circ} 26'$  west longitude, at 6 a. m. of the 5th. Weather for the run out from Boston was characterized by a rapidly rising barometer, with westerly gale diminishing. In Boston at 4 a. m. of the 2d barometer was 29.25 with NE. gale and heavy snowfall. At the time of our departure snow had ceased; barometer was 29.50; wind was west, blowing moderate gale force, with heavy banked clouds. By noon of the 3d barometer was 29.95, wind force 5, Beaufort scale, and partly clear; noon of the 4th, barometer 30.19, wind NNE., force 3; and noon of the 5th, barometer 30.35, wind NE., force 2; cloudy.

Having run 60 miles east from the point where the *Tampa* was relieved, a rectangular search was started at daybreak of the 6th, with excellent visibility, lookout aloft. At 9 a. m. the berg last seen by the *Tampa* on the 5th was sighted 13 miles distant. Its location at noon, as determined by observation of the sun, was  $42^{\circ} 19'$  North latitude,  $50^{\circ} 39'$  West longitude, having drifted  $226^{\circ}$

true 0.5 knot per hour during the last 24 hours. The visible portion of the berg was in two parts, separated by a shallow channelway, one part a rather low ice ridge, the other a peak approximately 150 feet high. In the bright light of the forenoon the berg showed up in fine shape and the play of lights and shadows on the ice made a beautiful picture. When abreast the perpendicular side of the peak and about 300 yards distant echoes from the steam whistle were clear and sharp. Oceanographic station No. 386 in the immediate vicinity of the berg was occupied. Temperatures indicated no trace of arctic water. Light airs and breezes from the northeast quadrant to calms prevailed to-day, with clear pleasant weather in forenoon and heavy snowfall from 1 to 5 p. m. Barometer, which was falling, stood 30.14 at midnight. Fulmars and dovekeys were plentiful and a few murrees were observed through the day. Special ice information was given steamship *Canadian Explorer*. Vessel drifted for the night near the berg.

The patrol remained in the vicinity of the above berg during the day, April 7, visibility excellent; and drifted for the night. This berg had reached the end of its westward drift and was now making to the southward and eastward at about 0.7 knot per hour. Position at noon, 42° 03' north latitude, 50° 28' west longitude. It was calving at intervals. Winds were from north, increasing in force from 4 to 6 and decreasing to 4 at the close; barometer was falling slowly and read 30.03 at midnight. Bird life was as described yesterday. The steamship *Schodack* sent the following message to the patrol:

Have patient with following symptoms: Temperature 103, pulse 112, respiration 28; movements normal; has frequent severe pains right side of chest which make breathing difficult. Patient worked in warm place all day and took a bath afterwards which was followed by chills and fever. Kindly advise. Wilson, Master.

Patrol medical officer promptly advised concerning treatment of patient.

The steamships *Idefjord* and *Mount Clinton* requested special ice information and were requested to await the patrol's evening broadcast.

At daybreak, April 8, the patrol was 4½ miles 44° from the berg. At this point surface sea-water temperature was 36° F. Approaching the berg, it rose rapidly and was 52° F. nearby. At 1 p. m. oceanographic station No. 386, near the berg, was occupied. Temperatures indicated Gulf Stream water, 56° to 54° F. down to 450 meters, then cooling rapidly to 39° at 750 meters. The berg, which was drifting 115° true at 1.5 knots per hour, was in 41° 40' north latitude, 49° 08' west longitude at 8 p. m. It was fast dwindling, cracking, calving, and rolling continuously. Light

breezes and airs from north shifting about dark into SE., and thick haze, with intermittent light fog, prevailed; barometer, which was falling, read 29.78 at midnight. A marked absence of bird life was noted, probably due to the fact that we were now in warm water and away from their feeding grounds.

The Swedish steamer *Drottningholm* was reported by radio for violation of the steamship track agreement.

Special ice information was furnished the steamships *Idefjord* and *Aymeric*.

There being no other reports of ice within the scope of operations of the patrol, the vessel kept in contact with the berg noted above which was at noon, April 9, in  $41^{\circ} 26'$  north latitude,  $48^{\circ} 34'$  west longitude, drifting  $120^{\circ}$  true 1.8 knots per hour. The warm water ( $56^{\circ}$  F.) and the buffetings of the southerly swell were reducing it with extraordinary rapidity. It was calving continuously and numerous growlers floated in its vicinity. Winds to-day were from the southeast quadrant, force 3 to 4, with frequent passing showers accompanied by thunder and lightning, with clear, sunny, pleasant weather between; barometer falling rapidly, read 29.31 at midnight. Bird life was scarce, a few fulmars, dovebies and Wilson's petrel being noted.

Having experienced interference with our broadcast through HYS (Ste. Pierre, Miquelon) broadcasting on the same schedule, the latter was requested to change his schedule, to which he replied as follows:

Referring to your message of last night, we beg to inform you that during the patrol season and in order to suit you, our broadcast will be sent at 1000 gmt., 1600 gmt., and 2200 gmt. We would be grateful to you if you would advise ships at sea.

Special ice information was given the steamships *Invader*, *Alaska*, and *Nieuw Amsterdam*.

At noon, April 10, our berg was in  $41^{\circ} 11'$  north latitude,  $48^{\circ} 18'$  west longitude, having drifted  $141^{\circ}$  true at 0.9 knot per hour. When near by, constant loud cracklings were heard and the moment sea water ran off, the entire exposed surface would blister, the next sea washing away this loose covering, followed by more blistering. This, together with the frequent calvings, was reducing its bulk rapidly. By dark it was apparent that the warm water, warm air, and constant pounding of the seas would make an end of this menace within the next 24 hours. Winds until 1 p. m. were from SE., force 3 to 4, partly clear, with passing heavy rain squalls, thunder, and lightning; barometer falling to 29.22, at which time it began to rise rapidly, wind backed into NW. and increased in force

to 6, overcast and cloudy; barometer at midnight 29.50. A few dovekies, fulmars, and Wilson's petrel were seen.

Special ice information was given the steamships *Evergreen City* and *Andalusier*.

At daybreak, April 11, the patrol steamed back along the line of its wind-drift during the night, but was unable to pick up the berg last seen at the close of the day yesterday. A careful thorough search, lookout aloft, visibility very good, was continued throughout the day without sighting ice, leading to the conviction that the berg had either melted or broken up into small growlers harmless to navigation. At dark the ship was stopped and allowed to drift. At 8 p. m. position  $40^{\circ} 30'$  north latitude,  $47^{\circ} 20'$  west longitude. Winds were WNW., force 6, during the day, hauling to N. at dark and diminishing to force 3; cloudy to overcast; barometer rose to 29.81 by 10 p. m. and then began to fall, reading 29.76 at midnight; surface water temperatures  $53^{\circ}$  to  $56^{\circ}$  F. A Leach's petrel flew on board, was identified, and set free. A few murre and some gulfweed were noted.

The following interesting report was received from the steamship *Galtymore*:

At 1730 gmt (April 11) Lat. 45-50 N., Long. 40-30 W., passed Frying Pan Shoal gas and whistling buoy, light extinguished, whistle operating.

The Danish steamship *Frederic VIII* was reported by radio for violation of the North Atlantic track agreement.

Being convinced that the berg we had been standing by had disappeared, the patrol at daybreak, April 12, stood to the westward to occupy oceanographic stations along the southern radial and to hold memorial service over the grave of the *Titanic* on the morrow (Sunday). Winds were from the NE. quadrant, force 2 to 5, during the forenoon; overcast and raining; clearing; barometer falling until 10 a. m., when it read 29.59, then rising for the remainder of the day, registering 29.90 at midnight. In the afternoon wind backed to NW. and increased to moderate gale force; partly clear; surface temperatures  $56^{\circ}$  to  $60^{\circ}$  F. There was practically no bird life in sight. Schools of porpoises were noted.

The *Majestic* reported passing at 1.30 Greenwich mean time the dismasted derelict schooner *Governor Parr* in  $45^{\circ} 00'$  north latitude,  $35^{\circ} 38'$  west longitude, dangerous to navigation.

Special ice information was given the steamship *Galtymore*. At 8 p. m. position was  $40^{\circ} 53'$  north latitude,  $48^{\circ} 45'$  west longitude.

April 13 was spent by the patrol in occupying oceanographic stations to the northward along the southern radial. At 6.45 and 11.25 a. m. and at 3.50, 7, and 10 p. m. stations Nos. 388 to 392, inclusive,

were occupied. At sunrise colors were half-masted and at 11 a. m. (sixtieth meridian time) the vessel was stopped over the grave of the *Titanic*, which sank after colliding with an iceberg April 14, 1912, and brief memorial services were held, including a memorial address by Lieut. Commander Chalker, prayer by Past Asst. Surg. Shipp, three volleys, and taps. Colors were then mastheaded and the vessel resumed her patrol duties. At 3.40 p. m. the French barkentine *Raymonde* asked for and was furnished his position. Winds were NW. to NNE., force 6 to 2, dropping to light ESE. airs at the close; clear to cloudy; barometer rising slowly, reading 29.96 at midnight. Many dovekeys and a few murrees were noted as the vessel approached cold water. At 8 p. m. the patrol was in  $42^{\circ} 30'$  north latitude,  $50^{\circ} 13'$  west longitude.

Special ice information was given the steamships *Canadian Freighter* and *Galtymore*. The latter inquired about a berg broadcasted from Ste. Pierre, giving its location on April 6. This was the same berg that the patrol followed until it vanished on the 11th. Ste. Pierre was advised that we were in close touch with conditions around the Tail of the Banks and requested to leave broadcasting of ice information in this vicinity to the patrol.

At 7.45 a. m. of the 14th, oceanographic station No. 393, on the Tail of the Banks, was occupied, after which the patrol scouted to the northward at 14 knots speed about 10 miles to the eastward of the eastern 100-fathom curve of the Banks, lookout aloft, visibility excellent. Any bergs drifting to the southward would have come within the range of visibility from the vessel's crows nest. No ice was seen. At 5.20 p. m. oceanographic station No. 394 was occupied. Temperatures indicated a narrow band of Arctic water down the east side of the Banks as far as the Tail at least. There was no appreciable current from the north noted in our run up the east side of the Banks today.

In reply to the patrol's protest of yesterday, Ste. Pierre sent this message:

Following your svc date, any ice information we may receive from ships at sea will be forwarded to you.

Weather was clear, with calms to light airs and breezes from eastward; barometer falling slowly and reading 29.71 at midnight. Several sailing vessels, presumably French fishermen, many murrees, a few fulmars, a school of whales, and one seal close aboard were sighted during the day. At 8.40 p. m. the vessel was anchored on the Banks in  $44^{\circ} 01'$  north latitude,  $49^{\circ} 19'$  west longitude. At 7.40 p. m. we sounded in  $43^{\circ} 59'$  north,  $49^{\circ} 16' 30''$  west, this position being accurately determined by moon sight, sun sights, and

radio compass bearings from Cape Race. Got 85 fathoms by careful sounding with machine; fine white sand. This spot is between 22 and 28 fathoms, as shown on H. O. Chart No. 980, corrected through Notice to Mariners No. 44, 1922. There was 26 fathoms where we anchored.

At 6 a. m. of the 15th the patrol left her anchorage and stood to the eastward to outside the 100-fathom curve, then to the northward parallel to said curve. At 8.15 a. m. the French barkentine *Viana* asked for and was furnished her longitude position. At 12.30 p. m. oceanographic station No. 395 was occupied. Visibility, which had been very good, becoming poor and weather stormy, the vessel was headed in for the banks and anchored at 6.40 p. m. in 44° 58' north latitude, 49° 23' west longitude. While standing in for an anchorage, careful soundings were made and the following positions and depths seem worth recording:

44° 49' 00'' north, 49° 03' 00'' west, 100 fathoms, no bottom.

44° 51' 10'' north, 49° 09' 00'' west, 60 fathoms.

44° 53' 20'' north, 49° 15' 00'' west, 60 fathoms.

44° 56' 00'' north, 49° 20' 00'' west, 60 fathoms.

44° 58' 30'' north, 49° 26' 00'' west, 34 fathoms.

These positions were carefully checked by sights and by radio bearings from Cape Race, and are believed to be correct. The last sounding, 34 fathoms, agrees with Hydrographic Office Chart No. 980. Depths in the other positions are not recorded on said chart. Oceanographic station No. 396, at the anchorage, was occupied. Winds were from the SW. quadrant, increasing in force from 3 to 5 and falling after 4 p. m. to calm at the close; clear to overcast and cloudy, with driving rain in afternoon, changing to thick fog from 5.30 to 6.30 p. m., clearing after dark; barometer was falling and registered 29.39 at midnight. Fulmars, murre, dovekies and whale were plentiful.

Special ice information was given the steamship *Berengaria*.

At 4.50 a. m. of the 16th the patrol left her anchorage and scouted to the northeastward along the 100-fathom curve of the Banks. At 9.20 a. m. oceanographic station No. 397 and at 3.15 p. m. No. 398, the latter in 46° north latitude, 47° 45' west longitude, were occupied. Water temperatures along the east slope of the Banks showed less of arctic character than was to be expected at this season of the year. They were in no instance below 0° C., whereas it is normal for them at this time to range from -1.2° to -1.8° C. Little or no surface current setting to the southward could be observed. Normally at this season a 0.5 to 0.7 knot current is setting southward in this locality. This abnormality would seem to explain the absence of bergs around the tail of the Banks. There may be ice

to the northward, but without the current it can not be borne south. This inactivity of the Labrador current may or may not continue through the season. In past years its strength has been observed to fluctuate considerably within a period of a few days. After station 398 the vessel was put on a course for the berg reported this date by the *Regina* in  $45^{\circ} 53'$  north latitude,  $51^{\circ} 59'$  west longitude. Winds were from SSW. to SW., increasing in force from 2 to 5; heavy southwesterly swell; partly clear to cloudy, with snow squalls at close; barometer slowly falling to 29.31 at midnight; halo around the moon. Many fulmars, a few dovekies, and Sabine gulls were noted. At 8 p. m. the vessel was in  $45^{\circ} 56'$  north latitude,  $48^{\circ} 25'$  west longitude.

At 2 p. m., April 17, the patrol arrived alongside the berg reported yesterday by the *Regina*. While crossing the Banks a 0.6 knot per hour set  $203^{\circ}$  true was experienced. This one, in  $45^{\circ} 53'$  north latitude,  $51^{\circ} 53'$  west longitude, was a small twin berg and appeared to be disintegrating. Its position removes it from any possibility of ever menacing the North Atlantic steamship tracks. At 6.15 p. m. the vessel was anchored on the Banks in  $46^{\circ} 16'$  north latitude,  $52^{\circ} 19'$  west longitude. Oceanographic station No. 399, near the berg, and No. 400, at the anchorage, were occupied. Winds were WSW., hauling to NNE. and backing to WNW., force 2 to 3; partly clear to cloudy, with short periods of heavy snowfall; heavy SW., changing in afternoon to heavy NE. swell; barometer steady, reading 29.37 at midnight. But little bird life was in evidence, a few fulmars and murre being seen.

At 5 a. m., April 18, we got under way and stood on a course for Cape Race, occupying oceanographic stations Nos. 401 to 404, inclusive, en route. At 12.25 p. m. the vessel was anchored in Trepassy Bay for shelter during the gale. Station No. 405, at the anchorage off Portugal Cove, was occupied. Winds were from north, force 5, at the beginning of the day, increasing to 10 in the afternoon and falling to 6 at the close; mostly cloudy, with heavy snowfall from 9 to 11 a. m.; barometer rising, registered 29.58 at midnight.

The Swedish steamer *Stockholm* was reported for violation of the North Atlantic track agreement.

At 6 a. m. of the 19th the vessel left her anchorage and proceeded to take oceanographic stations along the line  $222^{\circ}$  true from Cape Race, stations Nos. 406 to 414, inclusive, being occupied.

At 9.30 p. m. the *Tampa* was met in  $45^{\circ} 05'$  north latitude,  $55^{\circ} 05'$  west longitude. The observer and his assistant were transferred to the *Tampa* and the *Modoc* relieved of patrol duty. Winds were NW., changing at nightfall to E., force 6, diminishing to 3; barom-

eter rising slowly until 8 p. m., then dropping, reading 29.68 at midnight.

The steamer *Stavangerfjord* reported a berg in 45° 27' north latitude, 52° 15' west longitude, and was reported by the patrol for violation of the North Atlantic track agreement.

Special ice information was furnished the steamship *Tamarac*.

#### SUMMARY

This cruise had three remarkable features: First, with the exception of one berg which had melted by the 11th and another located on the 17th too far to the northward and westward to ever become a menace to the North Atlantic steamship tracks, no ice was seen or reported, though temperature reports indicated that the possible ice area was well covered by steamship traffic. Second, the rarity of fog, with the exception of about one hour on the 15th, no thick fog was encountered. Third, the current that usually bears the bergs to the southward along the east slope of the banks at from 0.5 to 0.7 knot per hour was negligible at this time.

The broadcasts and reports to the Hydrographic Office and the Weather Bureau were carried out as prescribed in Coast Guard letter of February 4, 1924 (612-601).

The patrol received 950 surface seawater temperature reports from 160 different vessels, 24 weather, 5 ice, and 5 wreck and obstruction reports.

Special ice information was furnished to 12 vessels.

#### COAST GUARD CUTTER "TAMPA," LIEUT. COMMANDER W. J. WHEELER, ICE PATROL, SECOND CRUISE, APRIL 19 TO MAY 4, 1924

The *Tampa* left the Halifax fuel oil docks at 6.15 p. m., April 17, and proceeded toward Grand Banks for relief of *Modoc*.

Arrangements were also made to place lines of drift bottles en route; this at the request of Prof. A. G. Huntsman, University of Toronto, representing the Biological Board of Canada. Putting over the first line of bottles was commenced at 2.30 a. m., April 18, latitude 44° 02' north, longitude 62° 03' west, and completed at 7.45 a. m., latitude 43° 47' north, longitude 61° 55' west, the bottles being placed two per mile for a distance of 50 miles. Each bottle was numbered and careful record compiled. Attached to each bottle by means of short wire was a galvanized sheet-iron anchor slit and bent in such form as to catch current equally from any direction. At 5.24 p. m. began putting over second line of bottles, from latitude 43° 48' north, longitude 59° 28' west, and completed this line at 10.55 p. m., latitude 43° 23' north, longitude 58° 27' west. This line was also 50 miles in length, with two bottles per mile.

We then stood course  $65^{\circ}$  true to meet *Modoc*, with whom we had communicated and found to be off Cape Race. At 12.30, April 19, course was changed to  $42^{\circ}$  true, and at 9.45 p. m. met *Modoc*, latitude  $45^{\circ} 15'$  north, longitude  $54^{\circ} 02'$  west. Sent mail to *Modoc*, and Lient. E. H. Smith, oceanographer, and his assistant, Yeoman R. Lewis, transferred to *Tampa* from *Modoc*, the former vessel assuming the ice patrol. Advantage was taken of fine weather conditions to calibrate radio compass of the *Modoc*, the *Tampa* steaming around her at moderate speed sending out signals. This was completed at 12.15 a. m., and the *Modoc* proceeded toward Halifax for fuel.

Prevailing ice conditions reported by *Modoc* were most unusual, there being but one berg south of Newfoundland. This one was last reported on the 18th (latitude  $45^{\circ} 53'$ , longitude  $51^{\circ} 53'$ ). No other ice had been seen or reported for a week past. This condition had permitted the *Modoc* to make a trip to Cape Race for oceanographic work and to continue a line of stations  $222^{\circ}$  true from Cape Race until relieved by *Tampa*.

On trip from Halifax the *Tampa* experienced mostly fine weather, with moderate to fresh N. to NE. breezes and few hours of strong NNE. breeze. At 12.25 a. m., April 19, the *Tampa* stood  $222^{\circ}$  true to continue the oceanographic work. At 2.40 stopped and occupied station No. 415. At 4.15 a. m. again stood course  $222^{\circ}$  true, and at 7.55 stopped to occupy station No. 416. By careful backing in rough sea this station was occupied. At 8.50 a. m. stood on course  $124^{\circ}$  true to reach western end of third line of drift bottles to be put over for Canadian Biological Board. A moderate to fresh gale, SSE., set in at 4 a. m. and continued until early afternoon, hauling to WSW., and falling to moderate breeze W. at close. Rough sea prevailed the greater part of the day and speed was reduced accordingly. Occasional snow squalls passed in forenoon and rain squalls in afternoon.

No ice sighted or reported this day.

April 21: Begins, standing on course  $124^{\circ}$  true. At 6.45 set course  $62^{\circ}$  true and began putting over third line of drift bottles, latitude  $43^{\circ} 15'$  north, longitude  $53^{\circ} 20'$  west. This line was completed at 3.50 p. m., in latitude  $43^{\circ} 20'$  north, longitude  $51^{\circ} 47'$  west, a distance of 75 miles, with four bottles to the mile.

At 3.57 stopped to examine wreckage near end of line of bottles. Found same to consist of side of wooden vessel some 50 feet long by 20 feet wide, of heavy timbers, including knees, and dangerous to navigation. Made preparations to destroy same with wrecking mine, and at 4.40 lowered surfboat in charge of Lieutenant Von Paulsen to place mine. Though swept by each succeeding sea, two

coxswains boarded the wreckage, rove a weighted line, attached to this line a 50-pound T. N. T. mine underneath wreckage, and it was exploded at 5.04. A column of water with fragments of wreckage were thrown into the air to a height of some 75 feet and the former solid piece was reduced to many bits of wreckage, no longer constituting a menace.

Hoisted surfboat, stood 20° true for a few miles, and at 6 anchored on edge of bank, latitude 43° 51', longitude 51° 46'; 48 fathoms of water, 105 fathoms of chain.

This day was overcast, with fresh SW. breezes, becoming strong NNW. breezes at the close. Rough to rather rough seas prevailed, with period of moderate sea about midday.

No ice reports were received.

April 22: Begins with moderate gale WNW., increasing to fresh gale, and hauling to NW., moderating to strong NW. breeze just before midnight. Overcast to clear; barometer slowly rising. Rough sea throughout. At 6.30 a. m. movable casting carrying riding pawl of port chain fractured from strain on chain, due to pitching of vessel. Hove up anchor to let vessel drift for remainder of day.

Gave special ice information to steamship *Canadian Leader*.

April 23: Beginning with strong NW. breeze, with rather rough sea, wind and sea both moderating to gentle N. breeze and moderate sea at close. Sky mostly clear prevailed throughout the day.

The vessel, drifting for the night, got under way at 6.30 a. m. to occupy line of stations around tail of bank.

At 10.35 a. m., 3.30 p. m., and 9.05 p. m. the following stations were respectively occupied: Nos. 418, 419, and 420. Arctic water was found at each station. At 10.25 p. m., having completed station No. 420, stood 43° true for station No. 421.

Schooner *David C. Ritchey* reported in sinking condition, latitude 40° 10' north, longitude 56° 07' west, 22d instant.

April 24: Light N. breezes, hauling to SSE., and becoming strong SE. breezes at close. Mostly cloudy; moderate to slight sea. Standing up east side tail of bank to occupy line of stations. On course 43° true at beginning. At 3.50 stopped and occupied station No. 421. At 4.30 course 27° true for 42 miles, to station No. 422, which was occupied at 10.10. At 11 course 13° true for 40 miles, to station No. 423, occupied at 3.40 p. m. At 4.55 stood on course 285° true to cross bank. At 8 anchored for the night near edge of bank, in 28 fathoms of water, 105 fathoms of chain; latitude 44° 30' north, longitude 49° 25' west. Some four fishing vessels sighted in vicinity of anchorage. Flocks of shearwater sighted this day, and a number of whales seen.

Gave special ice information to steamship *Canadian Mariner*. Derelict schooner *Governor Parr* reported sighted by steamship

*Lieut. Jean Laurent.* An unimportant obstruction report by steamship *West Cobalt* and a dead whale reported by steamship *Vincent*.

April 25: Begins with vessel anchored for night in fresh SE. breeze, fog, and rain; moderate sea. Crew tried fishing, without success; probably sea disturbed the bottom. At 6 a. m. wind shifted to NW. moderate breeze, which at 10 a. m. increased to strong breeze and moderate gale, with rather rough sea for remainder of day. At 9.15 under way and on course  $284^{\circ}$  true to make search for berg last reported on 22d instant. At 7.30 p. m., visibility failing, stopped and anchored for night; latitude  $44^{\circ} 40'$ , longitude  $50^{\circ} 48'$ ; 37 fathoms of water, 100 fathoms of chain. A number of French fishermen, mostly barkentines, sighted on either hand this day, and one some 3 miles ahead when we anchored. So far as observed, the weather was too rough for fishing to-day. A number of whales sighted and a few shearwater and sea parrots sighted.

Received from the steamship *Manchester Regiment* an unimportant obstruction report. (Spar.) No ice reports received.

April 26: Began with strong WNW. breeze, which fell to moderate breeze, hauled to NE., and closed with moderate NNE. gale. Rather rough sea throughout. Overcast; fog at intervals first part; fog and rain at close.

At 5.30 hove up anchor and began rectangular search to westward and southward for small berg last reported on 22d. At 6.15 p. m. discontinued search on account of fog and anchored for the night, latitude  $45^{\circ} 05'$ , longitude  $51^{\circ} 31'$ . Search this day having covered area of probable drift of berg, between latitudes  $44^{\circ} 15'$  to  $45^{\circ} 05'$  and longitudes  $50^{\circ} 45'$  to  $51^{\circ} 45'$ , we concluded that this small berg had melted and was no longer to be considered a menace.

Passed a number of French barkentine fishermen in forenoon.

Received ice report from steamship *Saxonia* and report of schooner wreckage sighted from steamship *Crete*. Attempted to secure details from *Crete*, but unable to further communicate with her. A few fulmar seen this day.

April 27: Strong NNE. to ENE. breezes to moderate gales, falling to fresh breeze at close. Rather rough to rough sea. Overcast; rain at intervals first part. At 5.30 up anchor and stood  $111^{\circ}$  true to station No. 425, latitude  $44^{\circ} 55'$ , longitude  $50^{\circ} 24'$ , which was occupied at 9 a. m.; both water temperatures and biological specimen being taken at this central station. At 10.35 under way and stood on course  $96^{\circ}$  true, line of stations Nos. 425, 426, and 427, occupied, respectively, at 1.47 p. m., 5.20 p. m., and 8.25 p. m. At 8.40 stood on course  $152^{\circ}$  true, with speed reduced to 4 knots, to reach position for beginning search to northward along eastern edge of Grand Banks at daybreak.

Received obstruction report from steamship *Columbus*. (Derelict schooner *Governor Parr*.)

Passed a number of French barkentine fishermen this day. Sighted numerous blackfish and in afternoon a few porpoises.

April 28: Begins with vessel on course  $152^{\circ}$  true, speed 4 knots, to reach point for beginning search at daybreak. At 5.45 course  $3^{\circ}$  true, standard speed, to search for bergs on eastern side of Banks. At 8.15 course  $18^{\circ}$  true. At 5.48, having searched east side of Bank to latitude  $45^{\circ} 45'$ , with visibility extending to latitude  $46^{\circ} 00'$ , stood west true to search for two bergs last reported on 26th instant. At 8.25 stopped and anchored for the night; 36 fathoms of water, 105 fathoms of chain; latitude  $45^{\circ} 45'$ , longitude  $48^{\circ} 50'$ .

This day numerous whales and blackfish and many flocks of murre and fulmars seen.

April 29: Moderate to light WNW. to NW. breezes; moderate sea; sky overcast. At 5.15 up anchor to continue rectangular search for two bergs last reported on 26th instant. Searched throughout the day under forced draft after 9 a. m. Covered area between parallels  $45^{\circ} 20'$  and  $46^{\circ} 30'$  and meridians  $49^{\circ} 00'$  and  $50^{\circ} 10'$ . Sighted passing steamers *Regina*, eastbound to northward of course, and *Dunaff Head*, westbound to south of course, and requested each to keep special lookout. No ice sighted or reported. Steamer *Regina* made special request for copy of article by Lieutenant Smith on subject of ice drift, published as supplement to March Pilot Chart; this to be mailed from Halifax.

At 7.30 stopped and anchored for the night in 37 fathoms of water, with 105 fathoms of starboard chain; latitude  $46^{\circ} 15'$ , longitude  $49^{\circ} 05'$ . A few murre, fulmars, and dovekeys seen this day.

April 30: Fresh to strong NW. to N. breezes; moderate NW. swell. Mostly cloudy; passing fog banks at intervals first part. At 8.55 up anchor and resumed search for bergs north and east of area previously covered. Stood west 8 miles, north 13 miles, then east true 30 miles. At 2.50 p. m. occupied station No. 429, latitude  $44^{\circ} 37'$ , longitude  $47^{\circ} 20'$ . At 3.10 set course  $160^{\circ}$  true to search east side of Bank until nightfall, then continue to outer end of line of stations. Flocks of fulmars and a limited number of murre observed this day.

Special ice information given to steamship *Athenia*.

May 1: Moderate to light NNW. to NE. breezes; moderate swell. Cloudy to clear, fine weather. At beginning on course  $160^{\circ}$  true to line of oceanographic stations. At 4.30 stopped and occupied outer station No. 429, latitude  $44^{\circ} 37'$ , longitude  $47^{\circ} 32'$ . At this station found warm Atlantic water prevailing to a greater extent than usual at the season. At 5.30 ahead course  $280^{\circ}$  true on line of sta-

tions toward Banks. At 8.10 stopped and occupied station No. 430, latitude  $44^{\circ} 40'$ , longitude  $48^{\circ} 00'$ . Put over 750 meters of sounding wire with six water bottles and thermometers. In heaving in, wire carried away at 600 meters, losing four water bottles with thermometers. Temperatures recorded by first two thermometers again indicated prevalence of Atlantic water nearer the Bank than usual.

At 8.55 stood  $294^{\circ}$  true to extend search for bergs last reported on 26th instant. Fitted new sounding wire and adjusted spare bottles and thermometers en route. At 1 changed course to  $280^{\circ}$  true to search south of area already covered. At 8 p. m. anchored for night in 33 fathoms of water, 105 fathoms of chain; latitude  $45^{\circ} 06'$ , longitude  $49^{\circ} 58'$ . Flocks of murre seen this day.

May 2: Begins foggy with light SE. breezes and smooth sea. Cleared at noon, and fine weather prevailed until dark, then wind hauled south, and increasing to strong breeze at close, bringing mist. Remained at anchor because of fog until 11.45, then under way, course  $307^{\circ}$  true, to scout for bergs last reported on April 26, covering area farther west than previously scouted. Passing merchant vessels had covered the greater part of area of possible drift. At 8 stopped and occupied station No. 431, latitude  $45^{\circ} 56'$ , longitude  $51^{\circ} 33'$ . At 8.30 set course  $305^{\circ}$  true for Cape Race, to take line of stations to westward. Flocks of fulmars and murre seen this day. Fishing at anchorage, but only one caught, a 28-pound cod.

May 3: Begins with strong southerly breezes and fog. Reduced speed and set course  $285^{\circ}$  true for greater safety in approaching Cape Race, sounding at intervals. At daybreak wind moderated to gentle SW. breeze and fog cleared. Remainder of day fine weather, closing with calms to light westerly airs. At 6.25 set course  $322^{\circ}$  true for Cape Race. At 7.10 Cape Race sighted, bearing  $370^{\circ}$  true; stood for it. Opportunity given by fine weather was utilized by swinging ship for compass-deviation table in Trespassey Harbor and anchored in 5 fathoms of water at 11.05, to become more familiar with harbor. Boat landed with officers, who looked at harbor and bay from promontory on east side.

At 12 underway; stood out and on line of oceanographic stations,  $251^{\circ}$  true from Cape Pine, stations being spaced 15 miles apart; occupied stations Nos. 432 to 437, inclusive. Fulmars and murre with a few jaeger were seen this day.

No ice reports received.

May 4: Gentle S. to SE. breezes; slightly hazy; fine weather. Occupying line of stations on course  $251^{\circ}$  true. Stations Nos. 238 to 242, inclusive, occupied, the last being in latitude  $45^{\circ} 50'$ , longitude  $56^{\circ} 57'$ , and showing a depth of some 250 fathoms, considerably

deeper than shown in the chart. Station No. 241 showed depth of 19 fathoms, near edge of Bank, markedly less than given on chart.

Met the *Modoc* at 2 p. m., latitude  $45^{\circ} 34'$ , longitude  $57^{\circ} 16'$ . Lieutenant Smith and Yeoman Lewis transferred to *Modoc* and that vessel assumed ice patrol.

#### SUMMARY

The weather experienced this cruise has been generally favorable. Some 12 per cent of gales has been experienced, which is approximately the amount given on pilot chart as the mean for the season, but less than experienced in the *Tampa's* two previous seasons. Some 12 per cent of fogs has also been experienced, which is markedly less than the 30 to 45 per cent given on pilot chart. Water temperature of the reservoir of the Grand Banks has been higher than usual at the season, and warm Atlantic water has been found prevailing closer to the Grand Banks than usual.

The extraordinary absence of ice is probably a result of this unusual water-temperature situation. We were unable to locate the small berg sighted by the *Modoc* on the Banks April 17 and last reported April 22, and we concluded that it had disintegrated. Later our diligent search, in which we utilized passing steamers, failed to locate two bergs reported on the Banks on 26th and we concluded that they also had disintegrated. No other ice has been seen or reported south of Newfoundland.

The schooner *David C. Ritchey*, reported abandoned in a sinking condition on April 22, has not been again reported, and we conclude that she must have sunk. The "drifting schooner wreckage," reported by steamer *Crete* on 26th instant has not been again reported, nor were we able to secure further details from the *Crete*. Possibly this wreckage was from the same schooner as the wreckage destroyed by the *Tampa* on April 21, possibly from the derelict schooner reported in latitude  $40^{\circ} 45'$ , longitude  $57^{\circ} 25'$ , on April 16. Normal Gulf Stream drift of 1.2 knots per hour would cover the intervening distance. The derelict schooner *Governor Parr* was again reported on April 26 and 29, having made an extraordinary drift throughout a circle of some 400 miles in diameter in a period of some months. This derelict was last reported on April 29 in latitude  $46^{\circ} 08'$ , longitude  $32^{\circ} 00'$ , in the main axis of the Gulf Stream, and it is hoped that it will drift to the northward.

During the period of this patrol ice reports were received from two vessels, obstruction reports from seven vessels, and 902 water-temperature reports were received.

Daily dispatches and radio broadcasts have been sent as follows:

(a) At 6 a. m. and 6 p. m., seventy-fifth meridian time, ice information has been broadcasted on 600-meter wave length (spark), and one hour later the same information has been broadcasted on 1,621 CW.

(b) Daily, at 8 p. m., seventy-fifth meridian time, information has been sent to Hydrographic Office, Washington.

(c) Daily weather reports have been sent to Washington.

Owing to inability to communicate with Bar Harbor, except intermittently, only a few weather reports from selected positions in the North Atlantic were transmitted in compliance with request of the United States Weather Bureau.

**COAST GUARD CUTTER "MODOC," LIEUT. COMMANDER L. T. CHALKER, ICE PATROL, SECOND CRUISE, MAY 4 TO MAY 19, 1924**

The *Modoc* left Halifax, Nova Scotia, at 8.45 a. m. May 3, 1924. After clearing the harbor, radio communication was established with the *Tampa*, and, as she was in the vicinity of Cape Race, a course was set to pass north of Sable Island. At 1 p. m. May 4 contact was made with the *Tampa* in  $45^{\circ} 39'$  north,  $57^{\circ} 31'$  west. Lieut. E. H. Smith, observer, and Yeoman, Second Class, R. W. Lewis, his assistant, were transferred from the *Tampa* to the *Modoc*. Mail was delivered to the *Tampa* and that vessel relieved of patrol duty. On leaving Halifax up to the time of relieving the *Tampa* the weather was very fine, the sky was mostly clear, visibility excellent, sea smooth, light to gentle SE. breezes prevailing. The barometer range was from 30.02 to 30.11. At 1.40 p. m. on the 4th a fog shut in and the barometer began to fall slowly. At 2.20 p. m. went ahead at reduced speed in a thick fog to run a line of oceanographic stations along the western edge of the Grand Banks.

The weather from midnight of the 4th until 9 p. m. of the 5th was overcast and foggy, with rain squalls before 4 a. m. There was a strong S. breeze at midnight, which had shifted to SW. and fallen to a gentle breeze by noon of the 5th. The barometer at noon was 29.93 and stationary. At 9 p. m. the fog cleared away but the horizon remained hazy. During the day cruised to the southward at reduced speed along the western side of the Grand Banks, stopping at 5.37 a. m. to occupy oceanographic station No. 443 and at 9 p. m. to occupy station No. 444. Drifted for the remainder of the night. No ice was reported this day.

Special ice information was furnished the *Leviathan*.

While drifting for the night, several Leach's petrel flew on board, and after resting for a short time flew away again. They were evidently attracted or blinded by the lights of the vessel. At 4.30 a. m. of the 6th went ahead and continued cruising to the south and east.



During the morning watch part of a tree trunk and branches of a tree were passed. They were not a menace to navigation. A report was received from the steamer *Barembek* of a large black conical spar buoy on which was a white flag with one black letter in it. The buoy was passed at 2.20 p. m. Greenwich mean time, May 6, in latitude  $43^{\circ} 15'$  north, longitude  $38^{\circ} 10'$  west. During this day oceanographic stations Nos. 445, 446, and 447 were occupied, the last at 6.40 p. m., after which the vessel drifted for the night. During the 6th the weather was mostly overcast and cloudy, with calm to light SW. airs and breezes. The visibility was fair except from noon to 2.30 p. m., when it was foggy. At 5.30 p. m. it began to rain and continued until midnight.

No ice was seen or reported this day.

The weather on May 7 was exceptionally fine. The drizzling rain which we had at midnight of the 6th had ceased by 1 o'clock and the wind had shifted to a gentle NW. breeze. The sky was clear, the visibility excellent, and the barometer was 29.80 and rising slowly. Throughout the day the sky was clear, the visibility excellent; the wind varied from NW. to WSW., and from moderate to light breezes. There was a moderate westerly swell. At midnight on the 7th the barometer was 30.06 and still rising. At 4.30 a. m., May 7, started ahead and continued cruising the remainder of the day and night. Oceanographic stations Nos. 448 to 452, both inclusive, were occupied along the southwest slope and south of the Grand Banks. Although many steamers crossed the Labrador current between Cape Race and latitude  $43^{\circ} 00'$  north, and the visibility was unusually good, none of them had seen any ice. No ice was sighted by this vessel.

Special ice information was furnished the *Berengaria*, and the French steamer *Ply No. 21* was, on request, given information as to the present location of the French fishing fleet.

The weather, which was exceedingly fine on the 7th, continued so on May 8. The atmosphere was very clear and the sky practically cloudless. Stars shone brightly during the early morning and at night and the moon from evening twilight until it set at 10.11 p. m. Throughout the day there were calms and light airs, and breezes from W. to NW. The sea was smooth. The barometer at midnight on the 7th was 30.06 and at midnight on the 8th it was 30.21. During the day the *Modoc* cruised along the south and southeastern slope of the Grand Banks as far north as latitude  $43^{\circ} 20'$  north. Oceanographic stations Nos 453 to 457, both inclusive, were occupied, the last one at 7.12 p. m., after which we drifted for the night. During the 8th several murre, fulmars, and dovekeys were seen. No ice was sighted this day and none was reported, although several steamers passed across the Labrador current between latitude  $43^{\circ} 00'$  north

and Cape Race. A current of from 0.8 to 1 knot was observed along the SE. slopes of the Grand Banks. The current had a general southerly direction parallel to the edge of the Grand Banks. At 11.55 p. m. an unidentified steamer passed close to us bound west.

At 4 a. m., May 9, started ahead and began to search for icebergs off the eastern slope of the Grand Banks, along the axis of the Labrador current. The general course of the vessel was about NNE. During the forenoon two schools of whales were sighted also several fulmars and dovekeys and numerous murre. A three-masted topsail schooner bound to the westward was sighted at 7.15 a. m., and at noon two sailing vessels were reported by the lookout aloft. All three vessels were too distant to signal, but it is probable they were French fishermen. At 11.55 we stopped to occupy oceanographic station No. 458. As a short circuit was found in the motor used to hoist the water bottles, the taking of this station was deferred until the motor could be repaired. It had begun to rain, and the visibility was greatly reduced, making a thorough search for ice impracticable. We, therefore, headed for the Grand Banks, where we anchored at 2.45 p. m. in 33 fathoms of water; latitude  $44^{\circ} 20'$  north, longitude  $49^{\circ} 15'$  west. At midnight on the 8th there was a dead calm, the sky was clear, sea smooth, and the barometer was 30.20 and had begun to fall. By noon a moderate SE. breeze was blowing, the barometer had fallen to 29.95 and it was raining hard. The conditions remained about the same until 7 p. m. when the wind shifted to ENE., force of 6, and the barometer, which had fallen to 29.77, began to rise. At midnight the wind was E., force 4, barometer 29.84, sky overcast, horizon hazy, and a moderate swell from the east.

No ice was seen or reported this day.

At 9 a. m., May 10, got up anchor and proceeded to the eastward to the Labrador current where we stopped at 11.30 a. m. and occupied oceanographic station No. 458. After completing this station a search for ice was made to the northward, following the general trend of the Labrador current. At 7.25 p. m. we stopped and occupied station No. 459 after which we drifted for the night. The search this day covered the eastern slope of the Grand Banks between latitude  $44^{\circ} 28'$  north, and latitude  $45^{\circ} 18'$  north. Although arctic water was found at both stations, no current was observed during the day's run.

No ice was sighted this day, but the steamer *Cranley* reported, via Cape Race, passing a narrow strip of field ice and growlers extending from  $48^{\circ} 42'$  north,  $51^{\circ} 12'$  west, for about 30 miles in a general direction of  $100^{\circ}$  true. This is the first ice which has been reported this cruise and it is so far north that it is very unlikely it will ever become a menace to vessels following the regular steamer tracks.

Two obstruction reports were received this day, one from the steamer *Speaker*, which sighted a buoy staff and cage in  $38^{\circ} 20'$  north,  $65^{\circ} 09'$  west, and the other from the *Patria* which passed a derelict in  $41^{\circ} 16'$  north,  $55^{\circ} 51'$  west, consisting of the after part of a schooner about 60 feet in length.

While cruising this day numerous murre, fulmars, and dovekeys and one whale were sighted. The weather was fine, horizon clear, fresh NE. to light ENE. breezes prevailing. The barometer rose from 29.88 at 1 a. m. to 30.15 at midnight. The moon shone brightly until it set at 11.53 p. m.

Special ice information was furnished the *Maindy Hill*.

At 4 a. m., May 11, a systematic search was begun to cover the northeastern and northern slope of the Grand Banks. The diagram was so laid out as to patrol the probable drift of ice from the north. At 1.20 p. m. and at 7.50 p. m. we stopped and occupied oceanographic stations Nos. 460 and 461, respectively. The last station taken was in  $47^{\circ} 24'$  north,  $48^{\circ} 47'$  west. We drifted for the night. No current was observed this day, but the water temperatures obtained at the last station are the coldest which have been recorded this cruise. During the day many birds were seen, consisting of murre, dovekeys, fulmars, shearwater, and jaegers. No ice was seen nor was any reported. The weather was generally clear, visibility excellent, moderate swell from the north, light airs to gentle breezes varying from NE. to NW. The barometer ranged from 30.15 at 1 a. m. to 30.26 at 5 p. m., and was 30.24 at midnight. The night was bright and starlit, with a halo around the moon.

At 4 a. m., May 12, started ahead and continued systematic search for ice or bergs north of the Grand Banks. The search was carried on during daylight hours under very favorable conditions until 6.35 p. m., when we stopped, occupied oceanographic station No. 462 in  $47^{\circ} 58'$  north,  $49^{\circ} 31'$  west, and then drifted for the remainder of the night. No ice was seen on the 12th nor was any reported.

The steamer *Tortugas* reported passing at 21.20 Greenwich mean time, May 12, in latitude  $49^{\circ} 13'$  north, longitude  $42^{\circ} 46'$  west, a large red gas buoy with light extinguished.

While cruising was passed numerous birds, consisting of murre, shearwater, dovekeys, Leach's petrel, and jaegers. The weather on the 12th was overcast and cloudy, with good visibility except from 3.30 to 4 p. m., when there was a light fog. There were light airs and gentle breezes from W. to N. and NE. The sea was smooth. The barometer was unusually high, being 30.24 at 1 a. m. and 30.31 at midnight.

On May 13 we continued searching for ice to the north, starting ahead at 4 a. m. At 10.15 a. m. increased to full speed, natural

draft, to take advantage of the unusually good weather conditions. The search was continued until dark, when we stopped in  $48^{\circ} 33'$  north,  $50^{\circ} 50'$  west, and occupied oceanographic station No. 463. Many murre, fulmar, and jaeger were passed this day; also one large whale asleep on the surface of the water. No ice was seen nor was any reported by the 15 or more steamers which crossed the usual ice zone. The weather this day was well adapted to search. While the sky was for the most part overcast, the visibility was excellent, the sea smooth. There were calms and light variable airs until 6 p. m., when the wind came out from SSW. and increased in force until there was a moderate breeze at midnight. The barometer was 30.32 at 1 a. m., 30.38 at noon, and 30.24 at midnight and falling steadily.

May 14 was a poor day for continuing the search for ice, on account of prevailing weather conditions, and not much area was covered. At 1 a. m. there was a gentle SSW. breeze, the sky was overcast, and the barometer stood at 30.18 and was steadily falling. During the day there was intermittent hail, rain, and fog, and at times the horizon was clear. We went ahead at 4 a. m. and cruised at varying speeds throughout the day, depending on weather conditions. At 7 p. m. the conditions had changed and gave promise of good weather on the following day. The wind had shifted to a gentle SW. breeze, the atmosphere was much clearer and drier, and the stars and moon were shining brightly. At midnight the barometer was 29.78 and steady. While cruising we passed a number of murre, fulmar, and jaeger. No ice was seen or reported. The steamer *Salina* reported passing a red gas and whistling buoy on May 14 at 16.30, Greenwich mean time, in  $50^{\circ} 12'$  north,  $42^{\circ} 28'$  west. The buoy was marked "FPUA." It is probably the same one reported on May 12 by the steamer *Tortugas*.

On May 15 the weather and visibility were good and we continued our search for ice. At 4 a. m. the patrol started ahead and cruised during daylight hours off the east coast of Newfoundland. At 9.50 a. m. we sighted land and then, after cruising parallel to the coast for a time, stood to the eastward. Stations Nos. 464, 465, and 466 were occupied during the day, the last at 7.35 p. m., after which we remained drifting. While occupying station No. 465 several jaegers hovered over the after part of the vessel. One of them became very bold and with beak extended flew at Yeoman Lewis, striking at his watch cap. He did this several times until frightened away by Lewis hitting at him with his fists. There were light airs and gentle breezes on the 15th, varying from SW. to NW., the sky was mostly clear, the sea smooth. The barometer was 29.78

at 1 a. m. and had risen to 29.94 at midnight. The steamer *Schenectady* reported passing, on May 15, at 6.30, Greenwich mean time, in latitude  $40^{\circ} 52'$  north, longitude  $52^{\circ} 49'$  west, part of the poop and stern of a wooden vessel. The wreckage was about 40 feet long, 15 feet wide, and floated 6 feet out of water. This is probably the same derelict reported by the *Patria* on May 10 in latitude  $41^{\circ} 16'$  north, longitude  $55^{\circ} 51'$  west. If the same wreckage, it has drifted  $100^{\circ}$  true, 150 miles in five days, an average drift of 30 miles a day. At 9.30 p. m. the *Oxonian* reported passing a small iceberg at 23.10, Greenwich mean time, in latitude  $46^{\circ} 14'$  north, longitude  $50^{\circ} 15'$  west. The position of the berg is fairly close to the Virgin Rocks. This probably accounts for its not having been reported sooner, as most vessels give these dangerous rocks a wide berth. At 9.34 p. m. we started ahead for the position of the berg, cruising at standard speed. The night was clear and bright, the moon casting a silvery path across the ocean.

On May 16 the patrol continued searching for the small iceberg reported yesterday until 12.05 p. m. when we anchored near its reported position in latitude  $46^{\circ} 15'$  north, longitude  $50^{\circ} 10'$  west. At 5 a. m. it began to get hazy and then a thick fog and heavy rain set in making it impracticable to search for the berg to advantage. When we arrived at its reported position we anchored to await clearing weather. Station No. 467 was occupied while at anchor. No arctic water was found. Special ice information was furnished the *Canadian Constructor*, the *Pipestone County*, and the *Capulin*. The weather this day was mostly overcast and cloudy, with fog and rain. At 5.45 p. m. the fog blew away and it became clear overhead. There were light to fresh SW. and W. breezes, moderate SW. sea. The barometer was 29.93 at 1 a. m., 29.83 at 3 p. m., and 29.91 at midnight.

At 8 p. m. a message was received from the *Tampa*, stating she left Halifax at noon to-day.

At daylight on the 17th the conditions were favorable for continuing the search for the small berg reported on the 15th. The anchor was hove up and at 4 a. m. we went ahead full speed, natural draft. We steamed to the northward as close to the Virgin Rocks as advisable and then to the west, then south, and then east. At 2.15 p. m. we stopped near the French barkentine *Pomone*, of St. Malo, at anchor in  $46^{\circ} 17'$  north,  $50^{\circ} 07'$  west, engaged in fishing. This anchorage is just 4 miles from the berg reported May 15 by the *Oxonian*. A ship's boat was sent to the barkentine to obtain information. The master stated that he had been anchored in his present location since May 15; that he had seen no iceberg; and, in fact, had seen none this season, which was unusual in his experience of 20 years as a fisherman on the Grand Banks. Other fishermen with whom he had been in

contact had seen no icebergs this season. The *Pomone* has been fishing on the Grand Banks since April 1. The ship's surgeon gave medical treatment to two of the fishermen, one of whom had a badly infected thumb and the other a strained shoulder. The master presented us with enough fine codfish for all hands, and in return we took his mail and gave him some cigarettes and fresh beef, for which he was very grateful. These French fishermen are always very courteous and hospitable and show great appreciation for any little service which may be rendered them. While lying to, the fog shut in thick. We recalled our boat and hoisted it, and then stood south to latitude  $46^{\circ} 00'$  north, and  $270^{\circ}$  true to make contact with the *Tampa*. About noon we sighted the steamer *Rygja* 5 or 6 miles south of us bound west. She had seen no ice. The steamer *Carrington Head* was sighted south of us at 1 p. m., and she had seen no ice.

Special ice information was furnished the *Kelsinoor*, and ice and weather reports to the *Glentworth* and *Marte*. The weather until 3.30 p. m. was mostly cloudy and hazy with visibility from 6 to 7. There were light SW. breezes. At 3.30 p. m. the fog shut in thick and for the remainder of the afternoon and night there was fog and rain and moderate breezes from the WSW. The barometer at 1 a. m. was 29.92, at noon 29.96, and at midnight 29.72.

On May 18 we continued on the course  $270^{\circ}$  true until 8 p. m., when the course was changed to  $280^{\circ}$  true, to meet the *Tampa* on the 19th. The thick fog which we had during the night and early morning cleared away by 9 a. m., after which the sky was partly clear and the horizon hazy. During the forenoon there were moderate to strong W. breezes which gradually decreased to gentle NW. breezes at midnight. There was a moderate sea from the west. The barometer, which was 29.71 at 1 a. m., gradually rose until it was 29.86 at midnight. No ice was reported.

At noon on May 19 the *Tampa* was met in latitude  $46^{\circ} 00'$  north longitude  $55^{\circ} 50'$  west. The observer and his assistant were transferred to the *Tampa* and the *Modoc* relieved of the patrol. We proceeded to Halifax for fuel and supplies.

#### SUMMARY

The two outstanding features of the second cruise of the *Modoc* are the absence of ice and the unusually good weather. Although a thorough and systematic search of the ice regions was made between latitudes  $43^{\circ} 00'$  north and  $49^{\circ} 00'$  north, no ice was seen. Of the many steamers crossing the ice zone in various latitudes only two reported having seen ice. One report was of field ice and growlers in  $48^{\circ} 42'$  north,  $51^{\circ} 12'$  west, and the other of a small berg in  $46^{\circ} 14'$  north,  $50^{\circ} 15'$  west. In each case a thorough search was

made for the ice reported, but none was found. The weather throughout the cruise was favorable for carrying out the mission of the patrol. The hours of fog were 17 per cent and of fog and low visibility 19 per cent. For the most part light to moderate breezes prevailed. On three days only did the breeze reach the force of 6, Beaufort scale, and then for only an hour or two. Twenty-five oceanographic stations were occupied. The data obtained from them indicates that the season is fully two weeks in advance of normal. The water is warmer than is usual at this time of the year, and the Labrador current shows a negligible southerly drift which is largely influenced by winds and tide. The broadcasts and reports to the Hydrographic Office and Weather Bureau were carried out as prescribed in Coast Guard letter of February 4, 1924 (612-601). The patrol received 850 surface sea-water temperatures from 140 different vessels, 35 weather, 2 ice, and 11 wreck and obstruction reports. Special ice information was furnished to 8 vessels, and weather reports to 3.

**COAST GUARD CUTTER "TAMPA," LIEUT. COMMANDER W. J. WHEELER, ICE PATROL, THIRD CRUISE, MAY 19 TO JUNE 4, 1924**

The *Tampa* left Halifax at 11.45 a. m. May 16, a day earlier than her schedule, in order that she might have time to stop at St. Pierre, Miquelon, to secure information regarding two French barkentines (fishermen) that were reported to have been sunk by ice last season without knowledge of the patrol vessel. Partially thick weather set in on afternoon of sailing, but utilization of the Canadian radio-compass stations enabled us to skirt the shore of Nova Scotia and Cape Breton Island without difficulty, and at 9.15 p. m. on the 17th we anchored on the northeastern edge of St. Pierre Bank, some 20 miles from St. Pierre, to await daylight and clearing weather. At 5 a. m. Sunday, May 18, we stood for St. Pierre, anchoring in the harbor at 10.05. Westerly breezes and clear weather prevailed. After exchanging calls with the French governor we received written report from him that the French barkentine *Le Raymond* was lost through collision with ice April 24, 1923, latitude 48° 57', longitude 45° 25' (from meridian of Paris), and the *France et Bretagne* on April 25, 1923, latitude 46° 15', longitude 44° 05' (from meridian of Greenwich). Neither vessel was equipped with radio. It is to be observed that *Le Raymond* was not in the vicinity of steamer lane for that reason. The *France et Bretagne* was in the vicinity of the route to Halifax, but naturally neither vessel could be considered within the scope of operations of the ice patrol, since neither was equipped with radio.

The *Tampa* sailed from St. Pierre at 6.15 a. m. on the 18th, and at 11.40 a. m. made contact with the *Modoc* in partially thick weather, latitude  $46^{\circ} 11'$ , longitude  $56^{\circ} 05'$ . Mail was delivered to the *Modoc*; Lieutenant Smith and his assistant, Yeoman Lewis, were transferred to the *Tampa*, and this vessel relieved the *Modoc* of ice patrol. The *Modoc* proceeded toward Halifax.

Summary of the ice situation was to the effect that no ice had been sighted by the *Modoc* during period of this patrol. A small berg was reported May 16 on northern part of the Grand Banks, but this report was considered erroneous, in view of the exhaustive search conducted in the vicinity by the patrol vessel. The only authentically located ice exists in the region of the Strait of Belle Isle, the most recent report, on April 29, giving 53 bergs and growlers.

There are three recent obstruction reports: On May 16 derelict schooner awash was reported in latitude  $40^{\circ} 39'$ , longitude  $53^{\circ} 45'$ , while wreckage, probably from this schooner, was reported on May 16 in latitude  $40^{\circ} 52'$ , longitude  $52^{\circ} 49'$ . The third was that of a schooner bottom up on May 11 in latitude  $44^{\circ} 39'$ , longitude  $55^{\circ} 08'$ , this being in the eddies west of the Grand Banks. In view of its proximity and the existing respite from necessity for ice investigation, the last-named report is deemed worthy of our immediate investigation. At 1.40 stood  $156^{\circ}$  true for reported position of schooner bottom up. Fog at intervals in the forenoon was succeeded by haze in afternoon. Fresh to gentle W. to SSW. breezes prevailed this day.

May 20: Light and gentle SSW. to NW. breezes, with fine weather, was experienced throughout the day. Speed was regulated so as to reach point for beginning search at daybreak. At 5.10 full speed, natural draft. At 6.12 reached last reported position of schooner bottom up—latitude  $44^{\circ} 39'$ ; longitude  $55^{\circ} 06'$ . Began rectangular search with 12 miles between lines of search. At 8.30 p. m. stopped and lay to for the night—latitude  $44^{\circ} 40'$ ; longitude  $55^{\circ} 35'$ .

The Cape Race broadcast of this date contained a report from steamship *Davisian* of growler in latitude  $41^{\circ} 00'$ ; longitude  $51^{\circ} 18'$  on May 19. This report had not been heard by radio of the patrol, and all circumstances indicated that it was erroneous, probably having been garbled by numerous transmissions and not worthy of consideration. The *Davisian* is of the Leyland Line, which operates ships to Halifax and the St. Lawrence; therefore it is most improbable that the *Davisian* would be so far south as latitude  $41^{\circ} 00'$ . Probably the position should have been given as latitude  $51^{\circ} 00'$ . Search of the patrol and passing steamships has shown no ice south of latitude  $46^{\circ} 00'$  for a month, and it is practically impossible

that an isolated berg or growler could traverse this distance of 300 miles unobserved.

May 21: Light variable airs and breezes, with remarkably smooth sea for the day. Mostly cloudy, but with good visibility. At 4.50 resumed rectangular search for capsized schooner reported on 11th instant, steaming on lines established 12 miles apart, to allow safe margin for sighting schooner's bottom. This day was occupied mostly with lines to westward and northward of area previously searched and closed on line to eastward of this area. At 8.15 stopped and drifted for the night—latitude  $44^{\circ} 43'$ ; longitude  $54^{\circ} 26'$ .

Special ice information to steamship *Acasto*.

A few Wilson's petrel and fulmar sighted to-day.

May 22: Light to moderate E. and NE. breezes, closing with strong ESE. breezes. Overcast, light rain, and slight haze beginning and close. Smooth to moderate sea. At 4.50 search for capsized schooner reported on 11th resumed. Under way, full speed, natural draft, spending hours of daylight on east side of area previously searched. At 8.10, visibility having failed through approaching nightfall and haze, gave up search for derelict and stood on course  $26^{\circ}$  true to investigate southernmost edge of ice east of Newfoundland. St. Lawrence broadcasts show practically no ice as far as Montreal, which is unusual at this season.

A few fulmar and gannet seen this day.

Received obstruction report from *Arminco*.

May 23: In forenoon strong breeze to moderate gale ESE. to SE., gradually falling to fresh moderate breeze in afternoon, becoming light SW. breeze at close. Foggy thick weather with rather rough SE. sea, clearing at close of day. On course  $28^{\circ}$  true for vicinity of Cape Race track to scout northward of same. Owing to thick weather decided to make St. Johns Harbor to await clearing weather and also obtain northern ice information from local sources.

At 8.43 made course  $4^{\circ}$  true and skirted shore at safe distance, keeping track of position by means of Cape Race radio compass bearings until Cape Spear diaphone fog signal was made out. At 3 p. m., Cape Spear abeam, stood into St. Johns Harbor, guided for most part by fog signals. Made out medium-sized berg ashore some half mile south of St. Johns entrance, which berg we later learned had been ashore in the vicinity for two months. At 4.35 anchored in harbor of St. Johns, Newfoundland. Paid call on American consul and arranged for oceanographic aid to interview sealing masters and others most familiar with northern ice conditions.

Received obstruction report from *President Roosevelt*.

May 24: Begins at anchor in St. Johns Harbor. The following information was obtained from local mariners: The drift ice has

been held inshore by easterly winds throughout spring this year on the east coast of Newfoundland. There has also been a remarkable scarcity of Arctic field ice. The Strait of Belle Isle was open along the eastern shore for breadth of some 2 miles on April 26. The sealing season has been very good, especially by stations along the coast, this being due to ice fields with seals being held inshore by the winds, as previously described. The mildness of last winter was remarked upon by all, the first sealing steamer breaking out of the harbor on March 6, a much earlier date than usual. The sealing fleet reported many bergs aground around Belle Isle, but few to the southward, and it was predicted that all bergs would be found inshore between Belle Isle and Cape Bonavista. This led to preliminary plans for ice patrol to visit this region as soon as intervening area could be scouted to verify above predictions, this as a matter of scientific interest associated with ice patrol.

Official call was made on the Governor of Newfoundland, which he returned in the afternoon. Salute was fired to the governor and to the American vice consul, and at 3.20 p. m. the *Tampa* proceeded to sea and resumed patrol. Course was laid  $110^\circ$  true from harbor entrance for distance of 30 miles, then  $60^\circ$  true for rectangular search to northward. At 8.30 stopped and drifted for the night.

Weather this day partly cloudy, with good visibility. Moderate to westerly fresh breezes; moderate sea outside.

May 25: Moderate to strong WNW. to NW. breezes, falling to light NW. breezes at close. Moderate to rather rough sea. Partly cloudy; good visibility.

At 4.45 under way, course  $60^\circ$  true, taking up rectangular search for two bergs to northward of Cape Race steamer track. At 10.23 course  $330^\circ$  true for 30 miles, then  $240^\circ$  true parallel with first line for 43 miles, then  $305^\circ$  true for 27 miles, by which time darkness had set in. Stood north true for 5 miles to counteract drift for night and stopped and lay to at 10.05 p. m.

Current of some 0.5 mile per hour experienced for the day. Fulmar, petrel, and jaeger observed this day.

Special ice information given to steamers *Maryland* and *Marbury*.

May 26: Begins light NNE. breezes and clear, shifting to S., increasing to moderate breeze and becoming foggy. Gentle NW. breeze at close, with clear weather. At 4.40 under way, course  $60^\circ$  true for 40 miles, continuing rectangular search to northward. At 6 sighted berg slightly on starboard bow 22 miles distant. At 8.15 berg abeam, some 2 miles distant, in latitude  $48^\circ 42'$ , longitude  $51^\circ 31'$ , some 85 miles north of steamer track. This was a pyramidal medium-sized berg 125 feet in height with square base dimensions probably 150 feet.

At 8.55 changed course to  $315^{\circ}$  true. At 9.30 fog shut in, set course  $325^{\circ}$  true to utilize foggy weather, taking advantage of remoteness of ice from steamer tracks, for oceanographic and ice observations toward Belle Isle.

Cape Race radio station agreed to repeat our broadcasts while we were at more remote distance from tracks. At 11.05 fog temporarily lifted, set course  $238^{\circ}$  true to resume rectangular search to northward. At 12 fog again shut in; stood toward Belle Isle course  $330^{\circ}$  true. At 4 stopped and occupied oceanographic station No. 468, latitude  $49^{\circ} 35'$ , longitude  $52^{\circ} 21'$ , finding arctic water. At 4.47 under way, course  $330^{\circ}$  true. At 5.15 changed course to north true to give greater clearance to Funk Island and surrounding shoals in fog. At 8 course  $322^{\circ}$  true. At 10 stopped and occupied station No. 469, latitude  $50^{\circ} 19'$ , longitude  $52^{\circ} 41'$ , again finding arctic water.

Gave ice information to steamers *Blyndendyk* and *Veerhaven*.

A few fulmar observed during day.

Arrangements made for Cape Race radio station to repeat our broadcasts while vessel is remote from steamer lanes.

May 27: Begins light NW. breeze, increasing to fresh W. breezes at close. Mostly clear fine weather. On course  $330^{\circ}$  true for Belle Isle. At 3.25 stopped and occupied station No. 470, finding arctic water. At 4.15 under way on course. At 9.05 stopped and occupied station No. 471, again finding arctic water. At 9.40 ahead on course. Twelve bergs and numerous growlers sighted west of longitude  $51^{\circ} 45'$  on route to Belle Isle, most of them being sighted the latter part of the trip.

At 3, off eastern side of Belle Isle, examined two bergs grounded on that side; then stood around to southern end of island off lighthouse landing and lay to. At 3.50 sent in surf boat with oceanographer to interview lighthouse keeper and secure information regarding ice conditions. Counted some 25 bergs in the entrance of the straits between Belle Isle and Cape Bauld, and eight grounded on south side of Belle Isle; four grounded on the west side. The entrance to the straits north of Belle Isle was practically covered with loose field ice, extending as far as the eye could reach. Eleven bergs were reported north of Battle Harbor. At 5.10 surf boat returned and attempt was made to steam to westward and northward around the field ice to Battle Harbor. After steaming some 3 miles to westward without observing open water, turned and stood south and east of Belle Isle. At 7.15 passed Belle Isle North Light, standing north and west for Battle Harbor. At 8 struck drift ice and worked through same. At 8.45 received radio message that boat communication with Battle Harbor would be impossible before morning, and stopped and drifted for the night. Radio operator

at Battle Harbor courteously agreed to meet us with launch off harbor at daybreak to-morrow to give ice information, his opportunities for observation from year to year having been unusually good.

Mr. Michael Thomas, lighthouse keeper, Belle Isle, stationed there since 1915, gave the following ice information to the oceanographer: That, as usual, the straits were blocked with ice the past winter, having cleared May 19, about the usual season. But the ocean side of the island had been clear of ice the entire winter, which phenomenon he had never before observed. The amount of drift ice this spring had not been as much as half what is usually seen. This was also true as regards bergs. The arctic drift ice appeared the first week in March, and that ice with a few bergs and the accompanying breeding seal had set southward into White Bay. While he keeps no special record, Mr. Thomas estimates that within sight of Belle Isle approximately three bergs set into the straits for every one that drifts southward into the Atlantic. During early season practically all drift ice sets into the straits and later practically all goes to the southward. Mr. Thomas gave the following dates for the first and last trans-Atlantic steamers entering and leaving the straits for the past three years: June 6, June 10, and July 1 and December 2, 12, and 15, respectively. As many as 10 trans-Atlantic steamers daily, mostly Scandinavian, use the straits in the summer season.

Received ice information from steamer *Veerhaven* (small berg), latitude  $48^{\circ} 29'$ , longitude  $52^{\circ} 23'$ . Received obstruction report from Cape Race.

May 28: Begins fresh W. breeze, gradually falling to calm at close. Mostly clear; excellent visibility. Drifting during hours of darkness. At 3.45 under way and stood course  $290^{\circ}$  true toward Battle Harbor. Field ice soon appeared; attempted to skirt same to the southward, but found that it extended to Belle Isle on the north, and that the straits to the southward were blocked. Stood down the coast skirting ice field and found that it extended almost to Gray Island, a distance of approximately 40 miles south of the straits and offshore to a distance of some 15 miles. The field was being carried offshore under influence of westerly winds, and apparently melting rapidly. Continued cruise to southward, keeping some 20 miles offshore, observing ice conditions, to Twillingate Harbor, which we entered at 8 p. m. During day a total of some 67 icebergs and hundreds of growlers were sighted, the greater number being stretched along an arc within some 20 miles of shore.

A few fulmar, gulls, and jaeger seen in vicinity of ice.

The following ice information was received by radio from the operator at Battle Harbor, Labrador: The arctic field ice struck that

vicinity on April 1 and remained there closely packed until May 10. Many growlers had been observed before this date, but only a few bergs, although many usually appear before this date. There had been practically no ice to eastward during March, the winds being from south and southeast. By May 14 there was practically no ice in any direction. On May 24, with northeast gale and snow, the field ice was closed tightly along the shore, moving to southward, with 11 large bergs and many growlers. A mild winter had been experienced and the quantity of ice and size of bergs had been much smaller than usual.

At Twillingate, Capt. A. J. Gillet was interviewed. His experience cruising and fishing along the Newfoundland and Labrador coast has covered a period of 60 years. He stated that weather and ice conditions for the past winter and the ensuing spring had been unprecedented in his experience. Local ice in bight between Cape Bauld and Funk Island had been unusually thin and small in quantity. The amount of arctic ice reaching this region had also been less than usual. This had caused open water to prevail in this region, except for small arctic field upon which the seals bred for the season, which field hugged the northwest shore and set down into White Bay. In a normal season practically solid ice fields would extend for a distance of 100 miles offshore. These unusual conditions permitted the bergs to be set to southward well into this extensive bight and become trapped there. This was corroborated by the number of bergs sighted this day by the patrol vessel. This would appear to be, at least in part, an explanation of the absence of the usual number of bergs from the steamer tracks.

At 11 p. m. the *Tampa* stood out of Twillingate Harbor and to northward to reach point for beginning search by daybreak.

May 29: Light to moderate breezes, E. to NE. Overcast, hazy and foggy at intervals after 11 a. m.; smooth sea. Stood on northerly courses from Twillingate Harbor, at reduced speed, to reach point for beginning search at daybreak, then made rectangular search north, east, and south, ending at noon at station No. 472, some 20 miles  $45^\circ$  true from Fogo radio station. Found very decided arctic water at this station. Some 12 bergs and hundreds of growlers found on this rectangular search. Fogo station reported 4 bergs grounded on this island. At 12.45 stood to eastward. At 5 off Funk Island stood  $146^\circ$  true for vicinity of Cape Race steamer track. The last berg, a small one, sighted in latitude  $50^\circ 05'$ , longitude  $53^\circ 20'$ . The last growlers sighted in vicinity of latitude  $50^\circ 00'$ , longitude  $53^\circ 00'$ .

A few mullimoke and petrel observed this day.

Gave special ice information to *President Garfield* and Canadian ice patrol vessel *Montcalm*.

May 30: Light and gentle N. breezes, becoming strong NW. breezes at close. Foggy, slightly clearing, with light rain at intervals throughout day. Smooth to moderate sea. Remarkably low and falling barometer—29.54 at beginning of day and 29.00 at close.

Standing  $146^{\circ}$  true for position to begin search for berg last reported on 27th instant. At 4.55 began search on course 114 at 5.25, fog shutting in, stopped and drifted for remainder of day. Noon position, by radio bearing and dead reckoning, latitude  $48^{\circ} 25'$ , longitude  $51^{\circ} 05'$ . Slight southerly and easterly drift experienced.

Special ice information regarding Cape Race track was given as follows:

Vessels *Cymric Queen*, *Cairngowan*, *Muresfield*, *West Lake*, *Constantin*.

A few fulmar and petrel seen during day.

Received obstruction reports from *West Quechee* and *Bayou Chico*.

May 31: Strong NW. to WSW. breezes; moderate to rather rough sea. Foggy, partially clearing at intervals.

At 5.05 under way and began searching, stopping from time to time because of fog. Barometer 30.00 at 1 a. m.; began slowly rising; 29.37 at close of day.

The following courses and distances run:  $158^{\circ}$  true for 20 miles;  $54^{\circ}$  true for 25 miles;  $135^{\circ}$  for 10 miles;  $234^{\circ}$  for 30 miles.

At 9.10 stopped and drifted for the night.

Special ice information given to the following steamships: *Bawtry*, *Holtby*, *Oxelosund*, *Minnedosa*, *Manchester Skipper*.

A few flocks of sooty tern, petrel, and haglets sighted.

June 1: Gentle breezes to moderate SW. gale. Moderate to rather rough sea. Overcast, hazy, partially clearing at intervals. Visibility fair to indifferent. Period of low barometer still prolonged; day begins with 2.937; closes with 29.55.

At 4.30 under way to resume search for berg last reported on May 27. First stood west 15 miles; then searched to northward and eastward on rectangular lines, assuming visibility of some 6 miles. At 8 p. m. slowed to  $\frac{1}{2}$  miles per hour and stood  $240^{\circ}$  true to reach position for beginning search to westward at daybreak to-morrow. Nothing seen of berg and steamer *Megantic*, passing to southward of area searched by *Tampa*, saw no ice.

Numerous shearwater in flocks and a few petrel seen.

Gave ice information to the following vessels: *Gorm*, *Bay State*, *Brecon*, *Porkhaven*.

June 2: Strong to moderate and gentle W. to SW. breezes. Rather rough to moderate sea. Clear, fine weather; excellent visibility. Begins standing at reduced speed,  $240^{\circ}$  true to reach daylight position for beginning search west of area searched previously. At 4.17

course  $310^{\circ}$  true, full speed, natural draft, for searching. At 11.28 sighted berg 16 miles distant, bearing  $292^{\circ}$  true: stood for same. At 12.45, within 4 miles of berg, which proved to be a small one, probably 50 feet high, with several pinnacles. Decided that it was not the one last sighted by *Tampa* on 26th, but doubtless the one reported by steamship *Veerhaven* on 27th in latitude  $48^{\circ} 42'$ , longitude  $52^{\circ} 35'$ . The present location of the berg is latitude  $48^{\circ} 29'$ , longitude  $52^{\circ} 23'$ ; therefore it had drifted  $150^{\circ}$  true 0.7 mile per hour, but doubtless it has been within influence of daily tides. At 12.45 changed course to  $160^{\circ}$  true to continue search west of area covered. Headlands of Newfoundland were in sight for about two hours. At 7.30 course  $90^{\circ}$  true. At 8.30 stopped and drifted for the night.

Special ice information given to the following steamships: *Metagama*, *Mount Royal*, *Briarwood*, *West Islets*.

Observed numerous flocks of greater shearwater, a few jaegers and kittiwakes, two flocks of sea snipe, and one goose.

Received obstruction report from *Waukegan*.

June 3: Begins light SW. breezes with fog setting in at daybreak and clearing at noon. with light to moderate N. to NW. breeze. Smooth to moderate sea.

Continued drifting because of fog. At 10 received message from steamship *Cymric Queen* that he had sighted berg, manifestly the one so long sought, latitude  $48^{\circ} 32'$ , longitude  $51^{\circ} 13'$ , only 16 miles  $130^{\circ}$  true from where we had last sighted it, May 26. At our request the master confirmed position by his run from Cape St. Francis, course  $57^{\circ}$ , distance 75 miles.

This berg had been reported 24 miles to southward on May 27, which report we correctly decided to be inaccurate, since such drift would be abnormal in one day. However, the normal drift here would be south some 10 miles per day, and a drift of only 16 miles in 8 days is difficult to account for. Poor visibility had prevented our sighting this berg in searching within a few miles on May 30. We had searched to southward and eastward on May 31. We had been almost within range of visibility on June 2 when we turned to westward because further search in this direction seemed futile.

Having been in touch with *Modoc* since yesterday the *Tampa* got under way at 11.20 and stood  $131^{\circ}$  true for Cape Race, thence  $246^{\circ}$  true to meet the *Modoc*.

Gave special ice information to the following vessels: *Verbania*, *Melita*, *Mount Clay*, *Caronia*, *Kastalia*, *Corby*, *Montreal*, *Cairn-valona*.

June 4: The *Tampa* met the *Modoc* at 5 a. m., latitude  $46^{\circ} 52'$ , longitude  $54^{\circ} 07'$ , and the oceanographer and assistant were transferred to the latter vessel, which assumed ice patrol.

## SUMMARY

This cruise has been characterized by continued extraordinary absence of ice from vicinity of steamer lanes, and by better weather than is usually experienced in this season. Some 22 per cent of fog has been experienced, in contrast with the 30 to 40 per cent given on pilot chart, and only some 3 per cent of actual gales, this in contrast with the pilot chart's 8 to 10 per cent.

Information gleaned in St. Johns and on the cruise to Belle Isle would indicate that not only have fewer bergs than usual come down from the arctic regions this year, but field-ice conditions have permitted a greater percentage of these than usual to drift inshore and ground, especially in the bight between Cape Bauld and Funk Island.

The conclusion of our cruise finds only two bergs within probable reach of even the Cape Race tracks, the smaller one being close inshore 85 miles north of this track and the other being 60 miles north of it. Our experience in locating the latter berg illustrates the ease with which a berg may be missed in searching, even close aboard, with poor visibility conditions; also the uncertainty of ocean currents even in localities where they appear to be well established.

After systematic rectangular search of three days with good visibility we failed to locate the schooner reported bottom up, latitude  $44^{\circ} 39'$ , longitude  $55^{\circ} 08'$ , on May 11. It is possible that this obstruction is identical with that reported from Cape Race May 27—two masts 20 feet above water, attached to wreckage, latitude  $45^{\circ} 28'$ , longitude  $55^{\circ} 49'$ . It would not appear probable that this obstruction would long remain afloat. This obstruction would doubtless have been sighted by *Tampa* but for its small size. Of other obstruction reports probably the most important was the one made by the *Waukegan* on June 2, and even this would not appear to be dangerous.

Broadcasts and reports to Hydrographic Office and Weather Bureau were carried out as required by instructions. The patrol received 618 surface-water temperature reports, 3 ice reports, and 8 wreck and obstruction reports.

The Canadian ice patrol of the Gulf of St. Lawrence was discontinued on or about May 29; this being earlier than usual.

Four oceanographic stations were occupied, all on northeast coast of Newfoundland.

COAST GUARD CUTTER "MODOC," LIEUT. COMMANDER L. T. CHALKER, ICE PATROL, THIRD CRUISE, JUNE 4 TO JUNE 19, 1924

At 12.45 p. m., June 2, 1924, the *Modoc* left Halifax, Nova Scotia, to relieve the *Tampa* and make her third cruise of the current ice-

patrol season. Making the cruise with us are Prof. H. T. Barnes, of Montreal, Canada, research ice expert, and Dr. Charles J. Fish, of the Bureau of Fisheries, Woods Hole, Mass. After clearing Halifax outer sea buoy a course was set north of Sable Island for Cape Race, Newfoundland. Fair weather prevailed on the trip out, and at 4.40 a. m., June 4, contact was made with the *Tampa* in latitude  $46^{\circ} 02'$  north, longitude  $54^{\circ} 14'$  west. Lieut. E. H. Smith, the observer, and Yeoman, Second Class, R. W. Lewis, his assistant, were received on board and mail was delivered to the *Tampa*. The *Modoc* took over the patrol duties, and at 6.25 a. m. went ahead for Cape Race. Just before dark on June 3 three French fishing vessels were passed at anchor on St. Pierre Bank, and after dark the lights of several fishing vessels at anchor were seen.

After relieving the *Tampa* on June 4 the patrol headed for Cape Race, which was passed at 12.25 p. m. close on the port beam. The course was then set for the iceberg reported by the steamer *Cymric Queen* on June 3 in latitude  $48^{\circ} 32'$  north, longitude  $51^{\circ} 13'$  west. During the afternoon we skirted the coast of Newfoundland, which was in sight until after passing St. Johns. No birds were seen in the morning, but in the afternoon numerous fulmars and a few murrets and gulls were seen. One hair seal and several whales were sighted and a large patch of gulf weed was passed. On the 4th there were gentle to light NW. breezes, falling to calm at noon and shifting to light SE. airs and calms for the remainder of the day. The sky was partly clear until 10 p. m., when it became overcast and a light fog shut in. The sea was smooth, with a moderate long NE. swell. At 1 a. m. the barometer was 29.80 and at midnight 29.70. At 10.07 p. m. we stopped and drifted for the night. No ice was seen or reported this day.

At 4.30 a. m., June 5, we went ahead and continued search for berg reported by the *Cymric Queen* on the 3d instant. At 6.14 a. m. the berg was sighted 13 miles distant and at 7.36 we stopped near it and drifted. The berg was of fair size, sextant angles showing it to be 187 feet high and 370 feet across the greatest length of its base. The general shape of the peak was that of a truncated prism. The berg was in water having the temperature of  $38^{\circ}$  F. and was disintegrating quite rapidly, as shown by the large amount of ice which had broken from it and was drifting off to leeward. During the afternoon the berg took a decided roll, causing loud reports and cracking noises, and a large amount of ice broke from its peak and crashed into the sea, throwing spray high in the air. A boat was sent to the berg and four guncotton mines were exploded against a large projecting ledge. While the berg gave a perceptible shiver, little ice was broken from it by the force of the explosion. Many birds were seen in the vicinity of the berg, some in the water feeding

on refuse from the ship and others perched on the berg itself. The birds were mostly fulmars, jaegers, and petrel. No murre were seen. Two whales swam about the ship, then over to the berg, and finally disappeared. Observations showed this berg to be in latitude  $48^{\circ} 21'$  north, longitude  $51^{\circ} 10'$  west. It had drifted 12 miles,  $175^{\circ}$  true, since June 3. Before nightfall we stood close to the berg and then drifted for the remainder of the night. The weather on the 5th was partly clear, visibility good, sea smooth. There were light, variable airs and calms until 8 p. m., when there was a light north breeze which had increased to a moderate breeze by midnight. The barometer was 29.70 at 1 a. m., 29.65 at 1 p. m., and 29.67 at midnight.

No ice was reported this day by other vessels.

At 4 a. m., June 6, went ahead and ran up close to iceberg, near which we had been drifting during the night. It had not rolled over or changed its appearance perceptibly during the night. Observations taken later in the day indicated it had drifted  $195^{\circ}$  true 0.5 knot per hour during the past 24 hours, its position being  $48^{\circ} 09'$  north,  $51^{\circ} 14'$  west. After leaving this berg, which remained in sight until we were 20 miles distant, we headed for the Newfoundland coast. At 8.18 a berg was sighted ahead, and after running 23 miles we were abreast of it at 10.30 a. m. This berg is the same one located by the *Tampa* on June 2 in  $48^{\circ} 29'$  north,  $52^{\circ} 23'$  west. Its present location,  $47^{\circ} 58'$  north,  $52^{\circ} 37'$  west, shows it to be drifting  $188^{\circ}$  true 0.035 knot per hour onto the coast south of Conception Bay. The berg is now in water having the temperature of  $42^{\circ}$  F. and should melt quite rapidly. It is very unlikely that either of these two bergs will ever become a menace to vessels following the prescribed steamer lanes. Pictures were taken of the last berg, after which we proceeded in the general direction of Funk Island. It is planned to search for ice as far north as latitude  $50^{\circ}$  north and then gradually work south and return to the two bergs seen to-day. While cruising, two large flocks of Bonaparte's gulls and several murre, fulmars, and Leach's petrel were passed. At 9.50 p. m. we stopped and drifted for the night. This day there were gentle breezes from N. to NW.; the sky was partly clear, visibility good, sea smooth with a long heavy swell from NE. The barometer was 29.68 at 1 a. m. and 29.74 at midnight.

Special ice information was furnished the *Kristiania*, *Sachem*, and *Kelsmore*.

On June 7, at 4 a. m. went ahead and stood to the westward searching for ice. Nothing was seen until 2 p. m. when a berg was sighted south of Stinking Island Light. This berg was well in shore and probably aground. A very decided mirage was noticed. At times there appeared to be two bergs, one above the other, and then for a

while the berg would disappear altogether. The same effect was observed when Stinking Island Light was passed at 3.30 p. m. We continued to the north until 5 p. m. when we stopped and occupied oceanographic station No. 473, about 17 miles south of Funk Island. Nets were also towed and samples of marine life obtained. At 6.10 p. m. went ahead on course  $90^{\circ}$  true and continued cruising until 9.10 p. m. when we stopped and drifted for the night. At 6.15 p. m. a small growler was passed. While drifting for the night a vertical haul was made with plankton net and specimens of small sea life obtained. The birds seen this day were chiefly fulmars, murro, and a few Leach's petrel. The winds to-day varied from W. to NE. with light to gentle breezes, the sky was mostly overcast, with fog after 6 p. m.; the sea smooth with a long NE. swell. The barometer was 29.75 at 1 a. m. and 29.90 at midnight.

Special ice information was furnished the *Cavendish* and *Leviathan*.

Throughout the 8th the weather was overcast and cloudy with intermittent fog and rain. The wind varied from light to moderate ENE. to SE. breezes shifting at 5 p. m. to light SSW. airs. There was a moderate sea and NE. swell. At 1 a. m. the barometer was 29.79, at 8 p. m. 29.46, and at midnight 29.48 and rising slowly. At 4 a. m. went ahead for probable position of berg last seen on June 6 in  $48^{\circ} 09'$ ,  $51^{\circ} 14'$ . At 8 p. m. we arrived at the probable position but on account of thick weather made no further search for it and stopped and drifted for the night. While under way we passed numerous fulmars, murrees, Leach's petrel, and Bonaparte's gulls, and at night, while drifting, birds were heard about the ship.

Special ice information was furnished the *King David* and *Galtymore*.

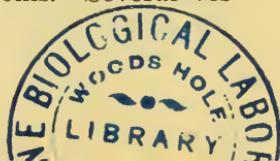
At 4 a. m. June 9 went ahead and began rectangular search for berg. At 4.50 it was sighted and at 5.50 we stopped and drifted near it. For the remainder of the day we drifted, except as it became necessary to steam up to berg to keep in close touch with it. This is the same berg located by the *Tampa* on June 2 and by the *Modoc* on the 5th and 6th. The track of this berg has been about south true with a gradual curve toward the westward as its latitude is decreased. Observations show that from June 6 to 9 it has drifted  $193^{\circ}$  true at the rate of 0.035 knot an hour. It is probable that the berg will drift toward Cape Race and ground on the Newfoundland shore or on the banks to the south. It should never become a menace to vessels using the prescribed tracks and by July 1 will in all probability have disintegrated. By use of range finder and sextant angles it was determined that the height of the berg is 95 feet and its length at the water line 200 feet.

The temperature of the water near the berg is  $41^{\circ}$  F. and soundings showed a depth of 64 fathoms, gray sand bottom. Small growlers are continually breaking from the berg, and the sea breaking against it threw spray to the height of 50 feet or more. A few birds were seen to-day, consisting for the most part of fulmars and petrel (probably Leach's). Gentle to fresh NE. and NNE. breezes prevailed, with overcast, rainy, and foggy weather and a moderate sea and NE. swell. The barometer range was from 29.48 at 1 a. m. to 29.93 at midnight.

Special ice information was furnished the *Aldersgate* and the Coast Guard practice ship *Alexander Hamilton*.

On June 10 the wind was from the NE., increasing from a light breeze at beginning to fresh breeze at close, and barometer falling from 29.93 to 29.77. The sky was overcast and cloudy, with fog, mist, and haze throughout the day. There was a moderate NE. sea and swell. The *Modoc* drifted during the entire day, steaming up to the berg as necessary to keep in close contact with it. Observations and radio compass bearings from Cape Race showed the position of the berg at noon to be  $47^{\circ} 36'$  north,  $51^{\circ} 28'$  west. From noon of the 9th the drift was  $201^{\circ}$  true, at the rate of 0.5 knot per hour. The water temperature about the berg was  $40^{\circ}$  F., and the depth obtained with sounding machine 68 fathoms. The berg is gradually breaking up and melting, although the change observed from day to day is not marked. A few Leach's petrel were observed about the berg during the day. A radio message was received from the steamer *Kerhonksen* to the effect that a French sailing vessel was drifting with a damaged rudder in latitude  $44^{\circ} 54'$  north, longitude  $48^{\circ} 00'$  west, and wished to be reported to a French man of war. The *Modoc* offered her services if they were found necessary, but the French cruiser *Regulus* was reached and the information furnished her. The *Regulus* will proceed to the assistance of the vessel and will probably meet her the afternoon of the 11th. The name of the vessel in distress could not be obtained.

On June 11 a moderate to fresh NNE. gale prevailed, with rough sea and intermittent fog, rain, and mist. At 1 a. m. there was a fresh NE. breeze, which by 5 a. m. had increased to a moderate gale and in the afternoon to a fresh gale. At 1 a. m. the barometer was 29.75, at 7 a. m. 29.70, and at midnight 29.89. Throughout the day we drifted near the berg, going ahead as necessary to keep in close touch with it. The berg is now in the track of steamers using the Cape Race route. Its position at noon was  $47^{\circ} 23'$  north,  $51^{\circ} 30'$  west. From noon of the 10th it has drifted  $193^{\circ}$  true, at the rate of 0.6 knot per hour. The temperature of the surrounding water is  $43^{\circ}$  F., and the depth, by sounding machine, 65 fathoms. Several ves-



sels, whose lights were seen during the night, were warned of the close proximity of an iceberg. The master of the steamer *Kerhonksen* was advised by the medical officer of the *Modoc* as to the treatment of a fireman who had been injured. The steamer *Veendam* reported submerged wreckage in  $46^{\circ} 13'$  north,  $54^{\circ} 33'$  west.

Special ice information was furnished the *Empress of France*, *Regina*, *Veendam*, and *Bertshire*.

No ice was seen or reported other than the one berg by which we are now drifting.

On June 12 the fresh NNE. gale continued until 8 a. m., when the wind began to decrease. At noon there was a fresh N. breeze, and at midnight it was calm. The sky was mostly overcast and cloudy, and at 10 p. m. a dense fog shut in and continued for the remainder of the night. The sea, which was rough at the beginning, decreased with the wind, until at midnight there was a moderate NE. sea and swell. At 1 a. m. the the barometer was 29.89 and by midnight had gradually risen to 30.03. Throughout this day we continued drifting near the berg, which is now in the Cape Race steamer track. At noon it was in latitude  $47^{\circ} 01'$  north, longitude  $51^{\circ} 38'$  west, and had drifted  $190^{\circ}$  true at the rate of 0.9 knot per hour since noon of the 11th. The temperature of the water near the berg varied from  $39^{\circ}$  to  $43^{\circ}$  F., and at noon soundings showed a depth of 65 fathoms. The berg was well washed by the rough sea and heavy swell; and although its general appearance remained the same, it seems to be melting and becoming gradually smaller. The steamers *Antonia*, *Marburn*, *Saturnia*, and *Carrington Head*, which were on the Cape Race track, near the position of the berg, were given a special warning, and the *France* was furnished special ice information. At 5 p. m. the *Antonia*, of the Cunard Line, passed within a few hundred yards of us as we lay near the berg. She was westbound for Cape Race. At 4.50 oceanographic station No. 474 was occupied and samples of marine life obtained by Doctor Fish, of the Bureau of Fisheries. No ice was seen or reported by other vessels.

On June 13 the fog, which had prevailed until 6.30, cleared away, and for the remainder of the day the sky was clear and visibility excellent. The day began with light SW. airs, which fell to calm by 7 a. m., and later a light breeze sprung up from the west, increasing to a moderate gale by 5 p. m. and falling to moderate W. breeze by midnight. The barometer was 30.02 at 1 a. m. and gradually rose to 30.10 by midnight. At 7 a. m. we steamed up to the iceberg, near which we drifted during the night, and found that it had broken up very much overnight. Several hundred yards from the berg was a large and dangerous growler, and about the berg were numerous smaller growlers and a great quantity of small ice. The

growler will probably be a menace to navigation for several days. By 8 p. m. the growler bore  $250^{\circ}$  true 4 miles from the berg. In the forenoon we lowered one of our ship's boats and gathered several tons of ice for the ice boxes. The surface-water temperatures varied from  $38^{\circ}$  to  $43^{\circ}$  F. At noon the berg was in latitude  $46^{\circ} 50'$  north, longitude  $51^{\circ} 45'$  west and had drifted  $202^{\circ}$  true 0.3 knot per hour since noon of the 12th. Soundings showed a depth of 58 fathoms. The birds seen this day consisted mainly of fulmars.

Special ice information was furnished the *Manchester Mariner*, *Trolleholm*, and *Blair*.

June 14 was an exceptionally fine day. The sky was clear, smooth sea, visibility excellent. The moderate W. breeze which we had at 1 a. m. had fallen to light airs by 11 a. m., and for the remainder of the day there were light airs from W. to SSW. The barometer was unusually high, being 30.10 at 1 a. m. and 30.30 at midnight. After sunset the atmospheric conditions were extremely peculiar. At 10 p. m. a flashing light was seen which was undoubtedly an aid to navigation. A bearing of it was obtained and its characteristics noted. It checked in every respect with the light on Cape Race and certainly was that light, which we could see at a distance of 56 miles. Its being visible at so great a distance was due to mirage or some freak atmospheric conditions. It was seen at intervals and in varying intensity until midnight. The ship's position is accurate, as observations were taken during the day and a sight of Jupiter at evening twilight. A bearing by radio compass was also obtained from Cape Race about 8 p. m. The radio operators reported abnormal atmospheric conditions throughout the night. We drifted near the berg throughout the day and at 8 p. m. steamed close to it. The berg is much changed in appearance and is appreciably smaller. In its vicinity were numerous smaller growlers which had broken from it during the afternoon. Just before sunset the color effects, due to shadows on the berg, were beautiful. Varying delicate shades of violet, lavender, heliotrope, and purple blended into a general white mass of the berg. The large growler which calved from the berg on the 13th drifted about 4 miles distant from it. Since noon of the 13th the berg has drifted but little and apparently is in an eddy which is giving it a circular movement in a counterclockwise direction. Its position at noon was  $46^{\circ} 44'$  north,  $51^{\circ} 44'$  west. The surface-water temperatures ranged from  $43^{\circ}$  to  $46^{\circ}$  F. and a sounding gave a depth of 52 fathoms. Few birds were seen this day, but a whale was seen near the berg at sunset. Several steamers were sighted, some eastbound and others westbound.

Special ice information was furnished the *Lady Beenda*, *Roxby*, and *Annapolis*. No ice was reported other than the berg by which we were drifting.

The wind on June 15 was variable in force and direction. The day began with light SW. airs, which later fell to calm, followed by light to moderate ESE. to SE. breezes and again falling to calm by 10 p. m. The sky was clear until 4 a. m., after which it was for the most part overcast with intermittent fog and haze until 6 p. m. The sea was smooth. The barometer was 30.30 at 1 a. m., 30.36 at 11 a. m., and 30.24 at midnight and falling. We drifted throughout the day, steaming up to the berg as necessary to keep in close touch with it. The berg has changed very little in its general appearance, although it is perceptibly smaller. There are now two growlers 5 miles south of the berg and many large pieces of ice near it. The position of the berg is  $46^{\circ} 42'$  north,  $52^{\circ} 00'$  west. Its drift is irregular and is apparently due mainly to the wind and tidal currents. Its principal drift is to the westward. The surface-water temperatures ranged from  $43^{\circ}$  to  $45^{\circ}$  F. No other ice was reported this day.

Special ice information was furnished the *Haltby*, *Canadian Mariner*, *Bowtry*, and *Ariano*.

On June 16 there was a moderate ESE. breeze which shifted to SSE. and increased to a moderate gale, then fell to a moderate SW. breeze at close. The weather throughout the day was overcast, with thick fog and rain. The barometer which was 30.20 at 1 a. m. had fallen to 29.77 by midnight. There was a moderate to rough sea. At 6 a. m. we started ahead and sighted berg in fog and haze and then drifted. No appreciable change was noticed in the looks of the berg although there was much ice and several growlers which had broken from it drifting near it. At 4.30 p. m. an attempt was made to again locate the berg but on account of poor visibility and fog it was not sighted. The estimated position of the berg at noon was  $46^{\circ} 48'$  north,  $52^{\circ} 12'$  west. The *Manchester Importer* reported passing close to the berg at 6.54 p. m. in  $46^{\circ} 54'$  north,  $52^{\circ} 06'$  west. No other ice was seen or reported.

Two whales and several Leach's petrel were seen during the day.

The weather on June 17 was overcast and cloudy, with thick fog and rain during the first part. There was a moderate sea and swell from the southwest. There was a fresh southwest breeze during the early morning which had fallen to a gentle breeze and shifted to WSW. by 9 p. m. The barometer rose from 29.74 at 1 a. m. to 29.82 at midnight. At 12.30 a. m., while drifting in the fog a medium-sized growler was sighted close aboard on the port side and a little farther off an object resembling the berg was seen. From then on we continued drifting until 6.38 a. m. when we went ahead in an attempt to locate the berg. The fog became more dense, however, and at 7.50 a. m. we stopped and drifted. At 3

p. m. the fog lifted somewhat and we began searching for the berg. The visibility was still poor and at 4.55 the fog shut in and we stopped and drifted for the remainder of the day. Nothing was seen of the berg this day other than the possible glimpse obtained at 12.30 a. m. The surface-water temperatures were from 43° to 46°F. and the temperatures of the air from 49° to 50°. A few murre, fulmars, and Leach's petrel were seen.

Special ice information was furnished the *Leviathan* and *Berengaria*.

By 4.30 a. m., June 18, the fog had cleared away and the visibility was good. We went ahead and began a rectangular search for the iceberg which we had lost in the fog of the 17th. At 9.30 a. m. the berg was sighted at a distance of 10 miles and at 10.30 we stopped alongside of it and drifted. After a meridian altitude of the sun was obtained, the noon position of the berg was accurately determined as 47° 15' north, 51° 59' west. Since noon of the 15th the berg had drifted north true 30 miles. It is evident that, due to the decrease in size and draft of the berg, its drift is now largely due to the wind.

As the prevailing winds are southerly, it is unlikely that the berg will go south of latitude 47° 00' north before it finally breaks up. The berg now has one slender peak 106 feet high while the remainder of the berg which is only 15 or 20 feet above water is 244 feet at its greatest length. The depth of the berg below water was obtained by using two boats. A heavy weight was lowered at a designated and measured distance from each boat. The weights were connected by a piece of sounding wire 450 feet long. The boats then separated, one going on either side of the berg, and the wire was pulled taut. When the wire touched the berg, the weights were lowered from each boat until the wire passed under the berg. In this way it was found that there were two decided peaks extending under the water. One of them had a depth of 160 feet and the other 200 feet. The surface water temperature near the berg was 41° F. At 2.40 p. m. we hoisted our boats and then went ahead for Cape Race and to make contact with the *Tampa* which left Halifax on the morning of the 17th. At 8.30 p. m. we were off Cape Race and from there continued at standard speed heading for the *Tampa*. The weather this day was fine and clear, except for the first two hours when there was fog. There was a moderate W. breeze and moderate sea.

On June 19 we met the *Tampa* at 6.15 a. m. in latitude 46° 08' north, longitude 55° 02' west. The observer, Lieut. E. H. Smith, and his assistant, Yeoman, Second Class, R. W. Lewis, were transferred to her. Mail was received from the *Tampa* and, after being relieved by her, we went ahead for Halifax, Nova Scotia.

## SUMMARY

During the third cruise of the *Modoc* three icebergs were located, one in  $47^{\circ} 58'$  north,  $52^{\circ} 37'$  west, one grounded south of Stinking Island Light, Newfoundland, and the third was first seen on June 5 in  $48^{\circ} 21'$  north,  $51^{\circ} 10'$  west. We remained by this last berg from the 9th to 18th, inclusive, and followed it as it drifted to  $46^{\circ} 42'$  north,  $52^{\circ} 00'$  west on the 15th and then north to  $47^{\circ} 15'$  north,  $51^{\circ} 59'$  west on the 18th. When the *Modoc* left this berg on the 18th to proceed to meet the *Tampa*, there was, as far as could be determined, no ice south of latitude  $47^{\circ} 15'$  north. Normal weather conditions were experienced during the cruise. There were no gales with a force of 8 or greater, 4 gales with a force of 6.5 or greater, and an average wind force of 3.4. There was 15 per cent of hours with fog. The broadcasts and reports to the Hydrographic Office and Weather Bureau were carried out as prescribed in Coast Guard letter of February 4, 1924 (601-612).

The patrol received 850 surface sea-water temperatures from 134 different vessels, 34 weather, and 7 wreckage and obstruction reports.

Special ice information was furnished to 26 vessels and 4 were given a special warning of their close proximity to an iceberg in the Cape Race route.

**COAST GUARD CUTTER "TAMPA," COMMANDER W. J. WHEELER,  
ICE PATROL, FOURTH CRUISE, JUNE 19 TO JUNE 30, 1924**

The *Tampa* left the fuel oil docks, Halifax, at 10.50 a. m., June 17, to proceed for the relief of *Modoc* on fourth ice patrol cruise. Course was laid north of Sable Island for Cape Race. Fresh to gentle SW. breezes, with clear weather, was experienced on 17th and 18th. The 19th began with rain, followed by mist and fog, which continued all day with moderate to fresh breezes from WSW. to W.

The *Modoc* was met at 6.45 a. m., June 19, in latitude  $46^{\circ} 04'$  north, longitude  $55^{\circ} 01'$  west. Lieut. E. H. Smith, the ice observer, and his assistant, Yeoman Lewis, transferred to *Tampa* and this vessel assumed ice patrol.

The ice situation was summarized as follows: One berg and three growlers were in latitude  $47^{\circ} 15'$ , longitude  $51^{\circ} 59'$  on June 18, and when left on that date they were drifting north at rate of 10 miles per day. This berg was comparatively shallow in draft, therefore both berg and growlers were largely under influence of the wind. No other ice had been seen or reported in the off-shore Atlantic.

At 7.46 the *Tampa* proceeded on course  $70^{\circ}$  true for Cape Race, moderate speed, in fog. *Modoc* directed to proceed to Halifax.

At 10.50 intercepted radio call from steamship *Metagama* stating that she had been in collision with steamship *Clara Camus* 7 miles ESE. from Cape Race; that boat and three men from *Metagama* were missing in fog; that both vessels were then heading for St. Johns and *Metagama* requested that nearby vessels stand by her. Immediately ordered all speed forced draft, recalled *Modoc* to look after missing boat and sent radio to *Metagama* that *Tampa* was coming to her assistance. Later radio dispatches showed that forward stokehold of *Metagama* was flooded, that forepeak of *Clara Camus* was badly damaged; that *Metagama* was making only 5 knots, with steamship *Kenbane Head* standing by her. The steamship *Rosalind* was also making for the position of the *Metagama* at urgent request of master of the latter vessel. We immediately cleared after deck and made ready for towing in emergency. At 3.25 the *Tampa* rounded Cape Race, using frequent radio compass bearings and also guided by the diaphone fog signal in the dense fog with currents prevailing in this vicinity. Later dispatches indicated that *Metagama* was making some 7 knots speed and that *Clara Camus* was ahead and in no need of assistance. At 3.55 the master of *Metagama* in response to inquiry stated that he then considered that he could safely reach St. Johns without *Tampa's* assistance, but he expressed much gratitude. Thus this vessel was released to assist in search for missing boat. Immediately stood some 5 miles to leeward of the last reported position hoping that the boat might be seen or heard.

We began rectangular search, fixing visibility at three-eighths mile, and watching closely for sight of boat or sound of her foghorn or voice of occupants. The fog gradually cleared, and at 5.45 increased to full speed, forced draft, and continued rectangular search to leeward, fixing visibility for boat at 3 miles, lines of search being 6 miles apart. Communicated with Furness Withy Co., steamship agents, St. Johns, and requested that they advise us via Cape Race if news were received of boat or occupants. At 9 stopped and drifted for the night because of failing visibility. At 10 p. m. received communication from Furness Withy Co. that *Metagama* had arrived, but nothing heard from boat. *Modoc* requested to search south of latitude  $46^{\circ} 35'$  and west of  $52^{\circ} 30'$ .

June 20: Moderate to fresh WNW. to SW. breezes throughout day. Partly cloudy; good visibility. At 4 a. m. under way: stood  $240^{\circ}$  true for 3 miles to recover drift for night, then took up rectangular search, full speed, forced draft, covering area directly to leeward of last position of boat; lines of search magnetic north and south, 24 miles in length, beginning 6 miles apart and later widened to 8 miles apart. Last line for the day was south of this area and extending west magnetic. At 9.20 stopped and drifted for the night

because of failing visibility. Cape Race  $273^{\circ}$  true 43 miles distant. Search had been extended to cover area extending some 52 miles to leeward of last reported position of boat. Used searchlight hourly during night to possibly attract attention of drifting boat. In afternoon three identified steamers, *Virgilia*, *Kastalia*, and *Manchester Brigade*, had come up from leeward and crossed northern part and slightly to north of area searched, and reported nothing seen of boat. Another unidentified steamer had come from leeward and crossed slightly north of center of searched area. Inquiry being frequently broadcast both by *Tampa* and Cape Race station. Four schooners were sighted at distance during day. *Modoc* searched area assigned her and at noon proceeded toward Halifax.

Ice information received from *Kastalia* and *Manchester Brigade* showing berg latitude  $47^{\circ} 28'$ , longitude  $51^{\circ} 22'$ , thus drifting  $62^{\circ}$  true 0.6 knot per hour, largely wind drift.

Ice information given to *Independence*.

June 21: Light to moderate NW. to W. breezes; partly cloudy, fine weather, good visibility. At 4.30 a. m., daybreak, under way. Resumed rectangular search for missing boat, extending searched area to southward and eastward. Three steamers crossed from eastward upper part of area being searched, thus enabling us omit further searching in that latitude. Inquiry being broadcast frequently, and all vessels requested to keep lookout. Replies, with assurance of cooperation received from time to time. A few schooners sighted at distance, and at 3.40 French schooner *La Revanche* from eastward passed close aboard, hailed, and requested to keep lookout. Search this day extended 80 miles to leeward of last reported position of boat over front covering 40 miles. At 9 stopped and drifted for the night; this on southern line of search some 55 miles  $110^{\circ}$  true from Cape Race.

Ice report received from steamship *Cornish Point* showing berg to-day in latitude  $47^{\circ} 17'$ , longitude  $51^{\circ} 18'$ , having drifted largely with wind  $168^{\circ}$  true 0.5 knot per hour since yesterday.

June 22: Gentle NW. breezes, becoming moderate SW. breezes at close. Mostly clear, fine weather; excellent visibility. Resumed search for missing boat a daybreak, 4.35 a. m., extending search to southward and eastward slightly beyond Virgin Rock in each direction, covering front of some 50 miles to distance of 100 miles to leeward of position in which berg was last seen. Five schooners were sighted in vicinity of Virgin Rocks, and our lines of search were modified accordingly. Steamships *Cabotia* and *River Tyne* crossed northern part of searched area from leeward, giving negative information regarding boat and both reporting berg sought, approximately latitude  $47^{\circ} 00'$ , longitude  $51^{\circ} 12'$ . At 1.36 small berg

sighted from aloft by *Tampa*, bearing 305° true, distance 16 miles. This berg sighted from deck bearing 270° true at 2.35. Continued rectangular search to eastward until 7.50 p. m., then gave up search for missing boat and stood back general course west true for berg. At 8.53 berg again sighted from aloft, and at 10.10 alongside of it we made examination with searchlight. Berg only about 25 feet high, about 60 feet long, shell-like, and showing rapid wasting. Its small size created some doubt as to whether this was the one reported or merely growler from same. We proceeded 7 miles to westward in further search, night visibility being good and fog being feared. At 11 stopped and drifted for the night, no other berg having been seen. Position of berg indicated drift of some 0.7 mile per hour approximately 150° true.

Inquiries for missing boat again frequently broadcasted this day and marked cooperation shown by passing steamships. Steamship *Watuka* in early morning reported that she saw a rocket in region of Trepassey Bay and stood toward location for examination, but saw nothing. Communication with steamship agents, St. Johns, via Cape Race radio station, disclosed that the boat was still reported missing.

A few flocks of murren seen this day.

Ice reports received this day from steamers *River Tyne*, *Cornish Point*, and *Cockrane*.

June 23: Light variable breezes and airs, calm at close. Foggy first part, later clearing. At 7.15 fog clearing, sighted berg visited last night. Steamship *Bothwell* passing to leeward reported a number of growlers from this berg. Made brief rectangular search to westward to make sure that there was no other berg, but found none. At 10.55 came alongside berg, found it to be wasting very rapidly and calving off, now reduced to mere growler 15 feet high and 50 feet long. Made preparations for placing 150-pound mine on berg; this partly because of its proximity to steamer lane, with fog threatening, and partly for experimental purposes. The small size and water-worn condition of berg made it very difficult to secure mine. Attempt first made to attach line by means of boat grapnel and finally with shot line from shoulder gun. At 12.50 mine secured and fired, with fair success. Developments indicated that the mine had drifted away from berg and had sunk to too great depth. Detonation broke off about one-third of the remainder of berg, and doubtless shattered the whole to some extent. Quantity of codfish came to surface, lowered a second boat and the two boats picked up over 90 cod of size averaging 12 pounds. Depth of water at this point, 50 fathoms. Concluded that this berg would cease to be an appreciable menace by nightfall and decided to go into St. Johns

Harbor for fresh water; this to enable us to avoid evaporating and to conserve fuel oil for further oceanographic work and for seeking derelict schooner reported. At 1.30 p. m., stood 303° true toward St. Johns.

Advised headquarters by radio of contemplated oceanographic work and contemplated brief search for derelict and recommended that ice patrol for season be discontinued.

At 9.20 p. m. moored to dock, St. Johns Harbor. Usual radio watches observed and communication carried on as usual.

June 24: Calm and partly cloudy followed by light to fresh southerly breezes and foggy. In St. Johns Harbor until 6.30 p. m. Morning broadcasts and other communication work carried on as at sea. Filled tanks with fresh water.

The Canadian Pacific steamship *Metagama* was at wharf with list of 36°, being pumped out and cofferdam being built to be placed over hole in starboard side while repairs can be made. *Metagama* too great beam for St. Johns dry dock.

Italian steamer *Clara Camus*, with bow badly crushed, was at wharf. Capt. J. T. Walsh, general manager of the Canadian Pacific Ocean Service, paid call on commanding officer to extend his thanks for services of *Tampa* in standing to aid of *Metagama* and in seeking missing boat. Captain Henderson, master of *Metagama*, also expressed his thanks for services rendered. Both officers believed that missing boat had been picked up by passing schooner and boat hoisted aboard. It developed that only two men were in the boat, a wooden lifeboat well equipped, which got adrift by accident after the collision, with one seaman and a third-class male passenger. *Metagama* immediately took 16° list when collision occurred and all boats were prepared for lowering. The *Metagama* had 700 passengers and 312 in crew.

At 6.30 p. m. under way and stood out of harbor. At 8.16 p. m. 5 miles off Cape Race, stood 195° true for position 10 miles off Cape Race to take up oceanographic work; moderate speed in fog. Received advice that Canadian Pacific steamers passed through straits of Belle Isle 20th instant.

June 25: Moderate to strong SSW. to SW. breezes; foggy for entire day; slightly clearing at intervals; standing 195° true, moderate speed. At 3.30 stopped and occupied station No. 475, 10 miles east of Cape Race. At 4.10 resumed course 195° true; at 6.08, station 476; at 9.15, station 477; at 2.10 p. m., station 478; at 8.05, station 479.

At 8.25 stood on course, 122° true. Broadcasted inquiries for derelict schooner reported bottom up June 12, latitude 43° 00', longitude 54° 45'.

Surgeon prescribed by radio for engineer officer steamship *West Lake*, suffering from result of injury.

June 26: Begins light SSW, increasing to strong breeze and moderate gale, with rather rough sea; falling to moderate breeze and shifting to NW., with moderate sea, at close. Overcast, foggy, and rainy throughout. Standing on course  $122^{\circ}$  true, occupied stations Nos. 480, 481, and 482. Speed reduced at intervals because of fog. At 3 course  $24^{\circ}$  true; at 6.30 occupied station No. 483. At 6.50 course  $292^{\circ}$  true; at 11.45 occupied station No. 484.

Ice information given to H. M. S. *Constance*.

June 27: Light variable breezes and airs; moderate swell; mostly clear, fine weather. Cruising southern part of Grand Banks for oceanographic work. On course  $48^{\circ}$  true until 4 a. m.; then occupied station No. 485. At 4.25 on course  $116^{\circ}$  true. At 8.25 occupied station No. 486. At 8.40 on course  $96^{\circ}$  true. At 11.35 occupied station No. 487. At 11.50 on course  $196^{\circ}$ . At 2.30 occupied station No. 488. Numerous French fishermen (sailing vessels) sighted in afternoon. Usual dories in water, often under sail, and trawl buoys often seen. The barkentine *St. Jean* gave us letters to mail and advised us that the fishing thus far had not been good this season. To date she had taken only some 8,600 pounds cod; less than usual. Possibly prevalence of warm water the cause of this. At 6.55 occupied station No. 489, and at 11.25 station No. 490. At 11.40 stood on course  $116^{\circ}$  true. Surgeon again prescribed by radio for injured engineer officer aboard steamship *West Lake*. From 8 a. m. until 6 p. m. 1-knot current experienced, setting  $100^{\circ}$  true.

June 28: Calm to light variable airs and breezes; smooth sea; slight haze first part; fog latter part. Cruising southeast part of Grand Banks and to westward, south of banks for oceanographic work. Begins on course  $118^{\circ}$  true. At 4.45 a. m. on course  $228^{\circ}$  true. At 10 a. m. on course  $300^{\circ}$  true. At 6.54 p. m. on course  $244^{\circ}$  true. The following stations were occupied: No. 491 at 1.50 a. m.; No. 492 at 4.23 a. m.; No. 493 at 9.10 a. m.; No. 494 at 3.15 p. m.; No. 495 at 6.36 p. m.; No. 496 at 10.10 p. m. A number of fishing schooners sighted on southern part of banks.

Gave special ice information to steamship *Monte Santo* and to H. M. S. *Constance*.

The following message was received at 8.50 a. m. from steamship *Coatsworth*:

*Coatsworth*, latitude  $47^{\circ} 17'$ , longitude  $51^{\circ} 35'$ , passed ship's lifeboat half full of water; "No. 6" on bow; no occupants in boat.

KILGOM, *Master*.

In reply to inquiry from *Tampa* the following details were received at 3:45 p. m.:

Boat was ship's lifeboat, marked "No. 6"; one thwart smashed, and loose wood floating in bottom. No indication that men had perished or boat had been occupied.

KILGOM, *Master*.

The position in which the boat was found was 72 miles bearing  $53^{\circ}$  true from position in which boat got adrift on 19th instant. This position is in area of Cape Race steamer tracks and had been repeatedly covered by passing steamers while *Tampa* searched elsewhere on 21st and 22d instant. Moreover the close rectangular search of *Tampa* had extended to within 20 miles to windward of this position on both 21st and 22d instant. Ice searching of *Tampa* on 23d instant was 10 miles to windward of this position. Certainly winds prevailing between 22d and 28th would have carried the boat more than 20 miles and the boat was necessarily within area searched by *Tampa*. Its water-logged condition doubtless prevented its being seen in the choppy sea experienced part of the time. How the boat became damaged or the fate of the occupants must be a mystery until more light is shed on the matter.

At 11 p. m. received headquarters telegram 9928-1035 discontinuing ice patrol as of 30th instant.

June 29: Gentle to strong SE. breezes which gradually hauled to WSW., and fell to light and NW. gentle breezes. Foggy for entire day. Stood on course  $244^{\circ}$  true for 20 miles, and at 2.20 occupied station No. 497, then lay to for remainder of day, awaiting opportunity to search for derelict schooner bottom up last reported on 12th, latitude  $43^{\circ} 00'$ , longitude  $54^{\circ} 45'$ . Radio bearings, Cape Race, showed easterly drift approximately 0.5 knot per hour; perhaps half was wind drift.

Received dispatch from steamship *West Lake* advising of satisfactory progress of engineer officer patient for whom *Tampa's* surgeon had prescribed, and expressing appreciation for services.

June 30: Calm, followed by light SW. breezes. Dense fog, partially clearing for short intervals at 10 a. m and 1.30 p. m. Vessel drifting, awaiting opportunity to search for derelict. At 9 a. m. received radio from steamship *Kurdistan* that she had passed heavy spar apparently attached to submerged wreckage, latitude  $43^{\circ} 00'$ , longitude  $52^{\circ} 15'$ . At 10 under way and stood  $145^{\circ}$  true 13 miles for above position to make examination. At 11.53, having reached position of spar as estimated from our dead reckoning position, and fog having again shut in, stopped and drifted. At 1.40 again temporarily cleared, secured observation to cross with bearing from Cape Race and found that we had been set 10 miles to northward and stood  $198^{\circ}$  true to attempt to find reported spar. At 3.15 fog again thick, stopped and drifted for remainder of day. Broadcasted notification of discontinuance of ice patrol, and advised

headquarters of plan to search two days for derelict and then return to Boston. Indications of drift  $50^{\circ}$  true 0.8 mile per hour. Perhaps one-half of this was wind drift.

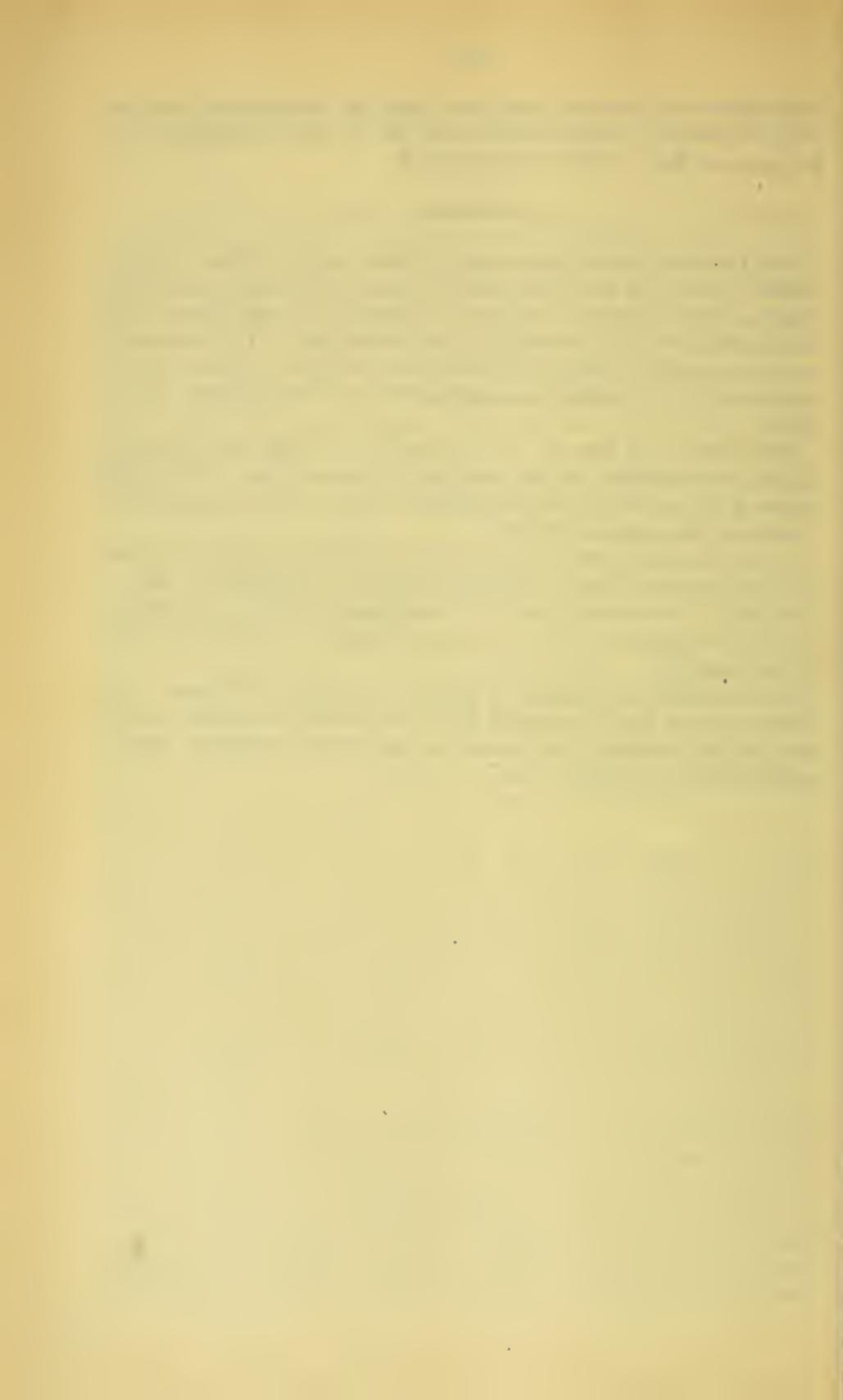
#### SUMMARY

Forty-six per cent of fog was experienced in this period, which is slightly below the normal of about 55 per cent, as given on Pilot Chart. Only 3 hours of gale and 14 hours of strong breezes were experienced, which is markedly below the normal. The disappearance as a menace of the single iceberg on June 23 in latitude  $46^{\circ} 58'$ , longitude  $51^{\circ} 18'$ , indicates continuance of extraordinary absence of ice.

Broadcasts and reports to Hydrographic Office and Weather Bureau were carried out, as required by instructions. The patrol received 457 surface-water temperature reports, 3 ice reports, and 6 wreck and obstruction reports.

The derelict schooner bottom up being sought at close of ice patrol and last reported June 12, latitude  $43^{\circ} 00'$ , longitude  $54^{\circ} 45'$ , is manifestly the same schooner that was reported May 11, in latitude  $44^{\circ} 39'$ , longitude  $55^{\circ} 08'$ , and was sought by patrol vessel May 20, 21, and 22.

This derelict had drifted, in 32 days, 101 miles  $170^{\circ}$  true. This being contrary to the expected drift northward is a further indication of the slacking this season of the usual northwest current around the Tail of the Bank.



## SUMMARY OF ICE PATROL, SEASON OF 1924

By Comander WILLIAM J. WHEELER, senior officer

The patrol for season was inaugurated by the *Tampa*, which left Boston March 18 and arrived off the Tail of the Bank on the night of March 21. The *Tampa* had reported ready on March 1, and thereafter had been awaiting orders to proceed when ice conditions required. The *Modoc* left the same port for relief of the *Tampa* 15 days later and the usual routine of relief after 15 days on the Banks was followed by the *Tampa* and *Modoc* for the season, with Halifax as base for fuel and supplies.

The month of March was characterized by less fog than is usual (as given on Pilot Chart), by low percentage of gales, and by warmer surface water on Grand Banks as result of mild winter, and by absence of field ice. There was also a prevalence of warm water in localities where arctic water might usually be expected, and as a logical result the number of bergs was much smaller than usual for the season. Only three bergs were reported south of Newfoundland after March 13, and of these only one showed a disposition to drift south or come south of parallel 45; this was tracked by the patrol after March 27.

During the month of April better weather than is usual for the season was again experienced, the percentage of both fogs and gales being below normal. Warm Atlantic water was found closer to the Grand Banks than usual, the water temperature over the reservoir of the Grand Banks was higher than normal. The only berg that might have menaced the North Atlantic lane route to the United States melted April 11 approximately in latitude  $41^{\circ} 11'$ ; longitude  $48^{\circ} 18'$ . A second was located on April 17 in latitude  $45^{\circ} 53'$ ; longitude  $51^{\circ} 53'$ , but its position and rapid melting precluded the possibility of its becoming a menace.

For the month of May the same general conditions that were experienced in April prevailed; a smaller percentage of both fogs and gales were experienced than is given on Pilot Chart for the season. There was likewise the extraordinary absence of ice from steamer lanes. On May 26 the patrol vessel located a berg in latitude  $48^{\circ} 42'$ ; longitude  $51^{\circ} 31'$ , 85 miles north of the Cape Race steamer track. On May 27, a small berg was reported in latitude  $48^{\circ} 42'$ ; longitude  $52^{\circ} 35'$ , still further from the steamer track. Advantage



was taken of absence of ice from steamer tracks for a most instructive trip to Belle Isle from May 27 to 30, partly for oceanographic work and partly for ice observation. Opinions of mariners long experienced on this coast, confirmed by circumstances this year, indicate that the mild winter and consequent reduced local field ice has permitted a larger percentage of bergs to drift ashore on northeast side of Newfoundland, thus removing them from sphere of possible drift further south. Advantage was also taken of conditions for search by patrol vessel for derelict west of banks in this month.

Weather conditions for the month of June were normal both as regards percentage of gales and fogs. There was no essential change in the ice situation. Only two bergs came south of latitude  $48^{\circ} 00'$ , these being the bergs reported on May 27 and 28. Of these the smaller was last seen on June 6 in latitude  $47^{\circ} 58'$ ; longitude  $52^{\circ} 37'$ , when it was rapidly disintegrating. The larger was tracked from May 26 to June 23, when its remnant was mined by patrol vessel in latitude  $46^{\circ} 58'$ , longitude  $51^{\circ} 18'$ .

The collision on June 19, off Cape Race, between the Canadian Pacific steamship *Metagama* and the Italian steamship *Clara Camus*, the former vessel having 700 passengers and 312 men in crew, indicated how readily a tragedy might occur in the foggy season in the vicinity of the Grand Banks. Both patrol vessels were in the vicinity, one being 60 and the other 100 miles away, and both made all speed for the scene. Fortunately favorable weather enabled both damaged vessels to reach St. Johns and the patrol vessels were only required to search for missing boats. But the value of patrol along this line is illustrated.

The contrast between the season of 1924 and that of 1923 is most striking: From March 15 to April 1, 1923, there were 20 bergs south of the forty-fifth parallel. Only one was reported south of this parallel in March, 1924, and only three south of Newfoundland. In April 1923, 24 bergs were reported south of the forty-fifth parallel. In the same month, 1924, only one berg was seen south of this parallel. In May, 1923, nine bergs were seen south of the forty-fifth parallel. In May, 1924, there were no bergs south of this parallel, or south of parallel 48. In June, 1923, there were 12 bergs south of the forty-third parallel. In June, 1924, but two bergs were south of the forty-eighth parallel, and only one south of the forty-seventh parallel.

The Strait of Belle Isle opened on or about June 20, this being markedly earlier than usual.

During the season 15 vessels were warned of the presence of ice on or near their tracks; 92 were furnished special information; approximately 4,794 water-temperature reports were furnished the patrol; 38 reports of ice sighted were received. Two steamships were given

medical advice by radio, and three were furnished weather reports. Four hundred and fifty-three steamships cooperated with the patrol this year, the names of which, and their masters, have been recorded in order that each one may appropriately be recognized. It was found that 64 per cent of the steamers on the North Atlantic routes were equipped with radio apparatus to receive continuous wave oscillation and occasional broadcasts; advised shipping that it was the intention of the patrol to broadcast all information on a continuous-wave next year.

Physical oceanographic investigation of the waters of the ice regions was carried on throughout the season of 1924 whenever opportunity offered. This work extended from the forty-first parallel to the entrance of the Strait of Belle Isle, Newfoundland. The subsurface investigations penetrated to a depth of 750 meters, the limit of active circulation. A total of 121 stations were occupied this season compared with 103 for 1923; the number this year exceeding all previous records.

The electric salinity apparatus installed was carried on board the *Tampa* and 622 tests were made on board throughout the season. This is the first authentic known record of salinities of the ocean being determined on board ship in any such great number, and being a practical instrument for determination of salinity on shipboard it is recommended for consideration in equipping other oceanographical expeditions. A detailed description of the apparatus is carried on page 136.

The oceanographic data is being treated and discussed under appropriate headings appearing further on in this publication. Records of surface thermal conditions, amounts of fog, directions of wind, drift ice, and other pertinent phenomena are shown by various charts, sketches, and also are discussed in detail under their respective headings to which the reader so interested may easily refer.



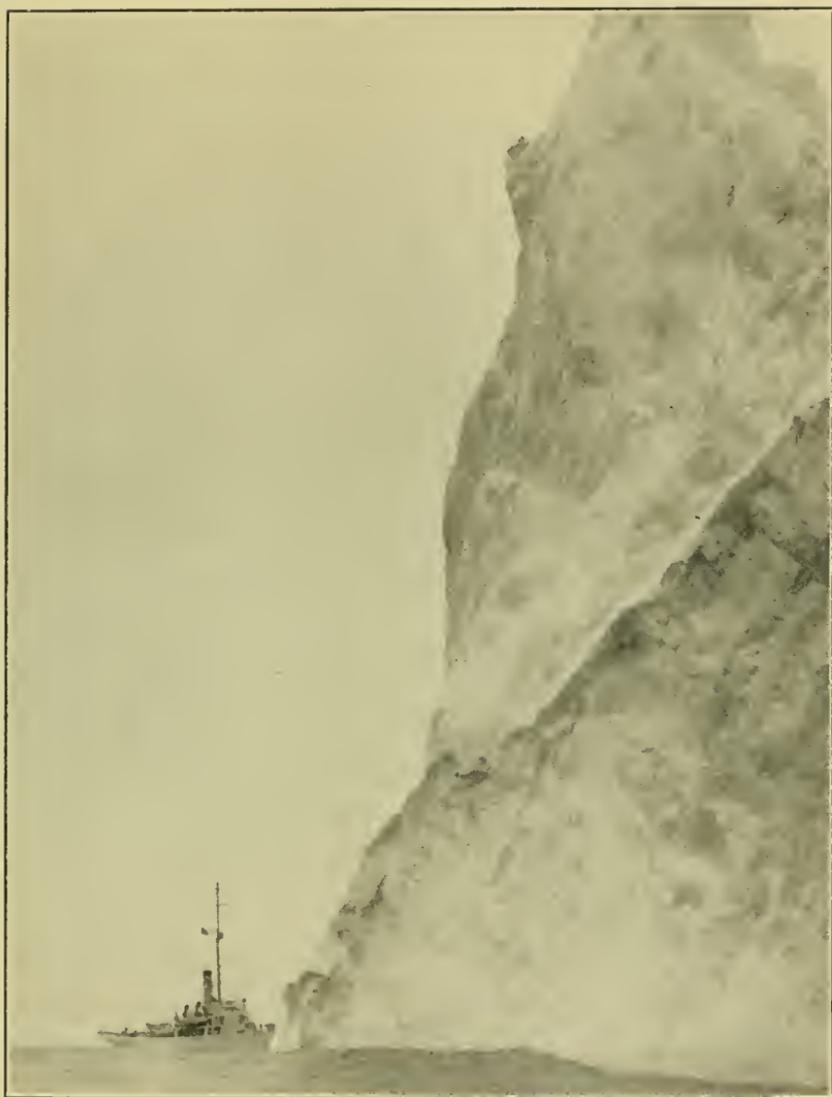


Plate I.—The precipitous face of a large berg found north of Cape Race during the ice patrol, 1924. The ice-patrol ship is seen in the background



Plate II.—A typical arctic berg which possesses two bodies of ice separated by a narrow channelway. Sometimes passing ships mistake such a formation for two separate bergs. Erosion is most rapid at the water line, and this fact is plainly visible on the extreme left side of this berg

# OCEANOGRAPHER'S REPORT

Lieut. EDWARD H. SMITH, United States Coast Guard

---

## MARCH

The international ice patrol, for the season of 1924, was inaugurated on March 22, when the patrol ship arrived on the southwest slope of the Grand Banks. Scientific observations were commenced and surface-water temperatures were solicited from all steamships within the Grand Bank regions. It is well known that winter cooling of the ocean surface sets up convectional currents which, in short, give to the ocean surface temperatures the virtue of a true thermal picture of the water mass as a whole. Thus chart F, the surface temperature chart for March, marking the temperature minimum of the 1923-24 winter, furnishes an accurate portrait of the major circulatory movements of the water masses around the Grand Banks of Newfoundland. It is one of the most interesting and valuable temperature charts which the patrol has secured in the past six years, because it reveals thermally the relative positions of Arctic, local, and Atlantic water, and which moreover was made possible through the agency of a mild winter.

The most prominent feature was the leg of frigid water extending southward to the Tail on the eastern side of the Grand Banks and stretching westward of the Tail, on the forty-third parallel, for a distance of nearly 100 miles. This area from surface to bottom was occupied by the coldest water south of Newfoundland for the year and has been inclosed by shaded crosshatching on chart F.

In marked contrast to the coldest water on the chart we found a large area of generally circular shape on the western and central part of the Grand Bank occupied by a water mass warmer than  $35^{\circ}$  in temperature extending from surface to bottom, being the portion of the Grand Bank which has characteristically exhibited a tendency to remain free from external intrusions and disturbances,<sup>1</sup> and thereby furnishes us with a thermal measurement of the degree to which winter chilling has proceeded.

The water lying over the southwestern and central part of the Grand Bank being free from external intrusions is chilled nor-

---

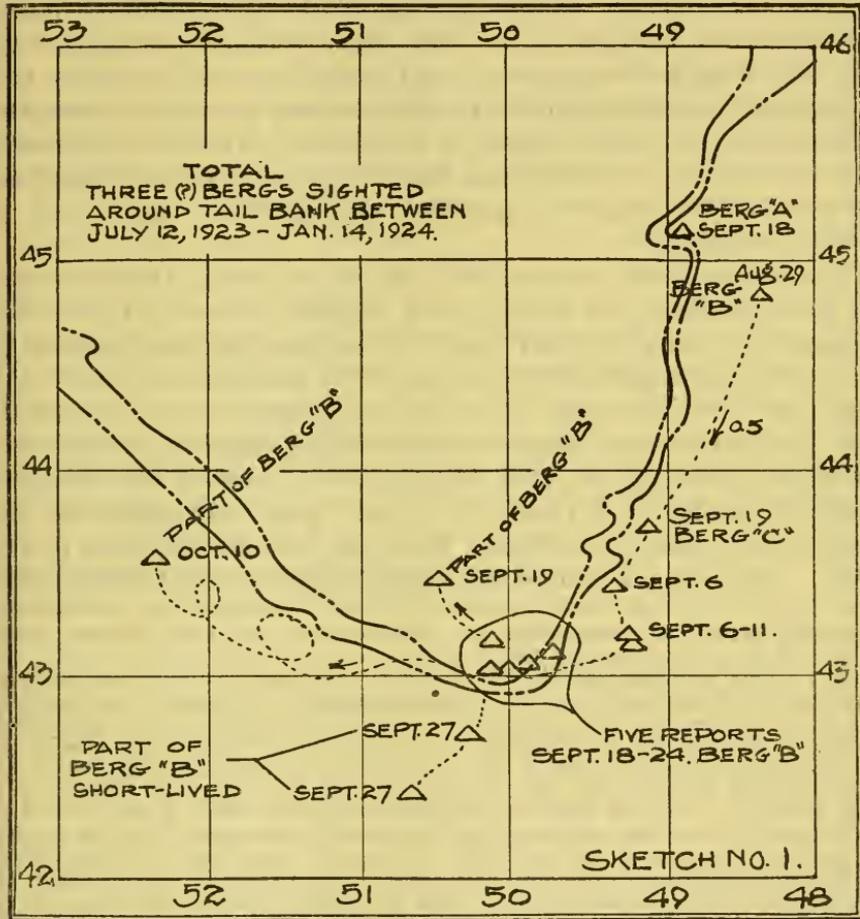
<sup>1</sup> Smith, Edward H.: International Ice Observation and Ice Patrol Service, 1923. U. S. C. G. Bull. No. 11, pp. 147-149.

mally by the end of winter to a uniform temperature of  $30^{\circ}$  to  $32^{\circ}$  F. from surface to bottom, and such temperatures as these are indistinguishable from those farther north and in the Arctic. The winter of 1923-24, however, chilled the water column in the above locality to a minimum of only  $35^{\circ}$  to  $38^{\circ}$  F., and this rare circumstance, due undoubtedly to a mild winter, not to occur here again probably for many years, permitted the thermal contrast between local and arctic water. In other words, since we possess evidence which attributes the  $37^{\circ}$  to  $38^{\circ}$  temperatures, found from surface to bottom in the central part of the Bank, as the minimum of local cooling, how then could the leg of icy water extending southward on the east side of the Bank have acquired a still lower temperature of  $32^{\circ}$ ? This latter body of water must have been transported here from a northern source—an Arctic invasion—which is outlined as strikingly as if chalked on a blackboard. The resemblance between the position and shape of the shaded area of arctic water on chart F and the normal distribution of arctic water as shown on sketch 10, page 150, International Ice Observation and Patrol Bulletin No. 11, for 1923, is astonishingly close, thus corroborating previous evidence accumulated during the past four or five years.

The northern edge of warm Atlantic water south of the Grand Bank between the forty-eighth and fifty-eighth meridians lay between the forty-first and forty-second parallels, a position which has been found normal for this time of year. (See charts I and G, Bulletins No. 10 and 11, respectively.) The "cold-wall" between the forty-seventh and forty-eighth meridians changed course abruptly to the north, and we found Atlantic water warmer than  $55^{\circ}$  as far north and west as latitude  $44^{\circ} 30'$  north, longitude  $46^{\circ} 20'$  west, and it will be noted on chart F that the shaded isotherm for  $35^{\circ}$  presents a shoulder-like form at this aforementioned northern and western point. Also the isotherms for  $45^{\circ}$ ,  $40^{\circ}$ ,  $35^{\circ}$ , and  $32^{\circ}$  plainly indicate a tendency upon the part of the warm Atlantic water to force its way inshore between the forty-fourth and forty-fifth parallels. Such a tendency has been previously described<sup>2</sup> wherein warm and salty Atlantic water tends to work inshore up the submarine valley, which exists at this place in the ocean bottom. Further evidence of this phenomenon was experienced by the patrol ship while cruising northward along the eastern edge of the Grand Bank on March 25. On that date, at 11.45 a. m., sixtieth meridian time, a well-defined tide-rip was observed extending in a general east-north-easterly direction from the continental edge. Just before crossing this wall observations were made of the surface which disclosed a

<sup>2</sup> Smith, Edward H.: International Ice Observation and Ice Patrol Service, 1923, U. S. C. G. Bull. No. 11, pp. 139-140.

temperature of  $31^{\circ}$  F., and a salinity of  $33.03$  ‰, while on the other side a few hundred yards north of the rip, a similar dip gave a temperature of  $45.5^{\circ}$  and a salinity of  $33.79$  ‰, a warming of  $14.5^{\circ}$  and a salting of  $0.74$  ‰. This warm salty water was pushing inshore to the westward, undoubtedly connected in its movement with the offshore Atlantic water as shown by the isotherm on chart F. Such a movement of the water masses on the eastern side of the Grand



Bank, combined with the body of relatively warm water on the Bank itself, which tended to resist displacement, reacted to pinch off the separating strip of icy northern water.

Attention is invited to the curled appearance of the isotherms, chart F, in the vicinity of  $42^{\circ} 00'$  north,  $49^{\circ} 00'$  west, which indicates a large vortex in process at that place and time, and is simply another illustration of the tendency of oceanic circulation to proceed in eddy-like formations which may be pictured as typical oc-

currences forming and dissipating in this particular region south of the Grand Banks where water masses are subject to intense transformations.

It is interesting to note the position of a surface pool of relatively cold water which was found in the vicinity of  $45^{\circ} 15'$  north,  $45^{\circ} 30'$  west, it evidently having become disconnected from the main mass of cold water to the northwest and moved offshore between the northeastern part of the Grand Banks and the Flemish Cap. This illustrates a tendency of the water masses in this vicinity to move offshore to the eastward in the early season when the circulation of the Gulf Stream is most intense and when its invasions inshore between the forty-fourth and forty-fifth parallels provides a favorable opportunity for such a scheme of circulation. The same phenomenon was observed in 1923 except that it was more striking then, due to the fact that these southeasterly moving water masses bore a freight of icebergs.<sup>3</sup>

The first ice to be reported for 1924 in the North Atlantic south of Newfoundland was a large berg sighted January 14, between Flemish Cap and the Grand Bank.<sup>4</sup> Subsequent reports identified it as drifting southeastward at the rate of 0.5 knot per hour to  $45^{\circ} 55'$  north,  $44^{\circ} 20'$  west, where it was last seen January 26 on the northern edge of the warm Atlantic water melting rapidly. (See chart D, which shows all ice, both bergs and field, seen in the Atlantic January 1 to March 1, 1924.) Two other bergs were sighted on the northeastern part of the Grand Bank but were not reported thereafter. There were a total of three bergs sighted in the Atlantic prior

<sup>3</sup> Smith, Edward H.: International Ice Observation and Ice Patrol Service, 1923, U. S. C. G. Bull. No. 11, pp. 139-140.

<sup>4</sup> It is worth recording that the only glacial ice (icebergs) sighted in the southern region of the Grand Banks after the discontinuance of the ice patrol, July 12, 1923, and the first icebergs for 1924, reported Jan. 14, were three bergs, two of which drifted southward along the east side of the Bank to the region of the Tail, and are shown, as it is believed they existed, on sketch No. 1. Berg A was reported on Sept. 18 in the vicinity of  $45^{\circ} 07'$  north,  $48^{\circ} 55'$  west, evidently set in on the slope where it was held fast as it was not reported southward thereafter. Berg B, the first berg to be sighted after the withdrawal of the patrol, was sighted Aug. 29 in the vicinity of  $44^{\circ} 50'$  north,  $46^{\circ} 29'$  west. It was seen again Sept. 6, having drifted southward at the rate of 0.5 knot per hour during the interim. It grounded on the Tail of the Bank, being reported there by several steamers from Sept. 18 to 25, where it gradually broke up. It, or parts of it, floated off and was reported south of the Tail on the 27th but not thereafter, and we may infer that this ice which had drifted offshore into the Atlantic basin had dwindled by this time to insignificant size as nothing more was heard of it. A report of ice on Sept. 19 on the bank and about 40 miles northwest of the Tail probably refers to another piece of berg B in process of disintegration. Its drift to the northwest from the Tail corresponds to the currents and records of drift of ice in this locality. Ice sighted to the northwest, on the southwest slope of the Bank, on Oct. 10, may have been the final remains of berg B which had been grounded on the Tail for so long. A berg was reported on Sept. 19 in the vicinity of  $43^{\circ} 48'$  north,  $49^{\circ} 10'$  west, which must be designated as a new berg, provided the report is authentic, has been marked "Berg C" on sketch No. 1. It is estimated there were three bergs in this region during the fall of 1923; certainly not more than five.

to March 1. The next berg was sighted on the 1st day of March in  $43^{\circ} 48'$  north,  $49^{\circ} 00'$  west, with two growlers to the eastward. It was sighted again on March 4 in  $43^{\circ} 00'$  north,  $49^{\circ} 40'$  west, drifting southward along the east side of the Bank at a rate of 0.5 knot per hour, but it was not seen again after that date. (See chart D, which shows this berg's drift.)

On the 14th of the month two bergs were reported 6 miles east of St. Johns, Newfoundland, but they were not seen again, unless a large growler reported 28 miles southwest of Cape Race on the 27th was the remaining sign of one of these. On March 12 a berg was reported in  $46^{\circ} 11'$  north,  $48^{\circ} 43'$  west, and on two subsequent days, the 13th and 17th, it was sighted again and also another berg in practically the same locality. This total of six bergs constitutes all the glacial ice in the Atlantic south of Newfoundland, prior to April 1.

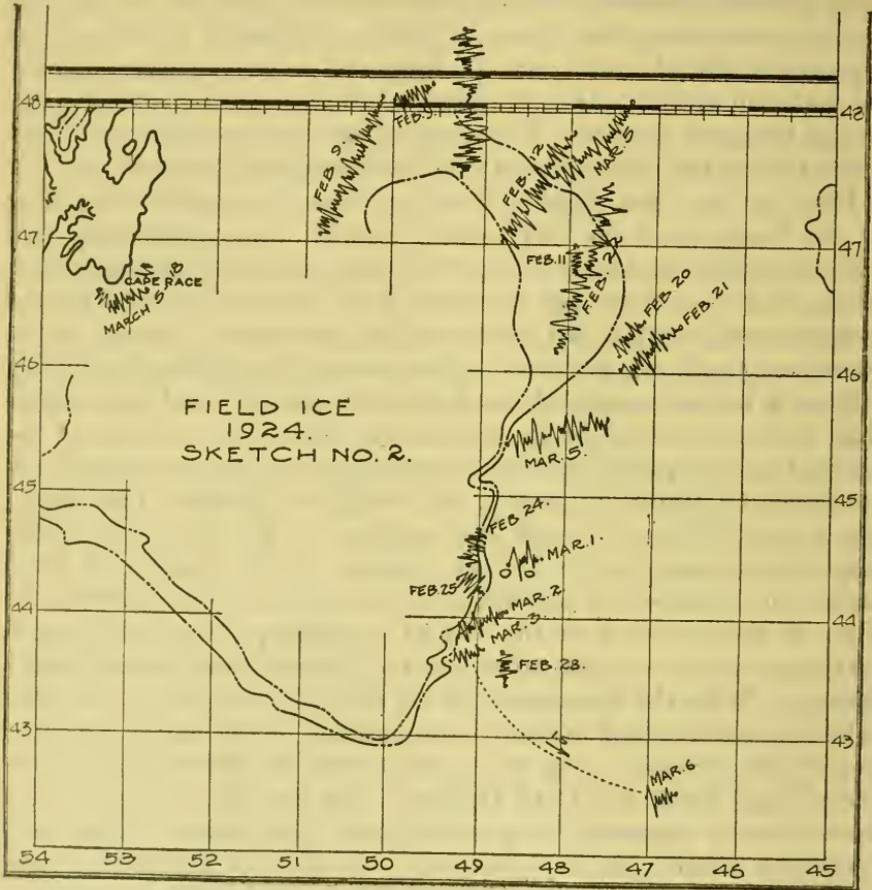
Field ice was first sighted February 9 on the northeastern edge of the Banks, near the forty-eighth parallel, and undoubtedly this was the first of the Arctic fields, which were putting in an appearance about on time. February 11 heavy field ice was reported on the forty-seventh parallel just inshore of the 100-fathom contour of the Bank, and the Arctic field was sighted several times thereafter during February but not south of the forty-fifth parallel and never more than 30 miles seaward of the continental edge. The presence of one ice field may be traced in its drift down the eastern side of the Bank by reports on March 1, 2, and 3, and, finally, on the 6th. (See sketch No. 2 and "Table of Ice and Obstructions.") This field was carried southward along the 100-fathom contour of the Bank and later, under the influence of prevailing northwesterly winds, driven offshore to the southeast at the rate of 40 miles per day, attaining a maximum distance of 120 miles into the Atlantic basin before finally melting. With the disappearance of this patch March 6, no more field ice was reported during the remainder of the month except a small field of shore ice on the eastern coast of Newfoundland, between Cape Spear and Cape Ballard. The scarcity of field ice at a time when it normally is spreading over the Grand Banks to a maximum extent was very noticeable, but quite in agreement, however, with the small quantity of Arctic water south of Newfoundland, and the abnormally high surface temperatures.<sup>5</sup>

One of the bergs sighted March 13-17 on the northeastern part of the Bank was sighted by the patrol on the 26th in  $45^{\circ} 33'$  north,

---

<sup>5</sup> Geographical Journal, January, 1924, Vol. LXIII, No. 1. Capt. H. T. Munn, trader and whaler, and annual visitor to the Baffin Bay region, reported that in September, 1923, he cruised northward on the west side of Baffin Bay (this region encompassing the heart of the south flowing current which transports the arctic ice southward into the Atlantic) from Cumberland Sound to Eclipse Sound and that he encountered little or no ice. He had never seen these northern waters so free from ice in his 10 years' experience. An Esquimo at Ponds Inlet, Eclipse Sound, states that the last ice left there in July, which is a month earlier than normal.

49° 29' west, it having drifted and dragged over the bottom 0.3 knot per hour, 218° true. A test of the effects from exploding a heavy charge of T. N. T. was carried out on this berg, the result being fully described in the report of the first cruise of the patrol ship. The other berg, also reported on the 13th and 17th, was followed by the patrol first in its drift southward along the east side of the Bank; then southward of the Tail; and later gradually wheeling to the eastward, as it entered the northern edge of the Gulf Stream, where



it finally disintegrated on April 11. This drift track for the period March 17 to April 11, in which the berg covered a distance of over 400 miles, is one of the most interesting which the patrol has secured and is shown as berg No. 2 on chart B. Berg No. 2 disintegrated at a more rapid rate than usual for this time of year, existing only seven days south of the Tail of the Bank, due to a high washing swell and many heavy rain squalls. There was one more berg reported in the north central part of the Bank on March 31, but this probably was a part of the first berg, reported March 17.

The winds were well diversified around the compass during the month of March, with the north and northeastern directions predominating slightly, the average force being 4.5, Beaufort scale. The strongest winds were from the north and the weakest from the southwest, with a total of five gales during the period. The absence of the northwesterlies which normally prevail at this time of year was noted and a comparison of the wind rose on chart F with that of chart G, Ice Patrol Bulletin, 1923, and chart I, Ice Patrol Bulletin, 1922, will bring out this fact. We experienced 16 per cent hours of fog and 18 per cent hours of fog and low visibility which was less than last year, the latter having 4 per cent hours of fog and 9 per cent hours of fog and low visibility. The United States Pilot Chart for the North Atlantic shows 31 per cent days of fog.

#### SUMMARY

Ocean temperatures  $5^{\circ}$  to  $6^{\circ}$  F. above normal over the Grand Banks' reservoir indicated that winter chilling in this region had been much less than normal. This fact provided a thermal contrast between the normal positions of the three classified types of water, viz, Arctic, Banks, and Atlantic. There were a total of six bergs south of Newfoundland during March. With the exception of a small amount of field ice in January and February, and the small patches of field ice, the last of which disappeared March 6, there was no field ice south of Newfoundland for the year—a very abnormal condition.

#### APRIL

April 1–11 the patrol was fully occupied in following berg No. 2 in its drift south of the Tail into the Gulf Stream, and an accurate drift track was obtained which is shown on chart B. From the 14th to the 16th the patrol scouted northward along the eastern side of the Grand Bank, about 10 miles seaward of the 100-fathom contour, where normally exists the heart of the south-flowing current. No appreciable set was observed during these two days, although the positions for latitude were checked carefully by sights of the sun and stars; remarkably clear atmospheric conditions permitted us to determine our positions with excellent accuracy. We crossed the Grand Banks east to west in the latitude of Cape Race, experiencing a southerly set in the neighborhood of 0.4 knot per hour while on the Banks, and a southwesterly set of 1 knot per hour while the ship crossed the gulley between the Banks proper and Cape Race. April 19–20 we ran a line of stations southwesterly into the deep water off the continental edge, and while doing this we allowed for a fair current of 0.5 knot per hour and from various

soundings and astronomical fixes this was a correct estimate. April 24-30 we again steamed up the eastern side of the Bank approximately 10 miles seaward of the continental edge but, in contrast to our earlier cruise, we found a southerly current of 0.8 knot from the Tail northward to the forty-sixth parallel. This current was determined by means of astronomical sights similar to the procedure followed during the cruise of April 14-16 and which in location also was similar to it. The fact that no current was noticed along the east side of the Bank April 14-16 and 0.8 knot southerly current observed here April 24-29 is difficult to explain. Although we have previously noted some variation in the rate of flow of the water around the Atlantic faces of the Grand Banks, this is a great range in a short interval.

The drift track of a derelict reported March 13 and April 4 (see Table of Ice and Obstructions) has been plotted on chart H, which indicates an easterly drift of 1.2 to 1.3 knots per hour. This corresponds in direction and rate of drift to the track of another derelict reported south of the Tail of the Grand Banks during March as plotted on chart F; and all of which corroborates previous evidence as to the rate of flow of the Gulf Streams in this region.

The position of the body of frigid water with a temperature of  $32^{\circ}$  (the coldest water south of Newfoundland), similar to that recorded on the March chart, is shown as a shaded crosshatched area on charts G and H. The leg which was found on the eastern side of the Bank during March was still present during April, but it had become more attenuated in shape and its southern extremity did not extend beyond  $43^{\circ} 20'$  north,  $50^{\circ} 00'$  west, a position just north of the Tail. (See chart G.) The position occupied by this body of cold water remained practically unchanged during the second half of the month, but its surface temperature was warmed by the sun  $1^{\circ}$ . (See chart H). An opportunity near the close of the month permitted the patrol to investigate the superficial extent of this same Arctic water mass southwest of Cape Race. It had encroached some 30 miles on the northwest part of the Bank itself and projected southwestward to the continental edge in the bottom depression between the Grand Banks and St. Pierre Bank but it was not found west of the meridian of St. Pierre. The surface temperature rose from  $33^{\circ}$  to  $35-36^{\circ}$  over St. Pierre Bank, which would indicate that the bottom configuration influences circulation in this region.

The central and southern portion of the Grand Banks during April continued to be flooded by a body of water  $35^{\circ}$  to  $38^{\circ}$  in temperature commonly known as local or bank water. This mass was

surrounded on all sides by water  $5^{\circ}$  to  $6^{\circ}$  colder except southwestward where warmer water lay. The first half of the month the influence of the  $35^{\circ}$ - $38^{\circ}$  water mass spread outward on all sides, as shown by the increase in white area over the Banks when we compare charts F and G. The Atlantic water lying off the eastern face of the Banks continued to press shoreward as shown by the convexity of isotherms 45, 38, 34, on chart G. The arctic water between these two classified types of water masses, viz. local, or Bank, on the west and the Atlantic on the east, was squeezed into a narrow strip barely 10 miles in width. The latter half of the month the Banks water spread northeastward on the surface in a prominent manner, displacing arctic water on the surface as far northeastward as  $46^{\circ} 45'$  north,  $49^{\circ} 20'$  west, as shown on chart H. The phenomenon of Banks water to expand over the central Banks region and spread to the northeastward was previously recorded in 1913, a year which in many respects, as to absence of normal masses of arctic water in the Grand Bank vicinity, corresponds with this spring.<sup>6</sup>

A comparison between charts G and H for the month of April and chart F for March brings out the fact that the northern edge of the warm Atlantic water, as indicated by the  $55^{\circ}$  isotherm, began receding southward between the forty-third and forty-fifth parallel early in April, a movement which continued the latter half of the month. This is entirely in accord with previous observations in this locality at this time of the year and which has been pointed out in previous discussions.<sup>7</sup> (See March report, p. 10.) The recession is due, it is believed, to a slackening in the intensity of circulation which prevails at a maximum during the winter months.

The "cold wall" changed position southeastward of the Tail and assumed a wedgelike form the latter part of the month, which is a characteristic shape that has often been charted and discussed heretofore. The bottom configuration, a rise in the ocean floor which extends southwestward from the Tail over 150 miles, is an important factor in determining the course of the easterly moving water masses, and its reflection is seen even in the surface water isotherms 55 and 60 on chart H.

Compared with previous years, the position of the "cold wall" between the forty-first and forty-second parallels is normal, and its behavior during the month was quite similar to its behavior during the same period of 1922.<sup>8</sup> Surface temperatures over the conti-

<sup>6</sup> Mathews, D. J.: "Report on the work carried out by the steamship *Scotia*, 1913." 1914.

<sup>7</sup> Smith, Edward H.: Ice Observation and Ice Patrol Service, U. S. C. G. Bull. No. 11, pp. 139-140.

<sup>8</sup> Smith, Edward H.: International Ice Observation and Ice Patrol Service, U. S. C. G. Bull. No. 10, 1923. Charts J and K.

mental shelf, and as far off shore as they affect adjacent water masses, were 3°-6° warmer during the month than observed at the same time during previous years, but the Atlantic water south of the "cold wall" did not differ in temperature from that observed during previous years.

The ice during April consisted of two bergs, one of which, berg No. 2, drifted south of the Tail into the Atlantic and melted April 11. (See chart B.) The other berg was a small one and was reported in the north-central part of the Grand Bank on the 16th, being sighted by the patrol on the 17th. It was reported on the 18th and on the 22d but not thereafter, most probably having melted. (See chart B.) Two bergs were reported on the 26th in the vicinity of 46° 11' north, 49° 00' west, but a most thorough and exhaustive search instituted immediately and continued for several days under excellent visibility conditions failed to reveal either one of them. Several passing steamers cooperated with the patrol in its search and we are forced to conclude that the steamer making the report was mistaken. The fact that it was near midnight when she claimed to have seen the bergs detracts from the credibility of the report.

Berg No. 2 after entering the water south of the Tail disintegrated more rapidly than any berg of which we have record. April 4 it passed the Tail, where it emerged into water at 34°-35°, a warming of 3°-4° from that of the Arctic current proper in which it had been floating. Oceanographic station No. 385 was taken near the berg this day at 4.30 p. m. (See Oceanographic station table.) On the 5th instant it was described as "a medium sized berg with a surface above water in two parts, separated by a shallow channel way, one part a rather low ice ridge, the other a peak approximately 150 feet high." The water temperature this day was 34°, and the wind on the 4th and 5th was light and variable and the sea smooth.

On the 6th the wind remained light and the water warmed from 34°-38°. A slight swell washed the base of the berg and assisted disintegration. A growler was calved occasionally but disintegration did not appear to be noticeably rapid. Oceanographic station No. 386 was taken this day at noon near the berg. It had begun to calve faster on the 7th when about noon a heavy swell made up from the northward, its rise having been observed during the morning. This, together with the water temperature of 40°, accelerated disintegration which may be termed "rapid" beginning with noon this date. Early in the morning of the 8th the berg crossed the "cold wall," entering water warmer than 56°; which was a rise in temperature of approximately 18°. Oceanographic station No. 387 was taken near the berg at 1 p. m. this date. It was noted that "it was fast dwindling, cracking, calving, and rolling continuously." The latter part of

the day the swell subsided somewhat. The following note was made on the 9th, "the warm water, of 56°, and the buffeting of the southerly swell were reducing berg No. 2 with extraordinary rapidity. It was calving continuously and numerous growlers were floating in the vicinity. We experienced frequent passing rain showers and sunny weather between." On the 10th probably the most rapid disintegration of any day took place. The following note was made: "When nearby the berg, constant loud cracklings were heard and the moment the sea water ran off the entire exposed surface would blister, the next sea washing away loose covering, followed by more blistering. This, together with frequent calvings was reducing its bulk rapidly. By dark it was apparent that the warm water, warm air, and constant pounding of the seas would make an end of this menace within the next 24 hours." The wind during this day was moderate, a moderate swell was running, passing rain squalls were experienced, and the weather is described as "typical Gulf Stream." Oceanographic station No. 388 was occupied near the berg at 9 a. m. this day. The next day, the 11th, there were no signs of berg No. 2 and we all were convinced that it had completely melted. From noon of the 7th until the morning of the 11th, a period of approximately four days, a medium size berg was completely dissipated. This is much faster than the normal rate of disintegration, which has been observed to be about seven days.

The winds for the month were well diversified around the compass with the northern semicircle slightly predominating. The average force of the wind for the first half of the month was 4, Beaufort scale, while the second half of the month the winds were the strongest, being from the north and the northwest. There were 4 gales during the month, 1 the first half and 3 the second half, all of a force 6.5 or greater, and 2 of the gales were force 8 or greater. Previous records indicate that this is the month during which the direction of the winds shift from a prevailing northwesterly direction to a prevailing southerly direction, but this year no such phenomenon was observed. We experienced 5 per cent of fog and 7.5 per cent hours of fog and low visibility. This is considerably below the average which we have experienced during the previous three years which averaged 28 per cent hours of fog and 48 per cent hours of fog and low visibility. The United States Pilot Chart shows 40 to 45 per cent days of fog.

#### SUMMARY

A current of 0.8 knot was observed during the first part of the month flowing southward along the east face of the Grand Banks, but no current was detected in this locality two weeks later. **A**

southwesterly current of 1 knot flowed through the gulley past Cape Race. The continued presence of arctic water on the northern part of the Bank and a leg down the east side was noted during the month. Expansion of the Banks water to the northeastward displaced arctic water in that locality the latter part of the month. The "cold wall" receded offshore on the east side of the Grand Banks the latter part of the month. A total of only 2 bergs were recorded south of Newfoundland, in the Atlantic, where the normal number for this month is 90.

#### MAY

The 1st day of the month the patrol crossed at right angles to the eastern side of the Grand Banks and observed a surface drift of 0.8 knot per hour which corresponds to the strength found in this region the latter part of April. Cruising toward Cape Race, no appreciable set was observed from positions of the ship as determined by astronomical sights; even in the gulley between the Banks and Cape Race no surface current was found where ordinarily a 1 knot southerly set is to be expected. Next the patrol ship ran a line of oceanographic stations from Cape Pine west-southwestward to the edge of the Laurentian Channel and no definite current of appreciable magnitude was found. We then cruised southeastward along the western slope of the Grand Banks, observing a surface drift  $215^{\circ}$  true one-half knot per hour. The following two days, May 9 and 10, from latitude  $43^{\circ} 30'$  north to latitude  $46^{\circ} 00'$  north, 10 miles seaward of the eastern slope of the Banks, no current was found; even northward between  $47^{\circ} 00'$  west and  $48^{\circ} 45'$  west, on the northwestern part of the Banks, no current existed. Normally, a continuous movement to the southward has been found along the east side of the Banks at this time of the year. Although variations in its strength have often been noticed, we have never found a complete cessation during spring. From the 20th to the 27th we cruised northward as far as the Strait of Belle Isle, but no positions were obtained which permitted us to detect any sizable current flow. The 27th to the 30th we skirted the Newfoundland coast, 10 to 20 miles offshore, from Cape Bauld to Funk Island, observing the ice conditions, and spending the last few days of the month searching in the vicinity of  $48^{\circ} 42'$  north  $51^{\circ} 32'$  west, for the southernmost iceberg at that time in the offshore Atlantic.

Charts I and J portray surface temperature conditions prevailing in the ice regions during the month. The body of cold water which flooded the northern part of the Bank and invaded southward in the form of two salients, one along the east side of the Grand Bank and the other in the trough southwestward of Cape Race, is not so prominently delineated on the charts for the month as it was on the

charts for earlier in the season. This is due to the sun's heat, which warmed the ocean surface over the continental shelf from a winter minimum of  $33^{\circ}$  to a temperature of  $39^{\circ}$  by the end of May. The temperature of the Atlantic water south of the "cold wall" warmed from  $55^{\circ}$  to  $58^{\circ}$  by the 15th of the month and to  $62^{\circ}$  by the latter part of the month. The position of the "cold wall" remained practically unchanged from that found the latter half of April. Due to the heating of the surface layers by an approaching summer's sun, and further to the fact that these layers are moved under the influence of prevailing winds, no true position of the "cold wall" can be obtained at this time of year superficially. An examination of the wind roses on charts H, I, and J reveal the fact that northerly winds prevailed the latter part of April, moderate variable winds the first half of May, and southerly winds of greater intensity the latter part of the month. For these reasons the surface-water layers were not subjected to any large and definite movement, and therefore the "cold wall" retained its general position unchanged throughout the month.

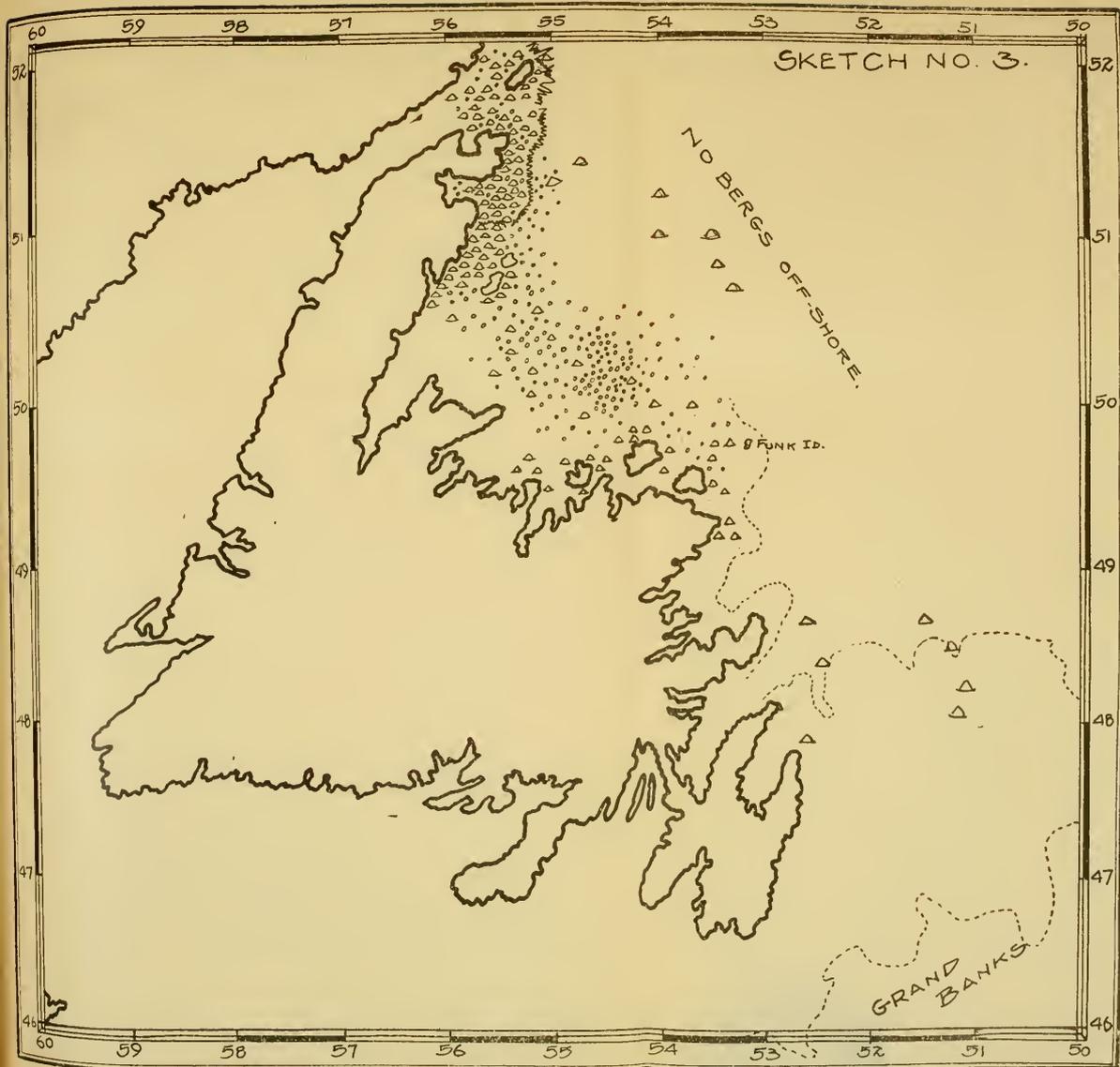
There was no ice reported or sighted during the first two weeks of the month except a small field on the extreme northern edge of the Grand Bank, May 10, in  $48^{\circ} 42'$  north,  $51^{\circ} 12'$  west, but on the 15th the steamship *Oxonian* reported passing a small berg in  $46^{\circ} 14'$  north,  $50^{\circ} 15'$  west, just south of the Virgin Rocks. A careful search, which occupied the 16th and 17th, failed to confirm this report, and the presence of a fishing vessel anchored in this position led us to suspect that it had been mistaken by the *Oxonian* some distance away as the shape of a berg. Especially were these views strengthened when this fishing vessel reported she had been anchored there during the past three days, the master of the craft adding that he and all the other fishing vessels with which he had spoken had seen no ice on the Grand Banks this season.

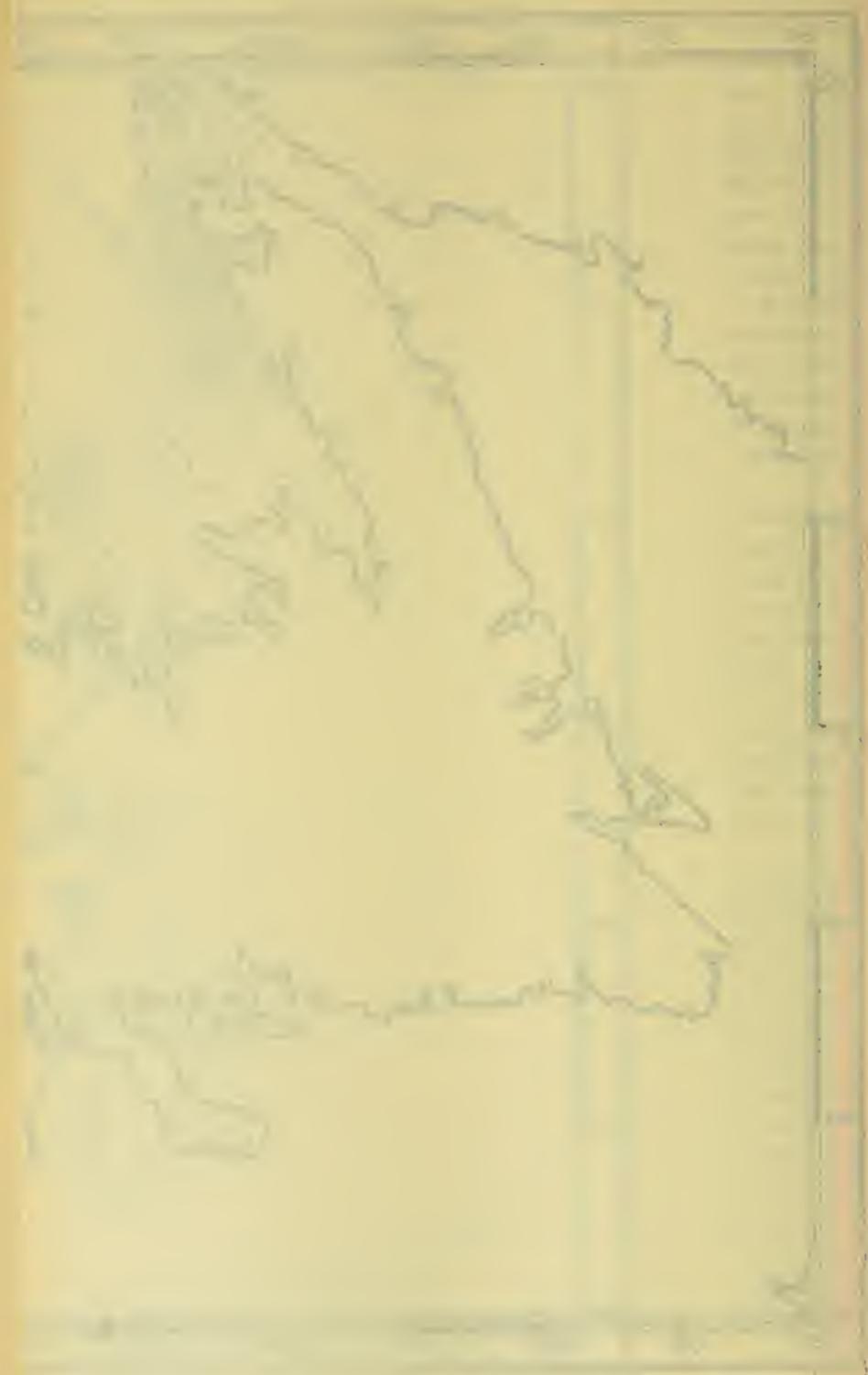
We called at St. Johns, Newfoundland, on the 24th and 25th in order to interview local mariners regarding ice conditions in the vicinity of Newfoundland this spring and also to gather general information which might be of value to the ice patrol. We left St. Johns the evening of the 25th and cruised northward toward Belle Isle, where we arrived the afternoon of the 27th. Our course ran from 30 miles off Funk Island to North End Light, Belle Isle, and during the run we sighted a total of seven bergs, but none offshore of our track. About 30 bergs were scattered around in various positions in the entrance of the strait, some having been set in closely under the cliffs, while others had been carried into pockets in the shore line, but they all plainly showed the general tendency of the currents in this locality, namely, to drift the bergs onto the shore.

As a result of our interview with observers at Battle Harbor, Labrador, and Belle Isle, Newfoundland, it appears that Battle Harbor experienced no drift ice in March, with the Arctic field arriving April 1, solidly jamming the coast and no open water to be seen from the shore. This is the ice which the seals usually choose when off the entrance of the Strait of Belle Isle upon which to whelp their young early in March. This spring the Arctic field was nearly a month late. These fields cleared from the vicinity of Battle Harbor May 14 and no more reappeared until May 25, the day following a northeasterly gale, when another field blocked the coast. May 27, the day we arrived, this Arctic ice was being driven southward, blocking the northern shore of Belle Isle itself and gradually surrounding it. The winds at Battle Harbor this spring prevailed from the east with frequent southeast and northwest disturbances; the periods of northwesterlies being of shorter duration this year than normally.

The observer at Belle Isle stated that no drift ice had been seen this past winter, on the seaward side of the island where normally it is jammed with ice and little open water in sight. Ice had filled the entrance of the strait toward the Gulf of St. Lawrence, however, throughout the winter, but occasionally a narrow lead of open water hugged closely under the Newfoundland side of the strait. The presence of such a lead also portrays a mildness of the 1923-24 winter. May 18 all the ice had broken out of the strait and clear open water was seen in every direction. The 27th the Arctic field which had appeared two days previously at Battle Harbor began to surround the island and block the strait, under the influence of a fresh northwest breeze.

Twillingate, situated near the head of the bight between Cape Bauld and Funk Island, observed the arrival of the first field ice early in March. This field was undoubtedly part of that which had blocked the entrance of the Strait of Belle Isle during the winter. The seals chose this small field upon which to have their young, the ice drifting southward, held inshore by easterly winds until it rested on the west side of White Bay: a narrow strip less than 10 miles in width, extending from Canada Bay to Coney Head. Last year the sealing fleet from St. Johns derived its catch from the Arctic flows 200 miles southeast of Funk Island, while this year, in marked contrast, it killed on the shores of White Bay. This latter position would ordinarily have been inaccessible, due both to local cooling, which freezes the surface waters with heavy ice from Cape Bauld to Gray Islands to Fogo Island, and, furthermore, due to the augmentation of Arctic ice in March and April, which normally leaves no open water for hundreds of miles offshore.





When the ice patrol vessel stood south along the coast we found a small ice field extending southward from Cape Bauld 35 miles, but not offshore more than 12 miles. This was probably the last of the fields which were observed to disappear from the entrance of the Strait of Belle Isle on May 18. Battle Harbor observed very few bergs and growlers this year before April 1, practically no definite movement to the southward being noted before that date.

Belle Isle sighted the first bergs between April 15 and 20 while Twillingate, on the north coast of Newfoundland, recorded their initial appearance on Easter Sunday, April 20. The patrol observed 52 bergs along the coast from Cape Bauld to Gray Islands, none of which were over 20 miles from the coast; and the majority of these had been set inshore and grounded, while the later arrivals appeared to be drifting into a similiar position. Off Twillingate, and from Notre Dame Bay to Funk Island, it was estimated there were between 15 and 20 bergs, some of which had worked inshore into what would at first glance appear to be inaccessible positions, behind headlands and islands. It is believed that such ones would survive well into August before they finally melted. The greatest abundance of ice appeared to lie in a belt which followed the general curve of the coast from Cape Bauld to Funk Island and it is believed that this indicates the normal and general course followed by icebergs southwards along the east coast of Newfoundland. In this connection, this large indentation in the coast line of Newfoundland between the Strait of Belle Isle and Cape Bonavista—the greatest break from Hudson Strait to the Grand Banks plays no small part as an influence on the amount of ice which succeeds in reaching the lower latitudes; that is, the region around the Tail of the Grand Banks.

Ice in normal winters, by the latter part of December, forms over the waters between Fogo Island and the Gray Islands. This ice is augmented after the middle of January by heavy arctic floes, often of large extent which hold within them, when tightly packed, a considerable number of icebergs. The flat ice is at a maximum in February and March, between Cape Bauld and Cape Bonavista, with no water to be seen in any direction, and the fields extend offshore sometimes for hundreds of miles. Those bergs which drift southward on the ocean side of this pack are under the control of relatively deep-seated currents, it being well known that the latter, due to the rotation of the earth swinging moving objects in the northern hemisphere to the right, tends to set in on the American shore from Baffin Land to Cape Race; but the bergs at this time of year are restricted from working inshore under the natural tendency of the currents by the fender of ice lying in that direction. Such bergs

therefore drift southward, wide offshore, in the Atlantic and are caught up in the northeasterly moving Atlantic waters, where they rapidly disintegrate. Many bergs, on the other hand, are found lodged in the ice fields themselves, and as long as the fields are heavy and tightly packed, the bergs will be moved in the direction in which the field moves, the latter being mostly under control of prevailing winds.

Now, in a spring in which there is a great scarcity of field ice, the icebergs are practically unaffected by the ice field influence and are thus free to drift in the currents, which is the same as saying that they will tend to set onshore and ground. In such years, it can be appreciated, the coast line affects the behavior of icebergs to a maximum extent and deters them from drifting southward throughout the entire year instead of during only a part of the year. In a season, therefore, characterized by an absence of field ice the great indentation in the coast line of Newfoundland, between Belle Isle and Cape Bonavista, assumes a tremendous significance and acts as a huge trap in which the bergs accumulate. The entrance to the Strait of Belle Isle is also another important point where bergs are liable to be trapped. Sketch No. 3 shows the distribution of ice as the patrol found it in this region the latter part of May. The remarkable absence of icebergs south of Newfoundland this year is attributable mainly to the facts as described in the foregoing.

The 30th we returned to the vicinity of the southernmost iceberg in the Atlantic, last seen by the patrol May 26 east of Cape Bonavista, in  $48^{\circ} 42'$  north,  $51^{\circ} 32'$  west. Fog and low visibility handicapped the search to a great degree, but the berg was finally located June 3 only 16 miles  $140^{\circ}$  true from its former position, which indicates a weakness at this time in the strength of the arctic current in this region of the northern part of the Grand Bank. Another berg inshore 40 miles to the westward exhibited a similarly small drift of 3 miles per day in the same general direction. No ice was authentically located south of this latitude in the Atlantic during May, a month in which bergs are normally at a maximum.

The winds for the first part of the month were well diversified around the compass and were much lighter than those of the preceding two weeks. The second half of the month the winds were somewhat stronger and blew mostly from the southern semicircle, the latter fact being reflected in the fog scale near the end of the month. The average force for the first 15 days was 2.5, while the second half averaged 3. There were two gales with a force of 6.5 or greater, but no gales with a force of 8. We experienced 16 per cent hours of fog and 19 per cent hours of fog and low visibility. This is below the average which we have experienced during the previous three years, which averaged 22 per cent hours of fog and 33 per cent hours of fog

and low visibility. The United States Pilot Chart shows 30 to 35 per cent days of fog.

#### SUMMARY

We found variable surface currents off the east slope of the Grand Banks. Once during the month we crossed the "gully" and found no appreciable current. Surface temperatures over the Grand Banks warmed  $6^{\circ}$  during the month, and  $5^{\circ}$  in the Atlantic water south of the Tail. Ice continued to be absent from the Grand Banks region, none being south of parallel  $48^{\circ} 42'$  north; this in a month when it is normally at a maximum. It is believed the bergs found strewn along the coast between the Strait of Belle Isle and Cape Bonavista, a total of at least 75 bergs and hundreds of growlers, were trapped in those regions, and in the main explains the remarkable absence of bergs southward near the steamship tracks. The winds were variable during the first half of the month and then shifted to the prevailing southerlies, which are normal with the advance of summer. There was less fog during the month than has been found to be normal.

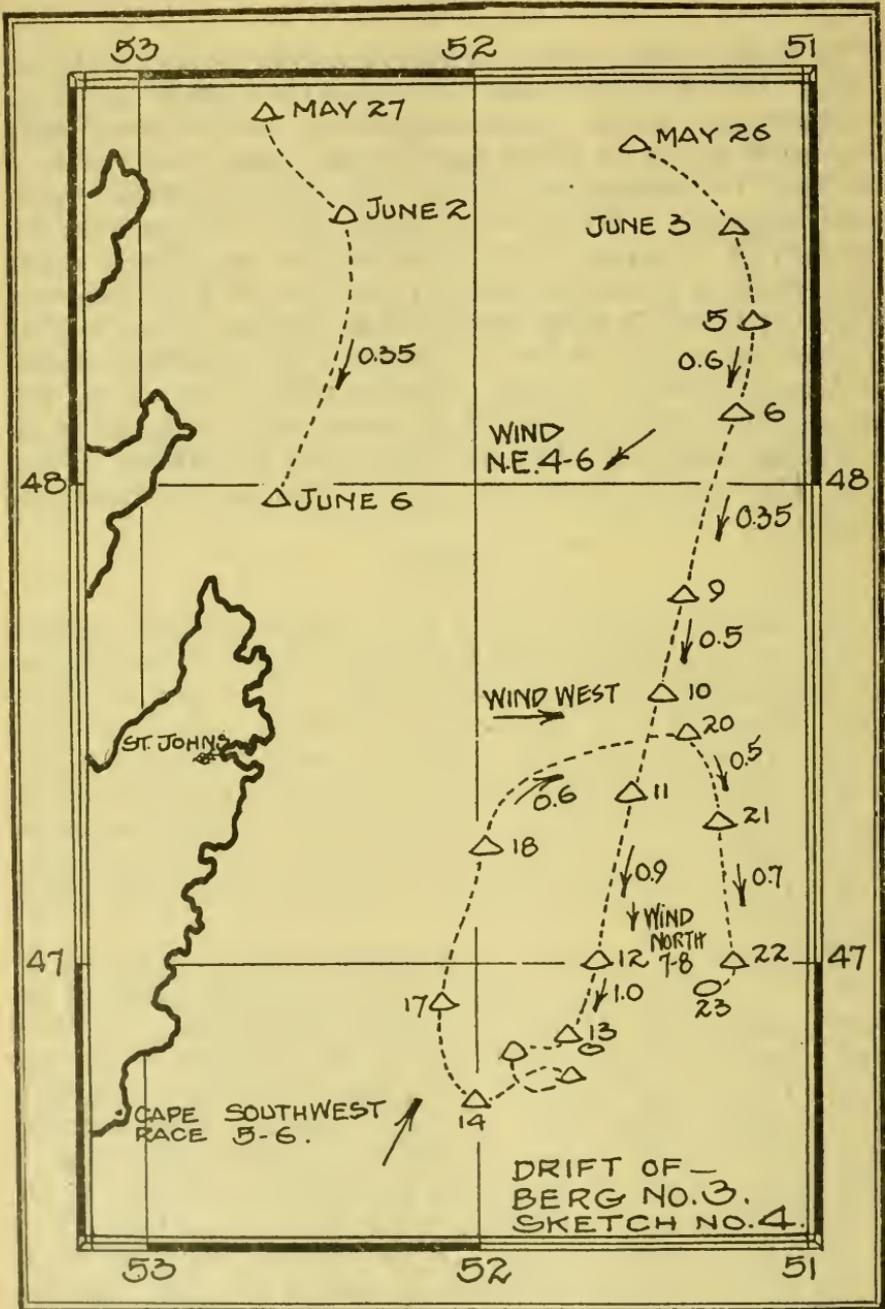
#### JUNE

The only iceberg which was in the ice regions held the attention and the presence of the patrol vessel in its locality off the east coast of Newfoundland nearly the entire month. This berg was designated as berg No. 3, and its geographical location is shown on sketch No. 4.<sup>9</sup> It melted to such proportions by the 23d instant that it no longer constituted a menace and the patrol was enabled to devote the last few days of the month to oceanographic investigation of the Grand Bank region. The currents observations for June, therefore, were all in the locality of berg No. 3, and are shown on the sketch of its drift.

Surface thermal conditions of the waters of the ice regions are shown on charts K and L for the first and second halves of the month, respectively. It will be noted that the position of the "cold wall" moved somewhat south of its limits as defined on previous charts, I, J, etc., its southern bound being in the vicinity of latitude  $40^{\circ} 45'$  north, during June. The frigid northern water which usually floods the northern part of the Grand Bank warmed from its temperature of  $39^{\circ}$  on the surface the latter part of May to  $41^{\circ}$  the first half of June and later in the month to  $43^{\circ}$ , a total rise of  $4^{\circ}$  in an interval of one month. On the southern part of the Bank, in the vicinity which has come to be regarded as a tidal reservoir, the water was warmed  $5^{\circ}$ — $45^{\circ}$  to  $50^{\circ}$  by the last few days of

<sup>9</sup> See sketch No. 4, p. 80.

June. This is the body of water which has been observed to undergo quite consistently the widest seasonal temperature range of



any water mass in the Grand Bank region. Water as warm as 70° began to put in an appearance south of the "cold wall."

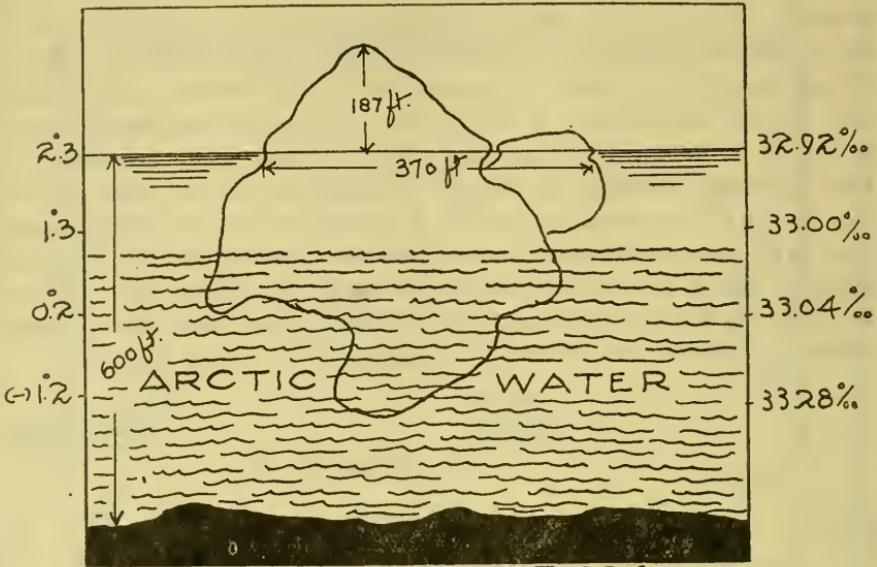
The only ice in the ice region of the western Atlantic, south of Funk Island, Newfoundland, was a total of three bergs, two of which are shown on sketch No. 4. The third berg was observed on the 7th, close inshore near Stinking Island, Newfoundland, and consequently was far removed as a possible menace to navigation. Berg No. 3 was first observed by the patrol May 26, and tracked as shown in the sketch until June 23, a period of 28 days, when it had melted to a size no larger than a ship's boat. When it was first observed it was a large bulky berg, and even on June 5 it measured 187 feet high and 370 feet in length. From May 26 to June 13 berg No. 3, it will be noted, drifted in a general southerly direction and this drift was attributed to the western branch of the Labrador current which is known to set southward past Cape Race, such a belief being further substantiated by the temperature of the water, surface to bottom, at station 474 taken near the berg June 12.

| Depth                    | Temperature | Salinity |
|--------------------------|-------------|----------|
|                          | ° C.        | ‰        |
| Surface.....             | 5.6         | 32.80    |
| 25 meters.....           | 4.4         | 32.82    |
| 75 meters.....           | 0.0         | 33.09    |
| Bottom (150 meters)..... | 0.0         | 33.52    |

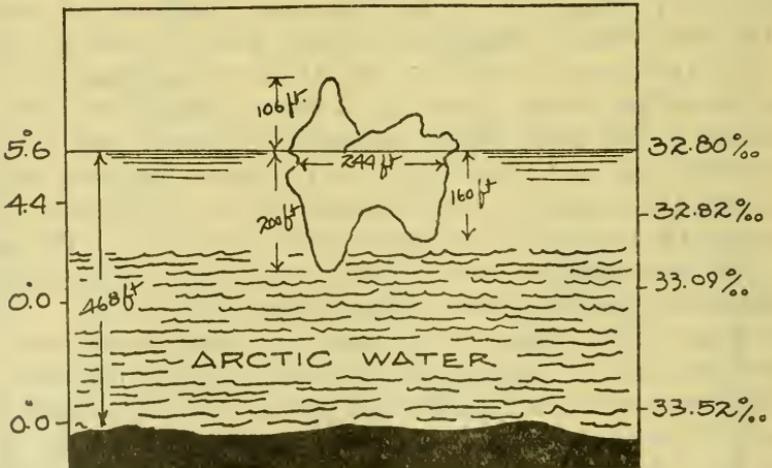
This record clearly shows that the upper 25 meters (14 fathoms) of the water was a coastal low-salinity film, expanding offshore, while in the deeper layers lay cold Arctic water whose movement was toward the south. Berg No. 3 drew at least 120 meters (66 fathoms) at this time, which conclusively indicates that its under-water body was under the control of the deeper northern currents. On June 13, however, a large quantity of ice was calved, greatly changing the form and reducing the draft of this berg. The irregular drift subsequent to June 13 can be explained as principally due to the wind, which thereafter assumed major control.

On June 18 a very interesting number of measurements were made of the berg, both as to its height and length and also its draft. The methods used to obtain the latter figures are related in detail in the report of the last cruise of the *Modoc* (p. 49). It was found that berg No. 3 possessed a pinnacle 106 feet high, but the remainder of the berg was not over 30 feet above the water. It was 244 feet long and its draft was 200 feet directly under the pinnacle, and 160 feet at another under-water peak. A sounding showed the water to be 78 fathoms in depth at this place. Sketch No. 4a, showing proportionate height, length, draft, and depth of water follows. Its foot at this date was not over 200 feet from the bottom. On June 18 berg No. 3 was classified as a typically well developed pinnacled

berg in such form as often may be observed in the later stages of disintegration. It has been stated that glacial ice floats with only one-eighth to one-ninth of its mass above the surface of the sea; but



BERG NO. 3. JUNE 5, 1924.  
UNDER CONTROL DEEP-SEATED ARCTIC CURRENT.



BERG NO. 3. JUNE 18, 1924.  
UNDER CONTROL OF WIND AND SURFACE LAYERS  
SKETCH NO. 4 (a).

since Arctic bergs are usually pinnaced, and often in their later stages of disintegration extremely so, the original proportions of one-eighth to one-ninth thus quoted does not follow with respect to height, and bergs shaped in lofty summits are shallow in draft. A

pinnacled berg, such as shown in photograph (Plate III), may be assumed to possess a draft approximately twice its height.

Bergs falling within such a category require modified statements as to the relative control of winds versus currents on their drifts. The records of the patrol<sup>10</sup> reveal that in most all cases the major control lies in the deep-seated currents and the effect of winds on bergs in the deep water south of the Tail of the Grand Bank are of an immeasurable magnitude. The drift of berg No. 3 emphasizes the need of modifying such a statement with respect to bergs which have become extremely pinnacled in the last stages of disintegration. Furthermore the extent to which the winds control the courses followed by such bergs is modified by the depth of water in which the berg floats. A berg of shallow draft will be more susceptible to winds when it is floating in shallow water than in the deeper waters offshore.

Berg No. 3 was the last one observed by the patrol for the ice season of 1924. A review of the amounts of ice show that there were a total of eight bergs in the western Atlantic during 1923, the drifts of which are shown on chart B, and after April 22 no ice was seen south of Newfoundland. This breaks all previous records as to glacial ice in the North Atlantic.

There were several strong winds from the north during the first half of June but the second 15 days the winds prevailed almost entirely from the southern semicircle. Their average force was 3.35 Beaufort scale. Four gales, strength 6.5 or more, were experienced June 1-15, but none thereafter, and at no time during the month did the wind blow with a force of 8. Corresponding with previous months of 1924, there was not so much fog during June, there being 27 per cent hours of fog and 29 per cent hours of fog and low visibility. The average found by the patrol, based on the past four years, is 44 per cent hours of fog and 53 per cent hours of fog and low visibility. The Pilot Chart for June shows 55 per cent of fog.

#### SUMMARY

Some of the noteworthy features of the season were:

1. Absence of ice.
2. Absence of fog.
3. More northerly and less southerly winds than usual.
4. Warmer water than usual over the Grand Bank region.
5. Large numbers of bergs trapped in bight of Newfoundland, between Cape Bauld and Funk Island.
6. Noteworthy variations in cold current around Atlantic faces of the Grand Banks.

<sup>10</sup> Smith, Edward H.: International Ice Observation and Ice Patrol Service. U. S. C. G. Bull. No. 11, 1923, p. 88.

7. The heart of the cold current along the eastern edge and around the Tail of the Grand Bank was  $0.6^{\circ}$  to  $1^{\circ}$  warmer than in former ice seasons.

8. Four years of records of fog kept by the patrol in the vicinity of  $43^{\circ} 00'$  north,  $50^{\circ} 00'$  west (the Tail of the Grand Bank), furnish the following average:

| Month      | Hours of fog | Hours of fog and low visibility |
|------------|--------------|---------------------------------|
| April..... | Per cent 29  | Per cent 50                     |
| May.....   | 27           | 39                              |
| June.....  | 44           | 53                              |

Although the patrol has never been in the ice regions the entire month of July, from the best estimates obtainable, there is more fog in July than in any of the previous months shown above.

Table of ice and obstructions

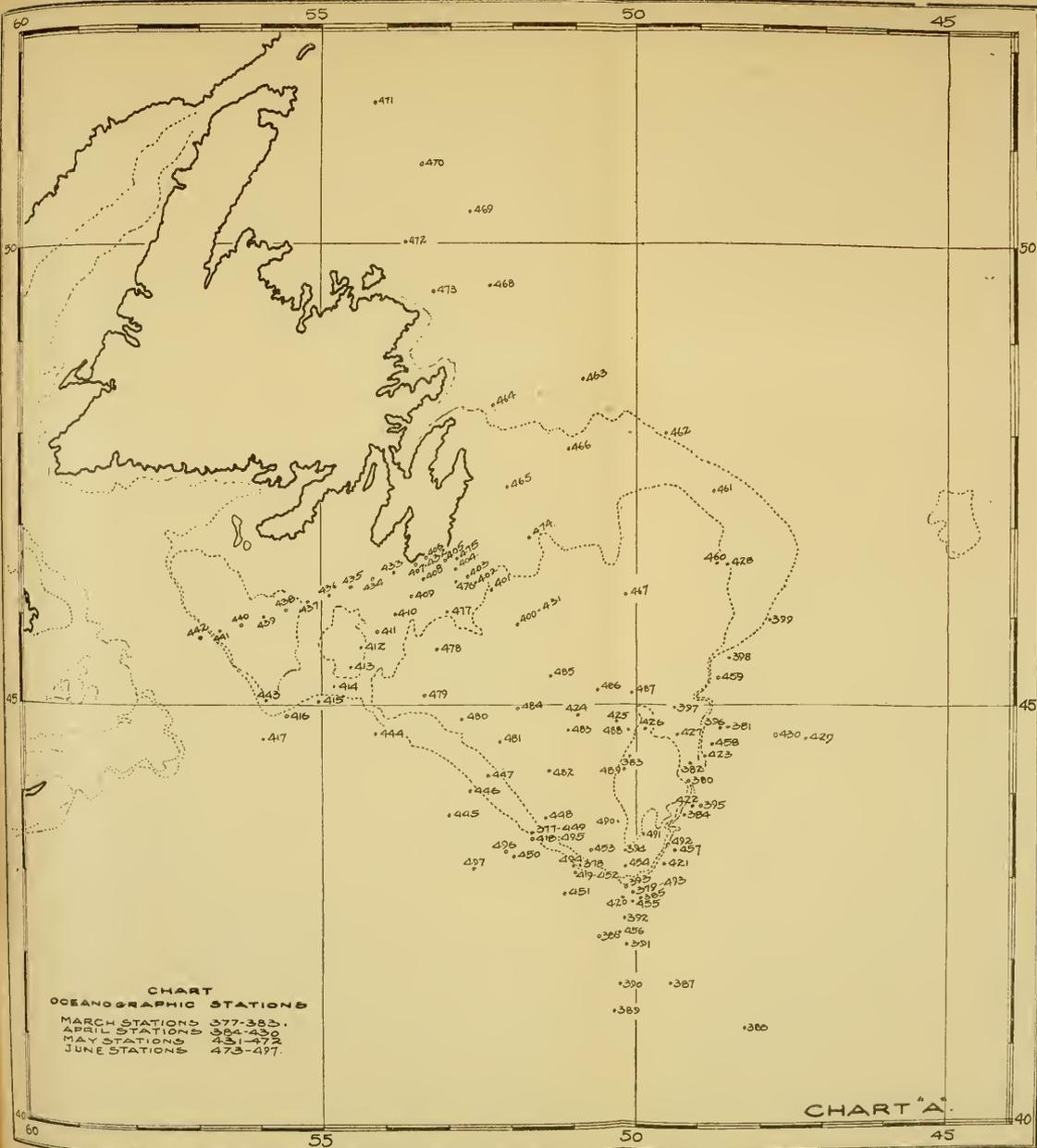
| Date    | No. | Vessel reporting | Position       |                | Nature of ice or obstruction                      |
|---------|-----|------------------|----------------|----------------|---------------------------------------------------|
|         |     |                  | Latitude north | Longitude west |                                                   |
| Jan. 14 | 1   | Cape Race.....   | 46 37          | 46 08          | Large berg.                                       |
| 18      | 2   | do.....          | 47 56          | 48 10          | Do.                                               |
| 21      | 3   | do.....          | 45 57          | 44 25          | Medium berg; same as No. 1.                       |
|         | 4   | do.....          | 45 57          | 44 35          | Large berg; probably same as No. 3.               |
| 26      | 5   | do.....          | 45 50          | 44 20          | Berg and two growlers.                            |
| Feb. 9  | 6   | do.....          | 48 20          | 49 35          | Field ice (pancake).                              |
|         | 7   | do.....          | 48 04          | 50 05          | Do.                                               |
|         |     |                  | to             | to             |                                                   |
|         |     |                  | 48 04          | 50 05          | Do.                                               |
|         |     |                  | 47 03          | 51 50          |                                                   |
|         | 8   | do.....          | to             | to             | Do.                                               |
|         |     |                  | 48 33          | 49 11          |                                                   |
| 11      | 9   | do.....          | 47 00          | 47 57          | Heavy field of ice, extending south.              |
| 12      | 10  | do.....          | 47 51          | 48 00          | Do.                                               |
| 18      | 11  | do.....          | 46 57          | 47 12          | Ice field 8 miles long.                           |
| 20      | 12  | do.....          | 46 21          | 47 12          | Ice field.                                        |
| 21      | 13  | do.....          | 46 10          | 47 20          | Do.                                               |
|         |     |                  | to             | to             |                                                   |
|         |     |                  | 46 25          | 46 45          | Small berg.                                       |
|         |     |                  | 46 02          | 47 14          |                                                   |
|         | 14  | do.....          | to             | to             | Heavy slob ice.                                   |
|         |     |                  | 48 34          | 50 00          |                                                   |
|         | 15  | do.....          | 49 15          | 49 07          | Heavy field of ice.                               |
|         |     |                  | 49 15          | 48 36          |                                                   |
| 22      | 16  | do.....          | to             | to             | Ice field to northward.                           |
|         |     |                  | 46 10          | 48 05          |                                                   |
|         |     |                  | 47 30          | 47 30          | Belt of heavy slob ice extending north and south. |
|         |     |                  | to             | to             |                                                   |
| 23      | 17  | do.....          | 44 50          | 48 20          | Medium low-lying berg.                            |
|         |     |                  | 44 33          | 49 02          |                                                   |
| 24      | 18  | do.....          | 43 38          | 49 00          | Two growlers.                                     |
| Mar. 1  | 19  | do.....          | 43 38          | 48 55          | Field ice stretching north and south.             |
|         | 20  | do.....          | 41 27          | 48 35          | Growlers.                                         |
|         |     |                  | 44 28          | 48 20          |                                                   |
|         | 21  | do.....          | to             | to             | Slob ice.                                         |
|         |     |                  | 44 27          | 48 34          |                                                   |
| 2       | 23  | do.....          | 41 01          | 48 45          | Do.                                               |
| 3       | 24  | do.....          | 45 50          | 49 06          |                                                   |

Table of ice and obstructions—Continued

| Date | No. | Vessel reporting        | Position       |                | Nature of ice or obstruction                                          |
|------|-----|-------------------------|----------------|----------------|-----------------------------------------------------------------------|
|      |     |                         | Latitude north | Longitude west |                                                                       |
| Mar. | 5   | 25 Cape Race            | 48 00          | 47 18          | Field ice and several growlers.                                       |
|      | 26  | do                      | 47 30          | 48 10          |                                                                       |
| 6    | 27  | do                      | 45 25          | 48 45          | Do.                                                                   |
|      | 27  | do                      | 45 35          | 47 30          |                                                                       |
| 12   | 28  | do                      | 42 34          | 46 47          | Large berg and growlers.                                              |
| 13   | 29  | do                      | 42 31          | 46 59          |                                                                       |
| 14   | 30  | do                      | 46 11          | 48 43          | Schooner, stumps of 2 masts, 5 fathoms above water.                   |
| 15   | 31  | do                      | 40 09          | 55 24          |                                                                       |
| 17   | 34  | Tyrifjord               | 46 13          | 48 31          | 2 bergs (same as 34) 6 miles east of St. Johns. Berg; same as No. 35. |
|      | 35  | do                      | 30 55          | 60 39          |                                                                       |
| 20   | 36  | Canadian Ranger         | 39 55          | 60 39          | Do.                                                                   |
| 25   | 37  | Lituania                | 46 19          | 48 26          | Large framework buoy.                                                 |
| 26   | 38  | Gorm                    | 46 24          | 48 32          | Berg.                                                                 |
| 27   | 39  | Patrol vessel           | 42 55          | 57 15          | Large spar floating perpendicular.                                    |
|      | 40  | West Quechee            | 45 18          | 49 36          | Large berg.                                                           |
| 29   | 41  | Patrol vessel           | 45 00          | 49 15          | Growler.                                                              |
|      | 42  | Eastern Sword           | 45 35          | 49 30          | Berg; same as No. 37.                                                 |
| 30   | 43  | Patrol vessel           | 44 31          | 49 03          | Berg; same as No. 34.                                                 |
|      | 44  | John W. Mackay          | 44 27          | 49 05          | Berg; same as No. 40.                                                 |
| Apr. | 1   | 46 Cairnvalona          | 41 24          | 34 38          | Derelict sailing vessel.                                              |
|      | 2   | 47                      | 44 19          | 49 08          | Berg; same as No. 41.                                                 |
| 4    | 48  | do                      | 45 55          | 49 11          | Berg; 445 feet long.                                                  |
|      | 49  | Sachem                  | 45 55          | 49 11          | Small patches field ice, Halifax to 60th meridian in 44° 29' north.   |
| 5    | 50  | do                      | 43 43          | 40 18          | Same as No. 43.                                                       |
|      | 51  | Vendome                 | 43 43          | 49 15          | Same as No. 46.                                                       |
| 6    | 52  | Cameronia               | 43 26          | 49 20          | Berg, drifting 192° true 0.9 knot per hour.                           |
|      | 53  | Patrol vessel           | 46 43          | 51 05          | Large berg.                                                           |
| 7    | 54  | do                      | 45 50          | 48 00          | Berg and several growlers.                                            |
|      | 55  | Coelleda                | 45 50          | 48 00          | Derelict schooner, drifting east 1.25 knots per hour; same as No. 29. |
| 8    | 56  | Patrol vessel           | 40 14          | 48 05          | Berg; same as No. 48.                                                 |
|      | 57  | Mount Clemens           | 42 34          | 50 03          | Same as No. 52.                                                       |
| 9    | 58  | Patrol vessel           | 42 35          | 50 26          | Same as No. 53.                                                       |
|      | 59  | do                      | 41 56          | 54 16          | Spar attached to wreckage.                                            |
| 10   | 60  | do                      | 42 19          | 50 37          | Berg; same as No. 54.                                                 |
|      | 61  | do                      | 46 30          | 32 40          | Jaques de Coeur, of Freecamp (barkentine).                            |
| 11   | 62  | Galtymore               | 42 03          | 50 28          | Berg; same as No. 56.                                                 |
|      | 63  | Majestic                | 41 43          | 49 36          | Berg; same as No. 58; drifting 110° true 1.5 knots per hour.          |
| 12   | 64  | Orduna                  | 41 26          | 48 34          | Berg; same as No. 59; drifting 120° true 1.8 knots per hour.          |
|      | 65  | Regina                  | 41 11          | 48 18          | Berg; same as No. 60; drifting 141° true 0.9 knot per hour.           |
| 13   | 66  | Patrol vessel           | 45 50          | 40 30          | Frying Pan gas buoy.                                                  |
|      | 67  | Stavangerfjord          | 45 00          | 35 38          | Derelict Governor Parr.                                               |
| 14   | 68  | Dromore                 | 45 54          | 32 53          | Large spar.                                                           |
|      | 69  | Cape Race               | 45 53          | 51 59          | Berg.                                                                 |
| 15   | 70  | do                      | 45 55          | 51 53          | Berg; same as No. 65.                                                 |
|      | 71  | Patrol vessel           | 43 27          | 52 15          | Small berg; same as No. 66.                                           |
| 16   | 72  | Valacia                 | 44 00          | 55 30          | Spar attached to wreckage.                                            |
|      | 73  | Cape Race               | 40 45          | 57 25          | Derelict schooner.                                                    |
| 17   | 74  | Vincent                 | 46 20          | 34 56          | Governor Parr, derelict.                                              |
|      | 75  | West Cobalt             | 43 51          | 51 46          | Wreckage; destroyed.                                                  |
| 18   | 76  | Lieutenant Jean Laurent | 44 57          | 52 00          | Small berg; same as No. 67.                                           |
|      | 77  | Saxonia                 | 40 10          | 56 07          | David C. Ritchey; derelict.                                           |
| 19   | 78  | do                      | 42 09          | 45 57          | Dead whale.                                                           |
|      | 79  | Grete                   | 45 31          | 39 01          | Spar, 50 feet long.                                                   |
| 20   | 80  | Columbus                | 46 22          | 34 46          | Derelict Governor Parr. Dismasted.                                    |
|      | 81  | Aquitania               | 46 11          | 48 57          | Berg.                                                                 |
| May  | 1   | 82 American Trader      | 46 08          | 32 00          | Do.                                                                   |
|      | 5   | 83 Barembeck            | 46 17          | 31 06          | Do.                                                                   |
| 8    | 84  | Sagaporack              | 43 15          | 38 10          | Conical spar buoy.                                                    |
|      | 85  | Speaker                 | 45 34          | 30 17          | Derelict Governor Parr.                                               |
| 9    | 86  | West Camak              | 40 24          | 47 08          | Wreckage, 40 feet long.                                               |
|      | 87  | do                      | 38 20          | 65 09          | Buoy, with staff.                                                     |
|      |     |                         | 35 57          | 51 16          | Two spars, with barnacles.                                            |

Table of ice and obstructions—Continued

| Date                    | No.                    | Vessel reporting       | Position                                     |                                                                             | Nature of ice or obstruction                             |                                                       |                        |
|-------------------------|------------------------|------------------------|----------------------------------------------|-----------------------------------------------------------------------------|----------------------------------------------------------|-------------------------------------------------------|------------------------|
|                         |                        |                        | Latitude north                               | Longitude west                                                              |                                                          |                                                       |                        |
| May                     | 10                     | 88 Cranley             | 48 42                                        | 51 12                                                                       | Narrow strip field ice.                                  |                                                       |                        |
|                         |                        | 89 Patria              | 41 16                                        | 55 51                                                                       | Derelict, 60 feet long.                                  |                                                       |                        |
|                         | 11                     | 90 General Milne       | 44 34                                        | 55 06                                                                       | Derelict, bottom up.                                     |                                                       |                        |
|                         | 12                     | 91 Tortugas            | 49 13                                        | 42 46                                                                       | Red-light gas buoy.                                      |                                                       |                        |
|                         | 14                     | 92 Salina              | 50 12                                        | 42 28                                                                       | Gas and whistling buoy No. 91.                           |                                                       |                        |
|                         | 15                     | 93 Schenectady         | 40 52                                        | 52 49                                                                       | Wreckage; same as No. 89.                                |                                                       |                        |
|                         |                        | 94 Oxonian             | 46 14                                        | 50 15                                                                       | Small berg (?).                                          |                                                       |                        |
|                         | 16                     | 95 Baltic              | 40 39                                        | 53 45                                                                       | Derelict schooner, awash.                                |                                                       |                        |
|                         | 21                     | 96 Mount Evans         | 38 39                                        | 57 08                                                                       | Timber, 30 feet long.                                    |                                                       |                        |
|                         | 22                     | 97 Arminco             | 39 15                                        | 51 00                                                                       | Red gas buoy.                                            |                                                       |                        |
|                         |                        | 98 President Roosevelt | 46 24                                        | 23 47                                                                       | Rusty mire, with prongs.                                 |                                                       |                        |
|                         | 26                     | 99 Patrol vessel       | 48 42                                        | 51 31                                                                       | Large berg.                                              |                                                       |                        |
| 100 Cape Race           |                        | 31 51                  | 53 00                                        | Conical buoy.                                                               |                                                          |                                                       |                        |
| 27                      |                        | 101 Patrol vessel      | 50 44                                        | 53 19                                                                       | Berg.                                                    |                                                       |                        |
|                         |                        | 102 do                 | 50 50                                        | 53 25                                                                       | Do.                                                      |                                                       |                        |
|                         |                        | 103 Veerhaven          | 48 47                                        | 52 37                                                                       | Do.                                                      |                                                       |                        |
|                         |                        | 104 do                 | 51 00                                        | 53 31                                                                       | Do.                                                      |                                                       |                        |
|                         |                        | 105 do                 | 51 15                                        | 54 02                                                                       | Do.                                                      |                                                       |                        |
|                         |                        | 106 do                 | 51 26                                        | 54 45                                                                       | 7 bergs and many growlers within 20 miles.               |                                                       |                        |
|                         |                        | 107 do                 | 51 02                                        | 53 59                                                                       | Berg.                                                    |                                                       |                        |
|                         |                        | 108 do                 |                                              |                                                                             | 25 bergs and growlers between Belle Isle and Cape Bauld. |                                                       |                        |
|                         |                        | 109 do                 |                                              |                                                                             | 7 bergs, grounded, east side Belle Isle.                 |                                                       |                        |
|                         |                        | 110 do                 |                                              |                                                                             | 4 bergs, grounded, west side Belle Isle.                 |                                                       |                        |
|                         | 111 do                 |                        | 48 20 51 20                                  | Berg; same as No. 99.                                                       |                                                          |                                                       |                        |
|                         | 112 Cape Race          | 45 28                  | 55 49                                        | Two masts, 20 feet above water, attached to wreckage.                       |                                                          |                                                       |                        |
| 28                      | 113 Veni               |                        |                                              | 35 bergs and field ice, Cape Bauld to Hare Bay, on coast.                   |                                                          |                                                       |                        |
|                         | 114 do                 |                        |                                              | 16 bergs and growlers, inshore at Gray Islands.                             |                                                          |                                                       |                        |
|                         | 115 do                 |                        |                                              | 4 bergs and 35 growlers, 10 miles north of Gull Island.                     |                                                          |                                                       |                        |
|                         | 116 do                 |                        |                                              | 8 bergs. Twillingate to Fogo Island.                                        |                                                          |                                                       |                        |
|                         | 30                     | 117 West Quechee       | 43 08                                        | 43 51                                                                       | Conical buoy.                                            |                                                       |                        |
|                         |                        | 118 Bayou Chico        | 43 34                                        | 37 37                                                                       | Wreckage.                                                |                                                       |                        |
|                         |                        | 119 Cape Race          | 41 07                                        | 53 45                                                                       | Drifting buoy.                                           |                                                       |                        |
|                         |                        | June                   | 1                                            | 120 Holtby                                                                  | 49 04                                                    | 53 18                                                 | Berg.                  |
|                         |                        |                        | 121 do                                       | 49 06                                                                       | 53 22                                                    | Do.                                                   |                        |
|                         |                        |                        | 2                                            | 122 Patrol vessel                                                           | 48 29                                                    | 52 23                                                 | Berg; same as No. 104. |
|                         |                        |                        | 123 Waukegan                                 | 43 47                                                                       | 51 55                                                    | Wreckage, 20 by 25 feet.                              |                        |
|                         |                        |                        | 3                                            | 124 Cymeric Queen                                                           | 48 32                                                    | 51 13                                                 | Berg; same as No. 99.  |
| 5                       |                        |                        | 125 Ala                                      | 43 50                                                                       | 43 40                                                    | Stern and side of small wooden vessel, 40 by 15 feet. |                        |
| 126 President Roosevelt |                        |                        | 46 26                                        | 30 39                                                                       | Large black can buoy.                                    |                                                       |                        |
| 127 Patrol vessel       |                        |                        | 48 21                                        | 51 10                                                                       | Berg; same as Nos. 124 and 99.                           |                                                       |                        |
| 128 do                  |                        |                        | 47 58                                        | 52 37                                                                       | Berg; same as No. 122.                                   |                                                       |                        |
| 129 do                  | 48 09                  |                        | 51 14                                        | Berg; same as No. 127.                                                      |                                                          |                                                       |                        |
| 130 Kenmore             | 49 48                  |                        | 53 22                                        | Berg.                                                                       |                                                          |                                                       |                        |
| 131 do                  | 49 48                  |                        | 53 10                                        | Do.                                                                         |                                                          |                                                       |                        |
| 7                       | 132 Patrol vessel      | 49 17                  | 53 22                                        | Do.                                                                         |                                                          |                                                       |                        |
| 9                       | 133 do                 | 47 46                  | 51 22                                        | Berg No. 3, drifting 193° 0.5 knot per hour.                                |                                                          |                                                       |                        |
| 10                      | 134 do                 | 47 36                  | 51 28                                        | Berg No. 3, drifting 201° 0.5 knot per hour.                                |                                                          |                                                       |                        |
| 11                      | 135 do                 | 47 22                  | 51 33                                        | Berg No. 3, drifting 198° 0.6 knot per hour.                                |                                                          |                                                       |                        |
| 12                      | 136 Stuttgart          | 43 57                  | 39 53                                        | Drifting raft.                                                              |                                                          |                                                       |                        |
| 137 Patrol vessel       | 47 01                  | 51 38                  | Berg No. 3, drifting 190° 0.9 knot per hour. |                                                                             |                                                          |                                                       |                        |
| 138 Avonmede            | 43 00                  | 54 45                  | Wooden hull 100 feet long, bottom up.        |                                                                             |                                                          |                                                       |                        |
| 13                      | 139 Patrol vessel      | 46 50                  | 51 45                                        | Berg No. 3; drifted 202° 4 miles in 24 hours.                               |                                                          |                                                       |                        |
| 14                      | 140 Cape Race          | 46 36                  | 51 31                                        | Two masts, attached to wreckage.                                            |                                                          |                                                       |                        |
| 14                      | 141 Patrol vessel      | 46 45                  | 51 44                                        | Berg No. 3 in eddy.                                                         |                                                          |                                                       |                        |
| 15                      | 142 do                 | 46 42                  | 52 00                                        | Berg No. 3, drifting west with east wind.                                   |                                                          |                                                       |                        |
| 16                      | 143 Kellerwald         | 39 44                  | 47 12                                        | Superstructure buoy.                                                        |                                                          |                                                       |                        |
| 18                      | 144 Patrol vessel      | 47 15                  | 51 59                                        | Berg No. 3; drifted north 30 miles in 3 days under influence of south wind. |                                                          |                                                       |                        |
| 145 Eglantine           | 40 19                  | 45 01                  | Wreckage; side of vessel.                    |                                                                             |                                                          |                                                       |                        |
| 20                      | 146 Manchester Brigade | 47 28                  | 51 22                                        | Berg No. 3; drifted 62° 0.6 knot per hour.                                  |                                                          |                                                       |                        |
| 21                      | 147 Cornish Point      | 47 17                  | 51 18                                        | Berg No. 3; drifted 163° 0.5 knot per hour.                                 |                                                          |                                                       |                        |
| 22                      | 148 Cabotin            | 47 00                  | 51 15                                        | Berg No. 3; drifted 175° 0.7 knot per hour.                                 |                                                          |                                                       |                        |
| 25                      | 149 George Washington  | 44 12                  | 37 58                                        | Half submerged portion of schooner.                                         |                                                          |                                                       |                        |
| 27                      | 150 Colleda            | 39 37                  | 53 57                                        | Log, 2 by 18 feet.                                                          |                                                          |                                                       |                        |
| 30                      | 151 Galtymore          | 39 50                  | 48 10                                        | Spar upright.                                                               |                                                          |                                                       |                        |
|                         | 152 Kurdestan          | 43 00                  | 52 15                                        | Heavy spar, attached to submerged wreckage.                                 |                                                          |                                                       |                        |

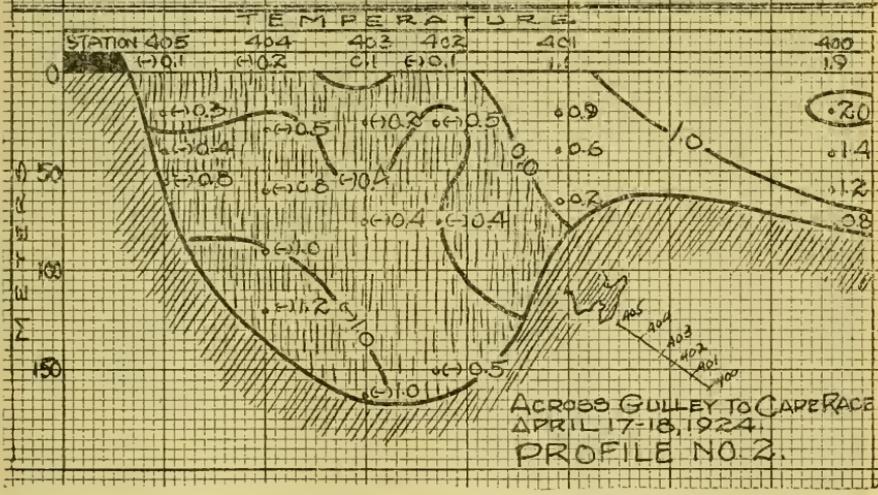
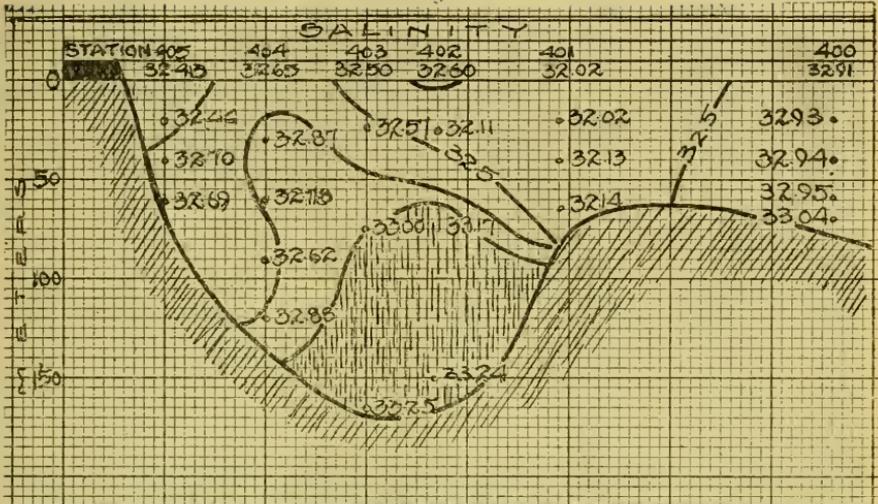




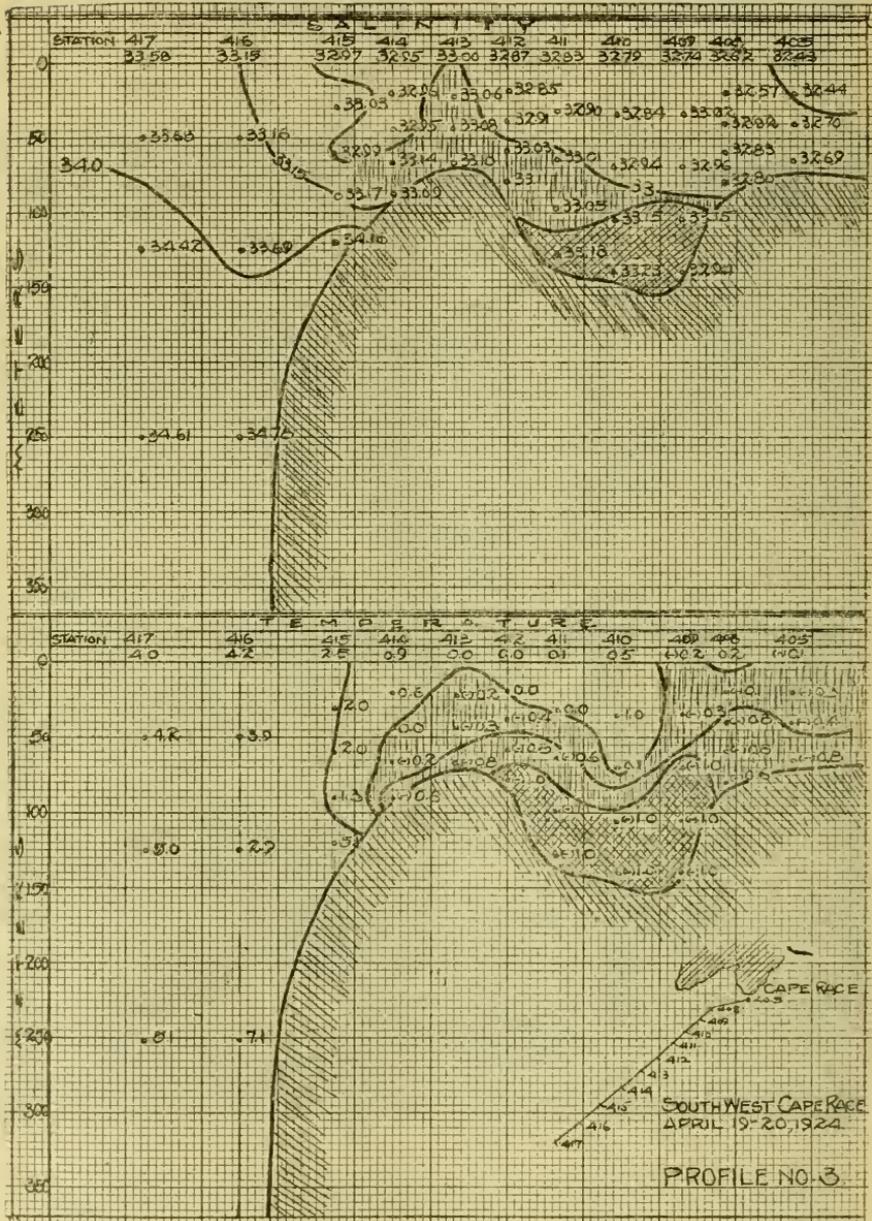
*Order of oceanographic stations, 1924*

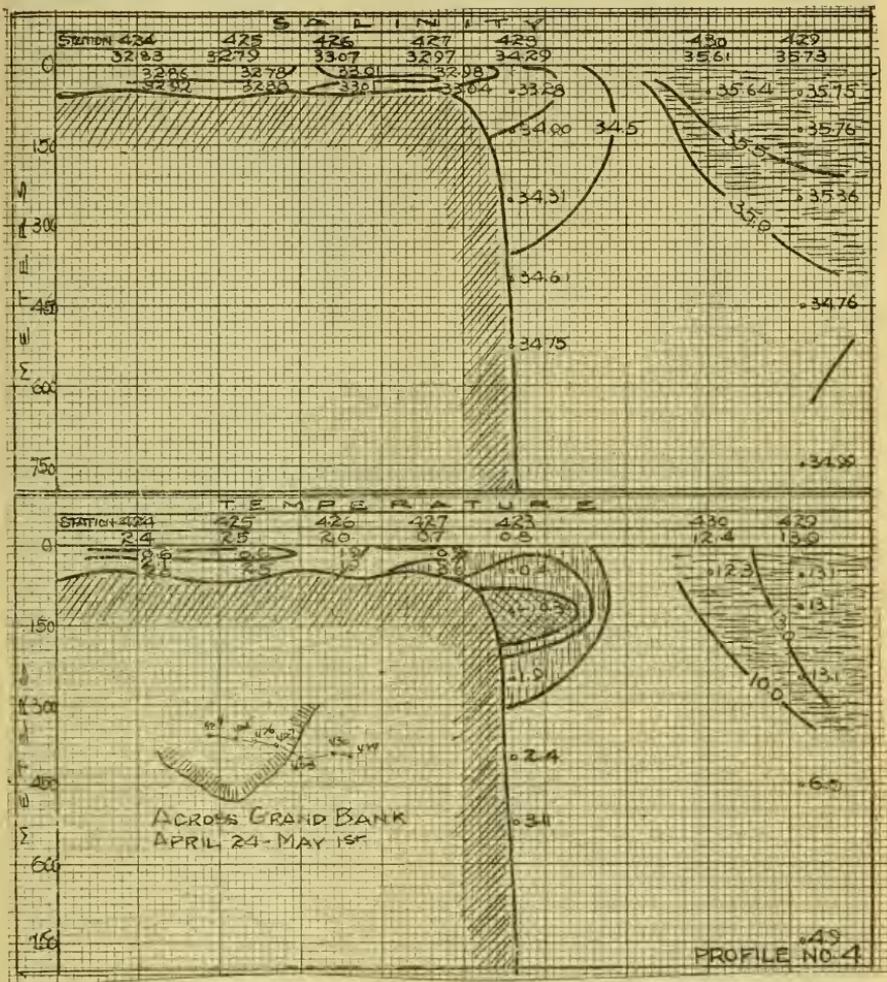
| Date           | Place                                       | Stations |
|----------------|---------------------------------------------|----------|
| Mar. 22-29     | Southwestern slope—Tail—eastern slope       | 377-382  |
| Mar. 29        | Central Grand Bank                          | 383      |
| Apr. 1-10      | Following berg No. 2 into Gulf Stream       | 384-388  |
| Apr. 13-14     | South radial                                | 389-394  |
| Apr. 14-16     | Eastern slope                               | 395-399  |
| Apr. 17-18     | Across "gulley" to Cape Race                | 400-405  |
| Apr. 18-19     | Trepassey Bay                               | 406-407  |
| Apr. 19-20     | Southwest from Cape Race                    | 408-417  |
| Apr. 23-24     | Southwestern slope—Tail—eastern slope       | 418-423  |
| Apr. 27-May 1  | Central bank, east into Atlantic            | 424-430  |
| May 2          | North bank, near "gulley" (Station No. 400) | 431      |
| May 3-4        | West-southwest from Cape Race               | 432-442  |
| May 5          | West side of Grand Bank                     | 443-444  |
| May 6-8        | Southwestern slope                          | 445-453  |
| May 8-8        | South radial                                | 454-456  |
| May 8-15       | Eastern slope                               | 457-464  |
| May 15-16      | North Grand Bank                            | 465-467  |
| May 26-27      | Funk Island to Belle Isle                   | 468-471  |
| May 29-June 12 | East coast Newfoundland                     | 472-474  |
| June 25-29     | Distributed over Grand Bank                 | 475-497  |

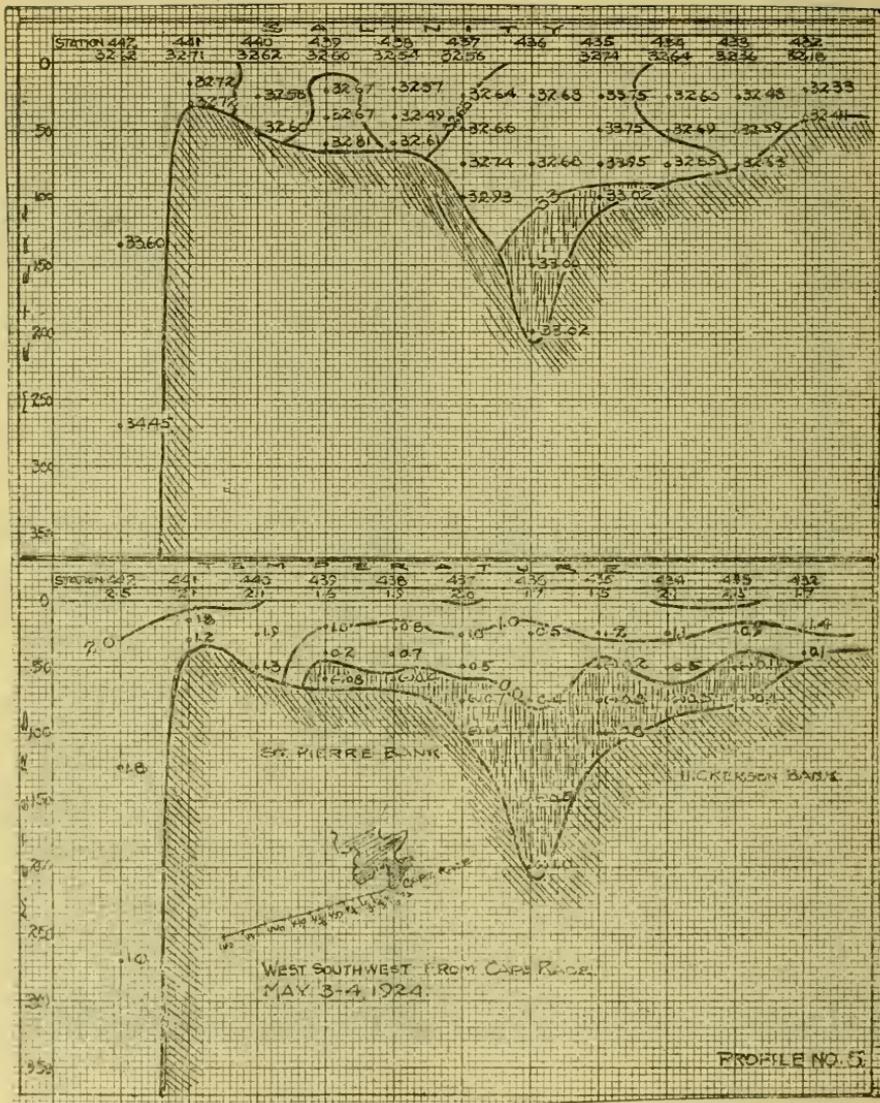


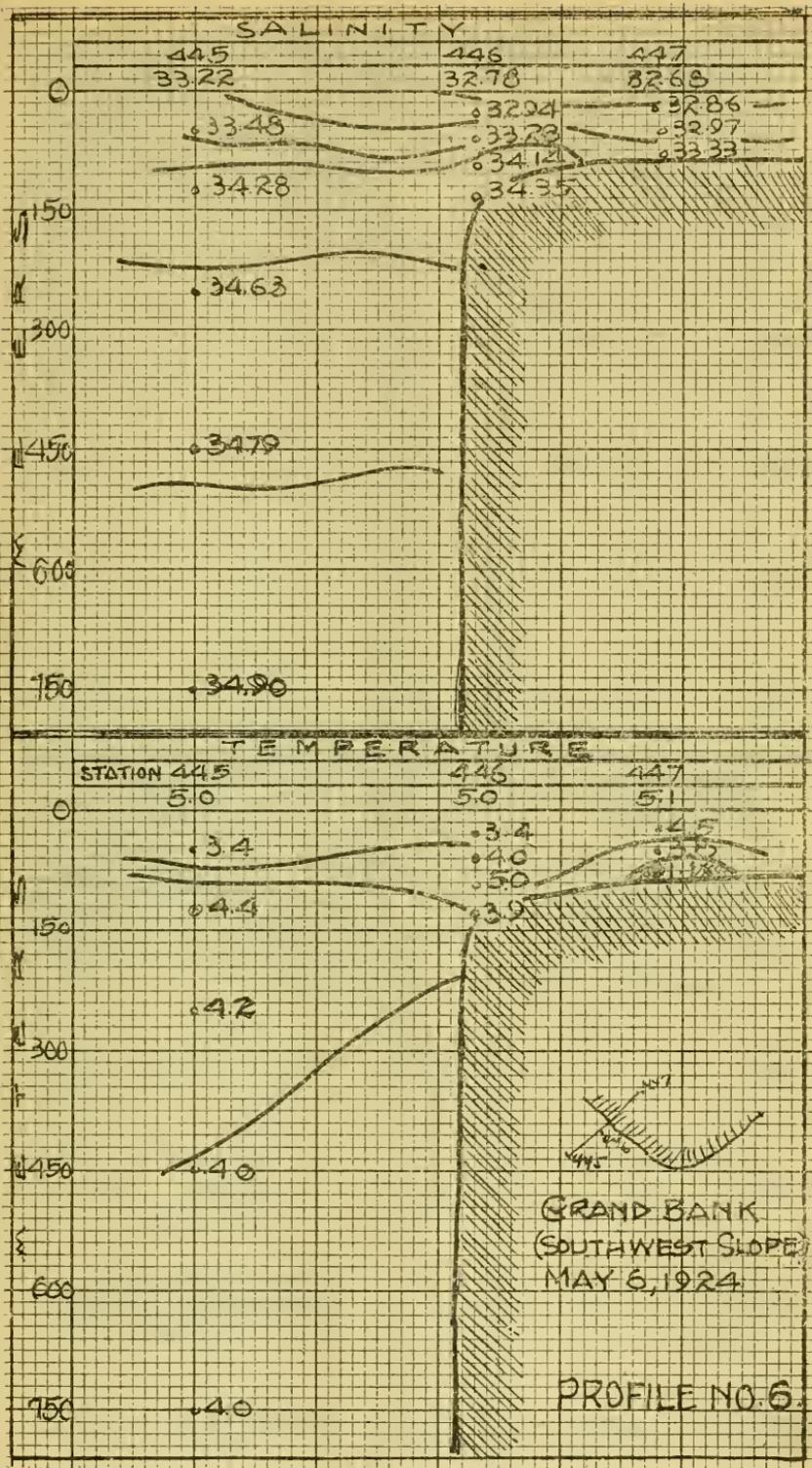


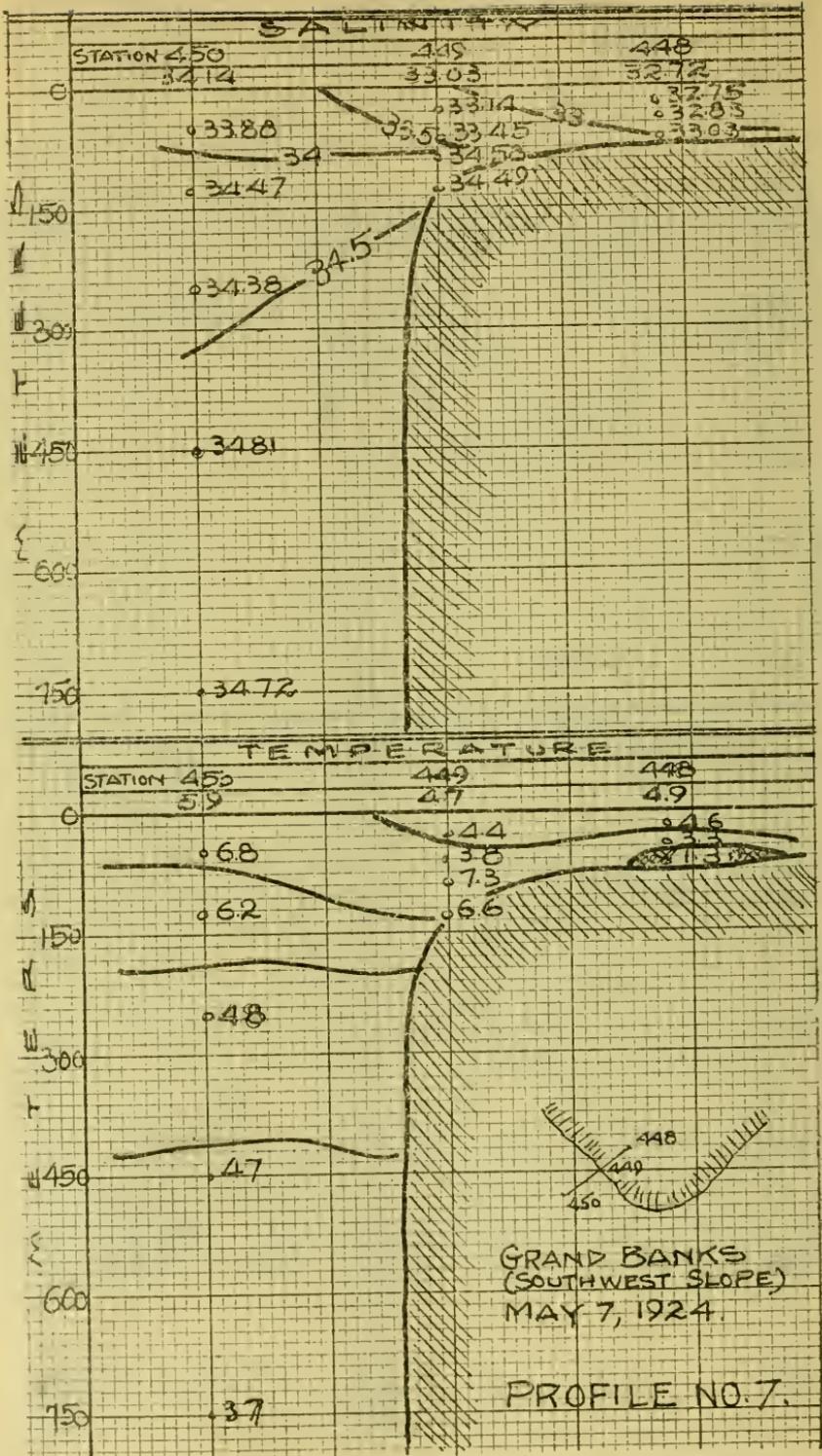
ACROSS GUILLEY TO CAPEFACE  
APRIL 17-18, 1924  
PROFILE NO. 2.

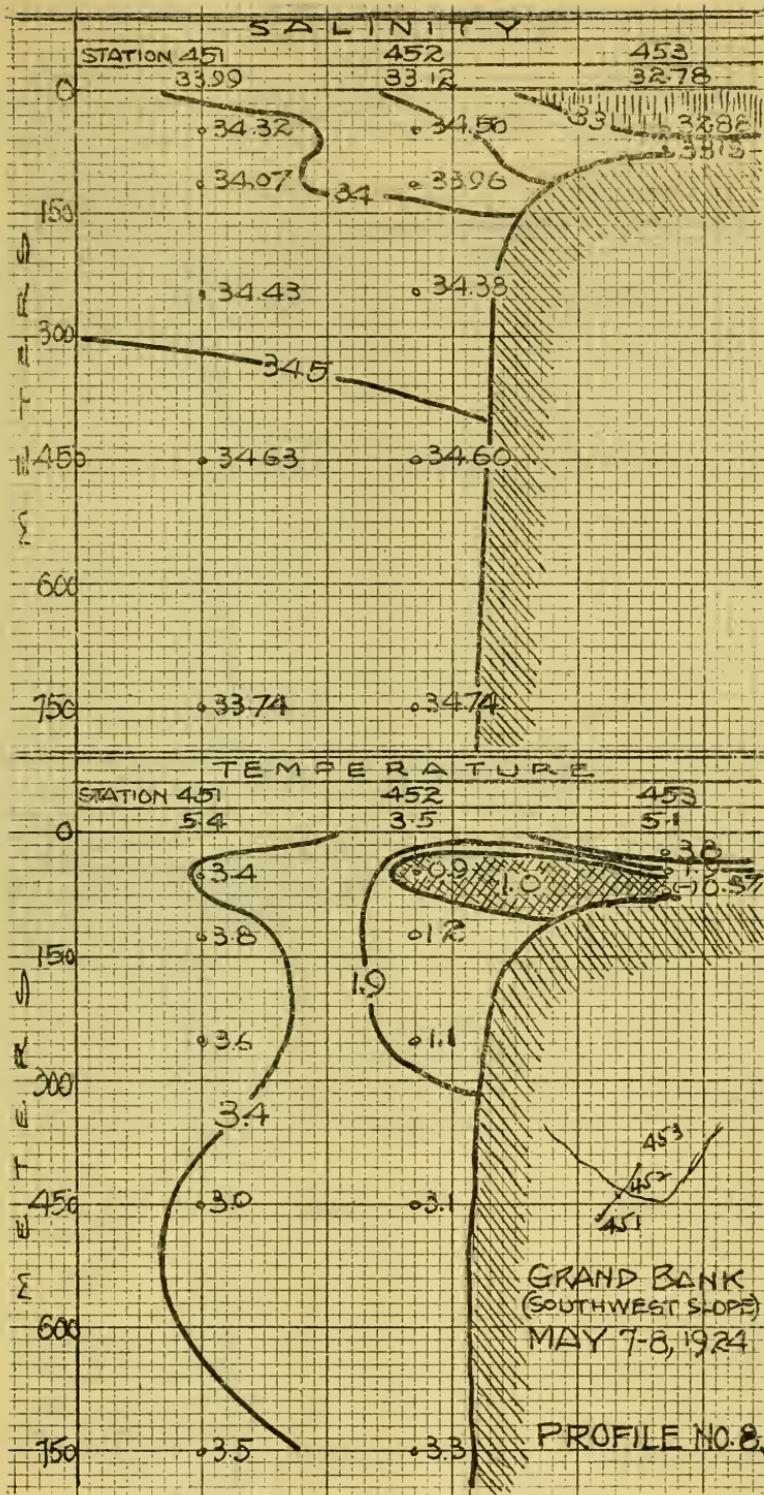


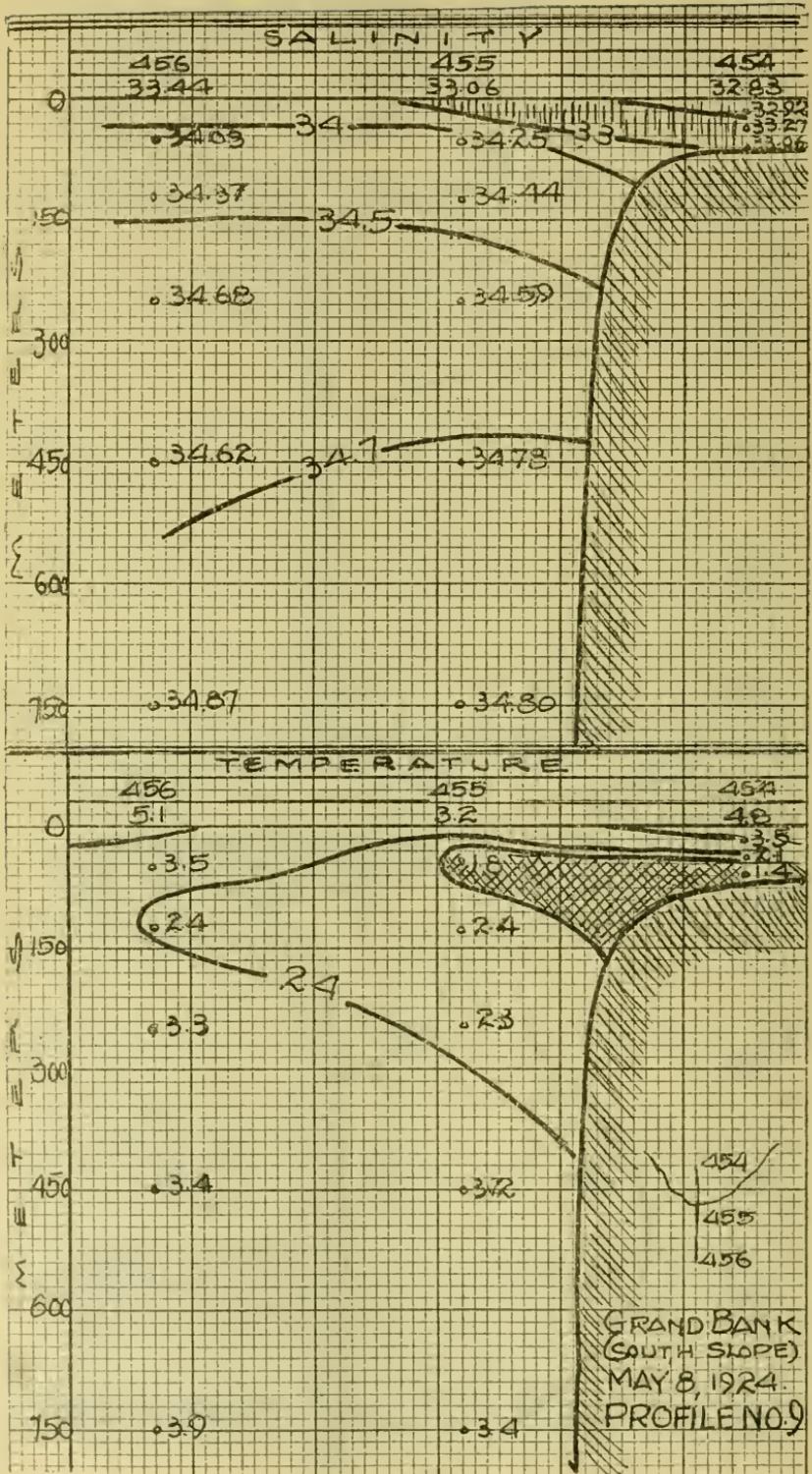


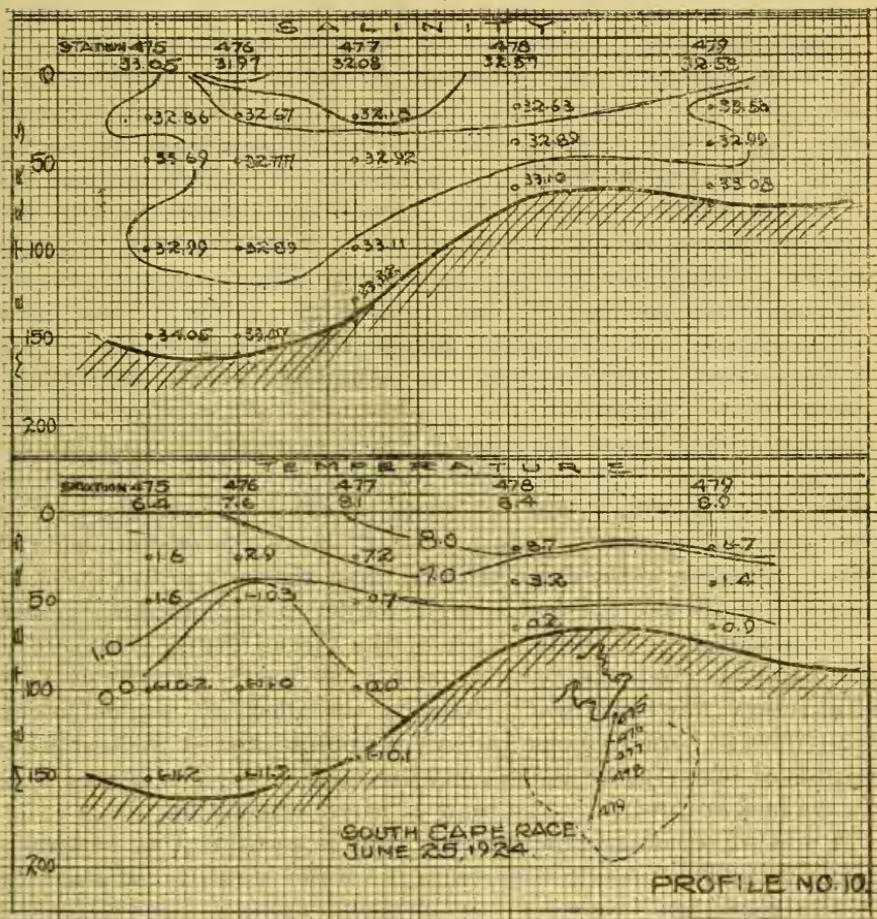












## DISCUSSION OF THE SUBSURFACE INVESTIGATION

Lieutenant Commander EDWARD H. SMITH, United States Coast Guard

Oceanographical investigation of the subsurface water of the ice regions has always been recognized as one of the most important branches of the scientific work of the ice patrol, which held hopes of some day leading us to a clear and correct knowledge of the behavior of floating ice in the North Atlantic. It is obvious that observations restricted solely to the surface do not furnish a true and complete picture of the circulation and it is only by including subsurface investigation that we can hope to obtain a correct view of the interaction between the water masses as a whole. Some years ago a program upon which this investigation should be carried out, or most nearly approximated, was formulated by the interdepartmental board charged with the administration of the patrol, and the program was pursued for several years, especially during the ice seasons of 1921, 1922, and 1923. Briefly it consists of five lines drawn so as to radiate from a central point on the southern part of the Grand Banks:  $43^{\circ} 50'$  north,  $50^{\circ} 25'$  west, the offshore ends of which terminate in the deep Atlantic water well seaward of the slope and thus cross more or less at right angles to currents long known to exist along the Atlantic faces of the Grand Bank. One radial line extends across the Bank from  $43^{\circ} 50'$  north,  $50^{\circ} 25'$  west, to Cape Race, Newfoundland. Stations, so called, are located along these lines at both frequent and critical points, and at these stations records of temperature and salinity are made at various depths from the surface downward to the limit of active circulation.

A line of oceanographic stations then is equivalent to passing a plane vertically downward through the water so as to cut a section of the water mass more or less at right angles to the continental slope. Furnished with these temperatures and salinities in a series of sections, we are able to chart the position and volume of water masses of varying character, which, for our interest in particular, is the icy current from the north. In general it has been found to flow clockwise around the Atlantic slopes of the Grand Bank and is the current which transports icebergs into menacing positions along the steamship lanes.

A large amount of data were collected during the ice season of 1922 and 1923, and the fall of 1923, in accordance with the program





of the ice patrol board as just described. Certain conclusions based on these data were published in the International Ice Observation and Ice Patrol Service Bulletin No. 11, which gives the most complete information of its kind, regarding conditions existing in the ice regions. This season, in view of the amount and type of data previously collected, it was decided that more information could be added to our ever increasing store by recourse to no set program of sections, but rather that places and events should to a great measure decide the course of investigation from time to time during the season of 1924. In a few instances lines of stations have been made, but a brief survey of the order of the oceanographical work this year will be of benefit to the reader.

March 22-31, five stations (377-382)<sup>11</sup> were occupied around the seaward face of the Grand Banks, beginning at a point on the slope 80 miles northwest of the Tail and extending up the eastern side of the Bank to parallel 44° 50' north. The stations were selected in critical positions on the edge of the Bank where normally during previous ice seasons we have found the heart of the arctic water. The first task of the ice patrol vessel arriving in the ice regions is to make a general survey of conditions by searching the area most liable to contain ice and also determining, if possible, the intensity and extent of arctic circulation by means of oceanographical observations. Stations 377-382, as will be seen later, assisted to cast light on the degree of arctic invasion in March, 1924. Station 383 was located in on the central part of the Bank. April 1-5<sup>11</sup> we took stations at intervals southward past the Tail and into warm Atlantic water as the patrol ship followed the course of berg No. 2.<sup>12</sup> Stations 389-394 constitute profile No. 1, a line running north and south of the Tail; while stations 395-399 follow northward along the eastern edge of the Bank to the forty-sixth parallel.

During the next two weeks, April 15-30, a total of 30 stations were worked, as follows: 400-405 is a section from the northern part of the Bank, running northwest across the "Gulley" to Cape Race. (See profile No. 2.) Stations 406 and 407 were located in Trepassy Bay to determine the possible presence and intensity of arctic water in that locality. We next ran a line (stations 408-417, profile No. 3) from Cape Race southwestward into the deep water of the Laurentian Channel, the purpose of which was to gain information regarding the probable distance southwest of Cape Race to which arctic water extended at this time of year. Stations 418-423 were taken April 23-24 along the southwest slope of the Grand Bank and up the east side, similar to the investigation made of these waters about a month

<sup>11</sup> When referring to stations, see "Order of oceanographic stations, 1924," pp. 86-87.

<sup>12</sup> See iceberg chart B.

earlier, the latter part of March. Information was sought as to the changes, if any, which had taken place in the size and position of the body of polar water along the eastern face of the Grand Banks. A section was next run from the central part of the Bank, near latitude  $45^{\circ} 00'$  north, eastward across the slope and offshore into the body of warm Atlantic water known to exist in that region at the time. This is shown in section on profile No. 4.

May 1-15 a total of 32 stations (431-463) were occupied as follows: 432-442 (profile No. 5), a line from Cape Race westward into the Laurentian Channel, this being inshore of profile No. 3, and taken to secure additional information as to the extent of Arctic intrusion, if any, in this locality off the south coast of Newfoundland. (See profile No. 5.) Stations 445-456 consist of short lines taken normal to the southwest slope of the Grand Bank at four equally spaced intervals from  $44^{\circ} 10'$  north,  $52^{\circ} 15'$  west, to the Tail. Stations 457-463 were occupied May 8-16, and extend northward along the eastern edge of the Bank to the east of St. Johns, Newfoundland, this being the third of the series, the two earlier ones having been taken March 29 and April 23, respectively. May 15-31 a total of 8 stations were made, 3 of which (465-467) were distributed on the northern part of the Grand Bank, while 5 were taken during a cruise of the patrol ship along the east coast of Newfoundland as far north as the Strait of Belle Isle.

May 29 station 473 was occupied, 20 miles south of Funk Island, and June 12 subsurface observations were made at station 475, east of Cape Race and near berg No. 3. June 25-29 a total of 22 stations were so distributed as to constitute a comprehensive investigation of the water mass covering the southern and western parts of the Grand Bank.

Sketch No. 5 gives a key to the order and distribution of oceanographic work carried out during the 1924 season.

#### STATIONS 377, 378, 379

The salinity and temperature of the body of water lying along the southwest slope of the Grand Bank was investigated as soon as the patrol vessel arrived in that region, March 22-23, stations 377, 378, and 379 being spaced at regular intervals from the Tail northward for a distance of 80 miles.

The coldest water found along the slope was at station 378,<sup>13</sup> it being colder than  $0^{\circ}$ <sup>14</sup> from a depth of 120 meters (66 fathoms) to a depth of 180 meters (96 fathoms). The lowest temperature at

<sup>13</sup> When referring to stations, see "Order of oceanographic stations, 1924," pp. 86-87.

<sup>14</sup> All temperatures in this chapter are centigrade unless otherwise specified.

station 377, the one farthest from the Tail, was  $0.6^{\circ}$ , which lay between 50 and 100 meters (27 and 55 fathoms) below the surface, while the coldest water at the Tail of the Bank on March 23 lay on the surface,  $-0.1^{\circ}$ . The water column at both stations 377 and 378, northwest of the Tail, was warmer on the surface than in the intermediate layers, these latter being the coldest of the column; and in the case of station 378 such layers were colder than  $0^{\circ}$ . The bottom water lying near the slope itself was in all cases the warmest water of the column, except at station 377 where, at a depth of 150 meters (82 fathoms), we encountered the surprisingly high temperature of  $5.3^{\circ}$ . But the striking feature of the temperature records



was the body of water in the mid depths at station 378, which was colder than the water on either side of it along the slope.

We found the freshest water on the southwestern slope at station 378, about 40 miles from the Tail, which position corresponds with the distribution of the coldest water along the slope. Also the freshest water in the column at 378, like the coldest layer, was found between the 120–180-meter (66–98-fathom) depths. The saltiest water,  $34.46 \text{ ‰}$ , lay on the bottom at the Tail, which corresponds in position with the warmest water on the slope, except for the 150-meter (82-fathom) depth at station 377, the farthest to the northwest, which registered  $5.3^{\circ}$  and a salinity of  $34.19 \text{ ‰}$ .

This water, at 150 meters (82 fathoms), station 377, was warmer than the local water lying on the bank to the northward (station 388,  $2.8^{\circ}$ – $2.35^{\circ}$  and  $32.84$ – $32.80$  ‰) and it was saltier than indigenous slope water— $32.98$ – $33.80$  ‰. To be so warm and so saline such water must have had an offshore connection, from which direction the warm and salty intrusions took place. The temperature of the saltiest water at the Tail,  $2.3^{\circ}$ – $2.5^{\circ}$ , and  $34.46$ – $34.69$  ‰ in the deeper layers on the other hand is too cool for the warm offshore Atlantic and too warm for Arctic origin, but, by virtue of both temperature and salinity, is precisely of the character classified as inactive, indigenous slope water.

The temperature stratification at stations 378, and to a less marked degree at station 377 to the northwestward, however, is typical of arctic water.<sup>15</sup> The minimum temperature below the surface is often a sign by which we may detect the presence of water of arctic character, even when such a mass has been transported considerable distances and admixture with other water masses of dissimilar character, such as coastal and Atlantic, has taken place. In contrast to the polar tinges along the slope was the water at the Tail, which grew steadily warmer, reaching a maximum of  $3.1^{\circ}$  as we lowered the thermometers close to the bottom.

The lowest temperatures found along the southwest slope,  $0.6^{\circ}$ ,  $-0.4^{\circ}$ , and  $-0.1^{\circ}$ , do not readily fall within the temperature criteria that has been held to characterize more or less unadulterated water from the far north. Such water, transported southward to the Tail and along the southwest slope at this time in previous years, has been found most often to possess a minimum temperature at least as low as  $-1^{\circ}$ . But the relatively higher than normal seasonal temperatures found along the southwest slope, March 22–23, do not necessarily signify a scarcity of arctic water. On the other hand, it may be present but less recognizable, due to warming indirectly because of the widespread mildness of the 1923–24 winter and the absence of ice, all of which certainly were responsible for warmer than normal surface layers of the ocean in the spring of 1924. In fact, the lowest temperatures,  $0.6^{\circ}$ ,  $-0.4^{\circ}$ , and  $-0.1^{\circ}$ , found along the southwest slope, March 22–23, show slight change from those found at the same places the previous October,  $-0.4^{\circ}$ ,  $1^{\circ}$ , and  $-0.25^{\circ}$ .<sup>16</sup> The temperature of the surface water lying over the continental shelf south of Newfoundland was  $5^{\circ}$ – $7^{\circ}$  warmer than usual the spring of 1924<sup>17</sup> and it is logical to assume that any northern water discharged

<sup>15</sup> Mathews, D. J.: Report on the work carried out by the steamer *Scotia*, 1913, 1914. P. 16.

<sup>16</sup> Smith, Edward H.: International Ice Observation and Ice Patrol Service. U. S. C. G. Bull. No. 11, pp. 151–164.

<sup>17</sup> See Oceanographer's report, March, p. 69.

into this area would also have been warmed to a correspondingly higher degree through mixture with it. As we remarked in discussing the observations of 1923,<sup>18</sup> it is necessary to apply different standards of temperature criteria in the autumn than in the spring, for the former period inherits the heat absorbed from an entire summer's sun, while the latter is just emerging from a winter's chilling, and, just as true, it is necessary to apply modified temperature criteria in a spring following a winter characterized by relatively high temperatures and a marked absence of ice.

Another method of identification of arctic water around the Tail of the Grand Bank at this period is to compare the temperature of the water mass which is questionable with the normal winter minimum temperatures of the surface layers lying over the central part of the Grand Bank, a region which most nearly approaches that of a tidal reservoir and is most free, of all localities, from external intrusions. The average normal winter minimum for the central Bank region is  $0^{\circ}$  to  $-0.5^{\circ}$ ;<sup>19</sup> but at the end of the 1923-24 winter it was  $2.3^{\circ}$ . Therefore, wherever we encountered water around the Tail of the Bank during 1924 whose temperature was below  $2.35^{\circ}$  we inferred that such water was not cooled locally, but necessarily must have been transported to that place from a northern source.

The fact that the water at the Tail, identified as Arctic in origin, was less pronounced in temperature character and of less volume than the body of northern water bathing the slope to the northwestward, it being restricted to a relatively shallow surface layer only 100 meters (55 fathoms) in thickness at the Tail, led to the conclusion that the rate of flow of the icy current around the Tail had shrunk from its size attained some time prior to March 23, the date of the investigation. This conclusion is based upon the assumption that the trunk of the cold current flows clockwise around the Atlantic faces of the Grand Bank and not across it.<sup>20 21</sup> The tendency of arctic water to pool along the southwest slope, or become pinched off from the main supply, has often been noted.<sup>22</sup>

#### SUMMARY

A pool of unmistakable Arctic water lay on the southwest slope of the Grand Bank 40 miles west of the Tail on March 22-23. It ex-

<sup>18</sup> Smith, Edward H.: International Ice Observation and Ice Patrol Service, U. S. C. G. Bull. No. 11, p. 160.

<sup>19</sup> Smith, Edward H.: International Ice Observation and Ice Patrol Service, U. S. C. G. Bull. No. 11, 1923, p. 148.

<sup>20</sup> Smith, Edward H.: International Ice Observation and Ice Patrol Service, U. S. C. G. Bull. No. 10, 1922, p. 88.

<sup>21</sup> Smith, Edward H.: International Ice Observation and Ice Patrol Service, U. S. C. G. Bull. No. 11, 1923, p. 114.

<sup>22</sup> Smith, Edward H.: International Ice Observation and Ice Patrol Service, U. S. C. G. Bull. No. 11, 1923, p. 145.

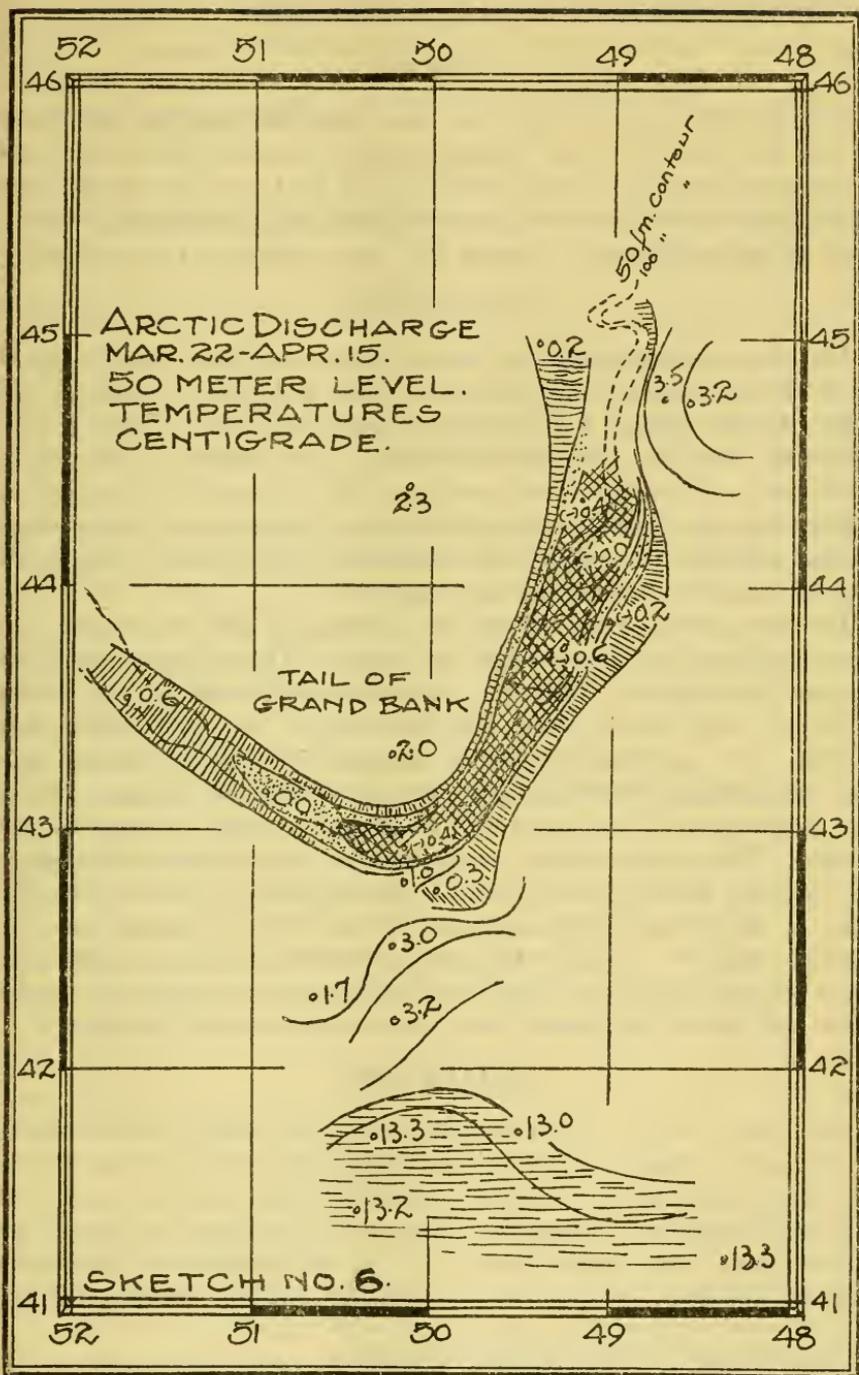
tended northwestward for a total distance of 80 miles from the Tail, at which place it was being engulfed by warm, salty, Atlantic water which intruded inshore at the 150-meter (82-fathom) depth.

The pool of icy water which rested on the southwest slope was connected to a shallow surface layer 100 meters (55 fathoms) thick, of similar character, but less plainly identified at the Tail. The supply of northern water to the Tail had suffered a shrinkage from its rate of flow, some time previous to March 23. The volume of polar water found along the southwest slope March 22-23 corresponded very closely with that found there October last.

A dwindling in the flow may have isolated patches of polar water, which have been freighted here during a flood period. Such icy pools left along the southwest slope become engulfed and finally absorbed by the warmer Atlantic water. In the deeper layers such arctic relics appear to work westward more or less, following around the continental edge, as evidenced by the records, which sometimes show extreme westerly drifts to bergs in the oceanic triangle west of the Grand Bank.

#### STATIONS 380, 381, AND 382

Finding no ice along the southwest slope or around the Tail, the patrol vessel cruised northward along the east side of the Bank, and stations 380, 381, and 382 were taken March 25-29. Stations 380 and 382 are both about 80 miles north of the Tail, 380 being located exactly on the continental edge, the steepest part of the slope upon which the axis of the icy current has been found to flow. Station 382 was only 18 miles northward of 380, in approximately the same relative position to the edge of the Bank. As might be expected the two stations correspond with respect to temperature and salinity. The temperatures at station 380 of  $-0.2^{\circ}$ — $-1^{\circ}$ , surface to bottom, and  $32.97$ — $33.25$  ‰ unquestionably designate this column of water as arctic in origin. But station 381, located 40 miles north of here and only 17 miles offshore of the edge, revealed some quite different records. The temperature of the surface water,  $2.8^{\circ}$ , was no colder than the water to the westward, in on the Bank (see station 383, p. 106), which, being free from external intrusions, registered solely local winter cooling. Below the surface downward to the limit of investigation the water was warmer than  $2.8^{\circ}$ , so we can confidently state that no arctic influence was felt at this station, only 17 miles offshore of the edge. The salinity of  $33.73$  ‰ on the surface, which increased to  $34.88$  ‰ at 450 meters (247 fathoms), classified this as slope water, a designation which is in accord with the temperatures; but there was a suggestion, in the salinities of  $34.86$ — $34.88$  ‰, of salty



Atlantic water not far offshore. Such a claim also was supported by the surface observations made in this locality.<sup>23</sup>

#### SUMMARY

March 25-29, pure Arctic water was found bathing the east slope of the bank between the 70-meter and 110-meter (38-fathom and 60-fathom) depth, 85 miles north of the Tail. It lay on the edge of the Bank in the form of a narrow band, with its influence not felt even 17 miles offshore, at station 381, thirty miles to the northward.

#### STATION 383

March 29 investigated the water column of the south central part of the Grand Bank (station 383), a locality which of all others in the Grand Bank region is most free from external disturbances (except from the westward), and thereby most nearly conforms to a closed tidal reservoir. It is true this locality is susceptible sometimes to irregular bottom intrusion of arctic water but its persistency to efface such intermittent Arctic traces fully justifies the character identification "local."

The temperatures of  $2.8^{\circ}$  on the surface to  $2.3^{\circ}$  on the bottom were too high for water from the north. The salinities of 32.84 ‰ on the surface to 32.779 ‰ on the bottom were also too fresh to accord with polar water, but classified it as pure Banks and coastal. The uniformity of the temperatures and salinities, surface to bottom, reflected a most complete state of mixing, which in a large measure was the result of an entire winter's convectional cooling. The water column, which lay over the central bank region, was warmer March 29 than any of which there is previous record.<sup>24</sup> This is attributed to the mildness of the 1923-24 winter and the absence of ice.<sup>25</sup> Consideration of the autumn records of 1923 and those secured March 29, 1924, justified the statement that no Arctic water had flooded the central bank region the winter of 1923-24.

#### STATION 384

On April 1, when 55 miles north of the Tail and 5 miles offshore of the eastern edge of the Bank, near berg No. 2,<sup>26</sup> we occupied station 384. Berg No. 2 was near by, drifting south at the rate of 0.9 knot per hour. The upper 125 meters (68 fathoms) of water was colder than  $0^{\circ}$  and fresher than 33.33 ‰, while below this depth the temperature rose abruptly to  $3.4^{\circ}$  and the salinity increased from

<sup>23</sup> See Oceanographer's report, March, 1923, p. 70.

<sup>24</sup> Smith, Edward H.: International Ice Observation and Ice Patrol Service, U. S. C. G. Bull. No. 11, 1923, p. 148.

<sup>25</sup> See Oceanographer's report, March, 1924, p. 67.

<sup>26</sup> See iceberg chart B.

34.392 ‰ at 250 meters (137 fathoms) to 34.79 ‰ at 750 meters (410 fathoms). Based on the criteria described on page 103, the upper 125 meters (68 fathoms) was flooded by Arctic water, but not below 250 meters (137 fathoms), where an abrupt change to warmer and saltier water took place.

#### STATION 385

It will be recalled that comparatively little northern water, confined to the upper 100 meters (55 fathoms), was found at the Tail station 379, on March 23.<sup>27</sup> When we took station 385, April 4, only 5 miles southeast of station 379, in 600 fathoms of water, on the slope, berg No. 2 was close by, drifting southwestward at the rate of 0.35 knot per hour, which is most direct evidence of an arctic discharge.

Cold water with a temperature of 0.2° to 1.4°, flooded the surface layers to a depth of 125 meters (68 fathoms). Such temperatures while according with a northern source are higher than the normal average of those found in the heart of the Labrador Current during previous ice seasons, or even at this time farther north along the east side of the Bank.<sup>28</sup> This indicates an arctic influence and mixture at station 385 as distinguished from the main unadulterated body which lay northward on the continental edge. Below 125 meters (68 fathoms) all traces of northern temperatures disappeared, being replaced in the deeper layers by water warmer than 2.3°, which was sufficient to identify this body as slope water.

The surface layers to a depth of 125 meters (68 fathoms) were fresher than 33.25 ‰, but from 250 meters (137 fathoms) to the limit of investigation the water was considerably saltier, 34.42–34.24 ‰. This corresponded to the distribution of temperature. Cold fresh layers spread over warmer saltier water. But the most significant event in connection with the shallow surface layers of northern complexion off the Tail was the presence of an iceberg which was drifting southward in this water. Although berg No. 2 had emerged from pure Arctic water and floated in the zone of mixed water which lay close inshore to the slope, it continued to drift southward with no appreciable reduction of rate.

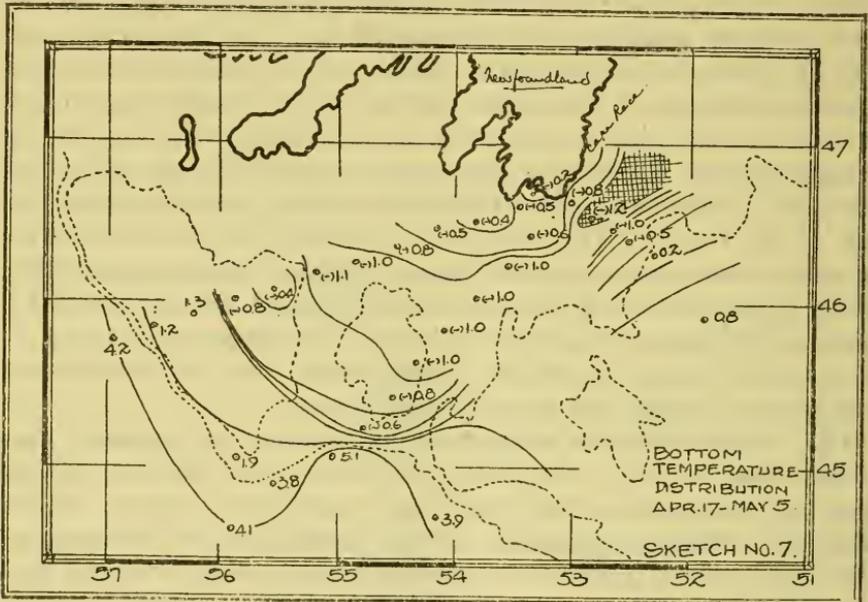
#### STATIONS 386, 387, AND 388

These three stations were taken April 6–10 as the patrol followed berg No. 2 in its southward drift. The northernmost one, station 386, was located 50 miles, 212° true from 43° 00' north, 50° 00' west, the Tail of the Bank. The temperatures, although relatively high, show the stratification which is so characteristic of water from the

<sup>27</sup> See discussion of station 379, p. 102.

<sup>28</sup> See records of  $-1^{\circ}$  at station 380 and  $-0.5^{\circ}$  at station 382.

far North, a minimum lay at 50 meters (27 fathoms) below the surface. The surface layers, also, to a depth of 100 meters (55 fathoms), were fresher than at the greater depths, and their salinity of 33.37–33.64 ‰ easily accords with the conclusions reached regarding the temperatures. The data gathered at station 386 reveal the distance which traces of arctic water may attain in a southwesterly direction from the Tail before their identity is completely effaced through mixing with the offshore Atlantic. April 6–10 there was a southwesterly flow to this water mass, as proved by berg No. 2, which floated within it, drifting southwest at the rate of 0.5 knot per hour. Station 378 was taken April 8 close aboard berg No. 2 which by that



date had been swung to the left and was drifting in a general southeasterly direction. At station 387 warm water, 13.9° to 12.4°, lay to a depth of 450 meters (247 fathoms). Abyssal water, 4.2°, was found at 750 meters (410 fathoms), and salty water, 35.79–34.92 ‰ extended from the surface to the depth of investigation.

This mass was warmer and saltier than water indigenous to these latitudes. It corresponds to water of tropical origin and from previous observations in these regions south of the Grand Bank it was recognized as water associated with the Gulf Stream. All Arctic traces had completely disappeared and berg No. 2 floated amidst tropical surroundings.

Station 388 was taken April 10, near berg No. 2. The temperature and salinities, although not so high as those at 387, showed that the

water was warm and salt enough to receive a tropical classification. It was in this locality that we witnessed the final melting of berg No. 2.

#### PROFILE NO. 1—STATIONS 389-394

The section was taken April 13-14 on the return of the patrol vessel northward to the Tail of the Bank.

*Salinity.*—Water saltier than 35.00 ‰ flooded the offshore stations 389 and 390. Water between 35.00 ‰ and 34.00 ‰ lay in the mid-zone, while a fresher mass bathed the steep part of the slope. The fresher water found, less than 33.00 ‰, flooded all depths right out to the edge of the Bank.

*Temperature.*—A body of water warmer than 10° flooded the upper water layers to a depth of 250 meters (137 fathoms); its northern bound was a sheer face just inshore of station 390. This body to be so warm and salty must be classified with water belonging to the Gulf Stream.<sup>29</sup> The coldest water lay on the continental edge to a depth of 150 meters (82 fathoms) but did not extend offshore or inshore over 18 miles. The intermediate zone, off the shelf, was very uniform in temperature, 3°-4° from surface to bottom, except at station 391—125 meters (68 fathoms)—where a core of cooler water, 2.7°, lay. Later this was found to be part of the main body of frigid water on the slope, which recurled in tonguelike form. The frigid water on the edge of the Bank was similar in temperature and salinity to that identified there March 22-23 as arctic in origin. A comparison between stations 379 and 393 as to relative amounts of arctic water on the slope reveals that an increase had occurred between March 23 and April 14.

A comparison between the Bank stations 394 and 383, although separated by two weeks, possessed the same general character which is evidence that a single large water mass, free from recent external intrusions had prevailed over this region of the Grand Bank in all depths.

#### STATIONS 395-399

These stations were taken along the eastern edge of the Grand Bank, where normally the heart of the south-flowing icy water is found. Station 395, taken April 14, 12 miles northeast of 384, shows little change to have taken place in the salinity or the temperature during the interval of two weeks. Arctic water with a minimum

<sup>29</sup> Smith, Edward H.: International Ice Observation and Ice Patrol Service. U. S. C. G. Bull. No. 11, 1923, p. 114. "Its northern face presented a nearly vertical temperature boundary, a phenomenon which is characteristic of late winter and early spring, when convector circulation has attained its maximum influence."

temperature of  $-1.3^{\circ}$  and a salinity of  $33.21$  ‰ at 100 meters (55 fathoms) depth flooded this place on the slope.

Station 396 was occupied April 15 at a point on the slope 5 miles inshore of station 381, which had been located there three weeks earlier. It will be recalled that no signs of northern water were discovered at station 381, only 17 miles seaward of the edge of the Bank and it was further surprising to find, at station 396, no water colder than  $3^{\circ}$ , the temperature of local water as a result of the 1923-24 winter's chilling. The freshest water,  $33.77$  ‰, was found on the surface, while the greater depths were flooded by a mass saltier than  $34.46$  ‰, all of which substantiates evidence that there was no arctic water at this place on the slope.

But at station 397, taken 19 miles inshore of the edge of the Bank in this latitude, the temperature of the surface water fell from  $1^{\circ}$  to a minimum of  $0^{\circ}$  at 15 meters (8 fathoms), and then rose slightly to  $0.2^{\circ}$  on the bottom. It was  $32.91$  ‰ on the surface and  $32.98$  ‰ on the bottom which is  $0.10$  to  $0.20$  ‰ saltier than the water which lay over the Bank at station 383, about 45 miles to the southward, and 23 miles farther inshore.

The patrol continued northward, skirting the continental edge, and took stations 398 and 399 at regular intervals as far as the forty-sixth parallel. A subsurface temperature minimum of  $0.4^{\circ}$  was recorded 42 meters (23 fathoms) below the surface at station 398, and a surface layer of 106 meters (58 fathoms) in thickness contained water fresher than  $34.00$  ‰. The coldest water found at station 399 was on the surface,  $0.7^{\circ}$ , which, besides being warmer than that at 398, was also slightly saltier, although located the same distance, 4 to 5 miles, offshore of the 100-fathom contour. The salinities of these two stations satisfy arctic qualifications, but the temperatures are too high to accord with those purely Arctic, yet are too low to be local. Considerable mixing and dissipation took place at station 398, but in spite of this the temperature stratification proves that a large proportion of the mixture was originally from the far North.

The outstanding features of the subsurface investigation were:

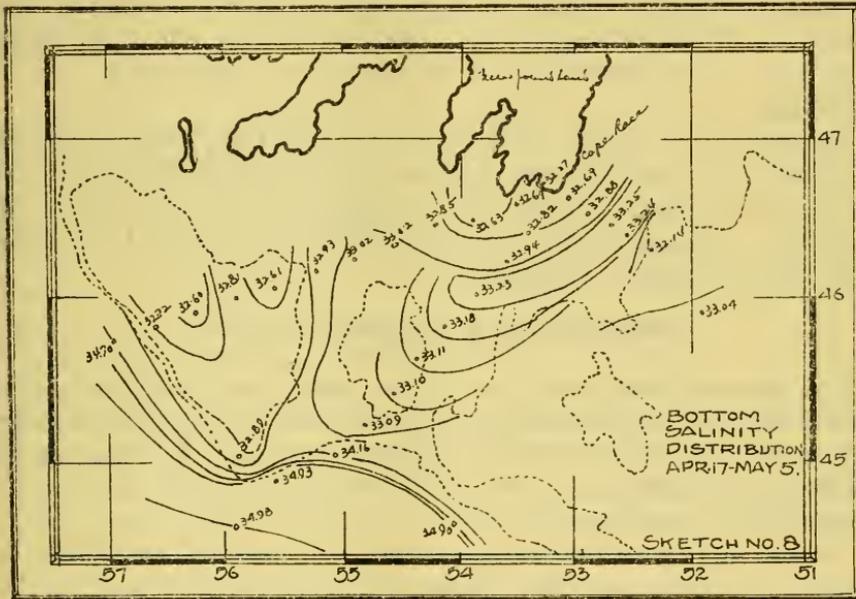
(a) No water of Arctic origin lay offshore of the edge of the Bank between  $44^{\circ} 30'$  and  $45^{\circ} 20'$ , and very slight traces were found even along the 100-fathom contour northward of this point to the forty-sixth parallel.

(b) Water colder than that just described and of unquestionable Arctic origin, lay inshore of the edge of the Bank, however, at the forty-fifth parallel, in a strip about 40 to 45 miles in width, which was connected southward to the coldest water found around the Tail, the latter of which was bathing the edge of the Bank.

## PROFILE NO. 2—STATIONS 400-405

The section runs from station 400, located on the northwestern side of the Grand Bank, northwesterly across the "gulley," to Cape Race. It was occupied April 17-18, one of the objects sought being the charting of the underwater size and position of polar water, if present, in the region around Cape Race, and also to determine to what extent it spread southward over the Grand Banks.

*Salinity.*—The saltiest water, 33.00 ‰, lay on the bottom of the "gulley," but on the Grand Banks side, away from the coastal slope. The section cut two bodies of water fresher than 32.50 ‰, one of which hugged the shore of Cape Race and the other a mass which



flooded all depths, station 401, on the edge of the Grand Bank and on the surface and had a width of 35 miles.

*Temperature.*—Water colder than 0° flooded all stations, surface to bottom, from Cape Race offshore to the edge of the Bank, where it presented a nearly vertical temperature face which lay between stations 402 and 401. The coldest water of the section, -1° to -1.2°, rested on the bottom of the "gulley" on the landward side, with a maximum thickness of 45 meters (25 fathoms).

The results of dilution from land drainage could be seen in the low salinity of the surface layers which extended a long distance off the coast. But the most important fact revealed from the viewpoint of the patrol was the presence of pure Arctic water, which flooded the "gulley" at all depths but did not spread offshore

farther than the edge of the Grand Bank. There were traces of an arctic influence at station 400 which crept southward on the bottom of the Bank, but such a movement was small, as evidenced by the salinities and temperatures at this station.

#### STATIONS 406 AND 407

Station 406 was taken April 18 on the eastern side of Trepassy Bay, well up near its head. Information was desired as to the range of the temperatures and salinities and also the possible extent of Arctic intrusion. Salinities were uniformly 32.27 ‰ from the surface to the bottom, and the water was 0.1° on the surface and -0.2° on the bottom. The water therefore was fresher but not so cold here as on the seaward side of Cape Race, as shown by station 405. The Coast Pilots all mention an indraft on the east side of Trepassy Bay and the records obtained by the patrol substantiate such a statement.

Station 407 was taken 3 miles south of Cape Pine where the water was saltier than in Trepassy Bay and also considerably colder, the temperatures being as low as those found at 405, 20 miles to the eastward. This indicated the direction of flow around Cape Race and to the westward at the time.

#### PROFILE NO. 3—STATIONS 408-417

This section was taken April 19-20, and ran from Cape Pine, Newfoundland, southwestward, crossing Green Bank with its outer end in the deep water of the Laurentian Channel. The number of stations (eight), taken at intervals of 15 miles, furnishes an accurate record of the water mass.

*Salinity.*—The saltiest water on the shelf, greater than 35.15 ‰ covered the bottom of the "gully" to a depth of 43 meters (26 fathoms). To the westward, on the Atlantic edge of the Newfoundland shelf, water equally salty presented a nearly vertical front from surface to bottom, facing Cape Race. Still farther offshore at the outer station, 417, the water was the saltiest of the section, >33.42 ‰. A surface layer of water <33.00 ‰, with an average thickness of 65 meters (35 fathoms), extended 94 miles offshore. Near the Newfoundland coast where the water had been diluted through land drainage, its salinity was <32.45 ‰.

*Temperature.*—Water colder than 0° lay as a bottom cover 59 meters (27 fathoms) in thickness from Cape Race to the continental edge, its upper wall conforming in general to the bottom configuration. Water colder than 2° lay offshore on the steep part of the continental slope. Its form, a nearly vertical face, extended from sur-

face to bottom. Offshore the temperature rose higher than  $4^{\circ}$ , a figure which marks the extent to which this water mass was cooled by the 1923-24 winter. The water on the Newfoundland shelf, colder than  $0^{\circ}$ , could not have attained such a temperature locally; therefore, it must have been transported here from the north, but on its landward side it had suffered considerable mixture with low-salinity water expanding from the Newfoundland shores. The salinity of the saltiest water on the shelf corresponds to that of the oceanic mass offshore but the great temperature difference disassociates any further relationship.

The most striking feature of this section, however, was the abrupt and unquestionable transition from the Arctic water on the shelf to the warmer saltier water offshore of the continental edge, the latter contour clearly marking the point to which northern water had advanced.

It is worth noting in connection with the two sections radiating southeast and southwest from Cape Race that the saltiest water lay on the bottom of the "gully," but on the Grand Banks side, while the coldest water also lay in the bottom depths, but on the Newfoundland side of the submarine valley. The freshest water was in the surface layers which extended considerably farther offshore from Cape Race to the southeast than to the southwest. Such a distribution may be due to the low-salinity surface water along the east coast of Newfoundland being set southward by the polar current, instead of following the normal offshore expansion of such land drainage. The bulk of the Arctic water, which normally seeks the bottom depths, being deflected more to the right, flows in the greatest depression of the shelf. Arctic water extended but little beyond the edge of the Grand Bank, to the southeast of Cape Race, where it was blocked by the vertical side of a salter warmer mass.

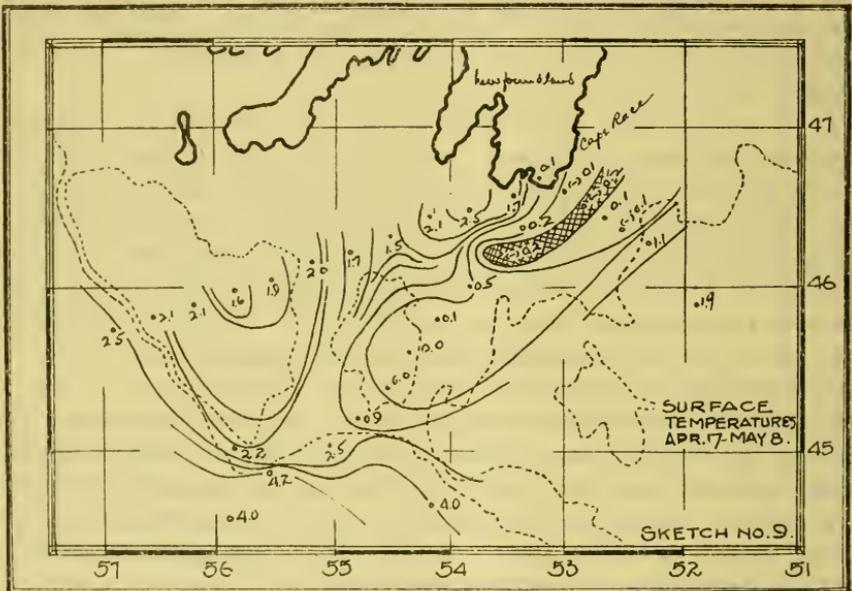
#### STATIONS 418-423 AND 428

April 23 to 30 the patrol cruised around the Atlantic edge of the Grand Bank searching the slope waters for icebergs. From the primary viewpoint of the ice patrol, which is safeguarding the main steamship routes between Europe and United States, this zone has come to be recognized as containing the richest distribution of glacial ice. Oceanographic observations of these waters were taken at stations 418-423, located along the slope at regular intervals, beginning with 418, 75 miles northwest of the Tail, and ending with 428, on the northeastern part of the Bank.

The subsurface minimum temperatures of  $-0.1^{\circ}$ ,  $-0.2^{\circ}$ , and  $-0.5^{\circ}$  at stations 418, 419, and 420, respectively with their salinities

of 33.18 ‰, 32.93 ‰, and 33.68 ‰, identify this water which bathed the southwest slope of the Grand Bank as arctic in origin.

A comparison with stations 377, 378, and 379, taken along the slope one month earlier, shows that the water at the Tail had grown colder during the interval. The colder water found in March at the mid-section on the slope had been displaced by warmer water, while at station 418, farthest to the northwest, lower temperatures prevailed than earlier in the season. Such a change in temperature distribution indicates a transference of cold water to the northwestward along the slope from the Tail, March 23 to April 23. The salinities of 32.94 ‰ and 32.95 ‰ found in the surface layers at



stations 418 and 419, respectively, points toward an offshore expansion of the fresher Banks water on the surface. The movement of warm salty water toward the slope in the deeper layers, which was found March 22, 90 miles northwest of the Tail, was not observed here April 23.

We continued northward along the eastern edge of the Bank April 24-27 and took stations 421, 422, 423, and 428. Minimum temperature of  $-0.4^{\circ}$ ,  $-0.2^{\circ}$ , and  $-0.3^{\circ}$  were recorded at an average depth of 75 meters (41 fathoms). The salinities at this depth, viz. 33.24 ‰, 33.22 ‰, and 33.28 ‰, respectively, were sufficient to accord the water along the eastern slope of the Bank an arctic derivation. At station 428, however, the coldest water,  $-1^{\circ}$ , was found on the bottom, where its salinity registered 33.04 ‰, which also designates such a mass as polar in character.

The most important point, besides the fact that northern water was bathing the eastern edge of the Bank, was the relatively high temperatures of this mass. The latter part of March when the first records of the subsurface were secured, it was soon noted that the arctic water was markedly warmer than normal, and yet the temperatures secured along the east side of the Bank April 24-30 indicated a still further warming when compared with the observations taken in this region only three weeks previously.

#### PROFILE NO. 4—STATIONS 424-430

The section runs from the central part of the Bank eastward over the slope and across the zone of mixed water, with its outer end in offshore Atlantic water. March 25 an intrusion of warm salty water was observed in the surface layers between the forty-fourth and forty-fifth parallels, on the east slope of the Grand Bank,<sup>30</sup> while to the westward a body of relatively fresh warm water flooded the central part of the Bank. Between these two lay frigid water, an intrusion from the North.<sup>31</sup> April 27 to May 1 stations 424 to 430 were located so as to investigate this interesting region in vertical section.

*Salinity*—The freshest water flooded 424 and 425, the two stations farthest inshore on the Bank, they being very nearly the middle of the bank. A shelf of water fresher than 32.96 ‰ 10 meters (5 fathoms) in thickness lay suspended at the mid-depths of stations 426 and 427. It extended out nearly to the edge of the Bank. Water saltier than 30.00 ‰, a bottom cover 15 meters (8 fathoms) thick, had crept in over the Bank a distance of 48 miles from the edge. But most striking was the mass of Atlantic water, >35.00 ‰, which extended downward to a depth of 330 meters (180 fathoms) at station 429 and 200 meters (109 fathoms) at station 430. The salty Atlantic water closely abutted the fresher water on the edge of the Bank and tended to work inshore especially on the surface, as indicated by the position and shape of the isohalines. The transition from slope to Atlantic was very abrupt.

*Temperature*.—The coldest water lay 125 meters (68 fathoms) below the surface, a shelf 120 meters (66 fathoms) thick, whose base rested on the steepest part of the slope. The water, colder than 1.9° and a salinity of 32.95-34.00 ‰, was unquestionably the trunk of the current with an Arctic source, which is shown in crosshatched shading on the temperature section, profile No. 4, hugging closely to the edge of the Bank and encroaching shoreward to a small extent.

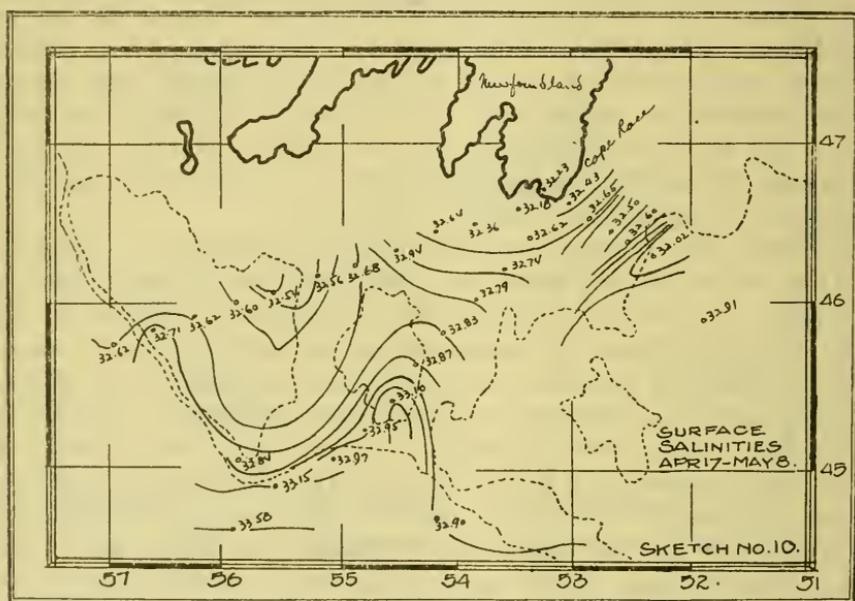
<sup>30</sup> See Oceanographer's report, March, p. 64.

<sup>31</sup> See chart F.

The temperatures of the water well in on the Bank, as represented by the position of stations 424 and 425, registered  $2.5^{\circ}$  to  $2^{\circ}$  except at the 16-meter (9-fathom) depth, at which it was  $0.6^{\circ}$ . The presence of this cold layer wholly cut off by warmer surroundings is unexplainable, and it is feared the thermometers registered an incorrect reading at this time and place.

Offshore, corresponding precisely in position to the salty water mass described in the salinity discussion, lay water warmer than  $12^{\circ}$ . It presented a more or less vertical face toward the Arctic water along the slope in a position similar to the salty water noted.

Probably the most striking feature portrayed by this section is the close proximity with which the three classified types of water, viz. Atlantic, Arctic, and Banks, abutted each other. No such ex-



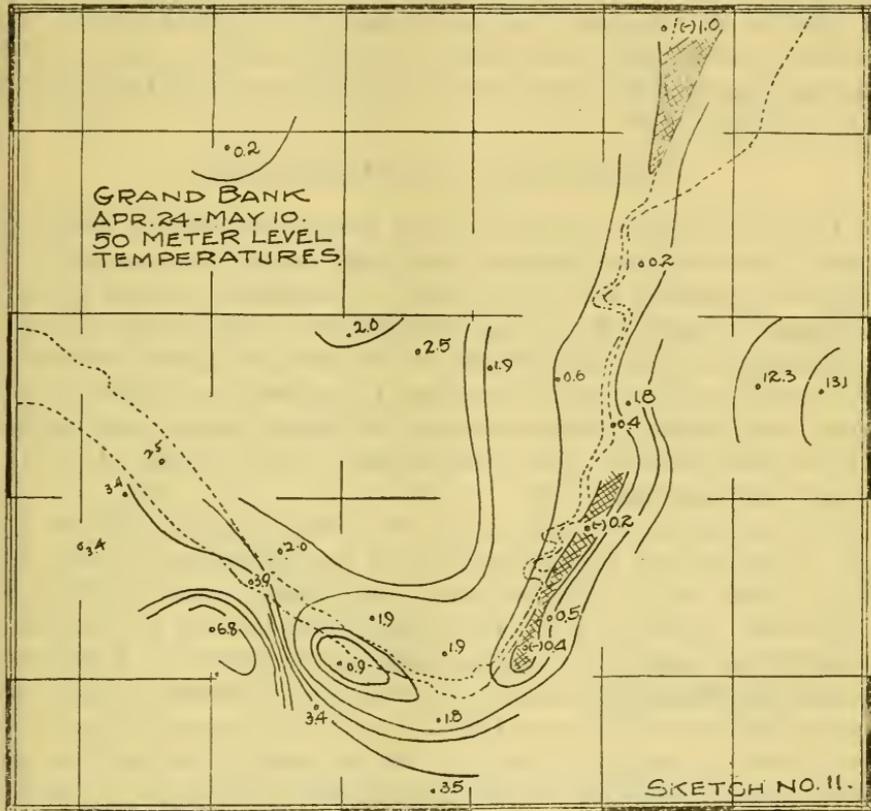
treme hydrographical ranges or such abrupt transitions are found at any other place in the world. An invasive body of warm salty Atlantic water had worked shoreward in the submarine depression which is charted on the eastern side of the Grand Bank in this latitude.<sup>32</sup> Banks water, which occupied all depths over the Grand Bank, has been found to resist displacement and has often shown a tendency to work eastward and northeastward, especially in the surface layers.<sup>33 34</sup> It exhibited such a characteristic tendency during

<sup>32</sup> Smith, Edward H.: International Ice Observation and Ice Patrol Service. U. S. C. G. Bull. No. 11, 1923, p. 140.

<sup>33</sup> Smith, Edward H.: International Ice Observation and Ice Patrol Service. U. S. C. G. Bull. No. 11, 1923, p. 147.

<sup>34</sup> Smith, Edward H.: International Ice Observation and Ice Patrol Service. U. S. C. G. Bull. No. 10, 1922, pp. 195-196.

the early spring of 1924 and on April 27 to May 1. Here, then, we had two bodies of water of opposite character, viz, the Atlantic masses intruding westward, and the Banks masses expanding eastward. Between the two, and holding closely to the edge of the Bank, lay the trunk of the icy current. The latter, which is the water mass that transports icebergs to menacing positions along the north Atlantic steamship lanes, is most clearly shown in vertical cross-section is profile No. 4.



STATION 431

This station was taken on the northwestern part of the Grand Banks, near the edge of the "gully," May 2, and it is of interest as a record to compare with station 400, taken in the same position April 17. An iceberg, one of the few in the Grand Banks region during the spring of 1924, was drifting southward near by.

The temperatures ranged from  $2.5^{\circ}$  on the surface to  $0.2^{\circ}$  on the bottom, while the salinity was  $33.05 \text{ ‰}$  on the surface and  $34.17 \text{ ‰}$  near the bottom. Compared with the record taken there in April we found that cooler and considerably saltier water had been en-

gulfed in this locality sometime between April 17 and May 2. The only direction from which cooler and saltier water may flood is the north and northeast, and this corresponds with a movement noticed in the surface layers during this time.<sup>35</sup>

The course followed by a small berg in this locality substantiates a southwesterly movement of the surface layers in this region, but, if the path of this berg be followed further, it will be noted that it did not continue across the western slope of the Bank, but soon after May 2 it swung to the eastward, where it eventually melted. Such a drift to the eastward was compromised in a great part by the offshore southeasterly movement of fresh coastal water<sup>36</sup> which spreads superficially over the south central area of the Grand Bank via its western side.

#### PROFILE NO. 5—STATIONS 432-442

This section runs from Cape Pine west-southwesterly, gradually parts from the Newfoundland coast, and crosses the depression in the shelf, bisecting St. Pierre Bank. The offshore end of the line extended 10 miles off the edge into the deep water of the Laurentian Channel. The object sought was to trace the inshore portion of the Arctic current which flows past Cape Race and which, it has often been claimed, continues down the United States coast inshore of the Gulf Stream. The observations, which consists of 10 stations, were made May 3-4.

*Salinity.*—Comparatively salty water, with a salinity of 33.00 ‰, lay 75 meters (41 fathoms) thick, in the depression between St. Marys Bank and St. Pierre Bank. The freshest water, 32.18-32.60 ‰ flooded all depths at the two inshore stations (432 and 433) and extended 27 miles out from the coast on the surface. A body of water, also fresher than 32.60 ‰, was found extending from surface to bottom on St. Pierre Bank, except at 439, where it was saltier than 32.60 ‰ below the surface. Off the edge of the shelf, at the outer station (442), the water was also saltier than 33.60 ‰, except on the surface.

*Temperature.*—The coldest water, 0°, a layer 25 to 100 meters (13 to 55 fathoms) in thickness, rested on the Newfoundland shelf. It extended from 8 miles off Cape Race to the middle of St. Pierre Bank, where it ceased between stations 439 and 440. Water colder than 1° lay superimposed upon the 0° water, it being 27 meters (15 fathoms) in thickness, with its upper surface temperature boundary coinciding closely in contour to the bottom cover underneath. The water flooding the slope was warmer than 2° on the surface and 1.2° in the

<sup>35</sup> See Oceanographer's report, April, pp. 69-74.

<sup>36</sup> Smith, Edward H.: International Ice Observation and Ice Patrol Service. U. S. C. G. Bull. No. 11, 1923, p. 147.



Grand Bank, south of which it disappeared through mixing with water of the Grand Bank.

(2) Southwest of Cape Race it was traced to the edge of the Newfoundland shelf, where it abutted against warm salty offshore water.

(3) It flowed westward in the depression of the shelf between St. Marys Bank and St. Pierre Bank, but not southwestward of a mid-point in St. Pierre Bank (station 440), offshore of which all traces ceased.

#### STATIONS 443 AND 444

These two stations were taken as the patrol cruised southward along the western slope of the Bank toward the Tail. Information was sought as to the temperature and salinity of the water which lay along the slope of the Bank that far northwestward of the Tail. The stations were taken May 5.

The minimum temperature at the 66-meter (36-fathom) depth at station 443 indicated a cooling which is believed to emanate from the direction of Cabot Strait. The water was considerably warmer farther south, at station 444, but it should be added that this last station was taken a few miles farther seaward of the slope than 443. The coldest water at 444 was  $3.6^{\circ}$  at the 50-meter (27 fathom) depth. Such a high temperature indicates a mixing with the offshore waters of the Atlantic basin, and the salinities below the 125-meter (68-fathom) depth substantiate such a premise. The surface layers were fresher than  $32.90$  ‰. The cause of such a warm fresh intrusion is difficult to explain.

Profiles No. 6-9 represent four vertical sections made of the water which lay on the southwest slope of the Grand Bank May 6 to 8. They were taken at regular intervals beginning at a point on the slope 130 miles northwest of the Tail, the last section being run at the Tail.

#### PROFILE NO. 6—STATIONS 445-447

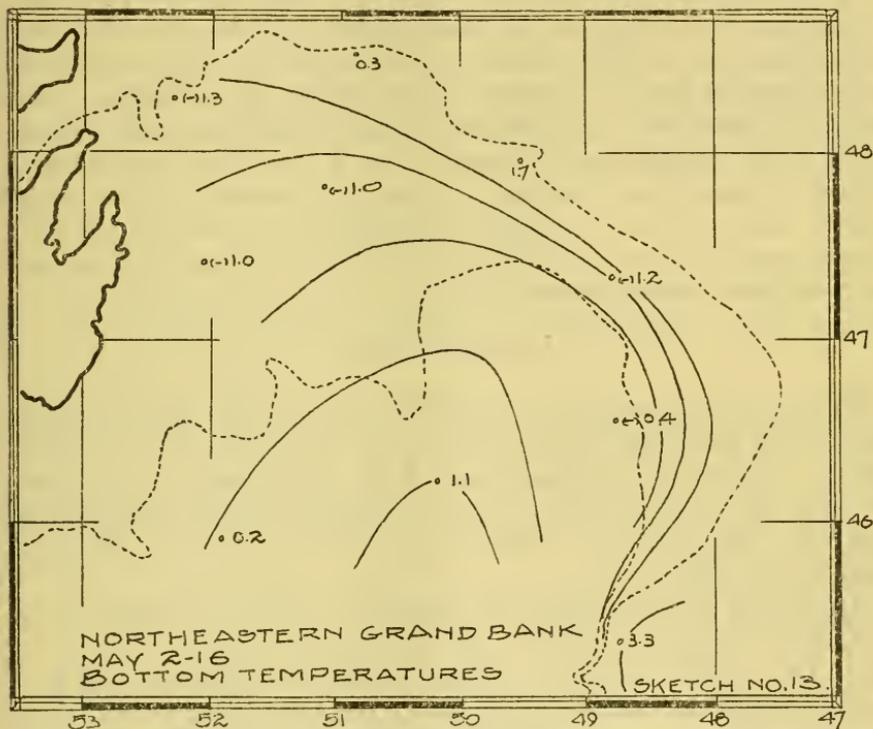
This section was taken normal to the southwest slope of the Grand Bank, May 6, 130 miles from the Tail. The coldest water, with a temperature of  $1.1^{\circ}$  and a salinity of  $33.33$  ‰ lay on the bottom of the Bank at the inner station (447). It was a small patch, not more than 20 meters (11 fathoms) in thickness and 7 miles in width. The warmest water,  $5^{\circ}$ , lay on the surface in a film 15 meters (8 fathoms) thick at all stations and the deeper layers were  $3.4^{\circ}$ - $4^{\circ}$  in temperature. The parallel and horizontal positions of the isotherms and isohalines indicate a water quite free from external disturbances except on the bottom of the slope. The patch of cold

water on the bottom at station 447 is evidence of an influence from the extreme penetration of Arctic water northwestward along the slope from the Tail.

#### PROFILE NO. 7—STATIONS 448-450

The two outstanding features shown in profile of the next section to the southward were:

(1) The patch of water colder than  $1.3^{\circ}$  which lay on the bottom of the shallow depths of the slope. It was connected to the body with a similar temperature and position noted in profile No. 7.



(2) A body of water saltier than  $34.00\text{‰}$  and warmer than  $6^{\circ}$  projected from the surface layers offshore inward and downward, and rested on the slope at a depth of 90 meters (49 fathoms).

#### PROFILE NO. 8—STATIONS 451-453

This section was taken 38 miles northwest of the Tail May 7-8. The body of cold water noted on the bottom of the Bank at each of the inshore stations in the two previous sections is noted in profile No. 8. The band at this point, about 10 miles seaward of the edge, with its temperature of  $-0.3^{\circ}$ , was the coldest found along the

slope May 6-8. The surface layers were warmer than  $5^{\circ}$  except those over the cold water on the slope where it registered  $3.5^{\circ}$

The noteworthy feature of this section was the increase in size of the cold water on the slope over the previous sections. It had grown to a magnitude and a frigidty that exceeded a mere suggestion of Arctic influence. On the other hand, this was identified as a band of polar water bathing the slope 38 miles northwest of the Tail, transferred to this locality from that direction.

#### PROFILE NO. 9—STATIONS 454-456

A surface film fresher than 33.00 ‰ and warmer than  $3.5^{\circ}$  spread out to the edge of the Bank at the Tail, May 8. This was pure Banks water. The coldest water, less than  $2^{\circ}$ , lay on the slope and down the grade to a depth of 50 meters (27 fathoms). This body of water bore a suggestion of Arctic character, but its relatively high temperature indicated that it had been considerably raised in temperature through mixing with unusually warm slope water. Instead, then, of a large volume of Arctic water at the Tail, where usually it has been found at this time in previous seasons, we found only traces of such a supply.

#### STATIONS 457-464

These eight stations were taken May 8-15 as the patrol steamed northward along the eastern and northeastern face of the Grand Bank. Station 457, the beginning of the investigation, was located 28 miles north of the Tail and the investigation ended with station 464, off Cape Bonavista, Newfoundland, a total distance along the slope of 450 miles.

Minimums at 50 meters (27 fathoms) below the surface were found (in order of stations, proceeding northward), as follows:  $0.5^{\circ}$ ,  $1.8^{\circ}$ ,  $-0.4^{\circ}$ ,  $-1^{\circ}$ ,  $0.1^{\circ}$ . The minimum temperature lay at a greater depth on the northern edge of the Bank than it did to the southward; the bottom temperatures at the three most northern stations being some of the coldest water of the column, viz.  $-1.3^{\circ}$ ,  $-1^{\circ}$ , and  $-1.1^{\circ}$ .

Compared with the temperatures of stations taken along the eastern slope of the Bank earlier in the season, we noted that the water mass in general along the east slope had been warmed approximately  $1^{\circ}$  over what had existed there previously, but the salinity remained unchanged. General consideration of the records of these eight stations, located where we have found the heart of the icy current most often to lie, leads to the conclusion that the current was not so strong or so voluminous as it was earlier in the season.

## STATIONS 465-467

These three stations were taken May 15-16 on the northern part of the Grand Bank, and deal with a water mass which normally during this period has been found to be Arctic in character. The lowest temperatures recorded May 15-16 at these stations were  $-1.4^{\circ}$ ,  $-1^{\circ}$ , and  $1.1^{\circ}$ . The coldest water in every instance lay on the bottom. The surface temperatures of  $4.5^{\circ}$ ,  $2.5^{\circ}$ , and  $3.8^{\circ}$  is conclusive evidence that not only had Arctic water mixed with the surface layers, but that it had crept in over the bottom of the Bank. This statement is further substantiated by consideration of the salinities, which show that the warm surface layers were also comparatively fresh, viz. 32.51 ‰, 32.93 ‰, and 32.81 ‰, salinities which accord with water of coastal character. The icy bottom cover was the saltiest water of the columns, and it is worth noting that the water on the bottom of the northern part of the Grand Banks, May 15-16, was the coldest of any encountered by the patrol up to this date.

## STATIONS 468-471

These stations were taken on a cruise of the patrol vessel northward from Funk Island to Belle Isle, Newfoundland. They were occupied May 26-27.

All stations exhibited an unmistakable Arctic character in the temperature stratification. The coldest water quite consistently lay between 50 and 100 meters (27 and 55 fathoms) below the surface, the temperature records were:  $-0.2^{\circ}$ ,  $-0.6^{\circ}$ ,  $-0.8^{\circ}$ , and  $-0.1^{\circ}$ . Such temperatures correspond to those found 500 miles to the southward, off the Tail of the Grand Banks. The coldest water was found May 29 at station 472, off Fogo Island, the thermometers reading  $-1.5^{\circ}$  when lowered near the bottom. This was the coldest water encountered during the 1924 season. The salinities of 33.61-33.51 ‰ is recognized as that according with the heart of the Labrador current off the east side of the Grand Banks.

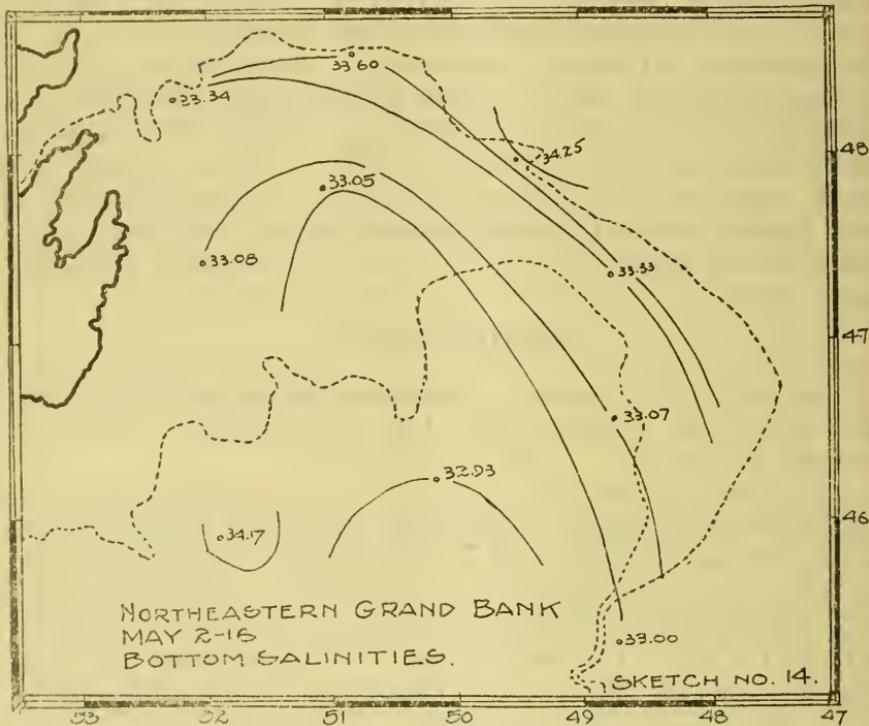
## PROFILE NO. 10—STATIONS 475-479

The section runs from 10 miles east of Cape Race, Newfoundland, southward across the "gully," the outer station, 479, being located on the extreme northwestern part of the Grand Bank. The stations were taken June 25. The object sought was to chart the position and size of the cold northern water in this direction south of Cape Race.

*Salinity.*—The section cut across a band of water floating in the surface layers fresher than 32.70 ‰. It had a maximum thickness of 35 meters (19 fathoms) at station 477, 25 miles off Cape Race, and it measured over 120 miles in its greatest width. A band of

still fresher water, 32.50 ‰ and 55 miles wide, lay within this limit, but the freshest water of all, 31.97 ‰, lay on the surface at station 476. A bottom cover, saltier than 33.00 ‰, with a thickness of 25 meters (14 fathoms) lay throughout the section.

*Temperature.*—The coldest water,  $-1.2^{\circ}$ , lay on the bottom of the "gully." The warmest water spread over the surface and this film grew steadily warmer as we proceeded southward away from Cape Race.

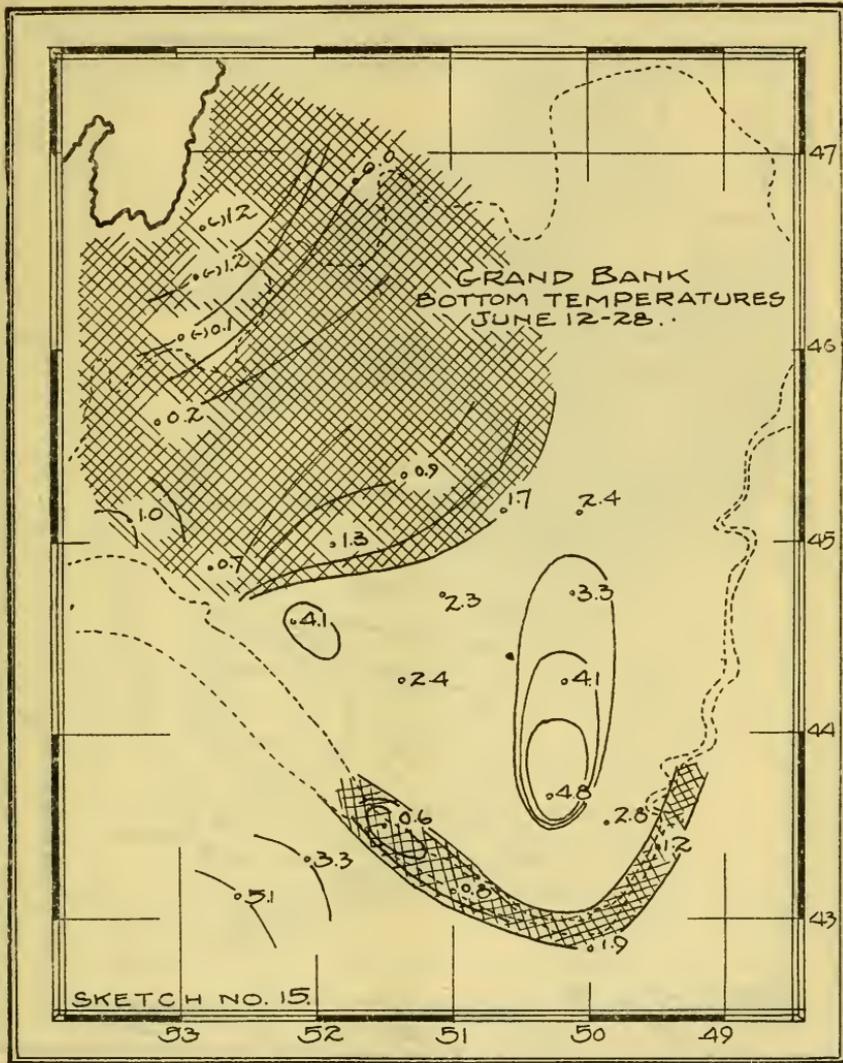


#### SUMMARY

A wide band of low-salinity water associated with a coastal connection lay in the surface layers south of Cape Race, June 25, while in the lower depths frigid Arctic water bathed the "gully" and crept southward as a thin film over the bottom of the Grand Bank 100 miles offshore from Cape Race. East, off Cape Race, the Arctic water flooded all depths, surface to bottom, but as we proceeded toward the Bank the Arctic influence grew less and less, until at the outer station, 479, it was confined solely to the bottom 25 meters (14 fathoms). On the other hand the influence of the fresh coastal water in the surface layers became increasingly effective, reaching a maximum in the midseason.

## STATIONS 480-497

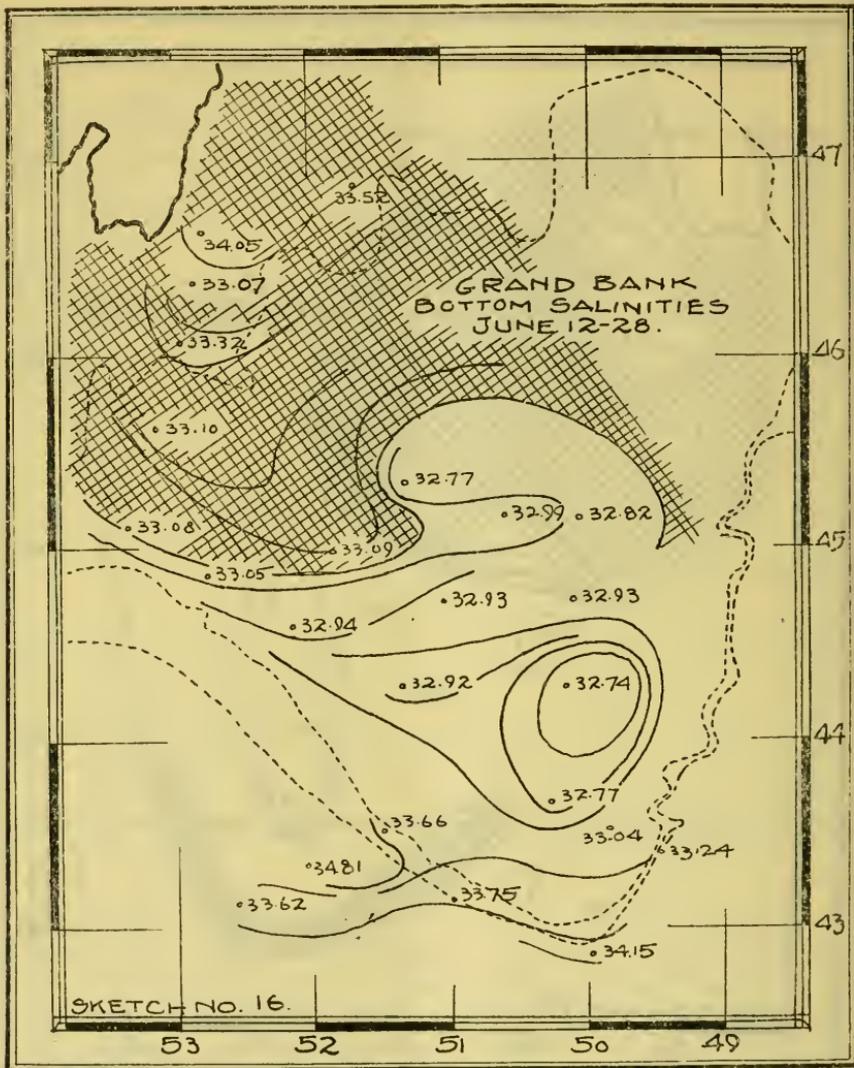
These 18 stations were so located over the southern part of the Grand Bank as to furnish a chart of the distribution of the water with respect to salinity and temperature.



*Bottom distribution.*<sup>37</sup>—Cold and comparatively salty water crept in over the bottom of the Bank for a distance of 80 miles from its edge. This water was part of the polar current which was flowing in the “gully” past Cape Race, and which encroached southeastward over the bank shallows. The frequency and the location of the sta-

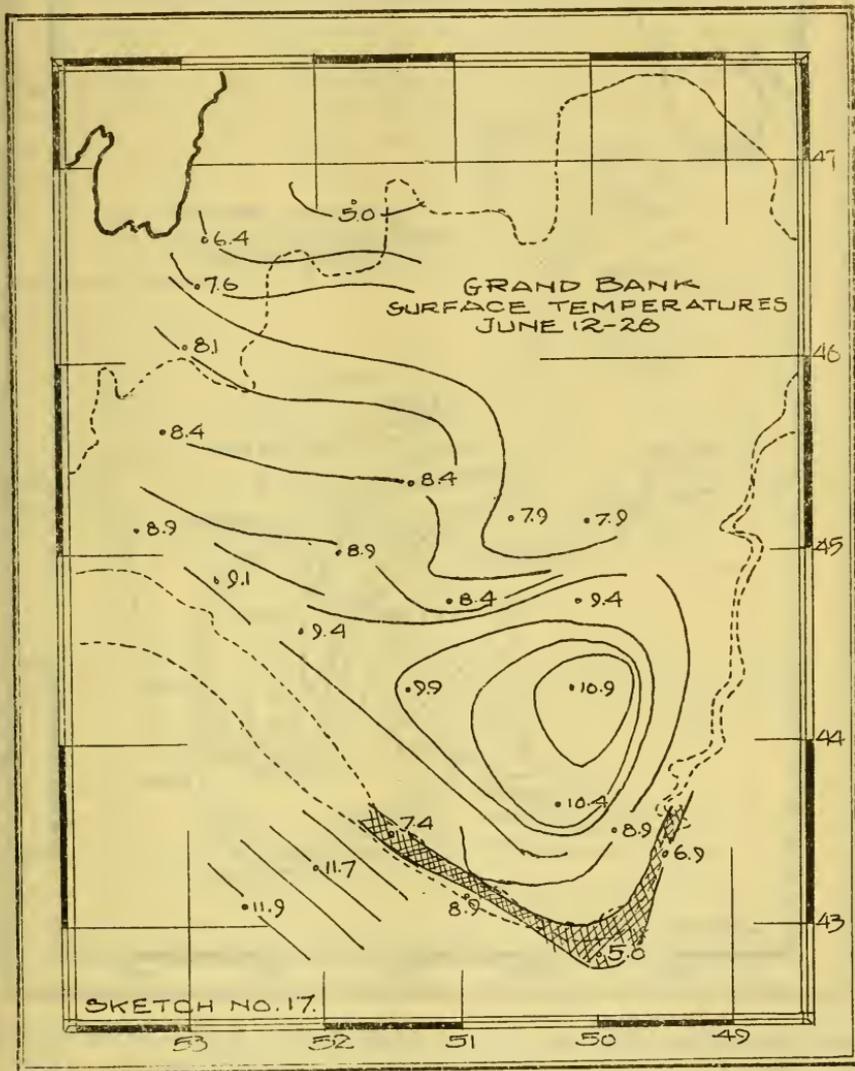
<sup>37</sup> See sketches Nos. 15 and 16.

tions are sufficient to delineate the limits to which this bottom intrusion extended on the Grand Bank. On the southern part of the Bank we found an area of approximately 2,000 square miles where the bottom water was warmest and freshest of any on the Grand



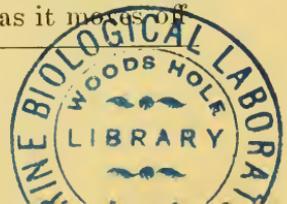
Bank. It had a temperature of  $4.8^{\circ}$ – $3.3^{\circ}$  and a salinity of  $32.74$  ‰. This water was purely local in character, a tidal reservoir which had remained free from external intrusions the entire winter of 1923–24 at least. It was noted that the low-salinity water exhibited a marked tendency to spread outward on the southern part of the Bank and its influence is seen in the bottom water at station 497, off the southwest slope.

*Surface distribution.*<sup>38</sup>—The band of low salinity water cut by profile No. 10 was connected in the surface layers to equally fresh water to the southeastward over the central bank region. The parallel position of the isohalines strikingly indicated the manner in

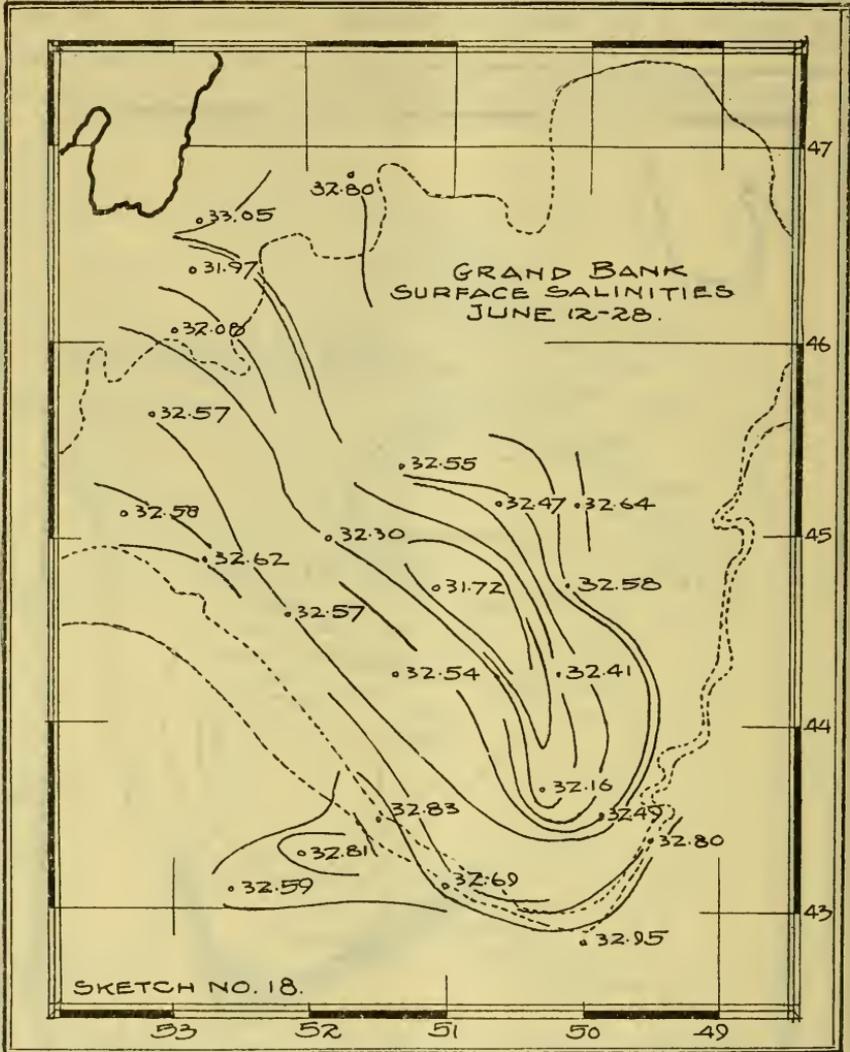


which the low-salinity coastal water worked off the Newfoundland shore. It is especially well defined at this period of the year when such a movement reaches its maximum effect. The temperature distribution further substantiates those conclusions. The freshest water naturally being warmest will remain on the surface as it moves off

<sup>38</sup> See sketches Nos. 17 and 18.



shore and thus will receive the full effects of the sun's heat. Such warm fresh surface layers spread southeastward from Cape Race



over the southern and central part of the Grand Bank via its western side June 12-28, and attained a maximum temperature of  $10.9^{\circ}$ .

## OCEANOGRAPHIC SUMMARY

Lieutenant Commander EDWARD H. SMITH, United States Coast Guard

The absence of ice during the spring of 1924 permitted the patrol vessels to extend their oceanographic observations over a greater area than in any previous season. This excellent diversification of stations has brought out in clearer detail than ever before the general distribution of salinity and temperature of the water masses in the ice regions during the danger season. Sketches Nos. 6 to 19, which are carried on subsequent pages, will give the reader the best idea of such distribution.

The most striking feature from an oceanographic point of view was the presence of water warmer than normal which lay over the Newfoundland shelf, and this was attributed both to the mildness of the 1923-24 winter and the absence of ice in the western North Atlantic.<sup>39</sup> As has been previously pointed out in the chapter on subsurface discussion, it was necessary to apply different standards of temperature criteria this spring than in former years.

### THE ICY CURRENT

Three different times, viz. March 22, April 23, and May 8, the patrol investigated the water mass around the Atlantic faces of the Grand Bank, and from the data collected it was definitely ascertained that arctic water was continually present there throughout the season.

The heart of the icy current which bears icebergs to menacing positions in the North Atlantic bathed the steepest part of the slope, 50-110 meters, continually swelling and shrinking upon this base. Similar to previous years, this water at various localities along the slope was subjected not only to offshore intrusions of salty Atlantic water working up the grade in the deeper layers, but also to dilution from inshore points, as fresh coastal water spread seaward in the surface layers. Such a flanking of dissimilar water masses from either side restricted the frigid zone to a band whose width south of latitude 45° 00' north, was not greater than 10 miles. This icy attenuation, however, maintained a continual connection which stretched southward as far as the Tail, where it discharged its supply into the mixed-water zone. Great variations in the rate of flow of the icy current

<sup>39</sup> See Oceanographer's report, March, pp. 63-69.

were noted. It appeared to assume its greatest velocity in the vicinity of the Tail on the eastern slope where a rate as high as 1.5 knots per hour was observed, and several times the patrol vessel detected a current of 0.8 knot per hour. Yet on several other occasions, separated by an interval as much as two weeks, we were convinced, by means of excellent astronomical sights, that no current flowed southward along the east side of the Bank at that particular time. Wide variations in the rate of flow of the arctic water in this region have been noted before, but no complete cessation has ever been recorded during the ice season.

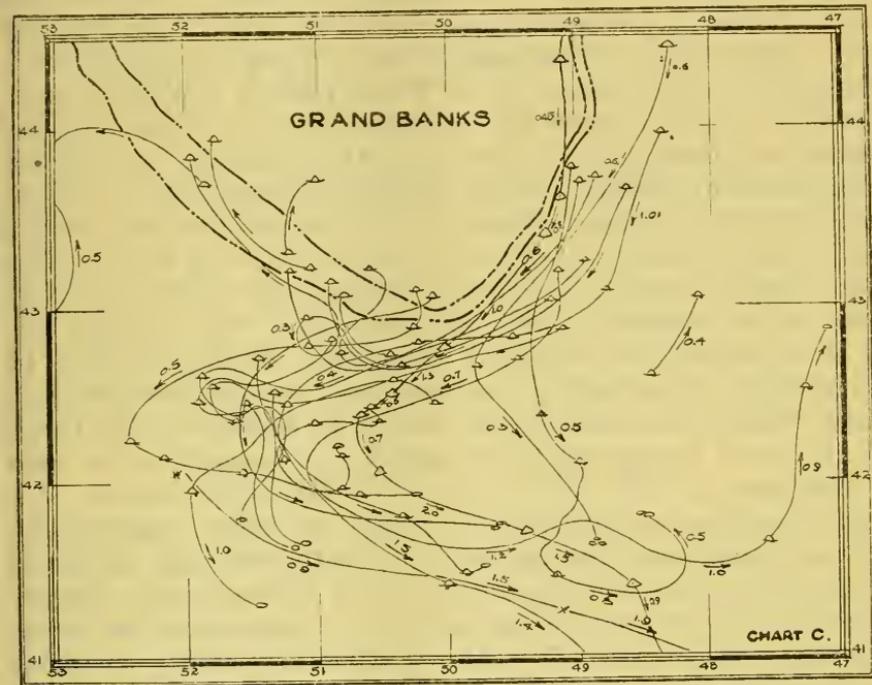
An interesting example of the manner in which the icy current mixes with the Atlantic water was shown by the behavior of berg No. 2 as it drifted southward past the Tail into the mixed water zone and finally floated in tropical Atlantic water where it eventually melted.<sup>40</sup> While this berg was drifting through the mixed-water zone which lay between the Tail of the Bank and the "cold wall," it was approximately 150 feet high, and drew about 350 feet (120 meters) and thus floated southwestward in water the surface layers of which we found to be Arctic.<sup>41</sup> That upper 125 meters were decidedly arctic, but below that depth the water became salty and warm, the transition just below the 125-meter depth being strikingly abrupt unmistakably defined the division between the Arctic discharge and the oceanic Atlantic. Berg No. 2 continued to follow a southwestward course until April 6, but its rate of drift diminished from 1 knot per hour at the Tail to 0.5 knot per hour 45 miles southwest of there. This furnishes an excellent example of the manner in which the Arctic water discharges become shallower and shallower as it spreads offshore in the mixing zone southwest of the Tail, yet such relatively superficial circulation is sufficient to transport a fairly large berg into menacing positions just north of the steamship tracks. Another observation of the subsurface taken near berg No. 2 farther south than its position April 6 showed that the water of arctic character became still shallower the nearer it approached the "cold wall." Arctic traces did not extend downward over 50 meters (27 fathoms) and on account of this the drift of berg No. 2 was correspondingly retarded. It was in this locality that it drifted from the mixed-water zone across the "cold wall" into tropical surroundings.

Sketch No. 6 shows the position of the Arctic discharge at a depth of 50 meters (27 fathoms) below the surface with respect to temperature distribution. It will be noted that Arctic water was more clearly traced by means of the lowest temperature in a direction

<sup>40</sup> See chart B.

<sup>41</sup> See oceanographic station table, p. 87. Station 385.

southwest of the Tail than it was due south, which plainly indicates the direction in which the water masses are discharged in this vicinity, and such a fact is further substantiated by the records of drift ice in this region.<sup>42</sup> Sketch No. 6 also delineates the distribution of the three classified types of water in this interesting area, the heart of the icy current being shown by crosshatched shading. This distribution corresponds in general to that which prevailed on the surface during this period, as shown by charts F and G, the



Composite iceberg chart, 1913-1914

latter of which reveals the presence of the frigid water with its largest portion inshoreward of the continental edge. The fact that this water mass lay in the shallow depths rather than hugging the slope of the Bank may be due in part to the warm salty Atlantic masses which protruded inshore between the forty-fourth and forty-fifth parallels, which movement is also shown on sketch No. 6.

#### CIRCULATION SOUTHWEST OF CAPE RACE

Sketches Nos. 7, 8, 9, and 10 show the bottom distribution of arctic and coastal water south and west of Cape Race with reference to temperature and salinity as found by the patrol April 17 to May 5.

<sup>42</sup> See chart C, "Drifts of Ice Around the Tail of the Grand Banks."

Due to the proximity of the Newfoundland land area and its consequent chilling effect on the bottom water, the bottom temperature distribution, as shown by sketch No. 7, does not give us the excellent picture of circulation that is presented in sketches 8, 9, and 10. The bottom salinity distribution, sketch No. 8, shows with the utmost clarity the movement of two distinct water masses at this time south of Newfoundland. The isohalines of relatively salt water projecting in consecutive tongue-like shapes into the "gulley," southwestward of Cape Race record the movement of Arctic water reaching out as far as the continental edge, at which point it abuts against salty oceanic water. Fresh coastal water is shown in wedge-like form covering the entire bottom of St. Pierre Bank, a movement which proceeded from the north and northwest and which unmistakably flanked any possible arctic invasion to the westward. The surface distribution of salinity and temperature, sketches Nos. 9 and 10, corroborate the evidence presented by the bottom salinities. Surface temperatures, sketch No. 9, portray the movement of the icy polar water which poured southwestward through the "gulley" and offshore but no farther than the continental edge. The continued flow of arctic water to the westward was equally effectually blocked by warm fresh surface layers spreading out from the Newfoundland coast. Such a movement, which flooded all depths over St. Pierre Bank, caused a sharp north-and-south line of demarkation to occur in longitude  $55^{\circ}$  west, between the Arctic and coastal masses. The patrol has long been of the opinion that little polar water succeeds in penetrating much farther than the continental edge south and west of Cape Race and the evidence which is presented by sketches 7 to 10 conclusively support such a belief. Furthermore they refute, for the period of April 17 to May 5 at least, a popular conception that the Labrador current flows inshore of the Gulf Stream southward down the United States coast.

#### CIRCULATION VICINITY TAIL OF GRAND BANK

Sketches 11 and 12 show the distribution of salinity and temperature at a depth of 50 meters (27 fathoms) around the southern part of the Grand Bank and along its eastern side April 24 to May 10. In general they picture a distribution similar to that shown on sketch No. 6, except to record a change since March in the transference of arctic water along the eastern slope. A movement of warm salty Atlantic water inshore toward the southwest slope also took place. The foregoing appears to establish one fact in particular, namely, that in general the distribution of Arctic, Atlantic, and Banks water maintains more or less the same relationship over extended periods. In fact the conditions as pictured by sketches 11

and 12 are not dissimilar to those which were found to exist during the fall of 1923, even the respective temperatures corresponding with those observed in the same localities last fall.

A comparison between the temperatures found in the heart of the icy northern water around the Grand Bank in 1924 with those found there the spring of 1923 reveal the fact that the temperature of the former was  $0.6^{\circ}$  to  $1^{\circ}$  higher than the latter. This may be due not only to the warmer winter's chilling proceeding to a less degree than usual, but is also dependent to a certain extent on the marked absence of ice, especially field ice which in season normally extends for hundreds of miles over coastal shelves to the northward.

The influence of the abnormally warm masses over the Newfoundland shelf this spring and the absence of ice reacted, then, to ameliorate the icy waters from the north. It is pointed out that failure to find water masses of extremely dissimilar temperature and salinity in the ice regions this spring was due to such abnormal factors outlined above and in no manner do absences of abrupt hydrographical changes under such conditions indicate a weak and inactive state of circulation. Such a premise being untenable, moreover, when we are confronted with evidence such as the rate of drift of berg No. 2 and current records of 0.8 knot per hour, which were observed several times along the eastern edge of the Grand Bank.

#### THE NORTHEASTERN GRAND BANK

Distribution of temperatures and salinities of the water mass which lay over the northeastern part of the Grand Bank was investigated May 2 to 16, the results of which are shown in sketches 13 and 14, the temperatures and salinities both show the manner in which the Arctic water coming down from the north floods this region of the Grand Bank. The isotherms strikingly portray with the position of the coldest water the manner in which the current from the north splits in two branches in the vicinity of  $46^{\circ} 20'$  north, and  $50^{\circ} 10'$  west. On the other hand it indicates that Banks water is less liable to be displaced inshore and to the southward than any other place and, too, there probably is a tendency indicated herein for the Banks water to spread northeastward.

#### GRAND BANKS

Sketches 15 to 18 show the relative distribution of Arctic and coastal water over the Grand Bank area June 25 to 29. The extent to which Arctic water spreads in over the bottom is shown on the crosshatched area of sketches 15 and 16. The manner in which fresh coastal water spreads offshore is also clearly shown on sketches 17

and 18. The bottom intrusions of Arctic water were found in general to be the same relative position as shown by previous records of the patrol and the area of freshest and warmest bottom water lay as a cover over the south-central part of the Bank, as an isolated circuit often referred to as a tidal reservoir.

It has long been known that the water in this vicinity of the Grand Bank promontory, especially the surface layers, although 250 miles from the nearest land, was of decidedly coastal character and it was believed that in order that such water be so fresh it must receive continual coastal contributions, but the actual manner in which such a movement took place was not proven heretofore. Sketches 17 and 18 conclusively show that coastal water moves offshore in the surface layers in the vicinity of Cape Race, southeastward to the south-central Grand Bank region via its western side. The continual contributions accumulating in the central Grand Bank region finally flood this place from surface to bottom with fresh water and give it a truly coastal character in spite of its distance, 250 miles at sea.

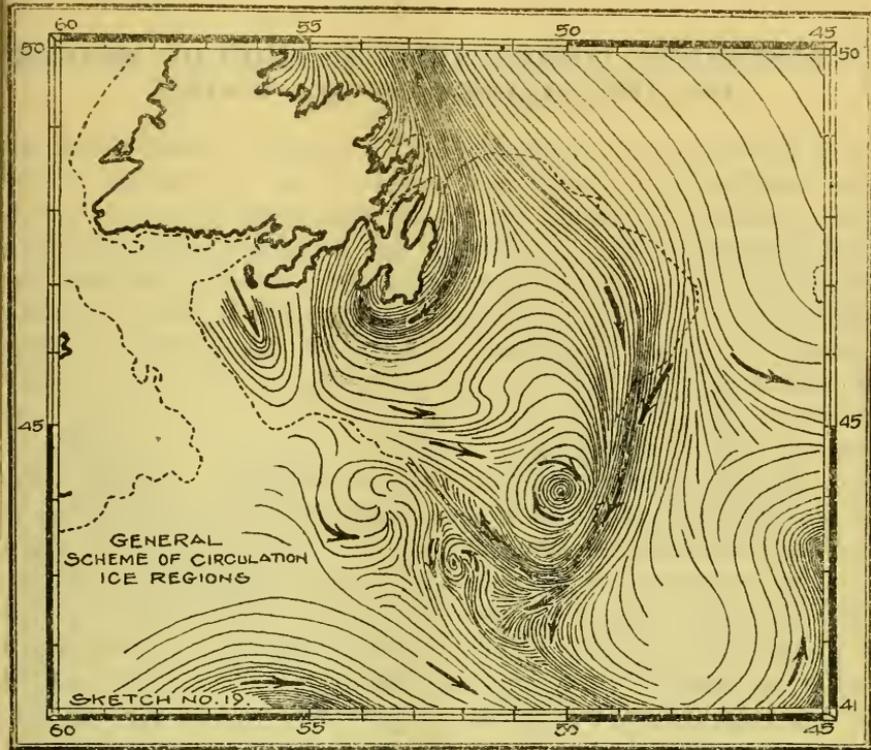
This water mass is isolated from all except its contributions which it receives from the westward, and possessing a rotary tidal motion, with its accumulations increasing, it spreads outward on all sides, most markedly toward the north and northeast, where by virtue of its fresher and warmer character it is continually swamping arctic intrusions from that direction.

The offshore movement on the west side of the bank is at a maximum during the summer and fall, when the arctic circulation is at a minimum, but intermittent communication takes place the year round, particularly in the surface layers. In the spring such offshore progression may be occurring, while in the deeper layers frigid arctic water may be creeping in over the bottom.

#### GENERAL SCHEME OF CIRCULATION IN ICE REGIONS

For some years it has been an ambition to present a current chart of the ice regions of the North Atlantic based upon the scientific investigation of the ice patrol, but as more and more evidence was accumulated it was found increasingly difficult to represent the varied movements for which the water masses of these regions are famous. At no other part of the world do such diametrically opposed bodies abut each other with a consequent complexity of circulation. It has been concluded, therefore, that the only correct manner to satisfy a current scheme of charting is to trace the average boundary of the three classified types of water, viz, Arctic, Banks, and Atlantic sketches, and, wherever it has been possible, to illustrate a more or

less characteristic movement—for example, such a one as prevails along the east side of the Grand Bank—the direction has been indicated by arrows.



## AN ELECTRICAL CONDUCTIVITY METHOD OF MEASURING THE SALINITY OF SEA WATER

The Convention for the Safety of Life at Sea, London, 1914, besides establishing a continuous patrol of the ice regions of the North Atlantic during the ice season, recognized the value of scientific research of the ice problem and advised a program which would institute a thorough and exhaustive investigation into the meteorology and oceanography of the ice regions in order to obtain a greater knowledge regarding the behavior of drifting ice. This led particularly to oceanographic investigation which primarily consists of the determination of the two physical characters of the water, the temperature and the salinity, which vary from place to place, and from time to time, both horizontally and vertically. The salinity character possesses an advantage over that of temperature in that the former is free from the seasonal changes which occur in the latter and with the approach of summer, nullifies its value to a great extent. The usual method of determining salinity is that of titration, a chemical method of measuring the chlorine content with silver nitrate. Other known methods are : The density method by either hydrostatic weighing or with the pycnometer, or hydrometer; and by the refractive indexes of samples of varying salinities. But all of these methods are of such a nature that they do not conform to an accurate, practical method for shipboard, and it was soon found by the ice patrol, that an immediate knowledge of the physical properties of the water masses in the ice regions was especially valuable in aiding to chart the probable movements of ice. In this way warnings could be sent to those vessels found on courses which were leading them toward unseen dangers. Therefore, as early as 1914 work was started on the design and construction of an apparatus for the determination of salinity on shipboard, based on the electric conductivity of sea water. The history of the vicissitudes and discouragements met in perfecting such a piece of apparatus, from 1914 to 1921, are told in Bulletin No. 9, International Ice Observation and Ice Patrol Service, 1921, pp. 79-84.

Taking up the thread of events, we find the apparatus at the end of ice patrol, 1922, described as based on sound theory but still having inherent mechanical faults which necessitated elimination before we could possess a machine which would function satisfactorily.



Plate III.—A Greenland iceberg in an advanced stage of disintegration. It has been found the best photographs of bergs are obtained by facing the sun and berg in order that full advantage may be taken of the shadows. The above plate is an example of this



Plate IV.—Berg No. 3. A photograph taken June 18, at the time careful measurements showed the height of its pinnacle to be 106 feet, its length 244 feet. It had two underwater peaks, the one below the pinnacle extending downward 200 feet and at the other end 160 feet. See sketches Nos. 4 and 4a

The Interdepartmental Board on International Ice Observation and Ice Patrol Derelict Destruction Service, at its meeting in the fall of 1922 requested the Bureau of Standards to receive all apparatus then on hand employed in connection with salinity measurements, and attempt to perfect a mechanical unit which would be a success. Shortly thereafter Mr. E. F. B. Fries, then scientific observer, delivered the apparatus to Dr. F. Wenner, United States Bureau of Standards, to whom finally the design of a successfully operating machine is mainly due.

At first it was presumed that only minor changes of the apparatus would be required, but a more thorough investigation and study of the problem by the bureau made it evident that it would be necessary to make an entirely new design, and in the construction use but a few parts of the old apparatus. This accordingly was done; the new instruments contained in a compact two-door wooden cabinet, 36 inches high, 33 inches across the front, and 13 inches deep, were installed on the cutter *Tampa* just before she sailed from Boston on ice patrol, March 15, 1923. Because of the shortness of time, however, between the sailing of the *Tampa* and the inability to procure sea water of known salinity in Boston, or vicinity, the apparatus could not be thoroughly tested or standardized until after the end of the ice season.

When the *Tampa* returned to Boston in July, 1923, the apparatus was tested using samples of sea water whose salinity had been determined by independent measurements. At that time the apparatus was found to be in excellent condition and gave results reliable to as high a degree of precision as is possible by the more tedious titration method. Four sketches, a general description, and instructions for use of the apparatus as designed and operated at present follow:

#### PURPOSE AND METHOD

The apparatus is intended to furnish a quick and reliable means for the determination of the salinity of sea water under conditions existing on shipboard. It was designed and constructed by the Bureau of Standards at the request of Dr. S. W. Stratton, acting as a member of the Interdepartmental Board on International Service of Ice Observation, Ice Patrol, and Ocean Derelict Destruction.

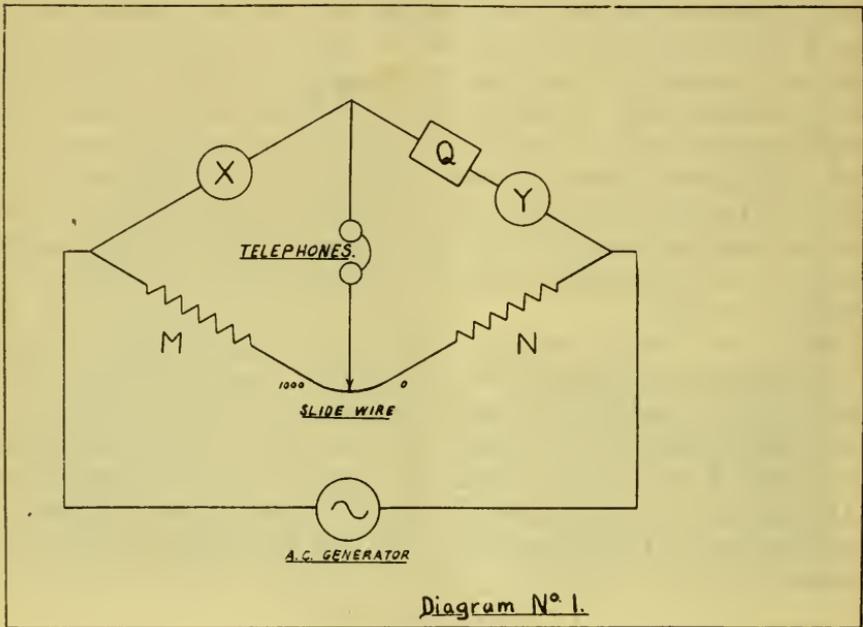
It is known that the electrical resistivity of sea water changes as its total salt content is changed either by evaporation or by dilution with rain, snow, or melting ice. Therefore the measurement of the resistivity may be made to serve instead of a titration density measurement, or direct determination of the salt contained; and this is what the apparatus is intended to do.

The resistivity is measured by a Wheatstone bridge equipment, making use of what is generally called the substitution method. In this method the solutions to be measured are placed one after another in the same cell so that the relative conductivities are obtained without a knowledge of the constant of

the cell. The plan presupposes that there will be kept on board one or more lots of sea water, the salinity of which will have been determined by some other method, and that these will be used at more or less frequent intervals for the purpose of standardization of the apparatus.

#### GENERAL DESCRIPTION

A simplified illustration of the bridge circuit is shown in Diagram No. 1. Here  $X$  represents the arm of the bridge containing the cell in which the sea water whose conductivity of salinity is to be measured is placed.  $Y$  represents the resistance of the cell containing other sea water whose conductivity need not be known.  $Q$  is an adjustable resistance in the same arm of the bridge as  $Y$ .  $M$  and  $N$  are the resistances of the remaining arms of the bridge when the contact on the slide wire is set at zero.



Readings of the apparatus are to be converted to salinities by means of a table or curve.

The test current is supplied by means of a microphone hummer, and a set of head telephones serve for indicating when the bridge is balanced. A thermostatically controlled water bath serves for keeping the cells at a constant known temperature during measurement.

#### THE MEASURING CIRCUIT

The arrangement is a simple Wheatstone bridge with what is sometimes called a third branch and an inductive coupling between the current leads and the detector leads. There is also a metallic shield. The arrangement of the circuit, except for this shield, is shown in Diagram No. 2. The test circuit is insulated from the power circuit. It is also insulated from the shield except for a single connection on the third branch of the bridge.

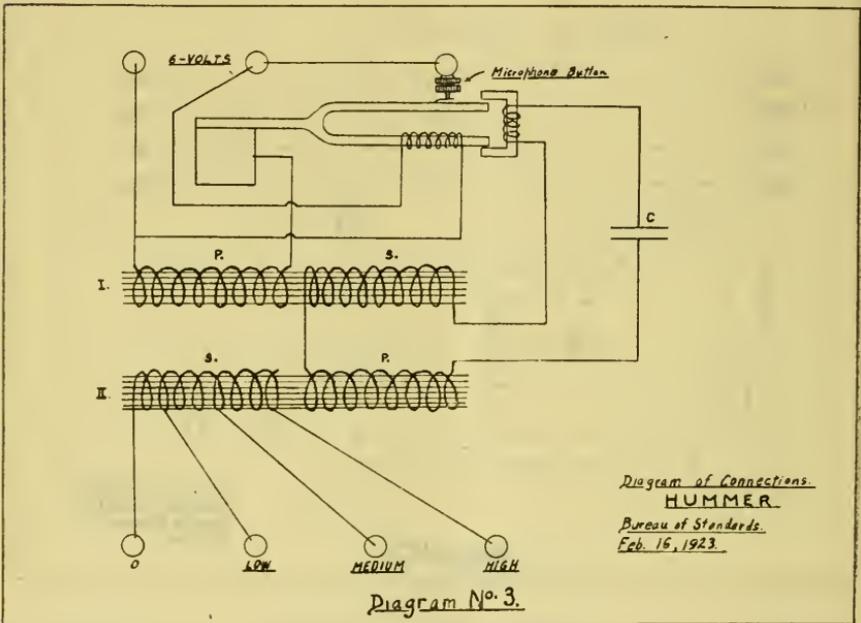


water. The hummer circuit is closed by the switch on the left side of the cabinet. This switch opens automatically when released. Should the hummer not start on closing the switch after two or three trials, the box containing the hummer should be tapped while the switch is held closed.

#### POWER CIRCUIT

Electric power for the entire operation of the apparatus is taken from the 110-120 volt direct current supply. This serves the following purposes:

1. Operation of the stirring motor.
2. The heating elements to maintain the bath at a desired temperature.
3. Heating lamps to keep inside the cabinet dry.
4. About 3 volts for the operation of the relay.
5. About 10 volts for the operation of the hummer which supplies the 1,000 cycle test current to the bridge.

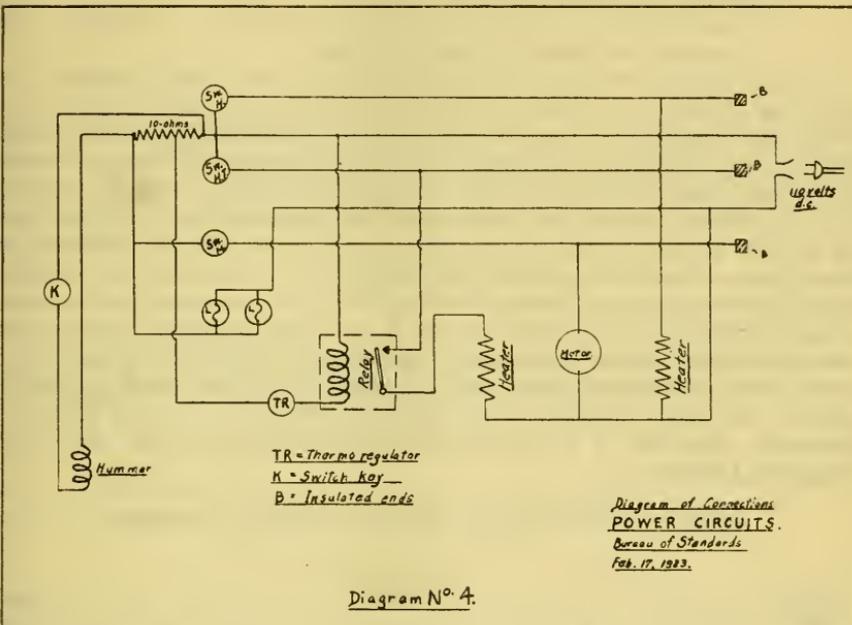


If one side of the power circuit of the ship is grounded, it is advisable to make the connection in such a way as to bring the relay and hummer to practically ground potential. This not only materially reduces the chances for getting an electrical shock, but also the fire hazard. The power circuits should be left closed for the greater part of each day to preserve the insulation of the entire apparatus. A diagram of the power circuit is shown in diagram No. 4. The heaters for the bath are connected into the circuit by the upper and middle snap switches on the right side of the left-hand compartment of the cabinet. The middle switch is in series with the relay and so is the one to be kept at the "On" position when it is desired that the temperature of the bath be regulated. The top switch is normally kept in the "Off" position, as only one of the heaters is regularly required. This second heater may be used to bring the bath quickly to the regulating temperature, or when otherwise needed.

## PROCEDURE IN BALANCING BRIDGE

The bridge is balanced as follows:

1. Adjustment of the setting of the slide wire so as to bring the sound in the telephone receivers to a small or minimum value.
2. Without changing the setting of the slide wire, adjust the mutual inductance so as to further reduce the sound in the telephone receivers, if possible.
3. Without changing either the setting of the slide wire or the mutual inductance, and with the ground switch closed, adjust the slider on the third branch of the bridge so as to reduce the sound in the telephone receivers as far as possible, being sure that connection from the third branch to the shield is functioning properly. The ground switch should be kept open at all times except during this adjustment.



4. Again adjust the setting of the slide wire so as to reduce the sound in the telephones, this time as far as possible or until the setting of the slide wire is as definite as is desired.
5. If the adjustment 4 can not be made as precisely as desired, all the adjustments should be repeated before recording the reading of the setting of the slide wire.

## PROCEDURE IN MAKING MEASUREMENTS

The procedure to be followed in carrying out a measurement is as follows:

1. Put into the auxiliary or Y cell sea water having a salinity slightly in excess of that which corresponds to a reading of 500 on the slide wire as given by the table or curve. This solution may be left in the cell more or less indefinitely if the cell is kept properly closed.

2. Put into the measuring or *X* cell sea water of known salinity and preferably of such salinity as corresponds to a reading in the vicinity of 500 as given by the table or curve, first having rinsed the *X* cell with sea water of substantially the same salinity.
3. Set the reading of the slide wire to correspond with the known salinity as given by the table or curve.
4. Balance the bridge according to instructions given above, making the adjustments of *Q* in each case instead of the slide wire which must be kept at the reading corresponding to the known salinity. Should this not be possible, very probably the salinity of the sea water used in the *Y* cell is not suitable.
5. Withdraw from the *X* cell the solution of known salinity. Rinse with some of the sea water whose salinity is to be measured, then fill with the sea water.
6. Balance the bridge according to directions given above.
7. Record the reading of the slide wire.
8. From the curve or table find, by interpolation if necessary, and record the salinity of the sea water.

In each case, before making the final balance of the bridge, sufficient time should be allowed for the sea water in the two cells to come within  $0.01^{\circ}$  C. of the same temperature, and the bath should be regulated at a temperature differing from  $25^{\circ}$  C. by not more than a few hundredths of a degree. Unless the *X* and *Y* cells have very nearly the same constants, it may be advisable or even necessary to take their differences into consideration in deciding upon the salinity of the sea water to be used in the *Y* cell. In any case this cell should have a resistance such that the bridge may be balanced with comparatively small setting for *Q* when the slide wire is set at a reading corresponding to the salinity of the sea water in the *X* cell. The following table for converting readings of the apparatus to salinities, is based on values for the conductivity published by Thuras in the Journal of the Washington Academy of Science, and upon constants of the apparatus determined in the Bureau of Standards. The way in which these enter into the construction table is explained in Appendix 1.

*Table for conversions of apparatus readings to salinities*

| Vertical scale | Drum readings |        |         |      |      |      |      |      |        |        | Differences |
|----------------|---------------|--------|---------|------|------|------|------|------|--------|--------|-------------|
|                | 0             | 10     | 20      | 30   | 40   | 50   | 60   | 70   | 80     | 90     |             |
| 0.....         | 30.000        | .094   | .189    | .283 | .378 | .473 | .567 | .662 | .757   | .853   | .95         |
| 1.....         | .950          | 31.045 | .140    | .236 | .333 | .429 | .525 | .623 | .719   | .816   | .96         |
| 2.....         | .915          | 32.014 | .111    | .208 | .307 | .405 | .502 | .602 | .702   | .802   | .98         |
| 3.....         | .899          | .999   | 33.098* | .199 | .299 | .400 | .502 | .603 | .704   | .806   | .101        |
| 4.....         | .908          | 34.069 | .112    | .214 | .318 | .420 | .528 | .634 | .743   | .847   | .104        |
| 5.....         | .953          | 35.057 | .162    | .269 | .378 | .483 | .593 | .700 | .811   | .919   | .108        |
| 6.....         | 36.030        | .143   | .251    | .362 | .473 | .587 | .696 | .809 | .926   | 37.040 | .112        |
| 7.....         | .150          | .296   | .388    | .502 | .620 | .738 | .860 | .975 | 38.097 | .220   | .116        |

#### CARE OF APPARATUS

In order to maintain the electrical insulation it is advisable to keep the inside of the cabinet as free as possible from salt, and thoroughly dry, at least whenever in use. Any sea water spilled inside the cabinet should be taken up promptly and thoroughly. The electrical terminals of the cells should be inspected occasionally, or wiped out with a small amount of cotton waste. Sea water left in these terminals in contact with the mercury and copper causes

apid corrosion. To facilitate keeping the cabinet dry, no water either fresh or salt should be kept on the inside unless properly sealed, and in addition the inside should, during the least part of the time, be kept at a temperature above that prevailing outside the ship. In any case care should be taken to see that the water bath does not freeze. The electrical contact in the thermoregulator should be inspected occasionally and cleaned if necessary.

## APPENDIX I

## RELATIONS BETWEEN BRIDGE READINGS AND SALINITIES

A simple plan of the bridge is shown in Diagram No. 1, where  $X$  is the resistance of the bridge arm, including the cell in which the sea water whose conductivity is to be measured is placed, and  $Q+Y$  is the resistance of the arm of the bridge containing the auxiliary or comparison cell.  $M$  and  $N$  are the resistances of the ratio arms when the slide is set at zero. If, then,  $Q$  is adjusted so that the bridge is balanced, from the Wheatstone bridge equation it follows that

$$X' = \frac{M}{N}(Q+Y) \quad (1)$$

where  $X'$  represents the resistance of the bridge arm when the cell contains sea water of resistivity  $R'$  and a salinity  $S'$ .

If now the sea water is changed to one of greater salinity and the bridge is balanced by changing the position of the slider from a reading of zero to a reading  $r$

$$X = \frac{M}{N} \left( \frac{1-mr}{1+nr} \right) (Q+Y) \quad (2)$$

Where  $m$  is the resistance of one division of the slide wire divided by  $M$ , and  $N$  is the resistance of one division of the slide wire divided by  $N$ , from equations (1) and (2) it follows that—

$$X = X' (1 - (m+n)r + (mn+n^2)r^2 - (mn^2+n^3)r^3) \quad (3)$$

or as the resistivities  $R'$  and  $R$  of the two samples have the same relation as their resistances, since the same cell is used in the two cases,

$$R = R' (1 - (m+n)r + (mn+n^2)r^2 - (mn^2+n^3)r^3) \quad (4)$$

Since it has been found that the relation between the salinity and resistivity is approximately linear it may be represented over the range in which we are concerned by a second-order equation of the following form:

$$R = R' (1 + A(S-S') + B(S-S')^2) \quad (5)$$

Where  $S$  is the salinity of the sea water having the resistivity  $R$ , and  $S'$  is the salinity of the sea water having the resistivity  $R'$ , from equations (4) and (5) it follows that—

$$S = - \left( \frac{m+n}{A} \right) r + \left( \frac{mn+n^2}{A} \right) r^2 - \left( \frac{mn^2+n^3}{A} \right) r^3 - \frac{B}{A} (S-S')^2 + S' \quad (6)$$

or

$$S = ar + br^2 + cr^3 + ds + S' \quad (7)$$

where,

$$s = S - S', \quad a = - \frac{m+n}{A}, \quad b = \frac{mn+n^2}{A}, \quad c = \frac{mn^2+n^3}{A}, \quad \text{and } d = - \frac{B}{A}.$$

Values for  $m$  and  $n$  found in testing the apparatus in February, 1923, are as follows:

$$m=0.000125 \qquad n=0.000143$$

From the data published by Thuras we find in the case  $S'$  is taken as 30 parts per thousand.

$$A=-0.02847 \qquad B=0.000648$$

These values for  $A$ ,  $B$ ,  $m$ , and  $n$ , give—

$$\begin{aligned} a &= 0.009413 \\ b &= -0.000001344 \\ c &= 0.0000000001920 \\ d &= 0.002276 \end{aligned}$$

## APPENDIX II

### SUGGESTIONS FOR THE CONSTRUCTION OF NEW CONVERSION TABLE OR CURVE

In order to avoid all possibility of errors in the determinations made by Thuras, in the calculation of the constants  $A$  and  $B$  from his data, errors in the test of the apparatus or possible changes in the apparatus, and in the calculation of the table it may be advisable to construct a new table or curve based directly upon measurements made with the apparatus, using samples of sea water whose salinity has been determined by the titration method. The table given above is for sea water of salinities from 30 to 38 parts per thousand, and might have been extended to about 40 parts per thousand before reaching the upper limit of the scale. In making a new table or curve, it seems that it would be well to start with a reading of about—

200 for a salinity of 30.

500 for a salinity of 33.

600 for a salinity of 34.

This would make the range of salinities which might be measured from about 28 to about 38. In making a new table or curve, as in the use of the apparatus and as in the determination of salinities by the titration method, it is necessary to have a quantity of sea water of known salinity to be used as a standard. However, this standard need not be the same as that which will later be taken aboard the ship.

With these values of  $a$ ,  $b$ ,  $c$ , and  $d$  substituted in equation 7, the data is in about as convenient form for calculations as it can conveniently be put. However, it would not be practicable to calculate the salinity directly from this equation each time a measurement were made. Therefore the equation was used in the construction of the table given above which is for the purpose of converting the readings of the apparatus to salinities. This table gives salinities directly for readings of 0, 10, 20, etc., up to a reading corresponding to a salinity of 38 parts per thousand. It is so tabulated that interpolations can readily be made to 1 in the reading of the slide wire or to 0.01 in the salinity.

Let us suppose that the sea water to be taken as a standard for this purpose has a salinity of 29.75. Then to have the table or curve extend over the range suggested above we should set the slide wire index at a reading of 175 and this arbitrarily fixes one point on the curve. Other points on the curve are then fixed with respect to this one when the changes in reading are noted as the sea water of salinity 29.75 in the  $X$  cell is replaced with sea water of other known salinities.

The greater the number of points from which to plot the curve the more reliable it should be. However, there is every reason to expect the curve to be

of the second order only, so that it could be determined accurately from three accurately located points, provided one of these is near the zero end, a second near the center, and a third near the upper end of the scale. The distribution of the points is therefore of more importance than the actual number. Consequently it may be advisable to make a special effort to get a few points corresponding to salinities as low as 29, and a few as high as 37. It is presumed that there will be available a considerable number of samples having salinities in the range from 30 to 35.

The general procedure in making these measurements should be identically the same as that outlined above for the use of the apparatus, except that points on the curve corresponding to known salinities and observed readings of the apparatus are determined instead of the salinities from a curve or table and the observed readings of the apparatus.

Any systematic error in the titrations of the sea water to be used in this work will of course be carried directly to the curve or table. An estimate of the magnitude of the errors from this source can only be made by the persons who will have the supervision of this part of the work. The indications are that errors from other sources need not exceed 0.01 in salinity. The curve or table determined with any one of the cells used as the  $X$  cell will not apply in the case of the use of any other cell, and, it will not apply in case of other apparatus even of the same type, unless the ratio of the resistance of a division of the slide wire to the resistance of the slide wire plus the end coils is the same for this apparatus, that is, unless the constants  $m$  and  $n$  referred to in Appendix I have the same values.

In case the curve is plotted to a scale sufficiently large so that it can be read somewhat better than hundredths in salinity it may be too large for convenient use on ship board, therefore it may be advisable to construct a table for this purpose and similar to the table given above. The data for such a table might be taken directly from the curve plotted to the large scale. A record should be kept of all readings taken with the apparatus for the purpose of making the curve so that in case difficulties are encountered in the construction of the curve by this means, its equation can be determined by an analytical method and the table calculated from the equation.

It was decided to calibrate the apparatus according to the method just described in Appendix II, which possesses the advantage of eliminating previous computations. The slide-wire readings were plotted on a large scale graph directly against salinities. This work was performed during the winter of 1923-24 at the museum of zoology, Harvard University, there being a large supply of known samples available from the ice season, all of which had previously been titrated at Cambridge. The procedure in detail was as follows:

1. A solution of known salinity 30.91 ‰ was placed in  $X$  cell.
2. A solution of about 33.00 ‰ was placed in  $Y$  cell, or of such salinity that for a small setting of  $Q$  the reading on the slide wire would be about 200.
3. By varying the salinity of this solution slightly we finally obtained a balance of the slide at 235 when  $Q$  read 243. This number of 235, therefore, was the first point in the construction of the curve.
4. Known solutions of increasing salinity were successively placed in the  $X$  cell and the readings of the slide gave points on the graph,

so frequently selected that no mistake could be made in connecting them by means of a smooth curve. A table was then constructed for each division of the slide-wire scale based on the data of the curve.

The work of testing 60 to 80 samples and locating a similar number of points along the curve of salinities versus slide-wire readings brought out some interesting facts in connection with the operation of the apparatus.

It was soon observed by readings of the apparatus that the temperature factor played an important part in the test of a sample and it was necessary that each sample be given plenty of time to permit its temperature to come to the same as that of the bath. In order to determine how long it took for a test sample to assume the bath temperature, 25° C., the following slide-wire readings were taken of a sample which was 22° C., when placed in the *X* cell.

| No.    | Time  | Interval                        | Reading | Salinity |
|--------|-------|---------------------------------|---------|----------|
| 1..... | 10.52 | } Sample in test 4 minutes....  | 725.0   | 35.799   |
| 2..... | 10.56 |                                 |         |          |
| 3..... | 11.00 | } Sample in test 8 minutes....  | 729.0   | 35.844   |
| 4..... | 11.04 |                                 |         |          |
| 5..... | 11.08 | } Sample in test 16 minutes.... | 730.5   | 35.859   |
| 6..... | 11.24 |                                 |         |          |
|        |       | } Sample in test 32 minutes.... | 730.5   | 35.859   |

It took approximately 12 minutes after placing the sample in the test cell to obtain an accurate scale reading.

A sample was then heated to approximately 25° C., that of the bath, and then placed in cell *X* of the apparatus.

| No.    | Time  | Interval                        | Reading | Salinity |
|--------|-------|---------------------------------|---------|----------|
| 1..... | 11.28 | } Sample in test 1 minute....   | 434.3   | 32.819   |
| 2..... | 11.29 |                                 |         |          |
| 3..... | 11.33 | } Sample in test 5 minutes....  | 433.9   | 32.808   |
| 4..... | 11.36 |                                 |         |          |
| 5..... | 11.40 | } Sample in test 8 minutes....  | 433.5   | 32.804   |
|        |       | } Sample in test 12 minutes.... | 433.6   | 32.805   |

It can be seen from the foregoing that in order to save time it is well to bring the samples of sea water desired tested near the temperature of the bath, and even then a sample which differs by 2° C. should be allowed at least 12 minutes to come to rest before testing. A sample near the bath temperature of 25° C. may be accurately tested from 5 to 8 minutes after placing it in *X* cell. In one instance where the sample placed in *X* cell was 3° colder than the bath temperature, the minimum point as heard by the phones gave slide-wire reading of 260. But this point crept continuously along the scale to 280 and 290 in less than 1 minute interval and finally came to rest at 330.70 points farther along on the

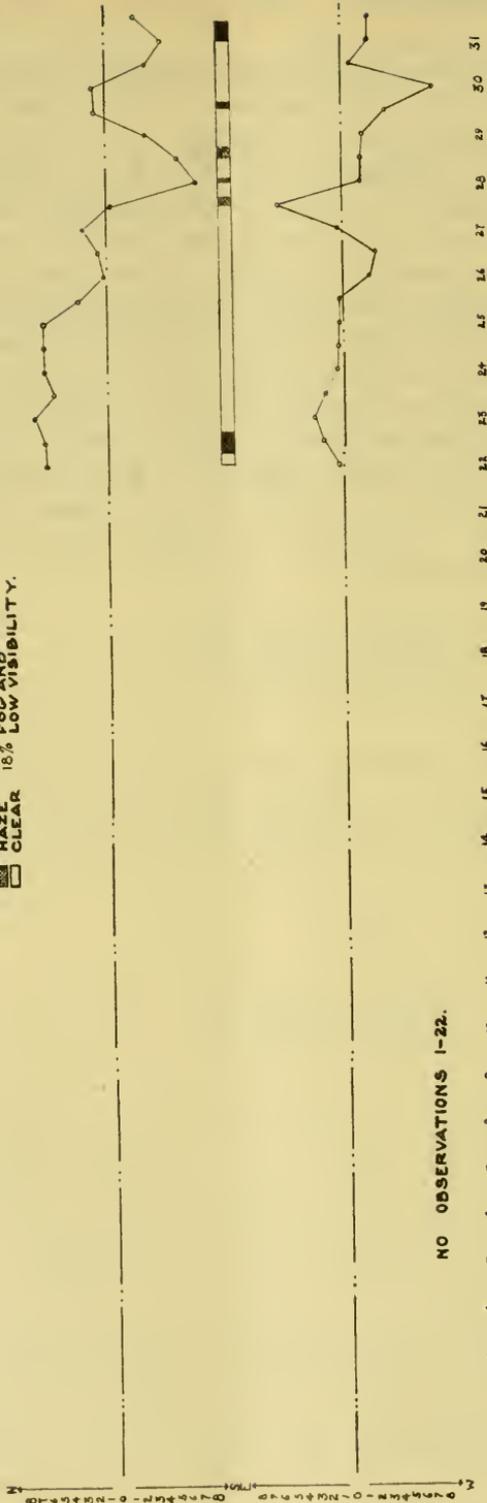
slide than originally tested. This represents a difference in salinity of 0.5 ‰.

Further experimenting with the apparatus revealed the fact that a difference of 0.1° in the temperature of the bath causes a difference of 3.5 divisions in the reading of the slide wire or approximately 0.035 ‰ difference in salinity, for a difference of one division of the slide wire units is approximately equal to 0.01 ‰ in salinity. From this it can be seen that the temperature of the bath should be carefully watched, a variation of 0.03° causing 0.01 ‰ variation in the salinity of the sample being tested. The warmer the bath the lower will be the salinity record obtained.

It is deemed advisable to recalibrate the apparatus at least once a week and at more frequent intervals if there is any reason to suspect evaporation or change in the *Y* cell. In this connection there should be a sufficient supply of three standard known solutions kept on board at all times. By such means a cross check can be made at any time to locate a possible change occurring in any one of the three solutions.

WIND DIAGRAM AND FOG SCALE

■ FOG  
 ■ 16% FOG  
 ■ 18% FOG AND  
 ■ MAZE  
 ■ 18% LOW VISIBILITY.  
 □ CLEAR

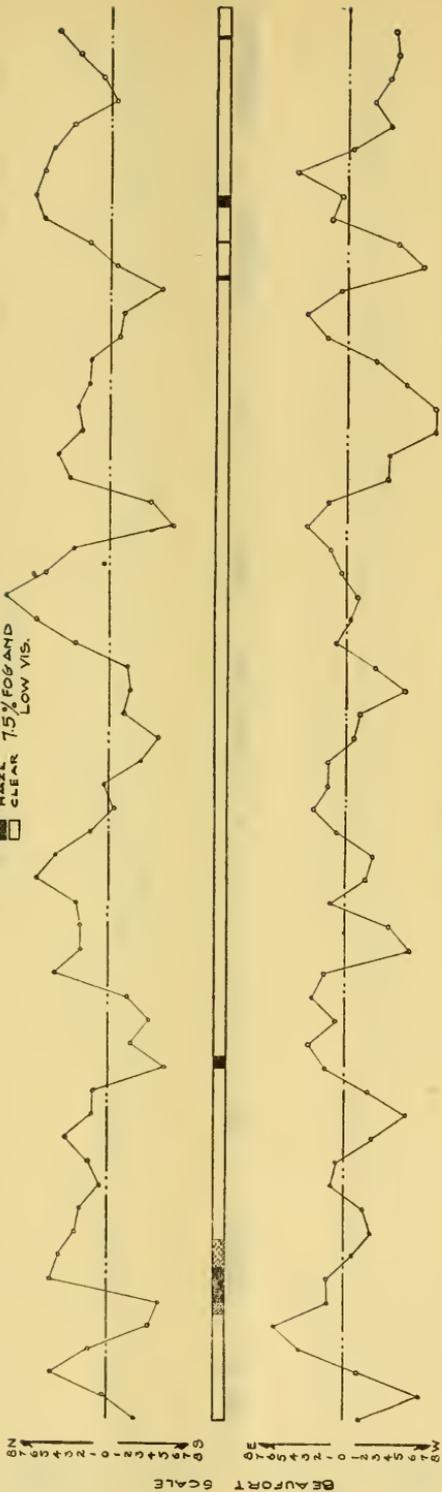


NO OBSERVATIONS 1-22.

MARCH-1924.

WIND DIAGRAM AND FOG SCALE

■ FOG  
 ■ 5% FOG-  
 ■ HAZE  
 ■ 75% FOG AND  
 ■ CLEAR  
 ■ LOW VIS.

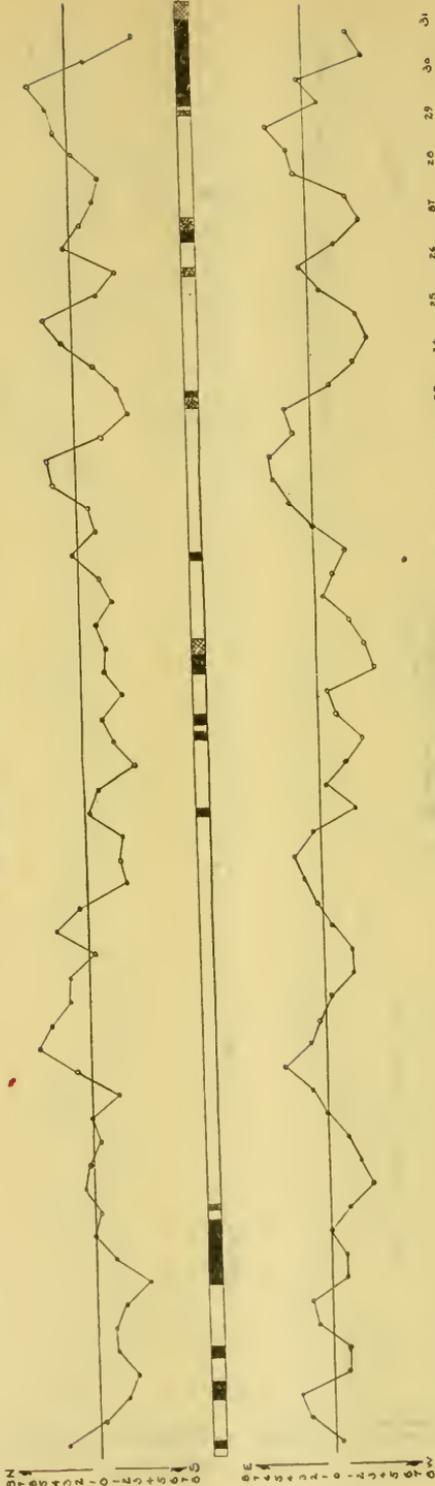


1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

APRIL - 1924.

WIND DIAGRAM AND FOG SCALE

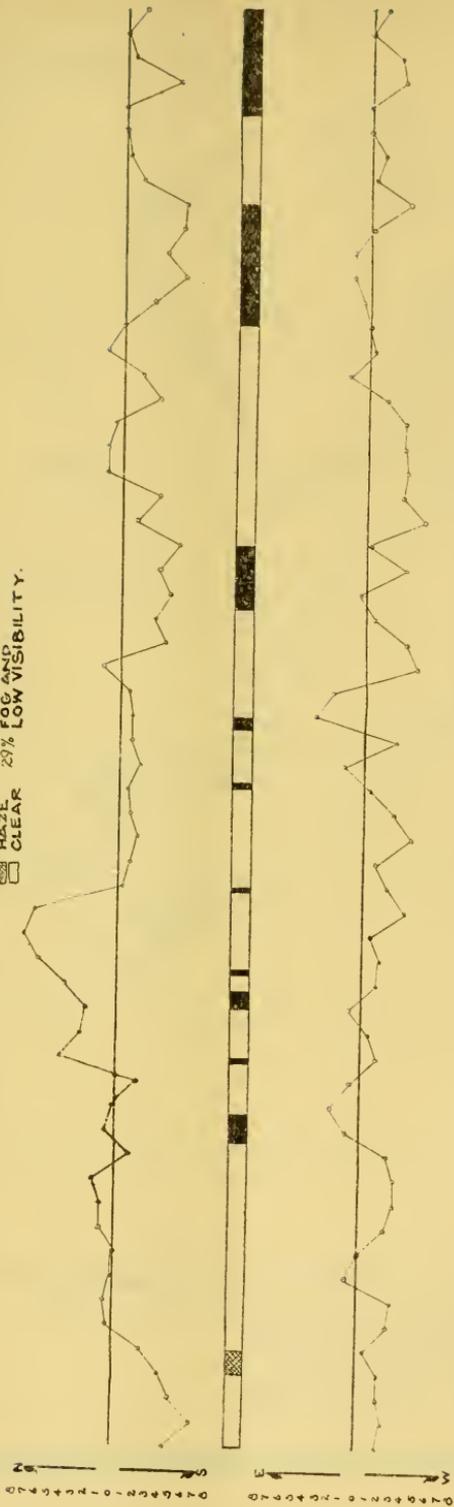
 FOG  
 16% FOG  
 HAZE  
 19% FOG AND LOW VISIBILITY  
 CLEAR



MAY-1924.

WIND DIAGRAM AND FOG SCALE

 WIND  
 FOG  
 HAZE  
 CLEAR  
 27% FOG AND LOW VISIBILITY  
 25% FOG AND LOW VISIBILITY



1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30  
 JUNE-1924.





△-BERGS.  
○-GROWLERS.  
—-FIELD ICE.

GENERAL CHART  
COVERING  
ICE PATROL  
MONTHLY POSITIONS "COLD-WALL"  
SHOWING SEA-WATER TEMPERATURES AND VARIOUS CONDITIONS IN VICINITY  
GRAND BANKS  
1924.

BEAUFORT SCALE FOR WIND DIAGRAM.

CHART "D."

U.S. NAUTICAL CHART





ANNUAL LIMITS "COLD WALL," GRAND JANKS. BATHYMETRICAL CHART

CHART E





Δ - BERGS.  
 O - GROWLERS.  
 NW - FIELD ICE.

BASED ON 812 WATER TEMPERATURES.

ARCTIC WATER

NORTHERN EDGE WARM ATLANTIC WATER.

GENERAL CHART

COVERING  
 ICE PATROL  
 MARCH 15 - APRIL 1, 1924.

SHOWING SEA-WATER TEMPERATURES AND VARIOUS CONDITIONS IN VICINITY  
 GRAND BANKS

BEAUFORT SCALE FOR WIND DIAGRAM.

CHART "F"





△ BERGS.  
○ GROWLERS.  
▨ FIELD ICE.

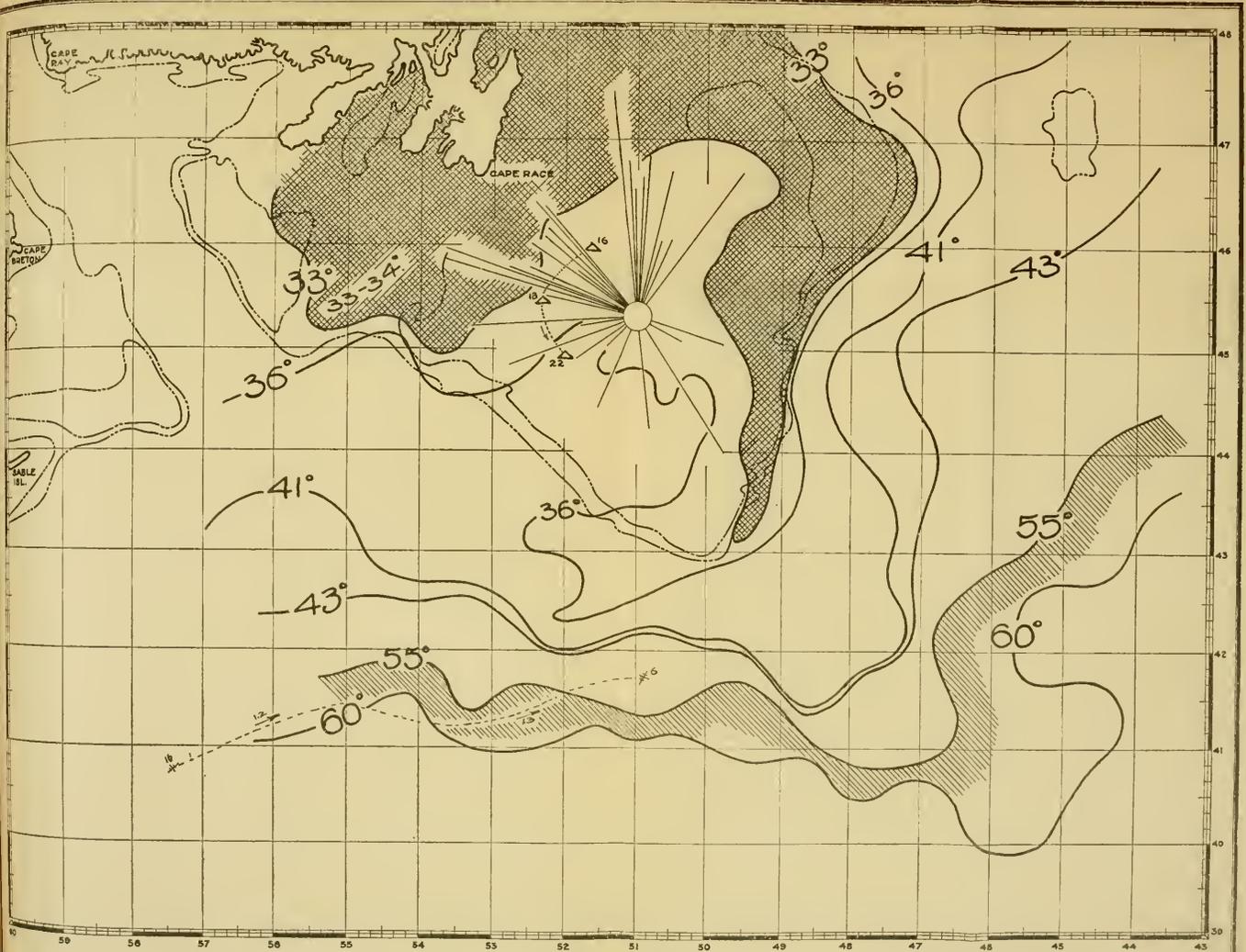
BASED ON 1010 TEMPERATURES.

GENERAL CHART  
COVERING  
ICE PATROL  
APRIL 1-15, 1924.  
SHOWING SEA-WATER TEMPERATURES AND VARIOUS CONDITIONS IN VICINITY  
GRAND BANKS

BEAUFORT SCALE FOR WIND DIAGRAM.

CHART "G"





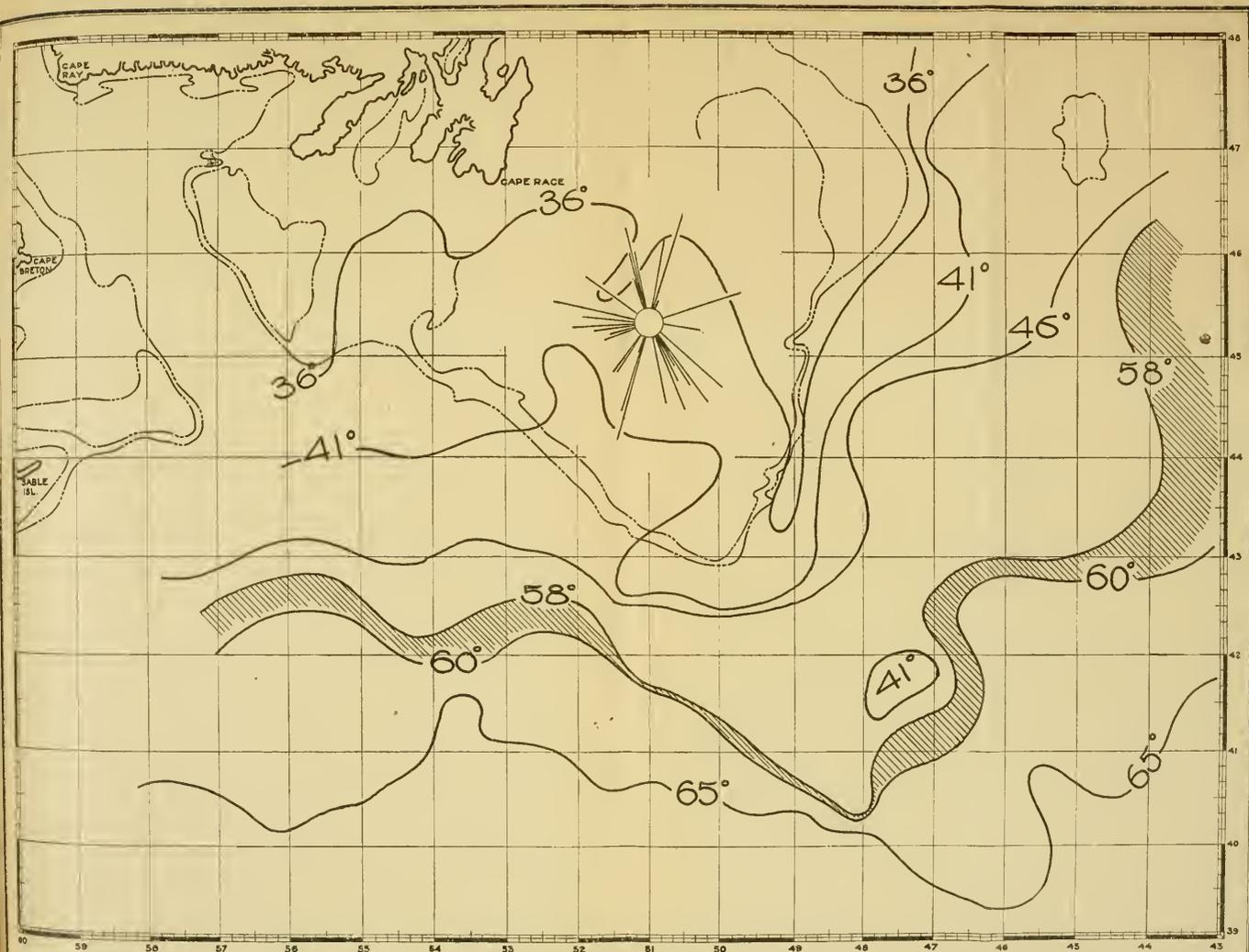
△-BERGS.  
 ○-GROWLERS.  
 -W-FIELD ICE.

BASED ON 752 TEMPERATURES.

GENERAL CHART  
 COVERING  
**ICE PATROL**  
 APRIL 15-30, 1924.  
 SHOWING SEA-WATER TEMPERATURES AND VARIOUS CONDITIONS IN VICINITY  
**GRAND BANKS**

BEAUFORT SCALE FOR WIND DIAGRAM.  
**CHART "H."**





Δ - BERGS  
 ○ - GROWLERS.  
 ▨ - FIELD ICE.

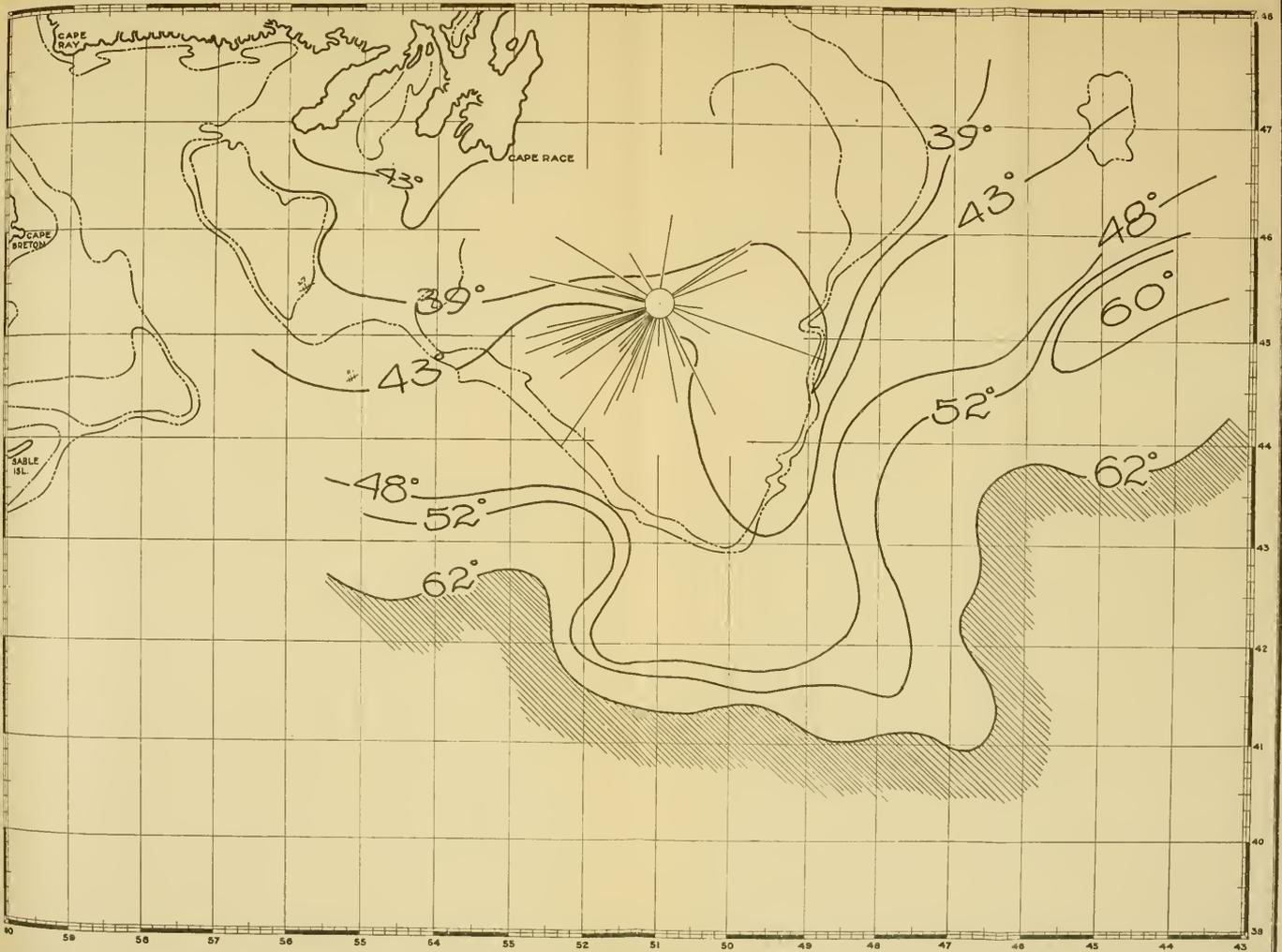
GENERAL CHART  
 COVERING  
**ICE PATROL**  
 MAY 1-13, 1924.  
 SHOWING SEA-WATER TEMPERATURES AND VARIOUS CONDITIONS IN VICINITY  
**GRAND BANKS**

BEAUFORT SCALE FOR WIND DIAGRAM.

CHART "I"

U. S. GOVERNMENT PRINTING OFFICE: 1924





△ - BERGS.  
 ○ - GROWLERS.  
 ▨ - FIELD ICE.

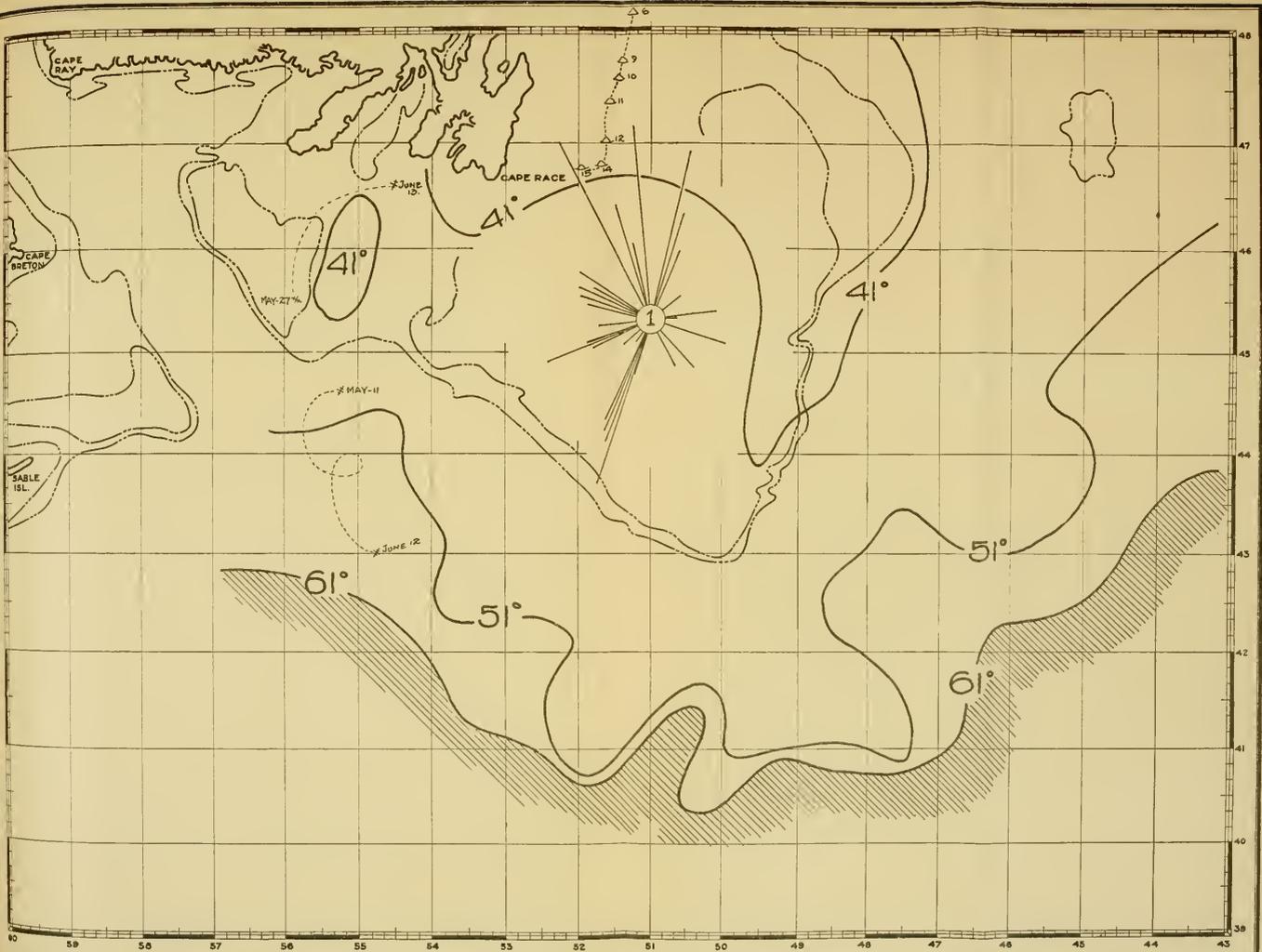
GENERAL CHART  
 COVERING  
**ICE PATROL**  
 MAY 15-31, 1924.  
 SHOWING SEA-WATER TEMPERATURES AND VARIOUS CONDITIONS IN VICINITY  
 GRAND BANKS

BEAUFORT SCALE FOR WIND DIAGRAM.

CHART "J."

NO. 1144, REV. 1911





- △ - BERGS.
- - GROWLERS.
- - FIELD ICE.
- ✕ - WRECKAGE.

BASED ON 650 WATER TEMPERATURES

GENERAL CHART  
COVERING  
ICE PATROL  
JUNE 1-15, 1924.

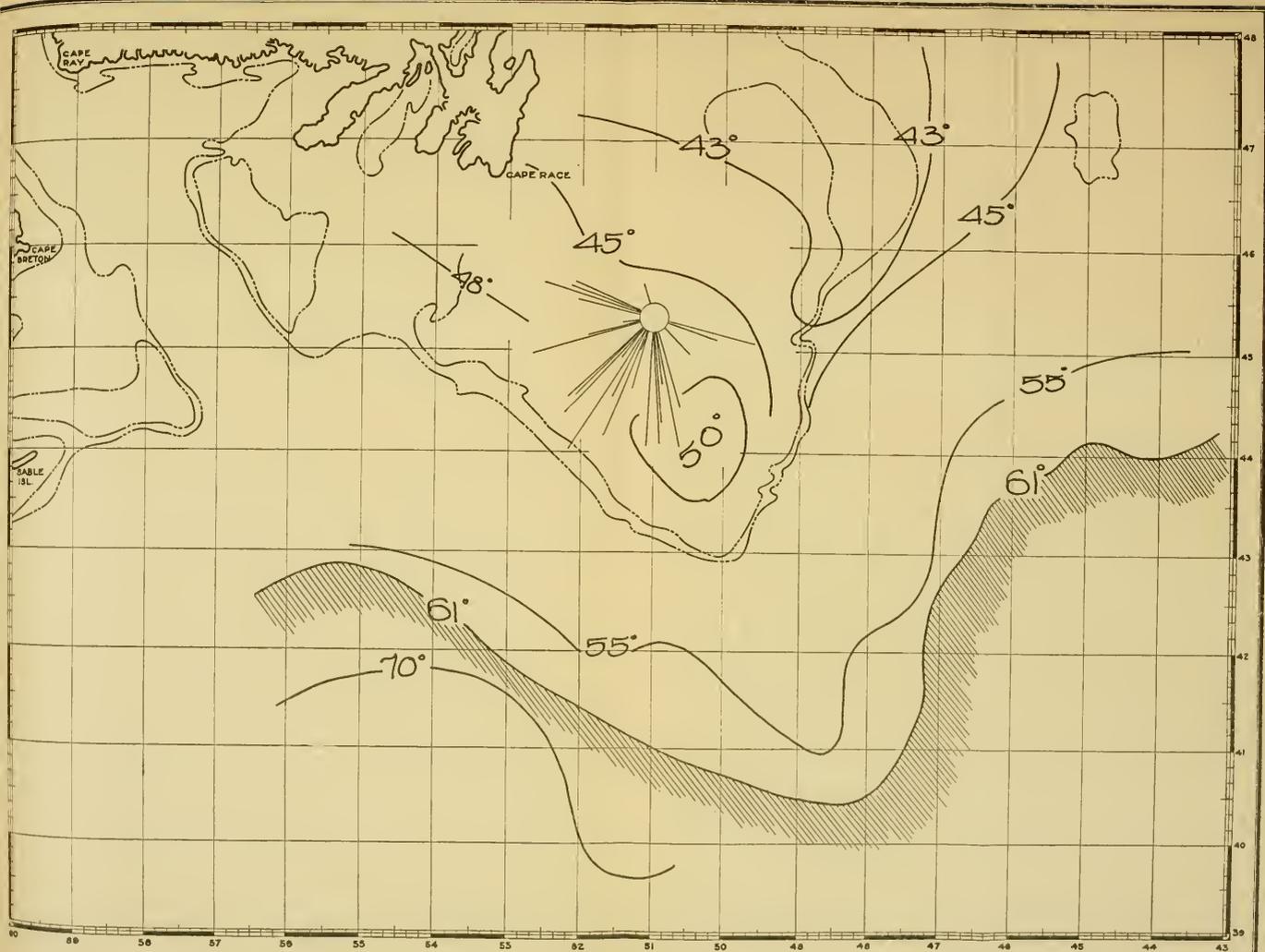
SHOWING SEA-WATER TEMPERATURES AND VARIOUS CONDITIONS IN VICINITY  
GRAND BANKS

BEAUFORT SCALE FOR WIND DIAGRAM.

CHART "K".

H. O. Misc. No. 2511





▲ - BERGS  
 ○ - GROWLERS.  
 --- FIELD ICE.

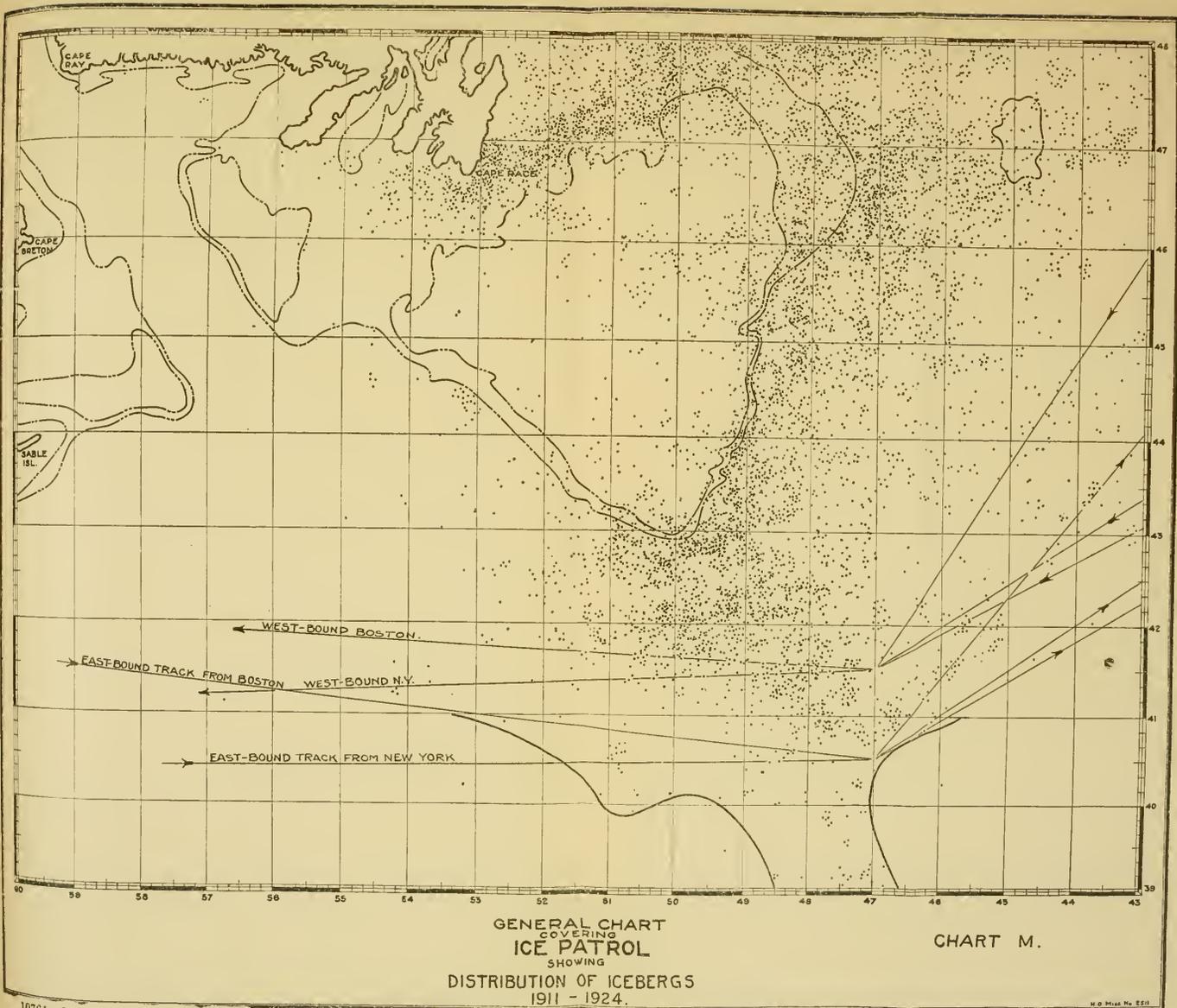
GENERAL CHART  
 COVERING  
**ICE PATROL**  
 JUNE 15-30, 1924.

SHOWING SEA-WATER TEMPERATURES AND VARIOUS CONDITIONS IN VICINITY  
**GRAND BANKS**

BEAUFORT SCALE FOR WIND DIAGRAM.

**CHART "L".**



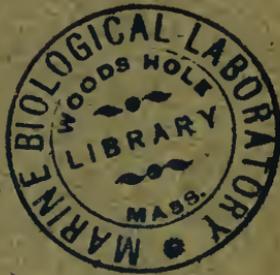




TREASURY DEPARTMENT - UNITED STATES COAST GUARD

BULLETIN No. 13

INTERNATIONAL ICE OBSERVATION  
AND ICE PATROL SERVICE IN THE  
NORTH ATLANTIC OCEAN - [SEASON of  
1925]





TREASURY DEPARTMENT  
UNITED STATES COAST GUARD

Bulletin No. 13

INTERNATIONAL  
ICE OBSERVATION AND ICE PATROL  
SERVICE

IN THE  
NORTH ATLANTIC OCEAN



---

Season of 1925



WASHINGTON  
GOVERNMENT PRINTING OFFICE

1926

1872

1873

1874

1875

1876

1877

1878

1879

1880

1881

1882

1883

1884

1885

1886

1887

1888

1889

1890

1891

1892

1893

1894

1895

1896

1897

1898

1899

1900





EXPLOSION OF TWO SMALL TNT MINES ON BERG NO. 7 ON MAY 20, 1925

No appreciable effect was noticed

## FOREWORD

This report was prepared by the oceanographer, Lieut. Commander F. A. Zeusler, United States Coast Guard. The data in general was obtained from the official letters of the commanding officers of the patrol vessels and the reports of the oceanographer. Unlike the ice-patrol reports of the previous seasons, the individual letters of the commanding officers have been omitted and the data prepared in narrative style with appendices covering the points not taken up in detail by the report proper. Attention is invited to the fact that the table of data concerning the scientific stations taken during the cruise of 1924 is also contained herein.



## TABLE OF CONTENTS

|                                                                                    | Page |
|------------------------------------------------------------------------------------|------|
| The Inauguration of the International Ice Patrol .....                             | vi   |
| The organization and duties of the International Ice Patrol.....                   | 1    |
| The first cruise, Tampa, March 23-April 9.....                                     | 5    |
| The second cruise, Modoc, April 9-April 24.....                                    | 8    |
| The third cruise, Tampa, April 24-May 8.....                                       | 14   |
| The fourth cruise, Modoc, May 8-May 23.....                                        | 18   |
| The fifth cruise, Tampa, May 23-June 8.....                                        | 21   |
| The sixth cruise, Modoc, June 8-June 25.....                                       | 24   |
| The seventh cruise, Tampa, June 25-July 9.....                                     | 29   |
| The eighth cruise, Modoc, July 9-July 12.....                                      | 32   |
| Report of the ice-patrol commander.....                                            | 33   |
| Ice observations. (Ice drift for each cruise is covered by the cruise report)..... | 36   |
| Sonic depth finder report.....                                                     | 45   |
| Charts showing soundings..... facing                                               | 90   |
| Radio communication.....                                                           | 51   |
| Miscellaneous data, birds, radiocompass, etc.....                                  | 61   |
| The salinity apparatus.....                                                        | 67   |
| Station table, cruise of 1925.....                                                 | 69   |
| Ice and obstruction reports, cruise of 1925.....                                   | 73   |
| Wind diagram and résumé.....                                                       | 80   |
| Surface temperature charts, cruise of 1925..... facing                             | 90   |
| Current chart..... facing                                                          | 90   |
| Station table, cruise of 1924.....                                                 | 81   |

## THE INAUGURATION OF THE INTERNATIONAL ICE PATROL

On April 14, 1912, the S. S. *Titanic* collided with an iceberg and was sunk with a great loss of life. After the disaster a universal demand arose to have the area containing ice patrolled to prevent further accidents of that nature. The ice area near the Tail of the Banks is particularly dangerous, as it is enshrouded by fog a great proportion of the time. On May 15, 1912, the United States Navy detailed two cruisers to establish the patrol and alternate on duty until the ice was no longer a menace. In 1913, the naval vessels not being available, the President of the United States directed the Secretary of the Treasury to detail two Coast Guard (then revenue cutters) cutters to perform the duty. The cutters *Seneca* and *Miami* were assigned, and they carried out the patrol for 1913. The British Government also took up the question of ice observation and ice patrol for the season 1913, with the result that the steam trawler *Scotia* was chartered and fitted out for the service. The work of the *Scotia* was confined almost entirely to ice and weather observations off the coast of Newfoundland. The *Scotia* cooperated with the cutters in so far as the conditions permitted in disseminating ice information to passing vessels. On November 12, 1913, an international conference for the safety of life at sea was convened at London. On January 20, 1914, an agreement was signed by the principal maritime nations of the world, providing among other things for the inauguration of the international derelict destruction, ice observation, and patrol service, to consist of two vessels which should establish and maintain a continuous patrol of the area of the North Atlantic Ocean most endangered by ice during the ice season. The United States was asked to undertake the management of this service, each of the contracting parties agreeing to bear its share of the cost of the patrol in proportion to the shipping tonnage. This was favorably considered by the President of the United States, and on February 7, 1914, the United States Coast Guard (then the Revenue Cutter Service) was directed to assume the duty of conducting the ice patrol. The Coast Guard has been carrying out the patrol and collecting data concerning the movements of the ice and currents in the ice area since that time, except for the years 1917 and 1918. The countries that are now a party to the agreement are Belgium, Canada, Denmark, France, Germany, Great Britain, Italy, Netherlands, Norway, Sweden, and the United States.

## THE INTERNATIONAL ICE PATROL, 1925

The International Ice Patrol, season of 1925, was inaugurated on March 23, 1925. The vessels designated for the regular patrol were the United States Coast Guard cutters *Modoc* and *Tampa*, with the cutter *Seneca* as the stand-by vessel. Commander H. G. Fisher, United States Coast Guard, was assigned as the ice patrol commander and was in command of the *Tampa*. Commander H. H. Wolf, United States Coast Guard, was in command of the *Modoc*.

In accordance with the practice established during the previous season, an oceanographer was appointed, and, in order to insure the continuity of the patrol, this officer was to transfer from ship to ship during the patrol season. Lieut. Commander F. A. Zeusler, United States Coast Guard, was designated to serve in this capacity in place of Lieut. Commander Edward Smith, who was temporarily absent from the United States on special duty in connection with the ice patrol and who was also studying oceanography under Prof. Helland Hansen at the Geophysical Institute in Bergen, Norway.

Due to the installation of new radio equipment on each vessel, sonic apparatus on the *Tampa*, and the desire of headquarters to carry out certain experiments, the oceanographer was assigned additional help consisting of the following men:

Ensign W. R. Richards, attached to the *Tampa*; Chief Radioman Ole Friis; and Yeoman (Second Class) Leo Shubow.

The primary duty of the patrol was to locate the icebergs and ice fields endangering the steamer lanes and to keep track of all the ice as it moved to the southward, eastward, and westward toward the steamship lanes, in order that the ice information could be disseminated to the vessels entering the ice-infested areas. The secondary duty was to carry out such oceanographic work as would not hamper the vessel in the execution of the primary duty. These two duties were more or less interrelated, especially in connection with the study of currents, the extent of Labrador current in the area where ice was usually found being determined by means of the oceanographic stations. Additional duties of the patrol included the experimenting with the sonic apparatus, current meters, and short-wave transmitters and receivers.

The primary duty was accomplished by (a) cruising in the ice-infested areas and in the doubtful areas, (b) requesting passing steamers to keep a bright lookout for ice and obstructions and reporting any seen to the patrol vessel. It may be stated at this time that

these steamer reports were of immense value in tracking the ice to the northward as the patrol vessel seldom left the areas that were menaced by the ice, and especially those areas near the steamship lanes. These "thousand eyes" of the merchant fleet proved the most valuable aid to the successful prosecution of the ice patrol.

Dissemination of the information was accomplished by means of radio, as follows:

(a) *Radio broadcasts*.—Regular broadcasts were transmitted twice a day on two wave lengths. (See Radio communication.)

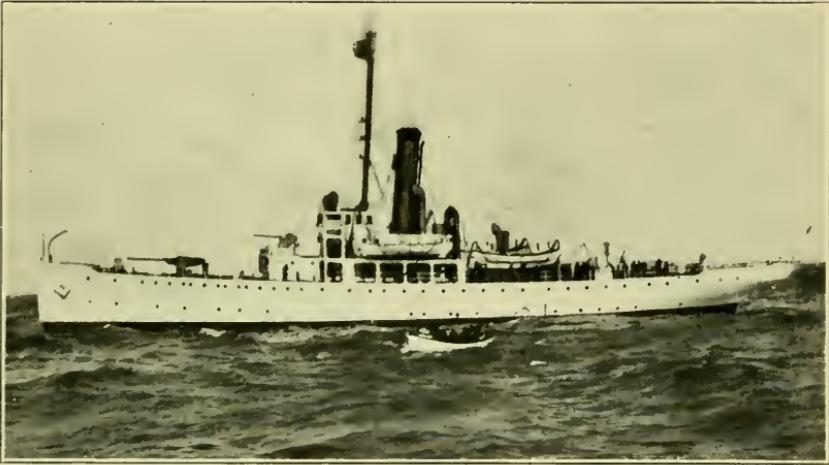
(b) *Special ice broadcasts*.—In foggy weather or whenever new ice was found a special broadcast was transmitted on 706 meters.

(c) *Special ice data*.—All positions of ships approaching the patrol or ice-infested areas were plotted whenever communication was established or their positions taken from the water temperature reports. Whenever a vessel was found approaching a dangerous area a special notice covering the latest ice information was transmitted to her.

(d) *Answering special requests from ships*.—All ships requesting special ice data were furnished complete information in regard to the ice.

The oceanographic work was planned so as to occupy stations at certain predetermined points at regular intervals of time and by taking stations alongside of bergs. The location of the ice and the weather at times, however, prevented regularity of schedules, but stations were usually taken at the various critical points. This work consisted of lowering specially constructed bottles, known as Greene Bigelow bottles, secured to a cable at the following depths: 0, 50, 125, 250, 450, and 750 meters. After being lowered each, bottle was tripped and closed at its depth by a messenger, or weight which slides down the wire for this purpose, thereupon securing a sample of the water at the various depths and simultaneously inverting a special type of reversible thermometer which registered the temperatures at those depths. The samples of water were tested for salinity and the information was compiled and profiles drawn. The data that was obtained determined the character of the water and was of special value in ascertaining the drift of the bergs and the location of the various currents. The salinity of the water was determined by means of the electric salinity tester installed on board the *Modoc*. A description of the apparatus is contained in the ice patrol report of 1924. Attention is invited to a general résumé of the practical operation of this apparatus and will be found on pages 67-69.

Another phase of the oceanographic work consisted in plotting the water temperatures as received from passing vessels and also taken from the patrol ship's observations. All passing vessels were requested, while within a certain prescribed area, to submit to the patrol



TRANSFER OF OCEANOGRAPHIC PARTY AT SEA, FROM THE RELIEVED  
PATROL VESSEL TO THE RELIEF

All necessary charts and data are transferred by the oceanographer. This insures the continuity of the patrol



TITANIC MEMORIAL SERVICES ON APRIL 14, 1925, HELD ON BOARD  
THE MODOC

vessel, once every four hours, their position, course, speed, sea-water temperature, and weather conditions. These temperatures were plotted on the water-temperature chart, from which the positions of the "cold wall" and Arctic water areas were determined. It may be of interest to note here that the "cold wall" is a name given to the boundary between the Arctic and Gulf waters. There is a noticeable difference between the temperature on either side of the cold wall and also a distinct change in color, the Arctic water being green and the Gulf water being blue. Whenever a vessel approached the cold-water area to the southward the master was further requested to submit the above information hourly, in order to secure sufficient data to determine the width of the Arctic water area. The positions of the ships were also plotted on the ship chart and track kept of all the vessels in the area or approaching the same. The meteorological data was plotted on the weather chart and certain of the reports transmitted to the Weather Bureau at 8 a. m. and 8 p. m. (seventy-fifth meridian time) daily.

The ice and obstruction reports were plotted on the ice chart and the set and drift calculated for further dissemination to the passing vessels. The bergs were followed constantly until their disintegration was complete or until they drifted into an area not traversed by passing ships and were no longer a menace to navigation. Daily at 8 p. m. (seventy-fifth meridian time) the patrol vessel transmitted a résumé of the ice conditions on the Grand Banks to the Hydrographic Office at Washington, D. C.

During the season the patrol vessels based temporarily at Halifax, obtaining their fuel and supplies at that port, and alternated every 15 days on patrol duty.

The Canadian Government assigned a vessel to ice-patrol duty in the waters from Cabot Strait inland to keep merchant shipping advised as to the ice conditions in the Gulf of St. Lawrence and the straits. This vessel cooperated constantly with the *Tampa* and the *Modoc* while on ice patrol duty.

In addition to the patrol another precaution, that is followed the year around, has been taken to protect the vessels passing in vicinity of the Tail of the Grand Banks. Certain routes or tracks across the North Atlantic Ocean have been established, known as the North Atlantic lane routes. These routes lead to the important ports in the northern part of the United States and those of Canada. There are seven tracks, tracks A to G, inclusive. Each track covers the eastbound and westbound traffic. The eastbound tracks are approximately 60 miles south of the westbound. The use of the individual track is dependant on the destination of the vessel, the season of the year, and the location of the ice. The list of the tracks is contained

in publication called the North Atlantic Lane Routes, which is revised whenever it is considered advisable. During the ice season the tracks leading to Halifax, New York, and Boston are shifted southward in accordance with a prearranged schedule, so as to be as clear as possible of the worst ice as it works down the eastern edge of the Banks. At the expiration of the patrol, usually about July 1, the tracks are again moved up as far north as safety permits. The principal trans-Atlantic steamship companies are signatories to the track agreement. It is the duty of the patrol vessel to report any vessel seen off the prescribed track.

The above presentation of the work of the patrol is made for the purpose of enabling the reader to fully comprehend the need for the oceanographic data that was collected and its relation to the patrol.

## CRUISES OF THE PATROL VESSELS

### FIRST CRUISE "TAMPA," MARCH 23-APRIL 9

The ice patrol season began on Monday, March 23, somewhat later than the cruise of 1924, due to the absence of ice on the Grand Banks, when the *Tampa* left Boston Navy Yard at 9.50 a. m. The vessel proceeded to Stellwagen Bank where the sonic depth finder and compensator were tested and compensated. A course was then laid up the coast of Nova Scotia to a point off Sambro Light Vessel and thence offshore. This gave the oceanographer an opportunity to test the sonic depth finder for depths in both shallow and deep water, in hard and soft bottom and over rocky bottom, obtaining excellent results. Communication was established with all radio stations interested in the ice patrol, and cooperation was requested from Cape Race, Chebucto, and St. Pierre, as well as the S. S. *Jacques Cartier*. All stations responded immediately, notifying the patrol vessel of their desire to cooperate. Cape Race was designated by the director of radio, Canadian Government, to disseminate all information relative to weather, ice, and obstructions emanating from the Canadian wireless service.

It was decided prior to the departure of the patrol vessels that the number of stations to be taken should be reduced to a minimum consistent with the efficiency of the patrol. During this patrol 20 stations were occupied. The first 3 were taken to determine whether Arctic water existed between Sable Island and the west side of the Grand Banks. Stations 4-20 were taken to determine the existence and extent of the Labrador current at the Tail of the Banks and its southern limits. Three radians on which these stations were located were centered on the critical point in latitude  $44^{\circ} 00' N.$ , longitude  $50^{\circ} 00' W.$

March 25 found the patrol vessel off Sable Island. A course was set to the southward to a point in latitude  $43^{\circ} 24' N.$ , longitude  $59^{\circ} 57' W.$  where the vessel arrived at 8 a. m., March 26. Here the first station was occupied. A moderate sea was encountered and for that reason only a limited number of samples were taken. This station also became the starting point for a series of soundings to the eastward to determine the general contour of the bottom on the approach to the Grand Banks from the southward and eastward. (See Charts Nos. 1 and 2.)

On March 27, Cape Race transmitted the following weather résumé for the winter months in Nova Scotia and Newfoundland:

Very favorable winter; January, cold; February, mild; average temperature 37°, March, favorable with a few cold spells; prevailing winds, December, NW.; January, NW.; February, SW. and SE., and March, NE.

A course was set to the eastward to a point in latitude 43° 18' N., longitude 51° 59' W. Two stations were taken on this leg. From that point the vessel proceeded to the extremity of the first radian where station No. 4 was taken. A course was laid along the radian and stations Nos. 5, 6, and 7 were taken at intervals. From station No. 7 a course was set along radian No. 2 and stations Nos. 8, 9, and 10 were taken. From station No. 10 a course was laid for the south-eastern extremity of radian No. 3 and stations Nos. 12 to 16, inclusive, were taken. When station No. 16 was reached a course was set for the critical point and a course laid to the eastward along radian No. 4 along which stations Nos. 17 to 20 were occupied. This work was completed by 6.30 p. m., April 1.

A résumé of the sea-water condition at various stations and depths is submitted. (See Charts Nos. 8 and 9.)

| Station No. | Date     | Position       |                | Data                                                                                                                                                                                                                                                                                                                                         |
|-------------|----------|----------------|----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|             |          | Latitude north | Longitude west |                                                                                                                                                                                                                                                                                                                                              |
| 1           | Mar. 26  | 43 24          | 59 57          | Arctic water throughout but with warmer water at the lower level. Very warm water throughout with Gulf stream salinity. The layer of water at 50 meters was somewhat cooler and fresher than that of the other layers.                                                                                                                       |
| 2           | ---do--- | 43 12          | 57 06          |                                                                                                                                                                                                                                                                                                                                              |
| 3           | Mar. 27  | 43 18          | 54 04          | Warm water throughout with Gulf stream salinity. Warm water throughout with Gulf stream salinity. The surface water was much warmer than the bottom water.                                                                                                                                                                                   |
| 4           | ---do--- | 41 53          | 51 59          |                                                                                                                                                                                                                                                                                                                                              |
| 5           | Mar. 28  | 42 26          | 51 30          | Warm water throughout with cooler water at the surface than at the bottom. Showed warm water. This water was much fresher than that at station No. 5.                                                                                                                                                                                        |
| 6           | ---do--- | 43 09          | 50 53          |                                                                                                                                                                                                                                                                                                                                              |
| 7           | ---do--- | 43 32          | 50 16          | Warm water at the surface but cooler at the bottom. Traces of Arctic water throughout.                                                                                                                                                                                                                                                       |
| 8           | Mar. 29  | 43 13          | 50 23          |                                                                                                                                                                                                                                                                                                                                              |
| 9           | ---do--- | 42 45          | 50 23          | Cool water at the surface increasing in temperature until 125 meters was reached. At this point temperature dropped considerably but again increased at 250 meters. Very warm water at the surface but decreasing in temperature as the depth increased. At 450 meters a very cold layer of water was found. All water was of high salinity. |
| 10          | ---do--- | 42 20          | 50 22          |                                                                                                                                                                                                                                                                                                                                              |
| 11          | Mar. 30  | 41 54          | 47 46          | Comparatively warm and salty water except for a layer of cooler water at 450 meters. Comparatively warm and salty water.                                                                                                                                                                                                                     |
| 12          | ---do--- | 42 13          | 48 15          |                                                                                                                                                                                                                                                                                                                                              |
| 13          | ---do--- | 42 33          | 48 43          | Comparatively warm and salty water throughout except at 50 meters where a layer of Arctic water was found. Cool water on the surface to Arctic water at a depth from 50 to 125 meters and warmer water below.                                                                                                                                |
| 14          | ---do--- | 42 54          | 49 16          |                                                                                                                                                                                                                                                                                                                                              |
| 15          | ---do--- | 43 09          | 49 39          | Cold water at surface but increasing in temperature. Warm water on surface decreasing toward bottom.                                                                                                                                                                                                                                         |
| 16          | Mar. 31  | 43 25          | 50 03          |                                                                                                                                                                                                                                                                                                                                              |
| 17          | ---do--- | 43 55          | 50 00          | Do.                                                                                                                                                                                                                                                                                                                                          |
| 18          | Apr. 1   | 44 00          | 49 06          |                                                                                                                                                                                                                                                                                                                                              |
| 19          | ---do--- | 44 01          | 48 50          | Cold water at surface and at bottom with a warmer layer between. Arctic water at surface and bottom with warmer layer between. Traces of cold water throughout, but all comparatively salty.                                                                                                                                                 |
| 20          | ---do--- | 44 02          | 48 25          |                                                                                                                                                                                                                                                                                                                                              |

A cruise to the northward was contemplated but a dense fog shut in on the evening of April 1 and the vessel was anchored on the

Banks. This fog lasted until 4 a. m., April 4, when a cruise was again undertaken to the northward. The vessel passed through a portion of the French fishing fleet that had arrived on the Banks, speaking 12 vessels, receiving their mail, rendering such medical and other assistance as was necessary, and giving positions to three. On the morning of April 5 a WSW. gale set in. The patrol ship was hove to a short distance away from the French schooner *L'Essor* which vessel desired her position. The gale lasted until noon April 6, when a cruise to the northward and eastward between latitudes  $46^{\circ}$  and  $47^{\circ}$  was attempted in search of ice. A SW. gale and snow was encountered and the vessel again slowed down. Word having been received at midnight April 7 that the *Modoc* had left Boston for the patrol, the vessel was headed south and west to a designated rendezvous in latitude  $45^{\circ} 00' N.$ , longitude  $55^{\circ} 00' W.$  Shortly after heading south the wind hauled more to the westward. The course of the vessel was changed to meet the new condition. The relief was accomplished at 8 a. m., April 9, in latitude  $44^{\circ} 22' N.$ , longitude  $56^{\circ} 34' W.$

#### RÉSUMÉ

During this cruise all the regular broadcasts and three special broadcasts were transmitted; 5 vessels were instructed as to safe course, 4 vessels were given special information, 14 were furnished positions and 18 were given weather information. Four reports of dangers to navigation were received and broadcast, and 710 water temperatures were received and plotted.

#### WEATHER

(See Charts Nos. 8, 9, and 16)

The weather experienced during the latter part of March was exceptionally good with less than 50 per cent of fog. However, during the first four days of April dense fog was encountered while from April 5 to 8 intermittent gales from various points of the compass hindered successful searching.

#### WATER TEMPERATURES

(See Charts Nos. 8 and 9)

The water temperatures and profiles plotted divulged some interesting facts. One of the most striking was the decided movement to the northward of the cold wall, even in excess of  $1924$ ; another was the disappearance of the  $32^{\circ}$  line on the southern part of the Banks with only a slight touch of cold water along the forty-fourth parallel; a third was the prevalence of warm water where Arctic water was usually found, and last the fact that the cold wall had a

decided tongue extending southeastward from the Tail of the Banks. Considering these in conjunction with the stations occupied, it was very evident that the Labrador Current was very weak, and that the influence of the Gulf Stream was felt well to the northward, saltier water than usual being found surprisingly near the Tail of the Banks. The stations taken on the southwest slope of the Banks showed no Arctic water, none on the south slope except between the forty-second and forty-third parallel, and that at a depth of 500 meters. The Arctic water was again found in a small quantity on the southeast slope on the forty-fourth parallel at 500 meters, and at the east slope along the forty-fourth parallel on the surface. This indicated that the Labrador Current did not extend to the westward of the southern edge of the Banks and was exceedingly weak.

#### ICE

(See Chart No. 3)

The first cruise was made without seeing ice. Cape Race reported two bergs in latitude  $49^{\circ} 25' N.$ , longitude  $50^{\circ} 23' W.$ , and a steamer reported one in latitude  $49^{\circ} 08' N.$ , longitude  $48^{\circ} 25' W.$  These bergs were well to the northward and were not a menace to the lanes at any time. The absence of Arctic water, the weakness of the Labrador Current, the overwhelming effect of the Gulf Stream, the mild winter conditions of the coast of Labrador, and the mildness of the season of 1924 leaving no remnants of the bergs to the southward, etc., were no doubt responsible for the total absence of bergs below latitude  $46^{\circ} 00' N.$

#### BERG DRIFTS DURING FIRST CRUISE

##### *Berg reported*

March 13: Latitude  $47^{\circ} 50' N.$ , longitude  $47^{\circ} 00' W.$ , again reported March 21, latitude  $47^{\circ} 48' N.$ , longitude  $45^{\circ} 44' W.$ , having drifted  $143^{\circ}$  true, approximately 0.4 knots per hour.

April 4: Latitude  $49^{\circ} 25' N.$ , longitude  $50^{\circ} 23' W.$ , again reported April 10, latitude  $48^{\circ} 45' N.$ , longitude  $49^{\circ} 38' W.$ , and again on April 21, latitude  $47^{\circ} 59' N.$ , longitude  $48^{\circ} 21' W.$ , having drifted  $136^{\circ}$  true, approximately 0.3 knots per hour.

April 4: Latitude  $49^{\circ} 08' N.$ , longitude  $48^{\circ} 25' W.$ , again reported April 17, latitude  $48^{\circ} 08' N.$ , longitude  $47^{\circ} 16' W.$ , having drifted  $147^{\circ}$  true, approximately, 0.4 knots per hours.

#### SECOND CRUISE, "MODOC," APRIL 9-24

The *Modoc* relieved the *Tampa* on April 9, at 8 a. m., having left the Boston Navy Yard at 11 a. m., April 6. The oceanographic party was received on board, the transfer being effected in a moderately rough sea and fresh NW. breeze. The vessel proceeded immediately

eastward to continue the search for a berg reported in latitude  $49^{\circ} 08' N.$ , longitude  $48^{\circ} 25' W.$  Engine trouble developed, making it necessary for the patrol vessel to proceed to a port for repairs. At 10.04 a. m., April 10, the *Modoc* anchored in Trepassey Bay, Newfoundland. The repairs, consisting of replacing the bearings of the main drive generator, were completed by 11 a. m., April 11, and the *Modoc* continued on her original search to the northward, encountering some fog and snow.

A résumé of the weather conditions during the past winter was obtained from the collector of customs at Trepassey by the oceanographer as follows: (a) The past season was the mildest season for years; (b) the first part of April was colder than any month during the winter; (c) no ice except local ice had been seen in Trepassey Bay, and that none had been seen on the eastern and southern part of the island; (d) that little ice was expected; (e) that the prevailing winds were NW. and NE., and that for the last month the wind had blown from the NE.

On April 13 the first ice of the season was located in latitude  $48^{\circ} 15' N.$ , longitude  $49^{\circ} 38' W.$ , visible a distance of 14 miles. It proved to be a berg about 300 feet long and about 125 feet high in the shape of a floating dry dock, and was so named for identification purposes thereafter. No. 1 berg, as it also became known, was surrounded by fulmars. Four other bergs were sighted that day. Sketches were made of the bergs on different bearings and pictures taken for identification.

The vessel was hoped to near the bergs in order to obtain the set and drift of them which was accomplished on April 14. In addition to the bergs sighted on the 13th four others were seen. Stations Nos. 21 and 22 were taken near the bergs. Station No. 21 showed Arctic water throughout, while station No. 22 showed Arctic water on the surface only. All ice was again found surrounded by fulmars. Berg No. 1 showed signs of disintegration. The *Modoc*, having charted all ice, proceeded to the southward for the purpose of determining the southern extremity of the Labrador current.

While en route southward April 14, memorial services for the *Titanic* were held. The crew having been mustered aft, Doctor Shipp, the cutter's surgeon, delivered a brief address and Commander Wolf led the officers and men in prayer, after which three volleys were fired. All shipping was requested to maintain radio silence from 3 to 3.05 p. m., and all graciously complied. Winter conditions prevailed. The intense cold, a rough sea, and biting NE. wind howling through the rigging, with a large berg astern of the *Modoc*, supplied fitting accompaniment and background for these services in memory of the 1,503 persons who died in that locality in the sinking of the *Titanic* by an iceberg on April 14, 1912.

The *Modoc* then zigzagged to the southward, cutting the eastern bank at intervals until latitude  $44^{\circ} 00'$  N. was reached. Snow and heavy weather was encountered at intervals. Stations Nos. 23 to 25 were taken on April 15, all showing Arctic water. On April 16 a radio request for medical assistance was received. The doctor diagnosed the case and prescribed for it. Excellent progress by the patient was later reported by radio.

Stations Nos. 26, 27, and 28 were taken on April 16; all showed traces of Arctic water and a lower layer of warmer water. Stations Nos. 29 to 32 were taken on April 17, showing no Arctic water and indicating that the southern extremity was north of latitude  $44^{\circ} 00'$  N. This latitude was taken as the southern limit for ice at this time and until the Labrador current increased in force, which subsequently occurred. The position of the southernmost ice having been determined and its set and drift calculated, the *Modoc* proceeded to examine the French fishing fleet and to render such assistance as was necessary. Contact was made on the 19th and eight fishermen spoken. Potatoes, frozen meat, cabbage, cigarettes, and chocolate were exchanged for fresh fish for the messes. The mail was taken on board and radio communication afforded. The master of the Breton schooner *L'Essor* of Grandville, came on board with the schooner's "perrier" or signal gun, on which the pivot had been broken from the saddle, thus rendering the gun useless. This was repaired, restoring to the fishermen a most useful implement depended upon to guide the dorymen back to their ship during the fog when the fog horn could not be heard.

All indications up to this time had been for a light ice season but these hopes were soon blasted when a number of bergs were reported north of latitude  $49^{\circ}$  N. It was soon realized that instead of a light ice season it would be a late but moderate ice season, the ice possibly not extending very far south but with one or two bergs reaching latitude  $42^{\circ}$  N. In view of this the *Modoc* again proceeded northward on April 20, having assured itself that no ice existed to the southward, and again located the ice on April 21. All bergs that had been previously seen were sighted again and identified. Their positions, set, and drift were determined. In addition, three other bergs were located in the axis of the rapidly increasing Labrador current leading the newly reported ice. A thorough search of the area was made and the set and drift of all ice again determined before proceeding to the southward. When this survey was completed the *Modoc* headed southwestward to meet the *Tampa*. The relief was accomplished at 11 a. m., April 24, in latitude  $44^{\circ} 57'$  N., longitude  $53^{\circ} 13'$  W.

## RÉSUMÉ

During this cruise suggestions as to safe courses to avoid ice on requests of masters of vessels were made in 18 instances; 36 special broadcasts locating positions of icebergs were sent out, in addition to regularly scheduled ice broadcasts; 7 reports of obstructions were broadcast; 25 weather reports were transmitted to passing vessels; 912 temperature reports and 7 obstruction reports were received from merchant vessels.

## WEATHER

(See Charts Nos. 9, 10, and 16)

The weather experienced during the cruise was very unfavorable for the work outlined with the exception of three days. Moderate breezes to moderate gales were experienced generally with moderate to rough seas. However, the weather was most favorable with excellent visibility on the days during which it was possible to explore the ice fields. Bergs were sighted from the masthead at a distance of 18 miles during that time. The amount of fog was average.

## WATER TEMPERATURES

(See Charts Nos. 9 and 10)

Nine hundred and fifteen water temperatures were received and plotted. The water temperature chart bore out the results of the data obtained from the stations. It further indicated that the 55° isotherm (cold wall) had not moved appreciably to the northward since the last report. The Arctic water had retreated considerably since the preceding period, the area around Flemish Cap having been covered with warmer water by a swirl of the Gulf stream and the western boundary of the frigid water having been pushed to the northeastward by the Banks' water between Flemish Cap and the 100-fathom curve of the Banks so as to leave a narrow tongue of Arctic water projecting to the eastward in latitude 47° 30' N. The leg extending southward was also covered on the surface by the warmer Gulf stream waters up to a point midway between the forty-fourth and forty-fifth parallels. The influence of the Labrador current, however, was still felt around the Tail of the Banks, its existence being marked by an eddy of comparatively cold water between 40 and 45° F. extending southeastward from the Tail almost to the fortieth parallel. Almost the entire area of the Banks was covered with the characteristic Banks' water of low salinity and temperature range from 34 to 40° F. to such an extent as to eliminate the tongue of Arctic water that extended along the eastern edge of the

Grand Banks to latitude  $44^{\circ}$  N. The boundary to the eastward of the Banks was more sharply defined and hugged the Banks more closely than is usually the case. In close accord with these findings and in marked contrast to the experience of previous years is the fact that not a single report of ice south of the forty-seventh parallel was received during this period.

## ICE

(See Chart No. 3)

On the first cruise of the *Modoc*, April 9 to 24, much ice was seen but its early disintegration seemed evident except in the case of two large bergs which, later, moved well to the southward. Seven reports containing the position of 12 bergs were received during the cruise from Cape Race and from steamers. The ice situation assumed a peculiar aspect. The dangerous ice usually arrived on the Banks early in March. The vanguard during this year was quite late and well to the northward. The advance of the warm water and the lateness of the arrival of the bergs worked toward an early disintegration. The ice observed indicated that the bergs were drifting toward a pool of Arctic water between Flemish Cap and the Banks. It was further noted that the ice was not concentrated in one mass but was widely spread out, particularly to the eastward. The ice that was reported early in the season had disintegrated rapidly.

The bergs observed by the *Modoc* on April 13 and 14 were as follows:

| Latitude<br>north | Longitude<br>west | Latitude<br>north | Longitude<br>west |
|-------------------|-------------------|-------------------|-------------------|
| ° /               | ° /               | ° /               | ° /               |
| 48 40             | 49 21             | 48 15             | 49 38             |
| 48 31             | 49 13             | 48 23             | 49 50             |
| 48 42             | 49 10             | 48 24             | 49 55             |

These bergs were again seen by the *Modoc* on April 21 and 22 as follows:

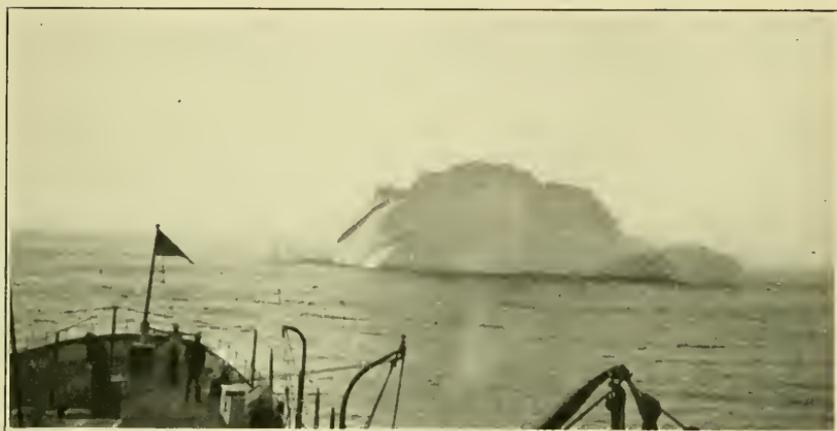
| Latitude<br>north | Longitude<br>west | Latitude<br>north | Longitude<br>west |
|-------------------|-------------------|-------------------|-------------------|
| ° /               | ° /               | ° /               | ° /               |
| 47 59             | 48 31             | 47 47             | 48 02             |
| 48 10             | 48 18             | 47 41             | 47 16             |
| 48 07             | 47 58             | 47 12             | 47 18             |
| 47 50             | 48 05             | 47 49             | 47 26             |

The berg located on April 14, in latitude  $48^{\circ} 15'$  N., longitude  $49^{\circ} 38'$  W., drifted during a period of seven days in the direction  $127^{\circ}$  true, at the rate of 0.35 knots per hour. The berg observed on



BERG NO 7 SIGHTED BY THE MODOC ON APRIL 14, 1925, IN LATITUDE  $48^{\circ} 15'$  N., LONGITUDE  $49^{\circ} 38'$  W.

This berg showed no signs of disintegration



BERG NO. 7 SIGHTED BY THE MODOC ON MAY 10, 1925

This berg had capsized since last seen



STEAMER PASSING CLOSE TO BERG NO. 7

This steamer is 552 feet long



BERG NO. 14 SIGHTED BY THE TAMPA ON JUNE 2, 1925, IN LATITUDE  $43^{\circ} 12' N.$ ,  
LONGITUDE  $49^{\circ} 05' W.$

This berg was observed 20 miles away. The length over all was 512 feet and the height  
at its highest point was 262 feet

the 13th, in latitude  $48^{\circ} 40' N.$ , longitude  $49^{\circ} 21' W.$ , drifted during a period of nine days in the direction  $137^{\circ}$  true, at the rate of 0.6 knots per hour.

The southermost berg in evidence on April 24 was in the Labrador current, in latitude  $47^{\circ} 12' N.$ , longitude  $47^{\circ} 18' W.$ , and was working to the eastward in a tongue of Arctic water. This berg was observed on the 22d, and showed marked signs of disintegration since last seen on the 13th. The southern limits of the ice were rather far north for this season of the year, probably due to mild winter conditions in the north, the prevailing winter winds from eastward, and the encroachment of the Gulf stream on the Labrador current.

#### RÉSUMÉ OF BERG DRIFTS

##### *Berg observed and reported*

April 9: Latitude  $48^{\circ} 48' N.$ , longitude  $49^{\circ} 28' W.$ , again on April 13, latitude  $48^{\circ} 40' N.$ , longitude  $49^{\circ} 21' W.$ , again on April 14, latitude  $48^{\circ} 31' N.$ , longitude  $49^{\circ} 13' W.$ , and again on April 22, latitude  $47^{\circ} 12' N.$ , longitude  $47^{\circ} 18' W.$ , had drifted  $137^{\circ}$  true, 0.6 knots per hour.

April 9: Latitude  $48^{\circ} 57' N.$ , longitude  $49^{\circ} 17' W.$ , again on April 10, latitude  $48^{\circ} 55' N.$ , longitude  $49^{\circ} 12' W.$ , again on April 14, latitude  $48^{\circ} 42' N.$ , longitude  $49^{\circ} 10' W.$ , again on April 21, latitude  $48^{\circ} 10' N.$ , longitude  $48^{\circ} 18' W.$ , had drifted  $133^{\circ}$  true, 0.3 knots per hour.

April 14: Latitude  $48^{\circ} 15' N.$ , longitude  $49^{\circ} 38' W.$ , and again on April 21, latitude  $47^{\circ} 22' N.$ , longitude  $48^{\circ} 26' W.$ , had drifted  $125^{\circ}$  true, 0.3 knots per hour.

April 14: Latitude  $48^{\circ} 42' N.$ , longitude  $49^{\circ} 55' W.$ , and again on April 16, latitude  $48^{\circ} 06' N.$ , longitude  $49^{\circ} 37' W.$ , had drifted  $147^{\circ}$  true, 0.4 knots per hour.

April 17: Latitude  $49^{\circ} 50' N.$ , longitude  $48^{\circ} 15' W.$ , and again on April 22, latitude  $49^{\circ} 24' N.$ , longitude  $48^{\circ} 24' W.$ , had drifted  $192^{\circ}$  true, 0.2 knots per hour.

April 22: Latitude  $49^{\circ} 38' N.$ , longitude  $48^{\circ} 21' W.$ , and again on April 24, latitude  $48^{\circ} 50' N.$ , longitude  $48^{\circ} 33' W.$

April 22: Latitude  $49^{\circ} 52' N.$ , longitude  $46^{\circ} 45' W.$ , and again on April 30, latitude  $48^{\circ} 38' N.$ , longitude  $46^{\circ} 45' W.$

April 22: Berg No. 1, latitude  $47^{\circ} 12' N.$ , longitude  $47^{\circ} 18' W.$ , again on April 24, latitude  $46^{\circ} 13' N.$ , longitude  $47^{\circ} 20' W.$ , again on April 30, latitude  $45^{\circ} 38' N.$ , longitude  $47^{\circ} 51' W.$ , again on May 1, latitude  $45^{\circ} 05' N.$ , longitude  $48^{\circ} 32' W.$ , again on May 2, latitude  $44^{\circ} 40' N.$ , longitude  $49^{\circ} 02' W.$ , again on May 3, latitude  $44^{\circ} 14' N.$ , longitude  $49^{\circ} 09' W.$ , and again on May 4, latitude  $44^{\circ} 19' N.$ , longitude  $49^{\circ} 17' W.$

April 22: Berg No. 7, latitude  $47^{\circ} 49' N.$ , longitude  $47^{\circ} 20' W.$ , and again on April 30, latitude  $45^{\circ} 44' N.$ , longitude  $46^{\circ} 54' W.$  This berg was later caught in the warm swirl and recurved to the following positions: May 1, latitude  $45^{\circ} 50' N.$ , longitude  $47^{\circ} 14' W.$ , and on May 2, latitude  $45^{\circ} 45' N.$ , longitude  $47^{\circ} 47' W.$

## THIRD CRUISE, "TAMPA," APRIL 24-MAY 8

The *Tampa* relieved the *Modoc* at 11 a. m., April 24. The oceanographic party was received on board, the transfer being effected in a moderate sea. The vessel then stood to the northeastward to search for bergs reported on April 22. On April 25 an intermittent fog being encountered, the *Tampa* was hove to until midnight when the cruise was again continued. During one of the clearings the French barkentine *Annie Cannes* was passed close aboard and given her position. A moderate NW. wind was encountered shortly after getting under way which increased to a force of eight and continued blowing during the 26th, 27th, and part of the 28th, when it came out from the northward and northeastward with a dense fog which lasted until 10 p. m., April 29. During this time the vessel was practically hove to, but worked very slowly toward the scene of the southernmost ice.

On the morning of April 29 during a fog a small berg was sighted in latitude  $45^{\circ} 49' N.$ , long.  $46^{\circ} 58' W.$  As the vessel approached the berg, which consisted of two large pinnacks, it capsized, breaking into a number of dangerous growlers. This proved to be a part of the large berg later sighted by the *Tampa*. The search for ice continued and at 11.30 a. m. on the 30th a large berg was found in latitude  $45^{\circ} 58' N.$ , longitude  $46^{\circ} 57' W.$  This was immediately recognized as No. 7 of the first bergs seen by the *Modoc* on April 22. It was remarkable how little change had occurred during the interval of time that had elapsed, there being no noticeable reduction in size, no old water lines visible, and no new ones formed. This was due no doubt to the fact that the berg had remained in the cold Arctic water until this time and that the temperature of the air was such as not to permit melting or disintegration. Station No. 33 was taken near this berg later on in the day but no Arctic water was found. On the contrary a rise in temperature was noticed showing the rapidity of the invasion of the warmer water from the southward. During the night of April 30, berg No. 7 continued in the eddy of warm water and was carried northwestward and returned to the cold water. It had not changed in shape or size when first observed, but 15 hours later while in the warm water had capsized and commenced disintegrating rapidly. While standing by this berg a report was received from a steamer stating that a large iceberg was seen in latitude  $45^{\circ} 38' N.$ , longitude  $48^{\circ} 51' W.$  The *Tampa* proceeded at 3.50 a. m., May 1 for this position. At 9.30 a. m. the position was reached but no ice was sighted. The area was thoroughly searched but nothing was seen. At 12 noon a report was received from a steamer stating that a large berg had been sighted in latitude  $45^{\circ} 05' N.$ , longitude  $48^{\circ} 32' W.$  A course was

set for this position and at 5.50 p. m., the same day the berg was found in latitude  $45^{\circ} 07' N.$ , longitude  $48^{\circ} 31' W.$ , 44 miles from the first report. It was recognized as No. 1 or the original "dry dock." As this was the southernmost ice it was decided to maintain position near it until it was no longer a menace. On May 2 station No. 34 was taken showing warm water on the surface but with traces of Arctic water below. Mining experiments were carried out with negligible results. On the forenoon of May 3 the area in the vicinity of the berg was searched but no new ice was seen. Later on in the day upon returning to the berg 6-pounder shells were fired into it but they did very little damage.

A number of 6-pounder bursting charges proved to be duds. The projectiles embedded themselves in the ice for a depth of about 8 inches. They remained in the bergs for a considerable time thereafter. Streaks of rust from them made excellent identification marks. Stations Nos. 35 and 36 were occupied on May 4 in the vicinity of the berg, both showing traces of Arctic water. On May 5, mining experiments and sonic tests were carried out on it. A dense fog shut in at noon May 5 which lasted until May 8, during which time the patrol vessel remained close by the southernmost ice. The *Tampa* was relieved at 2.40 p. m. May 8 in latitude  $45^{\circ} 06' N.$ , longitude  $51^{\circ} 58' W.$  By using the radiocompasses the two vessels were able to lay opposite courses on a line of bearing which brought them together with accuracy, avoiding delay in relief.

#### RÉSUMÉ

During this cruise 1 steamer and 1 French fisherman were furnished their positions; 27 vessels were furnished special ice information; 6 special ice broadcasts were transmitted in addition to the regular broadcasts, and 28 weather reports were transmitted to passing ships. Two obstruction reports were received from Cape Race and 4 from steamers. These were later broadcast.

#### WEATHER

(See Charts Nos. 10, 11, and 16)

The weather conditions on this cruise were for a great part unfavorable for good scouting, and for that reason only the southernmost ice was searched for and position maintained near it. This was found to be bergs Nos. 7 and 9. The patrol began with the barometer very low, having dropped suddenly on April 22 from 30.12 at 7 a. m. to 29.63 at midnight of the same day and continuing to drop to its lowest 29.22, at 7 p. m. on April 23. The barometer rose and fell alternately until 1 a. m., April 29, when it steadied itself and rose gradually until its highest point, 30.22 on May 2 at

1 p. m. It, however, remained fairly steady during that time and exceptionally good weather resulted. During the greatest part of the extreme low, strong NW. winds to NW. gales blew, hauling to NE. through N. and then backing to NNE. After the rise, however, it hauled rapidly from NNE. to SE. and SSE. The vessel during its entire time was in an area bounded by parallels  $44^{\circ}$  and  $46^{\circ}$ , and meridians  $46^{\circ}$  and  $49^{\circ}$ . From April 25 to April 29 it was impossible to search on account of heavy gales, mist, rain, and foggy weather. The cruise was thus featured by the absence of good weather and the prevalence of fog and days of poor visibility.

#### WATER TEMPERATURES

(See Charts Nos. 10 and 11)

Eight hundred and ten water temperature reports were received and plotted. Attention is invited to this chart. In general, it bears a great resemblance to that of the preceding period. The boundary of the Gulf Stream had moved slightly to the northward and the tongue of the cold water extending southeastward from the Tail of the Banks had decreased considerably. The cold-water area on the northern edge of the Banks in general had decreased, but two exceptions were noticed: The tongue lying down the northeastern slope of the Banks extended farther to the south and increased locally in strength of current, and the cold water around Cape Race also increased in area and strength of current. The above conditions were borne out by the action of the bergs reported during the period. It was the intention of the oceanographer to duplicate monthly stations Nos. 4 to 21 taken during the first cruise in order to obtain sufficient data, at the same place at regular intervals, but the location of the ice and the weather conditions prevented this procedure, so that stations at critical points were only taken when the opportunities presented themselves.

#### ICE

(See Charts Nos. 4 and 5)

The stations taken during this cruise were mostly close to bergs. They were generally in the path of Labrador current. The data obtained from them could be called the advance signal of the increasing Labrador current, and also gave an indication of the strength of the invading Gulf water. In addition to the ice observed by the *Tampa*, 28 ice reports were received from Cape Race and 95 from passing steamers. The bergs seemed to be advancing to the southward very rapidly due to the acceleration of the weak Labrador current then existing caused by the prevailing winds. A decided change took place in the general movement. Many new bergs appeared. Nearly all of them seemed to follow the cold-water tongue and when

they slipped out into warm water usually eddied about until they were back in the cold water, actually struggling for life, as was evidenced by bergs Nos. 1 and 7.

The southerly drift was decidedly accentuated during this period to a point in latitude  $44^{\circ} 30' N.$ , longitude  $49^{\circ} 00' W.$ , drifts as high as 1.8 knots being observed in bergs along the eastern slope of the Banks. An interesting condition was noted in the drift of berg No. 7 which was caught in an eddy of warm water along the eastern slope and carried far to the eastward, finally circling to the north-westward and returning to the cold water. Another interesting incident of this cruise was the disintegration of berg No. 1, the original "dry dock" observed by the *Modoc*. It had maintained its shape throughout its long course; it established a record in speed, making 1.8 knots per hour for a period of over 24 hours and reaching a point in latitude  $44^{\circ} 10' N.$ , longitude  $49^{\circ} 00' W.$ , then gradually recurving to the northwestward and then to the northward on the Banks and there disintegrating.

The Canadian Ice Patrol, which cooperated with the International Ice Patrol, was discontinued on May 6 as the waters from Cabot's Straits inland were clear of ice.

#### RÉSUMÉ OF BERG DRIFT

##### *Berg observed and reported*

April 24: Latitude  $46^{\circ} 13' N.$ , longitude  $47^{\circ} 20' W.$ , and again on April 30, latitude  $45^{\circ} 40' N.$ , longitude  $47^{\circ} 34' W.$ , disintegrating rapidly.

April 24: Four bergs, latitude  $48^{\circ} 50' N.$ , longitude  $48^{\circ} 33' W.$ , the two larger ones again on April 30, latitude  $48^{\circ} 17' N.$ , longitude  $49^{\circ} 28' W.$ , and on May 7, latitude  $47^{\circ} 33' N.$ , longitude  $49^{\circ} 32' W.$ , and again, latitude  $47^{\circ} 37' N.$ , longitude  $49^{\circ} 27' W.$ ; a smaller one on April 30, latitude  $48^{\circ} 25' N.$ , longitude  $49^{\circ} 01' W.$ , and another small one on April 30, latitude  $48^{\circ} 20' N.$ , longitude  $49^{\circ} 51' W.$

April 28: Latitude  $48^{\circ} 47' N.$ , longitude  $48^{\circ} 14' W.$ , on May 1, latitude  $47^{\circ} 49' N.$ , longitude  $48^{\circ} 07' W.$ , again on May 6, latitude  $46^{\circ} 31' N.$ , longitude  $48^{\circ} 23' W.$

April 28: Latitude  $47^{\circ} 28' N.$ , longitude  $51^{\circ} 16' W.$ , on April 29, latitude  $47^{\circ} 11' N.$ , longitude  $51^{\circ} 21' W.$ , again on May 2, latitude  $45^{\circ} 50' N.$ , longitude  $52^{\circ} 08' W.$

April 29: Large berg, latitude  $47^{\circ} 00' N.$ , longitude  $47^{\circ} 47' W.$ , on April 30, latitude  $46^{\circ} 49' N.$ , longitude  $47^{\circ} 58' W.$ , on May 2, latitude  $46^{\circ} 24' N.$ , longitude  $47^{\circ} 55' W.$ , again on May 4, latitude  $46^{\circ} 23' N.$ , longitude  $48^{\circ} 00' W.$ , and again on May 7, latitude  $46^{\circ} 12' N.$ , longitude  $47^{\circ} 52' W.$

April 29: Latitude  $46^{\circ} 47' N.$ , longitude  $48^{\circ} 22' W.$ , and again on May 2, latitude  $46^{\circ} 08' N.$ , longitude  $48^{\circ} 35' W.$

April 29: Latitude  $47^{\circ} 20' N.$ , longitude  $50^{\circ} 57' W.$ , and again on May 2, latitude  $45^{\circ} 49' N.$ , longitude  $51^{\circ} 40' W.$

April 30: Latitude  $46^{\circ} 55' N.$ , longitude  $47^{\circ} 35' W.$ , and again on May 2, latitude  $46^{\circ} 23' N.$ , longitude  $47^{\circ} 43' W.$ ; latitude  $46^{\circ} 20' N.$ , longitude  $47^{\circ} 50' W.$

April 30: Latitude  $46^{\circ} 47' N.$ , longitude  $48^{\circ} 21' W.$ , on May 1, latitude  $46^{\circ} 42' N.$ , longitude  $48^{\circ} 20' W.$ , again on May 2, latitude  $46^{\circ} 29' N.$ , longitude  $48^{\circ} 18' W.$ , and again on May 6, latitude  $46^{\circ} 12' N.$ , longitude  $48^{\circ} 15' W.$

April 30: Latitude 48° 00' N., longitude 52° 16' W., and again on May 2, latitude 47° 37' N., longitude 52° 15' W.

April 30: Two bergs, latitude 47° 57' N., longitude 52° 31' W., again on May 3, latitude 47° 36' N., longitude 52° 29' W.

May 1: Latitude 47° 58' N., longitude 50° 36' W., and again on May 3, latitude 47° 47' N., longitude 50° 39' W.

May 2: Latitude 46° 22' N., longitude 49° 00' W., and again on May 5, latitude 45° 32' N., longitude 49° 45' W., as large growler.

May 2: Latitude 47° 48' N., longitude 50° 58' W.; latitude 47° 45' N., longitude 50° 58' W., and again on May 3, latitude 47° 45' N., longitude 50° 53' W., considered largest berg on Banks.

#### FOURTH CRUISE, "MODOC," MAY 8-23

The *Modoc* relieved the *Tampa* at 2.40 p. m., May 8. The oceanographic party was received on board, the transfer being effected in a moderate sea with a dense fog. Upon relief the *Modoc* proceeded to search for the position of the southernmost ice in evidence on that date. Station No. 37 was taken on May 9, but no Arctic water was found. After a delay due to fog the berg was sighted on May 10 at 4.05 p. m. It was recognized as berg No. 7. Shortly thereafter another berg was sighted close by. Station No. 38 was taken alongside of the first one. Arctic water was found at depths of 50 to 175 meters, showing that the cold water current had again started to flow and that it was this current that was bringing the bergs outside the 100-fathom curve down the eastern edge of the Grand Banks. Position was held in the vicinity of this berg and its drift observed from time to time as clear weather permitted observation until the morning of May 20. On May 11, 14, and 15 experiments were carried out with mines and by gunfire. On May 14 station No. 39 was taken. This showed no Arctic water. Dense fog was encountered on May 16 and 17 and part of 18. The vessel was hove to and drifted. On the afternoon of May 18, while in a dense fog, innumerable fulmars were noticed close by the vessel. The fog lifted at 2.45 p. m. and a berg was observed 4 miles away. Stations Nos. 40, 41, and 42 were taken, showing fairly warm water except at station No. 40 at depths of 50 and 125 meters and station No. 41 at a depth of 40 meters, where Arctic water was found. Further mining experiments were carried out on May 19 and 20. On the morning of May 21 a search of the area was made and two bergs were sighted, one in latitude 44° 41' N., longitude 48° 41' W., and one in latitude 45° 04' N., longitude 48° 39' W. Station No. 43 was taken on May 21. No Arctic water was found. The remainder of the cruise was devoted to searching for and tracking the southernmost ice. On May 22 the French barkentine *Terra Neuve* was spoken and her position furnished. The *Modoc* was relieved of the patrol by the *Tampa* at 10 a. m., May 23, in latitude 44° 54' N., longitude 53° 03' W.

## RÉSUMÉ

During this cruise 160 ice reports and 950 water temperature reports were received from steamers and 17 ice reports from Cape Race. Six derelict reports were received and broadcast. Warnings of bergs on their courses were sent to 45 steamers following their requests for information and additional information was furnished to 7 other steamers. Eleven special ice broadcasts were sent out in addition to the scheduled ones and 27 weather reports were transmitted.

## WEATHER

(See Charts Nos. 11, 12, and 16)

Only one gale was experienced during this cruise. It made its appearance very suddenly at noon of May 21 and lasted until the evening of May 22. About 5 of the 15 days were favorable for visibility and observations, the rest being foggy and rainy with low visibility. The percentage of fog was 64.4 per cent.

## WATER TEMPERATURES

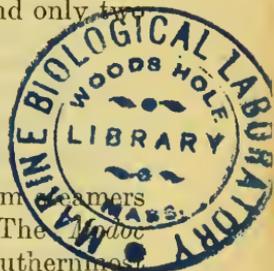
(See Charts Nos. 11 and 12)

Nine hundred and fifty water temperature reports were received and plotted. The chart evidenced a continuation of the conditions existing during the previous period. The cold water area decreased in size until at the end of the period there was very little cold water on the surface south of the forty-eighth parallel. A narrow tongue of Arctic water still extended to latitude  $46^{\circ} 20' N.$ , along the edge of the Banks. Although the warmer water was pushed northward along the Banks, there remained a subsurface tongue of Arctic water down to latitude  $45^{\circ} 30' N.$  at depths of 25 and 50 meters. This apparently accounted for the drift of a few bergs below latitude  $46^{\circ} 00' N.$  The weakness of the flow of the Arctic current was reflected in the movements of the bergs during that period. Although a comparatively large number of bergs were reported around the northeast slope, their southerly drift was very slow and only two bergs were encountered south of latitude  $46^{\circ} 00' N.$

## ICE

(See Chart No. 5)

One hundred and sixty berg reports were received from steamers and 17 reports from Cape Race during this cruise. The *Woods Hole* stood by the largest berg, which also proved to be the southernmost ice, a great deal of the time in order to obtain accurate data in regard to its drift. This berg was originally No. 7 of the first group seen



by the *Modoc*. It reached latitude  $46^{\circ} 00'$  N. before the Gulf stream pinched off the cold water to the southward leaving only a tongue paralleling the Banks, possibly 15 miles in width and reaching down to about latitude  $44^{\circ} 30'$  N. The berg was first observed on May 10. It drifted to the southward following the contour of the Banks to latitude  $44^{\circ} 28'$  N., longitude  $48^{\circ} 53'$  W., when it recurved to the eastward and was last seen by the *Modoc* in latitude  $44^{\circ} 40'$  N., longitude  $47^{\circ} 52'$  W. This berg was reported on the morning of the 21st by the *Tuscania* in latitude  $44^{\circ} 41'$  N., longitude  $47^{\circ} 36'$  W. It seemed that the bergs coming to the southward this season until this cruise having arrived at latitude  $46^{\circ} 00'$  N. increased their drift until latitude  $44^{\circ} 40'$  N. was reached when they ceased their southerly motion and moved off slowly to the eastward. On the afternoon of May 20, two bergs that had been reported south of latitude  $46^{\circ} 00'$  N. were sighted respectively in latitude  $44^{\circ} 41'$  N., longitude  $48^{\circ} 41'$  W., and latitude  $45^{\circ} 04'$  N., longitude  $48^{\circ} 39'$  W. Check was kept on these bergs until the night of May 21, when they lost their southerly drift and took up the easterly drift in latitude  $44^{\circ} 32'$  N.

The majority of bergs were in the Arctic water area and their movements were very slow. It is rather interesting to see how the bergs as a whole strive to remain in the cold water. It seemed that bergs located more than 10 miles off the northeast Bank paralleled the edge of the Bank in their drift, while those less than 10 miles drifted due south. The southern movement seemed to be very slow until latitude  $46^{\circ} 00'$  N. was reached when the bergs took an additional impetus, reaching a drift of 1 knot and better per hour. This, however, was reduced when the bergs reached latitude  $44^{\circ} 30'$  N. where the drift stopped and the bergs started their eastward journey. The Arctic cold tongue disappeared about May 15 and that allowed practically all bergs off the Banks to come south slowly.

There were 60 known bergs and 19 doubtful ones (bergs reported once but positions not confirmed later) on the ice chart, divided as follows:

|                                             | Bergs |
|---------------------------------------------|-------|
| Between latitudes 44 and $45^{\circ}$ ----- | 4     |
| Between latitudes 45 and $46^{\circ}$ ----- | 3     |
| Between latitudes 46 and $47^{\circ}$ ----- | 14    |
| Between latitudes 47 and $48^{\circ}$ ----- | 41    |
| Between latitudes 48 and $49^{\circ}$ ----- | 17    |

These did not include the bergs close to the coast of Newfoundland, but only bergs which were likely to endanger shipping when a departure was taken from land. It was comparatively easy to identify bergs, as practically all ships were kind enough to send a good description with their reports. This assisted the oceanographer to recognize the individual bergs and in observing their progress and

made it possible to check them as they moved from one area to another. The forty-fifth parallel and track "E" were seriously menaced by the ice.

It is thought advisable to mention that a number of steamers continued to cross the Banks on the assigned track "E" in spite of the many bergs which menaced this track, reported in the regular and special broadcasts as well as in individual messages to the crossing steamers. A number had reported sighting bergs on this track at night and in dense fog. The danger in this procedure was apparent. One notable case, which nearly ended in disaster, may be described here: The weather was exceedingly foggy and had been for two days. The patrol vessel had received from a steamer water-temperature, course, and position reports. The position and course were plotted and it was found that the steamer would, during the night, be in the vicinity of seven bergs. This danger was made known to the steamer by radio. At 6.30 a. m. the patrol vessel received the following message:

9.30 G. M. T. by account in latitude  $47^{\circ} 10' N.$ , longitude  $49^{\circ} 35' W.$ , dense fog. See through fog berg close aboard. Could not approximate size or if any more near. Temperature air  $33^{\circ}$ , sea  $36^{\circ}$ . Stopped.

The vessel was again cautioned and given the location of the remaining ice and advised to heave to or proceed very slowly. At noon it cleared and the steamer proceeded on her course and reported two more bergs shortly thereafter. The master was very grateful for the information.

#### RÉSUMÉ OF BERG DRIFT

##### *Berg observed and reported*

May 14: Latitude  $48^{\circ} 08' N.$ , longitude  $47^{\circ} 51' W.$ ; again on May 18, latitude  $47^{\circ} 26' N.$ , longitude  $47^{\circ} 30' W.$ ,  $158^{\circ}$  true, 0.4 knots.

May 14: Latitude  $48^{\circ} 07' N.$ , longitude  $48^{\circ} 17' W.$ ; again on May 19, latitude  $47^{\circ} 30' N.$ , longitude  $47^{\circ} 50' W.$ ,  $156^{\circ}$  true, 0.3 knots.

May 16: Latitude  $47^{\circ} 34' N.$ , longitude  $47^{\circ} 51' W.$ ; again on May 19, latitude  $46^{\circ} 30' N.$ , longitude  $47^{\circ} 16' W.$ ,  $158^{\circ}$  true, 0.6 knots.

May 20: Latitude  $48^{\circ} 44' N.$ , longitude  $48^{\circ} 28' W.$ ; again on May 23, latitude  $47^{\circ} 56' N.$ , longitude  $47^{\circ} 52' W.$ ,  $157^{\circ}$  true, 0.6 knots.

#### FIFTH CRUISE, "TAMPA," MAY 23-JUNE 8

The *Tampa* relieved the *Modoc* on May 23. The oceanographic party was taken on board, the transfer being effected in a choppy sea. The vessel steamed for the position of the two bergs last seen by the *Modoc*, locating them at 1 p. m., May 24. While observing the drift of these, four other bergs coming from the north joined the two under observation and started their drift to the eastward. The *Tampa* remained near the ice until May 29. On May 25, 27, and 28 sonic experiments were carried out upon the bergs, in 1,800

fathoms of water. Station No. 45 was taken on May 25, station No. 46 on May 26, and station No. 47 on May 27, warm water being found throughout except at 250 meters at station No. 46, where a trace of Arctic water was found.

When it became apparent that the bergs would take up the eastern drift the *Tampa* proceeded to the northward to search for ice that was menacing the Cape Race and "F" tracks and for those likely to become a menace to the southward. At 5. p. m., May 30, a large berg was located on the edge of the Banks in latitude  $47^{\circ} 17' N.$ , longitude  $47^{\circ} 55' W.$  This berg was about 700 feet long, 250 feet high, and about 200 feet wide. It was box-shaped and showed little signs of disintegrating. This was the largest berg seen by the *Tampa*. A series of sonic experiments were carried out around this berg. While lying alongside, a report was received from the S. S. *Oscar II*, of a large berg in latitude  $44^{\circ} 00' N.$ , longitude  $48^{\circ} 56' W.$  A course was laid for this position and the berg located at 7.25 p. m., on June 2, in latitude  $43^{\circ} 12' N.$ , longitude  $49^{\circ} 05' W.$  This berg was in the shape of a floating dry dock, having two distinct walls of ice. It was over 500 feet long and about 262 feet high at its highest point. En route to this berg another was sighted on May 31, at 3.45 a. m. in latitude  $46^{\circ} 20' N.$ , longitude  $48^{\circ} 03' W.$  The *Tampa* stood by the "dry dock" until relieved. This berg was the first to break the warm water barrier, it drifting down the tongue of cold water that lay along the Banks. On June 2, it drifted due west, to the extreme southwest end of the cold-water tongue and remained stationary for the remainder of the day, but later was caught in an eddy and whirled counter-clockwise for approximately a day when it again took up its westward drift. Station No. 48 was taken but no Arctic water was found. No opportunity was had to observe the berg on June 3, 4, or 5 on account of the gales and fog. The *Tampa* took station to the southward of the ice during this time as a considerable number of vessels were passing through the area in which the berg was located, giving them radio warning of the presence of this ice.

Attention is invited to the water temperature chart, May 1-15, and the ice chart, showing the drift of this berg in comparison with the drift of five others that were diverted to the eastward in latitude  $44^{\circ} 32' N.$  On the afternoon of June 5, the vessel cruised westward searching for ice. A fog shut in and the vessel was hove to until the morning of June 6 when the search was resumed. The fog again shut in during the day, but the vessel proceeded slowly to the westward as the set had been to the eastward during the night. At 5.46 p. m. a growler and considerable small ice were seen and the vessel was hove to for the night. At daybreak the "dry-dock" berg was seen to the westward. The vessel was headed for it. The position was determined and found to be latitude  $42^{\circ} 34' N.$ , longitude  $50^{\circ} 44' W.$

It had drifted around the Tail of the Banks a distance of 60 miles since last seen. The *Tampa* remained near this berg until relieved by the *Modoc* at 6 a. m., June 8, in latitude  $42^{\circ} 58' N.$ , longitude  $54^{\circ} 14' W.$

### Résumé

During the third cruise of the *Tampa* 850 temperature reports were received. In response to 2 requests for medical attention the ship's doctor prescribed, the vessels reported their patients doing well after a lapse of 3 days and thanked the patrol vessel. Thirty-nine requests for ice information were answered. Eight special ice broadcasts were sent out in addition to the regular broadcasts. Three obstruction reports were received and broadcast. Eighteen weather reports were transmitted to passing shipping; 92 ice reports were received from vessels, and 59 reports from shore stations.

### WEATHER

(See Charts Nos. 12, 13, and 16)

The weather experienced during this cruise was not very good for the work outlined. Only two gales were encountered, but considerable fog and rain prevailed.

### TEMPERATURES

(See Charts Nos. 12 and 13)

Warming up of the water masses in the patrol area had progressed to such extent that no Arctic water was reported south of the forty-eighth parallel. Surface temperatures over the northern and northeastern slopes of the Banks ranged from  $35^{\circ}$  to  $40^{\circ}$ , while over the central portions of the Banks they were well over  $40^{\circ}$ . The Gulf Stream had moved slightly to the northward. Of particular interest, as affecting the drift of bergs, was a narrow tongue of  $36-40^{\circ}$  water lying along the eastern slope and extending as far south as the Tail of the Banks. During the early part of the period the bergs in their southerly drift all stopped upon reaching the neighborhood of latitude  $44^{\circ} 30' N.$  and recurved to the northeastward, but toward the end of the period berg No. 14 came under the influence of the tongue of cold water extending southward and was carried down to the Tail of the Banks where its movements were watched with interest. The past developments of the cold tongue afforded valuable information relative to the drift of the bergs along the northeastern slopes of the Banks; thus should the tongue be pinched off by warmer currents it seemed probable that the southerly movement of the foregoing bergs would be greatly diminished. A tongue of cold water about  $38^{\circ}$  extended about 25 meters below the surface of the water. This was probably the propelling force of the bergs.

## ICE

(See Chart No. 6)

The ice situation simplified itself considerably during this cruise, and the menace to the northward was gradually disappearing. Only one tongue of cold water remained, extending practically the full length of the eastern slope of the Banks. Bergs that were caught in this swirl drifted southward. On June 8 only seven bergs were in this current. The ice on the Banks was practically stationary. Those bergs to the east of the Banks moved about ESE. then eastward and recurved northeastward. The Cape Race and "F" tracks were seriously menaced by the bergs. The ice as a whole seemed to remain in the cold water close to the Banks. Indications were that as long as that flow was not checked the bergs would tend to menace the Tail of the Banks, as was shown by berg No. 14 which broke through the warm-water barrier by hugging the edge of the Banks very closely while five other bergs proceeded due east from approximately the same latitude but a few miles farther east in longitude. At the close of the *Tampa's* cruise there was 1 berg below  $44^\circ$  which was rapidly disintegrating; 4 between  $48^\circ$  and  $49^\circ$ ; 26 between  $47^\circ$  and  $48^\circ$  of which 6 were west of longitude  $49^\circ 00'$  and 8 east of longitude  $47^\circ 00'$ , and 4 between latitude  $46^\circ$  and  $47^\circ$  of which 2 were west of longitude  $48^\circ$  and 1 east of longitude  $47^\circ$ . In all cases these bergs were surrounded by numerous growlers. Practically all the ice was between track "E" and track "B." June was particularly hard on the icebergs, it being ushered in by a dense fog and warm rain which was followed by two heavy gales with attending heavy seas.

## RÉSUMÉ OF ICE

*Berg observed and reported*

May 25: Latitude  $48^\circ 45'$  N., longitude  $50^\circ 14'$  W., and again on May 30, latitude  $48^\circ 26'$  N., longitude  $49^\circ 28'$  W.,  $125^\circ$  true, 0.3 knot per hour.

May 26: Latitude  $48^\circ 10'$  N., longitude  $49^\circ 15'$  W., and again on May 29, latitude  $47^\circ 53'$  N., longitude  $48^\circ 39'$  W.,  $127^\circ$  true, 0.37 knot per hour.

May 27: Latitude  $47^\circ 38'$  N., longitude  $48^\circ 00'$  W., and again on May 30, latitude  $47^\circ 17'$  N., longitude  $47^\circ 55'$  W.,  $158^\circ$  true, 0.3 knot per hour.

May 29: Latitude  $47^\circ 47'$  N., longitude  $48^\circ 18'$  W., and again on May 31, latitude  $47^\circ 20'$  N., longitude  $47^\circ 32'$  W.,  $136^\circ$  true, 0.6 knot per hour.

May 29: Latitude  $48^\circ 13'$  N., longitude  $47^\circ 30'$  W., and again on June 4, latitude  $47^\circ 46'$  N., longitude  $46^\circ 50'$  W.,  $141^\circ$  true, 0.27 knot per hour.

## SIXTH CRUISE, "MODOC," JUNE 8-23

The *Modoc* relieved the *Tampa* on June 8. The oceanographic party was received on board. The vessel proceeded to the position of the berg that had been under observation by the *Tampa* near the



MODOC ALONGSIDE OF BERG NO. 14



MODOC ROUNDING BERG NO. 14 ON JUNE 10, 1925

Note the various water lines

Tail of the Banks. The berg was sighted shortly before nightfall, and the vessel was hove to near by it upon coming up with it. On June 9 experiments were carried out with mines and stations Nos. 50 and 51 were occupied. Both stations indicated warm water on the surface with a trace of Arctic water at the bottom. From June 10 to 15 the vessel stood by the large berg experimenting with mines and 6-pounder gunfire. Station No. 52 was taken on June 11 and station No. 53 on June 12. Both stations indicated very warm water. On June 15 and 16 the area between latitude  $41^{\circ} 30'$  and latitude  $43^{\circ} 30'$  and longitude  $47^{\circ} 00'$  and longitude  $50^{\circ} 30'$  was searched and found free of ice except for one small berg in latitude  $42^{\circ} 39' N.$ , longitude  $49^{\circ} 31' W.$ , and the large one noted above. On June 15 stations Nos. 54 and 55 were taken, but no Arctic water was found.

The large berg, No. 14, was trailed between June 17 and 22. On the evening of June 19 the vessel encountered a southerly gale, and the berg was lost sight of. The berg was searched for, allowing the regular drift, but was not found until 1.05 p. m. June 20, when it was discovered well to the northward of the first position. It had been carried due north by the south gale. As the vessel approached the ice the seas could be seen striking the berg with such force as to throw the spray over 100 feet high. The berg was badly battered and reduced in size, with many dangerous growlers floating around.

On the morning of June 22 station No. 56 was taken, showing warm water throughout. In the evening of the same day a dense fog was encountered.

At 4.50 a. m. (patrol time) June 23, the patrol ship was advised by radio from the steamer *Saugus* that she was aground on the berg that the patrol vessel was watching. It was estimated that the distance was about 4 miles. Dense fog prevailed. A radio bearing of the *Saugus* was obtained, and the patrol ship put on a course for the stranded steamer. Shortly after starting the vessel was advised that the *Saugus* had backed clear of the berg without damage, and was proceeding without need of assistance. Unable to obtain details of the mishap, it was concluded that the steamer had run in on the flat part of the dry-dock structure of this berg, thereby avoiding a collision with the abrupt sides of it. If the *Saugus* had communicated her position and course during the night, she could have been advised, and the accident probably avoided. The position of the berg, latitude  $42^{\circ} 20' N.$ , longitude  $48^{\circ} 13' W.$ , and the fact that the *Modoc* was lying near it, were communicated in the regular broadcast of the preceding evening. The berg's position was accurately located three times on June 22, 8 a. m., noon, and 4.30 p. m. by intersection of lines. The tendency at noon had been south and west. The normal set and drift was applied to the 4 p. m. sight when it was noted that the set to the southward and westward had stopped. At 4 p. m. the

*France* passed close by the berg, and at 5 p. m. the steamer *Westerner* passed 10 miles to the southward. The positions of both these steamers indicated that the patrol's position was correct. The position the master of the *Saugus* gave at the time of grounding was passed over by a number of steamers during the two preceding days and no ice was seen. Also the *Westerner* passed within 10 miles on June 22, a beautiful, clear day and saw no ice. All of June 23 fog existed. The *Modoc* searched for berg No. 14 after the fog lifted, and found it just before noon on June 24 in latitude  $42^{\circ} 27' N.$ , longitude  $48^{\circ} 08' W.$  Upon the arrival of the *Modoc* the berg capsized and practically broke in half, one-half breaking into a great number of growlers and the other half remaining intact. Shortly thereafter a steamer was seen heading for the berg and passed the same close aboard, having to shift helm to avoid dangerous growlers. The patrol vessel asked the vessel for the position while abeam the berg, which was given as latitude  $42^{\circ} 05' N.$ , longitude  $48^{\circ} 12' W.$  The steamer was then requested to furnish a correct noon position. The steamer traveled exactly 32 minutes due west after passing the berg until local apparent noon. This steamer had not cooperated in any way. It is of interest to note that this steamer absolutely checked the patrol vessel's noon position which was latitude  $42^{\circ} 27' N.$ , longitude  $48^{\circ} 05' W.$

The track followed by this berg from the 9th instant in latitude  $42^{\circ} 02' N.$ , longitude  $50^{\circ} 42' W.$ , to the 24th instant, when it had reached latitude  $42^{\circ} 27' N.$ , longitude  $48^{\circ} 08' W.$ , was such as to render necessary the presence of the patrol vessel in its vicinity. Numerous vessels were coming in on courses which carried them across this area near to, and often north of the forty-second parallel. Although the periodic broadcasts from the patrol vessel advised all ships of the menace of this berg, special warnings were sent out, and special information given to approaching steamers on request, as to safe courses, the tendency of most of the passing craft seemed to be that of shaping their courses close to the successive positions of the berg, from day to day, in order to gain a few miles in their distances; and this practice was often carried to the point of involving considerable risk of running onto the berg at night or in thick weather if their positions were not accurately known. The patrol vessel was able to keep close record of the courses of all ships in the vicinity that gave information in connection with their temperature reports of their positions, courses, and speeds; and practically all of those communicated with altered course when it was suggested that they do so in the interest of safety. On five nights during this cruise the searchlight was used at intervals to show passing ships the berg that was being watched. In addition to the importance of the above supervision, there was that of observation of the

currents or absence of them as shown by the drift of the berg, in order that some advance information might be obtained as to the general menace of other bergs to the north, and their probable movements.

The *Modoc* trailed the berg until relieved of the patrol by the *Tampa* at 8.35 a. m., June 25 in latitude  $42^{\circ} 32' N.$ , longitude  $49^{\circ} 33' W.$  Practically the entire cruise was devoted to guarding the southern berg and the critical area in the vicinity of the Tail of the Banks; no time being afforded for exploring the fields to the extreme north. Two passenger liners sighted were reported for violation of the track agreement and that fact communicated by dispatch to coast guard headquarters.

#### RÉSUMÉ

Up to and including June 23, 49 berg reports were received from ships and 61 from Cape Race radio station; 7 reports of obstructions to navigation were received and broadcast. In addition to the periodic ice broadcast, 11 special broadcasts were transmitted; 35 steamers were given individual ice warnings for safe course to be followed in the vicinity of bergs. Eighteen weather reports were transmitted to passing ships. Nine vessels were observed by day passing the berg guarded, 2 of them passenger liners, and 5 vessels by night to whom the presence of the berg was communicated by searchlight beam.

#### WEATHER

(See Charts Nos. 13, 14 and 15)

The weather during this cruise was favorable in the main. One southerly gale of force eight was experienced on the 17th and strong breezes to a moderate gale from the same quarter on the 19th. The fog experienced was 26.8 per cent.

#### WATER TEMPERATURES

(See Charts Nos. 13 and 14)

An analysis of the water temperatures plotted during the period June 1-15, indicated that the cold wall had changed its position very little west of the Tail of the Banks, but had moved up considerably on the eastern side. The  $50^{\circ}$  curve worked up close to the eastern and western sides of the Tail of the Banks, leaving a narrow tongue of water at temperatures  $42^{\circ}$  to  $48^{\circ}$  extending south-southeast toward the  $60^{\circ}$  curve. A long narrow tongue of water carrying temperatures from  $38^{\circ}$ - $40^{\circ}$  extended the full length of the eastern edge of the Grand Banks. The chart begun for the period June 16-30 showed that this cold tongue had been pinched off at about latitude  $44^{\circ} 00' N.$

A number of pockets of cool water were found during the cruise in the area between latitude  $42^{\circ} 00' N.$  and  $43^{\circ} 00' N.$ , longitude  $48^{\circ} 00' W.$  and  $51^{\circ} 00' W.$ ; but these are being rapidly eliminated by the invasion of water of a temperature of  $48^{\circ}$  and above. These cold water pockets were the cause of the intermittent fog during the cruise. The vessel passing through these cold spots ran into a dense fog (clear over head) and upon leaving them and going into warmer water found clear weather.

## ICE

(See Chart No. 6)

All of the new bergs reported during this cruise were between latitudes  $46^{\circ} 00' N.$  and  $48^{\circ} 00' N.$ , and between longitudes  $50^{\circ}.00' W.$  and  $52^{\circ} 00' W.$ , except one berg reported in latitude  $48^{\circ} 19' N.$ , longitude  $47^{\circ} 52' W.$ , on June 15. At the expiration of this cruise there were only two known bergs below latitude  $44^{\circ} 00' N.$  A third berg was reported on the 15th in latitude  $43^{\circ} 52' N.$ , longitude  $48^{\circ} 51' W.$ , with position given by the reporting steamer as doubtful as the supposed berg was passed in the fog. From the 19th instant eight steamers passed through the area in which this berg was reported, with requests that they keep a bright lookout and report if they should sight it, but all reported that no ice had been seen. The temperature reports of these steamers showed no water below  $40^{\circ}$ . The existence of the berg in this area was, therefore, considered doubtful. The numerous bergs which had congregated in the area between latitudes  $46^{\circ} 00' N.$  and  $48^{\circ} 00' N.$ , longitudes  $47^{\circ} 00' W.$  and  $49^{\circ} 00' W.$  appeared to have drifted off to eastward or disintegrated in the area, with the exception of two large bergs, which broke through the warm water at latitude  $44^{\circ} 40' N.$ , near the edge of the Banks and reached a maximum southing at latitude  $41^{\circ} 58' N.$ , longitude  $49^{\circ} 27' W.$  on June 15. The disposition of the smaller bergs was checked by reports of bergs to the eastward, and of numerous growlers in the original area.

In general the drift of berg No. 14 was as follows:

The berg drifted  $193^{\circ} T.$  miles between noon, June 7, and 9.10 p. m., June 8, following the  $40^{\circ}$  temperature curve. The winds were NNW. NNE. and east breezes on the 7th and 8th and light airs on the 9th. The berg followed the  $50^{\circ}$  curve making a number of turns and dips, slowing up considerably when passing the cold tongue to the southward, but increasing after crossing the same. The southerly gales on June 18 drove the berg to the northward. The NW. winds on June 20 drove the berg due west and the NE. and easterly winds on June 21 set the berg due south for a distance of about 18 miles. From then on it again took up the NE. set.

The commanding officer of the *Modoc* made the following comprehensive report to the commander, International Ice Patrol, upon relief on June 25.

(a) Only two bergs are below latitude  $43^{\circ}$ , but well above latitude  $42^{\circ}$ . Both are disintegrating rapidly and will be gone in 10 or 12 days. The bergs are wind-borne and drift as the wind blows.

(b) The Labrador current has practically been pinched off.

(c) The Gulf stream is invading this area rapidly as is evidenced by the rising temperatures. The area between  $42^{\circ}$  and  $43^{\circ}$  is covered with pockets of cold water which have no motion.

(d) The current tendencies are well to the northward of latitude  $42^{\circ}$  and it is believed safe to say that no ice can possibly drift to the southward of  $42^{\circ}$  at any time from now on, thus making the trans-Atlantic lanes absolutely safe and ready for shifting on July 1. No new bergs have been reported south of latitude  $48^{\circ}$  which would indicate a cessation of Labrador current, and the only current that is left is between  $45^{\circ}$  and  $48^{\circ}$ , due probably to the momentum of the original stream.

(e) The area between  $43^{\circ}$  and  $45^{\circ}$  has been covered by a number of vessels without reporting ice, except on one occasion, June 15, a berg being sighted in latitude  $43^{\circ} 52' N.$ , longitude  $48^{\circ} 51' N.$ , fog existing at the time, but this position was very doubtful.

(f) No bergs have been reported or seen south of latitude  $42^{\circ}$  this year.

(g) The critical areas have been searched and no ice found.

#### SEVENTH CRUISE, "TAMPA," JUNE 25-JULY 9

The *Tampa* beginning her fourth cruise on June 25, continued the search for the remains of the berg to the eastward that was guarded by the *Modoc*. Upon relieving the *Tampa* the commanding officer of the *Modoc* stated that it was his intention to make a search for the berg previously reported to the northward. At 4 p. m., June 15, this berg was found by the *Modoc* in latitude  $42^{\circ} 41' N.$ , longitude  $50^{\circ} 56' W.$ , broken into three parts with much small ice in immediate vicinity and rapidly disintegrating. On the evening of June 25, a résumé of ice conditions was submitted to headquarters as follows:

COAST GUARD,

Washington, D. C.

Estimate of ice situation June 25. Only two bergs reported south of forty-fourth parallel as follows: Berg 4230 N. 4800 W. This berg has been under constant surveillance since May 21 by patrol vessel and is now rapidly disintegrating. This berg is drifting north-northeast and sea water temperature in vicinity is  $57^{\circ}$ . Other berg found at 4 p. m. to-day by *Modoc* 4241 N. 5056 W. drifting west-northwest sea water temperature in vicinity  $53^{\circ}$  small growlers nearby. Both these bergs rapidly disintegrating. No report of bergs south of latitude  $45^{\circ}$  except the two mentioned above has been recorded since June 9.

No report has been received of bergs in area between latitude 45° and 48° N., longitude 46° and 49° W. since June 7. All other ice reported since June 7 has been to eastward of longitude 49°. No water less than 40° F. south of latitude 44°. Effect of Gulf stream very noticeable over Banks and surrounding area. Effect of Labrador current no longer noticeable it is believed that steamer lanes may be moved to regular position on July 1 with safety.

COMMANDER INTERNATIONAL ICE PATROL.

As fog persisted intermittently, the vessel proceeded at slow speed to the last position of the berg as seen by the *Modoc* on June 24, and arrived near the reported position of this berg on June 26, but no ice was seen. The area was searched when clear weather permitted and, on June 30 at 1.40 p. m., a small growler was found, the remains of the berg, 44½ miles, 57° true from the last reported position. This shows a drift of 0.32 knots per hour during that period. The vessel hove to near the growler which rapidly disintegrated. The sonic apparatus was tested on this growler.

On the evening of June 30 headquarters informed the patrol that the steamship lanes would automatically be shifted on July 1, which information was broadcast to merchant shipping.

There being no further ice to the eastward, the *Tampa* headed for the Tail of the Banks to make further search. Fog shut in on the evening of July 1 and the vessel was hove to. After the fog lifted a cruise was made up the east Bank between latitude 43° and 44°, but no ice was seen.

On the evening of July 2 a recommendation to discontinue the patrol was forwarded to headquarters as follows:

COAST GUARD HEADQUARTERS,

Washington, D. C.

No ice known to be north of latitude 47°. This area has been traveled by a number of merchant vessels in clear weather these ships have been in communication with patrol vessel for some time before entering patrol area while crossing area and after leaving area. Two bergs previously reported south of latitude 47° have disintegrated. Patrol vessel was alongside of easternmost berg at time of final disintegration. Effect of Labrador current no longer noticeable. No water of less than 47° F. below Tail of Banks. The 60° F. curve has reached latitude 42° 30' N. between longitude 48° and 51° and up to 43° westward of longitude 51° and eastward of longitude 48°. The effects of the Gulf stream are very noticeable over the Grand Banks and the surrounding area prevailing winds from southward sending warm water northward. No new ice report received. In view of the foregoing the discontinuance of the patrol is recommended. Critical area has been searched by patrol vessel, no ice seen.

COMMANDER INTERNATIONAL ICE PATROL.

On July 3 a reply was received directing that the area between latitude 42° and 44° N., longitude 49° 30' and 52° W., be searched. The vessel proceeded to the upper section of the area and commenced searching by means of the rectangular search method. On July 7 the French barkentine *Voalle* was spoken, medical assistance was rendered, her position was determined, and fresh food was exchanged

for fish. Fog was encountered for part of the time but when relieved by the *Modoc* at 8 a. m., July 9, in latitude  $43^{\circ} 00' N.$ , longitude  $55^{\circ} 00' W.$ , a trifle more than one-fourth of the area had been covered.

#### RÉSUMÉ

During the last cruise of the *Tampa* four special ice broadcasts were transmitted in addition to the regular broadcast; 23 vessels were given special ice information; 27 vessels whose courses were in dangerous areas were warned; 3 vessels were rendered medical assistance by radio; 19 weather reports were transmitted to passing ships; 627 sea-water temperatures were received and plotted; 2 obstruction reports were received and broadcast; 5 ice reports were received from shore stations, and 6 ice reports from vessels; 1 S O S was intercepted but not within the jurisdiction of the *Tampa*.

#### WEATHER

(See Charts Nos. 14, 15, and 16)

The weather experienced during the cruise was very good except that considerable fog was encountered, hampering searching.

#### TEMPERATURES

(See Charts Nos. 14 and 15)

During this cruise there was a noticeable change in temperature. The prevailing southerly breezes had driven up the warm water so that  $52^{\circ} F.$  was found near the Tail of the Banks. The line of the axis of the Labrador current was  $47^{\circ}$  and the  $60^{\circ}$  curve reached latitude  $42^{\circ} 38' N.$ , between longitude  $48^{\circ}$  and  $50^{\circ}$ , while the  $50^{\circ}$  curve reached up to latitude  $45^{\circ} 00' N.$ , on the Banks. The Banks contain no water below  $40^{\circ}$ . The coolest water was still along the eastern side of the Banks. The characteristic southeast tongue still existed. The prevailing southerly winds seem to be the greatest aid in forcing up the warm water. A day or so of northerly gales made quite a difference in the movement offering a noticeable check to the northerly drift.

#### ICE

(See Chart No. 6)

The ice menace had practically disappeared during this cruise. No bergs were south of latitude  $48^{\circ} 00' N.$  except the two guarded by the patrol vessel. What ice existed above  $47^{\circ}$  seemed to take an eastward course reaching as far east as longitude  $40^{\circ} 00' W.$

## EIGHTH CRUISE, "MODOC," JULY 9-12

The *Modoc* took up the patrol at 8 a. m., July 9. A course was set for the northwest corner of the unsearched area, at a speed to bring the vessel up with the area shortly before daylight on the 10th. As a "high" was due in the area to be searched, the *Modoc* increased her speed to take advantage of all the good weather.

Search by rectangular method was begun at 5 a. m. of July 10 under ideal conditions, with clear skies and highest visibility, and was continued until sunset. The last portion of the explored area between parallels  $42^{\circ} 00'$  and  $44^{\circ} 00'$  and between meridians  $49^{\circ} 30'$  and  $52^{\circ} 00'$  was covered on July 11 and the patrol commander notified at Halifax by radio, through Cape Race and Camperdown, at 3 p. m., forty-fifth meridian time, that the search had been completed.

At 8 a. m., forty-fifth meridian time, of July 12 advice was received from the patrol commander that the International Ice Patrol was discontinued for the season, and this information was transmitted by broadcast from the *Modoc* to all vessels and stations as of noon, Greenwich civil time.

Junction was made with the *Tampa* at 5.30 a. m. on the 15th in latitude  $42^{\circ} 30'$  N., longitude  $65^{\circ} 23'$  W., where transfer of the oceanographic party was effected to that vessel. From this point the *Modoc* proceeded for her station at Wilmington, N. C., and the *Tampa* proceeded to Boston, Mass.

During this cruise of the *Modoc* only 75 temperature reports were received from steamers. This was far below the average and is probably explainable by the belief on the part of many that the necessity for the reports had passed.

No ice was seen or reported during the cruise. Seven requests for information regarding the ice situation were received and one request for medical advice. Two reports of drifting wreckage were received and forwarded to the Hydrographic Office.

The weather experienced during this cruise was very good, encountering no gales and very little fog. (See Charts Nos. 15 and 16.)

There was a remarkable change of temperature during this cruise. The characteristic southeast tongue still existed, but was much smaller. No water below  $42^{\circ}$  was found south of latitude  $47^{\circ} 00'$ . The Banks water became uniformly warmer, reaching as high as  $56^{\circ}$ . The Arctic water had completely disappeared. (See Chart No. 15.)

Messages of appreciation were transmitted to various land radio stations for assistance rendered by them during the season.

## REPORT OF ICE PATROL COMMANDER

Commander H. G. Fisher, United States Coast Guard

The International Ice Patrol for the season of 1925 was inaugurated on March 23, when the *Tampa* left Boston for the Grand Banks, and was continued until July 12, when the *Modoc* reported the steamship lanes entirely free from the ice menace.

The presence of the Coast Guard cutters has come to be looked upon as an established fact by all vessels passing through this area during the ice season. The prompt response to warnings, the absence of interference during the daily radio broadcasts, and the increased number of ice and temperature reports received from commercial vessels, indicate that the patrol is considered a most valuable aid to navigation.

In preparation for the patrol the *Tampa* and *Modoc* had been equipped with special radio sets of the latest improved design, and a sonic depth finder had been installed on the *Tampa* for the purpose of conducting experiments to test its value in locating ice bergs.

The radio outfit with which the vessels were equipped proved most valuable. The radio telephones were of especial value to the vessels in relieving each other. The splendid work of the radio personnel is worthy of mention. Each ship had a radio complement of four operators, and, while on patrol, an extra chief radioman was attached to the oceanographic party. In addition to the regular radio traffic it was found necessary to relay certain messages through the ship in port. The work of the radio force was hard, constant, and wearing, but it was all performed willingly and most efficiently.

The sonic depth finder as installed on the *Tampa* was found to be wholly unsuitable for locating ice bergs and other obstacles, but as a navigational aid in taking soundings and locating a position in a fog it proved of great value.

During the first cruise the limits of the Labrador current were determined. Then, no ice having been encountered to southward, a search was conducted as far north as latitude 48°, but no ice was seen. The presence of considerable warm water over the locality where Arctic water was usually found and the absence of ice were especially noted during the cruise. During the remaining cruises the limits of the Labrador current were determined whenever it was deemed necessary, but the "cold wall" was plotted every 15 days.

The first berg was sighted on April 13 in latitude  $48^{\circ} 40'$  N., longitude  $49^{\circ} 21'$  W. After this time the vessels worked to the southward with the southernmost berg, keeping under surveillance all bergs which showed signs of becoming a menace to the steamship lanes. From June 3 to June 30, bergs were sighted between latitudes  $42^{\circ}$  N. and  $43^{\circ}$  N., the southernmost ice in latitude  $41^{\circ} 55'$  N. being reached on June 15. While many more bergs were sighted during the season of 1925, the drift to the south was about two months later than last year. After the 1st of May a great influx of bergs started and large numbers remained in evidence until the end of the fifth cruise, June 8. By this time the bergs were rapidly disintegrating. During the latter part of the fifth cruise the Labrador current temporarily increased in strength, carrying with it the two bergs which threatened the steamer lanes during the month of June. But this menace had disappeared by the end of the month.

The upward trend of the Gulf Stream, at least 15 days ahead of the season of 1924, was apparent from the third cruise on. By the time the *Tampa* had made her last cruise the prevailing winds from the south had driven the warm water well up on the Banks. All ice south of latitude  $48^{\circ}$  N. had completely disintegrated.

The usual rough weather was experienced. Over 60 per cent of fog prevailed during the first cruise, while the second was characterized by gales and not more than average fog for the season. Fog and days of poor visibility predominated for about six weeks after the third cruise began. The amount of fog and the number of gales decreased during the sixth cruise, but from June 25 to July 9 fog again increased. The last cruise of the *Modoc* was accompanied by excellent weather, very little fog and no gales. It is of interest to note that the *Modoc* experienced the most clear weather and strong breezes, while the *Tampa* experienced the most fog and the least number of gales.

The cooperation of the Canadian officials, particularly those connected with the radio department and the ice patrol service, was most helpful. The courtesy of the commandant of His Majesty's Canadian dock yard, in extending the use of the wharf at Halifax to the cutters while in port, is gratefully acknowledged. The patrol commander further desires to express his appreciation of the excellent cooperation of navy radio stations and the Weather Bureau of the United States.

To enumerate all who were of service in making the patrol a success would necessitate naming the master and his assistants of practically every ship that passed through the ice area during the season. That their hearty cooperation and valuable assistance were appreciated they well know. The patrol commander and those associated with him desire to express their thanks for the ready spirit of com-

pliance with every suggestion made, which was manifest throughout the patrol.

As usual the patrol collected information on weather conditions, ice, water temperatures, and other data so valuable to the successful prosecution of the ice patrol. This data has all been tabulated by the oceanographer and will form a part of his report.

The following résumé of radio traffic for the season 1925 pertaining to the ice patrol is submitted:

|                                                          |        |
|----------------------------------------------------------|--------|
| Regular broadcasts.....                                  | 444    |
| Special broadcasts.....                                  | 79     |
| Ice information to vessels direct.....                   | 226    |
| Special information.....                                 | 11     |
| Positions furnished.....                                 | 17     |
| Weather reports to vessels.....                          | 141    |
| Dangers to navigation broadcast.....                     | 37     |
| Cases of medical assistance prescribed for by radio..... | 8      |
| Water temperature reports.....                           | 6, 369 |
| Berg reports received:                                   |        |
| Steamers.....                                            | 406    |
| Cape Race.....                                           | 176    |
| SOS not within jurisdiction of patrol vessels.....       | 7      |

## ICE OBSERVATION

The presence of ice is a constant menace to the navigator passing through the ice area. Were the ice stationary very little danger would exist, but its movement being dependent on the ocean currents, the sea, and to some extent on the wind, makes its location very uncertain and thus the more dangerous. Every ship speeding through the ice infested areas by night or in the fog plays a game of chance. It is the duty of the patrol vessel to attempt to eliminate the danger by giving each vessel passing through the ice areas all possible information in regard to the set and drift of currents, the set and drift of the ice, and its location at all times. To obtain this information requires considerable cruising and searching for bergs and then after finding them requires trailing them to determine their movements. Trailing a berg gives the patrol vessel an opportunity to study the ice.

The season of 1925 offered innumerable opportunities to observe the bergs and to experiment with them. At one time 169 bergs were plotted on the operating chart and, at that, no berg above latitude  $50^{\circ}$  N. was considered. Considerable time was devoted to experimenting with mine and gun fire and to observing the melting processes.

An estimate of the ice situation was made at the beginning of the patrol in an attempt to predict the future ice. The amount of ice and its location has been so variable from year to year, and the source never having been thoroughly observed, there has been no system of ice forecasting developed successfully as yet. Reports indicated at the beginning of the season that Nova Scotia, Newfoundland, and Labrador had had one of the mildest winters ever experienced in those areas, that the first part of April was colder than any month during the winter, that no ice except local ice had been seen around Cape Race and in the bays in that vicinity up to April 8. The prevailing winds of the winter had been northwest and northeast, but in the month of March and first part of April had been consistently northeast, and the average temperature for the winter had been  $37^{\circ}$  F. The ice reported prior to the commencement of ice patrol was as follows:

February 13.—Pan ice (lat.  $47^{\circ} 5'$  N., long.  $49^{\circ} 27'$  W.).

February 19.—Heavy slob ice (lat.  $48^{\circ} 35'$  N., long.  $49^{\circ} 15'$  W.).

February 24.—Slob ice (long.  $48^{\circ} 30'$  N., long. between  $48^{\circ} 50'$  and  $49^{\circ} 20'$  W.);  
iceberg (lat.  $50^{\circ} 00'$  N., long.  $46^{\circ} 25'$  W.).

March 1.—Large berg (lat.  $47^{\circ} 28'$  N., long.  $47^{\circ} 34'$  W.).

March 2.—Two bergs (lat.  $48^{\circ} 34'$  N., long.  $47^{\circ} 50'$  W.; lat.  $48^{\circ} 17'$  N., long.  $48^{\circ} 43'$  W.).

March 12.—Berg (lat. 47° 50' N., long. 47° 00' W.).

March 18.—Berg (lat. 49° 11' N., long. 47° 58' W.).

March 21.—Berg (lat. 47° 48' N., long. 45° 44' W.).

In addition, returning explorers reported an open season for ice, there being very little ice in Davis Strait, and none except local ice had been seen elsewhere. A weak Labrador current existed. This would necessarily be an indication of a light ice season. The southern limits appeared well defined and it was fully anticipated that with the later ice and the rapid approach of warm water, the southern limit would be above latitude 43° 00' N. As it later proved, only two bergs came below latitude 43° 00' N., one reaching latitude 42° 00' N., but at no time menacing the steamer lanes. The berg reached its southern limit during the month of June, about two months later than during the cruise of 1924.

The icebergs observed during the patrol were the Greenland type of berg. Their color was mostly opaque white. Scattered through most of them were strata of deep-blue ice of varying widths. The scenic effect produced by the deep blue intermingling with the soft white of the bergs was startling and beautiful. The blue stripes were probably formed by the filling up of fissures in the old ice with water and then freezing. At places the walls of the bergs appeared to have a beautiful shade of green when exposed to the sunlight.

Bergs were sighted at various distances, depending on the state of visibility, the height of the berg, and the height of the observer. They were picked up on a clear day from 12 to 20 miles. On one occasion a berg was sighted at a distance of 36 miles. In a low lying fog with a clear sky overhead bergs were seen over the fog bank at a distance of 6 miles; in a low haze about 9 miles; in a light fog and rain about 1 mile; on a dark clear night about half a mile; on a moonlight night about 2 miles, although at certain angles a berg was sighted at a longer distance than 2 miles and in a fog not over 100 yards. There is a tendency to overestimate the distance. In a light low fog the lookout aloft can see the berg sooner than the man on deck, but in a dense fog the man in the bow can observe the berg much sooner, as the first sign of the berg is either detritus or growlers or the lapping of the water at the base of the berg.

In general, the bergs were large, irregular masses of ice. Occasionally ice bulks of the regular shape were seen. One such regular-shaped berg was observed by the *Tampa*, well to the northward, approximately 700 feet long, 230 feet high, and 225 feet wide. Generally speaking, two types of bergs were observed, the "dry dock" and the solid berg.

It was found that the bergs that began their disintegration by forming a hollow or "dry dock" in the main body rarely capsized. The large underwater body with two upright shallow walls of ice thus

formed caused stable equilibrium and prevented capsizing. Such a berg reduced its size uniformly while maintaining an upright position, forming new water lines, one below the other as the berg lost bulk, until the last stage of disintegration was reached when the mass broke up into dangerous growlers. The "dry dock" was probably due to the action of the sea on cracks or crevices in the berg.

Bergs which did not form the "dry dock" at the beginning of their dissolution, usually disintegrated irregularly, losing their equilibrium and capsizing, thereupon throwing off considerable ice and continuing this action until completely gone or until a small "dry dock" type was formed. In capsizing usually dangerous growlers were formed and considerable detritus drifted away. Bergs that capsized showed evidence of underwater currents producing melting.

Many bergs had tongues projecting from under the water. It was found that the tongue was caused by the underwater melting and the slopping of the warm water waves against the ice. This tongue was usually found in the "dry dock" type of berg. It was this type of underwater ice that the *Saugus* grounded on.

At best most bergs appeared to be in an unstable equilibrium so that the slightest irregular melting caused a shifting of the center of gravity, thus causing the berg to take a new position and in some cases completely turn over. In one case the *Modoc* observed a large berg oscillate in which the period was eight minutes.

The greatest amount of destruction done to a berg was by heavy seas. The greatest amount of disintegration, due to expansion and contraction, was observed to take place at noon and shortly after sunset.

Considerable air seemed to be contained in the berg. This was probably responsible for the opaque appearance of these bergs. Whenever small pieces of ice fell into the water they seemed to effervesce like soda water, due probably to the liberation of the air noted above.

Although the ice appeared soft it was exceedingly hard, especially the ice which had not been subject to the disintegrating processes. Ice which had been underwater was brittle near the surface. Mining and gun fire dislodged very little ice when concentrated on a comparatively new berg. A berg in the last stages of disintegration was usually rotten and easily shattered. Disintegration seemed very slow below 36° F. Between 36° and 50° F., the melting and erosion were more noticeable, especially in the formation of new waterlines. When the bergs reached the warmer water, especially 50° and above, they seemed to disintegrate rapidly. There was a constant crackling sound and often very loud reports were heard.

Immense attempts were made to dislodge ice by the blowing of the whistle and by concussion, but without success. In a great many cases when the whistle was blown no echo was heard. The



SMUDGE FROM THE EXPLOSION OF A 150-POUND MINE

No appreciable effect was noticed



TYPICAL FRENCH FISHERMAN FOUND ON THE GRAND BANKS

*Saugus* reported blowing her whistle but hearing no echo until the vessel backed off the ice ledge when a faint echo was heard. The absence of an echo during a fog, while in the ice area, does not necessarily indicate the absence of ice nor does an echo necessarily indicate an obstruction.

The ice mirage was only observed on one day during the patrol and that was to the southward, in latitude  $43^{\circ} 12'$  N. during the latter part of May, when a large berg, 500 feet long and 262 feet high, was observed 20 miles away. A peculiar ice blink was noticed before the berg made its appearance. Mirages are frequent under favorable atmospheric conditions on the southern and eastern sides of the ice regions where the cold and warm waters mix. Bergs then appear inverted and assume fantastic shapes, causing them to appear much larger than they really are.

Experiments were made to determine the submergence of ice. Regular cakes of ice 9 by 18 by 9 inches, were cut and placed in the sea water and tested under various conditions. The ice variably floated 8 inches underwater and 1 inch out of water.

In carrying out the above experiments it was found that the water from the bergs was fresh and pure. Furthermore, no definite lines of cleavage were noted in the ice and that submergence seemed to depend on the mass and not on the height.

Generally speaking, the presence of a berg did not influence the temperatures of the water in the immediate vicinity. It was usually the case that when a vessel passed from water of one temperature to water of a lower temperature, it marked the passage of the vessel from a warm current to a colder current. The method of taking temperatures on board ship does not really enable detection of a slight rise or fall in temperature—not less than one-half degree; so that possibly the use of a very sensitive thermometer may disprove these statements. But it is believed that for practical purposes the berg does not alter the temperature of the water.

The Labrador current was ordinarily considered the carrier of the menace until the Tail of the Banks was reached, when the ice was subjected to other influences. Next to the current the wind affected the drift of the bergs the greatest. The wind affected some bergs more than others. Bergs with one or two pinnacles were affected the most and were the hardest to trail. Heavy seas affected the drift, also, in addition to materially assisting in destroying the berg. It was rarely the case of a berg drifting against the current, but it was quite often the case of a berg drifting against the wind. It was noted in a number of cases that the bergs were in the center of the area surrounded by detritis and growlers. It was thus shown that it was not always the case that the disintegrated fragments drifted to leeward, leaving clear water to windward. Vessels thus observing growlers should navigate with extreme caution.

When the weather was favorable, the effect of gun fire and mines was tried. Gunfire dislodged small sections of ice from the berg. This method of attack is considered of inappreciable value. Very little effect could be noted from mines fired alongside the berg at depths of 4 or 5 fathoms. The mining showed also that a single mine or even four had little or no more effect than to shake off loose ice and possibly set up an internal strain. Mines planted under the berg or shallow water near the side of berg, did more damage than those fairly deep. The tamping effect of water at deeper depths was very pronounced.

Experiments to determine the effect of T. N. T. mines detonated in the air on the surface of a berg were conducted and a large double-ridged "dry-dock" berg, approximately 500 feet long and 250 feet high at the highest elevation, was chosen for the demonstration. This berg which was guarded by the *Modoc* and *Tampa* during the month of June, presented a smooth water polished shelf along one side of its length 15 to 20 feet above level, which was scalable with some difficulty, owing to the rounded edge on which the boarding party must leap from the boat. Steps were cut out on this rounded face, and with the spiked shoes worn by the party, the landing and disembarking were successfully accomplished without accident.

The shelf mined was about 40 feet in width, and terminated in a cliff rising 150 feet above water from which dangerous falls of ice might occur; but this cliff appeared to be stable, and the belief in this regard proved correct, for no trouble was experienced from this source. In fact, the whole berg at the time was in solid condition and extremely resistant to the shock of the explosive; more favorable conditions with a disintegrating berg would entail too much risk for the mining party not commensurate with the results obtainable.

Five successive charges were detonated in one spot, the first four being the standard wrecking mine of about 65 pounds' charge of T. N. T. and the last a pair of these mines of 130 pounds' charge. The first mine laid on the surface of the shelf, about 20 feet back, excavated a hole 3 feet deep and 10 feet across; when the last charge had been set off the hole had increased in size to 15 feet deep and 20 feet across. On the rim of the hole a circular dyke of finely broken ice had been deposited to a height of several feet.

Very little effect was noticeable in falls of ice from the berg cliffs; but it is thought strains may have been set up in the structure and cracks started to account a day or two later for heavy falls when water from the melting ice had found its way into these crevices and accentuated them.

Some doubt was felt regarding the effect of air pressures to be set up by these mines detonated in air, inasmuch as there had been no experience with them in that way. The shock was found to be

quite pronounced in the boat at a firing distance of 800 to 1,000 feet, but not enough at twice that distance to damage any fittings on the vessel, except possibly the bridge windows, which had been opened.

Results of mining and shell fire accomplished during the second *Tampa* and second and third *Modoc* cruises were such as to indicate that this form of attack on a sound berg can produce only a negligible effect toward its disintegration. A few days after the charge had been set off on the berg described a heavy fall of ice occurred by partial disintegration of the top of the higher cliff whereby a mass of broken ice was precipitated without warning into the sea in amount estimated at around 20,000 tons. But when it is considered that a berg of this size contains fully a million and a half tons, the amount loosed is insignificant, granted that the mining was instrumental in producing this slight disintegration. There must always be risk from ice falls to the boat's crew working alongside any berg during the breaking-up season when the patrol is being carried on and, as has been said, the good results obtained are not commensurate with this risk.

An interesting temperature effect was noted at certain times when the vessel steamed under the lee of the high wall of the berg named. With a southerly wind (SE., S., and SW.) blowing, and the air temperature away from the berg as registered on the vessel at 44° F., immediately under the lee of it, in the williwaws set up, the thermometer would rise to 48° or 50°, a change quite noticeable physically, as well. The eddy from the berg summit had drawn down the warmer air of the stratum above.

The continued observation of this berg from day to day afforded a study of several features connected with the breaking up and erosion of the ice mass under the influence of warmer air currents and sea water. As a general proposition, it appeared that loss from simple melting goes on at a higher rate in the underwater body of the berg in water between 42 and 52°, which was the range experienced, than in the exposed portion with the air temperatures about the same or a little higher. The erosion at the water line, due to the wave action in bringing uncooled water to the attack, goes on much more rapidly than below, and the effect is a succession of undercut water lines on the berg.

But it was found that the reduction of the berg proceeded much more rapidly by another action than that of melting; and this, the disintegration by the spawling off of fragments of greater or less magnitude, due to temperature strains and seepage of the water from melting ice through the strain crevices, which tended to loosen the hold of the fragments on the main mass. Consequently, there was a continual emergence of the berg from the sea, due to the lightening effect of the losses above surface. It was seen that within 10 days

after this berg was placed under observation, the entire mass that had been above water, chiefly in two massive cliffs, respectively about 150 and 200 feet high, had been lost, and that the whole of the berg then showing to an approximate average height of 60 feet had been below the surface when the observation began on the 9th instant. Owing to the substantial underfooting of this berg, it was at all times in stable equilibrium, although there was considerable shifting of trim at times—the result of important losses above water at various points on its periphery. Stability was helped by the condition that, as the berg emerged by successive stages, there was a generally extended ledge of footing on all sides. The reduction of girth due to loss had been carried on more rapidly above and near the surface than below. Presenting on the 9th of June a general formation which may be likened to that of floating dry dock, with the two cliffs at either side running the full length of the berg, 400 to 500 feet, and a floor between 80 to 100 feet wide at or near the surface, the action of the sea was sufficient to maintain this condition for the berg throughout. It continued to hold this form, although at the end of the sixth Modoc cruise the floor was eroded to water level only at the side of the smaller cliff; the emergence had become too rapid at the end of the period to permit erosion of the whole floor. The berg continued to reduce in size from an upright position until June 24, when it broke up into a small berg and innumerable growlers and finally on June 30 it had completely disintegrated.

A berg of average size in the mixed waters south of the Tail of the Banks will survive as a menace to navigation for a period of 12 to 14 days during the months of April, May, and June, but will not survive longer than 10 to 12 days after that period. During the 1925 patrol the patrol vessels trailed a large berg in those waters for 30 days. A medium-sized berg will last about 7 days in the Gulf Stream. The bergs grounded on the Banks last the longest.

As stated before, the bergs seen by the patrol vessels were of the Greenland type. It may be of interest, therefore, to state in general the origin of the bergs and the nomenclature used in referring to the ice. Although some definitions have been referred to in previous reports, they will be repeated.

Greenland, as is known, is covered by a large area of ice. The temperature remains usually so low that no material decrease is encountered by melting, and thus one layer of snow can not melt before the next one falls. Thus a massive ice formation is produced known as the Greenland ice cap. It is the largest in the Northern Hemisphere. From this ice cap the Greenland glaciers are formed. The process is never ending. The snow is converted into a form of ice by the immense pressure. The ice is forced down to the sea by the force of gravity and by the weight of the accumulation of the snow and ice. The movement seaward is constant, as an enormous



BERG NO. 14 SIGHTED ON JUNE 9

Note the difference between this berg and the picture of June 2



BERG NO. 14 AT 1 P. M. JUNE 20 AFTER HAVING RECEIVED A BATTERING FROM A SOUTHERLY GALE



BERG NO. 14 AT NOON JUNE 21 AFTER HAVING RIGHTED ITSELF

Note the pinnacle on the tongue on the extreme right end



BERG NO. 14 AT 4 P. M. JUNE 21 THE FORWARD END HAS RISEN AND NOW SHOWS A PART OF THE BOTTOM OF THE ORIGINAL "DRY DOCK"

The tongue shown in the picture of noon June 21 has sunk beneath the surface of the water again



BERG NO. 14 AT NOON JUNE 24

The berg is in the process of breaking up



BERG NO. 14 AT 1 P. M. JUNE 24

The berg has lost one side

pressure is behind the rivers of ice or glaciers, as they are called, forcing them into the deep fiords or long narrow bays that are found along the eastern and western coasts of Greenland. When the ice reaches the water's edge, it is very thick and of large proportion. The ice continues to work out into the water in the fiords. When the upward pressure due to the buoyant force becomes sufficiently great, the front end of the glacier is broken off. This break usually comes at some deep fissure in the ice. The berg that is formed then drifts out of the fiord, where it begins its journey propelled by the currents encountered.

There are, generally speaking, three currents, two cold water and one warm water, that interest the ice patrol vessels. The cold currents, the Labrador and the East Greenland, have their origin in the Arctic. They are the carriers of the iceberg menace from the northward. The warm-water current, the Gulf Stream, has its origin in the Gulf of Mexico. This is the current that is really responsible for the disintegration of the menace and the melting of the ice as it comes from the northward.

The bergs which appear in the North Atlantic Ocean have their origin almost exclusively from the fiords around Disco Bay in western Greenland and from Jacobshavn, Umanak, Upernivik, and Godhab.

The bergs from eastern Greenland usually drift down the east coast and round Cape Farewell and then turn to the northward along the west coast of Greenland. They usually disappear before reaching latitude 64° N. When strong northerly and northeasterly winds prevail in the eastern part of Davis Strait, some of the bergs are driven westward, but it is believed that they usually disintegrate in the comparatively warm water in the center of the strait and never reach the Grand Banks. Some of the bergs from the east coast it is believed find their way to the eastward of Flemish Cap.

The following expressions and their meanings are submitted as of interest.

"Beset," a ship closely surrounded by ice.

"Bore," to enter the ice under power and force the way through.

"Bay ice," very thick young ice.

"Brash," also called "trash," a collection of small pieces or fragments of ice not frozen together.

"Ice blink," a bright line on the horizon seen over an ice field and denoting more ice. When a blue streak is seen on the horizon, it is an indication of open water and is called "water sky."

"Calving," a large piece of ice breaking off a parent berg and falling into the water, or the breaking off of an iceberg from a glacier.

"Field"—a field is a large collection of any kind of ice, usually pans, adrift at sea and the extent not necessarily bounded by the

horizon. Field ice usually varies in thickness from 5 to 20 feet. Its surface is usually covered by a large deposit of snow, which usually melts during the summer, forming many fresh-water pools. Generally the field is covered by long ridges or hummocks, some of which are often very high.

A "floe" is a collection of sheets of ice, more or less connected by freezing. The pieces vary from one-half to one mile in diameter. The extent of the ice can usually be seen. When the pieces of ice are smaller, the ice is called "drift ice."

"Floe berg," a large mass of ice broken off from floes of great thickness usually built up by rafting and freezing and forced on shore.

"Ground ice," ice formed on the rivers and inlets before the general freeze up.

"Growler," a small piece of glacial ice dangerous to navigation, usually caused by the capsizing and disintegration of an iceberg.

"Iceberg," a large mass of glacial ice.

"Ice foot," floe ice frozen fast to shore.

"Land ice," comparatively thin ice attached to shore.

"Lane" or "lead," a narrow track of open water between floes or pack ice.

"Nipped," when a vessel is pressed by ice floes on both sides.

"Pan," a large sheet of ice thicker at the edges than in the middle.

"Pack," a large collection of heavy ice closely packed together and usually impossible of navigation, ordinarily of such extent that its limits can not be seen. When the individual pieces do not touch, an "open pack" exists; when they are pressed together, a "close pack" exists.

"Patch," a small collection of drift ice.

"Rotten ice," old ice that has been subjected to the disintegrating forces and is well honeycombed.

"Rafting," piling up of sheet on sheet of ice by the action of the wind and sea.

"Stream," a drifting line of drift ice.

"Sheet ice," a large sheet of floe or bay ice adrift at sea.

"Shore ice," the original ice formed along the shore, free from motion due to tide and sea.

"Sludge," a field of brash ice.

"Slob ice," loose broken ice that collects in bays and along edges of floes, usually more or less discolored.

"Tongue," a projecting point of ice from a berg under the water.

"Young ice," ice that forms in the open sea early in the autumn, when the temperature is sufficiently low, usually a film of ice. When the ice becomes very thick it is called "bay ice."

## SONIC DEPTH FINDER

The sound apparatus was installed for the purpose of determining the practicability of locating icebergs by means of submarine echoes.

The sound installation on the *Tampa* consisted of the following:

(a) Two 12-spot MV hydrophone lines, housed in type JC blisters, the blisters being installed symmetrically, one on either side of the vessel, centered on frame 29, and separated horizontally by a distance of 14 feet.

(b) Type CAG-4217 compensator, to bring the sound responses from the several receivers into phase. Installed in chart room.

(c) Test panel, consisting of 24 milliammeters, each in series with a microphone of the receiving line to indicate condition of microphones. Installed in chart room.

(d) Two Submarine Signal Co. 540-cycle oscillators, mounted in fore and after peak tanks, respectively. Forward oscillator mounted 2 inches abaft of frame 5, on starboard bow, in skin type mounting, facing outboard and downward at an angle of about 15° below the horizontal plane. After oscillator mounted on 10-inch channel iron on port side of after peak tank, facing outboard and at an average distance of about 18 inches from skin of ship. Base line from center of microphone lines to forward oscillator, 47 feet; to after oscillator, 126 feet.

(e) Five-kilowatt, Holtzer-Cabot motor generator, installed in engine room.

(f) Cutler-Hammer starting box, installed in engine room, with remote control in chart room.

(g) Oscillator control panel, mounted in chart room.

(h) Type SE-1987 sonic depth finder, installed in chart room.

Originally only one oscillator, the forward one, was contemplated. Upon the completion of the forward oscillator calibration was attempted, using it as the sound producer. It was found that the base line was rather short and that the direct signal from the oscillator was so loud as to destroy the binaural effect. Even in the deepest water no satisfactory results were obtained. It was then decided to install the oscillator in the after peak tank. This was a much better location with reference to the microphones, the direct signals being completely absorbed by the hull of the ship and an increase being made in the base line. The location was bad for signals from ahead. The propeller sounds did not affect the transmission or reception.

Upon installation of the after oscillator the sonic depth finder was tested and the compensator compensated. The vessel proceeded down Boston Bay to Stellwagen Bank, testing all apparatus in shallow and deep water. A 75-foot patrol boat was used as a sound maker and the compensation made.

## Results of compensation

| Compen-<br>sator<br>Reading | Depth          | Compen-<br>sator<br>Reading | Depth          |
|-----------------------------|----------------|-----------------------------|----------------|
| <i>Degrees</i>              | <i>Fathoms</i> | <i>Degrees</i>              | <i>Fathoms</i> |
| 13                          | 2              | 62                          | 20             |
| 19                          | 3              | 64                          | 22             |
| 23                          | 4              | 66                          | 24             |
| 27                          | 5              | 68                          | 26             |
| 30                          | 6              | 70                          | 28.5           |
| 33                          | 7              | 72                          | 32             |
| 36                          | 7.5            | 73                          | 34             |
| 39                          | 8.5            | 75                          | 39             |
| 42                          | 9.5            | 76                          | 42             |
| 44                          | 10             | 78                          | 49.5           |
| 46                          | 11             | 80                          | 59.5           |
| 48                          | 11.5           | 82                          | 72.5           |
| 50                          | 12.5           | 83                          | 83             |
| 52                          | 13             | 84                          | 100            |
| 56                          | 15             |                             |                |
| 58                          | 17             |                             |                |
| 60                          | 18             |                             |                |

NOTE.—Correction of  $+4^\circ$  and correction of  $+2$  fathoms.

The apparatus was used to determine depths on numerous occasions with very favorable results. Depths obtained in this manner were checked by hand soundings, taken while the vessel was hove to, and were found to be accurate to the nearest fathom up to the limits of the sounding machine approximately 200 fathoms. Depths ranging from 13 to 2,500 fathoms were determined by the use of the time method.

Experiments were carried out on different types of bergs, both large and small, in shallow and deep water, and in soft and hard bottom. Following shows the method of procedure in carrying out these experiments:

- (a) *Conditions*.—Latitude  $45^\circ 48' N.$ , longitude  $46^\circ 57' W.$  Depth of water 2,300 fathoms. Character of bottom, muddy. Temperature of sea, 38; temperature of air, 39. Size of berg above water: Height, 200 feet; length, 300 feet; shape, irregular.

*Observations*.—Steamed toward and around berg at various speeds and from the berg at various distances, but no echoes were received. Stopped at various distances, around the berg, but no echoes were received.

- (b) *Conditions*.—Latitude  $44^\circ 25' N.$ , longitude  $48^\circ 10' W.$  Depth of water, 1,800 fathoms. Character of bottom, fine-grain sand and small gravel. Temperature of sea, 39; temperature of air, 44. Size of berg above water: Height, 100 feet; length 250 feet, shape, irregular.

*Observations*.—While stopped, with berg abeam, echoes could be heard at 1,000 yards. Steaming at 10 knots toward berg, no echoes could be heard. Circling the berg at a range of 1,000 yards, weak echoes were heard, varying considerably in intensity, the loudest echoes being received when the bottom echoes were at a maximum. Circling the berg at a range of 1,500 yards, weak echoes were occasionally heard. While circling the berg better results were noted with the berg bearing abeam or abaft of the beam than with it bearing forward of the beam.

- (c) *Conditions*.—Latitude  $47^\circ 17' N.$ , longitude  $47^\circ 55' W.$  Depth of water, 120 fathoms. Character of bottom, gravel. Temperature of sea, 38;

temperature of air, 38. Size of berg above water: Height, 200 feet; length, 600 feet; shape, regular.

*Observations.*—While stopped, with the berg dead ahead, echoes could be heard at 1,500 yards. Steaming toward the berg at 10 knots, no echoes were heard until the berg was at a range of 400 yards. Circling the berg at a range of 1,000 yards, very good echoes were heard. Circling the berg at a range of 1,500 yards, weak echoes were heard. While circling the berg better results were noted with the berg bearing abeam or abaft of the beam than with it bearing forward of the beam. Steaming directly away from the berg at a speed of 10 knots, weak echoes could be heard at a maximum range of 2,500 yards occasionally.

(d) *Conditions.*—Latitude  $44^{\circ} 00' N.$ , longitude  $49^{\circ} 30' W.$  Depth of water 39 fathoms. Character of bottom, fine-grained sand, shells, and small gravel. Temperature of water, 37; temperature of air, 47. Size of berg above water: Height, 30 feet; length, 65 feet; shape, remains of "dry dock," being irregular ridges with apparently solid base.

*Observations.*—Approached berg from 2,500 yards at various speeds. At maximum speed received echoes when close aboard; at slow speed, moderate intensity, echoes were heard at 500 yards. Circled berg at various distances and speeds, received good echoes from about  $15^{\circ}$  off either bow at distances up to 1,500 yards. Intermittent echoes were heard while circling up to a distance of 2,200 yards. Weak echoes were heard at 2,500 yards at times. The best intensity was heard with bergs abeam or abaft the beam.

#### ECHOES

While off the coast of Nova Scotia the sound apparatus was tested for echoes in sandy bottom and rocky bottom with good results but with varying intensities.

#### CONCLUSIONS

(a) It was established that the equipment installed on the *Tampa* affords an efficient means of determining depths.

(b) It was established that echoes of oscillator signals were reflected from icebergs and could be heard under favorable circumstances.

(c) That such echoes varied in intensity, depending upon the depth of water, character and contour of the bottom, the relative bearing of berg with reference to oscillator, the speed of vessel and the nature, form, and size of the reflecting surface, and the location of the oscillator.

(d) That the range at which echoes could be heard varied with the relative bearings of the berg with respect to the vessel, being at a minimum with the berg bearing forward of the beam, and also that this range decreased when the speed of the vessel was increased due to the increased amount of local disturbing noises in the location of sound maker.

(e) That with the iceberg dead ahead and the vessel steaming at 12 knots no echoes could be heard above a range of 500 yards, even in 39 fathoms of water, and that better results for all purposes



were obtained by the use of the after oscillator than by the use of the forward apparatus.

(f) That the present equipment is a valuable means of conveniently determining depths and thereby a valuable aid to navigation.

(g) That the apparatus in its present development is not a suitable means for detecting icebergs and would not be sufficient to avert a collision, due to lack of echoes from dead ahead and the limited ranges.

(h) That specially trained operators are required for this particular work, necessitating additional members in the complement of the vessel for constant watch. A personal error was noted in practically all observers. It has been observed that the greatest personal error in operation was in depths of between 15 and 60 fathoms, and where the bottom was sloping or irregular. Ensign Richards was the most efficient observer, especially in shallow water, both with the angle method and sonic depth finder.

(i) That the scope of the present apparatus is very limited and the apparatus too unwieldy for constant use to be of value as an obstruction detector. It is uncertain in its results to the extent that detection at this stage is really a matter of chance with the odds decidedly against the vessel. The sound wave, spreading in all directions caused echoes from a number of points at times.

(j) The compensator bearings were not reliable. If the general bearing of the object were known it would be possible to obtain fair results—the accuracy of the bearing being dependent, as above shown, on the depth of the water, the intensity of the echo and the speed of the vessel.

(k) That the present location of the forward oscillator afforded a very poor installation, due to direct sound.

(l) That the location of the after oscillator was not very favorable for echoes from ahead.

(m) That an iceberg forms a medium for reflecting submarine sounds.

(n) That an echo was invariably received from a berg on all approaches under normal conditions. That the side of approach, whether to windward or leeward, had no material effect on the intensity of the signal.

(o) That no direct echoes from bergs were received in so far as the operating personnel could identify. All echoes were recognized as reflected echoes from the bottom.

(p) That local noises, while very noticeable, did not seem to affect the reception to a marked degree while at anchor or when hove to, but while under way under abnormal sea conditions in deep water, the interference was very marked.

(q) That growlers and very small bergs did not reflect the sound very well under normal conditions.

(r) That the hulls of vessels will reflect the sound as, in a number of cases, the hulls of fishing vessels in shallow water, reflected echoes at 1,000 yards and less.

(s) That hard bottom gave better echoes than soft. That a variable contour bottom caused considerable trouble in determining proper depths in both methods.

(t) That sloping bottom caused erratic soundings.

#### RECOMMENDATIONS

(a) That further experiments be carried out with the sonic apparatus.

(b) That a number of the crew of the *Tampa* be given instruction in the use of the sonic.

(c) That the apparatus be overhauled and placed in first-class condition.

(d) That the super sonic equipment be investigated with a view of carrying out experiments with that installation.

(e) That the forward oscillator be sheathed with cement.

(f) That lines of sounding be run every  $20^\circ$  from latitude  $44^\circ$  longitude  $50^\circ$  from west, south, and east, for a distance of 120 miles from center at 10-mile intervals, except where abrupt changes in depth are noted when the intervals should be shortened.

#### OPERATION OF SONIC APPARATUS

The apparatus worked very well during the first part of the patrol. There was considerable noise in the worm, motor, and gears, and this was adjusted by proper aligning. During the third cruise it was found that two solenoids of the starting relays had burned out. Upon the arrival of the vessel in port the apparatus was tested and found in good shape. New parts were however taken on board. When the vessel returned on patrol the apparatus failed to function. The machine could not be started even by working the relays by hand. The solenoids were removed and the apparatus tested and it was found that the solenoids were shorted and the bank resistance in the first starting stage burned out.

The type of starter used must necessarily have a long time interval from 0 to full speed. Due to line voltage, this interval was nearly one minute. As the location of the remote control was in the chart room, it was rather difficult at times for the operator to tell when the machine was up to speed. If a load was given the machine before it was up to speed, the time interval in starting was increased. By increasing this time interval, additional load was thrown on the

solenoids of the starting relays and this was undoubtedly the reason for failure to function.

The original source of supply for the sonic was taken from the 75-kilowatt distributing board. With the starting box burned out, it was out of the question to use the 75-kilowatt machine as the ship's supply was taken from that board. As it was imperative that the sonic be started to complete the tests, two jumper wires were put across the starting box and the source of supply taken from the 10-kilowatt machine. By starting the 10-kilowatt machine at 0 voltage and building both the generator and sonic motor-generator up to voltage and speed simultaneously, the sonic was placed in operation. This method of starting was found to be satisfactory in the existing emergency and the tests were completed.

It is recommended that a new starter of the remote control type be furnished the *Tampa*.

#### SOUNDINGS

Attention is invited to Charts Nos. 1 and 2. These soundings were taken at regular intervals. The sonic depth finder was checked for depth by hand lead and sounding machine and found to agree very closely to both up to the limits of the sounding machine. The positions on the chart were checked as often as it was possible to take sights. During the clear weather, sights were taken every two hours and lines of position from stars were determined whenever possible.



BERG NO. 14 AT 4 P. M. JUNE 30, 1925

This growler had completely disappeared by 6 a. m. July 1



"DRY-DOCK" BERG  
Loose ice due to swash of water



SOLID BERG CAPSIZING

## RADIO COMMUNICATION

The entire plan and structure of the ice patrol rests upon a foundation of efficient communication and intercommunication. The more exact and complete the information received from cooperating vessels and stations, as to location and movement of ice, the more successful the patrol will be. It is not too imaginary to say that as the ice information is news of a perishable nature, almost everything depends upon its rapid and accurate dissemination.

The success of the patrol has been due primarily to communication made possible through the courtesy and cooperation of the merchant fleets of the various nations in furnishing ice, weather, and temperature data; the willing and efficient service afforded by the Canadian radio stations in transmitting reports of weather conditions and radiocompass bearings, as well as that of the Navy Radio Station NAA (Arlington), the radio stations of the first naval district, and WCC, the Radio Corporation of America's radio station at Chatham, Mass.

During the ice patrol of 1925 a total of 524 vessels of different nationalities cooperated by furnishing radio reports of derelicts, ice, currents, and weather, some for a single cruise and others constantly. These may be summarized as follows:

|               |     |                |    |                    |     |
|---------------|-----|----------------|----|--------------------|-----|
| Belgian.....  | 4   | German.....    | 20 | Panaman.....       | 3   |
| British.....  | 226 | Greek.....     | 4  | Spanish.....       | 5   |
| Canadian..... | 12  | Italian.....   | 5  | Swedish.....       | 18  |
| Dutch.....    | 32  | Japanese.....  | 2  | United States..... | 158 |
| French.....   | 14  | Norwegian..... | 21 |                    |     |

On the part of the patrol a splendid record was made by the radiomen assigned to the two vessels under the leadership of Chief Radioman Ole Friis ably assisted by Chief Radioman G. M. Gallagher of the *Modoc* and Chief Radioman T. H. Rounsefell of the *Tampa* and their assistants in receiving and disseminating radio data which, as stated above, are so important to the successful operation of the ice patrol. The radio work covered every phase of traffic and required a continuous watch.

The following radio equipment was carried by the patrol vessels during the International Ice Patrol, season of 1925:

(a) *Main transmitting set.*—Coast Guard model T-2; 2-kilowatt CW, ICW, and phone transmitter; reliable transmitting range under average conditions 900 miles daylight, 1,200 miles night on CW, 600 miles daylight and 800 miles night on ICW, and 400 miles daylight and 600 miles night on phone; wavelength range in two bands, from 550 to 960 meters and 1,550 to 2,750 meters.

(b) *Auxiliary transmitting set.*—Navy model SE 1205, 2-kilowatt spark set; reliable transmitting range under average conditions, 500 miles daylight and 700 miles night; wave-length 600, 706, and 800 meters.

(c) *Main receiving set.*—Navy type SE 1420C intermediate wave receiver; wave-length range 450–7,500 meters; and type SE 1000F two-stage audio-frequency amplifier.

(d) *Short-wave transmitting set.*—Coast Guard model T-1; 50-watt ICW and phone transmitter, used for experimental purposes and for communication between the patrol vessels; reliable transmitting range under average conditions 350 miles daylight and 800 miles night on ICW, and 150 miles daylight and 200 miles night on phone; wave-length range 70 to 180 meters.

(e) *Short-wave receiving set.*—Coast Guard type CGR-1 short-wave receiver, wave-length range from 100 to 200 meters and a special Reinartz receiver, wave-length range from 40 to 610 meters.

(f) *Radiocompass.*—*Tampa* was equipped with a Kolster radiocompass and the *Modoc* with a type SE-1512 Navy standard radiocompass.

The broadcasting schedule maintained by the patrol was as follows:

| Time               | Broadcast                                                                                     |
|--------------------|-----------------------------------------------------------------------------------------------|
| 0000 G. C. T. .... | Ice broadcast, 3 times, interval of 2 minutes.                                                |
| 0100 G. C. T. .... | Call NBD (Bar Harbor) to transmit weather for Weather Bureau.                                 |
| 0200 G. C. T. .... | QST for water temperatures.                                                                   |
| 0430 G. C. T. .... | NAA (Arlington) weather, press, and Coast Guard messages.                                     |
| 0600 G. C. T. .... | QST for water temperatures.                                                                   |
| 0800 G. C. T. .... | Special broadcast if necessary.                                                               |
| 1100 G. C. T. .... | Ice broadcast, 3 times, interval of 2 minutes.                                                |
| 1200 G. C. T. .... | Do.                                                                                           |
| 1300 G. C. T. .... | Call NBD (Bar Harbor) to transmit weather for Weather Bureau and ice for Hydrographic Office. |
| 1400 G. C. T. .... | Special broadcast if necessary and QST for water temperatures.                                |
| 1500 G. C. T. .... | Weather from Halifax and Cape Race.                                                           |
| 1630 G. C. T. .... | Press and weather from NAA (Arlington).                                                       |
| 1800 G. C. T. .... | QST for water temperatures.                                                                   |
| 1900 G. C. T. .... | Special ice broadcast when necessary.                                                         |
| 2100 G. C. T. .... | QST for water temperatures.                                                                   |
| 2300 G. C. T. .... | Ice broadcast, 3 times, interval of 2 minutes.                                                |

#### FIRST CRUISE, MARCH 22–APRIL 8, "TAMPA"

Splendid results were obtained with the 2-kilowatt tube transmitters during this patrol, a considerable portion of which was devoted to cruising near the Tail of the Banks. Very unusual static conditions were found at this time—conditions that were never noticed before the latter part of May or the first part of June in previous years. This may have been partly due to the failure of the patrol vessels to maintain communication with NAA (Arlington). The shift from NAA (Arlington) to NBD (Bar Harbor) and NAD (Boston) was productive of gratifying results.

Communication with the shore was established on the 50-watt set, which operated exceptionally well until the arrival of the vessel in a static band at the Tail of the Banks. Direct communication was maintained with amateur radio stations in Cleveland, New York, and Manchester. The Reinartz receiver, constructed at Coast Guard headquarters and adapted for the lower wave lengths, was operated successfully. Stations as far west as Hastings, Nebr., were heard

distinctly on 64 meters from a position in latitude  $46^{\circ}$  N., longitude  $48^{\circ}$  W., using only a dry cell for the filament current and a 37-foot vertical antenna.

During this cruise approximately 180,000 words were sent and received and the transmitters were in operation about 70 per cent of the time.

#### SECOND CRUISE, APRIL 8-22, "MODOC"

No trouble of any nature was experienced with the 2-kilowatt tube transmitter on this patrol. Considerable leakage was found in the rigging in damp and wet weather, and this was further prevented by grounding all the antenna wire guys. All signal halyards on the signal yard were burned off and fell to the deck. This defect was remedied by placing a 12-inch porcelain insulator between the yard and the halyards. A very good test of the antenna insulation was made while the vessel was north in latitude  $49^{\circ} 00'$  near the bergs. The antenna and pyrex insulators were completely covered with ice. The output with the antenna in the above condition was reduced only about 10 per cent. There is no doubt that with the old arc transmitter the output would have been reduced to such an extent that the set would have been worthless. A test with the spark set showed about 40 per cent reduction in output. The pyrex insulators held the ice and snow longer and were covered with thicker layers than the porcelain, but allowed the water to drop off more rapidly without accumulating during the rainy weather. During the cruise the bakelite strip on the transformer band-change switch broke down between the contacts. This defect is believed to have been due to poor bakelite. Temporary repairs were made and the output was not affected noticeably.

All the official traffic was sent via NBD (Bar Harbor) except for one schedule, which was sent to NAB (Portland, Me.). NBD's (Bar Harbor) weak signals made it very difficult to work that station.

The vessel communicated with WCC (Radio Corporation, Chatham, Mass.) every night on CW. The station reported the signals very strong. WCC was also worked on ICW several times, on 2,100 meters. About 8 amperes were put in the antenna. These signals were also reported strong. The distance from WCC at the time was approximately 1,000 miles.

Eastbound ships copying the 1,621-meter broadcasts, were requested to listen for the broadcast en route to Europe, and also while lying in European ports. Two reports were received, one on April 11, from the S. S. *Scandia* at a distance of 1,590 miles, reporting

the signals strong; the other from the S. S. *Montclare* at a distance of 1,700 miles, which also reported the signals strong.

The new Coast Guard modified receiver, type BC-131, was hooked up and used during the entire patrol in order to give it a thorough test. It was found that, with some minor adjustments, this receiver would be entirely satisfactory and its efficiency equal to the Navy type 1420.

It was found impracticable to operate the 50-watt tube set which was located on the bridge, on account of the exceptionally cold weather.

The 50-watt telephone set was used when relieving, constant communication being maintained between the vessels from the time they were 225 miles apart until they met.

A large amount of traffic was handled during this patrol. It was estimated that approximately 195,000 words were received and sent. Transmitters were in continuous operation about 80 per cent of the entire patrol period. The spark transmitter was used for the 706-meter broadcast instead of the ICW, the latter transmission being too sharp and causing many requests for repetitions.

The phone attachment on the 2-kilowatt tube transmitters was not tested on account of lack of time due to heavy patrol traffic.

### THIRD CRUISE, APRIL 23-MAY 8, "TAMPA"

During this cruise, on April 30, the starting box of the motor generator was found out of order. It was examined and found that the contactors on the second step of the starter did not release when stopping the machine, thereby throwing the full load on the motor when starting the machine again. Minor adjustments were made to the contactors and the machine placed in working order. This trouble, however, did not delay any of the schedules.

A new arrangement was made during this cruise whereby the ship at Halifax checked the traffic with NBD (Bar Harbor), relaying the messages, if necessary. This enabled the patrol to keep in constant and direct communication with NBD. The arrangement was as follows:

Commencing at 11.30 G. C. T., April 29, the vessel on patrol will call the vessel in port immediately after the completion of the spark broadcast on 1,621 meters CW. for immediate transmission of traffic to NBD. If the traffic is not received before 12 G. C. T., the time for CW. broadcast, the patrolling vessel will call again after the CW. broadcast. The operators of vessel in port must remain on watch until the traffic is cleared. This procedure will be carried out in the evening after the spark broadcast, and if necessary, immediately after the CW. broadcast requiring watch until 23.30 or whenever the traffic is cleared.

This arrangement was probably the best that could be made to absolutely insure the passage of the traffic, as all messages could be classed under the heading of perishable—that is, the information

would not be of any value after a certain stated time. It assured the personnel at Bar Harbor two opportunities for reception and practically guaranteed the transmission of the messages; but it greatly inconvenienced the patrol vessel off duty and caused considerable radio interference to the receivers in the vicinity of the dockyard at Halifax. The vessels were granted permission to use the transmitters between certain stated hours, which periods were often greatly exceeded on account of the stress of business due to the inability of NBD (Bar Harbor) to receive the messages, or perhaps to the inability of the transmitting vessel to receive the check from Bar Harbor with its low power. The station at Bar Harbor maintained a perfect schedule as far as could be observed, and the ice-patrol vessels deeply appreciated the excellent cooperation given the patrol by the radio stations in the first naval district.

The following objections are interposed to the method of relaying messages via the patrol vessel in Halifax:

1. Errors were introduced due to the repetition of messages.
2. It cut down the time for repairs while the vessel was in port on account of having to use the exciter.
3. It required an extra watch in port.
4. The arrangement was unnecessary from the viewpoint of the patrol vessel because of the high class of equipment. The transmitters are fully capable of handling the regular schedule from 1,000 to 1,400 miles with any efficient station.
5. It was an imposition on the Canadian stations.
6. It caused interference to receiving stations close by the Halifax dockyard, where the relay ship is moored.
7. It added extra responsibility to the patrol vessel.

It is estimated that approximately 175,000 words were sent and received during the cruise, and the transmitters were in constant operation about 78 per cent of the total time of the cruise.

Excellent results were obtained with the 50-watt tube transmitter during this cruise. A fairly consistent schedule was kept with NCG (Coast Guard radio station, Rockaway Point, Long Island). Nightly schedules with 1BQQ at Mansfield, Mass., were maintained, and approximately 60 messages were handled through this station. A schedule was also kept with 2TR (Newark, N. J.), 10 messages being handled through this station, and with NAD (Boston Navy Yard) on 80 meters. The *Tampa* heard NAD on the Reinarts receiver but, apparently, NAD did not hear the *Tampa*.

The following are registered on the meters on the transmitter working on 143 meters, ICW.:

|                               |                |      |
|-------------------------------|----------------|------|
| Antenna current.....          | amperes..      | 3    |
| Primary current.....          | do....         | 8    |
| Filament current.....         | do....         | 3. 2 |
| Oscillator grid current.....  | milliamperes.. | 20   |
| Modulator plate current.....  | do....         | 100  |
| Oscillator plate current..... | do....         | 140  |
| Plate voltage.....            | volts..        | 780  |

All stations reported the signals loud, clear, and steady.

The phone was used for intercommunication between patrol vessels when being relieved, and very satisfactory results were obtained, the maximum distance being approximately 250 miles.

The S. S. *Montclare* reported copying the QST (CW.) of April 25 from a distance of approximately 1,800 miles. The signals were reported loud and clear.

#### FOURTH CRUISE, MAY 8-22, "MODOC"

No difficulties were experienced with the transmitter during this cruise. All traffic was routed via NBD (Bar Harbor), either direct or relayed via the *Tampa* at Halifax. Considerable difficulty was encountered in working NBD direct, due to this station's weak signals, which were scarcely audible at times.

The radio operator on the S. S. *Coelleda* reported copying the QST on 1,621 meters daily while crossing the Atlantic Ocean and also while at Liverpool, England.

Unusually heavy ice patrol traffic was handled during this cruise. It is estimated that approximately 192,000 words were transmitted and received. The hydrographic reports assumed large proportions, one containing 369 words, and the average message containing 200 words. Radio transmitters were in constant operation 85 per cent of the time during this cruise.

A large amount of commercial traffic was handled through WCC, Chatham, Mass., which station reported the signals strong and clear at all times.

The CGR-1 short wave receiver was removed from the bridge and installed in the chart room during the cruise. Remote control was run from the T-1 transmitter on the bridge down to the chart room and very satisfactory results were obtained. The *Tampa* at Halifax was worked without difficulty. A schedule with 1BQQ at Mansfield, Mass., was maintained, handling about 30 messages. All the Coast Guard destroyers and cutters off New York were copied nightly. One Coast Guard destroyer (NIN) was plainly heard by phone 45 minutes after daylight on May 21, the position of the patrol vessel being in latitude 44° 47' N., longitude 48° 42' W.

#### FIFTH CRUISE, MAY 22-JUNE 8, "TAMPA"

The entire cruise was marked by heavy static and electrical disturbances, causing some delay in transmission of traffic to NBD (Bar Harbor) at times and on one occasion necessitating the evening traffic being transmitted to NBD the following morning. All traffic was routed to NBD via the *Modoc* at Halifax.

During the evening of May 27 the contactor arm of the key relay parted close to where it enters the shaft. All the traffic to NBD had

been transmitted so that no delay was occasioned in the schedules. This break was repaired during the night and the transmitter was in commission for the morning schedules. It is believed that this accident was due to the lock nuts having worked loose, allowing too much play between the contact points.

During the morning of May 31, the power amplifier plate by-pass condenser was punctured, causing a delay of about one hour in the morning schedule before the trouble was traced and the punctured condenser replaced by a spare on hand. This trouble was believed to be due either to overloading of the transmitter or to a defective condenser.

On June 4 the master oscillator grid condenser was punctured. The trouble occurred after the traffic to NBD had been transmitted. The transmitter was in commission for the morning schedules. The puncture was evidently due to one of the 1-kilowatt power amplifier tubes becoming defective. It was noted before the condenser punctured that one of the tubes had heated up more than the other. The defective tube was replaced by a spare one.

Approximately 176,000 words were transmitted and received during the patrol, and the transmitters were in continuous operation 78 per cent of the entire time. Static was responsible for the failure to receive special weather bulletins on five occasions during the cruise and the failure to receive press on six occasions.

Owing to adverse atmospheric conditions prevailing during the cruise, only fair results were obtained on the 50-watt tube transmitter. Station 1BQQ (Mansfield, Mass.) was communicated with on 3 nights and about 30 messages were handled. Coast Guard vessels off New York were heard on ICW almost nightly, and NIL (the Coast Guard destroyer *Cummings*) was copied plainly one night by phone. Atmospheric conditions caused the schedule with NKF (Bellevue, D. C.) to be abandoned, NKF being unable to hear the patrol vessel although the patrol vessel could hear NKF.

#### SIXTH CRUISE, JUNE 8-24, "MODOC"

No difficulties were encountered with the set during the entire patrol. Official traffic was routed to Bar Harbor via the *Tampa* at Halifax, except on the evening of June 22 when it was impossible to establish communication with either Bar Harbor or the *Tampa*, due to bad atmospheric conditions. On this occasion the traffic was routed via WCC (Chatham, Mass.). This message was the first official message to be sent via WCC during the patrol. It was again necessary to use WCC on June 23 in getting the *Saugus* report to headquarters.

An unusually heavy amount of traffic was handled during the patrol. It is estimated that approximately 250,000 words were sent and received, and the transmitters were in continuous operation 82 per cent of the total time of the patrol.

The following is a résumé of the outstanding messages handled during this cruise:

- Requests for water temperature reports transmitted, 80.
- Water temperature reports received, 1,387.
- Radio compass bearings, 20.
- Requests for ice information received and transmitted, 110.
- Requests for special information received from vessels and answers transmitted, 60.
- Messages for passing shipping transmitted, 27.
- Messages in French, German, Italian, and Scandinavian transmitted, 19.
- Special broadcasts transmitted, 11.
- SOS received, 1.
- All regular broadcasts transmitted.
- All United States weather reports received.
- All Halifax, Cape Race and Belle Isle weather reports received.
- All press reports except one received.

On June 9, 11, and 19, tests were made with NKF (Navy Experimental and Research Laboratory, Bellevue, D. C.), and with NIDK (*Tampa*), transmitting on 117 meters. It is not known whether NKF copied or not. NKF was copied every night on 71 meters, the signals being very loud and clear at all times; the adverse atmospheric conditions seeming not to affect the signal strength. No daytime tests were made, but it is believed that the signals could be read just as well during daylight.

After the NKF tests the transmitter was tuned to 80 meters and station 3BMV (Philadelphia, Pa.) was worked on two occasions, transmitting four messages. The signals were reported loud and clear. LAC (Liverpool, Nova Scotia) on 80 meters was also worked. Amateur stations in all parts of the United States were copied during the patrol and several English amateur stations were heard, one coming in particularly loud on 50 meters; this was G5DH (Dollis Hill, London), a radio experimental station. The Reinarts short-wave receiver, with no amplification, was used on the above tests. This receiver proved very satisfactory for short-wave reception.

#### CRUISE, JUNE 24-JULY 9, "TAMPA"

*Two-kilowatt tube transmitter.*—One of the power amplifiers, a 1-kilowatt tube, heated up slightly more than the other one, due, probably, to a defective parasitic plate choke coil. This did not interfere with the schedules or reduce the working efficiency materially. All the official traffic was routed through NBD, via the *Modoc* at Halifax, except one message which was sent via WCC, Chatham, Mass.

*Fifty-watt transmitter.*—This transmitter was tuned to 80 meters for the cruise, on account of the heavy atmospheric conditions prevailing. Messages were exchanged with amateur stations at Waterbury, Conn., Lincoln, N. H., and Milton, N. Y. In all cases the signals were reported good. NKF was copied every night on 71.5 meters without difficulty. The signal strength varied between 8 and 9. There seemed to be no trouble for the short waves to pierce the heavy static that existed around the Tail of the Banks at this time.

It is estimated that approximately 160,000 words were received and transmitted during the cruise, and the transmitters were in continuous operation 72 per cent of the cruise.

#### CRUISE, JULY 9-13, "MODOC"

Owing to the short cruise and the patrol being practically over, very little traffic was handled. All official traffic was routed to NBD via the *Tampa* at Halifax. No difficulties were experienced with the transmitter. It is estimated that approximately 15,000 words were sent and received and that the apparatus was in operation approximately 68 per cent of the total time of the cruise.

On this cruise telephone experiments were carried out with passing vessels, and Cape Race, distant about 350 miles. The signals were reported very good, with no mush.

#### MISCELLANEOUS

Experiences from the 1925 ice patrol and the previous patrols show that no regular, reliable communication can be maintained with NBD (Bar Harbor) with the present equipment at that station. This, however, does not refer to the personnel, as their cooperation was perfect, as far as it could be observed—all possible effort being made to maintain 100 per cent communication. A fairly consistent schedule was kept during March, April, and parts of May, when the atmospheric conditions were good, but during the latter part of May and the remainder of the patrol it was impossible to keep a direct schedule, owing to the low power of the station, the signals scarcely being audible, which made it impossible to receive the acknowledgment of traffic transmitted. As stated before, this condition made it necessary to establish a relay station in Halifax. Such an arrangement, however, is not desirable and certainly not conducive to the greatest efficiency.

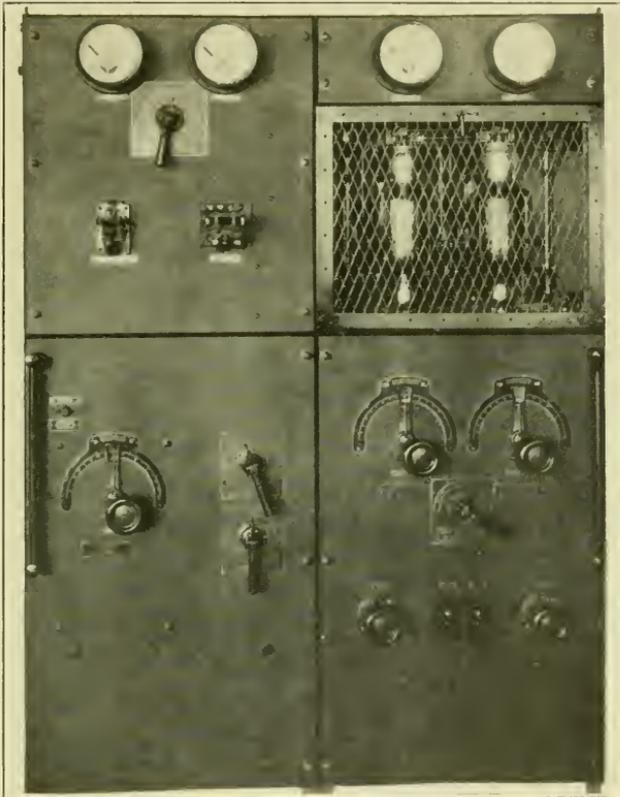
It is believed that a different wave length from that of 1,621 meters should be used for CW traffic with Bar Harbor, as that wave length is very congested, due to harmonics from certain high-power stations.

It is recommended that the patrol attempt direct communication with Washington, using short-wave transmission. It is believed a  $\frac{1}{2}$ -kilowatt short-wave transmitter, wave lengths between 36 and 75 meters, would be ample. This transmitter could be located in the chart room and could be operated by the radio aide assigned to the oceanographer. This would thus give the regular radio watch an opportunity to guard 600 meters at all times except during the broadcasts and would give them more time to devote to the ever-increasing ship-to-ship traffic, relieving them of the Hydrographic Office, Weather Bureau, and Coast Guard traffic.

It is recommended that an additional wave-length band between 960 and 1,600 meters be provided and that the present band between 1,600 and 2,800 meters be reduced to the band 1,600 to 2,400 meters.

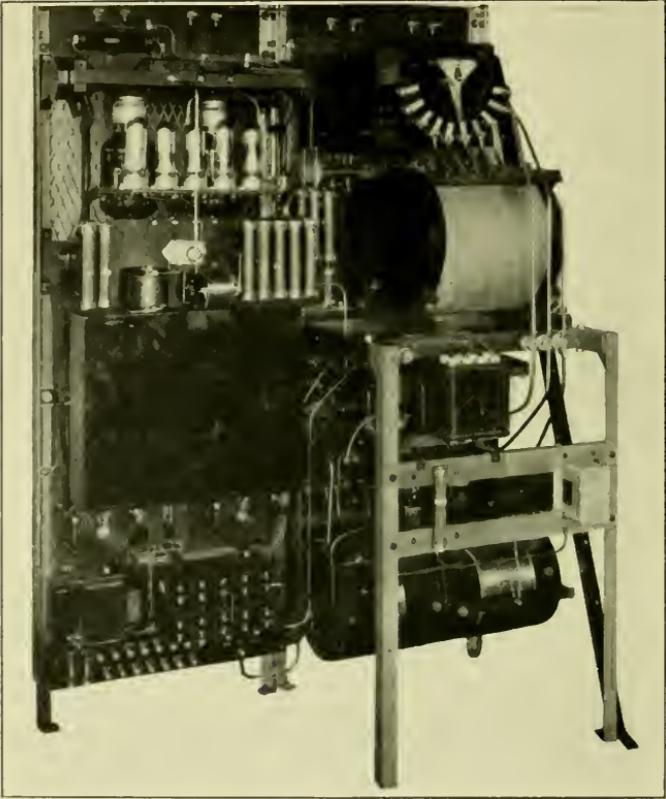
It is recommended that a radio aide who is fully cognizant of the construction, maintenance, and repairs of the radio sets on board the patrol vessels, be assigned to the oceanographic staff, to transfer from ship to ship with the oceanographer.

It is also recommended that further tests be carried out with the phone in connection with the ice-patrol broadcasting.



2 K. W. TUBE TRANSMITTER, C. W., I. C. W., AND PHONE

Front view



2 K. W. TUBE TRANSMITTER, C. W., I. C. W., AND PHONE

Rear view

## MISCELLANEOUS

---

### BIRDS

During the first cruise very few birds were seen near the Tail of the Banks. No ice was reported and the Labrador current was very weak. As the vessel moved northward into the iceberg area, especially above latitude  $44^{\circ}$ , the temperature of the air and the sea water decreasing, the birds became more abundant. In the immediate vicinity of the bergs great numbers of fulmars were found resting in the water among the detritis which was broken or washed off the berg, and were also circling the berg. Whenever the ship moved away numbers of the birds would follow for some distance and then turn back to their iceberg. Apparently there was more food supply in the vicinity of the bergs. The Labrador current containing many forms of marine life, copepods, diatoms, and many varieties of fish are abundant. The marine life was probably brought to the surface by the action of masses of ice in breaking up the seas which were dashed against the bergs thus accounting for the abundance of birds. The ice thus was only an incident. It is doubtful whether any food was obtained from the berg other than fresh water. At various times shearwaters, fulmars, murre, kittiwakes, and dovebies were also observed.

On the second and third cruises, while the patrol vessel was near the bergs in arctic water, large numbers of fulmars, some boatswain birds, and murre were found around the ice. On one occasion the vessel was proceeding in a dense fog toward the location of a berg whose position was in doubt, when an increasing number of fulmars were found gathering around the vessel. The fog lifted shortly thereafter and the berg was sighted four miles distant.

During the remainder of the ice patrol the bergs tracked were in warm water, near the Tail of the Banks. It was found that the fulmars which had been present in large numbers around the bergs to the northward in previous cruises had entirely disappeared from the vicinity of the bergs. This is believed due to the fact that the warmer water of the Gulf stream, which does not contain the same kind of marine life, had mixed with the Arctic water, thereby killing the Arctic marine life and thus destroying the food of the birds, and for that reason the icebergs did not attract the birds. Thus it may be inferred that the presence of fulmars far from land and in the vicinity of the cold water is an indication of ice.

No seals were seen during the patrol and only a few schools of whales and porpoises came in view.

#### RADIOCOMPASS, CAPE RACE

The patrol vessels had reason to use radiocompass bearings all during the season due to the great amount of fog. These bearings were obtained through the kindness and cooperation of the Cape Race Radio Station. The bearings were available practically at all times, a service highly appreciated. Although usually confined to foggy weather, a test of the accuracy was made by the patrol vessel on numerous occasions during clear weather when sights were obtainable. It was found that when the vessel was within the area bounded by latitudes  $42^{\circ}$  and  $43^{\circ}$  N., and longitudes  $48^{\circ}$  and  $51^{\circ}$  W., an error between three and five miles applied to the left (facing Cape Race) gave excellent results for a new line of bearing, usually cutting the position determined by sights. Whenever the vessel was between latitudes  $44^{\circ}$  and  $46^{\circ}$  N., and longitudes  $47^{\circ}$  and  $49^{\circ}$  W., an error of three miles applied to the left, facing Cape Race, for the new line of bearing proved very accurate. Cape Race is to be complimented on its extreme accuracy. A point worthy of comment was the fact that Cape Race invariably made known to the patrol vessel whether the bearing was good, approximate, or doubtful.

#### RADIOCOMPASS, CUTTERS

The radiocompasses proved to be an invaluable aid in foggy weather when the patrol vessels relieved each other. At the time of the grounding of the *Saugus* the bearing obtained by the radiocompass enabled the patrol vessel to head directly for the *Saugus* without undue delay.

#### MINES

In mining it was found necessary in all cases to detonate the 150-pound mines by firing a small T. N. T. mine, the detonator furnished being either too small for the large mine or the space surrounding it too large. The detonator usually fired, bursting the primer charge case but not setting off the primer. When the larger mine was detonated by the smaller mine, two separate and distinct explosions were felt with quite a perceptible interval between them.

#### VIOLATIONS

Only two vessels were reported for violation of the track agreement. These vessels were sighted by the patrol close by large icebergs, well to the northward of the authorized steamship lanes.

### MEDICAL ATTENTION

Medical attention was afforded the crews of the fishing vessels whenever the patrol made contact and with other shipping when required. On occasions the medical advice (diagnosis and treatment) required was furnished by radio for the following urgent cases: Two cases of appendicitis; three cases of infected arms and legs; two of stomach trouble and one of fainting spells. In every instance communication was maintained until the patient was reported resting easier and improving.

### GYROCOMPASSES

The gyrocompasses were of invaluable aid to the oceanographer. Excellent results were obtained, courses were usually made good, and mysterious currents eliminated. The operation of the compasses was simple and their upkeep was very reasonable.

### CURRENT METER

The current meter work was not satisfactory. It was impossible to obtain good results when under way and while at anchor there was usually too much motion to secure accurate results without danger of losing the meter. Excellent results in regard to the set and drift of the vessel while hove to were obtained by use of the drift stick.

### SURFACE WATER SAMPLES

The patrol vessels collected samples of Arctic water for Doctor Haber of the University of Berlin. It was the intention to obtain samples of water at the various depths, but the equipment on hand was insufficient to obtain the proper quantities of water at the difference depths.

### COMMUNICATIONS

A novel experiment in communications was attempted during the last three cruises, which worked very well. A great many foreign operators did not understand the English language very well so that considerable difficulty was encountered in transmitting the ice information and having it properly received. The ice observer conceived the idea of transmitting the warning or request in the language of the nationality of the vessel. More prompt action and better results and cooperation were obtained. Messages were transmitted in German, French, Danish, and Spanish.

## WEATHER

Opportunity is taken to express the appreciation of the Coast Guard for the splendid cooperation of the Weather Bureau as well as the navy radio station at Arlington (NAA). The patrol vessels were furnished daily, by the Weather Bureau, a special weather forecast for the region in which they were operating—a service of great value to the patrol vessels and also to the many vessels passing through the ice area. The Weather Bureau, in addition, furnished each patrol vessel a supply of base maps on which the meteorological reports, broadcast each morning and evening from NAA (Arlington), could be charted. Besides the regular meteorological reports certain supplemental reports were supplied. All of this assistance, combined, made it possible for the patrol vessels to prepare a weather map twice a day which proved invaluable to the commanding officer and the oceanographer in determining future weather conditions and in planning cruises. This method of plotting the data and constructing weather charts is highly recommended.

The patrol vessels sent to the Weather Bureau twice each day, at 8 a. m. and 8 p. m. (seventy-fifth meridian time), an observation containing the usual data, surface and intake temperatures. These were coded and sent via Bar Harbor. In addition, weather reports from vessels were also transmitted and relayed.

Many requests for weather conditions were received, especially from vessels coming from the eastward. The information obtained from the weather maps, forecasts, and local conditions, were usually broadcast for the benefit of vessels desiring this data.

In connection with the forecasts from the Weather Bureau it was noted that at times the forecasts were somewhat premature, that is, the weather predicted did not arrive until 18 to 24 hours later than the time anticipated by those forecasts. This discrepancy was due, it is believed, to the many local "lows" occurring on the Banks unknown to the Weather Bureau and to the lack of sufficient meteorological data between Bermuda and the coast of the United States and to the northward. As an example of this, the following is cited: The 8 a. m. data of May 15 showed a decided curvature or indentation between Nantucket and Sable Island, due evidently to a local "low." High barometric pressures existed at Bermuda and at our position, under normal conditions, should have brought NE. winds, but the "low" evidently forced itself northeastward and the patrol ship's barometer dropped to 30.00, resulting in fog, rain, and SE. breezes. This indentation was still more pronounced in the p. m. data of the 15th. The forecast predicted strong NE. winds and overcast, the actual conditions were moderate E. to SE. breezes with fog and rain.

The following are examples of abnormal rise and fall of barometer:

At noon, March 24, the barometer being 30:00 (moderate N. breezes), started dropping steadily. The wind encircled the compass, going from N. to E. through SW. and back to NE. It blew NE. until 6 a. m., March 26, the barometer at 29.73, when it came out from the NW. The barometer continued falling until 5 a. m., March 27, when 29.58 was reached. The NW. wind continued blowing with a rising barometer until midnight March 30, when the atmospheric pressure registered 30.05, and the wind hauled to NE. April 1 saw a small drop to 29.97 but it rose again to 30.10 with a SSW. breeze. A normal barometer continued until April 3, when a drop came. It dropped very slowly, wind increasing from the SE. until 7 a. m., April 5, when 29.59 was reached. The wind then came out from the WSW. A variable barometer existed, but gales from the WSW., WNW., and SW. blew during April 6, 7, and 8, the barometer dropping to its lowest (29.58) again on April 9, when a gale from the NW. set in. The barometer started to rise, reaching 29.70, and then dropped, SW. and WSW. gales prevailing on April 10 and 11. The barometer reached its lowest, 29.56, at 3 a. m., April 11. On April 12 the wind backed to ENE. and the barometer rose to 29.86 when it again began to drop. This drop continued until 1 a. m., April 13, when it reached 29.49. The wind shifted from ENE. to the NW. with gale force and a rapidly rising barometer. At midnight, April 13, the barometer reached 30.01 and continued rising until 11 a. m., April 14, it read 30.10. The wind came from the NE. with a rising barometer which continued until the morning of April 16, when the wind changed to strong southerly breezes and the barometer began to drop. This drop, however, was slight, going only to 29.98 when a decided rise followed. A "high" existed all of April 18, reaching 30.30 with NW. breezes. On April 22, at 2 a. m., the barometer dropped by leaps and bounds, and a NE. breeze arose with rain and fog. At midnight the barometer reached 29.63, with a SW. gale. It continued dropping until 7 p. m., April 23, when 29.22 was reached. A variable but low pressure existed on April 25, steadying to 29.52 with moderate SW. to NW. gales, dropping to 29.47 on April 26, with moderate NW. gales and continuing to April 27 and 28, when the gales ceased and the barometer took a sudden rise with moderate NE. breezes.

From a normal barometer of 30.13 on May 21, with light SW. breezes, the register dropped by leaps and bounds until at midnight it read 29.82, with strong southerly breezes; 2 a. m., May 22, 29.67 with moderate SE. gale; 5 a. m., 29.48 with strong SE. gale, hauling to a full SW. gale; and an immediate rise to 29.52 at 6 a. m. In the succeeding interval the register teetered, reaching 29.56 with

full WSW. gales at 10 a. m., when the wind hauled to the westward. This continued with a very fluctuating barometer rising to 29.67 at 10 a. m., May 23, when the wind backed to S. and the barometer dropped to its lowest, reaching 29.42 at midnight, May 23. At this hour a SW. breeze sprang up with a slowly rising barometer gradually veering to ENE. breezes. The barometer did not reach normal until noon of May 25.

On June 2 the barometer registered very peculiarly. At 1 a. m., reading 29.81, with SSW. breezes, it began dropping until at 8 a. m., it reached 29.58, when a SW. gale was experienced. This hauled to WSW. and then gradually to WNW. The barometer reached its highest, 30.22, at 10 p. m. the same day, when the WNW. gale died down to a light WNW. breeze. The overcast, foggy, rainy weather of 1 a. m. had completely cleared up by 10 p. m.

## SALINITY APPARATUS

An excellent description of the electrical salinity apparatus is contained in the report of 1924. A general résumé of the practical operation is submitted herewith.

The cabinet containing the apparatus is divided into two compartments by a vertical partition. The apparatus is shielded by a sheet-copper lining on the inside of each compartment.

The right-hand compartment contains the following:

Two "X" cells, one "Y" cell, one thermo-regulator cell, two heating elements, and a sensitive centigrade thermometer—all immersed in a salt-water bath contained in a copper tank at the bottom of the cabinet. The upper part of this cabinet contains a relay for maintaining constant temperature in the bath and a small motor for stirring the water in the bath.

The left-hand compartment contains the hummer mounted in a hardwood box in the bottom of the compartment, the variable slide wire resistance used in balancing the bridge when making salinity measurements, a head telephone, a variable resistance "Q" in three dials, a variable resistance wound as a cylindrical coil with sliding contact (this is third branch), a mutual inductance coil, a fixed resistance unit, a small single pole-knife switch, three snap switches, and a small push-button switch on left side to close hummer circuit.

Each compartment is lighted, heated, and kept dry by means of incandescent lights. Electric leads are carried from the cells and units to bus rods running along the under side of the top of the cabinet.

### TO SET UP APPARATUS

The cabinet, 33 inches wide and 36 inches high, should be supported on a table about 30 inches high, so that the apparatus will be at a height convenient for working. The table and cabinet should be well secured against motion in a seaway. The ship's 120-volt direct-current circuit is the only electric power necessary.

NOTE.—When using the apparatus ashore where direct current is not available it will be necessary to insert four dry cells in series in the hummer circuit. The relay will not operate on alternating current so that the bath temperature must be regulated by the superheater. This requires practice on the part of the operator. The stirring motor will operate on 110-volt 60-cycle alternating current.

## TO OPERATE APPARATUS

Turn the bottom snap switch to "on" position, thus starting stirring motor.

Turn middle snap switch to "on" position thereby putting current on the relay, thermoregulator, and first heater. This automatically brings the bath temperature to  $25.15^{\circ}$  C. and maintains it at that temperature.

The top snap switch controls the current to the second heater or superheater. This heater has no thermoregulator and is only used when it is desired to bring the bath quickly to the regulating temperature. This top switch is normally kept in "off" position. Whenever it is turned "on" the operator should stand by the apparatus and when mercury shows in the bath thermometer, switch it "off" and let the first heater bring the temperature up to the testing point. Under no circumstance should the temperature of the bath be permitted to rise beyond  $27^{\circ}$  C. as such a high temperature causes the mercury in the thermoregulator to expand out through the top of the glass tube and change the critical temperature at which the thermoregulator automatically operates.

There is a salinity table prepared for this apparatus giving the salinity that corresponds to each reading of the slide wire. The "Y" cell contains water whose salinity is approximately known (about 500 on the slide wire). Place water of known salinity in the "X" cell (near 500 on the slide wire) and when the bath comes to the desired temperature ( $25.15^{\circ}$  C.), note reading on slide wire. If this reading does not fall on the salinity curve for water of this known salinity, then adjust the resistance on the "Q" dials until the salinity of water in the "X" cell as shown by slide wire is the same as the known salinity. This is done by setting the slide wire at the reading corresponding to the known salinity of the water in the "X" cell. Then balance the bridge by varying the resistance on the "Q" dials until the sound of hummer is a minimum. This setting of the "Q" dials should not be changed as long as the water in the "Y" cell undergoes no change in salinity. The "Y" cell should be sealed with paraffine to prevent evaporation.

The actual work of balancing bridge is as follows:

1. Adjust the setting of the slide wire so as to bring the sound in the telephone receivers to the minimum intensity.
2. Without changing the setting of the slide wire adjust the mutual inductance so as to further reduce the sound in the telephone receivers, if possible.
3. Without changing either the slide wire or mutual inductance and with the ground switch closed (small single pole-knife switch), adjust the slider on the third branch of the bridge (resistance coil



SUNSET ON THE GRAND BANKS ON JULY 11, 1925

This proved to be the last day of the Ice Patrol for 1925



near top of cabinet) so as to reduce the sound of hummer in telephone receivers as much as possible, being sure that the connection from the third branch to the shield is functioning properly. The ground switch should be kept open at all times except during this test. It may be necessary, however, to make this adjustment every day.

4. Again adjust the setting of slide wire so as to reduce as much as possible the sound of the hummer in the telephones—this gives the salinity of the water being tested.

There are two "X" cells, but only one can be in circuit at a time. Either one may be used in testing samples. It is customary to fill both cells with water and let them both come up to temperature at the same time, and both samples can be tested at practically the same time by shifting the wires from one to the other. The "X" cell is empty tied by connecting a rubber tube to the glass discharge pipe and blowing through the filling tube. If the end of the rubber hose is below the level of the bottom of the cabinet the water will syphon out of the cell. When rinsing out the cell keep the rubber hose on the discharge tube and fill the cell with water to be tested, syphon out this water and remove the rubber hose, then fill the cell with the water to be tested. A glass stopper should be placed in tube after filling the cell and kept there during the salinity test. There is sufficient water in a citrate bottle to permit rinsing of the cell. It is always advisable to bring the water in the citrate bottles close to the testing temperature. This will speed up the testing work, as the greatest delay is caused by waiting for the sample under test to come up to testing temperature. Fifteen minutes is enough to allow for the cell to acquire the temperature of the bath.

*Table of data concerning scientific stations occupied during 1925*

| Station No. | Date            | Time of day           | Position       |                | Wind direction and force, Beaufort | Water, physical data |             |                 |
|-------------|-----------------|-----------------------|----------------|----------------|------------------------------------|----------------------|-------------|-----------------|
|             |                 |                       | Latitude north | Longitude west |                                    | At depth             | Temperature | Salinity        |
| 498 (1)     | 1925<br>Mar. 26 | 8-8.25 a. m. ....     | 43 24          | 59 57          | WNW. 4. ....                       | Meters               | ° C.        | 0/100 by weight |
|             |                 |                       |                |                |                                    | 0                    | -0.5        | 31.69           |
|             |                 |                       |                |                |                                    | 50                   | -0.5        | 31.79           |
|             |                 |                       |                |                |                                    | 125                  | 0.8         | 34.00           |
|             |                 |                       |                |                |                                    | 250                  | 0.3         | 34.16           |
| 499 (2)     | ...do....       | 5.05-6.10 p. m. ....  | 43 32          | 57 02          | NNW. 4. ....                       | 0                    | 9.0         | 34.66           |
|             |                 |                       |                |                |                                    | 50                   | 11.1        | 35.22           |
|             |                 |                       |                |                |                                    | 125                  | 13.1        | 35.77           |
|             |                 |                       |                |                |                                    | 250                  | 10.8        | 35.86           |
|             |                 |                       |                |                |                                    | 450                  | 7.0         | 35.10           |
| 500 (3)     | Mar. 27         | 9.50-10.25 a. m. .... | 43 16          | 54 04          | WNW. 3. ....                       | 750                  | 6.0         | 35.04           |
|             |                 |                       |                |                |                                    | 0                    | 5.9         | 34.41           |
|             |                 |                       |                |                |                                    | 125                  | 4.6         | 34.38           |
|             |                 |                       |                |                |                                    | 250                  | 4.2         | 34.59           |
|             |                 |                       |                |                |                                    | 450                  | 6.6         | 34.91           |
| 501 (4)     | ...do....       | 10-11.00 p. m. ....   | 41 53          | 51 59          | NW. 3. ....                        | 0                    | 11.15       | 35.33           |
|             |                 |                       |                |                |                                    | 50                   | 10.6        | 35.33           |
|             |                 |                       |                |                |                                    | 125                  | 12.1        | 35.70           |
|             |                 |                       |                |                |                                    | 250                  | 10.2        | 35.36           |
|             |                 |                       |                |                |                                    | 450                  | 4.4         | 34.67           |
|             |                 |                       |                |                |                                    | 750                  | 4.85        | 34.75           |

Table of data concerning scientific stations occupied during 1925—Continued

| Station No. | Date            | Time of day       | Position       |                | Wind direction and force, Beaufort | Water, physical data |             |                |
|-------------|-----------------|-------------------|----------------|----------------|------------------------------------|----------------------|-------------|----------------|
|             |                 |                   | Latitude north | Longitude west |                                    | At depth             | Temperature | Salinity       |
| 502 (5)     | 1925<br>Mar. 28 | 7.30-8.30 a. m.   | 42 26          | 51 30          | NW. 3.                             | Meters               | °C.         | 0/00 by weight |
|             |                 |                   |                |                |                                    | 0                    | 6.6         | 33.26          |
|             |                 |                   |                |                |                                    | 50                   | 11.2        | 35.00          |
|             |                 |                   |                |                |                                    | 125                  | 12.2        | 35.33          |
|             |                 |                   |                |                |                                    | 250                  | 10.3        | 35.59          |
| 503 (6)     | do.             | 2.15-2.45 p. m.   | 43 09          | 50 53          | do.                                | 450                  | 10.9        | 35.75          |
|             |                 |                   |                |                |                                    | 750                  | 4.6         | 34.50          |
|             |                 |                   |                |                |                                    | 0                    | 6.4         | 33.43          |
|             |                 |                   |                |                |                                    | 50                   | 4.8         | 33.31          |
|             |                 |                   |                |                |                                    | 125                  | 3.1         | 33.21          |
| 504 (7)     | do.             | 8.15-8.30 p. m.   | 43 42          | 50 16          | NW. 4.                             | 0                    | 4.7         | 33.74          |
|             |                 |                   |                |                |                                    | 25                   | 1.3         | 33.53          |
|             |                 |                   |                |                |                                    | 50                   | 1.1         | 33.51          |
|             |                 |                   |                |                |                                    | 0                    | 1.1         | 32.11          |
|             |                 |                   |                |                |                                    | 25                   | -1.3        | 32.73          |
| 505 (8)     | Mar. 29         | 7.10-7.30 a. m.   | 43 13          | 50 22          | WNW. 3.                            | 50                   | 0.6         | 33.00          |
|             |                 |                   |                |                |                                    | 75                   | 0.6         | 33.06          |
|             |                 |                   |                |                |                                    | 0                    | 1.1         | 32.99          |
|             |                 |                   |                |                |                                    | 50                   | 7.7         | 34.49          |
|             |                 |                   |                |                |                                    | 125                  | 0.6         | 33.56          |
| 506 (9)     | do.             | 10.15-10.30 a. m. | 42 45          | 50 23          | NW. 3.                             | 250                  | 5.5         | 34.64          |
|             |                 |                   |                |                |                                    | 0                    | 10.5        | 35.26          |
|             |                 |                   |                |                |                                    | 50                   | 13.55       | 36.17          |
|             |                 |                   |                |                |                                    | 125                  | 13.0        | 36.13          |
|             |                 |                   |                |                |                                    | 250                  | 9.78        | 35.44          |
| 507 (10)    | do.             | 11.15-2 p. m.     | 42-20          | 50-22          | do.                                | 450                  | 0.8         | 34.37          |
|             |                 |                   |                |                |                                    | 750                  | 4.8         | 34.82          |
|             |                 |                   |                |                |                                    | 0                    | 9.4         | 33.74          |
|             |                 |                   |                |                |                                    | 50                   | 5.85        | 34.56          |
|             |                 |                   |                |                |                                    | 125                  | 4.92        | 34.56          |
| 508 (11)    | Mar. 30         | 12.45-1.40 a. m.  | 41-51          | 47-46          | NW. 4.                             | 250                  | 4.45        | 34.60          |
|             |                 |                   |                |                |                                    | 450                  | 0.6         | 34.27          |
|             |                 |                   |                |                |                                    | 750                  | 4.1         | 34.83          |
|             |                 |                   |                |                |                                    | 0                    | 8.2         | 33.61          |
|             |                 |                   |                |                |                                    | 50                   | 3.1         |                |
| 509 (12)    | do.             | 4.15-6 a. m.      | 42-13          | 48-15          | do.                                | 125                  | 4.8         | 33.78          |
|             |                 |                   |                |                |                                    | 250                  | 4.5         | 31.17          |
|             |                 |                   |                |                |                                    | 450                  | 0.6         | 34.27          |
|             |                 |                   |                |                |                                    | 750                  | 4.0         | 34.71          |
|             |                 |                   |                |                |                                    | 0                    | 6.05        | 33.28          |
| 510 (13)    | do.             | 9.10-10.20 a. m.  | 42-33          | 48-43          | NW. 3.                             | 125                  | 6.3         | 33.83          |
|             |                 |                   |                |                |                                    | 250                  | 3.1         | 33.76          |
|             |                 |                   |                |                |                                    | 450                  | 3.3         | 34.23          |
|             |                 |                   |                |                |                                    | 750                  | 3.9         | 34.97          |
|             |                 |                   |                |                |                                    | 0                    | 1.2         | 32.95          |
| 511 (14)    | do.             | 4.10-1.50 p. m.   | 42-51          | 49-16          | Calm.                              | 50                   | -2.5        | 33.07          |
|             |                 |                   |                |                |                                    | 125                  | 0.4         | 33.29          |
|             |                 |                   |                |                |                                    | 250                  | 3.3         | 33.95          |
|             |                 |                   |                |                |                                    | 450                  | 3.2         | 34.28          |
|             |                 |                   |                |                |                                    | 750                  | 1.2         | 34.77          |
| 512 (15)    | do.             | 7.15-8 p. m.      | 43-09          | 49 39          | N. 1.                              | 0                    | 0.4         | 33.19          |
|             |                 |                   |                |                |                                    | 25                   | 0.45        | 33.47          |
|             |                 |                   |                |                |                                    | 50                   | 3.2         | 33.91          |
|             |                 |                   |                |                |                                    | 125                  | 1.95        | 34.29          |
|             |                 |                   |                |                |                                    | 0                    | 3.5         | 34.13          |
| 513 (16)    | Mar. 31         | 8.50-9.10 p. m.   | 43-25          | 50 03          | ESE. 1.                            | 25                   | 3.25        | 34.28          |
|             |                 |                   |                |                |                                    | 50                   | 1.1         | 34.45          |
|             |                 |                   |                |                |                                    | 0                    | 3.5         | 34.47          |
|             |                 |                   |                |                |                                    | 25                   | 3.25        | 34.54          |
|             |                 |                   |                |                |                                    | 50                   | 1.1         | 34.24          |
| 514 (17)    | do.             | 5.15-5.15 p. m.   | 43-53          | 50 00          | ENE. 2.                            | 0                    | 0.8         | 32.93          |
|             |                 |                   |                |                |                                    | 25                   | 2.2         | 34.46          |
|             |                 |                   |                |                |                                    | 50                   | 1.4         | 33.44          |
|             |                 |                   |                |                |                                    | 125                  | 0.1         | 33.64          |
|             |                 |                   |                |                |                                    | 250                  | 0.1         | 32.70          |
| 515 (18)    | Apr. 1          | 12.45-1.10 p. m.  | 41-00          | 49 06          | SSE. 4.                            | 50                   | 0.9         | 33.08          |
|             |                 |                   |                |                |                                    | 125                  | 5.1         | 34.08          |
|             |                 |                   |                |                |                                    | 250                  | 1.4         | 34.29          |
|             |                 |                   |                |                |                                    | 450                  | 4.0         | 34.42          |
|             |                 |                   |                |                |                                    | 750                  | 0.5         | 34.20          |
| 516 (19)    | do.             | 3.10-4 p. m.      | 41-04          | 48 50          | do.                                | 0                    | 0.5         | 32.67          |
|             |                 |                   |                |                |                                    | 50                   | 5.5         | 33.31          |
|             |                 |                   |                |                |                                    | 125                  | 0.9         | 33.70          |
|             |                 |                   |                |                |                                    | 250                  | 2.0         | 34.25          |
|             |                 |                   |                |                |                                    | 450                  | 4.15        | 34.57          |
| 517 (20)    | do.             | 5.50-6.30 p. m.   | 42-02          | 48-25          | SE. 4.                             | 750                  | 0.25        | 34.26          |
|             |                 |                   |                |                |                                    | 0                    | 0.5         | 32.67          |
|             |                 |                   |                |                |                                    | 50                   | 5.5         | 33.31          |
|             |                 |                   |                |                |                                    | 125                  | 0.9         | 33.70          |
|             |                 |                   |                |                |                                    | 250                  | 2.0         | 34.25          |

Table of data concerning scientific stations occupied during 1925—Continued

| Station No. | Date            | Time of day          | Position       |                | Wind direction and force, Beaufort | Water, physical data |             |                |
|-------------|-----------------|----------------------|----------------|----------------|------------------------------------|----------------------|-------------|----------------|
|             |                 |                      | Latitude north | Longitude west |                                    | At depth             | Temperature | Salinity       |
| 518 (21)    | 1925<br>Apr. 14 | 6.30-7 a. m.-----    | 48-15          | 49-38          | NNW. 3.-----                       | Meters               | ° C.        | 0/00 by weight |
|             |                 |                      |                |                |                                    | 0                    | -0.8        | 32.23          |
|             |                 |                      |                |                |                                    | 50                   | -0.8        | 32.23          |
|             |                 |                      |                |                |                                    | 125                  | -2.0        | 32.47          |
| 519 (22)    | ...do....       | 11.30-12.45 p. m.--- | 48-30          | 49-15          | NW. 5.-----                        | 250                  | -0.4        | 33.01          |
|             |                 |                      |                |                |                                    | 0                    | -0.38       | 32.49          |
|             |                 |                      |                |                |                                    | 50                   | 1.25        | 33.21          |
|             |                 |                      |                |                |                                    | 125                  | 0.2         | 33.38          |
| 520 (23)    | Apr. 15         | 12.15-1.30 p. m.---  | 47-00          | 47-21          | N. 5.-----                         | 250                  | 2.1         | 33.74          |
|             |                 |                      |                |                |                                    | 450                  | 2.8         | 34.10          |
|             |                 |                      |                |                |                                    | 750                  | 3.2         | 34.51          |
|             |                 |                      |                |                |                                    | 0                    | -0.45       | 33.31          |
| 521 (24)    | ...do....       | 5.10-5.40 p. m.---   | 46-45          | 47-56          | WNW. 4.-----                       | 50                   | 1.3         | 33.51          |
|             |                 |                      |                |                |                                    | 125                  | 1.3         | 33.70          |
|             |                 |                      |                |                |                                    | 250                  | 1.7         | 33.98          |
|             |                 |                      |                |                |                                    | 0                    | -0.5        | 33.17          |
| 522 (25)    | ...do....       | 8.05-8.25 p. m.---   | 46-35          | 48-20          | ...do....                          | 25                   | 1.3         | 33.58          |
|             |                 |                      |                |                |                                    | 50                   | 1.3         | 33.76          |
|             |                 |                      |                |                |                                    | 100                  | -1.0        | 33.73          |
|             |                 |                      |                |                |                                    | 0                    | -0.3        | 32.84          |
| 523 (26)    | Apr. 16         | 11.10-11.25 a. m.--- | 45-15          | 49-00          | SSW. 4.-----                       | 25                   | 1.3         | 33.59          |
|             |                 |                      |                |                |                                    | 50                   | -1.0        | 33.53          |
|             |                 |                      |                |                |                                    | 0                    | 1.3         | 33.61          |
|             |                 |                      |                |                |                                    | 25                   | 1.3         | 33.73          |
| 524 (27)    | ...do....       | 1-2 p. m.-----       | 45-12          | 48-38          | ...do....                          | 50                   | -0.9        | 33.81          |
|             |                 |                      |                |                |                                    | 0                    | 2.0         | 33.31          |
|             |                 |                      |                |                |                                    | 50                   | -1.5        | 33.54          |
|             |                 |                      |                |                |                                    | 125                  | 1.9         | 33.95          |
| 525 (28)    | ...do....       | 3.45-4.30 p. m.---   | 45-09          | 48-13          | S. 4.-----                         | 200                  | 2.0         | 34.04          |
|             |                 |                      |                |                |                                    | 0                    | 1.1         | 33.73          |
|             |                 |                      |                |                |                                    | 50                   | 1.1         | 33.46          |
|             |                 |                      |                |                |                                    | 125                  | -0.8        | 33.55          |
| 526 (29)    | Apr. 17         | 9.22-9.40 a. m.---   | 43-59          | 49-18          | SSW. 4.-----                       | 250                  | 4.2         | 34.18          |
|             |                 |                      |                |                |                                    | 450                  | 4.15        | 34.41          |
|             |                 |                      |                |                |                                    | 750                  | 3.7         | 34.70          |
|             |                 |                      |                |                |                                    | 0                    | 5.0         | 33.85          |
| 527 (30)    | ...do....       | 11-11.45 a. m.---    | 44-00          | 49-09          | SSE. 5.-----                       | 25                   | 1.3         | 33.84          |
|             |                 |                      |                |                |                                    | 0                    | 3.8         | 33.29          |
|             |                 |                      |                |                |                                    | 25                   | 2.35        | 33.31          |
|             |                 |                      |                |                |                                    | 50                   | 1.85        | 33.90          |
| 528 (31)    | ...do....       | 2-3 p. m.-----       | 44 00          | 48 48          | SSE. 6.-----                       | 0                    | 4.8         | 33.64          |
|             |                 |                      |                |                |                                    | 50                   | 3.4         | 33.52          |
|             |                 |                      |                |                |                                    | 125                  | 3.55        | 33.81          |
|             |                 |                      |                |                |                                    | 250                  | 4.05        | 34.01          |
| 529 (32)    | ...do....       | 4.10-4.40 p. m.---   | 44 02          | 48 14          | SSE. 5.-----                       | 450                  | 4.3         | 34.29          |
|             |                 |                      |                |                |                                    | 750                  | 3.8         | 34.69          |
|             |                 |                      |                |                |                                    | 0                    | 6.15        | 33.86          |
|             |                 |                      |                |                |                                    | 50                   | 4.4         | 33.85          |
| 530 (33)    | Apr. 30         | 4.45-5.30 p. m.---   | 45 43          | 46 58          | NNE. 4.-----                       | 125                  | 5.2         | 33.97          |
|             |                 |                      |                |                |                                    | 200                  | 4.1         | 34.27          |
|             |                 |                      |                |                |                                    | 500                  | 4.2         | 34.56          |
|             |                 |                      |                |                |                                    | 0                    | 2.6         | -----          |
| 531 (34)    | May 2           | 9.20-9.45 a. m.---   | 44 43          | 49 00          | NNE. 2.-----                       | 50                   | 1.9         | -----          |
|             |                 |                      |                |                |                                    | 125                  | 3.2         | -----          |
|             |                 |                      |                |                |                                    | 250                  | 3.4         | -----          |
|             |                 |                      |                |                |                                    | 450                  | 3.6         | -----          |
| 532 (35)    | May 4           | 9-9.20 a. m.-----    | 44 21          | 49 17          | SSE. 5.-----                       | 0                    | 3.2         | -----          |
|             |                 |                      |                |                |                                    | 25                   | 0.4         | -----          |
|             |                 |                      |                |                |                                    | 50                   | 0.0         | -----          |
|             |                 |                      |                |                |                                    | 0                    | 0.8         | -----          |
| 533 (36)    | ...do....       | 1.55-2.10 p. m.---   | 44 24          | 49 16          | SSE. 4.-----                       | 25                   | 1.24        | -----          |
|             |                 |                      |                |                |                                    | 50                   | 0.9         | -----          |
|             |                 |                      |                |                |                                    | 0                    | 2.3         | -----          |
|             |                 |                      |                |                |                                    | 25                   | 1.4         | -----          |
| 534 (37)    | May 9           | 6.50-7 p. m.-----    | 45 16          | 50 13          | W. 1.-----                         | 50                   | 0.4         | -----          |
|             |                 |                      |                |                |                                    | 0                    | 1.55        | 32.85          |
|             |                 |                      |                |                |                                    | 25                   | 2.7         | 33.68          |
|             |                 |                      |                |                |                                    | 50                   | 1.8         | 34.25          |
| 535 (38)    | May 10          | 5.30-5.50 p. m.---   | 44 44          | 48 52          | S. 1.-----                         | 0                    | 1.2         | 33.22          |
|             |                 |                      |                |                |                                    | 50                   | -1.0        | 33.39          |
|             |                 |                      |                |                |                                    | 125                  | -0.7        | 33.48          |
|             |                 |                      |                |                |                                    | 175                  | -0.5        | 33.58          |
| 536 (39)    | May 14          | 4.20-5.45 p. m.---   | 44 28          | 48 15          | NNW. 2.-----                       | 0                    | 4.1         | 33.16          |
|             |                 |                      |                |                |                                    | 50                   | 2.9         | 33.63          |
|             |                 |                      |                |                |                                    | 75                   | 1.14        | 33.66          |
|             |                 |                      |                |                |                                    | 250                  | 2.5         | 33.94          |
|             |                 |                      |                |                |                                    | 500                  | 3.4         | 34.41          |
|             |                 |                      |                |                |                                    | 800                  | 3.7         | 34.90          |

Table of data concerning scientific stations occupied during 1925—Continued

| Station No. | Date           | Time of day            | Position       |                | Wind direction and force, Beaufort | Water, physical data |             |                |
|-------------|----------------|------------------------|----------------|----------------|------------------------------------|----------------------|-------------|----------------|
|             |                |                        | Latitude north | Longitude west |                                    | At depth             | Temperature | Salinity       |
| 537 (40)    | 1925<br>May 18 | 1.30-2 p. m.-----      | 44 25          | 48 38          | NW. 2.-----                        | Meters               | ° C.        | 0/00 by weight |
|             |                |                        |                |                |                                    | 0                    | 1.95        | 33.26          |
|             |                |                        |                |                |                                    | 50                   | -0.6        | 33.26          |
|             |                |                        |                |                |                                    | 125                  | -0.2        | 33.34          |
| 538 (41)    | do-----        | 2.10-2.20 p. m.-----   | 44 25          | 48 38          | do-----                            | 250                  | 3.9         | 34.08          |
|             |                |                        |                |                |                                    | 0                    | 1.9         | 33.26          |
|             |                |                        |                |                |                                    | 25                   | 1.1         | 33.28          |
|             |                |                        |                |                |                                    | 40                   | 0.1         | 33.33          |
| 539 (42)    | do-----        | 3.50-4.15 p. m.-----   | 44 22          | 48 26          | S. 4.-----                         | 0                    | 4.45        | 33.29          |
|             |                |                        |                |                |                                    | 25                   | 4.1         | 33.40          |
|             |                |                        |                |                |                                    | 50                   | 1.3         | 33.34          |
|             |                |                        |                |                |                                    | 125                  | 1.6         | 33.61          |
| 540 (43)    | May 21         | 1.15-1.40 p. m.-----   | 44 32          | 48 28          | W. 1.-----                         | 0                    | 4.2         | 33.26          |
|             |                |                        |                |                |                                    | 25                   | 4.5         | 33.47          |
|             |                |                        |                |                |                                    | 50                   | 1.95        | 33.46          |
|             |                |                        |                |                |                                    | 125                  | 1.25        | 33.77          |
| 541 (44)    | May 24         | 5.20-5.55 p. m.-----   | 44 46          | 48 05          | SW. 2.-----                        | 0                    | 5.4         | 33.28          |
|             |                |                        |                |                |                                    | 25                   | 3.1         | 33.28          |
|             |                |                        |                |                |                                    | 50                   | -0.6        | 33.35          |
|             |                |                        |                |                |                                    | 125                  | 0.7         | 33.72          |
| 542 (45)    | May 25         | 4.20-4.50 p. m.-----   | 44 49          | 47 37          | WNW. 1.-----                       | 250                  | 5.6         | 34.34          |
|             |                |                        |                |                |                                    | 0                    | 5.3         | -----          |
|             |                |                        |                |                |                                    | 50                   | 2.2         | -----          |
|             |                |                        |                |                |                                    | 125                  | 2.9         | -----          |
| 543 (46)    | May 26         | 8.15-9.15 a. m.-----   | 44 42          | 48 51          | SSW. 4.-----                       | 0                    | 3.3         | -----          |
|             |                |                        |                |                |                                    | 25                   | 4.2         | -----          |
|             |                |                        |                |                |                                    | 125                  | 2.1         | -----          |
|             |                |                        |                |                |                                    | 200                  | 4.7         | -----          |
| 544 (47)    | May 27         | 6.15-6.40 p. m.-----   | 44 29          | 48 22          | SW. 2.-----                        | 250                  | 0.4         | -----          |
|             |                |                        |                |                |                                    | 0                    | 5.2         | -----          |
|             |                |                        |                |                |                                    | 25                   | 6.85        | -----          |
|             |                |                        |                |                |                                    | 50                   | 1.6         | -----          |
| 545 (48)    | June 2         | 8-8.30 p. m.-----      | 43 12          | 49 02          | WNW. 4.-----                       | 0                    | 3.0         | -----          |
|             |                |                        |                |                |                                    | 25                   | 2.4         | -----          |
|             |                |                        |                |                |                                    | 50                   | 3.4         | -----          |
|             |                |                        |                |                |                                    | 125                  | 2.3         | -----          |
| 546 (49)    | June 7         | 8.30-9 a. m.-----      | 42 40          | 50 44          | NNE. 4.-----                       | 0                    | 3.4         | -----          |
|             |                |                        |                |                |                                    | 25                   | 3.0         | -----          |
|             |                |                        |                |                |                                    | 50                   | 2.2         | -----          |
|             |                |                        |                |                |                                    | 125                  | 3.7         | -----          |
| 547 (50)    | June 9         | 9.15-9.45 a. m.-----   | 41 59          | 50 39          | E. 1.-----                         | 0                    | 6.2         | 32.82          |
|             |                |                        |                |                |                                    | 25                   | 2.6         | -----          |
|             |                |                        |                |                |                                    | 50                   | 1.6         | 32.92          |
|             |                |                        |                |                |                                    | 75                   | -0.2        | 33.17          |
| 548 (51)    | do-----        | 4-4.20 p. m.-----      | 42 00          | 50 34          | SE. 1.-----                        | 125                  | 0.7         | 33.71          |
|             |                |                        |                |                |                                    | 0                    | 9.75        | -----          |
|             |                |                        |                |                |                                    | 25                   | 6.3         | 33.03          |
|             |                |                        |                |                |                                    | 50                   | 0.45        | 33.16          |
| 549 (52)    | June 11        | 10.10-11 a. m.-----    | 42 07          | 49 41          | S. 3.-----                         | 125                  | -0.3        | 33.53          |
|             |                |                        |                |                |                                    | 0                    | 4.9         | 32.83          |
|             |                |                        |                |                |                                    | 50                   | 4.8         | 33.08          |
|             |                |                        |                |                |                                    | 125                  | 4.9         | 33.45          |
| 550 (53)    | June 12        | 3-3.30 p. m.-----      | 42 11          | 49 39          | SSW. 3.-----                       | 250                  | 4.1         | 33.80          |
|             |                |                        |                |                |                                    | 450                  | 1.7         | -----          |
|             |                |                        |                |                |                                    | 750                  | 4.2         | 34.71          |
|             |                |                        |                |                |                                    | 0                    | 10.6        | -----          |
| 551 (54)    | June 15        | 10.55-11.30 a. m.----- | 41 58          | 49 27          | SSW. 1.-----                       | 50                   | 7.5         | 33.40          |
|             |                |                        |                |                |                                    | 125                  | 5.9         | 33.62          |
|             |                |                        |                |                |                                    | 250                  | 5.0         | 34.01          |
|             |                |                        |                |                |                                    | 0                    | 9.7         | 33.29          |
| 552 (55)    | do-----        | 7.50-8.15 p. m.-----   | 42 38          | 49 31          | SE. 2.-----                        | 50                   | 5.3         | 33.30          |
|             |                |                        |                |                |                                    | 125                  | 6.6         | 33.71          |
|             |                |                        |                |                |                                    | 250                  | 5.6         | 34.07          |
|             |                |                        |                |                |                                    | 450                  | 5.2         | 34.19          |
| 553 (56)    | June 22        | 8.30-9.30 a. m.-----   | 42 22          | 48 05          | ENE. 2.-----                       | 750                  | 4.4         | 31.53          |
|             |                |                        |                |                |                                    | 0                    | 4.4         | 33.16          |
|             |                |                        |                |                |                                    | 50                   | 1.7         | 33.18          |
|             |                |                        |                |                |                                    | 125                  | 1.8         | 33.23          |
|             |                |                        |                |                |                                    | 250                  | 2.3         | 33.53          |
|             |                |                        |                |                |                                    | 450                  | 4.3         | 34.02          |
|             |                |                        |                |                |                                    | 750                  | 3.9         | 34.19          |
|             |                |                        |                |                |                                    | 0                    | 12.1        | 33.11          |
|             |                |                        |                |                |                                    | 50                   | 12.6        | 33.71          |
|             |                |                        |                |                |                                    | 125                  | 11.4        | 33.71          |
|             |                |                        |                |                |                                    | 250                  | 8.1         | 34.16          |
|             |                |                        |                |                |                                    | 450                  | 5.1         | 34.26          |
|             |                |                        |                |                |                                    | 750                  | 7.4         | 35.25          |
|             |                |                        |                |                |                                    |                      |             |                |

## Record of bergs, International Ice Patrol, 1925

| Date   | Position       |                | Reported by—     | Remarks               |
|--------|----------------|----------------|------------------|-----------------------|
|        | Latitude north | Longitude west |                  |                       |
| Mar. 1 | 47 28          | 47 34          | Cape Race        | Large berg.           |
| 1      | 48 45          | 47 50          | do               | Do.                   |
| 2      | 48 43          | 48 50          | Coronia          | 2 bergs.              |
| 2      | 48 17          | 48 43          | Cape Race        | Do.                   |
| 2      | 47 50          | 47 00          | Coronia          | Berg.                 |
| 2      | 47 28          | 47 24          | do               | Do.                   |
| 2      | 46 17          | 48 43          | do               | Do.                   |
| 2      | 48 17          | 48 43          | Cape Race        | Do.                   |
| 2      | 48 43          | 47 50          | do               | Do.                   |
| 12     | 47 09          | 47 02          | Stockholm        | Do.                   |
| 12     | 47 48          | 45 44          | do               | Do.                   |
| 13     | 47 50          | 47 00          | Cape Race        | Do.                   |
| 18     | 49 11          | 47 58          | do               | Do.                   |
| 21     | 47 48          | 45 44          | do               | Do.                   |
| 28     | 50 00          | 46 25          | do               | Do.                   |
| Apr. 3 | 49 25          | 50 23          | do               | Large berg.           |
| 8      | 48 08          | 48 25          | Drothningholm    | Do.                   |
| 9      | 48 48          | 49 28          | Cape Race        | Small berg.           |
| 9      | 48 57          | 49 17          | do               | 3 small bergs.        |
| 10     | 48 55          | 49 12          | do               | Large berg.           |
| 10     | 48 45          | 49 38          | do               | Small berg.           |
| 13     | 48 40          | 49 21          | Modoc            | Berg No. 2.           |
| 14     | 48 31          | 49 13          | do               | Berg No. 1.           |
| 14     | 48 41          | 49 14          | do               | Berg No. 2.           |
| 14     | 48 41          | 49 10          | do               | Do.                   |
| 14     | 48 15          | 49 38          | do               | Berg.                 |
| 14     | 48 23          | 49 50          | do               | Do.                   |
| 14     | 48 24          | 49 55          | do               | Do.                   |
| 17     | 48 06          | 49 37          | Cape Race        | Several bergs.        |
| 17     | 47 50          | 48 34          | do               | Large berg.           |
| 17     | 49 25          | 48 25          | do               | Berg.                 |
| 17     | 49 50          | 48 15          | do               | Do.                   |
| 18     | 48 08          | 47 16          | Modoc            | Do.                   |
| 18     | 48 47          | 49 40          | Cape Race        | Do.                   |
| 21     | 47 42          | 48 26          | Modoc            | Do.                   |
| 21     | 47 50          | 48 05          | do               | Do.                   |
| 21     | 47 47          | 48 02          | do               | Do.                   |
| 21     | 47 59          | 48 31          | do               | Do.                   |
| 21     | 48 10          | 48 18          | do               | Do.                   |
| 21     | 48 07          | 47 58          | do               | Do.                   |
| 22     | 49 52          | 46 45          | Blackheath       | Large berg.           |
| 22     | 49 34          | 47 52          | do               | Berg.                 |
| 22     | 49 38          | 48 21          | do               | Do.                   |
| 22     | 49 26          | 48 18          | do               | Do.                   |
| 22     | 49 24          | 48 24          | do               | Do.                   |
| 22     | 49 52          | 46 45          | do               | Do.                   |
| 24     | 46 13          | 47 16          | Andania          | Do.                   |
| 26     | 46 53          | 46 44          | Arabic           | Do.                   |
| 28     | 47 48          | 50 33          | Gorm             | Do.                   |
| 28     | 47 48          | 50 32          | do               | Large berg.           |
| 28     | 47 50          | 50 31          | do               | Small bergs.          |
| 28     | 48 47          | 48 14          | Alchiba          | Berg.                 |
| 29     | 47 30          | 50 57          | do               | Large berg.           |
| 29     | 45 49          | 46 57          | Tampa            | Berg.                 |
| 29     | 47 11          | 51 21          | Canadian Mariner | Do.                   |
| 29     | 47 00          | 47 47          | Marloch          | Large berg.           |
| 29     | 46 47          | 48 22          | do               | 2 medium-sized bergs. |
| 30     | 46 47          | 48 21          | Regina           | Berg.                 |
| 30     | 45 40          | 47 12          | Glentworth       | Do.                   |
| 30     | 45 40          | 47 34          | Drothningholm    | Do.                   |
| 30     | 46 55          | 47 35          | Lititia          | Do.                   |
| 30     | 46 49          | 47 58          | do               | Do.                   |
| 30     | 48 20          | 48 51          | Cairnavon        | Small berg.           |
| 30     | 48 38          | 46 54          | Canadian Mariner | Do.                   |
| 30     | 48 38          | 46 53          | do               | Large berg.           |
| 30     | 47 11          | 51 21          | Cape Race        | Berg.                 |
| 30     | 47 58          | 50 36          | Cairnavon        | Do.                   |
| 30     | 47 50          | 50 48          | do               | 2 bergs.              |
| 30     | 47 38          | 51 08          | do               | Large berg.           |
| 30     | 48 25          | 49 01          | Digby            | Small berg.           |
| 30     | 48 17          | 49 28          | do               | 2 large bergs.        |
| 30     | 46 47          | 48 21          | Regina           | Berg.                 |
| May 1  | 47 00          | 47 47          | Cape Race        | Do.                   |
| 1      | 48 47          | 48 22          | do               | 2 bergs.              |

## Record of bergs, International Ice Patrol, 1925—Continued

| Date  | Position                                                           |                | Reported by—       | Remarks                           |
|-------|--------------------------------------------------------------------|----------------|--------------------|-----------------------------------|
|       | Latitude north                                                     | Longitude west |                    |                                   |
| May 1 | 48 08                                                              | 51 33          | Cape Race          | Berg.                             |
| 1     | 47 57                                                              | 52 31          | do                 | Do.                               |
| 1     | 48 00                                                              | 52 16          | do                 | Do.                               |
| 1     | 47 58                                                              | 50 36          | do                 | Large berg.                       |
| 1     | 47 50                                                              | 50 48          | do                 | 2 large bergs.                    |
| 1     | 47 38                                                              | 51 08          | do                 | Large berg.                       |
| 1     | 46 42                                                              | 48 20          | Lititia            | Berg.                             |
| 1     | 45 05                                                              | 48 32          | Assyria            | Do.                               |
| 1     | 47 38                                                              | 51 34          | America            | Large berg.                       |
| 2     | 47 48                                                              | 51 04          | do                 | Do.                               |
| 2     | 47 48                                                              | 50 58          | do                 | 3 large bergs.                    |
| 2     | 47 45                                                              | 50 58          | do                 | Very large berg.                  |
| 2     | 46 23                                                              | 47 43          | Manchester Hero    | Large berg.                       |
| 2     | 46 08                                                              | 48 35          | do                 | Do.                               |
| 2     | 46 20                                                              | 47 50          | Concordia          | Do.                               |
| 2     | 46 29                                                              | 48 18          | do                 | Medium-sized berg.                |
| 2     | 46 28                                                              | 47 55          | Canadian Hunter    | Berg 4 miles S. of this position. |
| 2     | 46 37                                                              | 52 15          | Cape Race          | Large berg.                       |
| 2     | 47 19                                                              | 52 00          | do                 | Do.                               |
| 2     | 15 miles E. of Cape Spear.                                         |                | do                 | Do.                               |
| 2     | 46 23                                                              | 47 43          | do                 | Do.                               |
| 2     | 46 18                                                              | 48 35          | do                 | Do.                               |
| 2     | 45 49                                                              | 51 40          | do                 | Small berg.                       |
| 2     | 46 22                                                              | 49 00          | Concordia          | Do.                               |
| 2     | 46 28                                                              | 48 23          | Fantee             | Berg.                             |
| 2     | 45 45                                                              | 47 47          | Bennedyk           | Do.                               |
| 2     | 45 50                                                              | 51 47          | Corrigan Head      | Do.                               |
| 3     | 45 51                                                              | 51 48          | Cape Race          | Do.                               |
| 3     | 48 04                                                              | 50 04          | Ardenza            | Do.                               |
| 3     | 47 36                                                              | 52 29          | Sachem             | Small berg.                       |
| 3     | 47 39                                                              | 52 02          | do                 | Do.                               |
| 3     | 47 41                                                              | 51 46          | do                 | Large berg.                       |
| 3     | 47 38                                                              | 51 42          | do                 | Small berg.                       |
| 3     | 47 49                                                              | 51 30          | do                 | Do.                               |
| 3     | 47 44                                                              | 51 24          | do                 | Large and medium berg.            |
| 3     | 47 50                                                              | 51 10          | do                 | Medium berg.                      |
| 3     | 47 44                                                              | 51 01          | do                 | Small berg.                       |
| 3     | 47 45                                                              | 50 53          | do                 | Large berg.                       |
| 3     | 47 47                                                              | 50 39          | do                 | Do.                               |
| 3     | 47 55                                                              | 50 28          | do                 | Do.                               |
| 4     | 46 48                                                              | 52 00          | Cape Race          | Berg.                             |
| 4     | 46 50                                                              | 52 05          | do                 | Do.                               |
| 4     | 46 28                                                              | 48 38          | do                 | Medium berg.                      |
| 4     | 46 23                                                              | 48 00          | Bolingbroke        | Large berg.                       |
| 6     | 46 31                                                              | 48 23          | Montrose           | Berg.                             |
| 6     | 48 28                                                              | 46 57          | Cape Race          | Do.                               |
| 6     | 46 12                                                              | 48 15          | Aurania            | Large berg.                       |
| 7     | 46 13                                                              | 47 52          | Welsbman           | Very large berg.                  |
| 7     | 46 32                                                              | 48 54          | Saturnia           | Several medium bergs.             |
| 7     | 47 37                                                              | 49 27          | Canadian Leader    | Large berg.                       |
| 7     | 47 33                                                              | 49 32          | do                 | Do.                               |
| 7     | 46 22                                                              | 48 30          | Manchester Spinner | Do.                               |
| 7     | 46 25                                                              | 48 38          | do                 | Do.                               |
| 7     | 46 19                                                              | 48 41          | do                 | Do.                               |
| 7     | 1 mile E. of Sugarloaf                                             |                | Silvia             | Berg.                             |
| 7     | 5 miles off St. Johns                                              |                | do                 | 3 small bergs.                    |
| 7     | 5 miles S. of Cape Spear                                           |                | do                 | Large berg.                       |
| 7     | Petty Harbor                                                       |                | do                 | Small berg.                       |
| 7     | 4 miles N. of Bill Head                                            |                | do                 | 3 large and 2 small bergs.        |
| 8     | 46 56                                                              | 49 36          | Manchester Spinner | Large berg.                       |
| 8     | 47 12                                                              | 50 02          | do                 | 2 large bergs.                    |
| 8     | 47 21                                                              | 50 35          | do                 | Small berg.                       |
| 8     | Between 47° 49' and 47° 12' N., and between 51° 12' and 51° 17' W. |                | do                 | 15 bergs.                         |
| 8     | 48 18                                                              | 47 10          | Moana              | Large berg.                       |
| 8     | 46 59                                                              | 52 16          | Cape Race          | 2 medium bergs.                   |
| 8     | 47° 40' to 47° 50' N.; 49° 35' to 49° 50' W.                       |                | do                 | Bergs.                            |
| 8     | 32 miles E. of Cape Race.                                          |                | do                 | 2 bergs.                          |
| 8     | 48 47                                                              | 45 37          | do                 | Small berg.                       |
| 9     | 47 45                                                              | 48 35          | Riado              | Medium berg.                      |
| 9     | 47 37                                                              | 49 03          | do                 | Large berg.                       |
| 9     | 47 25                                                              | 49 40          | do                 | Do.                               |
| 9     | 47 17                                                              | 50 29          | Riobarado          | Do.                               |

## Record of bergs, International Ice Patrol, 1925—Continued

| Date  | Position                                |                | Reported by—             | Remarks         |
|-------|-----------------------------------------|----------------|--------------------------|-----------------|
|       | Latitude north                          | Longitude west |                          |                 |
| May 9 | 44 48                                   | 48 42          | West Haven.....          | Large berg.     |
| 9     | 47 20                                   | 49 40          | Cape Race.....           | Do.             |
| 10    | 47 35                                   | 49 33          | Montauban.....           | Do.             |
| 10    | 47 51                                   | 48 41          | "C. M. B.".....          | Do.             |
| 10    | 47 35                                   | 49 33          | do.....                  | Do.             |
| 10    | 47 55                                   | 47 48          | Grenas.....              | Do.             |
| 10    | 47 42                                   | 48 55          | do.....                  | Do.             |
| 10    | 47 33                                   | 49 19          | do.....                  | Do.             |
| 10    | 47 23                                   | 49 45          | do.....                  | Do.             |
| 11    | 46 42                                   | 47 36          | Commino.....             | Berg.           |
| 11    | 48 03                                   | 48 18          | Montclair.....           | Medium berg.    |
| 11    | 48 19                                   | 48 35          | do.....                  | Berg.           |
| 11    | 47 13                                   | 50 48          | do.....                  | Small berg.     |
| 11    | 47 29                                   | 50 13          | do.....                  | Medium berg.    |
| 11    | 47 42                                   | 49 36          | do.....                  | Large berg.     |
| 11    | 47 40                                   | 49 36          | do.....                  | Small berg.     |
| 11    | 47 41                                   | 49 25          | do.....                  | Do.             |
| 11    | 47 53                                   | 49 08          | do.....                  | Berg.           |
| 11    | 48 01                                   | 48 45          | do.....                  | Large bergs.    |
| 11    | 46 18                                   | 48 01          | Lilitia.....             | Large berg.     |
| 11    | 46 45                                   | 48 35          | Commino.....             | Medium berg.    |
| 11    | 46 44                                   | 48 43          | do.....                  | Do.             |
| 11    | 47 38                                   | 47 36          | Amsterdam.....           | Large berg.     |
| 11    | 46 38                                   | 47 26          | do.....                  | Do.             |
| 11    | 46 22                                   | 47 52          | do.....                  | Do.             |
| 11    | 46 21                                   | 48 03          | Reyburn.....             | Do.             |
| 12    | 46 57                                   | 47 26          | Batsford.....            | Berg.           |
| 12    | 46 41                                   | 47 21          | Cape Race.....           | Large berg.     |
| 13    | 46 27                                   | 48 05          | Pittsburgh.....          | Do.             |
| 13    | 46 27                                   | 48 05          | Cape Race.....           | Do.             |
| 13    | 47 20                                   | 47 00          | Lord Antoin.....         | Do.             |
| 13    | 46 29                                   | 47 19          | Blydendyk.....           | Berg.           |
| 13    | 6 miles N. of 46° 29' N.,<br>47° 19' W. |                | do.....                  | Large berg.     |
| 13    | 47 30                                   | 50 33          | Cape Race.....           | 2 medium bergs. |
| 14    | 47 56                                   | 49 15          | Turcoman.....            | Small berg.     |
| 14    | 48 07                                   | 48 17          | do.....                  | Large berg.     |
| 14    | 48 08                                   | 47 51          | do.....                  | Do.             |
| 14    | 48 32                                   | 47 16          | do.....                  | Do.             |
| 14    | 48 18                                   | 49 12          | Kurdistan.....           | 2 large bergs.  |
| 14    | 48 08                                   | 49 26          | do.....                  | Berg.           |
| 14    | 47 53                                   | 50 04          | do.....                  | Large berg.     |
| 14    | 48 47                                   | 48 05          | Athenia.....             | Berg.           |
| 14    | 47 11                                   | 47 08          | Dorie.....               | Medium berg.    |
| 14    | 49 47                                   | 44 59          | Athenia.....             | Large berg.     |
| 14    | 47 12                                   | 47 06          | Cameronia.....           | Do.             |
| 14    | 46 32                                   | 47 21          | Andania.....             | Do.             |
| 14    | 46 30                                   | 47 38          | Ansonia.....             | Berg.           |
| 14    | 46 18                                   | 47 54          | do.....                  | Do.             |
| 14    | 46 20                                   | 48 23          | do.....                  | Do.             |
| 14    | 47 48                                   | 50 00          | Cape Race.....           | Do.             |
| 14    | 49 47                                   | 44 59          | do.....                  | Large berg.     |
| 14    | 46 30                                   | 47 38          | do.....                  | Berg.           |
| 14    | 46 18                                   | 47 54          | do.....                  | Do.             |
| 14    | 46 20                                   | 48 23          | do.....                  | Do.             |
| 14    | 48 40                                   | 48 27          | Athenia.....             | Large berg.     |
| 14    | 48 18                                   | 49 22          | do.....                  | Berg.           |
| 14    | 48 14                                   | 49 29          | do.....                  | Do.             |
| 14    | 47 12                                   | 49 18          | New Astor.....           | Large berg.     |
| 14    | 47 01                                   | 48 00          | Doric.....               | Berg.           |
| 14    | 47 55                                   | 50 00          | Athenia.....             | Do.             |
| 14    | 47 45                                   | 50 32          | do.....                  | Small berg.     |
| 14    | 47 56                                   | 47 06          | Bergsdale.....           | Large berg.     |
| 14    | 47 35                                   | 47 53          | do.....                  | Do.             |
| 14    | 47 46                                   | 48 03          | do.....                  | Do.             |
| 14    | 47 30                                   | 48 47          | do.....                  | Do.             |
| 14    | 47 32                                   | 48 52          | do.....                  | Do.             |
| 14    | 47 31                                   | 48 54          | do.....                  | Do.             |
| 14    | 47 35                                   | 48 57          | do.....                  | Do.             |
| 14    | 47 56                                   | 49 15          | Cape Race.....           | Small berg.     |
| 14    | 48 07                                   | 48 17          | do.....                  | Large berg.     |
| 14    | 48 08                                   | 47 51          | do.....                  | Do.             |
| 14    | 48 32                                   | 47 16          | do.....                  | Do.             |
| 14    | 47 51                                   | 51 12          | do.....                  | Berg.           |
| 14    | 47 36                                   | 51 43          | do.....                  | Do.             |
| 14    | 47 55                                   | 50 00          | do.....                  | Do.             |
| 14    | 47 45                                   | 50 32          | do.....                  | Small berg.     |
| 16    | 47 35                                   | 48 35          | Empress of Scotland..... | 3 bergs.        |

## Record of bergs, International Ice Patrol, 1925—Continued

| Date   | Position                                               |                | Reported by—             | Remarks          |
|--------|--------------------------------------------------------|----------------|--------------------------|------------------|
|        | Latitude north                                         | Longitude west |                          |                  |
| May 16 | 48 00                                                  | 48 50          | Grainton.....            | Berg.            |
| 16     | 49 10                                                  | 48 58          | Cape Race.....           | Large berg.      |
| 16     | 49 08                                                  | 49 14          | do.....                  | Do.              |
| 16     | 49 07                                                  | 49 25          | do.....                  | Small berg.      |
| 16     | 48 57                                                  | 49 39          | do.....                  | Do.              |
| 16     | 48 53                                                  | 50 08          | do.....                  | Large berg.      |
| 16     | 48 37                                                  | 49 44          | do.....                  | Do.              |
| 16     | 48 39                                                  | 49 36          | do.....                  | Do.              |
| 16     | 48 00                                                  | 50 43          | do.....                  | Do.              |
| 16     | 48 06                                                  | 50 58          | do.....                  | Do.              |
| 16     | 47 58                                                  | 50 46          | do.....                  | Do.              |
| 16     | 48 07                                                  | 49 41          | do.....                  | Small berg       |
| 16     | 47 30                                                  | 47 51          | Empress of Scotland..... | Berg.            |
| 16     | 47 33                                                  | 47 37          | do.....                  | Do.              |
| 16     | 48 01                                                  | 49 13          | Grainton.....            | Do.              |
| 16     | 48 12                                                  | 49 49          | Johanne Dybward.....     | Large berg.      |
| 18     | 48 07                                                  | 49 21          | Cape Race.....           | Berg.            |
| 18     | 45 58                                                  | 47 36          | Zwartee Zee.....         | Medium berg.     |
| 18     | 47 10                                                  | 49 35          | Emanuel Stavarondis..... | Berg.            |
| 18     | 48 07                                                  | 49 21          | Montrose.....            | Do.              |
| 18     | 47 33                                                  | 50 51          | Admiral Hamilton.....    | Do.              |
| 18     | 48 33                                                  | 47 40          | Montrose.....            | Medium berg.     |
| 18     | 47 58                                                  | 49 25          | Lancastria.....          | Berg.            |
| 18     | 45 08                                                  | 48 45          | Baron Garioch.....       | Large berg.      |
| 18     | 48 17                                                  | 48 32          | Salacia.....             | Berg.            |
| 19     | 48 33                                                  | 46 40          | Lancastria.....          | Do.              |
| 19     | 47 55                                                  | 46 10          | Emanuel Stavarondis..... | Do.              |
| 19     | 47 30                                                  | 48 20          | Christina.....           | Do.              |
| 19     | Between 47° 35', 49° 08' and between 47° 35', 49° 02'. |                | do.....                  | 3 bergs.         |
| 19     | 45 25                                                  | 48 32          | Garioch.....             | Large berg.      |
| 19     | 45 58                                                  | 47 51          | do.....                  | Medium berg.     |
| 19     | 46 30                                                  | 47 16          | Bothwell.....            | Large berg.      |
| 19     | 46 29                                                  | 48 00          | do.....                  | Do.              |
| 19     | 48 55                                                  | 50 35          | Black Heath.....         | Do.              |
| 19     | 47 32                                                  | 49 08          | Manchester Hero.....     | Do.              |
| 19     | 47 34                                                  | 49 05          | do.....                  | Do.              |
| 19     | 47 35                                                  | 49 02          | do.....                  | Do.              |
| 19     | 48 22                                                  | 48 45          | Admiral Hamilton.....    | Medium berg.     |
| 19     | 47 42                                                  | 49 38          | Canada.....              | Large berg.      |
| 19     | 47 41                                                  | 49 33          | do.....                  | Medium berg.     |
| 19     | 47 35                                                  | 49 21          | do.....                  | 3 large bergs.   |
| 19     | 47 41                                                  | 49 38          | do.....                  | Medium berg.     |
| 19     | 47 45                                                  | 49 21          | do.....                  | Very large berg. |
| 19     | 48 33                                                  | 46 40          | Lancastria.....          | Berg.            |
| 19     | 47 37                                                  | 49 20          | Glentworth.....          | Large berg.      |
| 19     | 47 35                                                  | 49 26          | do.....                  | Do.              |
| 19     | 47 41                                                  | 49 19          | do.....                  | Do.              |
| 19     | 47 40                                                  | 50 37          | Concordia.....           | Medium berg.     |
| 19     | 48 42                                                  | 51 00          | Black Heath.....         | Berg.            |
| 19     | 48 25                                                  | 51 04          | do.....                  | Large berg.      |
| 19     | 48 20                                                  | 51 35          | do.....                  | Berg.            |
| 19     | 48 24                                                  | 51 35          | do.....                  | Do.              |
| 19     | 48 24                                                  | 51 40          | do.....                  | Do.              |
| 19     | 47 26                                                  | 47 30          | Aval.....                | Large berg.      |
| 19     | 47 30                                                  | 47 50          | do.....                  | Berg.            |
| 19     | 48 36                                                  | 49 15          | Cape Race.....           | Medium berg.     |
| 19     | 47 34                                                  | 49 05          | do.....                  | Very large berg. |
| 20     | 48 19                                                  | 49 33          | do.....                  | Large berg.      |
| 20     | 48 25                                                  | 49 20          | do.....                  | Do.              |
| 20     | 48 22                                                  | 48 25          | Aurania.....             | Berg.            |
| 20     | 48 00                                                  | 49 13          | Cornishman.....          | Large berg.      |
| 20     | 48 04                                                  | 49 00          | do.....                  | Small berg.      |
| 20     | 48 04                                                  | 48 42          | do.....                  | Berg.            |
| 20     | 48 09                                                  | 48 32          | do.....                  | Do.              |
| 20     | 48 12                                                  | 48 18          | do.....                  | Do.              |
| 20     | 47 26                                                  | 49 26          | Carrigan Head.....       | Do.              |
| 20     | 48 01                                                  | 48 12          | do.....                  | Do.              |
| 20     | 48 04                                                  | 49 04          | do.....                  | Do.              |
| 20     | 48 01                                                  | 48 47          | do.....                  | Do.              |
| 20     | 48 11                                                  | 45 31          | do.....                  | Do.              |
| 20     | 49 33                                                  | 49 38          | Sirrah.....              | Do.              |
| 20     | 47 38                                                  | 49 17          | do.....                  | Do.              |
| 20     | 47 31                                                  | 49 03          | do.....                  | Do.              |
| 20     | 47 46                                                  | 49 43          | Megantic.....            | Do.              |
| 20     | 47 44                                                  | 49 05          | do.....                  | Do.              |
| 20     | 47 46                                                  | 49 15          | do.....                  | Do.              |

## Record of bergs, International Ice Patrol, 1935—Continued

| Date   | Position                                               |                | Reported by—          | Remarks          |
|--------|--------------------------------------------------------|----------------|-----------------------|------------------|
|        | Latitude north                                         | Longitude west |                       |                  |
| May 20 | 47 33                                                  | 49 34          | Celtic.....           | Large berg.      |
| 21     | 48 30                                                  | 48 18          | Montreal.....         | Berg.            |
| 21     | 47 14                                                  | 52 34          | Cape Race.....        | Very large berg. |
| 21     | 48 45                                                  | 48 21          | Montreal.....         | Do.              |
| 21     | 47 07                                                  | 52 00          | Cape Race.....        | Growlers.        |
| 21     | 44 40                                                  | 47 50          | Mabeldis.....         | Large berg.      |
| 21     | 47 11                                                  | 53 43          | Cape Race.....        | Do.              |
| 21     | 44 41                                                  | 47 36          | Tuscania.....         | Berg.            |
| 21     | 47 10                                                  | 52 48          | Cape Race.....        | Do.              |
| 21     | 48 00                                                  | 50 16          | Montcalm.....         | Small berg.      |
| 21     | 48 17                                                  | 47 30          | Cape Race.....        | Large berg.      |
| 21     | 48 15                                                  | 47 38          | do.....               | Do.              |
| 21     | 47 13                                                  | 52 47          | do.....               | Growlers.        |
| 21     | 47 52                                                  | 49 27          | do.....               | Berg.            |
| 21     | 47 37                                                  | 49 40          | do.....               | Large berg.      |
| 21     | Area of 47° 54' and 48° 09' N., 49° 25' and 48° 55' W. |                | Carso.....            | 3 small bergs.   |
| 22     | 46 40                                                  | 47 14          | Orduna.....           | Large berg.      |
| 23     | 47° 40' N.; 49° 30' W.                                 |                | Cape Race.....        | 2 large bergs.   |
| 23     | 47° 52' N.; 49° 11' W.                                 |                | do.....               | 3 large bergs.   |
| 23     | 20 miles 118¼° from Cape Race.                         |                | Borsiose.....         | Large berg.      |
| 23     | 44 51                                                  | 47 30          | do.....               | Do.              |
| 23     | 47 58                                                  | 47 53          | Melita.....           | Berg.            |
| 23     | 47 54                                                  | 47 52          | do.....               | Large berg.      |
| 23     | 48 06                                                  | 47 50          | do.....               | Do.              |
| 23     | 48 10                                                  | 47 08          | Rovas.....            | Berg.            |
| 23     | 46 46                                                  | 47 55          | Wildrecht.....        | Do.              |
| 24     | 46 03                                                  | 47 57          | Aylestone.....        | Large berg.      |
| 24     | 46 10                                                  | 47 40          | do.....               | Do.              |
| 24     | 41° 46' N.; 48° 05' W.                                 |                | Tampa.....            | Berg.            |
| 24     | 48 09                                                  | 51 00          | Sachem.....           | Large berg.      |
| 24     | 48 04                                                  | 48 31          | Maribon.....          | Berg.            |
| 24     | 47 44                                                  | 49 39          | do.....               | Do.              |
| 24     | 47 41                                                  | 49 20          | Cape Race.....        | Large berg.      |
| 24     | 47 42                                                  | 49 40          | Maribon.....          | Berg.            |
| 24     | 48 14                                                  | 48 14          | Marburn.....          | Medium berg.     |
| 24     | 47 31                                                  | 49 22          | do.....               | Small berg.      |
| 24     | 47 38                                                  | 49 09          | do.....               | Large berg.      |
| 25     | 44° 49' N.; 47° 37' W.                                 |                | Tampa.....            | Berg.            |
| 26     | 48 10                                                  | 49 15          | Graeia.....           | Small berg.      |
| 26     | 44° 42' N.; 47° 51' W.                                 |                | Tampa.....            | Berg.            |
| 26     | 48 13                                                  | 49 04          | do.....               | Large berg.      |
| 26     | 48 15                                                  | 50 11          | Cape Race.....        | Do.              |
| 26     | 48 49                                                  | 40 35          | do.....               | Do.              |
| 26     | 48 45                                                  | 50 39          | do.....               | Do.              |
| 26     | 48 35                                                  | 51 37          | do.....               | Do.              |
| 26     | 48 31                                                  | 51 35          | do.....               | Do.              |
| 26     | 48 22                                                  | 51 33          | do.....               | Do.              |
| 26     | 48 40                                                  | 50 33          | do.....               | Small berg.      |
| 26     | 49 28                                                  | 44 58          | do.....               | Do.              |
| 26     | 48 52                                                  | 46 04          | Doric.....            | Do.              |
| 26     | 45 35                                                  | 48 09          | Kelberger.....        | Berg.            |
| 26     | 48 05                                                  | 46 32          | Cape Race.....        | Medium berg.     |
| 27     | 47 26                                                  | 45 10          | Gothia.....           | Berg.            |
| 27     | 47 38                                                  | 48 06          | Blydendyk.....        | Do.              |
| 27     | 47 25                                                  | 48 17          | Batsford.....         | Do.              |
| 27     | 47 38                                                  | 48 06          | Blydendyk.....        | Do.              |
| 27     | 47 38                                                  | 48 06          | Tampa.....            | Do.              |
| 28     | 48 21                                                  | 48 40          | Regina.....           | Large berg.      |
| 28     | 48 08                                                  | 48 00          | Lititia.....          | Do.              |
| 28     | 29 miles from Cape Race.                               |                | Regina.....           | Do.              |
| 28     | 48 34                                                  | 48 28          | Cape Race.....        | Berg.            |
| 28     | 48 30                                                  | 49 16          | do.....               | Do.              |
| 28     | 10 miles E. of Ferryland Light.                        |                | do.....               | Large berg.      |
| 28     | 48 13                                                  | 46 06          | do.....               | Small berg.      |
| 29     | 47 52                                                  | 48 44          | Elaine Llewellyn..... | 3 bergs.         |
| 29     | 47 47                                                  | 48 18          | Ascania.....          | Large berg.      |
| 29     | 47 53                                                  | 48 39          | do.....               | Do.              |
| 29     | 49 14                                                  | 45 01          | Loctic.....           | Berg.            |
| 29     | 47 52                                                  | 48 44          | Elaine Llewellyn..... | Large berg.      |
| 29     | 47 59                                                  | 48 17          | Ascania.....          | Do.              |
| 29     | 47 38                                                  | 48 20          | Salmonpool.....       | Do.              |
| 29     | 47 58                                                  | 48 10          | do.....               | Do.              |
| 29     | 47 13                                                  | 47 30          | Elaine Llewellyn..... | Do.              |

## Record of bergs, International Ice Patrol, 1925—Continued

| Date   | Position                       |                | Reported by—             | Remarks          |
|--------|--------------------------------|----------------|--------------------------|------------------|
|        | Latitude north                 | Longitude west |                          |                  |
| May 29 | 9 miles E. of Ferryland Light. |                | Cape Race.....           | Large berg.      |
| 29     | 7 miles E. of Bull Head.       |                | do.....                  | Do.              |
| 29     | 4 miles E. of St. Johns.       |                | do.....                  | Do.              |
| 29     | 9 miles E. of Cape Race.       |                | do.....                  | Berg.            |
| 30     | 44 56                          | 46 45          | Citos.....               | Do.              |
| 30     | 47 58                          | 49 37          | Kurdistan.....           | Small berg.      |
| 30     | 47 17                          | 47 55          | Tampa.....               | Berg.            |
| 30     | 48 00                          | 49 23          | do.....                  | Large berg.      |
| 30     | 48 14                          | 49 00          | do.....                  | 2 large bergs.   |
| 30     | 48 09                          | 49 00          | Lock Tay.....            | Large berg.      |
| 30     | 48 00                          | 49 33          | do.....                  | Medium berg.     |
| 30     | 47 26                          | 51 50          | Assyria.....             | Berg.            |
| 30     | 44 36                          | 46 49          | East side.....           | Do.              |
| 30     | 44 32                          | 47 12          | do.....                  | Large berg.      |
| 30     | 17 miles off Cape Race.        |                | Cape Race.....           | Do.              |
| 31     | 46 34                          | 52 37          | Montreal.....            | Do.              |
| 31     | 46 20                          | 48 03          | Tampa.....               | Berg.            |
| 31     | 46 39                          | 52 32          | do.....                  | 3 small bergs.   |
| 31     | 48 00                          | 49 11          | Salacia.....             | Small berg.      |
| 31     | 48 09                          | 49 07          | do.....                  | Do.              |
| 31     | 47 57                          | 49 09          | do.....                  | Do.              |
| 31     | 47 17                          | 48 02          | Penhill.....             | Do.              |
| 31     | 47 20                          | 47 32          | do.....                  | Large berg.      |
| 31     | 47 22                          | 47 03          | do.....                  | Very large berg. |
| 31     | 46 10                          | 48 00          | Forsanger.....           | Berg.            |
| 31     | 48 36                          | 44 34          | Canadian Mariner.....    | Small berg.      |
| 31     | 47 35                          | 45 30          | Cape Race.....           | Large berg.      |
| 31     | 47 50                          | 45 48          | do.....                  | Berg.            |
| June 1 | 10 miles from Cape Race.       |                | do.....                  | Large berg.      |
| 1      | 48 02                          | 49 00          | Auramia.....             | Berg.            |
| 1      | 48 02                          | 48 55          | do.....                  | Do.              |
| 1      | 48 10                          | 48 45          | do.....                  | Very large berg. |
| 1      | 47 48                          | 48 32          | Canadian Mariner.....    | Large berg.      |
| 2      | 46 32                          | 52 52          | Tuscania.....            | Berg.            |
| 2      | 47 55                          | 49 00          | Megantic.....            | Do.              |
| 2      | 48 15                          | 45 24          | Brandon.....             | Small berg.      |
| 2      | 48 04                          | 48 35          | Megantic.....            | Medium berg.     |
| 2      | 47 56                          | 47 52          | Verbania.....            | Large berg.      |
| 2      | 47 50                          | 46 20          | Canadian Raider.....     | Small berg.      |
| 2      | 43 12                          | 49 02          | Tampa.....               | Berg.            |
| 3      | 48 10                          | 40 00          | Manistee.....            | Large berg.      |
| 3      | 48 13                          | 48 50          | Tuscania.....            | Small berg.      |
| 3      | 48 00                          | 48 12          | Veendom.....             | Medium berg.     |
| 3      | 48 06                          | 48 10          | do.....                  | Do.              |
| 3      | 47° 56' N.; 47° 42' W.         |                | Verbania.....            | 4 bergs.         |
| 3      | 47 29                          | 48 23          | Veendom.....             | Medium berg.     |
| 3      | 47 53                          | 48 26          | do.....                  | Do.              |
| 3      | 47 58                          | 49 32          | do.....                  | Do.              |
| 3      | 8 miles SE. of Cape Race.      |                | Brandon.....             | Large berg.      |
| 3      | 46 37                          | 52 53          | Veendom.....             | Berg.            |
| 4      | 47 41                          | 49 37          | Cape Race.....           | Large berg.      |
| 4      | 46 45                          | 40 06          | do.....                  | Small berg.      |
| 4      | 47 23                          | 47 21          | Blairberg.....           | 2 bergs.         |
| 4      | 47 42                          | 47 34          | Bothwell.....            | Berg.            |
| 4      | 46 35                          | 47 34          | do.....                  | Do.              |
| 4      | 47 46                          | 46 58          | do.....                  | Do.              |
| 4      | 47 56                          | 47 46          | do.....                  | Do.              |
| 5      | 46 24                          | 47 24          | Hanlerwig.....           | Do.              |
| 6      | 45 39                          | 45 08          | Hoosac.....              | Do.              |
| 7      | 45 00                          | 48 54          | P. L. M 23.....          | Do.              |
| 8      | 46 46                          | 47 06          | Baron Harries.....       | Do.              |
| 8      | 46 41                          | 47 36          | do.....                  | Do.              |
| 8      | 46 40                          | 47 53          | do.....                  | Do.              |
| 8      | 45 40                          | 45 00          | Tortugas.....            | Large berg.      |
| 8      | 45 47                          | 44 37          | Bay State.....           | Do.              |
| 8      | 47 14                          | 51 25          | Cape Race.....           | Medium berg.     |
| 8      | 47 24                          | 52 06          | do.....                  | Large berg.      |
| 9      | 44 11                          | 48 46          | Manchester Merchant..... | Do.              |
| 9      | 47 27                          | 49 11          | Cape Race.....           | Do.              |
| 9      | 47 18                          | 50 51          | do.....                  | 2 small bergs.   |
| 9      | 45 00                          | 47 53          | West Pool.....           | Large berg.      |
| 9      | 45 16                          | 46 33          | do.....                  | Do.              |
| 9      | 45 00                          | 47 53          | do.....                  | Do.              |

## Record of bergs, International Ice Patrol, 1925—Continued

| Date   | Position                         |                | Reported by—            | Remarks                   |
|--------|----------------------------------|----------------|-------------------------|---------------------------|
|        | Latitude north                   | Longitude west |                         |                           |
| June 9 | 46 30                            | 52 52          | Antonio.....            | Large berg.               |
| 9      | 46 50                            | 52 51          | do.....                 | Small berg.               |
| 9      | 46 31                            | 53 06          | Assyria.....            | Large berg.               |
| 9      | 45 13                            | 46 47          | Bay State.....          | Berg.                     |
| 9      | 44 58                            | 48 15          | do.....                 | Do.                       |
| 9      | 45 03                            | 48 42          | do.....                 | Do.                       |
| 10     | 42 01                            | 50 34          | Collame.....            | Large berg.               |
| 10     | 47 17                            | 49 05          | Pittsburgh.....         | Berg.                     |
| 10     | 47 16                            | 51 03          | Assyria.....            | Do.                       |
| 10     | 47 21                            | 50 52          | do.....                 | Small berg.               |
| 10     | 47 34                            | 50 40          | do.....                 | 1 small and 1 large berg. |
| 10     | 47 21                            | 50 52          | do.....                 | Do.                       |
| 10     | 47 17                            | 49 05          | Pittsburgh.....         | Medium berg.              |
| 10     | 42 40                            | 47 10          | City of Birmingham..... | Berg.                     |
| 11     | 47 17                            | 49 05          | Cape Race.....          | Medium berg.              |
| 12     | 47 00                            | 52 17          | do.....                 | Berg.                     |
| 13     | 47 40                            | 51 58          | do.....                 | Large berg.               |
| 13     | 47 11                            | 52 11          | do.....                 | Do.                       |
| 13     | 48 07                            | 50 11          | do.....                 | Medium berg.              |
| 13     | 48 29                            | 50 22          | Galtymore.....          | Do.                       |
| 13     | 47 54                            | 51 37          | Cape Race.....          | Large berg.               |
| 13     | 46 42                            | 46 20          | Liverza.....            | Berg.                     |
| 13     | 46 42                            | 46 20          | do.....                 | Do.                       |
| 13     | 47 07                            | 50 11          | Digby.....              | Do.                       |
| 13     | 47 54                            | 51 37          | do.....                 | Do.                       |
| 13     | 48 29                            | 50 22          | Cape Race.....          | Large berg.               |
| 14     | 47 50                            | 52 31          | Achem.....              | Do.                       |
| 14     | 48 00                            | 51 45          | do.....                 | Do.                       |
| 14     | 48 10                            | 51 20          | do.....                 | Do.                       |
| 14     | 48 15                            | 50 20          | Manchester Spinner..... | Do.                       |
| 14     | 48 27                            | 49 03          | do.....                 | Medium berg.              |
| 14     | 47 39                            | 50 36          | Cape Race.....          | Do.                       |
| 14     | 42 23                            | 49 30          | Fredensbro.....         | Large berg.               |
| 15     | 41 35                            | 49 50          | Irma Kimmi.....         | Do.                       |
| 15     | 43° 52' N.; 48° 51' W.           |                | Igotz Mendi.....        | Berg.                     |
| 15     | 42 53                            | 49 25          | Argosy.....             | Large berg.               |
| 16     | 48 19                            | 47 52          | Cape Race.....          | Do.                       |
| 16     | 47 58                            | 50 30          | Bergensfjord.....       | Berg.                     |
| 16     | 47 37                            | 50 29          | do.....                 | Large berg.               |
| 17     | 18 miles E. of Cape Race.        |                | Cape Race.....          | Berg.                     |
| 17     | 42 48                            | 49 35          | Hellig Olav.....        | Very large berg.          |
| 18     | 46 24                            | 44 02          | Cape Race.....          | Small berg.               |
| 18     | 46 27                            | 44 09          | Cold Harbor.....        | Berg.                     |
| 18     | 46 28                            | 44 16          | Estonia.....            | Small berg.               |
| 20     | 48 15                            | 52 31          | Lord Kelvin.....        | Large berg.               |
| 20     | 48 20                            | 52 35          | do.....                 | Do.                       |
| 20     | 48 21                            | 52 35          | do.....                 | Do.                       |
| 20     | 48 24                            | 52 44          | do.....                 | Do.                       |
| 20     | 48 33                            | 52 39          | do.....                 | Do.                       |
| 21     | 42 45                            | 50 06          | Reaper.....             | Berg.                     |
| 21     | 42 47                            | 50 06          | Liberty.....            | Do.                       |
| 21     | 47° 55' N.; 50° 55' W.           |                | Cape Race.....          | 3 medium bergs.           |
| 22     | 42 18                            | 48 10          | France.....             | Berg.                     |
| 22     | 48 21                            | 52 34          | Lord Kelvin.....        | Do.                       |
| 25     | 49 20                            | 46 01          | Assyria.....            | Large berg.               |
| 24     | 42 26                            | 48 06          | Hektor.....             | Do.                       |
| 25     | 42 41                            | 50 56          | Modoc.....              | Small berg.               |
| 28     | 48 30                            | 49 16          | Korsholman.....         | 2 bergs.                  |
| 28     | 49 35                            | 45 19          | Loch Fay.....           | Berg.                     |
| 26     | 49 00                            | 50 10          | Drubergen.....          | 2 bergs.                  |
| 26     | 49 14                            | 49 08          | do.....                 | Berg.                     |
| 29     | 10 miles E. of Cape St. Francis. |                | do.....                 | Do.                       |
| July 2 | 48 27                            | 49 45          | Stavangerfjord.....     | Do.                       |
| 5      | 48 25                            | 49 30          | Drubergen.....          | Do.                       |
| 5      | 49 42                            | 48 50          | Nevada.....             | Do.                       |
| 6      | 48 04                            | 48 41          | Clairton.....           | Do.                       |
| 6      | 48 01                            | 48 40          | do.....                 | Small berg.               |
| 8      | 48 05                            | 47 45          | Cape Race.....          | Berg.                     |

## Record of obstruction reports, International Ice Patrol

| Date    | Vessel                            | Position       |                | Description                                       |
|---------|-----------------------------------|----------------|----------------|---------------------------------------------------|
|         |                                   | Latitude north | Longitude west |                                                   |
| 1925    |                                   |                |                |                                                   |
| Mar. 25 | Cape Race (British)-----          | 40 00          | 48 37          | Derelict schooner awash.                          |
| 27      | Waimate (British)-----            | 38 37          | 62 23          | Spar 40 feet long, 2 feet diameter.               |
| 29      | Saguaeche (British)-----          | 40 53          | 44 17          | Conical gas and whistle buoy 8 feet high, rusty.  |
| 29      | Blue Triangle (American)-----     | 41 21          | 52 37          | Steel barrel NR2 painted on end.                  |
| 31      | Waimate-----                      | 40 41          | 44 29          | Large light and whistle buoy.                     |
| Apr. 3  | Bannoek (American)-----           | 43 36          | 45 24          | Dead whale.                                       |
| 3       | Cape Race (British)-----          | 39 33          | 48 36          | Wreckage 20 feet long, 2 feet high.               |
| 11      | Hellenic (Swedish)-----           | 39 58          | 55 02          | Log 20 feet long.                                 |
| 14      | Cape Race (British)-----          | 40 26          | 47 28          | Wreckage 25 feet long.                            |
| 17      | Eglantine (American)-----         | 41 58          | 44 15          | Gas and whistling buoy.                           |
| 17      | Balsam (American)-----            | 42 40          | 45 44          | Gas and whistling buoy 25 feet high.              |
| 24      | Tampa, C. G. C.-----              | 45 00          | 58 50          | Striped buoy.                                     |
| May 2   | West Madaket (American)-----      | 45 33          | 43 33          | Log 25 feet long.                                 |
| 4       | Oscar II (Danish)-----            | 44 12          | 44 48          | Iron gas buoy.                                    |
| 7       | Engene Schneider (French)-----    | 45 38          | 30 20          | Derelict with 1 mast.                             |
| 14      | Skard (Norwegian)-----            | 45 47          | 42 43          | Frame work of gas-whistling buoy.                 |
| 13      | Hoxie (American)-----             | 40 45          | 48 28          | Large iron gas buoy with superstructure.          |
| 5       | Carso (Italian)-----              | 41 25          | 43 15          | Conical iron buoy 5 feet high.                    |
| 19      | Blackheath (British)-----         | 49 45          | 44 50          | Barrel or mine.                                   |
| 25      | Cape Race (British)-----          | 40 38          | 43 59          | Part of wooden vessel.                            |
| 28      | Svanhild (Danish)-----            | 46 10          | 40 03          | Gas and whistling buoy.                           |
| 31      | Ossag (Germany)-----              | 45 10          | 42 27          | Gas and whistling buoy marked Rockwood.           |
| June 4  | Topeka (American)-----            | 44 00          | 42 59          | Whistle buoy.                                     |
| 10      | Monrolite (British)-----          | 43 37          | 43 30          | Dory marked Aralia J R6.                          |
| 15      | Manchester Shipper (British)----- | 44 35          | 43 01          | Whistling buoy.                                   |
| 16      | Schenectady (American)-----       | 41 27          | 50 15          | Log 30 feet long 1 1/2 feet diameter.             |
| 17      | Arlington-----                    | (1)            | (1)            | Broadcast in re 4-masted schooner James B. Hamlin |
| 18      | Nicolas Odrea-----                | 39 42          | 42 38          | Iron raft 15 feet long, 10 feet wide.             |
| 22      | West Ino (American)-----          | 33 20          | 51 15          | Spar on end.                                      |
| 28      | Stroma (British)-----             | 41 38          | 51 05          | Log 25 feet long.                                 |

1 Unknown.

## Weather résumé, March 25-July 12

|                            | Percentage |      |      |     |    |     |      | Hours |        |      |        |    |        |      |        |     |        |      |        |    |        |      |        |   |     |    |
|----------------------------|------------|------|------|-----|----|-----|------|-------|--------|------|--------|----|--------|------|--------|-----|--------|------|--------|----|--------|------|--------|---|-----|----|
|                            | Fog        | O.C. | B.C. | B.  | R. | Z.  | Calm | N.    | N.N.E. | N.E. | E.N.E. | E. | E.S.E. | S.E. | S.S.E. | S.  | S.S.W. | S.W. | W.S.W. | W. | W.N.W. | N.W. | N.N.W. |   |     |    |
| MARCH                      |            |      |      |     |    |     |      |       |        |      |        |    |        |      |        |     |        |      |        |    |        |      |        |   |     |    |
| Actual-----                | 22         | 82   | 14   | 4.0 | 6  | 29  | 2    | 6     | 5      | 27   | 10     | 2  | 8      |      |        |     |        |      |        |    |        |      | 3      | 8 | 77  | 16 |
| Pilot chart (approx.)----- | 30         |      |      |     |    |     | 4    | 21    |        | 17   |        |    |        | 13   |        | 20  |        | 20   |        |    |        |      | 25     |   | 26  |    |
| APRIL                      |            |      |      |     |    |     |      |       |        |      |        |    |        |      |        |     |        |      |        |    |        |      |        |   |     |    |
| Actual-----                | 39         | 66   | 31   | 3   | 13 | 6.0 | 1    | 33    | 24     | 101  | 41     | 12 | 18     | 39   | 35     | 36  | 21     | 60   | 47     | 37 | 36     | 157  | 14     |   |     |    |
| Pilot chart (approx.)----- | 45         |      |      |     |    |     | 4    | 86    |        | 65   |        |    |        | 64   |        | 137 |        | 144  |        |    |        |      | 94     |   | 101 |    |
| MAY                        |            |      |      |     |    |     |      |       |        |      |        |    |        |      |        |     |        |      |        |    |        |      |        |   |     |    |
| Actual-----                | 36         | 71   | 22   | 7   | 15 | 10  | 2    | 20    | 31     | 25   | 19     | 16 | 6      | 38   | 64     | 54  | 46     | 137  | 83     | 78 | 30     | 18   | 5      |   |     |    |
| Pilot chart (approx.)----- | 35         |      |      |     |    |     | 7    | 135   |        | 59   |        | 59 |        | 59   |        | 89  |        | 97   |        |    |        |      | 89     |   | 105 |    |
| JUNE                       |            |      |      |     |    |     |      |       |        |      |        |    |        |      |        |     |        |      |        |    |        |      |        |   |     |    |
| Actual-----                | 30         | 57   | 38   | 4   | 26 | 12  | 5    | 15    | 31     | 11   | 20     | 16 | 14     | 33   | 35     | 68  | 125    | 70   | 48     | 44 | 71     | 48   |        |   |     |    |
| Pilot chart (approx.)----- | 40         |      |      |     |    |     | 6    | 66    |        | 57   |        | 50 |        | 50   |        | 122 |        | 109  |        |    |        |      | 137    |   | 86  |    |
| JULY                       |            |      |      |     |    |     |      |       |        |      |        |    |        |      |        |     |        |      |        |    |        |      |        |   |     |    |
| Actual-----                | 32         | 69   | 28   | 2   | 7  | 13  | 5    | 28    | 14     | 16   | 7      | 24 |        | 27   | 6      | 54  | 54     | 10   | 9      | 10 | 4      | 5    | 6      |   |     |    |
| Pilot chart (approx.)----- | 40         |      |      |     |    |     | 10   | 17    |        | 18   |        | 18 |        | 43   |        | 43  |        |      |        |    |        |      | 46     |   | 31  |    |

Table of data concerning scientific stations occupied during 1924

| Station No. | Date            | Time of day                   | Position       |                | Depth of water | Wind direction and force Beaufort | Water, physical data |             |                 |                    |
|-------------|-----------------|-------------------------------|----------------|----------------|----------------|-----------------------------------|----------------------|-------------|-----------------|--------------------|
|             |                 |                               | Latitude north | Longitude west |                |                                   | At depth             | Temperature | Salinity        | Density $\delta_t$ |
| 377         | 1924<br>Mar. 22 | 2.30-3.30 p. m.               | ° ' 43 30      | ° ' 51 42      | Meters<br>216  | NE. 5.                            | Meters               | ° C.        | 0/100 by weight |                    |
|             |                 |                               |                |                |                |                                   | 0                    | 0.8         | 33.15           | 26.50              |
|             |                 |                               |                |                |                |                                   | 50                   | 0.6         | 33.16           | 26.50              |
|             |                 |                               |                |                |                |                                   | 100                  | 0.6         | 33.50           | 26.88              |
|             |                 |                               |                |                |                |                                   | 125                  |             |                 | 2 26.95            |
|             |                 |                               |                |                |                |                                   | 150                  | 5.3         | 34.19           | 27.01              |
|             |                 |                               |                |                |                |                                   | 200                  | 1.1         | 33.88           | 27.15              |
| 378         | Mar. 23         | 11.45 a. m. to<br>12.30 p. m. | 43 06          | 50 55          | 260            | NE. 6.                            | 0                    | 0.06        | 33.03           | 26.53              |
|             |                 |                               |                |                |                |                                   | 50                   |             |                 | 2 26.53            |
|             |                 |                               |                |                |                |                                   | 60                   | 0.0         | 33.02           | 26.53              |
|             |                 |                               |                |                |                |                                   | 120                  | -0.4        | 33.06           | 26.57              |
|             |                 |                               |                |                |                |                                   | 125                  |             |                 | 2 26.58            |
|             |                 |                               |                |                |                |                                   | 180                  | -0.3        | 33.30           | 26.74              |
|             |                 |                               |                |                |                |                                   | 240                  | 1.9         | 34.16           | 27.33              |
|             |                 |                               |                |                |                |                                   | 250                  |             |                 | 2 27.41            |
| 379         | do.             | 5.20-6.30 p. m.               | 42 49          | 50 05          | 420            | NE. 5.                            | 0                    | -0.1        | 33.05           | 26.55              |
|             |                 |                               |                |                |                |                                   | 50                   |             |                 | 2 26.82            |
|             |                 |                               |                |                |                |                                   | 100                  | 1.7         | 33.83           | 27.08              |
|             |                 |                               |                |                |                |                                   | 125                  |             |                 | 2 27.20            |
|             |                 |                               |                |                |                |                                   | 200                  | 2.5         | 34.46           | 27.51              |
|             |                 |                               |                |                |                |                                   | 250                  |             |                 | 2 27.58            |
|             |                 |                               |                |                |                |                                   | 300                  | 2.7         | 34.63           | 27.63              |
|             |                 |                               |                |                |                |                                   | 400                  | 3.1         | 34.70           | 27.65              |
| 380         | do.             | 8.50-9.20 a. m.               | 44 07          | 49 10          | 110            | NNE. 3.                           | 0                    | -0.2        | 32.70           | 26.28              |
|             |                 |                               |                |                |                |                                   | 25                   | -0.66       | 32.73           | 26.31              |
|             |                 |                               |                |                |                |                                   | 50                   | -0.9        | 32.80           | 26.38              |
|             |                 |                               |                |                |                |                                   | 75                   | -0.9        | 32.95           | 26.50              |
|             |                 |                               |                |                |                |                                   | 100                  | -1.0        | 33.25           | 26.75              |
| 381         | Mar. 25         | 4.10-5.49 p. m.               | 44 45          | 48 34          | 750            | do.                               | 0                    | 2.8         | 33.73           | 26.90              |
|             |                 |                               |                |                |                |                                   | 50                   | 3.24        | 33.94           | 27.04              |
|             |                 |                               |                |                |                |                                   | 125                  | 3.0         | 34.49           | 27.50              |
|             |                 |                               |                |                |                |                                   | 250                  | 4.15        | 34.86           | 27.68              |
|             |                 |                               |                |                |                |                                   | 450                  | 3.9         | 34.88           | 27.72              |
|             |                 |                               |                |                |                |                                   | 750                  | 3.4         | 34.86           | 27.75              |
| 382         | Mar. 29         | 7-7.30 a. m.                  | 44 19          | 49 04          | 70             | SW. 4.                            | 0                    | -0.2        | 32.94           | 26.47              |
|             |                 |                               |                |                |                |                                   | 20                   | -0.5        | 32.96           | 26.49              |
|             |                 |                               |                |                |                |                                   | 40                   | -0.35       | 32.92           | 26.49              |
|             |                 |                               |                |                |                |                                   | 50                   |             |                 | 2 26.51            |
|             |                 |                               |                |                |                |                                   | 60                   | -0.4        | 33.00           | 26.53              |
| 383         | do.             | 3.30-4 p. m.                  | 44 25          | 50 07          | 55             | SW. 6.                            | 0                    | 2.8         | 32.84           | 26.20              |
|             |                 |                               |                |                |                |                                   | 15                   | 2.45        | 32.77           | 26.25              |
|             |                 |                               |                |                |                |                                   | 27                   | 2.3         | 32.81           | 26.22              |
|             |                 |                               |                |                |                |                                   | 39                   | 2.45        | 32.79           | 26.20              |
|             |                 |                               |                |                |                |                                   | 50                   |             |                 | 2 26.20            |
|             |                 |                               |                |                |                |                                   | 51                   | 2.35        | 32.79           | 26.20              |
| 384         | Apr. 1          | 5-6.10 p. m.                  | 43 43          | 49 15          | 750            | WNW. 6.                           | 0                    | -0.5        | 32.94           | 26.48              |
|             |                 |                               |                |                |                |                                   | 50                   | -0.56       | 33.00           | 26.54              |
|             |                 |                               |                |                |                |                                   | 125                  | -0.9        | 33.33           | 26.81              |
|             |                 |                               |                |                |                |                                   | 250                  | 1.15        | 34.39           | 27.50              |
|             |                 |                               |                |                |                |                                   | 450                  | 3.05        | 34.67           | 27.63              |
|             |                 |                               |                |                |                |                                   | 750                  | 3.4         | 34.79           | 27.70              |
| 385         | Apr. 4          | 4.05-5.05 p. m.               | 42 44          | 49 56          | 4,000          | N. 3.                             | 0                    | 0.2         | 33.11           | 26.58              |
|             |                 |                               |                |                |                |                                   | 50                   | 0.3         | 33.25           | 26.78              |
|             |                 |                               |                |                |                |                                   | 125                  | 1.4         | 33.84           | 27.12              |
|             |                 |                               |                |                |                |                                   | 250                  | 2.8         | 34.52           | 27.54              |
|             |                 |                               |                |                |                |                                   | 450                  | 3.4         | 34.75           | 27.66              |
|             |                 |                               |                |                |                |                                   | 750                  | 3.6         | 34.84           | 27.72              |
| 386         | Apr. 6          | 10.25 a. m. to<br>noon.       | 42 18          | 50 38          | 2,760          | ENE. 1.                           | 0                    | 3.0         | 33.37           | 26.60              |
|             |                 |                               |                |                |                |                                   | 50                   | 1.7         | 33.64           | 26.82              |
|             |                 |                               |                |                |                |                                   | 125                  | 2.3         | 34.36           | 27.46              |
|             |                 |                               |                |                |                |                                   | 250                  | 3.5         | 34.72           | 27.63              |
|             |                 |                               |                |                |                |                                   | 450                  | 4.0         | 34.88           | 27.71              |
|             |                 |                               |                |                |                |                                   | 750                  | 3.9         | 34.90           | 27.74              |
| 387         | Apr. 8          | 1-2 p. m.                     | 41 43          | 49 28          | 4,000          | N. 3.                             | 0                    | 13.9        | 35.79           | 26.83              |
|             |                 |                               |                |                |                |                                   | 50                   | 13.0        | 35.48           | 26.78              |
|             |                 |                               |                |                |                |                                   | 125                  | 12.7        | 35.43           | 26.80              |
|             |                 |                               |                |                |                |                                   | 250                  | 10.5        | 35.19           | 27.05              |
|             |                 |                               |                |                |                |                                   | 450                  | 5.9         | 34.79           | 27.42              |
|             |                 |                               |                |                |                |                                   | 750                  | 4.2         | 34.92           | 27.72              |
| 388         | Apr. 10         | 9-10.20 a. m.                 | 41 11          | 48 18          | 4,060          | SW. 2.                            | 0                    | 13.7        | 35.85           | 26.82              |
|             |                 |                               |                |                |                |                                   | 50                   | 13.3        | 35.75           | 26.93              |
|             |                 |                               |                |                |                |                                   | 125                  | 12.1        | 35.46           | 26.95              |
|             |                 |                               |                |                |                |                                   | 250                  | 9.6         | 34.98           | 27.02              |
|             |                 |                               |                |                |                |                                   | 450                  | 6.5         | 34.95           | 27.47              |
|             |                 |                               |                |                |                |                                   | 750                  | 4.3         | 34.90           | 27.69              |

<sup>1</sup> Error.<sup>2</sup> Interpolated.<sup>3</sup> Extrapolated.

Table of data concerning scientific stations occupied during 1924—Continued

| Station No. | Date            | Time of day           | Position       |                | Depth of water  | Wind direction and force Beaufort | Water, physical data |             |                 |            |
|-------------|-----------------|-----------------------|----------------|----------------|-----------------|-----------------------------------|----------------------|-------------|-----------------|------------|
|             |                 |                       | Latitude north | Longitude west |                 |                                   | At depth             | Temperature | Salinity        | Density at |
| 389         | 1924<br>Apr. 13 | 7-7.50 a. m.-----     | 41 22          | 50 32          | Meters<br>4,068 | N. 5.-----                        | Meters               | °C.         | 0/100 by weight |            |
|             |                 |                       |                |                |                 |                                   | 0                    | 12.9        | 35.92           | 26.94      |
|             |                 |                       |                |                |                 |                                   | 50                   | 13.2        | 35.75           | 26.95      |
|             |                 |                       |                |                |                 |                                   | 125                  | 13.1        | 35.75           | 26.97      |
|             |                 |                       |                |                |                 |                                   | 250                  | 11.2        | 35.18           | 27.07      |
|             |                 |                       |                |                |                 |                                   | 450                  | 8.7         | 35.12           | 27.28      |
| 390         | do-----         | 10.50-11.45 a. m.     | 41 41          | 50 17          | 4,068           | NNE. 2.-----                      | 750                  | 4.5         | 34.89           | 27.66      |
|             |                 |                       |                |                |                 |                                   | 0                    | 13.7        | 35.90           | 26.96      |
|             |                 |                       |                |                |                 |                                   | 50                   | 13.3        | 35.75           | 26.96      |
|             |                 |                       |                |                |                 |                                   | 125                  | 12.0        | 35.46           | 26.98      |
|             |                 |                       |                |                |                 |                                   | 250                  | 10.4        | 35.30           | 27.13      |
|             |                 |                       |                |                |                 |                                   | 450                  | 7.35        | 35.04           | 27.43      |
| 391         | do-----         | 4-4.50 p. m.-----     | 42 10          | 50 12          | 3,700           | N. 4.-----                        | 750                  | 4.05        | 34.87           | 27.70      |
|             |                 |                       |                |                |                 |                                   | 0                    | 4.0         | 33.80           | 26.86      |
|             |                 |                       |                |                |                 |                                   | 50                   | 3.2         | 33.92           | 27.02      |
|             |                 |                       |                |                |                 |                                   | 125                  | 2.7         | 34.36           | 27.42      |
|             |                 |                       |                |                |                 |                                   | 250                  | 4.4         | 34.81           | 27.61      |
|             |                 |                       |                |                |                 |                                   | 450                  | 4.0         | 34.89           | 27.72      |
| 392         | do-----         | 7.15-8 p. m.-----     | 42 30          | 50 13          | 2,500           | NE. 2.-----                       | 750                  | 3.7         | 34.90           | 27.76      |
|             |                 |                       |                |                |                 |                                   | 0                    | 3.5         | 33.62           | 26.75      |
|             |                 |                       |                |                |                 |                                   | 50                   | 3.0         | 33.64           | 26.81      |
|             |                 |                       |                |                |                 |                                   | 125                  | 3.0         | 34.34           | 27.38      |
|             |                 |                       |                |                |                 |                                   | 250                  | 4.3         | 34.66           | 27.50      |
|             |                 |                       |                |                |                 |                                   | 450                  | 4.5         | 34.86           | 27.64      |
| 393         | do-----         | 10-10.45 p. m.-----   | 42 51          | 50 13          | 295             | NE. by E.<br>1.                   | 750                  | 3.3         | 34.91           | 27.80      |
|             |                 |                       |                |                |                 |                                   | 0                    | 0.5         | 32.98           | 26.47      |
|             |                 |                       |                |                |                 |                                   | 50                   | -0.4        | 33.01           | 26.53      |
|             |                 |                       |                |                |                 |                                   | 100                  | -0.6        | 33.38           | 26.84      |
|             |                 |                       |                |                |                 |                                   | 150                  | 0.3         | 33.77           | 27.12      |
|             |                 |                       |                |                |                 |                                   | 210                  | 1.4         | 34.15           | 27.36      |
| 394         | Apr. 14         | 8-8.40 a. m.-----     | 43 17          | 50 14          | 64              | SE. 2.-----                       | 250                  | 2.5         | 34.55           | 27.59      |
|             |                 |                       |                |                |                 |                                   | 0                    | 3.1         | 32.89           | 26.21      |
|             |                 |                       |                |                |                 |                                   | 20                   | 2.8         | 32.86           | 26.25      |
|             |                 |                       |                |                |                 |                                   | 40                   | 2.6         | 32.97           | 26.32      |
|             |                 |                       |                |                |                 |                                   | 50                   |             |                 | 26.33      |
|             |                 |                       |                |                |                 |                                   | 60                   | 2.0         | 32.97           | 26.35      |
| 395         | do-----         | 5.30-5.50 p. m.-----  | 43 50          | 49 00          | 343             | Calm-----                         | 0                    | 1.6         | 32.93           | 26.36      |
|             |                 |                       |                |                |                 |                                   | 30                   | 0.1         | 32.93           | 26.45      |
|             |                 |                       |                |                |                 |                                   | 50                   |             |                 | 26.52      |
|             |                 |                       |                |                |                 |                                   | 100                  | -1.3        | 33.21           | 26.73      |
|             |                 |                       |                |                |                 |                                   | 125                  |             |                 | 26.88      |
|             |                 |                       |                |                |                 |                                   | 200                  | 1.5         | 34.24           | 27.42      |
| 396         | Apr. 15         | 12.30-1.30 p. m.----- | 44 44          | 48 40          | 2,400           | SSE. 6.-----                      | 250                  |             |                 | 27.46      |
|             |                 |                       |                |                |                 |                                   | 320                  | 2.8         | 34.50           | 27.52      |
|             |                 |                       |                |                |                 |                                   | 0                    | 3.7         | 33.77           | 26.86      |
|             |                 |                       |                |                |                 |                                   | 50                   |             |                 | 27.14      |
|             |                 |                       |                |                |                 |                                   | 125                  |             |                 | 27.46      |
|             |                 |                       |                |                |                 |                                   | 125                  | 3.0         | 34.46           | 27.47      |
| 397         | do-----         | 7.30-7.57 p. m.-----  | 41 58          | 49 23          | 57              | SSW. 2.---                        | 250                  |             |                 | 27.62      |
|             |                 |                       |                |                |                 |                                   | 258                  | 4.5         | 34.85           | 27.63      |
|             |                 |                       |                |                |                 |                                   | 450                  | 3.9         | 34.86           | 27.71      |
|             |                 |                       |                |                |                 |                                   | 0                    | 1.0         | 32.91           | 26.38      |
|             |                 |                       |                |                |                 |                                   | 15                   | 0.0         | 32.97           | 26.49      |
|             |                 |                       |                |                |                 |                                   | 34                   | 0.1         | 32.98           | 26.49      |
| 398         | Apr. 16         | 9.30-10.45 a. m.----- | 45 29          | 48 34          | 700             | SW. 3.-----                       | 50                   |             |                 | 26.49      |
|             |                 |                       |                |                |                 |                                   | 33                   | 0.2         | 32.98           | 26.49      |
|             |                 |                       |                |                |                 |                                   | 0                    | 1.0         | 33.12           | 26.55      |
|             |                 |                       |                |                |                 |                                   | 42                   | 0.4         | 33.55           | 26.98      |
|             |                 |                       |                |                |                 |                                   | 50                   |             |                 | 27.02      |
|             |                 |                       |                |                |                 |                                   | 106                  | 0.5         | 33.98           | 27.28      |
| 399         | do-----         | 3.30-4.55 p. m.-----  | 45 56          | 47 52          | 800             | WSW. 5.---                        | 125                  |             |                 | 27.33      |
|             |                 |                       |                |                |                 |                                   | 212                  | 1.5         | 34.28           | 27.45      |
|             |                 |                       |                |                |                 |                                   | 250                  |             |                 | 27.50      |
|             |                 |                       |                |                |                 |                                   | 381                  | 1.5         | 34.45           | 27.59      |
|             |                 |                       |                |                |                 |                                   | 450                  |             |                 | 27.62      |
|             |                 |                       |                |                |                 |                                   | 636                  | 1.8         | 34.56           | 27.66      |
| 399         | do-----         | 3.30-4.55 p. m.-----  | 45 56          | 47 52          | 800             | WSW. 5.---                        | 0                    | 0.7         | 33.27           | 26.69      |
|             |                 |                       |                |                |                 |                                   | 0                    | 2.0         | 33.89           | 27.10      |
|             |                 |                       |                |                |                 |                                   | 125                  | 2.6         | 34.45           | 27.50      |
|             |                 |                       |                |                |                 |                                   | 250                  | 3.0         | 34.71           | 27.67      |
|             |                 |                       |                |                |                 |                                   | 450                  | 3.4         | 34.86           | 27.76      |
|             |                 |                       |                |                |                 |                                   | 750                  | 2.6         | 34.93           | 27.88      |

1 Error.

2 Interpolated.

3 Missing.

Table of data concerning scientific stations occupied during 1924—Continued

| Station No. | Date            | Time of day       | Position       |                | Depth of water | Wind direction and force Beaufort | Water, physical data |             |                |                    |
|-------------|-----------------|-------------------|----------------|----------------|----------------|-----------------------------------|----------------------|-------------|----------------|--------------------|
|             |                 |                   | Latitude north | Longitude west |                |                                   | At depth             | Temperature | Salinity       | Density $\sigma_t$ |
| 400         | 1924<br>Apr. 17 | 1.55-2.15 p. m.   | 45 53          | 51 53          | Meters<br>80   | NE. 3                             | Meters               | ° C.        | 0/00 by weight |                    |
|             |                 |                   |                |                |                |                                   | 0                    | 1.9         | 32.91          | 26.33              |
|             |                 |                   |                |                |                |                                   | 20                   | 2.0         | 32.93          | 26.34              |
|             |                 |                   |                |                |                |                                   | 40                   | 1.4         | 32.94          | 26.35              |
|             |                 |                   |                |                |                |                                   | 50                   |             |                | <sup>2</sup> 26.39 |
| 401         | do              | 7-7.30 p. m.      | 46 16          | 52 19          | 72             | N. 2                              | 0                    | 1.2         | 32.95          | 26.40              |
|             |                 |                   |                |                |                |                                   | 80                   | 0.8         | 33.04          | 26.50              |
|             |                 |                   |                |                |                |                                   | 0                    | 1.1         | 32.02          | 25.66              |
|             |                 |                   |                |                |                |                                   | 20                   | 0.9         | 32.02          | 25.67              |
|             |                 |                   |                |                |                |                                   | 40                   | 0.6         | 32.13          | 25.78              |
| 402         | Apr. 18         | 6.30-7 p. m.      | 46 22          | 52 33          | 160            | NE. 6                             | 50                   |             |                | <sup>2</sup> 25.80 |
|             |                 |                   |                |                |                |                                   | 65                   | 0.2         | 32.14          | 25.81              |
|             |                 |                   |                |                |                |                                   | 0                    | -0.1        | 32.60          | 26.23              |
|             |                 |                   |                |                |                |                                   | 25                   | -0.5        | 33.11          | 26.62              |
|             |                 |                   |                |                |                |                                   | 50                   |             |                | <sup>2</sup> 26.65 |
| 403         | do              | 8-8.30 a. m.      | 46 26          | 52 42          | 170            | NE. 5                             | 75                   | -0.4        | 33.17          | 26.67              |
|             |                 |                   |                |                |                |                                   | 125                  |             |                | <sup>2</sup> 26.72 |
|             |                 |                   |                |                |                |                                   | 150                  | -0.5        | 33.24          | 26.73              |
|             |                 |                   |                |                |                |                                   | 0                    | 0.1         | 32.50          | 26.10              |
|             |                 |                   |                |                |                |                                   | 25                   | -0.2        | 32.57          | 26.17              |
| 404         | do              | 9.10-9.40 a. m.   | 46 31          | 52 51          | 134            | NNE. 5                            | 50                   |             |                | 26.28              |
|             |                 |                   |                |                |                |                                   | 75                   | -0.4        | 33.00          | 26.53              |
|             |                 |                   |                |                |                |                                   | 125                  |             |                | <sup>2</sup> 26.70 |
|             |                 |                   |                |                |                |                                   | 165                  | -1.0        | 33.25          | 26.75              |
|             |                 |                   |                |                |                |                                   | 0                    | -0.2        | 32.65          | 26.24              |
| 405         | do              | 10.30-11 a. m.    | 46 36          | 53 01          | 72             | do                                | 30                   | -0.5        | 32.70          | 26.30              |
|             |                 |                   |                |                |                |                                   | 50                   |             |                | <sup>2</sup> 26.34 |
|             |                 |                   |                |                |                |                                   | 60                   | -0.8        | 32.78          | 26.36              |
|             |                 |                   |                |                |                |                                   | 90                   | -1.0        | 32.82          | 26.41              |
|             |                 |                   |                |                |                |                                   | 120                  | -1.2        | 32.88          | 26.45              |
| 406         | do              | 1-1.30 p. m.      | 46 42          | 53 17          | 30             | NE. 9                             | 125                  |             |                | <sup>3</sup> 26.45 |
|             |                 |                   |                |                |                |                                   | 0                    | -0.1        | 32.43          | 26.06              |
|             |                 |                   |                |                |                |                                   | 20                   | -0.3        | 32.44          | 26.05              |
|             |                 |                   |                |                |                |                                   | 40                   | -0.4        | 32.52          | 26.18              |
|             |                 |                   |                |                |                |                                   | 50                   |             |                | <sup>2</sup> 26.20 |
| 407         | Apr. 19         | 7-7.30 a. m.      | 46 33          | 53 27          | 57             | NNW. 6                            | 65                   | -0.8        | 32.60          | 26.29              |
|             |                 |                   |                |                |                |                                   | 0                    | 0.1         | 32.27          | 25.92              |
|             |                 |                   |                |                |                |                                   | 12                   | 0.2         | 32.28          | 25.94              |
|             |                 |                   |                |                |                |                                   | 25                   | -0.2        | 32.30          | 25.95              |
|             |                 |                   |                |                |                |                                   | 0                    | 0.0         | 32.48          | 26.02              |
| 408         | do              | 8.10-8.45 a. m.   | 46 26          | 53 21          | 85             | do                                | 15                   | -0.3        | 32.48          | 26.10              |
|             |                 |                   |                |                |                |                                   | 34                   | -0.4        | 33.49          | 26.42              |
|             |                 |                   |                |                |                |                                   | 50                   |             |                | 26.80              |
|             |                 |                   |                |                |                |                                   | 53                   | -0.5        | 33.69          | 26.90              |
|             |                 |                   |                |                |                |                                   | 0                    | 0.2         | 32.62          | 26.20              |
| 409         | do              | 9.58-10.27 a. m.  | 46 15          | 53 25          | 147            | NNE. 4                            | 20                   | -0.1        | 32.77          | 26.34              |
|             |                 |                   |                |                |                |                                   | 40                   | -0.8        | 32.82          | 26.39              |
|             |                 |                   |                |                |                |                                   | 50                   |             |                | <sup>2</sup> 26.39 |
|             |                 |                   |                |                |                |                                   | 60                   | -0.8        | 32.83          | 26.39              |
|             |                 |                   |                |                |                |                                   | 80                   | -0.6        | 32.82          | 26.40              |
| 410         | do              | 11.35-11.58 a. m. | 46 02          | 58 40          | 147            | NNE. 3                            | 0                    | -0.2        | 32.74          | 26.31              |
|             |                 |                   |                |                |                |                                   | 35                   | -0.3        | 33.02          | 26.55              |
|             |                 |                   |                |                |                |                                   | 50                   |             |                | <sup>2</sup> 26.58 |
|             |                 |                   |                |                |                |                                   | 70                   | -1.0        | 33.08          | 26.61              |
|             |                 |                   |                |                |                |                                   | 105                  | -1.0        | 33.15          | 26.67              |
| 411         | do              | 1.30-2.10 p. m.   | 45 50          | 53 50          | 136            | do                                | 125                  |             |                | <sup>2</sup> 26.69 |
|             |                 |                   |                |                |                |                                   | 140                  | -1.0        | 33.20          | 26.72              |
|             |                 |                   |                |                |                |                                   | 0                    | 0.5         | 32.79          | 26.32              |
|             |                 |                   |                |                |                |                                   | 35                   | 1.0         | 32.84          | 26.33              |
|             |                 |                   |                |                |                |                                   | 50                   |             |                | <sup>2</sup> 26.37 |
| 412         | do              | 1.30-2.10 p. m.   | 45 50          | 53 50          | 136            | do                                | 70                   | 0.1         | 32.94          | 26.46              |
|             |                 |                   |                |                |                |                                   | 105                  | -1.0        | 33.15          | 26.67              |
|             |                 |                   |                |                |                |                                   | 125                  |             |                | <sup>2</sup> 26.70 |
|             |                 |                   |                |                |                |                                   | 140                  | -1.0        | 33.23          | 26.73              |
|             |                 |                   |                |                |                |                                   | 0                    | 0.1         | 32.83          | 26.37              |
| 413         | do              | 1.30-2.10 p. m.   | 45 50          | 53 50          | 136            | do                                | 32                   | 0.0         | 32.90          | 26.43              |
|             |                 |                   |                |                |                |                                   | 50                   |             |                | <sup>2</sup> 26.50 |
|             |                 |                   |                |                |                |                                   | 64                   | -0.6        | 33.01          | 26.54              |
|             |                 |                   |                |                |                |                                   | 96                   | -1.1        | 33.05          | 26.59              |
|             |                 |                   |                |                |                |                                   | 125                  |             |                | <sup>2</sup> 26.69 |
| 414         | do              | 1.30-2.10 p. m.   | 45 50          | 53 50          | 136            | do                                | 128                  | -1.0        | 33.18          | 26.70              |
|             |                 |                   |                |                |                |                                   |                      |             |                |                    |

<sup>1</sup> Error.<sup>2</sup> Interpolated.<sup>3</sup> Extrapolated.

Table of data concerning scientific stations occupied during 1924—Continued

| Station No. | Date            | Time of day       | Position       |                | Depth of water | Wind direction and force Beaufort | Water, physical data |             |                    |                    |
|-------------|-----------------|-------------------|----------------|----------------|----------------|-----------------------------------|----------------------|-------------|--------------------|--------------------|
|             |                 |                   | Latitude north | Longitude west |                |                                   | At depth             | Temperature | Salinity           | Density $\sigma_t$ |
| 412         | 1924<br>Apr. 19 | 3.30-3.59 p. m.   | 45 38          | 54 22          | 83             | NNW. 3.                           | Meters               | ° C.        | 0/100 by weight    |                    |
|             |                 |                   |                |                |                |                                   | 0                    | 0.0         | 32.87              | 26.41              |
|             |                 |                   |                |                |                |                                   | 19                   | 0.0         | 32.85              | 26.39              |
|             |                 |                   |                |                |                |                                   | 38                   | -0.4        | 32.91              | 26.45              |
|             |                 |                   |                |                |                |                                   | 50                   |             |                    | <sup>2</sup> 26.53 |
| 413         | do.             | 5.30-5.50 p. m.   | 45 27          | 57 34          | 72             | NW. 3.                            | 57                   | -0.8        | 33.03              | 26.56              |
|             |                 |                   |                |                |                |                                   | 77                   | -1.0        | 33.11              | 26.63              |
|             |                 |                   |                |                |                |                                   | 0                    | 0.0         | 33.00              | 26.51              |
|             |                 |                   |                |                |                |                                   | 22                   | -0.2        | 33.06              | 26.57              |
|             |                 |                   |                |                |                |                                   | 44                   | -0.3        | 33.08              | 26.59              |
| 414         | do.             | 7-7.35 p. m.      | 45 15          | 54 50          | 91             | WNW. 2.                           | 50                   |             |                    | <sup>2</sup> 26.60 |
|             |                 |                   |                |                |                |                                   | 66                   | -0.8        | 33.10              | 26.62              |
|             |                 |                   |                |                |                |                                   | 0                    | 0.9         | 32.95              | 26.42              |
|             |                 |                   |                |                |                |                                   | 20                   | 0.6         | 32.96              | 26.45              |
|             |                 |                   |                |                |                |                                   | 44                   | 0.0         | 32.95              | 26.47              |
| 415         | do.             | 9-9.50 p. m.      | 45 05          | 55 02          | 140            | do.                               | 50                   |             |                    | <sup>2</sup> 26.49 |
|             |                 |                   |                |                |                |                                   | 66                   | -0.2        | 33.04              | 26.56              |
|             |                 |                   |                |                |                |                                   | 88                   | -0.6        | 33.09              | 26.61              |
|             |                 |                   |                |                |                |                                   | 0                    | 2.5         | 32.97              | 26.32              |
|             |                 |                   |                |                |                |                                   | 30                   | 2.0         | 33.03              | 26.42              |
| 416         | Apr. 20         | 2.30-4.10 a. m.   | 44 52          | 55 35          | 2,900          | SE. 6.                            | 50                   | 2.0         | <sup>1</sup> 33.10 | 26.48              |
|             |                 |                   |                |                |                |                                   | 90                   | 1.3         | 33.17              | 26.57              |
|             |                 |                   |                |                |                |                                   | 120                  | 5.1         | 34.16              | 27.02              |
|             |                 |                   |                |                |                |                                   | 125                  |             |                    | <sup>3</sup> 27.10 |
|             |                 |                   |                |                |                |                                   | 0                    | 4.2         | 33.15              | 26.32              |
| 417         | do.             | 7.55-8.50 a. m.   | 44 37          | 55 58          | 1,800          | SSE. 7.                           | 50                   | 3.9         | 33.16              | 26.36              |
|             |                 |                   |                |                |                |                                   | 125                  | 2.9         | 33.69              | 26.86              |
|             |                 |                   |                |                |                |                                   | 250                  | 4.4         | <sup>1</sup> 34.52 | 27.38              |
|             |                 |                   |                |                |                |                                   | 450                  | 4.8         | 34.78              | 27.54              |
|             |                 |                   |                |                |                |                                   | 750                  | 3.8         | 34.93              | 27.77              |
| 418         | Apr. 23         | 10.30-11.20 a. m. | 43 28          | 51 41          | 280            | NW. 4.                            | 0                    | 4.0         | 33.58              | 26.68              |
|             |                 |                   |                |                |                |                                   | 50                   | 4.2         | 33.68              | 26.74              |
|             |                 |                   |                |                |                |                                   | 125                  | 5.0         | 34.42              | 27.23              |
|             |                 |                   |                |                |                |                                   | 250                  | 5.1         | 34.61              | 27.37              |
|             |                 |                   |                |                |                |                                   | 450                  | 4.2         | 34.89              | 27.70              |
| 419         | do.             | 3.40-4.30 p. m.   | 43 05          | 51 00          | 530            | NNW. 2.                           | 750                  | 4.1         | 34.98              | 27.78              |
|             |                 |                   |                |                |                |                                   | 0                    | 2.5         | 32.94              | 26.30              |
|             |                 |                   |                |                |                |                                   | 50                   | -0.1        | 33.18              | 26.46              |
|             |                 |                   |                |                |                |                                   | 100                  | 0.4         | 33.43              | 26.50              |
|             |                 |                   |                |                |                |                                   | 125                  |             |                    | 26.54              |
| 420         | do.             | 9.15-10.20 p. m.  | 42 44          | 50 15          | 4,850          | NW. 2.                            | 150                  | 1.9         | 33.81              | 26.57              |
|             |                 |                   |                |                |                |                                   | 200                  | 3.4         | 33.44              | 26.62              |
|             |                 |                   |                |                |                |                                   | 250                  |             |                    | 26.67              |
|             |                 |                   |                |                |                |                                   | 265                  | 2.2         | 33.40              | 26.70              |
|             |                 |                   |                |                |                |                                   | 0                    | 2.9         | 32.95              | 26.28              |
| 421         | Apr. 24         | 3.50-4.30 a. m.   | 43 09          | 49 35          | 275            | NNE. 2.                           | 0                    | 2.1         | 32.88              | 26.29              |
|             |                 |                   |                |                |                |                                   | 125                  | -0.2        | 32.93              | 26.46              |
|             |                 |                   |                |                |                |                                   | 250                  | 1.9         | 34.13              | 27.30              |
|             |                 |                   |                |                |                |                                   | 450                  | 2.6         | 34.54              | 27.57              |
|             |                 |                   |                |                |                |                                   | 450                  |             |                    | <sup>1</sup> 27.60 |
| 422         | do.             | 10-11 a. m.       | 43 50          | 49 07          | 480            | SSE. 3.                           | 520                  | 3.1         | 34.67              | 27.63              |
|             |                 |                   |                |                |                |                                   | 0                    | 0.9         | 32.02              | 26.47              |
|             |                 |                   |                |                |                |                                   | 50                   | 0.0         | 33.03              | 26.53              |
|             |                 |                   |                |                |                |                                   | 125                  | -0.5        | 33.68              | 27.18              |
|             |                 |                   |                |                |                |                                   | 250                  | 2.0         | 34.38              | 27.50              |
| 423         | Apr. 24         | 3.50-4.30 a. m.   | 43 09          | 49 35          | 275            | NNE. 2.                           | 450                  | 2.9         | 34.64              | 27.63              |
|             |                 |                   |                |                |                |                                   | 750                  | 3.2         | 34.89              | 27.80              |
|             |                 |                   |                |                |                |                                   | 0                    | 0.2         | 33.03              | 26.53              |
|             |                 |                   |                |                |                |                                   | 50                   |             |                    | <sup>2</sup> 26.72 |
|             |                 |                   |                |                |                |                                   | 60                   | -0.4        | 33.24              | 26.73              |
| 424         | do.             | 10-11 a. m.       | 43 50          | 49 07          | 480            | SSE. 3.                           | 130                  | -0.2        | 33.42              | 26.86              |
|             |                 |                   |                |                |                |                                   | 125                  |             |                    | <sup>2</sup> 26.88 |
|             |                 |                   |                |                |                |                                   | 180                  | 1.5         | 34.15              | 27.35              |
|             |                 |                   |                |                |                |                                   | 240                  | 1.2         | 34.47              | 27.63              |
|             |                 |                   |                |                |                |                                   | 250                  |             |                    | 27.65              |
| 425         | do.             | 10-11 a. m.       | 43 50          | 49 07          | 480            | SSE. 3.                           | 0                    | 0.5         | 33.15              | 26.60              |
|             |                 |                   |                |                |                |                                   | 50                   | -0.2        | 33.22              | 26.70              |
|             |                 |                   |                |                |                |                                   | 125                  | 0.9         | 33.86              | 27.15              |
|             |                 |                   |                |                |                |                                   | 250                  | 1.9         | 34.29              | 27.44              |
|             |                 |                   |                |                |                |                                   | 450                  | 3.0         | 34.66              | 27.36              |

<sup>1</sup> Error.<sup>2</sup> Interpolated.<sup>3</sup> Extrapolated.

Table of data concerning scientific stations occupied during 1924—Continued

| Station No. | Date           | Time of day       | Position       |                | Depth of water | Wind direction and force Beaufort | Water, physical data |                   |                    |                    |
|-------------|----------------|-------------------|----------------|----------------|----------------|-----------------------------------|----------------------|-------------------|--------------------|--------------------|
|             |                |                   | Latitude north | Longitude west |                |                                   | At depth             | Temperature       | Salinity           | Density $\delta_t$ |
| 423         | 1924<br>Apr 24 | 3.45-5 p. m.      | 44 25          | 48 53          | Meters<br>540  | SE. 3                             | Meters               |                   |                    |                    |
|             |                |                   |                |                |                |                                   | 0                    | 0.8               | <sup>1</sup> 33.15 | 26.58              |
|             |                |                   |                |                |                |                                   | 50                   | 0.4               | 33.28              | 26.71              |
|             |                |                   |                |                |                |                                   | 125                  | -0.3              | 34.00              | 27.33              |
|             |                |                   |                |                |                |                                   | 250                  | 1.9               | 34.31              | 27.50              |
|             |                |                   |                |                |                |                                   | 400                  | 2.4               | 34.61              | 27.65              |
|             |                |                   |                |                |                |                                   | 450                  |                   |                    | <sup>2</sup> 27.66 |
| 424         | Apr. 27        | 9.10-11.15 a. m.  | 44 54          | 50 58          | 50             | NNE. 7                            | 525                  | 1.2.6             | 34.71              | 27.70              |
|             |                |                   |                |                |                |                                   | 0                    | 2.4               | 32.83              | 26.22              |
|             |                |                   |                |                |                |                                   | 16                   | <sup>1</sup> 2.3  | 32.84              | 26.24              |
|             |                |                   |                |                |                |                                   | 32                   | 2.1               | 32.86              | 26.27              |
|             |                |                   |                |                |                |                                   | 48                   | 1.2.0             | 32.92              | 26.33              |
|             |                |                   |                |                |                |                                   | 50                   |                   |                    | <sup>3</sup> 26.35 |
|             |                |                   |                |                |                |                                   | 525                  |                   |                    | 26.18              |
| 425         | do.            | 1.45-2.56 p. m.   | 44 49          | 50 25          | 60             | NE. 7                             | 0                    | 2.5               | 32.79              | 26.19              |
|             |                |                   |                |                |                |                                   | 15                   | <sup>1</sup> 2.5  | 32.80              | 26.25              |
|             |                |                   |                |                |                |                                   | 35                   | 2.5               | 32.88              | 26.25              |
|             |                |                   |                |                |                |                                   | 50                   |                   |                    | <sup>2</sup> 26.30 |
| 426         | do.            | 8.30-9 a. m.      | 44 44          | 49 51          | 50             | ENE. 7                            | 55                   | 2.5               | 32.97              | 26.32              |
|             |                |                   |                |                |                |                                   | 0                    | 2.0               | 33.07              | 26.40              |
|             |                |                   |                |                |                |                                   | 16                   | 1.9               | 33.00              | 26.40              |
|             |                |                   |                |                |                |                                   | 32                   | 1.9               | 32.95              | 26.41              |
|             |                |                   |                |                |                |                                   | 48                   | 1.9               | 33.01              | 26.42              |
|             |                |                   |                |                |                |                                   | 50                   |                   |                    | 26.43              |
| 427         | do.            | 8.30-9 p. m.      | 44 40          | 49 20          | 50             | NE. 7                             | 0                    | 0.7               | 32.97              | 26.45              |
|             |                |                   |                |                |                |                                   | 16                   | 0.9               | 32.98              | 26.45              |
|             |                |                   |                |                |                |                                   | 32                   | 0.7               | <sup>1</sup> 32.99 | 26.47              |
|             |                |                   |                |                |                |                                   | 48                   | 0.6               | 33.04              | 26.51              |
|             |                |                   |                |                |                |                                   | 50                   |                   |                    | 26.52              |
|             |                |                   |                |                |                |                                   | 50                   | 0.8               | 32.78              | 26.29              |
| 428         | Apr. 30        | 2.51-3.10 p. m.   | 46 34          | 48 31          | 110            | N. 6                              | 25                   | 0.5               | <sup>1</sup> 32.78 | 26.31              |
|             |                |                   |                |                |                |                                   | 50                   | -0.1              | 32.86              | 26.40              |
|             |                |                   |                |                |                |                                   | 75                   | -0.5              | 33.01              | 26.54              |
|             |                |                   |                |                |                |                                   | 100                  | -1.0              | 33.31              | 26.80              |
|             |                |                   |                |                |                |                                   | 0                    | 13.0              | 35.73              | 26.98              |
|             |                |                   |                |                |                |                                   | 50                   | 13.1              | 35.75              | 26.97              |
| 429         | May 1          | 4.30-5.30 a. m.   | 44 48          | 47 15          | 4,080          | NNW. 4                            | 125                  | 13.1              | 35.72              | 26.99              |
|             |                |                   |                |                |                |                                   | 250                  | <sup>1</sup> 10.8 | 35.36              | 27.10              |
|             |                |                   |                |                |                |                                   | 450                  | 6.0               | 34.76              | 27.38              |
|             |                |                   |                |                |                |                                   | 750                  | 4.9               | 34.99              | 27.70              |
|             |                |                   |                |                |                |                                   | 0                    | 12.4              | 35.61              | 27.00              |
|             |                |                   |                |                |                |                                   | 50                   | 12.3              | 35.64              | 27.04              |
| 430         | do.            | 8.15-9.10 a. m.   | 44 50          | 47 40          | ---            | NW. 4                             | 0                    | 2.5               | 33.05              | 26.38              |
|             |                |                   |                |                |                |                                   | 25                   | 1.7               | 34.03              | 27.24              |
|             |                |                   |                |                |                |                                   | 50                   | 1.2               | 34.17              | 27.38              |
|             |                |                   |                |                |                |                                   | 75                   | 0.2               | 34.17              | 27.44              |
| 431         | May 2          | 8-8.30 a. m.      | 45 56          | 51 33          | 82             | S. 4                              | 0                    | 1.7               | 32.18              | 25.75              |
|             |                |                   |                |                |                |                                   | 20                   | 1.4               | 32.33              | 25.90              |
|             |                |                   |                |                |                |                                   | 40                   | 0.1               | 32.41              | 26.03              |
|             |                |                   |                |                |                |                                   | 50                   |                   |                    | <sup>3</sup> 26.12 |
|             |                |                   |                |                |                |                                   | 0                    | 2.5               | 32.36              | 25.84              |
|             |                |                   |                |                |                |                                   | 25                   | 0.9               | 32.48              | 26.04              |
| 432         | May 3          | 1.20-1.40 p. m.   | 46 35          | 53 31          | 44             | SW. 2                             | 50                   | -0.1              | 32.59              | 26.19              |
|             |                |                   |                |                |                |                                   | 75                   | -0.4              | 32.63              | 26.23              |
|             |                |                   |                |                |                |                                   | 0                    | 2.1               | 32.64              | 26.10              |
|             |                |                   |                |                |                |                                   | 25                   | 1.1               | 32.60              | 26.13              |
|             |                |                   |                |                |                |                                   | 50                   | 0.5               | 32.69              | 26.24              |
|             |                |                   |                |                |                |                                   | 75                   | -0.5              | 32.85              | 26.41              |
| 433         | do.            | 3.10-3.30 p. m.   | 46 32          | 53 50          | 84             | SW. 3                             | 0                    | 1.5               | 32.74              | 26.22              |
|             |                |                   |                |                |                |                                   | 25                   | 1.2               | 33.75              | 27.04              |
|             |                |                   |                |                |                |                                   | 50                   | -0.2              | 33.75              | 27.16              |
|             |                |                   |                |                |                |                                   | 75                   | -0.8              | 33.95              | 27.31              |
|             |                |                   |                |                |                |                                   | 100                  | -0.8              | 34.02              | 27.37              |
|             |                |                   |                |                |                |                                   | 0                    | 1.7               | 32.65              | 26.13              |
| 434         | do.            | 5.25-5.45 p. m.   | 46 25          | 54 11          | 87             | SSW. 3                            | 25                   | 0.5               | 32.68              | 26.23              |
|             |                |                   |                |                |                |                                   | 50                   |                   |                    | <sup>2</sup> 26.23 |
|             |                |                   |                |                |                |                                   | 75                   | 0.4               | 32.68              | 26.24              |
|             |                |                   |                |                |                |                                   | 125                  |                   |                    | <sup>2</sup> 26.44 |
|             |                |                   |                |                |                |                                   | 150                  | -0.5              | 33.00              | 26.53              |
|             |                |                   |                |                |                |                                   | 200                  | -1.0              | 33.02              | 26.56              |
| 435         | do.            | 7.15-7.30 p. m.   | 46 22          | 54 30          | 110            | WSW. 2                            | 0                    | 2.0               | 32.56              | 26.04              |
|             |                |                   |                |                |                |                                   | 25                   | 1.0               | 32.64              | 26.16              |
|             |                |                   |                |                |                |                                   | 50                   | 0.5               | 32.66              | 26.21              |
|             |                |                   |                |                |                |                                   | 75                   | -0.7              | 32.74              | 26.33              |
|             |                |                   |                |                |                |                                   | 100                  | -1.1              | 32.93              | 26.50              |
|             |                |                   |                |                |                |                                   | 0                    | 1.7               | 32.65              | 26.13              |
| 436         | do.            | 9.15-9.40 p. m.   | 46 15          | 54 50          | 210            | do.                               | 25                   | 0.5               | 32.68              | 26.23              |
|             |                |                   |                |                |                |                                   | 50                   |                   |                    | <sup>2</sup> 26.23 |
|             |                |                   |                |                |                |                                   | 75                   | 0.4               | 32.68              | 26.24              |
|             |                |                   |                |                |                |                                   | 125                  |                   |                    | <sup>2</sup> 26.44 |
|             |                |                   |                |                |                |                                   | 150                  | -0.5              | 33.00              | 26.53              |
|             |                |                   |                |                |                |                                   | 200                  | -1.0              | 33.02              | 26.56              |
| 437         | do.            | 11.20-11.45 p. m. | 46 18          | 55 14          | 110            | W. 1                              | 0                    | 2.0               | 32.56              | 26.04              |
|             |                |                   |                |                |                |                                   | 25                   | 1.0               | 32.64              | 26.16              |
|             |                |                   |                |                |                |                                   | 50                   | 0.5               | 32.66              | 26.21              |
|             |                |                   |                |                |                |                                   | 75                   | -0.7              | 32.74              | 26.33              |
|             |                |                   |                |                |                |                                   | 100                  | -1.1              | 32.93              | 26.50              |
|             |                |                   |                |                |                |                                   | 0                    | 1.7               | 32.65              | 26.13              |

<sup>1</sup> Error.<sup>2</sup> Interpolated<sup>3</sup> Exterpolated.<sup>4</sup> Missing

Table of data concerning scientific stations occupied during 1924—Continued

| Station No. | Date          | Time of day       | Position       |                | Depth of water | Wind direction and force Beaufort | Water, physical data |             |                |                    |
|-------------|---------------|-------------------|----------------|----------------|----------------|-----------------------------------|----------------------|-------------|----------------|--------------------|
|             |               |                   | Latitude north | Longitude west |                |                                   | At depth             | Temperature | Salinity       | Density $\sigma_t$ |
|             |               |                   | ° ' "          | ° ' "          | Meters         |                                   | Meters               | ° C.        | 0/00 by weight |                    |
| 438         | 1924<br>May 4 | 1.30-1.50 a. m.   | 46 08          | 55 32          | 65             | W. 2.                             | 0                    | 1.9         | 32.54          | 26.02              |
|             |               |                   |                |                |                |                                   | 20                   | 0.8         | 32.57          | 26.12              |
|             |               |                   |                |                |                |                                   | 40                   | 0.7         | 32.59          | 26.15              |
|             |               |                   |                |                |                |                                   | 50                   |             |                | 26.15              |
|             |               |                   |                |                |                |                                   | 60                   | -0.4        | 32.61          | 26.21              |
| 439         | do.           | 3.30-3.50 a. m.   | 46 02          | 55 53          | 65             | SW. 3.                            | 0                    | 1.6         | 32.60          | 26.15              |
|             |               |                   |                |                |                |                                   | 20                   | 1.0         | 32.67          | 26.19              |
|             |               |                   |                |                |                |                                   | 40                   | 0.2         | 32.67          | 26.24              |
|             |               |                   |                |                |                |                                   | 50                   |             |                | 26.30              |
|             |               |                   |                |                |                |                                   | 60                   | -0.8        | 32.81          | 26.37              |
| 440         | do.           | 5.15-5.35 a. m.   | 46 00          | 56 12          | 54             | E. 1.                             | 0                    | 2.1         | 32.62          | 26.08              |
|             |               |                   |                |                |                |                                   | 25                   | 1.9         | 32.63          | 26.10              |
|             |               |                   |                |                |                |                                   | 50                   | 1.3         | 32.63          | 26.14              |
|             |               |                   |                |                |                |                                   | 60                   |             |                | 26.15              |
|             |               |                   |                |                |                |                                   | 60                   | 2.1         | 32.71          | 26.15              |
| 441         | do.           | 7.15-7.35 a. m.   | 45 57          | 56 34          | 34             | do.                               | 0                    | 2.1         | 32.71          | 26.15              |
|             |               |                   |                |                |                |                                   | 15                   | 1.8         | 32.72          | 26.18              |
|             |               |                   |                |                |                |                                   | 30                   | 1.2         | 32.72          | 26.22              |
|             |               |                   |                |                |                |                                   | 40                   | 2.5         | 32.62          | 26.05              |
|             |               |                   |                |                |                |                                   | 50                   |             |                | 26.27              |
| 442         | do.           | 9.05-10.40 a. m.  | 45 58          | 57 00          | 544            | WSW. 3.                           | 125                  |             |                | 26.62              |
|             |               |                   |                |                |                |                                   | 135                  | 1.8         | 33.30          | 26.65              |
|             |               |                   |                |                |                |                                   | 250                  |             |                | 27.40              |
|             |               |                   |                |                |                |                                   | 270                  | 1.0         | 34.45          | 27.62              |
|             |               |                   |                |                |                |                                   | 465                  | 0.5         | 34.62          | 27.70              |
|             |               |                   |                |                |                |                                   | 450                  |             |                | 27.17              |
|             |               |                   |                |                |                |                                   | 540                  | 4.2         | 34.70          | 27.72              |
|             |               |                   |                |                |                |                                   | 0                    | 2.2         | 32.84          | 26.17              |
|             |               |                   |                |                |                |                                   | 22                   | 2.0         | 32.74          | 26.18              |
|             |               |                   |                |                |                |                                   | 44                   | 1.0         | 32.93          | 26.40              |
| 443         | May 5         | 5.37-6.10 a. m.   | 45 05          | 55 55          | 95             | SSW. 3.                           | 50                   |             |                | 26.41              |
|             |               |                   |                |                |                |                                   | 66                   | 0.0         | 32.89          | 26.44              |
|             |               |                   |                |                |                |                                   | 88                   | 1.9         | 33.10          | 26.51              |
|             |               |                   |                |                |                |                                   | 0                    | 4.0         | 32.90          | 26.14              |
|             |               |                   |                |                |                |                                   | 50                   | 3.6         | 32.93          | 26.20              |
| 444         | do.           | 9-10.40 p. m.     | 44 42          | 54 10          | 970            | NW. 1.                            | 125                  | 4.2         | 34.00          | 26.99              |
|             |               |                   |                |                |                |                                   | 250                  | 5.2         | 34.50          | 27.27              |
|             |               |                   |                |                |                |                                   | 450                  | 4.1         | 34.86          | 26.68              |
|             |               |                   |                |                |                |                                   | 750                  | 3.9         | 34.90          | 27.74              |
|             |               |                   |                |                |                |                                   | 0                    | 5.0         | 33.22          | 26.28              |
| 445         | May 6         | 12.45-2.30 p. m.  | 43 45          | 53 00          | 200            | SW. 2.                            | 50                   | 3.4         | 33.48          | 26.65              |
|             |               |                   |                |                |                |                                   | 125                  | 4.4         | 34.28          | 27.19              |
|             |               |                   |                |                |                |                                   | 250                  | 4.2         | 34.63          | 27.49              |
|             |               |                   |                |                |                |                                   | 450                  | 4.0         | 34.79          | 27.64              |
|             |               |                   |                |                |                |                                   | 750                  | 4.0         | 34.90          | 27.73              |
| 446         | do.           | 4.45-5.15 p. m.   | 41 02          | 52 39          | 140            | do.                               | 0                    | 5.0         | 32.78          | 25.95              |
|             |               |                   |                |                |                |                                   | 30                   | 3.4         | 32.94          | 26.22              |
|             |               |                   |                |                |                |                                   | 50                   |             |                | 26.37              |
|             |               |                   |                |                |                |                                   | 60                   | 4.0         | 33.28          | 26.44              |
|             |               |                   |                |                |                |                                   | 95                   | 5.0         | 34.14          | 27.01              |
| 447         | do.           | 6.40-7.10 p. m.   | 44 12          | 52 25          | 90             | do.                               | 125                  |             |                | 27.24              |
|             |               |                   |                |                |                |                                   | 130                  | 3.9         | 34.35          | 27.30              |
|             |               |                   |                |                |                |                                   | 0                    | 5.1         | 32.68          | 25.85              |
|             |               |                   |                |                |                |                                   | 20                   | 4.5         | 32.86          | 26.05              |
|             |               |                   |                |                |                |                                   | 40                   | 3.8         | 32.89          | 26.15              |
| 448         | May 7         | 9.24-9.42 a. m.   | 43 12          | 51 29          | 75             | WNW. 4                            | 50                   |             |                | 26.24              |
|             |               |                   |                |                |                |                                   | 60                   | 2.2         | 32.97          | 26.35              |
|             |               |                   |                |                |                |                                   | 80                   | 1.1         | 33.33          | 26.71              |
|             |               |                   |                |                |                |                                   | 0                    | 4.9         | 32.72          | 25.90              |
|             |               |                   |                |                |                |                                   | 20                   | 4.6         | 32.75          | 25.97              |
| 449         | do.           | 11.30-11.55 a. m. | 43 30          | 51 42          | 125            | W. 4.                             | 40                   | 3.3         | 32.83          | 26.15              |
|             |               |                   |                |                |                |                                   | 50                   |             |                | 26.24              |
|             |               |                   |                |                |                |                                   | 65                   | 1.3         | 33.03          | 26.46              |
|             |               |                   |                |                |                |                                   | 0                    | 4.7         | 33.03          | 26.17              |
|             |               |                   |                |                |                |                                   | 30                   | 4.4         | 33.14          | 26.29              |
| 450         | do.           | 2.14-3.10 p. m.   | 43 15          | 51 59          | 1,100          | WNW. 5.                           | 50                   |             |                | 26.46              |
|             |               |                   |                |                |                |                                   | 60                   | 3.8         | 33.45          | 26.60              |
|             |               |                   |                |                |                |                                   | 90                   | 7.3         | 34.58          | 27.07              |
|             |               |                   |                |                |                |                                   | 120                  | 6.0         | 34.40          | 27.00              |
|             |               |                   |                |                |                |                                   | 12                   |             |                | 27.09              |
|             |               |                   |                |                |                |                                   | 0                    | 7.9         | 34.75          | 26.65              |
|             |               |                   |                |                |                |                                   | 70                   | 6.8         | 33.88          | 26.58              |
|             |               |                   |                |                |                |                                   | 125                  | 6.2         | 34.47          | 27.13              |
|             |               |                   |                |                |                |                                   | 250                  | 4.8         | 34.73          | 27.22              |
|             |               |                   |                |                |                |                                   | 130                  | 4.7         | 34.81          | 27.58              |
|             |               |                   |                |                |                |                                   | 750                  | 3.7         | 34.86          | 27.61              |

1 Error.

- Interpolated.

3 Missing.

Table of data concerning scientific stations occupied during 1924—Continued

| Section No. | Date   | Time of day               | Position       |                | Depth of water | Wind direction and force Beaufort | Water, physical data |             |                |                    |
|-------------|--------|---------------------------|----------------|----------------|----------------|-----------------------------------|----------------------|-------------|----------------|--------------------|
|             |        |                           | Latitude north | Longitude west |                |                                   | At depth             | Temperature | Salinity       | Density $\delta_t$ |
|             | 1924   |                           |                |                | Meters         |                                   | Meters               | ° C.        | 0.00 by weight |                    |
| 451         | May 7  | 7.23-8.20 p. m.           | 42 49          | 51 11          | 1,800          | W. 1                              | 0                    | 5.4         | 33.99          | 26.85              |
|             |        |                           |                |                |                |                                   | 50                   | 3.4         | 34.07          | 27.13              |
|             |        |                           |                |                |                |                                   | 125                  | 3.8         | 34.32          | 27.29              |
|             |        |                           |                |                |                |                                   | 250                  | 3.6         | 34.43          | 27.39              |
|             |        |                           |                |                |                |                                   | 450                  | 3.0         | 34.63          | 27.61              |
|             |        |                           |                |                |                |                                   | 750                  | 3.5         | 34.71          | 27.65              |
| 452         | do     | 10-1.25 p. m.             | 43 03          | 51 00          | 800            | W. 2                              | 0                    | 3.5         | 33.12          | 26.36              |
|             |        |                           |                |                |                |                                   | 50                   | 0.9         | 33.50          | 26.90              |
|             |        |                           |                |                |                |                                   | 125                  | 1.2         | 33.96          | 27.22              |
|             |        |                           |                |                |                |                                   | 250                  | 1.2         | 34.38          | 27.43              |
|             |        |                           |                |                |                |                                   | 450                  | 3.1         | 34.60          | 27.58              |
|             |        |                           |                |                |                |                                   | 750                  | 3.3         | 34.74          | 27.67              |
| 453         | May 8  | 1.30-1.50 a. m.           | 43 18          | 50 46          | 80             | do                                | 0                    | 5.1         | 32.78          | 25.92              |
|             |        |                           |                |                |                |                                   | 25                   | 3.8         | 32.78          | 26.06              |
|             |        |                           |                |                |                |                                   | 50                   | 1.9         | 32.88          | 26.30              |
|             |        |                           |                |                |                |                                   | 75                   | -0.3        | 33.13          | 26.63              |
| 454         | do     | 4.24-4.42 a. m.           | 43 10          | 50 10          | 68             | do                                | 0                    | 4.8         | 32.83          | 26.00              |
|             |        |                           |                |                |                |                                   | 20                   | 3.5         | 32.92          | 26.20              |
|             |        |                           |                |                |                |                                   | 40                   | 2.1         | 33.27          | 26.60              |
|             |        |                           |                |                |                |                                   | 50                   |             |                | 26.84              |
| 455         | do     | 6.58-8.23 a. m.           | 42 46          | 50 14          | 1,400          | do                                | 60                   | 1.4         | 33.40          | 27.07              |
|             |        |                           |                |                |                |                                   | 0                    | 3.2         | 33.06          | 26.34              |
|             |        |                           |                |                |                |                                   | 50                   | 1.8         | 33.73          | 27.00              |
|             |        |                           |                |                |                |                                   | 125                  | 2.4         | 34.23          | 27.34              |
|             |        |                           |                |                |                |                                   | 250                  | 3.0         | 34.59          | 27.58              |
|             |        |                           |                |                |                |                                   | 450                  | 3.2         | 34.78          | 27.71              |
|             |        |                           |                |                |                |                                   | 750                  | 3.4         | 34.80          | 27.71              |
| 456         | do     | 10.15-11.30 a. m.         | 42 20          | 50 18          | 2,000          | Calm                              | 0                    | 5.1         | 33.44          | 27.24              |
|             |        |                           |                |                |                |                                   | 50                   | 3.5         | 34.03          | 27.08              |
|             |        |                           |                |                |                |                                   | 125                  | 2.4         | 34.37          | 27.45              |
|             |        |                           |                |                |                |                                   | 250                  | 3.3         | 34.68          | 27.62              |
|             |        |                           |                |                |                |                                   | 450                  | 3.4         | 34.78          | 27.69              |
|             |        |                           |                |                |                |                                   | 750                  | 3.9         | 34.87          | 27.22              |
| 457         | do     | 8.30-9.10 p. m.           | 43 19          | 49 22          | 210            | do                                | 0                    | 3.0         | 33.21          | 26.47              |
|             |        |                           |                |                |                |                                   | 50                   | 0.5         | 33.50          | 26.88              |
|             |        |                           |                |                |                |                                   | 100                  | 0.7         | 33.75          | 27.07              |
|             |        |                           |                |                |                |                                   | 125                  |             |                | 27.20              |
|             |        |                           |                |                |                |                                   | 150                  | 1.2         | 34.01          | 27.26              |
|             |        |                           |                |                |                |                                   | 200                  | 1.4         | 34.11          | 27.32              |
| 458         | May 10 | 11.45 a. m. to 1.15 p. m. | 44 32          | 48 49          | 1,510          | NE. 4                             | 0                    | 5.4         | 33.31          | 26.31              |
|             |        |                           |                |                |                |                                   | 50                   | 1.8         | 33.66          | 26.93              |
|             |        |                           |                |                |                |                                   | 125                  | 1.8         | 34.21          | 27.37              |
|             |        |                           |                |                |                |                                   | 250                  | 3.0         | 34.62          | 27.60              |
|             |        |                           |                |                |                |                                   | 450                  | 3.3         | 34.69          | 27.63              |
|             |        |                           |                |                |                |                                   | 750                  | 3.5         | 34.83          | 27.72              |
| 459         | do     | 7.25-9 p. m.              | 45 18          | 48 42          | 780            | do                                | 0                    | 1.9         | 32.88          | 26.30              |
|             |        |                           |                |                |                |                                   | 50                   | 0.2         | 33.26          | 26.71              |
|             |        |                           |                |                |                |                                   | 125                  | -0.1        | 33.43          | 26.86              |
|             |        |                           |                |                |                |                                   | 250                  | 0.7         | 34.55          | 27.75              |
|             |        |                           |                |                |                |                                   | 450                  | 1.5         | 34.84          | 27.62              |
|             |        |                           |                |                |                |                                   | 750                  | 3.3         | 34.89          | 27.75              |
| 460         | May 11 | 1.20-1.35 p. m.           | 46 35          | 48 44          | 70             | N. 3                              | 0                    | 2.2         | 32.68          | 26.12              |
|             |        |                           |                |                |                |                                   | 20                   | 2.3         | 32.83          | 26.23              |
|             |        |                           |                |                |                |                                   | 40                   | 0.9         | 32.96          | 26.42              |
|             |        |                           |                |                |                |                                   | 50                   |             |                | 26.50              |
|             |        |                           |                |                |                |                                   | 60                   | -0.4        | 33.07          | 26.58              |
| 461         | do     | 7.50-8.30 p. m.           | 47 23          | 48 45          | 125            | NW. 3                             | 0                    | 1.6         | 32.80          | 26.26              |
|             |        |                           |                |                |                |                                   | 30                   | 1.4         | 32.91          | 26.36              |
|             |        |                           |                |                |                |                                   | 50                   |             |                | 26.46              |
|             |        |                           |                |                |                |                                   | 60                   | -0.2        | 33.01          | 26.53              |
|             |        |                           |                |                |                |                                   | 90                   | -1.0        | 33.17          | 26.68              |
|             |        |                           |                |                |                |                                   | 120                  | -1.2        | 33.33          | 26.82              |
|             |        |                           |                |                |                |                                   | 125                  |             |                | 26.86              |
| 462         | May 12 | 6.35-7.15 p. m.           | 47 58          | 49 31          | 212            | N. 3                              | 0                    | 1.5         | 32.94          | 26.38              |
|             |        |                           |                |                |                |                                   | 50                   | 0.6         | 33.01          | 26.49              |
|             |        |                           |                |                |                |                                   | 100                  | -1.0        | 33.34          | 26.82              |
|             |        |                           |                |                |                |                                   | 125                  |             |                | 26.99              |
|             |        |                           |                |                |                |                                   | 150                  | 0.9         | 33.88          | 27.16              |
|             |        |                           |                |                |                |                                   | 200                  | 1.7         | 34.25          | 27.42              |
| 463         | May 13 | 7.27-9.40 p. m.           | 48 33          | 50 50          | 175            | SSW. 4                            | 0                    | 2.0         | 32.91          | 26.32              |
|             |        |                           |                |                |                |                                   | 40                   | 1.2         | 33.10          | 26.52              |
|             |        |                           |                |                |                |                                   | 50                   |             |                | 26.61              |
|             |        |                           |                |                |                |                                   | 80                   | 0.1         | 33.02          | 26.76              |
|             |        |                           |                |                |                |                                   | 120                  | -1.1        | 33.38          | 26.86              |
|             |        |                           |                |                |                |                                   | 125                  |             |                | 26.88              |
|             |        |                           |                |                |                |                                   | 168                  | 0.3         | 33.60          | 29.89              |

<sup>1</sup>Error.<sup>2</sup>Interpolated.<sup>3</sup>Extrapolated.<sup>4</sup>Missing.

Table of data concerning scientific stations occupied during 1924—Continued

| Section No. | Date           | Time of day       | Position       |                | Depth of water | Wind direction and force Beaufort | Water, physical data |             |                 |            |
|-------------|----------------|-------------------|----------------|----------------|----------------|-----------------------------------|----------------------|-------------|-----------------|------------|
|             |                |                   | Latitude north | Longitude west |                |                                   | At depth             | Temperature | Salinity        | Density at |
| 464         | 1924<br>May 15 | 10.10-10.39 a. m. | 48 17          | 52 16          | Meters<br>160  | NW. 3                             | Meters               | ° C.        | 0/100 by weight |            |
|             |                |                   |                |                |                |                                   | 0                    | 2.7         | 32.04           | 25.57      |
|             |                |                   |                |                |                |                                   | 50                   | -0.4        | 32.68           | 26.27      |
|             |                |                   |                |                |                |                                   | 100                  | -1.0        | 32.68           | 26.38      |
|             |                |                   |                |                |                |                                   | 125                  | -1.2        | 32.99           | 26.54      |
| 465         | do             | 2.44-3.08 p. m.   | 47 27          | 52 02          | 160            | SW. 1                             | 150                  | -1.3        | 33.34           | 26.83      |
|             |                |                   |                |                |                |                                   | 0                    | 4.5         | 32.51           | 25.77      |
|             |                |                   |                |                |                |                                   | 50                   | 2.0         | 32.84           | 26.26      |
|             |                |                   |                |                |                |                                   | 100                  | 0.0         | 32.70           | 26.27      |
|             |                |                   |                |                |                |                                   | 125                  | -1.2        | 32.87           | 26.45      |
| 466         | do             | 7.32-8 p. m.      | 47 50          | 51 03          | 150            | SSW. 1                            | 0                    | 2.5         | 32.93           | 26.30      |
|             |                |                   |                |                |                |                                   | 50                   | 1.4         | 32.93           | 26.37      |
|             |                |                   |                |                |                |                                   | 100                  | -0.5        | 32.84           | 26.40      |
|             |                |                   |                |                |                |                                   | 125                  |             |                 | 26.44      |
|             |                |                   |                |                |                |                                   | 140                  | -1.0        | 32.92           | 26.48      |
| 467         | May 16         | 7.10-7.25 p. m.   | 46 14          | 50 10          | 170            | W. 2                              | 0                    | 3.8         | 32.81           | 26.09      |
|             |                |                   |                |                |                |                                   | 30                   | 2.7         | 32.90           | 26.25      |
|             |                |                   |                |                |                |                                   | 50                   |             |                 | 26.34      |
|             |                |                   |                |                |                |                                   | 60                   | 1.1         | 32.93           | 26.39      |
|             |                |                   |                |                |                |                                   | 0                    | 3.1         | 33.03           | 26.32      |
| 468         | May 26         | 4-4.47 p. m.      | 49 35          | 52 21          | 340            | S. 3                              | 50                   | 1.8         | 33.05           | 26.42      |
|             |                |                   |                |                |                |                                   | 125                  | 10.8        | 33.10           | 26.55      |
|             |                |                   |                |                |                |                                   | 250                  | 2.1         | 33.32           | 26.65      |
|             |                |                   |                |                |                |                                   | 325                  | 2.9         | 33.67           | 26.85      |
|             |                |                   |                |                |                |                                   | 0                    | 2.0         | 32.78           | 26.21      |
| 469         | do             | 10-10.45 p. m.    | 50 19          | 52 41          | 310            | S. 2                              | 50                   | -0.2        | 33.09           | 26.60      |
|             |                |                   |                |                |                |                                   | 100                  | -0.6        | 33.51           | 26.95      |
|             |                |                   |                |                |                |                                   | 125                  |             |                 | 27.00      |
|             |                |                   |                |                |                |                                   | 200                  | 1.6         | 34.21           | 27.39      |
|             |                |                   |                |                |                |                                   | 250                  | 2.0         | 34.38           | 27.50      |
| 470         | May 27         | 3.25-4.20 a. m.   | 50 52          | 53 26          | 330            | WNW. 3                            | 300                  | 2.6         | 34.47           | 27.52      |
|             |                |                   |                |                |                |                                   | 0                    | 0.5         | 32.38           | 25.99      |
|             |                |                   |                |                |                |                                   | 50                   | 1.2         | 32.93           | 26.38      |
|             |                |                   |                |                |                |                                   | 125                  | -0.8        | 33.41           | 26.87      |
|             |                |                   |                |                |                |                                   | 250                  | 1.6         | 34.14           | 27.33      |
| 471         | do             | 9-9.40 a. m.      | 51 27          | 54 10          | 220            | NW. 3                             | 325                  | 2.6         | 34.52           | 27.55      |
|             |                |                   |                |                |                |                                   | 0                    | 0.6         | 31.97           | 25.65      |
|             |                |                   |                |                |                |                                   | 50                   | -0.2        | 32.75           | 26.32      |
|             |                |                   |                |                |                |                                   | 100                  | -0.1        | 32.88           | 26.42      |
|             |                |                   |                |                |                |                                   | 125                  |             |                 | 26.55      |
| 472         | May 29         | 12.15-12.45 p. m. | 50 01          | 53 40          | 150            | SSE. 3                            | 150                  | -0.9        | 33.30           | 26.78      |
|             |                |                   |                |                |                |                                   | 200                  | 2.0         | 34.35           | 27.47      |
|             |                |                   |                |                |                |                                   | 0                    | 4.0         | 32.61           | 25.95      |
|             |                |                   |                |                |                |                                   | 50                   | -1.0        | 32.85           | 26.42      |
|             |                |                   |                |                |                |                                   | 100                  | -1.3        | 33.07           | 26.60      |
| 473         | June 7         | 5-6.10 p. m.      | 49 20          | 53 07          | 387            | E. 1                              | 125                  |             |                 | 26.60      |
|             |                |                   |                |                |                |                                   | 140                  | -1.5        | 33.05           | 26.60      |
|             |                |                   |                |                |                |                                   | 0                    | 5.1         | 31.84           | 25.18      |
|             |                |                   |                |                |                |                                   | 50                   | 0.2         | 32.72           | 26.28      |
|             |                |                   |                |                |                |                                   | 125                  | -1.1        | 32.93           | 26.40      |
| 474         | June 12        | 5-5.30 p. m.      | 46 53          | 51 43          | 120            | NW. 1                             | 250                  | -1.3        | 33.04           | 26.59      |
|             |                |                   |                |                |                |                                   | 370                  | -1.0        | 33.26           | 26.76      |
|             |                |                   |                |                |                |                                   | 0                    | 5.0         | 32.80           | 25.95      |
|             |                |                   |                |                |                |                                   | 25                   | 4.4         | 32.82           | 26.03      |
|             |                |                   |                |                |                |                                   | 50                   |             |                 | 26.38      |
| 475         | June 25        | 3.30-4.10 a. m.   | 46 40          | 52 45          | 160            | SW. 4                             | 75                   | 0.0         | 33.09           | 26.58      |
|             |                |                   |                |                |                |                                   | 115                  | 0.0         | 33.52           | 26.98      |
|             |                |                   |                |                |                |                                   | 125                  |             |                 | 27.01      |
|             |                |                   |                |                |                |                                   | 0                    | 6.4         | 33.05           | 25.98      |
|             |                |                   |                |                |                |                                   | 25                   | 1.6         | 32.86           | 26.30      |
| 476         | do             | 6.10-6.48 a. m.   | 46 23          | 52 53          | 160            | SW. 4                             | 50                   | 1.6         | 32.90           | 26.34      |
|             |                |                   |                |                |                |                                   | 100                  | -0.2        | 32.99           | 26.51      |
|             |                |                   |                |                |                |                                   | 125                  |             |                 | 26.56      |
|             |                |                   |                |                |                |                                   | 150                  | -1.2        | 33.05           | 26.60      |
|             |                |                   |                |                |                |                                   | 0                    | 7.6         | 31.97           | 24.97      |
| 477         | do             | 9.15-9.50 a. m.   | 46 06          | 52 59          | 140            | SSW. 6                            | 25                   | 2.9         | 32.67           | 26.05      |
|             |                |                   |                |                |                |                                   | 50                   | -0.3        | 32.77           | 26.34      |
|             |                |                   |                |                |                |                                   | 100                  | -1.0        | 32.89           | 26.45      |
|             |                |                   |                |                |                |                                   | 125                  |             |                 | 26.50      |
|             |                |                   |                |                |                |                                   | 150                  | -1.2        | 33.07           | 26.61      |
|             |                |                   |                |                |                |                                   | 0                    | 8.1         | 32.08           | 24.99      |
|             |                |                   |                |                |                |                                   | 25                   | 7.2         | 32.18           | 25.19      |
|             |                |                   |                |                |                |                                   | 50                   | 0.7         | 32.92           | 26.41      |
|             |                |                   |                |                |                |                                   | 100                  | 0.0         | 33.11           | 26.66      |
|             |                |                   |                |                |                |                                   | 125                  |             |                 | 26.75      |
|             |                |                   |                |                |                |                                   | 130                  | -0.1        | 33.32           | 26.78      |

<sup>1</sup> Error.<sup>2</sup> Interpolated.

Table of data concerning scientific stations occupied during 1924—Continued

| Section No. | Date            | Time of day                   | Position       |                | Depth of water | Wind direction and force Beaufort | Water, physical data |             |                 |                    |
|-------------|-----------------|-------------------------------|----------------|----------------|----------------|-----------------------------------|----------------------|-------------|-----------------|--------------------|
|             |                 |                               | Latitude north | Longitude west |                |                                   | At depth             | Temperature | Salinity        | Density $\sigma_t$ |
| 478         | 1924<br>June 25 | 2.10-2.25 p. m.---            | 45 37          | 53 11          | Meters<br>75   | SSW. 5.---                        | Meters               | ° C.        | 0/100 by weight |                    |
|             |                 |                               |                |                |                |                                   | 0                    | 8.4         | 32.57           | 25.33              |
|             |                 |                               |                |                |                |                                   | 20                   | 8.7         | 32.63           | 25.33              |
|             |                 |                               |                |                |                |                                   | 40                   | 3.2         | 32.89           | 26.20              |
|             |                 |                               |                |                |                |                                   | 50                   |             |                 | 26.36              |
| 479         | ...do....       | 8.05-8.30 p. m.---            | 45 06          | 53 23          | 75             | SW. 5.---                         | 65                   | 0.2         | 33.10           | 26.58              |
|             |                 |                               |                |                |                |                                   | 0                    | 8.9         | 32.58           | 25.26              |
|             |                 |                               |                |                |                |                                   | 20                   | 8.7         | 32.86           | 25.51              |
|             |                 |                               |                |                |                |                                   | 40                   | 1.5         | 32.99           | 26.42              |
|             |                 |                               |                |                |                |                                   | 50                   |             |                 | 26.51              |
| 480         | June 26         | 12.40-1.05 a. m.---           | 44 52          | 52 48          | 70             | SSW. 4.---                        | 65                   | 1.0         | 33.08           | 26.52              |
|             |                 |                               |                |                |                |                                   | 0                    | 9.1         | 32.62           | 25.26              |
|             |                 |                               |                |                |                |                                   | 20                   | 8.1         | 32.69           | 25.47              |
|             |                 |                               |                |                |                |                                   | 40                   | 2.1         | 32.90           | 26.30              |
|             |                 |                               |                |                |                |                                   | 50                   |             |                 | 26.47              |
| 481         | ...do....       | 8.10-8.40 a. m.---            | 44 36          | 52 10          | 72             | SSW. 3.---                        | 60                   | 0.7         | 33.05           | 26.51              |
|             |                 |                               |                |                |                |                                   | 0                    | 9.4         | 32.57           | 25.17              |
|             |                 |                               |                |                |                |                                   | 20                   | 9.2         | 32.58           | 25.21              |
|             |                 |                               |                |                |                |                                   | 40                   | 5.8         | 32.68           | 25.76              |
|             |                 |                               |                |                |                |                                   | 50                   |             |                 | 26.05              |
| 482         | ...do....       | 2.25-3.10 p. m.---            | 44 16          | 51 21          | 70             | SSW. 6.---                        | 60                   | 3.9         | 32.94           | 26.18              |
|             |                 |                               |                |                |                |                                   | 0                    | 9.9         | 32.54           | 25.07              |
|             |                 |                               |                |                |                |                                   | 20                   | 9.4         | 32.54           | 25.15              |
|             |                 |                               |                |                |                |                                   | 40                   | 6.4         | 32.54           | 25.58              |
|             |                 |                               |                |                |                |                                   | 50                   |             |                 | 26.00              |
| 483         | ...do....       | 6.30-6.55 p. m.---            | 44 43          | 51 07          | 60             | SSW. 5.---                        | 60                   | 2.4         | 32.92           | 26.30              |
|             |                 |                               |                |                |                |                                   | 0                    | 8.4         | 32.72           | 25.45              |
|             |                 |                               |                |                |                |                                   | 20                   | 8.0         | 32.68           | 25.45              |
|             |                 |                               |                |                |                |                                   | 35                   | 6.2         | 32.68           | 25.72              |
|             |                 |                               |                |                |                |                                   | 50                   | 2.3         | 32.93           | 26.32              |
| 484         | ...do....       | 11.45 p. m. to<br>12.15 a. m. | 44 58          | 51 55          | 60             | NW. 3.---                         | 0                    | 8.9         | 32.30           | 25.04              |
|             |                 |                               |                |                |                |                                   | 20                   | 8.8         | 32.51           | 25.22              |
|             |                 |                               |                |                |                |                                   | 35                   | 6.6         | 32.65           | 25.64              |
|             |                 |                               |                |                |                |                                   | 50                   | 1.3         | 33.09           | 26.50              |
|             |                 |                               |                |                |                |                                   | 50                   |             |                 | 26.50              |
| 485         | June 27         | 4-4.25 a. m.---               | 45 20          | 51 22          | 68             | NNW. 1.---                        | 0                    | 8.4         | 32.55           | 25.31              |
|             |                 |                               |                |                |                |                                   | 20                   | 8.2         | 32.58           | 25.36              |
|             |                 |                               |                |                |                |                                   | 40                   | 4.8         | 32.64           | 25.85              |
|             |                 |                               |                |                |                |                                   | 50                   |             |                 | 26.15              |
|             |                 |                               |                |                |                |                                   | 60                   | 0.8         | 32.77           | 26.25              |
| 486         | ...do....       | 8.25-8.40 a. m.---            | 45 10          | 50 37          | 57             | ESE. 1.---                        | 0                    | 7.9         | 32.47           | 25.32              |
|             |                 |                               |                |                |                |                                   | 25                   | 7.5         | 32.63           | 25.50              |
|             |                 |                               |                |                |                |                                   | 50                   | 1.7         | 32.99           | 26.40              |
|             |                 |                               |                |                |                |                                   | 0                    | 7.9         | 32.64           | 25.46              |
|             |                 |                               |                |                |                |                                   | 25                   | 8.0         | 32.67           | 25.46              |
| 487         | ...do....       | 11.40-11.55 a. m.---          | 45 08          | 50 02          | 52             | ...do....                         | 45                   | 2.3         | 32.82           | 26.23              |
|             |                 |                               |                |                |                |                                   | 50                   |             |                 | 26.40              |
|             |                 |                               |                |                |                |                                   | 0                    | 9.4         | 32.58           | 25.15              |
|             |                 |                               |                |                |                |                                   | 25                   | 8.3         | 32.68           | 25.43              |
|             |                 |                               |                |                |                |                                   | 45                   | 3.3         | 32.93           | 26.23              |
| 488         | ...do....       | 2.30-2.45 p. m.---            | 44 45          | 50 07          | 50             | ESE. 1.---                        | 50                   |             |                 | 26.40              |
|             |                 |                               |                |                |                |                                   | 0                    | 9.4         | 32.58           | 25.15              |
|             |                 |                               |                |                |                |                                   | 25                   | 8.3         | 32.68           | 25.43              |
|             |                 |                               |                |                |                |                                   | 45                   | 3.3         | 32.93           | 26.23              |
|             |                 |                               |                |                |                |                                   | 50                   |             |                 | 26.40              |
| 489         | ...do....       | 7-7.15 p. m.---               | 44 16          | 50 10          | 51             | NW. 1.---                         | 0                    | 10.9        | 32.41           | 24.80              |
|             |                 |                               |                |                |                |                                   | 25                   | 9.0         | 32.51           | 25.19              |
|             |                 |                               |                |                |                |                                   | 45                   | 4.1         | 32.74           | 26.00              |
|             |                 |                               |                |                |                |                                   | 50                   |             |                 | 26.25              |
|             |                 |                               |                |                |                |                                   | 50                   |             |                 | 26.25              |
| 490         | ...do....       | 11.25-11.45 p. m.---          | 43 40          | 50 16          | 55             | WSW. 2.---                        | 0                    | 10.4        | 32.16           | 24.69              |
|             |                 |                               |                |                |                |                                   | 25                   | 9.8         | 32.42           | 24.99              |
|             |                 |                               |                |                |                |                                   | 50                   | 4.7         | 32.77           | 25.96              |
|             |                 |                               |                |                |                |                                   | 0                    | 8.9         | 32.49           | 25.19              |
|             |                 |                               |                |                |                |                                   | 25                   | 6.2         | 32.65           | 25.72              |
| 491         | June 28         | 1.50-2.10 a. m.---            | 43 32          | 49 54          | 57             | Calm.---                          | 0                    | 8.9         | 32.49           | 25.19              |
|             |                 |                               |                |                |                |                                   | 25                   | 6.2         | 32.65           | 25.72              |
|             |                 |                               |                |                |                |                                   | 50                   | 2.7         | 33.04           | 26.37              |
|             |                 |                               |                |                |                |                                   | 0                    | 6.9         | 32.80           | 25.72              |
|             |                 |                               |                |                |                |                                   | 25                   | 5.5         | 32.51           | 25.72              |
| 492         | ...do....       | 4.23-4.40 a. m.---            | 42 23          | 49 31          | 56             | ...do....                         | 50                   | 1.2         | 33.24           | 26.63              |
|             |                 |                               |                |                |                |                                   | 0                    | 5.0         | 32.95           | 26.07              |
|             |                 |                               |                |                |                |                                   | 25                   | 1.2         | 33.36           | 26.45              |
|             |                 |                               |                |                |                |                                   | 50                   | 1.2         | 33.36           | 26.45              |
|             |                 |                               |                |                |                |                                   | 100                  | 1.1         | 33.91           | 27.17              |
| 493         | ...do....       | 9.10-10.05 a. m.---           | 42 51          | 50 00          | 239            | ENE. 2.---                        | 125                  |             |                 | 27.24              |
|             |                 |                               |                |                |                |                                   | 150                  | 1.6         | 34.04           | 27.27              |
|             |                 |                               |                |                |                |                                   | 200                  | 1.8         | 34.12           | 27.30              |
|             |                 |                               |                |                |                |                                   | 225                  | 1.9         | 34.15           | 27.32              |
|             |                 |                               |                |                |                |                                   | 0                    | 8.9         | 32.69           | 25.35              |
| 494         | ...do....       | 3.15-3.30 p. m.---            | 43 08          | 51 00          | 130            | SE. 2.---                         | 50                   | 2.0         | 33.21           | 25.56              |
|             |                 |                               |                |                |                |                                   | 100                  | 0.5         | 33.60           | 26.97              |
|             |                 |                               |                |                |                |                                   | 125                  | 0.7         | 33.75           | 27.07              |
|             |                 |                               |                |                |                |                                   | 0                    | 8.9         | 32.69           | 25.35              |
|             |                 |                               |                |                |                |                                   | 50                   | 2.0         | 33.21           | 25.56              |

<sup>1</sup> Error.<sup>2</sup> Interpolated<sup>3</sup> Extrapolated.

Table of data concerning scientific stations occupied during 1924—Continued

| Section No. | Date            | Time of day          | Position       |                | Depth of water | Wind direction and force Beaufort | Water, physical data |             |                    |                    |
|-------------|-----------------|----------------------|----------------|----------------|----------------|-----------------------------------|----------------------|-------------|--------------------|--------------------|
|             |                 |                      | Latitude north | Longitude west |                |                                   | At depth             | Temperature | Salinity           | Density $\sigma_t$ |
| 495         | 1924<br>June 2s | 5.36-6.55 p. m.---   | 43 28          | 51 33          | 120            | NE. 1-----                        | Meters               | ° C.        | 0/100 by weight    | Density $\sigma_t$ |
|             |                 |                      |                |                |                |                                   | 0                    | 7.4         | 32.83              |                    |
|             |                 |                      |                |                |                |                                   | 35                   | 3.2         | 33.06              |                    |
|             |                 |                      |                |                |                |                                   | 50                   |             |                    |                    |
|             |                 |                      |                |                |                |                                   | 75                   | 0.0         | <sup>4</sup> 33.42 |                    |
| 496         | ---do-----      | 10.10-11.15 p. m.--- | 43 18          | 52 03          | 1,006          | SE. 2-----                        | 110                  | 0.5         | 33.66              | Density $\sigma_t$ |
|             |                 |                      |                |                |                |                                   | 0                    | 11.7        | 32.81              |                    |
|             |                 |                      |                |                |                |                                   | 50                   | 7.2         | 33.20              |                    |
|             |                 |                      |                |                |                |                                   | 125                  | 4.8         | 33.75              |                    |
|             |                 |                      |                |                |                |                                   | 250                  | 3.4         | 34.25              |                    |
| 497         | June 29         | 2.20-3.25 a. m.---   | 43 07          | 52 35          | 2,470          | SE. 6-----                        | 450                  | 3.2         | 34.59              | Density $\sigma_t$ |
|             |                 |                      |                |                |                |                                   | 750                  | 3.3         | 34.81              |                    |
|             |                 |                      |                |                |                |                                   | 0                    | 11.9        | 32.59              |                    |
|             |                 |                      |                |                |                |                                   | 50                   | 6.4         | 33.20              |                    |
|             |                 |                      |                |                |                |                                   | 125                  | 3.8         | 33.88              |                    |
|             | 250             | <sup>1</sup> 3.8     | 34.51          | 27.43          |                |                                   |                      |             |                    |                    |
|             | 450             | 5.1                  | 35.00          |                | 27.68          |                                   |                      |             |                    |                    |

<sup>1</sup> Interpolated.<sup>4</sup> Missing.

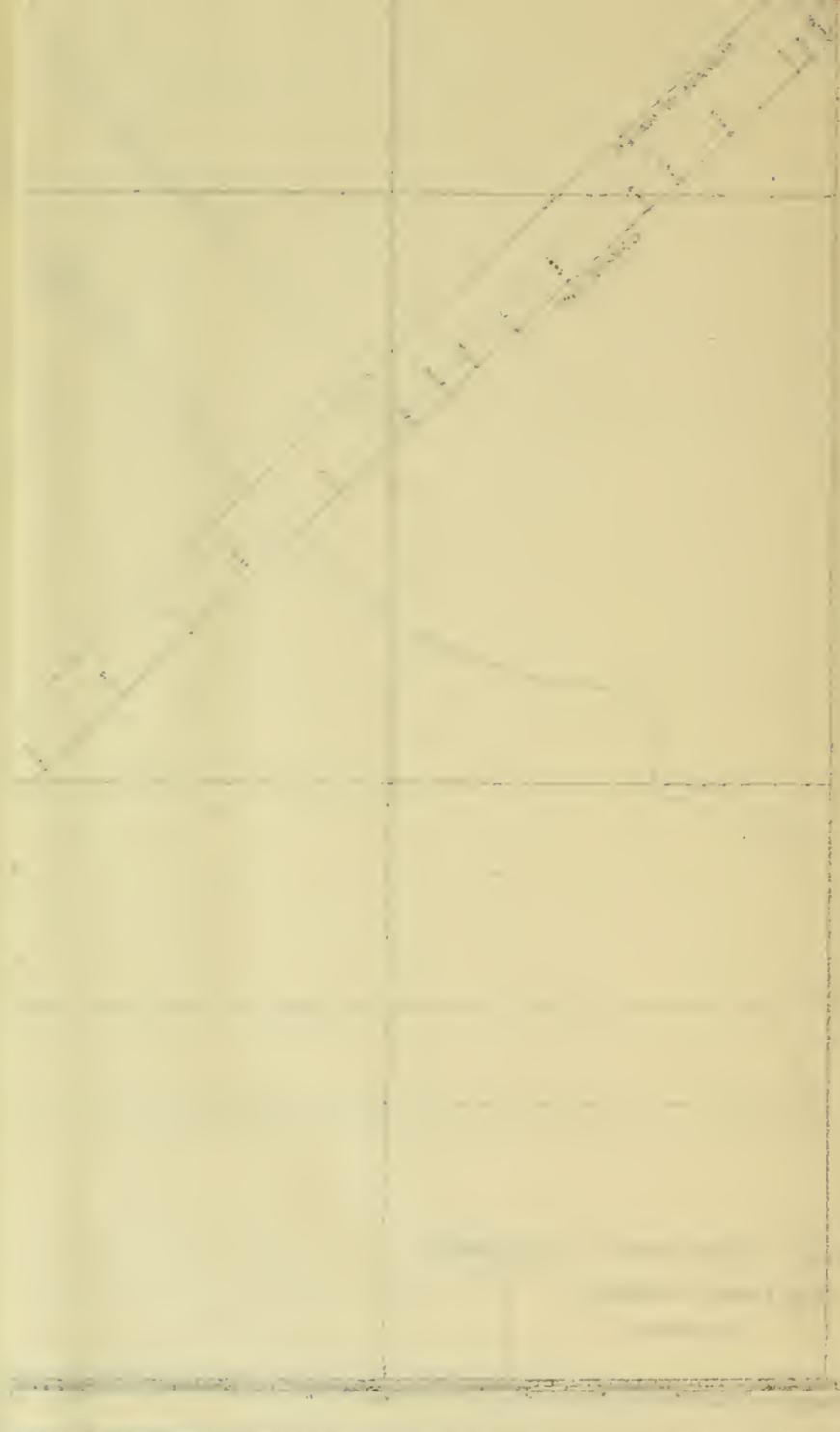




.....







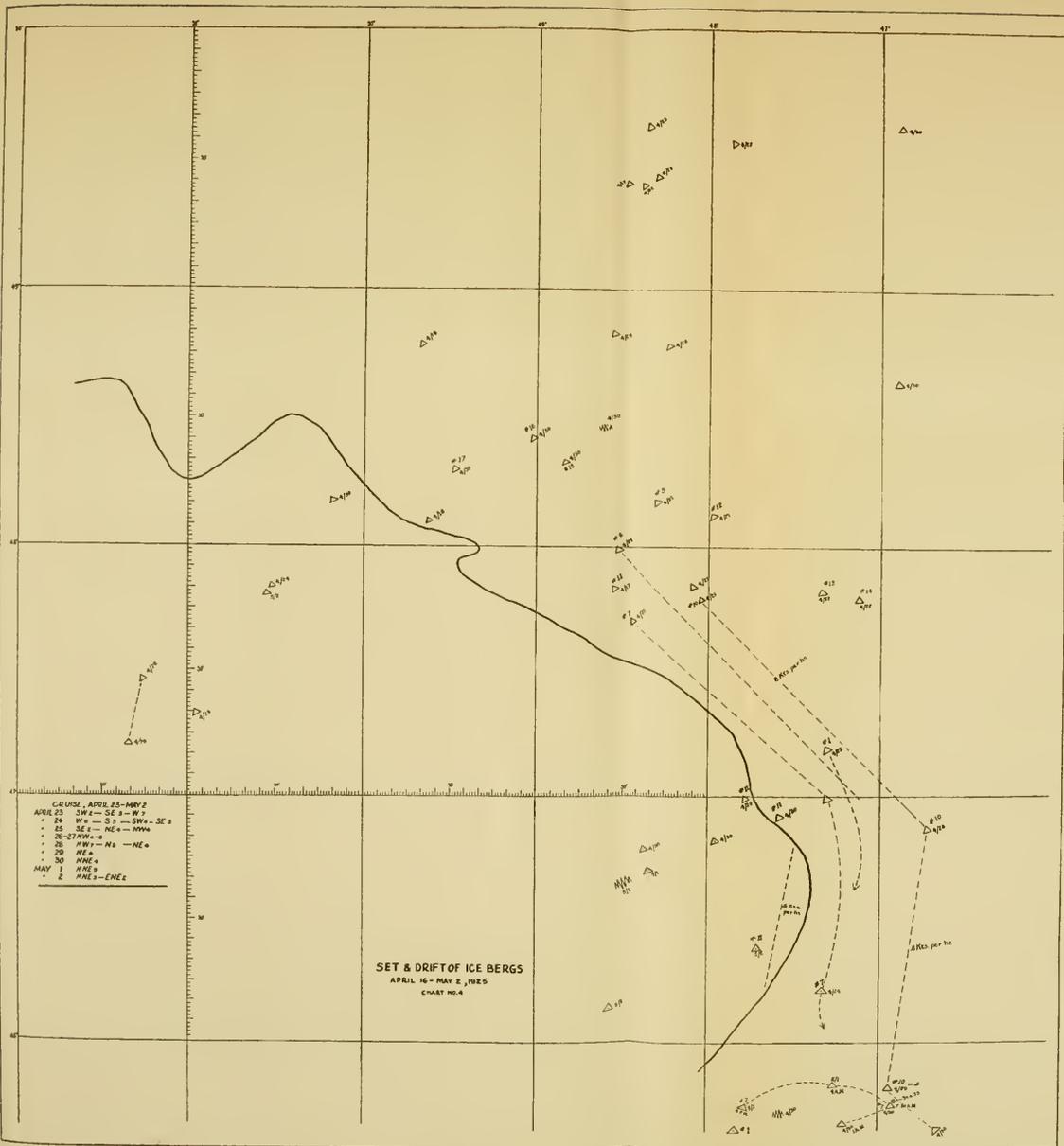


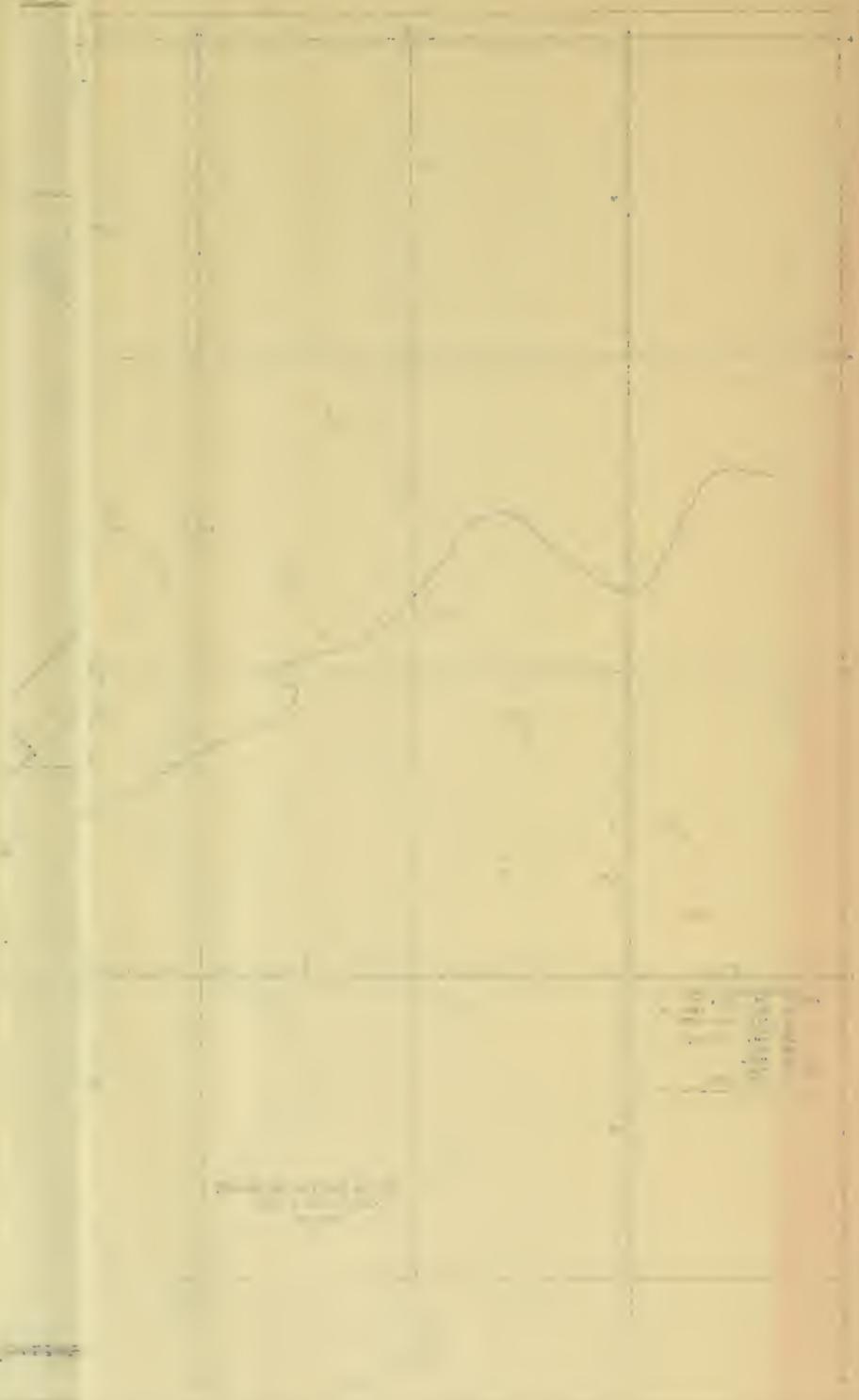


- 1. Sandstone
- 2. Shale
- 3. Limestone
- 4. Gypsum
- 5. Clay
- 6. Coal
- 7. Iron ore
- 8. Lead ore
- 9. Zinc ore
- 10. Copper ore
- 11. Silver ore
- 12. Gold ore
- 13. Platinum ore
- 14. Nickel ore
- 15. Cobalt ore
- 16. Arsenic ore
- 17. Antimony ore
- 18. Bismuth ore
- 19. Vanadium ore
- 20. Uranium ore

Scale 1:1000

Geological Survey of India

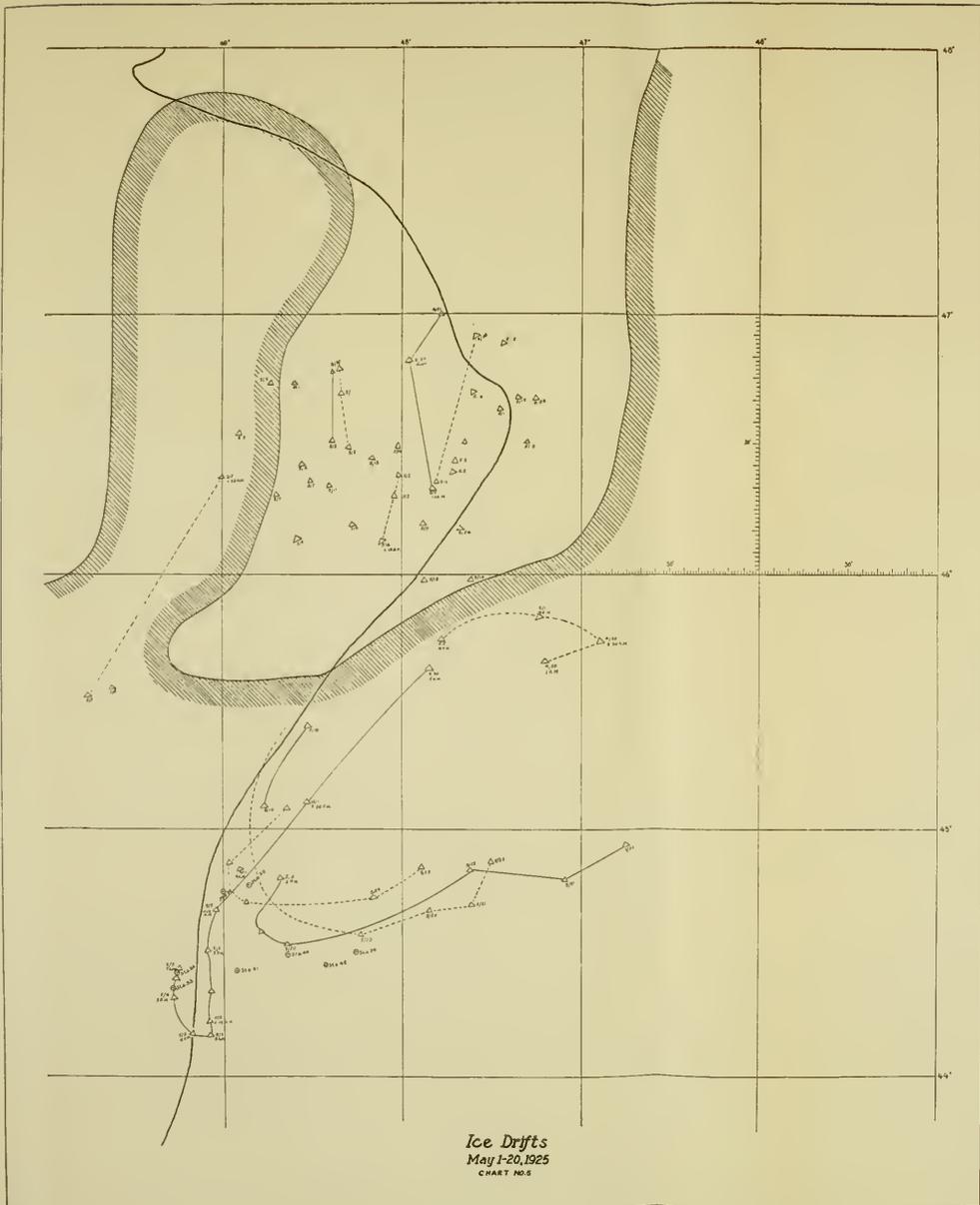




1890  
J. H. [unclear]  
[unclear]

[unclear]

1890

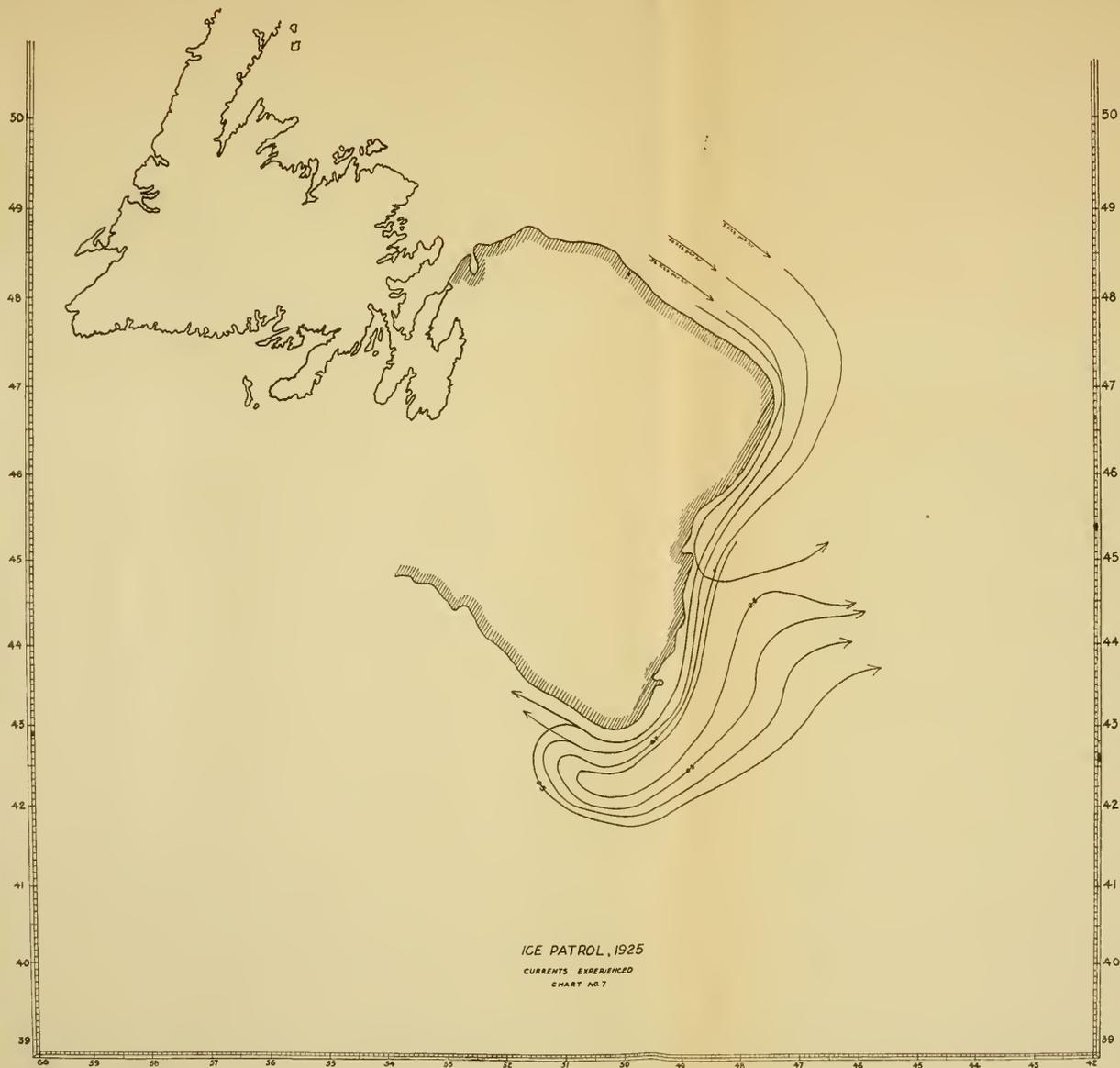




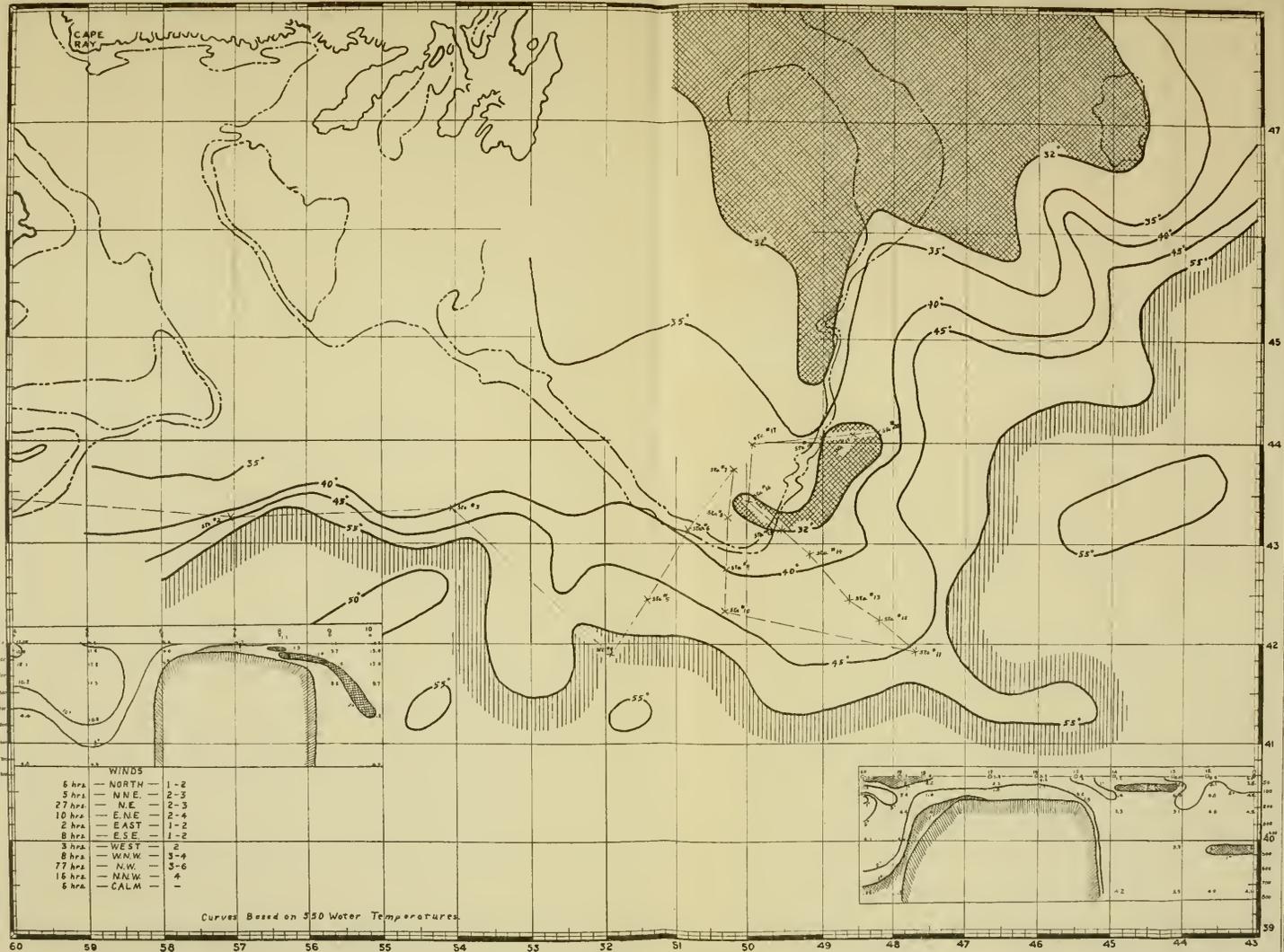
TAIL OF GRAND BANKS

SET & DRIFT OF ICE BERGS  
OBSERVED BY MODC AND TAMPA  
1925  
MAY 19 - JUNE 30  
CHART 6









▲ - BERGS.  
 ○ - GROWLERS.  
 NW - FIELD ICE.  
 Arctic Water  
 Warm Atlantic Water

GENERAL CHART  
 COVERING  
 ICE PATROL  
 MARCH 25 - APRIL 1, 1925.  
 GRAND BANKS

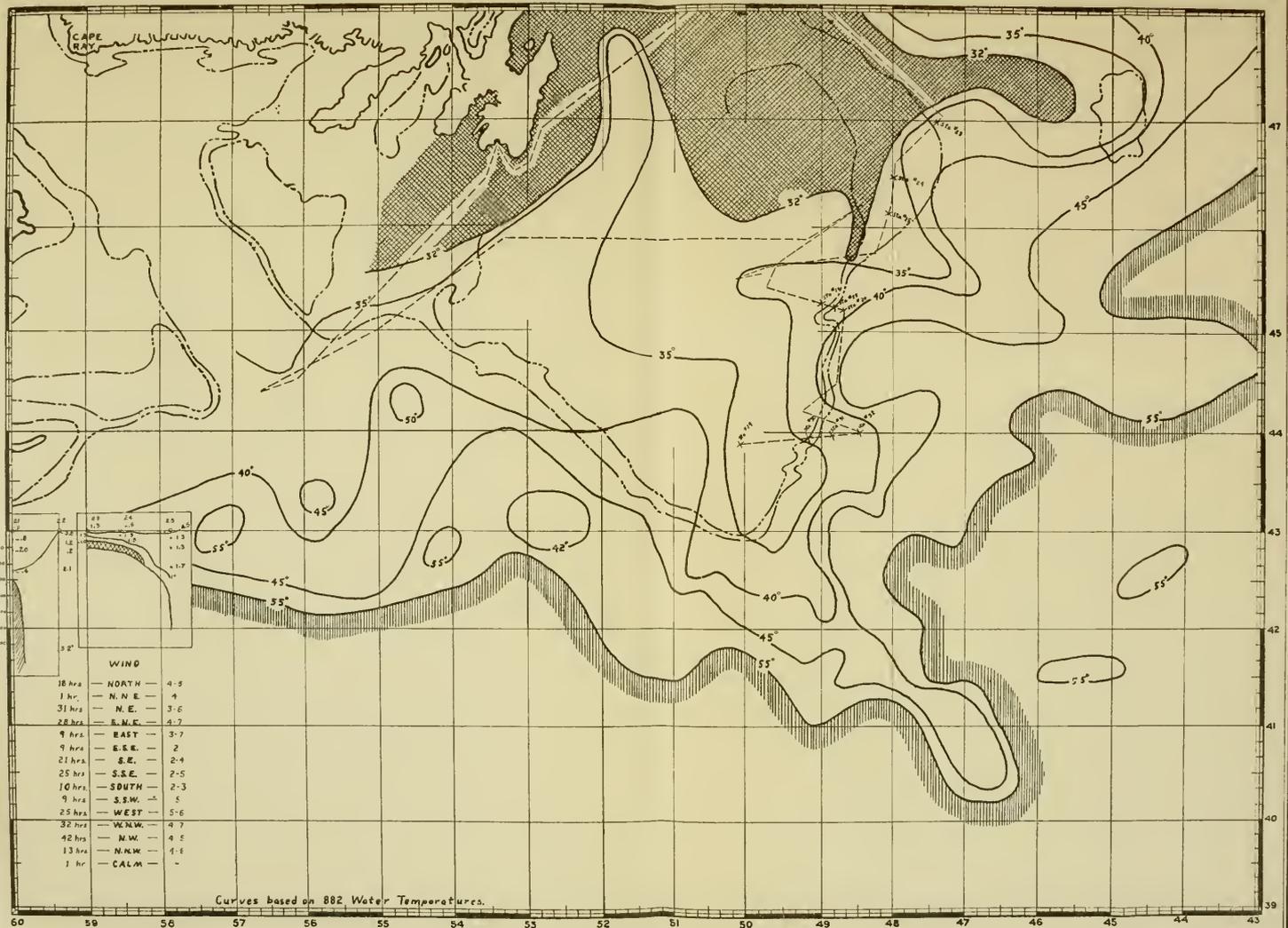
CHART NO. 8

WEATHER CONDITIONS  
 CLEAR - - - - 42 %  
 PARTLY CLOUDY - 14 %  
 OVERCAST - - - 81 %  
 RAIN - - - - - 0.6 %  
 FOG - - - - - 22.6 %  
 HAZE & MIST - 24.1 %



10  
 11  
 12

13  
 14  
 15  
 16  
 17  
 18  
 19  
 20  
 21  
 22  
 23  
 24  
 25  
 26  
 27  
 28  
 29  
 30  
 31  
 32  
 33  
 34  
 35  
 36  
 37  
 38  
 39  
 40  
 41  
 42  
 43  
 44  
 45  
 46  
 47  
 48  
 49  
 50



△ - BERGS.  
 ○ - GROWLERS.  
 ■ - FIELD ICE.  
 ■ - WARM ATLANTIC WATER  
 ■ - ARCTIC WATER

GENERAL CHART  
 COVERING  
 ICE PATROL  
 APRIL 1-15, 1925.  
 GRAND BANKS

WEATHER CONDITIONS  
 B ----- 9.6 %  
 BC ----- 35.0 %  
 OC ----- 51.0 %  
 FOG ----- 54.0 %  
 HAZE ----- 0.6 %  
 RAIN ----- 3.6 %

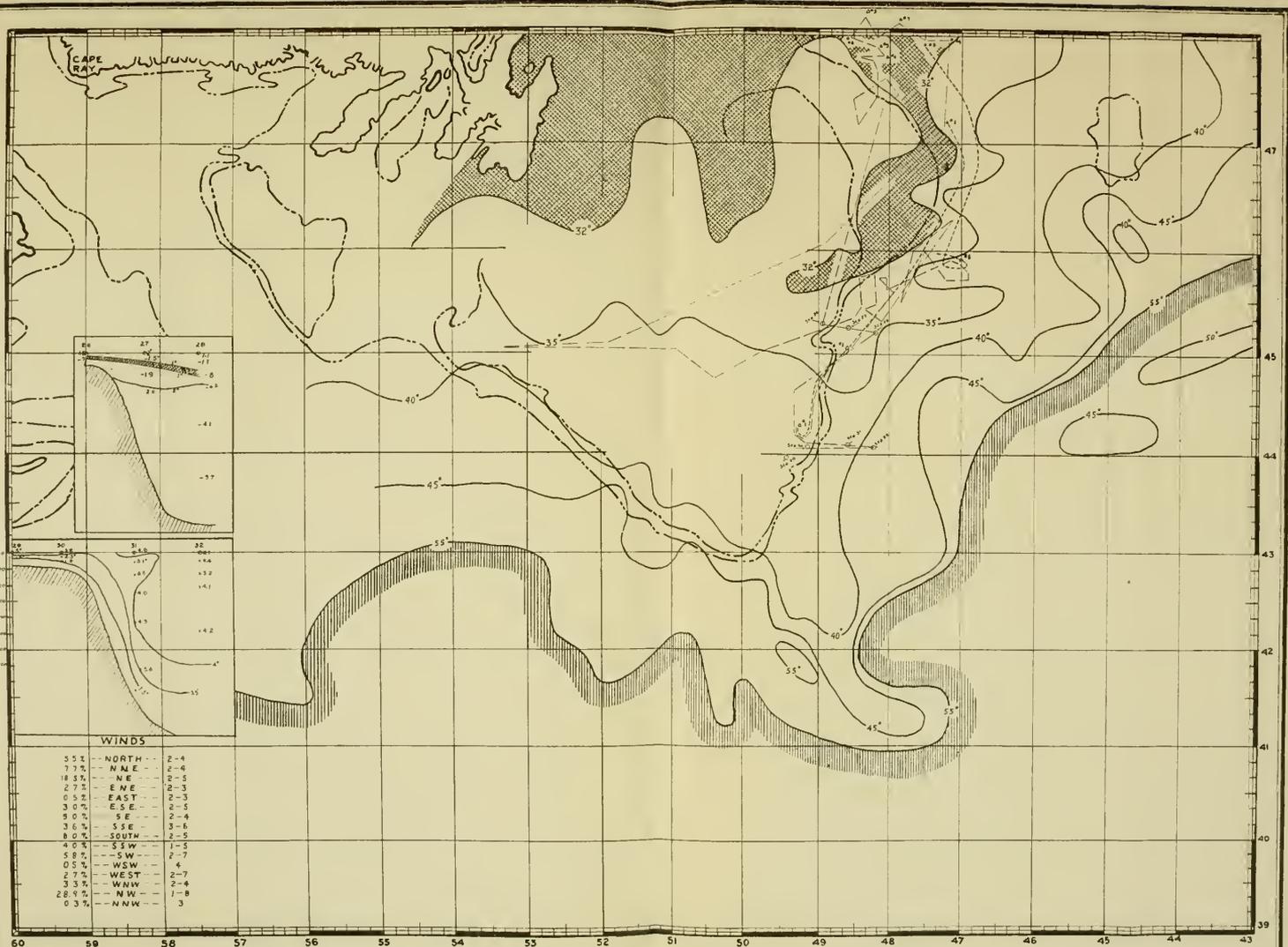
CHART NO. 9



1000000  
1000000  
1000000

1000000  
1000000  
1000000

1000000  
1000000  
1000000



▲ - BERGS.  
 ○ - GROWLERS.  
 ◊ - FIELD ICE.  
 ARCTIC WATER  
 WARM ATLANTIC WATER

GENERAL CHART  
 COVERING  
**ICE PATROL**  
 APRIL 15-30, 1925.  
**GRAND BANKS**

**WEATHER CONDITIONS**  
 CLEAR --- 05%  
 CLOUDY --- 42%  
 OVERCAST --- 57%  
 RAIN --- 10%  
 FOG & HAZE 44%

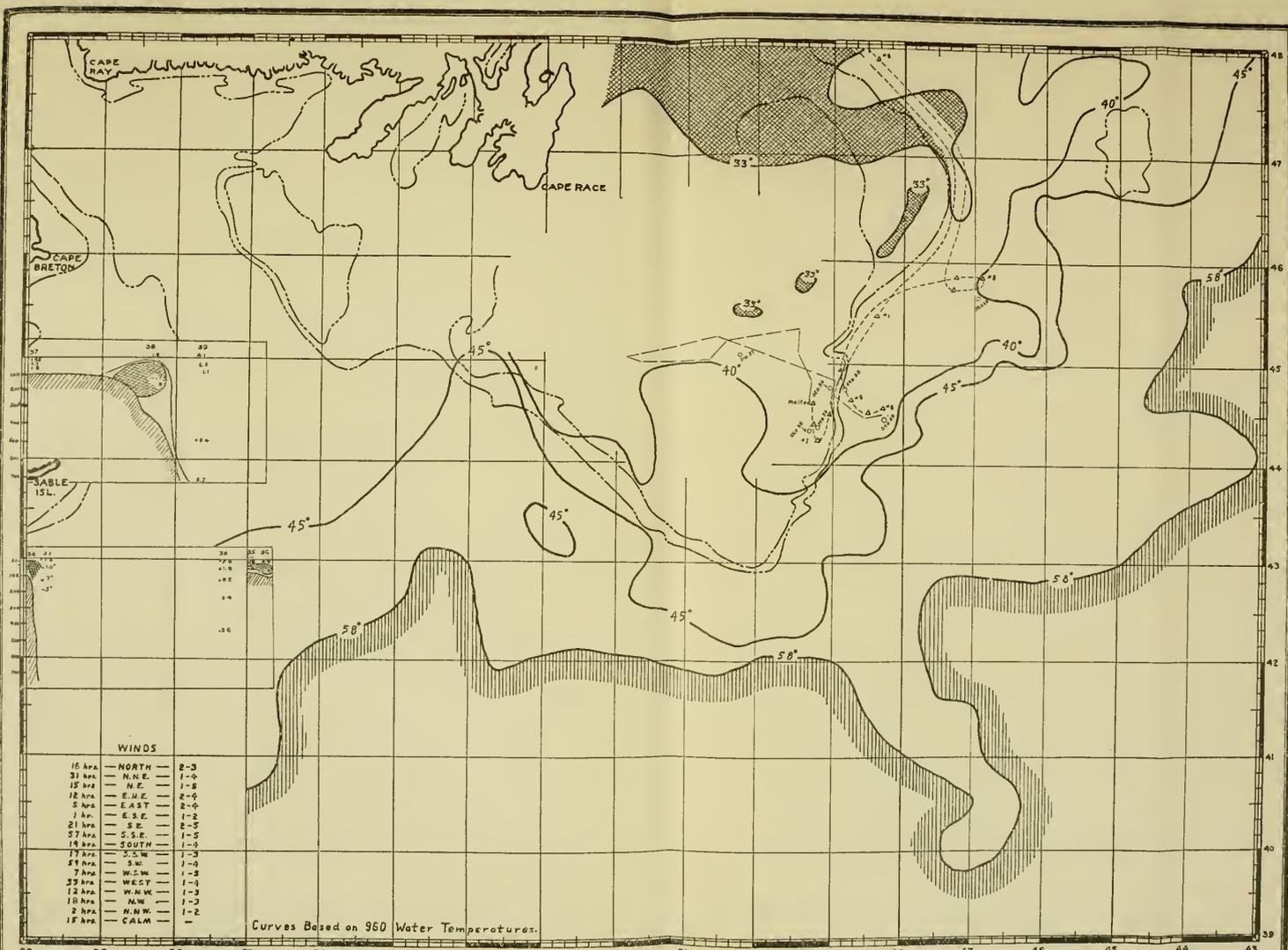
CHART NO. 10



FIELD NO. 111

1911  
111  
111

111  
111  
111



WINDS

|         |        |     |
|---------|--------|-----|
| 16 Apr. | NORTH  | 2-3 |
| 31 Apr. | N.N.E. | 1-0 |
| 15 Apr. | N.E.   | 1-8 |
| 12 Apr. | E.N.E. | 2-0 |
| 5 Apr.  | EAST   | 2-0 |
| 1 Apr.  | E.S.E. | 1-2 |
| 21 Apr. | S.E.   | 2-5 |
| 27 Apr. | S.S.E. | 1-5 |
| 19 Apr. | SOUTH  | 1-0 |
| 17 Apr. | S.S.W. | 1-3 |
| 24 Apr. | S.W.   | 1-0 |
| 7 Apr.  | W.S.W. | 1-5 |
| 33 Apr. | WEST   | 1-0 |
| 12 Apr. | W.N.W. | 1-3 |
| 18 Apr. | N.W.   | 1-2 |
| 2 Apr.  | N.N.W. | 1-2 |
| 18 Apr. | CALM   | —   |

Curves Based on 950 Water Temperatures.

GENERAL CHART  
COVERING  
ICE PATROL  
MAY 1-15, 1925.  
GRAND BANKS

WEATHER CONDITIONS

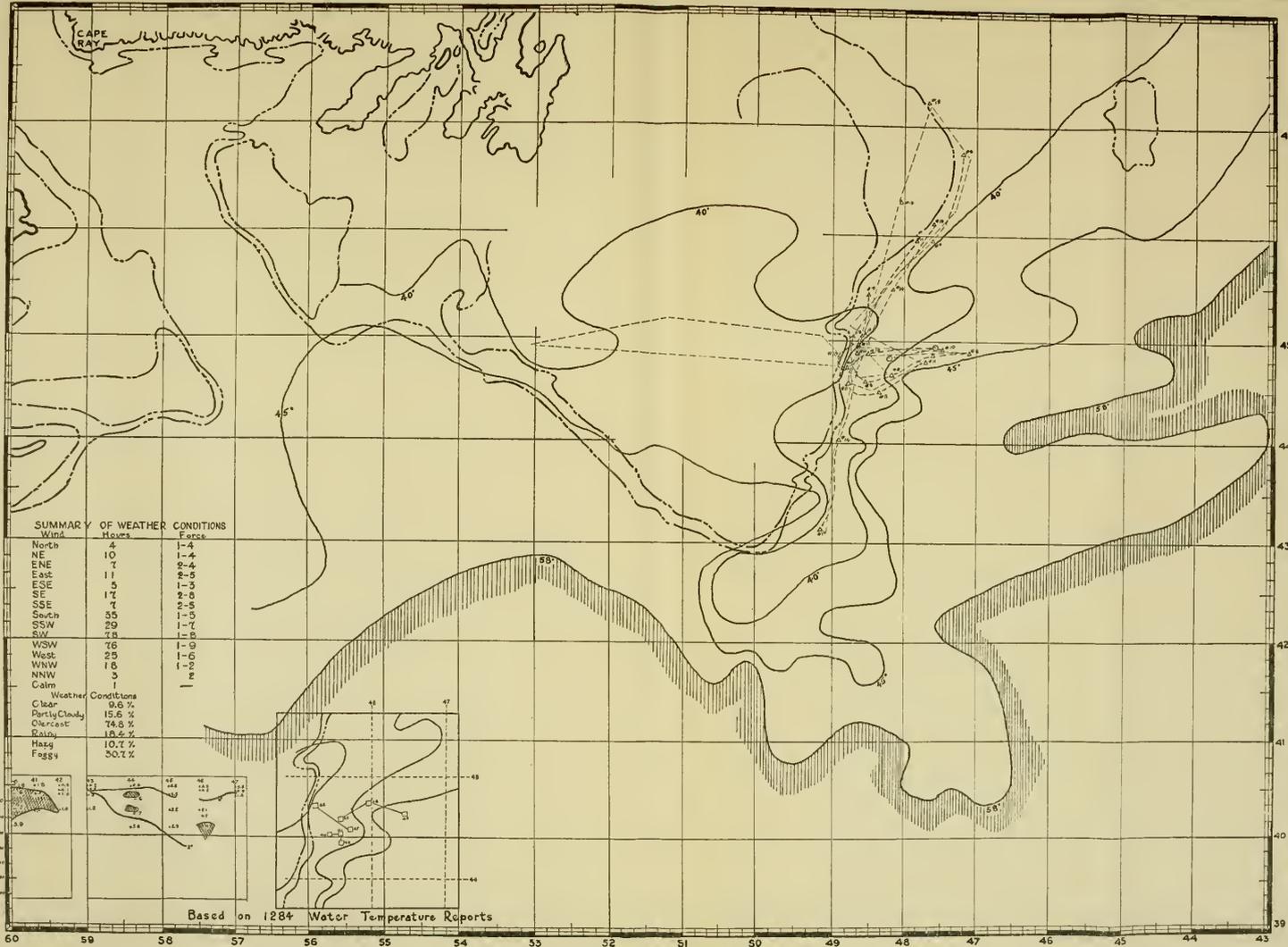
|               |         |
|---------------|---------|
| CLEAR         | — 81%   |
| PARTLY CLOUDY | — 28%   |
| OVERCAST      | — 68.1% |
| RAINY         | — 11.1% |
| FOGGY         | — 39.7% |
| HAZY          | — 8.8%  |

CHART NO. 11



1875  
1876  
1877

1878  
1879  
1880

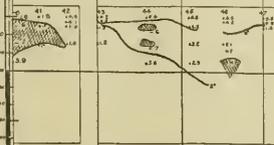


SUMMARY OF WEATHER CONDITIONS

| Wind  | Hours | Force |
|-------|-------|-------|
| North | 4     | 1-4   |
| NE    | 10    | 1-4   |
| ENE   | 7     | 2-4   |
| East  | 11    | 2-5   |
| ESE   | 5     | 1-3   |
| SE    | 17    | 2-5   |
| SSE   | 7     | 2-5   |
| South | 35    | 1-5   |
| SSW   | 29    | 1-7   |
| SW    | 78    | 1-5   |
| WSW   | 76    | 1-5   |
| West  | 25    | 1-5   |
| WNW   | 18    | 1-2   |
| NNW   | 3     | 1     |
| Calm  | 1     | 1     |

Weather Conditions

|               |        |
|---------------|--------|
| Clear         | 9.6 %  |
| Partly Cloudy | 15.6 % |
| Overcast      | 74.8 % |
| Rainy         | 18.2 % |
| Mist          | 10.7 % |
| Foggy         | 30.7 % |



Based on 1284 Water Temperature Reports

△ - BERGS.  
 ○ - GROWLERS.  
 ~ - FIELD ICE.

GENERAL CHART  
 COVERING  
 ICE PATROL  
 MAY 16-31, 1925  
 GRAND BANKS

CHART NO. 12

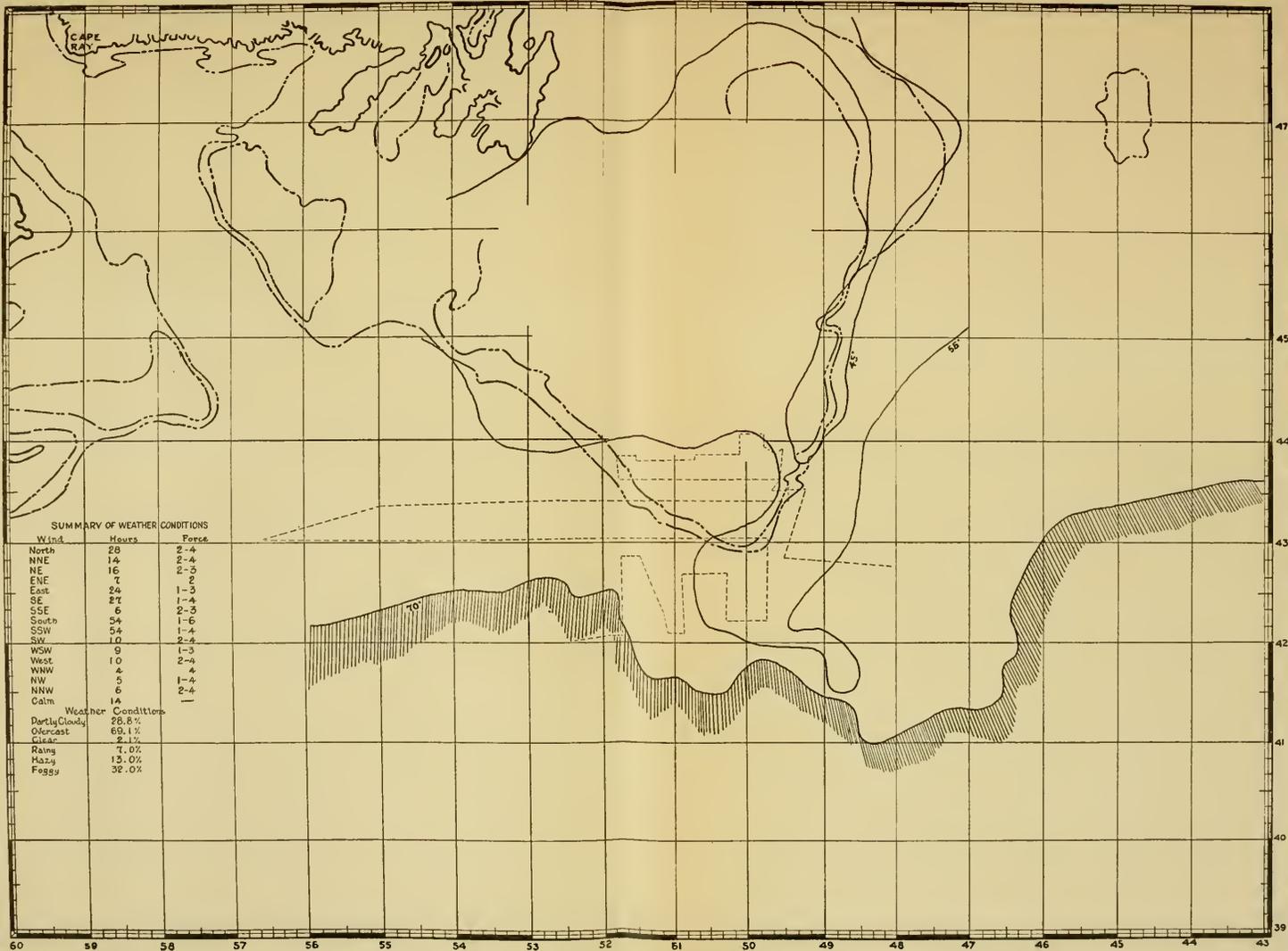












SUMMARY OF WEATHER CONDITIONS

| Wind  | Hours | Force |
|-------|-------|-------|
| North | 28    | 2-4   |
| NNE   | 14    | 2-4   |
| NE    | 16    | 2-3   |
| ENE   | 7     | 2     |
| East  | 24    | 1-3   |
| SE    | 27    | 1-4   |
| SSE   | 6     | 2-3   |
| South | 54    | 1-6   |
| SSW   | 54    | 1-4   |
| SW    | 10    | 2-4   |
| WSW   | 9     | 1-3   |
| West  | 10    | 2-4   |
| WNW   | 4     | 4     |
| NW    | 5     | 1-4   |
| NNW   | 6     | 2-4   |
| Calm  | 14    | —     |

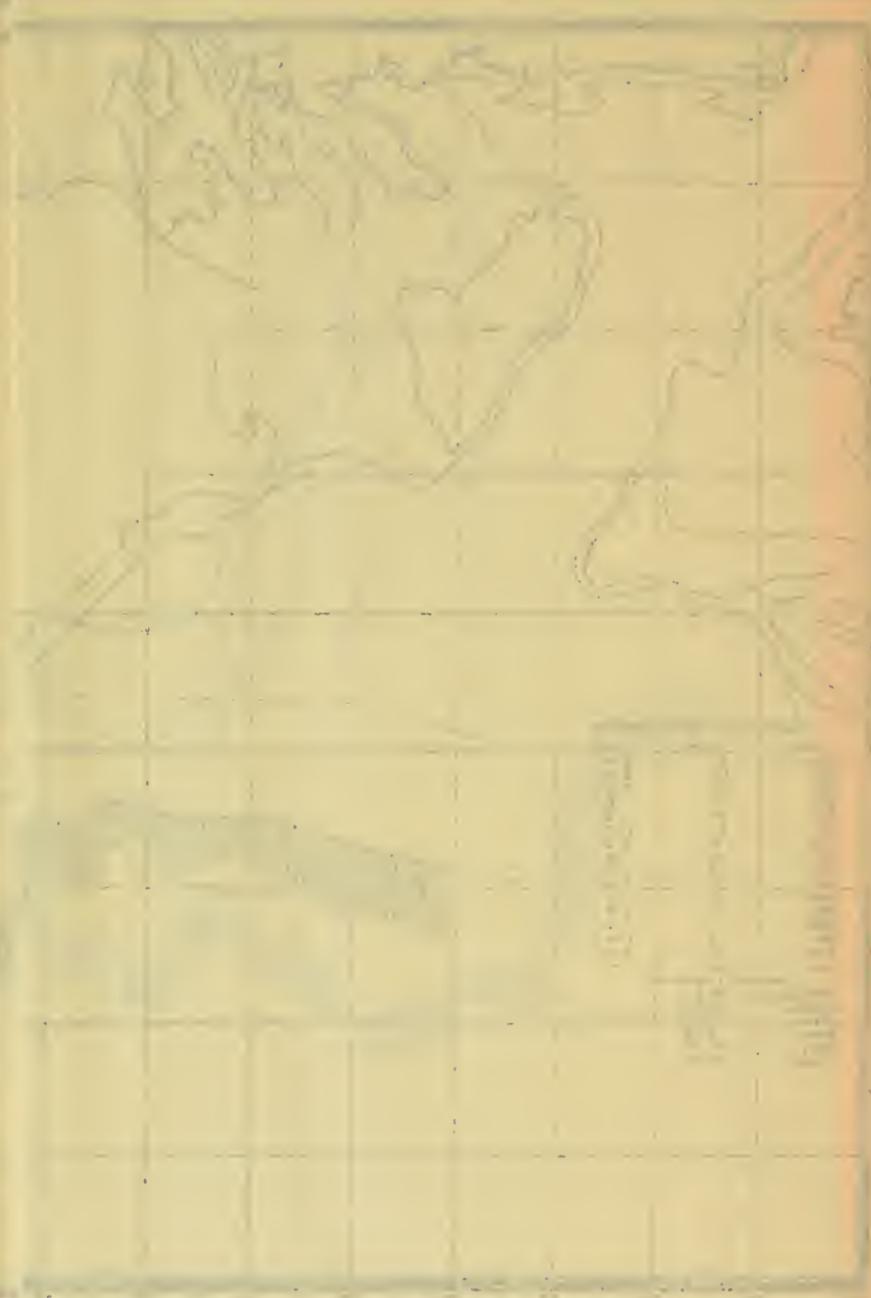
| Weather Conditions |       |
|--------------------|-------|
| Partly Cloudy      | 28.8% |
| Overcast           | 69.1% |
| Clear              | 2.1%  |
| Rain               | 7.0%  |
| Haze               | 13.0% |
| Foggy              | 32.0% |

- △ - BERGS.
- - GROWLERS.
- - FIELD ICE.

BASED ON 752 TEMPERATURE REPORTS

GENERAL CHART  
COVERING  
ICE PATROL  
JULY 1-12, 1925  
GRAND BANKS

CHART NO. 15

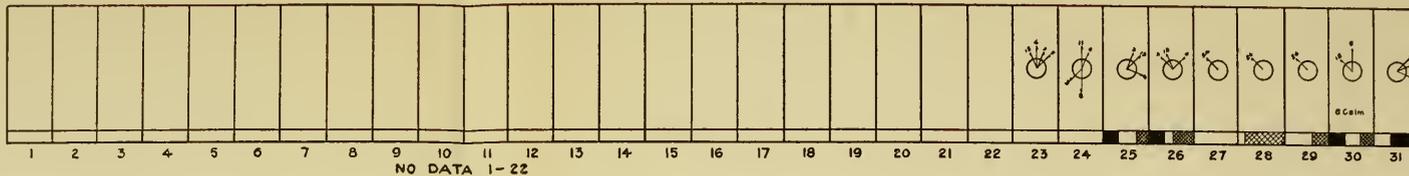


1882  
 10  
 100

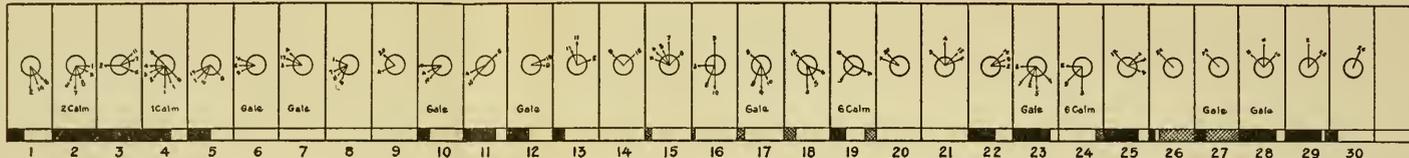
NORTH BRITISH AMERICA

1882  
 10  
 100

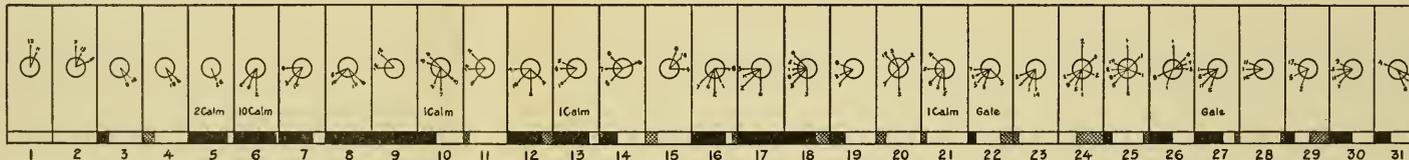
MARCH



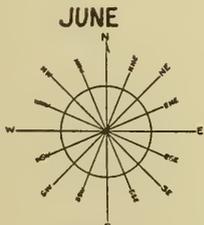
APRIL



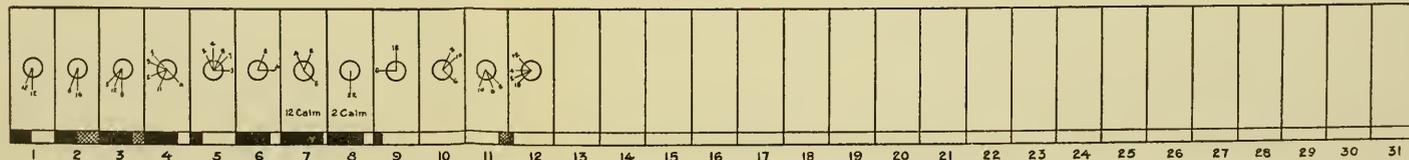
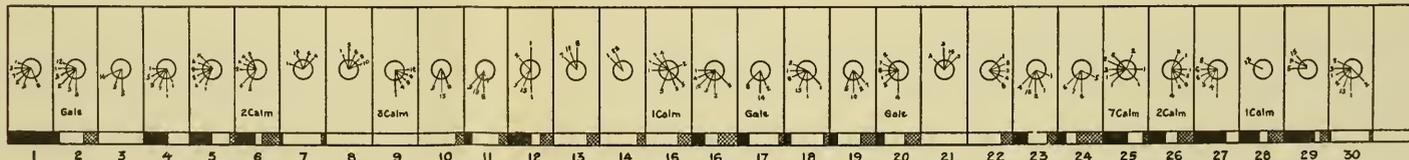
MAY



JUNE



JULY



FOG  
HAZE  
CLEAR

NUMBERS AT COMPASS POINTS INDICATE HOURS  
GALE, WIND FORCE OF OVER 6

DAILY WEATHER CHART

NO DATA 13-31

CHART NO. 16

|  |  |  |  |  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|--|--|--|--|
|  |  |  |  |  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|--|--|--|--|

MARCH

|  |  |  |  |  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|--|--|--|--|
|  |  |  |  |  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|--|--|--|--|

APRIL

|  |  |  |  |  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|--|--|--|--|
|  |  |  |  |  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|--|--|--|--|

MAY

|  |  |  |  |  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|--|--|--|--|
|  |  |  |  |  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|--|--|--|--|

|  |  |  |  |  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|--|--|--|--|
|  |  |  |  |  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|--|--|--|--|



1880

...











