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INTERNATIONAL ICE OBSERVATION

AND

ICE PATROL SERVICE

IN THE NORTH ATLANTIC OCEAN

FROM FEBRUARY TO AUGUST

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INTERNATIONAL ICE OBSERVATION AND ICE PATROL SERVICE.

Icebergs and derelicts have for many years been the dread of trans-Atlantic navigators, particularly along the lanes that run near the Grand Banks of Newfoundland. In the days of slow steamers most of the vessels took a course directly across the banks, which carried them through the ice zone during a large portion of the year. Since the advent of large and fast steamers agreements have been entered into whereby definite routes have been established to the southward of the normal ice zone. If the ice zone were fixed nothing further would be required to assure reasonable safety along these routes, but unfortunately the limits of ice fields and bergs vary considerably, in location as well as in season, and consequently a vessel might sail on a course that was clear at the time of her departure, but encounter ice which had drifted into her path before she reached the Grand Banks.

Up to 1912 nothing had been done toward the establishment of any system for guarding against the danger from floating ice, but on April 14 of that year, when the giant passenger steamer *Titanic* was sunk on her maiden voyage by striking an iceberg, there arose an almost universal demand for a patrol of the ice zone to warn passing vessels of the limits of danger from day to day during the ice season.

The Navy Department met this demand by detailing the scout cruisers *Chester* and *Birmingham*, which immediately took up the patrol of the ice regions and continued it throughout the dangerous period of that year.

In the spring of 1913 marine interests again applied to the Navy Department to perform the ice-patrol duty, but that department had no vessels to spare for the purpose. Application was then made to the Treasury Department, and the Secretary of the Treasury selected the revenue cutters *Seneca* and *Miami* for the work, those cutters being deemed best fitted for it on account of their comparatively large cruising radii.

The work of these two cutters embraced the months of April, May, and June, during which they alternated on patrol, each vessel taking 15 days on the patrol and 9 days in Halifax, Nova Scotia, each month. The remaining six days were consumed in making the trip from Halifax to the patrol grounds and return.

Besides the regular work of locating the ice and warning passing vessels of the danger limits, the officers of the cutters were directed to make a study of the ice situation, particularly as to the currents in the vicinity of the Grand Banks, the physical properties of the ice, its drift, erosion and melting; temperatures of sea water and atmosphere in the vicinity of ice; habits of birds and seals with regard to ice, and, in short, to gather all sorts of information that might help the navigator in those regions.

The patrol of 1913 was most satisfactory. The reports of the commanding officers of the patrol vessels contained many interesting features, and the department has received several flattering testimonials from masters of vessels and others who had been in a position to appreciate the work that had been done.

The British Government also took up the question of ice observation and ice patrol for the season of 1913, with the result that the steam trawler *Scotia* was chartered and fitted out for this service, the expense being shared by the British Board of Trade and the various British steamship companies operating trans-Atlantic lines. The work of the *Scotia* was confined almost entirely to ice and weather observations off the coast of Newfoundland, and this work was greatly hampered by fog and storm. Nevertheless, much useful information was gathered and the *Scotia* cooperated with the revenue cutters, in so far as conditions permitted, in disseminating ice information to passing vessels.

At the International Conference on the Safety of Life at Sea, which was convened in London on November 12, 1913, the subject of patroling the ice regions was thoroughly discussed, and the convention signed on January 20, 1914, by the representatives of the various maritime powers of the world, provided for the inauguration of an international derelict-destruction, ice-observation, and ice-patrol service, consisting of two vessels, which should patrol the ice regions during the season of danger from icebergs and attempt to keep the trans-Atlantic lanes clear of derelicts during the rest of the year. The Government of the United States was invited to undertake the management of this triple service, the expense to be defrayed by the 13 powers interested in trans-Atlantic navigation in a fixed proportion which was definitely agreed upon, subject to ratification by the law-making bodies of the governments concerned.

The convention, when ratified, would not go into effect until July 1, 1915, and as this made no provision for continuing the ice patrol during the seasons of 1914 and 1915, the Government of Great Britain, on behalf of the several powers interested, made inquiry on January 31, 1914, as to whether the United States would be disposed to undertake the work at once under the same mutual obligations as provided in the convention. The proposition was favorably considered by the

President, and on February 7, 1914, he directed that the Revenue-Cutter Service begin, as early as possible in that month, the international ice observation and patrol service. On February 11 orders were issued to fit out the *Seneca* for that duty, and on February 19 she sailed for the Grand Banks.

The *Seneca* was directed to make ice-observation cruises, with headquarters at Halifax, Nova Scotia, until such time as a continuous patrol should be necessary, when she would be joined by the *Miami*, the two vessels alternating on patrol during the dangerous season in the same manner as during the season of 1913.

The *Seneca* reached the Grand Banks on February 24, and after locating the southern limits of the ice and determining its drift, proceeded to Halifax for coal and provisions. This work was continued, the *Seneca* making observation cruises to the ice fields, using Halifax as a base, until April 1, when the continuous patrol was established and maintained until July 1. By the latter date the ice had ceased to be a menace to the southern lanes and the patrol was discontinued for the season.

The *Miami* then returned to the United States and the *Seneca* was detailed to make a special cruise for the purpose of obtaining oceanographical and meteorological data between St. Johns, Newfoundland, and Greenland, and also from Flemish Cap to the tail of Great Bank.

The *Seneca* sailed from Halifax on this mission July 5 and cruised as far north as ice conditions permitted. She then made a series of tidal and current observations from St. Johns, Newfoundland, to the tail of Great Bank, thence to Flemish Cap, and thence to St. Johns. During this cruise she also ran lines of soundings which will prove valuable in checking up existing records for that vicinity.

Upon the request of the Secretary of the Treasury, the Secretary of Commerce detailed scientists from the Bureau of Standards and Bureau of Fisheries to the *Seneca*, and also supplied apparatus for taking meteorological and oceanographical observations and collecting specimens of plankton. These scientists accompanied the *Seneca* throughout the ice-patrol season and during the special cruise in July. The data they gathered will prove of great value in clearing up many of the problems of ice movement and ocean currents, but owing to the time required to analyze the samples and classify the specimens obtained, definite conclusions could not be reached in time to incorporate them in this report.

In dispatching the *Seneca*, on such short notice, to observe and study ice conditions, it was impossible to provide all of the instruments necessary for the scientific obeservers. This difficulty, however, was overcome through the hearty cooperation of the British

Board of Trade, which tendered to the United States Government the apparatus used by the *Scotia* the previous season. The generous offer was highly appreciated and gratefully accepted, and the apparatus thus provided has enabled the scientific party on the *Seneca* to conduct their investigations in a more comprehensive manner than would otherwise have been possible this season.

Having completed her work, the *Seneca* returned to Halifax and shortly thereafter was directed to return to her regular station.

DISSEMINATION OF ICE INFORMATION.

All ice information collected by the vessels on ice-observation and ice-patrol duty, whether from original observations or from authentic reports of other vessels, was sent out broadcast twice a day. Each message was repeated three times, using 300-meter waves in the first set of warnings and 600-meter waves in the second. If the ice conditions were unusually serious, messages were sent more frequently—sometimes as often as once an hour.

Besides this broadcast warning to commerce, the patrol vessels sent daily radiograms via Cape Race radio station to the branch Hydrographic Office, United States Navy, at New York. Upon being received at that office, the messages were made public by telephone and by memoranda to the shipping offices, Maritime Exchange, and others interested. The branch Hydrographic Office was kept open beyond the statutory hours for this purpose. That office also telegraphed each message to the Hydrographic Office in Washington, where the information was circulated in the Daily Memorandum, which goes to each branch office, and was also broadcasted by radio from the Arlington Naval Radio Station.

The Hydrographic Office cabled the substance of these messages to the Deutsche Seewarte, at the request of that institution. The same information, together with all other ice reports, was published from week to week in the Hydrographic Bulletin, and finally appeared in graphic form each month on the pilot charts.

Besides cooperating in the dissemination of ice information, as above set forth, the Hydrographic Office, at the request of the captain commandant of the Revenue-Cutter Service, drew up a plan for observing and reporting upon ice conditions, based upon the instructions to patrol vessels for the seasons of 1912 and 1913, and another plan for the collection of hydrographic information used by the *Seneca* on the special cruise in July.

INSTRUCTIONS FOR ICE OBSERVATION.

TREASURY DEPARTMENT,
OFFICE OF THE SECRETARY,
Washington, February 11, 1914.

COMMANDING OFFICER REVENUE CUTTER "SENECA,"
Tompkinsville, N. Y.

SIR: 1. When the *Seneca* is in all respects ready for sea, she is detached from the New York Division and assigned to duty in connection with the International Ice Observation and Ice Patrol Service. You will, as soon as possible, leave New York with the vessel under your command, proceed to the coast of Newfoundland and locate the ice fields and positions of the icebergs. You will then keep in touch with the ice situation, making such observations as practicable on the quantities of ice, its kind and extent, its drift, and obtain any other information that 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 Bank of Newfoundland, and the dissemination of the information so ascertained for the guidance and warning of navigators; and, coordinately with these primary duties, in making such oceanographical and meteorological observations as will form a contribution toward the causes why the limiting lines assume their observed localities.

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 movement of the waters in the different depths.

(*c*) The collection and preservation of samples of the waters of the ocean from ascertained depths.

(*d*) The repetition of these observations in the same localities when these localities are revisited.

4. At intervals of four hours, there should be recorded the reading of the barometer, the temperature of the air, the humidity, the direction and force of the wind, the percentage of cloudiness, and the state of the weather and the sea.

5. Scientists will be detailed to the *Seneca* as soon as possible for the purpose of carrying on these observations, and in addition, certain instruments will be forwarded to the *Seneca* at Halifax. You will afford the scientists every facility for, and assistance in, making such observations and collecting such data as they may desire, bearing in mind 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 investigation. It should also 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*. Until such time as the scientists above mentioned report on board, you will make and record such observations as your present equipment will permit.

6. During the period of ice observation the *Seneca* will be the only vessel employed on this duty and you will make such ports as you deem expedient for coal, water, and other supplies, and in cases of emergency.

7. When the ice has moved southward so as to make a constant ice patrol necessary, you will notify the department in sufficient time to enable an additional vessel to be detailed for that purpose, at which time instructions concerning the patrol will be issued.

8. On your passage to the eastward, you will report your position daily to the department through coast naval radio stations as long as practicable and thereafter through Camperdown, Sable Island, or Cape Race Marconi stations. If not practicable to send by any of these stations, you will relay through any vessel within reach. After getting in touch with the ice, you will discontinue reports to the department and will 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 the telegraphic address of the Hydrographic Office at New York City is "Hydrographic, New York."

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

10. While on ice-observation duty, you will make reports in duplicate to the department from time to time as opportunity is afforded.

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 this work be done as thoroughly and in as satisfactory a manner as possible in order that

the record of the United States, and the Revenue-Cutter Service in particular, for efficiency, shall be sustained.

Respectfully,

BYRON R. NEWTON,
Assistant Secretary.

TREASURY DEPARTMENT,
OFFICE OF THE SECRETARY,
DIVISION OF REVENUE-CUTTER SERVICE,
Washington, February 18, 1914.

COMMANDING OFFICER REVENUE CUTTER "SENECA,"
Tompkinsville, N. Y.

SIR: 1. Referring to paragraph 7 of department order of the 11th instant, you are informed that when the *Seneca* receives orders later in the season to begin the regular ice patrol (as distinct from ice observation), you will be governed by the "Instructions to the Revenue Cutters on Ice Patrol, 1914," copies of which are herewith inclosed.

2. While the *Seneca* is on ice-observation duty, information should be given as to the positions of the icebergs and fields in accordance with paragraphs 4, 5, and 6, of the "Instructions to the Revenue Cutters on Ice Patrol, 1914."

Respectfully,

E. P. BERTHOLF,
Captain Commandant.

INSTRUCTIONS FOR THE ICE PATROL.

TO THE COMMANDING OFFICERS OF REVENUE CUTTERS ON ICE PATROL, 1914.

TREASURY DEPARTMENT,
OFFICE OF THE SECRETARY,
Washington, February 18, 1914.

1. The object of the patrol is to locate the icebergs and field ice nearest to the trans-Atlantic steamship lane. 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 steamer lane.

2. 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.

3. While on this patrol the vessels will 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 Halifax. The senior commanding officer 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 Halifax, replenish her coal 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.

4. 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 formation 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 6.15 p. m. (seventy-fifth meridian time) the same information will be sent broadcast three times in similar manner, using 300-meter wave length.

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

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

5. 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.

6. Attention is called to circular letter No. 122, the provisions of which will be followed in radiograms sent to the Hydrographic Office. (See par. 4 (*c*) of this order.) In radiograms sent to vessels other than revenue cutters, the words "latitude" and "longitude" will not be omitted.

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

8. 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 the department by radio.

9. At the end of each cruise each vessel will forward to the department a full report in triplicate. Each vessel will send these reports direct to the department, and each vessel will furnish a copy of such reports to the other vessel on patrol.

10. Each vessel will plot on tracing paper used in connection with Hydrographic Office chart No. 955 the positions and the extent of the ice, as located from time to time. These data will also be plotted on a duplicate tracing paper, and this duplicate will be delivered to the relieving vessel.

11. If, in an emergency, it becomes necessary for the junior commanding officer to communicate directly with the department, in order to avoid delay, a copy of such communications will be furnished to the senior commanding officer.

12. Upon the discontinuance of the ice patrol, further instructions will be issued by the department.

BYRON R. NEWTON,
Assistant Secretary.

REPORTS OF VESSELS ON ICE OBSERVATION AND ICE PATROL.

ICE OBSERVATION.

FEBRUARY 19 TO MARCH 4—FIRST CRUISE OF THE "SENECA," CAPTAIN C. E. JOHNSTON.

Sailing from New York at 7 p. m. February 19, 1914, we had fitful weather, varying from northeast gales and snowstorms to bright and warm days. In the Gulf Stream the temperature ran up to 60°, while in the northern current it was hanging in the vicinity of 25°. We reached the tail of the Grand Bank on the 25th of February, but were immediately forced to run off before a northeast gale and snowstorm, which gradually backed into the northwest with clearing weather. On the the night of the 26th the wind let up and we ran for lat. 43° N., long. 49° W., where the steamer *Canada* had reported field ice on the 24th.

We reached the reported vicinity of ice at noon on the 27th of February, but the field had almost completely disappeared, there being only a small piece of ice here and there. This locality is in the edge of the Gulf Stream, with sea water at a temperature of 42° to 48°. Running northward 25 miles we found an extensive field of ice and put in the afternoon making observations. That night we lay by the ice to get its drift and note how rapidly it was melting. On the morning of the 28th nearly all of the detached pieces of ice were reduced to slush. Some of these pieces were a mile or more in length and 200 yards in width. The sea water was 34° to the east of the ice and 32° south of it. To the southwest, near the tail of the Bank, it fell to 28°, which is the coldest water we found. Observations showed that the current was running almost due south at a rate of about 10 miles a day. There were no seals in sight and only a few birds—murres, dovekies, herring gulls, phalarope, and one or two hagdon shearwaters. There was a very slight blink over the field ice, not enough to attract one's attention if it were not being searched for.

On the morning of February 28 a small iceberg was made out to the westward, just south of the edge of the ice. We ran over to it and took pictures of it. Sea water here was 32°; lat. 43° 15′ N., long. 49° 02′ W. Steaming to the southwest we picked up at 10.30 a. m. another berg, somewhat larger. At noon we were alongside it, in lat. 42° 45′ N., long. 49° 08′ W. Sea water here was 40° and the current was running ENE., about a quarter of a mile an hour. Fifteen miles farther south the current was about a mile an hour to the ENE. Close to the tail of the Bank the current ran west a mile an hour.

Further search to the west and south failed to discover any more ice, and on March 1 I proceeded for Halifax, where we arrived on the morning of March 4.

On the whole, there does not seem to be a great deal of ice for this season of the year. The two bergs and one large field at the tail of the Banks are not unusual. I look for the field to melt promptly and for the bergs to curve back northward as soon as they get the full influence of the Gulf Stream. Last year there were two bergs around the tail of the Bank in early March, and we found them in April north of 44°.

I expect to start back for the ice regions on March 10.

March 10 to March 25—Second Cruise, "Seneca."

Steaming from Halifax on March 10, 1914, we had fair weather most of the way to the Grand Bank, arriving on the tail of the Bank the evening of the 13th. On the 14th we scouted between parallels 42° and 43°, meridians 49° and 51°, seeing no ice. Passing vessels reported none. March 15 was a perfect day for our work and we spent it in cruising between the tail of the Bank and the northern branch of the Gulf Stream north to latitude 43° 30′. We saw a few scattered growlers that remained from the melting of the large ice field that was in that vicinity the last of February, but only one of them was dangerous. The field itself had completely disappeared. The temperature of the sea was 32° in the Labrador Current, gradually rising to 57° in the Gulf Stream. The Gulf Stream was very strong, running nearly northeast at a rate of a mile and a half an hour. One peculiar point we noticed, and the same observation was made last year, is that as we come out of the Gulf Stream going westward the sea water drops suddenly from 52° to 32°, then rises gradually to 36°. As the Labrador Current is entered the temperature falls again quite suddenly to about 32°. The water between the extreme cold and the extreme warm currents partakes of the direction of the Gulf Stream, but very much diminished in velocity. We found the water of 36° temperature moving northeast about 6 miles a day. Field ice in this water melts quite rapidly, but bergs disintegrate slowly in it.

March 16 was hazy with light southerly winds. We continued cruising to the northward and at noon ran upon a field of northern slob extending in a long, narrow ribbon from 43° 40′ N., 48° 35′ W., in a general northeasterly direction. To the west was a clear space, but more ice could be seen beyond this. The ice was loose and not very dangerous. I think we could have gone through it anywhere without much damage. There were several large growlers in it, the largest being about 15 feet high and perhaps 20 feet long. The ice was melting rapidly, the fresh water extending for miles along the edges in the form of a *slick*. Sea birds apparently find food in these slicks, for they are much more numerous there than elsewhere. During the night we lay about 3 miles to the eastward of the ice. About 11 p. m. the British steamer *Southfield* came up to speak us, having seen our two red lights. We warned him of the location of the ice field and the ship stood south to clear it before heading west for Halifax.

The 17th was mostly rainy with southerly winds; temperature of the air, 42°, sea 32° near ice and 36° a few miles away. Ice melting rapidly. Mar. 18 and 19 were foggy. The 20th broke clear with light northerly winds. We ran over to the ice and found it much

thinner than the last time we saw it. In places it was entirely melted, so that there were gaps between the patches of ice. To the westward we could see a berg, so we ran through a thin patch to have a look at it. At 8 a. m. we reached it in latitude 44° 06′ N., longitude 48° 42′ W. It turned out to be the same berg we saw Feb. 28 in latitude 42° 45′ N., longitude 49° 08′ W., it having made good 82 miles to the northward in the meantime. It had evidently been in warm water and had lost about one-third of its bulk, one end being completely broken off and the opposite end having settled about 15°. Its general shape was unchanged and it bore the two clearly defined blue streaks that we noticed before. We next began to look for the other berg that we saw on February 28, and in about an hour we raised a berg about 15 miles to the northwest of the one we examined. We headed for it, but a dense fog settling down and ice having been seen to the westward, I turned about and stood to the southward. The berg had two peaks and bore a strong resemblance to the one we were looking for, but I can not say definitely that it was the same.

After running south about 10 miles the fog began to thin out and finally lifted. We could see a long ribbon of ice to the westward, running almost north and south, and much heavier than the ice to the eastward. Running along it to the southward we found that it was continuous with the ice east of us, forming a U with it. The slob ice coming from the north apparently had followed the east edge of the Bank as far south as latitude 45°, when it ran almost due south. At latitude 43° 40′ it struck the current running northeast and eddied around with it, melting rapidly as it came in contact with the warmer water. This phenomenon absolutely corroborates the observations I made last year as to the movements of the currents in this vicinity, the ribbon of slob ice marking the eddy as plainly as could be done with a piece of chalk on a blackboard.

The 21st was threatening, with falling barometer, and I stood south for sea room. The wind increased from the southward and finally shifted to the west in a white squall, lasting about five minutes. It then settled down to a moderate westerly gale with rising barometer. We ran slowly southward, entering warm water, which gradually rose to 57°. In the next 24 hours we were carried northeast over a mile and a half an hour. During the day I had reports of small patches of field ice just to the north of latitude 43° and between meridians 49° and 50°. On the 22d I worked down between latitude 42° and latitude 43° N., longitude 49° and longitude 50° W. We saw one small piece of ice, not dangerous. That night I headed back for Halifax.

I was particularly struck during this cruise with the difference in bird life observed from what it was last year in April and even this year in February. Last April we saw no gulls, but many hagdons, fulmars, and murres. Last month we saw many kittiwake gulls and herring gulls, very few hagdons and fulmars, and only a few murres and dovekies. This month we saw the greatest variety of gulls I have ever seen—kittiwakes, herring gulls, glaucus gulls, great black backs, and one ivory gull. Near the ice the gulls became less numerous and the fulmars, hagdons, and the sooty shearwaters became predominant. We saw very few murres and not many dovekies. One growler served as a perch for eight of the finest specimens of the great black backed gulls I have ever seen. These are the largest

of the gull family, but only slightly larger than the less striking glaucus gull.

The return to Halifax was uneventful and we arrived early in the morning of March 25.

ICE PATROL REPORTS.

April 1 to April 15—First Cruise of the "Seneca," Captain C. E. Johnston.

The *Seneca* sailed from Halifax on April 1, 1914, and reached the tail of Grand Bank on April 4, having had generally good weather across. No ice was seen or reported during the trip. On April 5 we cruised around the tail of the Bank where ice was last reported, but found none. The warm water of the Gulf Stream was found as far north as parallel 43°, strong tide rips marking the meeting of the cold and warm streams. On the 6th we worked to the northward between the Bank and the Gulf Stream and continued this work daily until the 10th without sighting ice of any sort.

On April 11 we found loose field ice extending from latitude 44° 46′ N., longitude 48° 39′ W., as far as we could see in a NNE. direction. Three small bergs lay from 5 to 10 miles northwest of the tail of this field. On the 12th and 13th we thoroughly explored the vicinity of this field, finding it about 25 miles long, 5 miles broad at its middle, and tapering to a point at each end. Numerous large growlers were scattered through the field, but the main part of the ice consisted of small pieces which were melting so rapidly that the length of the field was diminishing about a mile a day at each end. The lee side of the field is well marked, but the weather side is ragged and broken. The small stuff drifts with the wind faster than the large pieces, so that all of the heavy ice lay on the windward side; some of the larger growlers and all of the bergs lay outside of the ice entirely. In all, we found eight icebergs, seven small and one large. The large one was a lofty three-pinnacled mass, in latitude 44° 46′ N., longitude 48° 23′ W., and was the northernmost but one small berg, which lay about 5 miles to the northeast. All of these bergs were evidently last year's bergs which did not get far north during the autumn and winter and which consequently were the first to return south. All of them showed erosion and were gradually breaking up. One was apparently the same one we saw about 25 miles farther south in March and about 100 miles farther south in February. So much of its visible part had been broken up that identification could not be definitely made, but enough remained to make me fairly sure of it. The last berg we saw in June, 1913, bore a strong resemblance to the big three-pinnacled berg we found this time, and by allowing for a loss of about one-half of its former visible bulk I could plainly trace how the three pinnacles were formed. I am as positive as one can be without absolute certainty that these bergs are one and the same. It shows a former water line about 30 feet above water and almost parallel to the present line of flotation. This difference in water lines would just about account for the loss of bulk necessary to produce the present shape from last year's form. It is the most picturesque berg I have seen.

Observations of currents showed that the ice field was in almost dead water, to the east of which the current was in a general NNE. direction and to the west in a general SSW. direction along the edge of the Bank. The weather has been mostly westerly and fair, which tends to make the Gulf Stream strong and the Labrador Current weak, and as a result the bergs move northward. I believe that the ice field occupies the center of an eddy that I have mentioned in previous reports both this year and last. We took numerous observations in a scientific way, but their results can not be announced until our samples shall have been analyzed.

Very little ice was reported by other vessels. On April 5 a berg and two growlers were reported a little north of parallel 43° and west of meridian 44°, and another berg about a degree farther north and half a degree farther west. On the 10th the French steamer *Californie* reported that during a dense fog she passed through loose ice with seals on it in latitude 46° 40′, extending from meridian 47° to 48°. These are the only ice reports I received. I sent out warnings daily as specified in my instructions, and also gave them individually to vessels that asked for information.

We had a remarkably smooth and clear cruise. There was fog on only three days, and of these only one was such that we could do no work. The sea birds were much the same as last month, the gulls becoming less numerous and the shearwaters more so. I saw one jaeger and one gannet, the first of the season. Last year we saw many French fishermen after April 12, but this year we saw none.

The *Miami* arrived on the 15th and relieved this vessel. We left patrol grounds at 5 p. m. that date and arrived at Halifax about 2 p. m. on the 18th instant. I expect to sail on the 28th to relieve the *Miami*.

April 15 to May 1—First Cruise of the "Miami," Captain J. H. Quinan.

The *Miami* left Halifax at 1.30 p. m., April 12, 1914, and relieved the *Seneca* of patrol duty on the Grand Banks at 4.50 p. m., the 15th, in latitude 44° N., longitude 52° W., the meeting place previously arranged by radio. The sea being too rough for boating, the *Seneca* came under our lee quarter and we shot a line across her bow, sent over ship's mail and received copies of radiograms, ice information, etc. The *Seneca* then proceeded direct to Halifax.

The *Miami* lay to for the night and the next day ran over to the eastern edge of Banks in vicinity of parallel 44° and meridian 50° and again lay to till the morning of the 19th, during which time bad weather prevailed—gales from every direction, with fog and rain and occasional snow flurries. On the evening of the 17th, we got in communication by radio with the S. S. *Dominion*, bound eastward from Halifax. By dead reckoning, she was on the same parallel as the *Miami* and, there being a dense fog, we kept in constant communication with her by wireless and sounded whistle to avoid a possible collision. The course, too, which she was steering would have taken her dangerously close to bergs and field ice reported by the *Seneca* on the 13th.

On the 18th we sighted the first French fishing vessel. The S. S. *Mongolian* reported passing a moderate-sized berg in latitude 43° 18′ N., longitude 47° 58′ W. The S. S. *Lackawanna* reported having sighted two dangerous growlers, one in latitude 44° 04′ N., longitude 47° 39′ W., the other in latitude 43° 39′ N., longitude 47° 58′ W.

April 19, weather clearing, we ran to the southward and eastward and searched for the berg reported by the *Mongolian*, but could not find it. We sighted a number of French fishing vessels standing for the Banks. At 5 p. m., in latitude 43° 06′ N., longitude 47° 49′ W., the temperature of the sea water jumped from 30° to 45° on the surface and from 34° to 50° in the engine room. In another half hour the temperature had again dropped to 34°, showing that the *Miami* had passed through a band of warm water, evidently a part of the Gulf Stream.

From April 20 until the afternoon of the 21st we lay to in a fresh WSW. gale and fog. I found from the temperature of the sea water that we were in the Gulf Stream and were drifting rapidly to the eastward, so we ran back to the 30-fathom Bank and lay to for the night.

Dense fog and stormy weather prevailed on the 22d. When the fog lifted, we counted eight French fishing vessels, all barkentine or topsail schooner rigged. Most of them were anchored. They had caught no fish, but were apparently procuring bait.

The weather clearing, started north the early morning of the 23d to search for bergs reported by the *Seneca*. The *Canada*, bound from Halifax to Liverpool, reported that she had sighted heavy field ice extending from latitude 46° 06′ N. to latitude 45° 20′ N. and from longitude 48° 50′ W. to longitude 47° 34′ W. She had run 52 miles along the southern edge of the field before clearing it. At 12.20 p. m. we sighted a berg through the mist, latitude 44° 54′ N. longitude 48° 35′ W. It was visible 6 miles. There was no drop in the air temperature and only 1° in the surface temperature as we approached the berg. Whistle was sounded, but there was no echo. This berg was about 200 feet long, 50 feet high, and in appearance greatly resembled the right whale. Three beautiful blue veins ran transversely through it. The weather becoming thick and stormy we ran in on the Banks and lay to for the night.

April 24, underway at daylight and ran to the northward and eastward. In the forenoon watch we found between latitude 44° 57′ N. and latitude 45° 10′ N. and between longitude 48° 25′ W. and longitude 48° 50′ W. 1 growler and 11 bergs; in addition heavy field ice was sighted to the northward and was said to extend to the forty-seventh parallel and to the eastward as far as longitude 47° 34′. There were also many bergs in the field ice. The large bergs sighted by us were of various shapes and sizes. One of them was really picturesque. When we first sighted it, it looked like the Woolworth Building; from another point of view it resembled a State capitol building with dome in center. When we got close to berg and viewed it from other side, we found that it consisted of two parts, one conical in shape, the other rectangular, the parts being connected under water. Our "right-whale berg," sighted the previous day, had drifted in the meanwhile 10 miles to the northward. Temperatures of air and sea at surface were taken near the bergs; former 32°, latter 29°, with no appreciable change. Instead of seeing great numbers of sea birds,

said to hover around icebergs and indicate their presence, we noted their absence. We did see some on small drifts, but not on the bergs proper. We ran in to the Banks, lay to that night, and were underway again early next morning.

Although there was no wind, there was a heavy westerly ground swell caused by a previous blow, and when we reached the largest berg we found by observation and distance run by log that we had drifted eastward during the night 22 miles. We stopped near the largest berg and by range finder and sextant computed it to be 450 feet long and 130 feet high. Although we had gotten within 150 yards of the perpendicular face of this berg and obtained no echo from the steam whistle, Professor Fessenden and Mr. Blake, representatives of the Submarine Signal Company, obtained satisfactory results with the submarine electric oscillator placed 10 feet below surface, getting distinct echoes from the berg at various distances, from one-half mile to 2½ miles. These echoes were not only heard through the receivers of the oscillator in the wireless room, but were plainly heard by the officers in the ward room and engine room storeroom below the water line. Sound is said to travel at the rate of 4,400 feet per second under water. The distance of the ship, as shown by the echoes with stop watch, corresponded with the distance of the ship as determined by range finder. On account of the great velocity of sound through water, it was our intention to try the oscillator at a greater distance for even better results, but a thick snowstorm drove us in to shelter on the Banks again.

On the 26th, I allowed the vessel to drift with moderate northerly wind.

On the morning of April 27, anchored in 31 fathoms of water with 75 fathoms of chain in order to make current observations. We found the current to be tidal, but very weak, running NNE. in the forenoon and SSW. in the afternoon. This data, however, was very unsatisfactory, for when we determined the ship's position by observation we found that we had drifted to the southward and westward about 53 miles in 36 hours. Professor Fessenden also took advantage of the smooth sea to further experiment with his oscillator in determining by echo the depth of water; the result giving 36 fathoms, which seemed to me very close. That evening a NNE. gale sprang up and continued all next day with fog, rain, hail, and snow.

On the 29th, reports came in from steamers of bergs and field ice to the southward of the forty-fourth parallel. I decided to locate the ice if possible, as I suspected that it had drifted far to the southward with the recent northerly gale. At 12.20 p. m. we sighted the field ice in the vicinity of latitude 44° N., longitude 49° W., and one large berg which we recognized as our friend the "State Capitol," which loomed up white in bold relief against the gray sky. By taking bearings and distance run by log, we found this berg to be 17 miles distant, in latitude 43° 57′ N., longitude 48° 56′ W. It had changed its legislative headquarters 72 miles to the southward in five days. After locating several other bergs, we ran to the southern end of the main field ice and found it to extend to latitude 43° 40′ N., its western limits, to longitude 49° 10′. This field ice was reported to extend to the eastward to latitude 44° 30′ N., longitude 44° 17′ W. Ridges of field ice and scattered pans were reported as far south as

latitude 42° 50′ N., longitude 49° W. One large berg, two small bergs, and several growlers in latitude 43° 13′ N., longitude 49° W. In sending out ice information that night all vessels were advised to keep south of forty-second parallel as far east as the forty-seventh meridian. At 3 p. m., the 29th, the barometer falling rapidly and a NW. gale threatening, we stood to northward and westward for the Banks.

On the evening of April 30 the S. S. *Cameronia* reported passing several small bergs and growlers in latitude 42° 25′ N., longitude 49° 20′ W. This message was received just about the time the wireless operators were sending out ice information. I had it sent immediately afterwards as additional information. The larger bergs had drifted to the southward and westward 72 miles in five days and the smaller bergs, growlers, and ridges of field ice at a much faster rate, some 120 miles.

At 7.30 a. m. May 1, in latitude 44° N., longitude 51° 36′ W., we met the *Seneca* and I turned the patrol over to Captain Johnston, furnishing him all necessary information, also photographs of principal bergs with dates and position when sighted in order that he might be able to identify them and obtain exact knowledge of their drift. The *Miami* proceeded to Halifax, arriving 5.45 a. m. this date.

During the cruise of the *Miami* on the Banks we had all kinds of weather except good weather; seven distinct gales in 14 days and all the gales attended with fog, rain, or snow. We were in frequent wireless communication with various vessels and exchanging information. There was some compensation for the discomforts we experienced in knowing that we prevented several ships from running into serious danger. All of the trans-Atlantic liners with whom I communicated were courteous and cheerfully gave me all information requested.

Many of the shipmasters, however, did not understand the arrangement for our giving out ice information daily at 6 p. m. and 6.15 p. m. They would not "stand by," but kept up a continual exchange of radios between themselves and greatly interfered with us and with other vessels which were "listening in." A better understanding must be had in the future.

I expect to leave Halifax for the patrol grounds on the 12th instant.

May 1 to May 15—Second Cruise "Seneca."

Drift ice having been reported in March and early April as far south as Sable Island, coming out of St. Lawrence Gulf, I went to the north of that island when we sailed from Halifax on April 28 to see what the conditions were. We found no ice worth reporting. On the east side of Banquereau Bank we did see a few scattered pieces of ice, but they were not dangerous. Continuing to the eastward, we reached Grand Bank May 1 and took over the patrol from the *Miami*.

Captain Quinan reported that he had had continuous gales from the north and that the ice was running south. I accordingly stood to the southeast and stopped that night near the tail of the Bank. Next morning, May 2, we continued to the southeast and at noon picked up berg No. 11 in latitude 42° 49′ N., longitude 48° 54′ W. It had recently turned over and was not recognizable. We then

stood to the southward and at 4 p. m. picked up No. 12 in latitude 42° 24′ N., longitude 48° 54′ W., also 2 growlers, one 5 and the other 10 miles to the east of the berg. The *Winifredian* reported by radio that a berg had been seen that morning in latitude 42° 15′ N., longitude 48° 43′ W., and chunks of ice from that position northeast to latitude 43° N., longitude 48° W. At 4 p. m. a heavy northeast snowstorm broke and continued most of the night. We lay with engine stopped about 2 miles from berg No. 12.

May 3 was thick, with passing snow flurries and fog, the wind veering south. The *Czar* reported by radio that at daylight 4 small bergs in latitude 41° 43′ N., between longitude 47° 55′ and longitude 48° 10′ W., had been seen, and at 9 a. m. she reported passing 2 more small bergs. At 9.30 we met the *Czar* and from her course I felt confident that she was out of her reckoning, or we were out of ours. I radioed our position to the captain of the *Czar* and he gave me the course and distance to the locality where he first saw ice. Plotting it on the chart, by our reckoning, he saw no ice south of latitude 42° 15′. Fog becoming thicker, I stood south to get into warm water, the sea water being 33° where we were. We found better weather as we went south, and as soon as the water rose above 48° the fog cleared. We verified our reckoning by sights and found it nearly correct. The next day, May 4, we cruised all around the vicinity where the *Czar* reported ice south of latitude 42°, but found the water warm (57°) and no ice. The day was bright and clear. Between meridians 48 and 49 cold water was found as far south as latitude 41° 30′, which is 90 miles farther south than normal at this season.

May 5 we cruised to the northwest and entered cold water on parallel 42 in longitude 47° 55′ W. Before reaching cold water we picked up a berg in a mirage at a distance of 20 miles. It was *first seen from the deck*, and could be made out from the bridge only when the vessel settled between waves; it could not be seen at all from the crow's nest for fully 10 minutes after it was reported from deck. In about half an hour the mirage disappeared and the berg could then be seen from the bridge and crow's nest, but not from the deck. When about 10 miles from this berg we picked up a much larger one to the westward and stood for it, finding it in latitude 42° 34′ N., longitude 48° 15′ W. I believe it is the same one reported by the *Winifredian* May 2 in latitude 42° 15′ N., longitude 48° 43′ W., in which case it has moved NE. 19 miles in 2 days. The line between cold and warm water extended in a NE. direction. This berg had one low, bulky mass and one high pinnacle. Without being able to identify it positively, I feel pretty well satisfied that it is the same one we saw April 12 in latitude 44° 58′ N., longitude 48° 18′ W. The bulk above water is only about half of what that berg had, but there are certain marks of similarity and I could easily trace how this berg could be made from the other by breaking out certain parts and trimming others. A dense fog closing in, I stopped about 2 miles to the SW. of the berg and drifted (wind northerly), making a drift of about a mile an hour to the SE.

May 6 was foggy all day. I received a radiogram saying the Cape Race track was now open and another that Cabot Straits and the St. Lawrence were open. The season there is very late. May 7 broke fair and we made out our last berg to the southward. I had expected

to find it to the northward. This puzzled me not a little, but I now figure out that we first drifted SE. into the edge of the Gulf and were carried NE. much faster than the berg, then the wind came out east and drifted us back into the cold water. By observation the berg had gone N. 95° E. 23 miles in two days. I attribute its easting to the fact that the high pinnacle acted as a sail, carrying the low mass SE. in a NW. wind, while the current was carrying it NE., the actual drift being a resultant of those two motions. It was entering warm water and was breaking up rapidly, being scarcely recognizable as the same berg we had seen two days before.

May 8 was foggy all day. We ran south into warm water and the weather cleared at nightfall. May 9 was fine, with gentle variable winds, barometer steady at 30.45. We cruised north and picked up 2 bergs in latitude 42° 46′ N., one in longitude 47° 55′ W., and the other 4 miles west; also 3 growlers 8 miles to the southward. Cruising westward we found No. 16 in latitude 42° 54′ N., longitude 48° 34′ W. We stopped for the night in latitude 42° 55′ N., longitude 49° W. The line between cold and warm water this day was along parallel 42° 30′, 1° farther north than on the 3d, but still 30 miles south of normal.

May 10 came in with light easterly airs, clear weather, and wonderful mirage effects. Two bergs were seen to the westward in a mirage. We ran 30 miles before reaching the first, in latitude 42° 52′ N., longitude 49° 48′ W. It is our No. 17, but from a photograph sent me by Captain Quinan I recognize it as the *Miami's* No. 4, seen April 29 in lat. 43° 57′ N., longitude 48° 56′ W. It has come down in the Labrador current. A dense fog came in from the southeast and we lost the other berg. Fog becoming hourly thicker, we ran south and found fine weather in the Gulf stream. The 11th, 12th, and 13th were foggy all day over cold water and hazy over warm water. Light southerly winds prevailed, with barometer steady around 30.20. On the 12th we had real summer weather and I gave swimming liberty, several of the men taking advantage of it; sea water 57°.

May 14 was clear in the morning, foggy the rest of the day. We ran to the NW. and picked up in latitude 42° 30′ N., longitude 50° 05′ W., No. 18, which is evidently the remains of No. 17, seen the 10th in latitude 42° 52′ N., longitude 49° 48′ W. It looked as if it had recently suffered an earthquake shock and was surrounded by about 1,000 tons of brash ice, varying in size from a bird's egg to growlers of a hundred tons. Sea water 40°, ice melting fast. The current here was moving SE., evidently the southern edge of an eddy where the cold and warm water meet just before straightening out to the ENE. We saw another berg, No. 19, in latitude 42° 37′ N., longitude 49° 55′ W., but did not go to it on account of the fog.

The 15th was foggy, with occasional rifts. The *Miami* reached patrol grounds and took over the patrol by radio, it being impracticable to effect a meeting. The steamer *Breslau* reported having seen that morning in latitude 42° 01′ N., longitude 49° 35′ W., a small berg, melting rapidly. The *Breslau* passed close to us in latitude 42° 34′ N. I left patrol grounds at 8 p. m., 15th, and arrived at Halifax at 9 a. m., 18th. I expect to sail the 28th.

The weather this cruise has been very odd. The first week the barometer was steady in the region of 29.60, with variable winds, unsettled weather, snow, rain, and fog. We had no high winds. The

barometer then climbed steadily to 30.45 and remained steady there for a week, with southerly winds, mild weather, and much fog over cold water, but hazy over the Gulf Stream. The third week the barometer slowly fell to normal, with variable winds and a continuance of the fogs.

The Gulf Stream is very weak, running only about a quarter of a mile an hour where it was running over a mile an hour in February and March. Its temperature is 3° lower than in February along the northern edge. The Labrador is still strong and has evidently been very strong, pushing the Gulf 90 miles south and nearly as far east at the point where the northeast turn is usually made—in the vicinity of latitude 43° N., longitude 49° W. This is not a case of the Labrador overriding the Gulf, but pushing it bodily away. Samples of water taken down to 500 fathoms show a practically uniform ocean bed at 400 fathoms with temperature 38° to 39° F. In the Gulf Stream there is a gradual fall from surface to this temperature, and in the Labrador there is a gradual rise from about 32° to 39°. At the point of meeting of the two currents we got a zigzag of temperatures, indicating a gradual mixing. The temperature of the Labrador Stream near the tail of the Bank is now about 34°, 2° up from last month.

On several occasions, particularly with easterly winds, we have had marked mirage effects. In approaching the cold water, May 10, while still in the Gulf, we saw the horizon over the cold stream in a double mirage, the first being 4 minutes and 30 seconds above true horizon and the second a minute still higher. There is usually a cold gray sky above the mirage, giving it the effect of a barrier of ice. I had a lengthy message by radio from Captain Irvine, of the *Laconia*, describing a similar phenomenon and stating that it was difficult to convince the passengers that it was not ice.

Bird life has changed again. The gulls have gone landward to nest; the murres and dovekies are to the north around field ice and will soon be nesting; the jaegers are appearing in number; terns are fairly numerous, and Wilson petrel not uncommon, particularly in warm water. The shearwaters and fulmars remain mostly around cold water, especially around the cod banks, now that the French fishing fleet is there. We saw three varieties of jaeger—the pomarine, parasitic, and long-tail, the last being most numerous.

May 15 to May 31—Second Cruise, "Miami."

The *Miami* left Halifax at 4.45 p. m. May 12, 1914, and proceeded to the patrol grounds. Arrangements were made by radio to meet the *Seneca*, but owing to a dense fog and prospects of its continuance, all ice information was turned over to me by wireless by Captain Johnston, and at 8 p. m. May 15, in latitude 42° 56′ N., longitude 52° 32′ W., the *Seneca* was relieved and directed to proceed to Halifax.

The *Miami* arrived on the tail of the Banks the next morning, our approximate position being determined by a series of soundings. At 6.45 a. m. of the 17th, the fog having lifted, we sighted a large berg, which proved to be grounded in 41 fathoms of water on the edge of the Banks in about latitude 43° N., longitude 50° W. We recognized it as the same berg from which we had obtained echoes with the submarine oscillator on April 25 in latitude 45° N. It was rapidly break-

ing up into numerous small growlers and we took advantage of the occurrence to fill up the ship's ice chests. In nearing the berg there was no drop in the temperature of the air or surface water, which was 38° F. In the engine room the temperature dropped only 1°. At 35 fathoms, in close proximity, the deep-sea thermometer registered 32° F. At a distance of 400 yards, ship and berg at an angle of 90° to axis of wind, *we obtained an echo from the steam whistle on one side but none on the other, although the walls on both sides were high and perpendicular.* There were several bergs in the vicinity. At one of these, at a depth of 35 fathoms, the deep-sea thermometer registered 31.7° F. and at another 31.4° F. There were few birds of any kind near by, but 3 miles away we passed a large flock of gulls. The weather becoming thick, we ran in on the Banks. Here we remained on the 18th, and the ship's surgeon rendered medical assistance to two sick French fishermen, one from the topsail schooner *St. Marthe* and one from the bark *Paquerette,* both hailing from Fécamp, France. I was told that a French hospital ship does not visit the fleet on the Banks. The master of the *St. Marthe* reported that on the voyage to the Banks a huge sea had boarded his vessel and swept off three of his crew. Both vessels had a fairly good catch of cod.

On the 19th we started out in search of ice recently reported. Numerous bergs and growlers were sighted. The most western berg was found in latitude 42° 51′ N., longitude 50° 24′ W., the others extending to the southward and eastward as far as latitude 42° 15′ N., longitude 49° 22′ W. The day was clear with a tendency to mirage, and one berg was visible 20 miles. From this berg we obtained *an excellent echo from all sides within a distance of ½ mile.* That evening reports came from the *Frankfurt* and *Columbia* of three bergs in the vicinity of latitude 41° 44′ N., longitude 48° 20′ W. We immediately got busy with the wireless and many steamers caught our warning and kept wisely to the southward. The *Vaterland,* which was making her maiden trip, was one of these.

We sighted the three bergs on the morning of the 20th at a distance of 18 miles and arrived there at 10.45 a. m. Two steamers were near by, the *France* and the *Deutschland.* Captain Poncelet, of the *France,* placed the most southern and western berg about latitude 41° 22′ N., and longitude 48° 07′ W. The largest of the three was measured by sextant and found to be 170 feet high and 650 feet long. The air temperature was 52° F. Near the berg and directly to windward the surface temperature dropped from 52° F. to 48° F. The deep-sea thermometer registered 52.8° F. at 35 fathoms. The second berg bore S. ½ E. true, 6.6 miles from the first berg. This berg was about the same length as the first berg, but not half as high. Broad, deep-blue veins ran diagonally through it. The third berg bore W. by S. true, 4.7 miles from the second berg. I am giving these relative positions because later we found they changed from day to day. The third berg was smaller than the others and had no particular characteristics except it was rounded on top and had apparently capsized. Our observations that day were very poor on account of a hazy horizon and we first assumed that these three bergs were the ones sighted by the *Frankfurt* and *Columbia* in latitude 41° 44′ N., and we searched that afternoon to the southward and westward for the berg and two growlers reported by the *Mauretania.* Not finding them we felt con-

fident, from the latitude given by the *France*, that they were the ones sighted by the *Mauretania;* anyway we were sure that they were the most southern bergs. A thick fog shutting in the evening of the 20th, the *Miami* took position several miles to the southward and westward of the bergs. Radiogram was received from Captain Commandant Bertholf directing me to investigate bergs and growlers reported by the *Mauretania*. An acknowledgment was immediately made stating that I was already on the spot. The *Miami* lay to in a dense fog all that night. Owing to the gravity of the situation ice warnings were sent out, not only at the regular time, but every two hours during the night and continued for several days. Two large steamers passed close to us. One was the *Ultonia* and the other probably the *Philadelphia*. We exchanged fog signals but could not see each other. Right in the steamer tracks, with bergs on one side whose drift was not known, our position was an uneasy one, so we ran well to the northward and westward and lay to for the night. That evening we received a message from the captain of *La Touraine*, bound to the westward, that he had sighted two small bergs and several growlers in latitude 41° 39′ N., longitude 48° W. and there was a dense fog. He took my advice, steered 10 miles east true, and then SE. true, until he reached the forty-first meridian. He afterwards reported that he saw no ice.

On the 22d we stood to the eastward and that afternoon again sighted the three bergs and to the northward two more small bergs and several growlers. These three large bergs had changed their relative positions and were on a straight line WNW. ⅞ W.; No. 1 berg most easterly, No. 2 was 6 miles from the first, and No. 3 was 11 miles from the second.

On the 23d we obtained good observations, which put the most southern berg (No. 1) in latitude 41° 18′ N., longitude 48° 03′ W. We remained in the vicinity of this berg four days, watching it changing its formation from day to day and its drift to the northward and eastward which on the 26th was found to be 17 miles per day. The temperature of the sea water was 54° F. and the berg was evidently in the strength of the Gulf Stream. The temperature of the air averaged 60° F., and it was melting fast. Large chunks in the shape of small growlers were constantly dropping off and drifting to leeward, which was in the direction of northeast. It was estimated that it was disintegrating 5 per cent daily. Both bergs were in a very unstable equilibrium and we saw them roll over time and time again so as to be utterly unrecognizable. Photographs as a means of identification were of no value now.

On May 25 No. 1 was in latitude 41° 37′ N., longitude 47° 54′ W., No. 2 bore NNE. true 8 miles from the first, and the third berg was almost out of sight to the northward.

On May 26 the position of the first and largest berg was latitude 41° 53′ N., longitude 47° 30′ W. The second berg had now become the most southern, bearing W. ¾ S., 7 miles from the first, and the third berg was almost out of sight to the northward. For diversion and in the nature of an experiment we fired twelve 6-pounder shots at the second berg, but they were just as effective as if we had stormed the Rock of Gibraltar. *At night we experimented with the searchlight, but found it to be of little use. We could see farther at night with the naked eye and marine glasses, distance about 2 miles.*

On the 27th we obtained good observations and at noon placed the most southern berg (second berg) in latitude 42° 04′ N., longitude 47° 27′ W. It was drifting rapidly to the northward and eastward. The first berg was 7 miles farther to the northward and the third berg was out of sight. The drift of these bergs, although to the northward and eastward, was very eccentric to one another. It looks as if the Gulf Stream runs a little south of east as far as the forty-eighth meridian and then inclines abruptly to northward and eastward. Having satisfied ourselves that these bergs were above the forty-second parallel and moving northeast, the *Miami* stood to the westward on the forty-second parallel to ascertain, if possible, the southern limits of the bergs reported to the westward in latitude 42° 14′ N. on the 25th by the steamers *Manx, West Point, Principello,* and *Sagamore.* At the same time all vessels were advised to keep as far south as latitude 41° N. as far east as the forty-seventh meridian until the southern limits of those bergs could be accurately determined. The *Olympic* on May 25 had run west on parallel 41 from meridian 47 and reported no ice. The *Kaiserin Auguste Victoria,* on the 27th, ran west on parallel 41° 40′ and saw no ice.

On our westward trip we drifted well to the southward for some unaccountable reason. Perhaps we were influenced by the Labrador Current. On the 30th we got in radio communication with the *Seneca* and on the 31st, at 3 p. m., met in latitude 42° 07′ N., longitude 52° 25′ W. I turned the patrol over to Captain Johnston together with ice charts and ice information and proceeded to Halifax, arriving 5.10 a. m. this day, June 3.

The recent cruise was in marked contrast in point of weather with what we experienced in April, the weather being generally good. The barometer remained high. At one time it reached 30.70. At no time was it below 30. I never realized until this cruise what great chances the trans-Atlantic liners have taken heretofore, and how valuable is the ice patrol when the bergs drift south into the regular lanes. We sighted a number of steamers near the bergs during the day.

May 31 to June 15—Third Cruise, "Seneca."

The *Seneca* left Halifax on May 28, and arrived on patrol grounds May 31, relieving the *Miami* that day. On June 1 I proceeded to the southeast to look for a berg reported that morning by the *Imperator* in latitude 40° 55′ N., longitude 48° 20′ W. On the morning of June 2 the *Zent* reported a berg in latitude 40° 34′ N., longitude 47° 34′ W., and I headed for that position. On the way we passed about 20 miles to the westward of a berg which, owing to mirage, appeared to be right on the horizon. After a thorough survey of the locality where the *Zent* reported ice we found none and I believe her people must have seen the berg in a mirage and that it was the same one we passed. It was plainly visible from where we were searching. Running to it we found it in latitude 40° 54′ N., longitude 47° 38′ W. This is the southernmost position ice has been found this season. The berg was in the edge of warm water and was drifting eastward at a rate of about a mile an hour. Just to the eastward of this point the stream took a rank sheer to the northward, running 30 miles a day. We lost the berg in the fog and did

not see it again. Sea water was 57° near the berg and 46° a couple of miles to the north. The wind was light from the southward and there was a dense fog over the cold water, while perfectly clear over warm water.

From June 3 to June 7 this foggy condition prevailed. Being unable to do anything in the way of locating bergs, I put in the time determining the limits of cold and warm water and calculating the strength of the currents. We found that the southern edge of cold water crossed meridian 50 just north of parallel 42, running thence nearly southeast until it crossed parallel 41, when it rapidly curved eastward and northward, crossing parallel 41 again in longitude 47° 40′, and parallel 42 in longitude 47° 50′. The temperature of sea water in the stream was 63°, the warmest I have found this season. My observation has been that high temperature in the Gulf means strong currents, and it certainly was the case this time. During these five days the warm water was working northward rapidly, *overspreading* the cold water. At 50 fathoms, near the meeting of the two currents, the water was still cold. In my last report I stated that when the cold water invaded the Gulf Stream it pushed the warm water bodily before it. Southerly winds having cut off the supply of cold water, it was only natural that the warm water should overspread and eventually amalgamate the cold.

On the 8th four bergs were reported by different steamers near latitude 42° 20′, between longitudes 48° 34′ and 49°. There being indications of clearing weather I proceeded northward and in the afternoon the fog cleared. At sunset we made out the four bergs and stopped for the night. On the morning of the 9th we visited all four, finding them moving in a general northeast direction at a rate of one-half mile an hour. Two of them had pinnacles high enough to be affected by the wind and they moved to the south of east until the wind shifted, when they fell in behind the others in a northeasterly procession. They were all small and in advanced stages of disintegration. The sea water was around 46° and the bergs turned over two or three times a day. One berg turned over while we were within 200 yards of it. The turn was very gradual and was not accompanied by any splashing, but the berg creaked and groaned and cracked like an old wooden ship laboring in a heavy sea.

On the 9th we revisited all the bergs, after having made a thorough examination of the territory to the southward, where the fog had been thickest, and finding no ice there. The four bergs had continued their easterly and northerly movement and were breaking up rapidly. We located them again on the 10th, finding the same general movement continued. Being satisfied that they would be of no further menace to the steamer lanes, I steamed westward to see if I could find anything further. The *Mackay Bennett* reported several bergs to the northward and also gave me valuable data on temperatures of sea water and air. On the 11th we found a new berg, No. 25, in latitude 42° 28′ N., longitude 49° 24′ W. It was quite fantastic in form, being eroded through in several places. It was in water of 47° and was moving almost due east, half a mile an hour.

The next day we ran west as far as meridian 50, thence north to the tail of the Bank, finding no ice. The warm water was then within 30 miles of the Bank. On the Bank there was a dense fog and we took the back track on the morning of the 13th, looking for

No. 25. The weather was foggy or hazy and we failed to find the berg.

The 14th was foggy in the morning, clearing toward night. We made another unsuccessful search for No. 25 and then headed westward to join the *Miami*. On the morning of the 15th we met the *Miami* and Captain Quinan relieved me. I then proceeded to the northeast along the eastern edge of Grand Bank to see if there was any more ice coming south. Finding no ice and the current being found running northeast, I stopped near the French fishing barkentine *Suffren*, of Fécamp, which was anchored on the east edge of the bank. The master told me that the season had been a hard one, with much rain, wind, and fog; that he had been anchored there since Apr. 24, and had seen many icebergs go by to the southward, but that for the past 10 days the current had been northeast and the ice had gone back northward. The last bergs he had seen were going northeast about half a mile an hour on the 13th of June. The sea water there was 45°. Being satisfied that the season was about at an end, barring a spell of northerly weather, I proceeded westward by way of Whale Deep and Green Bank for scientific research, and arrived at Halifax at 7 p. m., June 18.

The weather this cruise was mild, with southerly winds and much fog over cold water. Several mild disturbances passed, but the wind always flew back to the south as soon as the center had gone by. This southerly wind checked the Labrador and strengthened the Gulf, so that normal conditions were being rapidly reestablished when I left.

We saw very few birds of any kind, even in cold water. On the 10th a land bird, one of the flycatchers, flew on board almost entirely exhausted. We were 330 miles from nearest land. We gave it food and water, but it died that night. On the same day I saw a gannet. I had never seen one of these birds so far from shore. I believe both birds mentioned had become lost in foggy weather. We had a few Wilson petrels with us all the time, saw a few pomarine jaegers, and in water below 50° there were a few shearwaters and fulmars. I saw no gulls of any sort.

June 15 to July 1—Third cruise, "Miami."

The *Miami* left Halifax 5.15 p. m., June 11, 1914, and at 8 a. m., June 15, relieved the *Seneca* of patrol duty in latitude 42° 25′ N., longitude 50° 12′ W., after which the *Seneca* stood to northward and eastward along the Banks to make some scientific research and incidentally to look for bergs before proceeding to Halifax, and the *Miami* continued east on parallel 42° 26′ N.

That evening the *Seneca* wired that she had steamed to latitude 43° 35′ N., longitude 49° 30′ W., temperature of sea water 45° F. and had not sighted ice; had boarded a fishing vessel and was informed that two bergs had been sighted on the 13th drifting to the northeast and that the current had been setting to the northward the past 10 days.

The *Miami* cruised as far east as 48° 10′ W. on the 15th, and, although we could see clearly for miles, no bergs were sighted. The next day, cruised to the east as far as 47° 42′ W., and then due north to parallel 43. All of this time we were evidently in the strength of

the Gulf Stream, the temperature of the sea water reached as high as 62° F., and we experienced a moderate easterly set the first day and a strong northerly set on the second. It was my intention to run west on parallel 43, and later search between parallels 43 and 44, but by the time we reached that latitude the southerly wind had freshened and sea become very rough. The fog was so dense one could not see a hundred feet ahead, and we therefore ran to the southward again and cruised between longitudes 48° and 49° and north of latitude 42°; but our position was uncertain, as the same weather conditions continued all next day.

On the morning of the 17th we exchanged fog signals with the *Niagara*, bound east. She afterwards reported her noon position as latitude 42° 56′ N., longitude 46° 51′ W., clear weather since 10 a. m., and no ice.

On the 18th, the weather clearing, we searched north of latitude 42°, between meridians 49 and 50, and in the evening stopped on the tail of the Banks and lay to for the night.

On the 19th and 20th, strong SW. wind, reaching at times the force of a moderate gale, rough sea, and impenetrable fog. On the 20th, steamed 20 miles to the westward to clear a number of French fishing vessels that were known to be anchored on the 30-fathom bank.

In the meanwhile I had requested all ships to report to me their routes and whether or not they had sighted ice, and if ice had been seen, to give full particulars. Numerous trans-Atlantic steamers did this, reporting no ice.

On the 20th, from this information, and from the fact that fresh southerly winds had been blowing for three weeks, I was certain that the trans-Atlantic lanes were clear of ice and that all bergs were now in high latitudes and there was no probability of their coming south again this season, on account of the prevailing winds, weakness of the Labrador Current and corresponding strength of the Gulf Stream, which had shifted to the northward; so I wired the department the facts and recommended that the patrol be discontinued.

On the morning of the 22d I read in the press news from New York: "The British steamer *Isle of Mull* arrived to-day from Lisbon and reports on June 16, while crossing in latitude 40° 40′ N. (no longitude given) in dense fog, steaming slowly, sounding whistle at frequent intervals suddenly startled by quick return sound. Steamer stopped, whistle sounded again and again with the same return of sound. Steamer then steered away from course until return sound no longer heard. Captain believed that they had narrow escape from collision with iceberg." I knew that there were no icebergs in that latitude and the captain must have heard the reverberation of his own whistle. I have had a similar experience, have experimented a number of times since in fog, when I knew there were no bergs within 50 miles of the ship and occasionally got reverberations resembling echoes so pronounced as to be startling. I find that this effect can be obtained only when it is calm or wind very light.

June 23 received message from the department to continue patrol until the end of the month and if conditions then remained the same to return to Halifax for orders.

On the evening of the 25th received telegram from the department that the S. S. *Zijldijk* reported June 10 berg 50 feet high and 140

feet long, latitude 41° 25′ N., longitude 48° W.; another 250 feet high and 1,500 feet long, latitude 41° 55′ N., longitude 48° 52′ W., and directing me to search the area between parallels 42 and 46 and meridians 45 and 47. The information given by the *Zijldijk* was manifestly in error. No berg of such dimension has been seen this season, and there is every reason to believe that the two were the ones the *Seneca* had in sight on the 10th, north 42° 22′. The *Zijldijk* had evidently experienced a strong northerly set and was out of her reckoning. Since the 17th the *Niagara*, *Bergensfjord*, *La Savoie*, and *Narragansett* have traversed the parallelogram in which the department feared there might be ice and reported all clear with no ice.

On the 28th, the *San Melito* reported having passed on the 25th a water-logged derelict lying broadside, with lowermast attached, in latitude 47° 28′ N., longitude 32° 27′ W. This information was sent out broadcast immediately, and again at midnight, and for several days afterwards.

We left the patrol grounds on the evening of the 1st and arrived in Halifax 3 p. m. July 4.

The month of June was very disappointing with respect to weather, and was not favorable for cruising on account of the dense fog. During our cruise of 23 days we had 5 days of clear weather, 14 days of dense fog, and 4 days of mist and light fog. But it was comforting to know that the strong southerly winds sweeping from over the warm waters of the Gulf Stream and producing this fog were also driving the icebergs to the northward out of the lanes of the great ocean liners.

SPECIAL CRUISE—ICE OBSERVATION.

INSTRUCTIONS.

TREASURY DEPARTMENT,
OFFICE OF THE SECRETARY,
Washington, June 23, 1914.

COMMANDING OFFICER REVENUE CUTTER "SENECA,"
Halifax, N. S.

SIR: 1. Being in all respects ready for sea, proceed with your command on July 5 for a cruise in the waters adjacent to Labrador and Greenland for the purpose of observing conditions governing the origin of the ice which annually appears on the Banks of Newfoundland and investigating the agencies by which it is transported from the north.

2. You will proceed from Halifax to the port of St. Johns, where you will coal the vessel to her capacity. From St. Johns it is desired that you proceed in a general direction 40° true a sufficient distance to carry you across the eastern limit of the Labrador current; then pursue a general direction toward Indian Harbor, Labrador; from Indian Harbor take direction toward Cape Farewell, and from that point proceed in the direction of Cape Chudleigh, the southern entrance of Hudson Bay. When in the vicinity of Cape Farewell it is desired that you obtain a series of observations across the axis of the East Greenland current.

3. You should extend your cruise as long as possible in order to cover the greatest amount of ground, leaving sufficient coal to enable you to return to St. Johns.

4. It is also desired to obtain a line of observations extending in a southeastern direction across the Grand Banks and another line from St. Johns across the Grand Banks in the direction of Flemish Gap, after which you will return to Halifax, where further orders will await you.

5. It is also desired to continue the meteorological observations as in the past.

6. You will afford the scientific party on board every facility for the collection of the data required.

7. At the conclusion of the cruise you will submit a detailed report of your operations covering particularly the physical conditions observed in connection with the origin of the ice.

8. You will instruct the members of the scientific party on board to submit their official reports to the heads of their bureaus through the captain commandant.

9. All official reports in connection with the ice observations and the ice patrol should be submitted in triplicate.

10. You will advise the department by wire of the date of your arrival at and departure from Halifax and St. Johns and will advise the department by radio as often as possible, giving the position of the vessel.

Respectfully,

BYRON R. NEWTON,
Assistant Secretary.

SPECIAL CRUISE—ICE OBSERVATION.

REPORT.

JULY 9 TO JULY 28—ICE OBSERVATION BY THE "SENECA," CAPTAIN C. E. JOHNSTON.

The *Seneca* sailed from Halifax on July 5 and arrived at St. Johns on the 7th. On the 8th I had bunkers and tanks filled to capacity, and on the morning of the 9th sailed from St. Johns, steering N. 40° E. true. The weather was fine and clear, light westerly winds and mild. The temperature of the sea water at surface was 49°, gradually falling to 41°. Fifteen fathoms down the water was near the freezing point and the depth of the warm layers became less as we went northward. By night it was only about 5 fathoms deep. No ice was seen until the early morning of the 10th, when we found in the vicinity of latitude 49° N., longitude 51° W., a group of bergs, 12 in number, within a radius of 10 miles. From that time we were constantly within sight of bergs. The temperature of the water here dropped to 38° and remained near that point until noon of the 10th, when it rose abruptly to 41°. No bergs were in sight to the eastward of this point and a dense pall of fog to the northeast indicated the presence of warm water, the wind now being fresh from the NW. and the weather raw and cold. Being satisfied that we were at the east edge of the Labrador Current, I hauled to the northward and westward. A northwest gale blew that afternoon and was followed by rain and fog. On the morning of the 11th we ran into loose field ice and for several hours were dodging large growlers in the fog. I then hauled westward and in about two hours cleared the field, when we continued to the northwest. The position where we first encountered ice was 300 miles southeast of Hamilton Inlet, Labrador. The sea water was 41° right up to the edge of the ice field and then fell quite rapidly to 35°. During the rest of the 11th and all of the 12th we continued to the northwest, dodging ice in the fog and stopping when it was too dark or thick to see ice. By dark on the 12th the ice was getting very heavy and I began to despair of being able to work through it. I learned by radio that the ice conditions on the Labrador coast were the worst for years and that the steamer *Invermore* had been totally wrecked near Indian Harbor, Labrador, and the *Kyle* had been unable to make her northern trip. Both of these vessels were specially constructed to withstand heavy ice.

The morning of the 13th broke clear and we were completely surrounded by ice as far as we could see in every direction. Eighteen bergs were in plain sight and others could be seen in all directions through the binoculars. The wind was now light from the southward and the sea water was 33°. Believing that the warm water of the Gulf Stream was not far to the northeast, I stood in that direction for 10 miles, looking for open water. The ice became worse all

the time, however, and finally I could see no opening ahead between the great pans of ice. I then decided to abandon the attempt to get through and turned back, notifying the department by radio of my decision. If it had been simply a case of reaching Greenland I could have gone around the ice to the southeast and then northward; but one of the main objects of the cruise was to take observations across the Labrador Current and I was satisfied that this was not feasible. The farthest point north that we reached was latitude 52° 45′, longitude 53° 15′. About 6 p. m., 13th, we cleared the last of the field ice in latitude 51° 45′ N., longitude 53° 30′ W. Most of the day was foggy and we had some close work avoiding growlers. We struck only one and that lightly and head-on, so that no damage was done. During this day I saw the largest berg I have seen yet. It was about 650 feet long, 600 feet wide, and 50 feet out of the water; just one great block of ice, weighing about five million tons. During rifts in the fog we could see bergs scattered about, averaging one in every five miles. Sea water rose to 35° when we cleared the ice fields.

On the 14th we continued south, the bergs becoming less numerous and the sea water gradually rising to 41°. South of latitude 50° there was a berg about every 10 miles on the average. From the number of bergs we actually saw I calculate that there are 2,000 bergs between Hamilton Inlet and the Grand Bank. The last berg we saw was about 20 miles north of St. Johns. On the afternoon of the 15th I ran into St. Johns for mail and despatches, and sailed on the morning of the 16th for Grand Bank.

From the night of the 16th to noon of the 22d we were taking observations for current and temperatures on the Grand Bank, anchoring every night and running days. While at anchor we used the current meters for subsurface currents and a chip log for surface currents. Temperatures were taken hourly, also soundings. The temperatures gradually increased from 47° at the north end of the bank to 62° near the south end. Running thence toward latitude 45°, longitude 49°, it gradually fell to 50°. During the night of July 21–22 the weather was fairly smooth and we took observations with the deep-sea lead for rise and fall of tide. Owing to the swinging of the ship and some unevenness of the bottom, the observations were not entirely satisfactory, but the results were sufficient to give a fair idea of the tides.

As a result of all the current observations I conclude that the currents on Grand Banks are tidal, largely influenced by the wind. The tide begins to flood from the southward and ends from the northwest; it begins to ebb from the northward and ends from the southeast, going around in almost a complete circle. The time of high and low water corresponds closely to the tide tables for St. Johns, but the rise and fall are greater, being about 6 feet at full and change. Soundings agreed closely with the chart, except in the vicinity of latitude 45° N., longitude 49° W., where there is considerable discrepancy.

Leaving Grand Bank on the 22d, I proceeded due east to locate the Gulf Stream. On the east edge of the Bank the sea water fell to 45°, then gradually rose to 50°. Near longitude 47°, latitude 45°, it rose quickly to 58°, but a few miles farther east it fell again to 50°, From longitude 46°, latitude 45°, to Flemish Cap the water rose from

50° to 52°, remaining at 52° as far north as latitude 47°, longitude 45°. Proceeding thence toward St. Johns, N. F., the water fell quite rapidly to 44° at latitude 47°, longitude 47°, then rose to 50° within the next 30 miles, then dropped to 47° and hung between 46° and 47° as far west as latitude 47°, longitude 50°, where it rose to 49°, at which point it remained all the way to St. Johns.

The current off the Bank ran northward about a quarter of a mile an hour during light southerly winds and half a mile an hour in moderate southerly winds. Near the northeast edge of the Bank we were set northward about three-quarters of a mile an hour during a fresh south breeze. The winds were southerly almost without change. The weather was mild but foggy. We had only one day without fog during the whole trip. One of the French fishermen on the Banks told me that there had been scarcely a clear day since he came there in April.

Only four bergs were seen or reported on this last cruise. The line of southern limit was from the northeast side of Flemish Cap to Cape St. Francis, N. F. Many bergs are being seen daily north of that line.

The results of these two cruises confirm what I have previously stated: That during June the Labrador Current dwindles to nothing and the northern branch of the Gulf Stream spreads out fan-shaped, losing depth and temperature and becoming a surface drift, which gradually carries the ice northward of the Straits of Belle Isle; there part of the ice melts and the rest lies there until the next spring, when it comes south again as the Labrador Current gains strength.

On the deeper parts of Grand Bank we caught numerous cod, and on the 30-fathom bank we hooked a good supply of haddock. In both cases we used jigs—that is, imitation lead fishes with two hooks at one end. Jigging is one of the chief methods used in catching fish along the coasts of Newfoundland and Labrador, but is never practiced by the Frenchmen on Grand Bank.

Birds were very scarce everywhere. A few petrels and fulmars were seen on the Banks and a few murres and shearwaters near the field ice. Occasionally we ran across a school of porpoises, and near the ice field I saw several very large spotted porpoises (possibly grampuses)—the only ones of this variety I have ever seen. Whales were unusually scarce.

Throughout the cruise, and, indeed, during the whole season, many stations have been taken for temperatures, salinity, and plankton, and I believe when our samples shall have been analyzed and our plankton classified it will be found that we have contributed generously to the scientific side of oceanography.

SUMMARY OF OBSERVATIONS AND OPERATIONS, ICE PATROL, SEASON OF 1914.

REPORT OF CAPTAIN J. H. QUINAN, COMMANDING THE "MIAMI," AND SENIOR OFFICER OF PATROL.

I transmit under separate cover track and ice charts for the months of April, May, and June. The ice charts include only ice sighted by and reported to the patrol vessels. Many bergs were reported to the Hydrographic Office by passing steamers which were not reported to us, the omission on the part of the shipmasters being probably due to a misunderstanding of the international agreement rather than to intentional neglect. Bergs shown on the chart are necessarily multiplied, as many are one and the same berg reported by various steamers at different times.

On another chart I have endeavored to indicate the composite or general drift of the bergs through the patrol season. In doing so, scattering bergs and those in high latitudes have not been considered. While such a chart is naturally imperfect, it is sufficiently accurate for the reader to get at a glance some idea of the paths of the bergs and the general trend of the Labrador and Gulf Stream currents.

The season of 1914 differs from the season of 1913 in three respects, a stormy April, more ice, and the bergs came farther south. Last year the most southern berg reported was in latitude 43° 02′, this year latitude 40° 54′. The ice charts will show that up to April 24 almost all the bergs and field ice were east of the Banks, just above parallel 45. Northerly winds, at times with the force of a fresh gale, prevailed from April 25 to April 28, both inclusive. This is what "turned the trick." The Labrador Current, which up to this time had remained sluggish, was set in motion and the ice shot to the southward. On April 30 some bergs were reported as far south as latitude 42° 25′.

On April 29 the wind came out strong from the northwest and continued for three days. Under the combined influence of this wind and the Gulf Stream the bergs began their march to the eastward, or, rather, to the southward and eastward, and in a short time they were strung all along east of the fifty-first meridian above the forty-second parallel. There was little wind during the month of May, but the April gales had given the Labrador Current such an impetus that it pushed the Gulf Stream bodily to the southward and the bergs took a southeast direction as far as longitude 47° 38′. On June 1 the most southern berg was in latitude 40° 54′, longitude 47° 38′. Had northerly winds continued, there is no telling how far south this berg would have traveled, but fortunately the southerly wind asserted itself, the Gulf Stream shifted to the northward and the bergs started north with almost as great a velocity as when they came south. Even the Labrador Current was forced to reverse

itself, and the French fishermen on the Banks in June observed bergs moving rapidly to the northward and eastward. By the 20th of June the trans-Atlantic lanes were clear.

I can only conclude from this that the winds have a marked effect on icebergs, directly and indirectly; indirectly, by influencing the current, and directly, but in a less degree, on the bergs themselves. Many authorities have asserted that it is only field ice that is blown about, and the wind has no effect on icebergs except as it influences the current. It is true that the current is the controlling factor, but it is not true that the wind has no direct effect. Although the mass of an iceberg under water is about eight times that out of water, it does not necessarily follow that the depth is eight times the height. All bergs are irregular in shape and many of them have high sides and pinnacles but a flat base. Such bergs are greatly exposed to the wind and influenced thereby. Often an iceberg is seen drifting directly to windward. This is because the current is stronger than the wind. The direction of drift of a berg is sometimes the resultant of wind and current, which proves my statement. I hold that if a berg be in slack water strong northerly winds will drive it south and southerly winds north. The wind, surface current, and swash of the sea all have their effect. A small berg will go to leeward faster than a large berg and a high berg faster than a low one of equal size.

As to my other observations, I can heartily indorse everything that my predecessor, Captain Gamble, and Captain Johnston have said. Captain Johnston, in his report for 1913, has gone into the subject so exhaustively there is little left for me to say. However, the most important points, facts most useful to the mariner, have been covered in the reports of the three cruises. But to summarize: Echoes—that is, air echoes—are erratic and not to be relied upon; there is no appreciable change of temperature, air or water, when approaching a berg. If a fresh wind be blowing and you get within a hundred yards or so to leeward, one experiences a sensation of cold, but the thermometer may not register any drop. And when a ship unwittingly gets that close to a berg, she would be in serious danger. Birds do not indicate presence of ice. They are more numerous around vessels where they can find something to eat. There is no iceblink over a berg as some have asserted, but we noticed the blink over field ice. The mariner must depend on his eyesight alone; he should navigate cautiously in a fog or at night, and keep to the southward when passing the ice zone.

It seems to me that trans-Atlantic steamers plying from Boston, New York, and other southern ports would find it to their advantage to keep to the southern lanes, for what they lose in distance they gain in better and clearer weather, greater speed, and safety. Many of the Canadian steamers take the northern route on account of the shorter distance. These men expect ice and are prepared for it.

The only accident that I have heard of this year was in the month of May when the S. S. *Royal Edward* struck a berg in a dense fog about 100 miles east of Cape Race, damaging her bow. It is said the captain, seeing a collision unavoidable, in order to save his ship, had the nerve and good sense to strike the berg bow on, an example that might well be followed by others in a like predicament.

REPORT OF CAPTAIN C. E. JOHNSTON, COMMANDING THE "SENECA."

Definitions.—Before proceeding with a discussion of the ice question, I shall give a few definitions of terms I shall use. *Slob ice* is loose, broken ice that collects in bays and along the exposed edges of floes; it is usually more or less discolored and contains some miscellaneous flotsam. *Sheet ice* is a large piece of floe or bay ice that drifts to sea unbroken. A *floe* is a collection of sheets of ice, more or less connected by freezing. A *shore floe* or *ice foot* is a floe frozen fast to the shore. *Brash ice* is a collection of small pieces of ice not frozen together; I have seen this word written *trash* and *thrash*. A field of brash ice is called *sludge*. A *pan* is a large sheet of ice thicker at the edges than in the middle. *Rafting* is the piling-up of sheet on sheet of ice by the action of wind and sea. A *field* is a large collection of any kind of ice, particularly of pans, adrift at sea. A *pack* is a large collection of heavy ice closely packed together and impossible of navigation. A *glacier* is a stream of solid ice flowing down a declivity. *Calving* is the breaking off of an iceberg from its mother glacier or of a growler from a berg. An *iceberg* is a large piece of glacial ice. A *growler* is a small piece of ice, but large enough to be dangerous to navigation. A *floeberg* is a large mass of sea ice built up by rafting and freezing.

I shall now attempt a brief outline of the five currents that will be mentioned in this report. The Gulf Stream is a large stream of warm water flowing from the Gulf of Mexico in a general northeasterly direction, crossing the Atlantic and making the British Isles, Norway, Iceland, and the west coast of Greenland inhabitable. From Florida to the tail of Grand Bank this stream is unbroken, but after passing the Bank it breaks up into five separate streams, like the thumb and fingers of a hand. The northernmost, or thumb, branch turns sharply to the northward about one degree east of the Bank, flows past the east side of Flemish Cap, then turns north again, spreads out somewhat and washes the west coast of Greenland as far north as Cape York. In my previous reports I have called this the northern branch of the Gulf Stream, but I shall now call it the West Greenland stream. The second, or index, branch of the Gulf Stream branches off the main stream about a degree farther east than the first and gradually bends to the northward, washing the shores of Iceland. The other branches will not be mentioned herein. The three cold streams to be mentioned are the St. Lawrence current, the Labrador current, and the East Greenland current. The St. Lawrence current comes out of the Gulf of St. Lawrence, flows southerly and westerly until it meets the Gulf Stream, which it parallels, but in an opposite direction. The Labrador current comes down the coast of Labrador from Baffins Bay and Davis Strait, flows in a general southeast direction between Flemish Cap and the Grand Bank thence southwestward along the east side of the Bank until it encoun-

ters the Gulf Stream, which is strong enough to deflect it back to the northeast, parallel to the West Greenland stream. A minor branch of this current enters the Gulf of St. Lawrence through the Strait of Bells Isle, eddies about in the Gulf and comes out south of Belle Isle. The East Greenland current comes down southwestward along the east coast of Greenland and continues in that direction until it encounters the West Greenland stream, when it deflects southward and parallels that stream in an opposite direction down to about parallel 43. Here it strikes the main Gulf Stream and is deflected backward parallel to itself in the same manner as just described in the case of the Labrador current. Its northerly course lies immediately west of the Iceland branch of the Gulf Stream, or Iceland Stream, as I shall call it henceforth. On its return trip the East Greenland current crosses meridian 40 somewhere near parallel 48.

The next item of importance is the weather. The movement of ice southward in the Labrador and East Greenland currents is largely due to the influence of winds in the far north. At St. Johns, Newfoundland, the inhabitants begin to take account of the winds in November—some even earlier—in order to predict what will be the next ice season. High north winds start the Labrador and East Greenland currents to running, while southerly winds retard them. The winter gales that sweep across the United States in winter come from three directions: first, across the Canadian border, Great Lakes, and New England; second, from southern California, by way of Oklahoma, Ohio Valley, New York City, and Nantucket, and third, from the Gulf States along the Atlantic seaboard to Hatteras, thence northeast along the north edge of the Gulf Stream. These are all cyclonic storms, and will give southwest gales followed by northwest gales if the centers pass to the northward of a given locality, or northeast gales backing into the northwest if the centers pass to the southward. In January and February practically all of these storms pass just south of the tail of the Bank; in March they cross the Bank in about latitude 44; in April they pass near Cape Race, Newfoundland; in May and June they go down the St. Lawrence Valley, and after July they are mostly north of Belle Isle and much less frequent than in winter and spring. Now, every storm center that passes south of Cape Race brings a northeaster followed by a northwester along the coasts of Labrador and Greenland, and as there is in February and March a storm on the average of one every four days, it will be readily seen that the cold streams must receive an enormous southerly impetus. The amount of northerly winds in late winter and early spring governs the strength of these cold currents and the quantity of ice they carry; and the strength of the currents governs the distance they will invade the Gulf Stream before being deflected back northward. Wherever the cold and warm streams come together there are heavy rips, and during stormy weather the seas are at times terrible. It is because of this that the region between meridians 40 and 50 West and parallels 40 and 50 North has come to be known to English-speaking mariners as the Roaring Forties and to Frenchmen as le Trou du Diable.

On the average, the first slob ice may be looked for off St. Johns in January, coming down in a narrow stream and reaching the tail of the Bank sometime late in February. Northwest winds drive it into warm water and it quickly melts. Heavy fields of sheet ice

come next, appearing off St. Johns in early March and reaching the Banks 10 days to two weeks later. Frequently they never reach the tail of the Bank, but are caught in an eddy near the Virgin Rocks and are held there until their final melting. It is on these large pans of ice that the Greenland seals come down, to be killed by the thousand off the coast of Newfoundland for their pelts and blubber. With the ice pans are usually found the first of the large bergs, and from that time until June 15 they may be expected to threaten the trans-Atlantic steamship lanes.

Concurrently with the southern movement of ice in the Labrador current there is a similar movement of ice in the East Greenland current. In the early season, bergs are first reported near Flemish Cap or else well to the eastward of that point. Labrador water and East Greenland water are separated by the West Greenland stream, in which bergs are practically never found, except the very edges of it. As a rule, all bergs seen east of longitude 44° are from eastern Greenland and all seen from Flemish Cap westward are from Baffins Bay and Davis Straits. They are essentially the same kind of ice, but come from different sources and in different streams. The freak bergs seen off Ireland and the Azores are, I believe, from the East Greenland current. Occasionally we see a berg with one or more high pinnacles that catch the wind and act as sails, carrying the low bulk of ice along to leeward at a speed of a knot an hour or even more. These "sailers" are capable of crossing the Gulf water, and all bergs I have heard of in freak places have been described as having high pinnacles.

In the Labrador current there are at least three marked eddies; one near Flemish Cap, one near Virgin Rocks, and one near the tail of the Bank. Comparatively few bergs get past the first eddy, many more are grounded on the northeast side of Grand Bank by being caught in the second eddy, and probably in an average year not over 100 bergs ever reach the lower eddy. In a previous report I have stated that in July, 1914, I calculated from the number of bergs I actually saw off the coast of Newfoundland and Labrador that there were 2,000 bergs in the Labrador current south of Indian Harbor, Labrador. This is no exaggeration. If it were not for the two northern eddies navigation in late spring would be impossible around the tail of the Bank.

In May or June the winds on the Banks become southerly and the cold currents become weak. The Gulf Stream at the same time becomes stronger and warm water overspreads the cold, gradually forcing the bergs northward and melting such as it comes in contact with. By June 15 we may look for navigation to be clear of bergs south of latitude 43°, and by July 15 all should be clear south of Flemish Cap. Freak bergs are at times reported near the steamship lanes, well to the eastward, in late season, but they will not last long, being quickly caught in the Iceland stream and carried back northward.

Occasionally ice will be reported to the southward and eastward of Georges Bank. This, I feel sure, comes out of the Gulf of St. Lawrence. As a rule, St. Lawrence ice melts along the coast of Nova Scotia or passes out to the eastward from Cape Ray to Virgin Rocks, where it joins the ice already caught in the eddy there, and all melt

together. Rarely are bergs seen west of Cape Race, but in times of exceptional northeasterly winds they have been seen as far west as St. Pierre. Small bergs sometimes get into the Gulf of St. Lawrence through the Straits of Belle Isle, but large ones can hardly get past Point Amour. The movement of ice in the Gulf of St. Lawrence is governed almost entirely by winds. Westerly winds bank it up against the Newfoundland shore and easterly winds drive it across to the Nova Scotia and New Brunswick side. As a rule, most of the ice east of St. Paul Island works out to the southeast in spring, while that west of St. Paul drifts out around Scatari, thence southward across Banquereau Bank toward Sable Island and southwest along the Nova Scotia coast as far as Halifax. One small berg was reported in April, 1914, off Egg Island, a few miles northeast of Halifax. In an average season the St. Lawrence is open to navigation about April 20.

In my report last year I covered the physical aspects of ice pretty thoroughly and I have little to add now. On the other hand, I have a few points to recede from. Speaking of currents I stated that the Labrador stream seemed to divide at the northeast end of Grand Bank, one part of it flowing to the westward between the Bank and Newfoundland. I am now satisfied that this statement is erroneous and that the current between Newfoundland and the Bank is easterly under ordinary conditions. There is plenty of authority, however, for the statement that a minor inshore current does normally run to the westward along the south shore of Newfoundland, rounding Cape Ray and continuing northeast along the west shore of the island. I am also satisfied that, as a stream, Labrador water never gets west of Grand Bank and, consequently, the name of Labrador current, as applied to the cold water along the east coast of the United States, is a misnomer. The water between the coast and the Gulf Stream is a coast tidal reservoir, influenced more by local winds than anything else. The Gulf Stream acts as a flexible dam, holding this coast water pent up. Surplus water in the coastal reservoir is relieved by passing out under the Gulf Stream, not as a fixed current, but as a general indraught toward the Equator.

Another point to recede from: I stated, upon the authority of a Government publication, that the East Greenland current dived under the Gulf Stream and emerged in Sargasso Sea. I now state on my own authority that it does no such thing, but eddies back northward, as described in a previous paragraph of this report. I do not believe that any ocean stream crosses another ocean stream by diving under it.

In my last year's report I said that cold water means nothing, so far as icebergs are concerned. I will modify that statement by saying that cold water does not necessarily indicate ice, but that ice is likely to be found in cold water and not in warm water. Consequently, when encountering water below 40° in spring and below 50° in early summer, it is well to be on guard for ice. In foggy weather I would advise vessels to keep in water above 50° while crossing the ice zone, thereby avoiding both ice and fog.

The key note of the ice situation will be found in the vicinity of the tail of the Bank. Under normal conditions the warm water of the Gulf Stream will be found near latitude 43° in longitude 49°. If it is

far to the south of there the Labrador is strong and ice may be expected not far away in ice season. The stronger the Labrador current, the more deeply it invades the Gulf Stream, but it always eddys back to the north and never crosses the Gulf Stream entirely. In scouting ice in the early ice season, I would recommend the ice scout to approach the tail of the Bank from the southward, so as to know where there is clear water to run for when the inevitable northeaster comes on. Generally speaking, it is safe to approach the ice fields from the westward, and ice is seldom found on the western half of Grand Bank.

In several cruise reports I have mentioned that in running westward from the West Greenland stream, we emerged from water of some 50° directly into water of 32°. This phenomenon is perfectly clear and logical in view of the eddying of the Labrador. The coldest part of the Labrador as it runs southwest along the east edge of the Bank is the very western edge of the current; consequently, as it eddys around to the east and north that coldest water becomes the eastern edge of the return stream, and lies right next to the warm water of the Gulf. Nothing could be simpler when one knows the reason.

Now, a word as to animal life in the vicinity of ice: Birds and seals do not remain near the ice for the love of ice, but because their food supply is to be found there. To them the ice is an incident. The warm water of the Gulf contains very few fishes or crustaceans, while the cold waters teem with all sorts of marine life. Diatoms, one of the lowest orders of life, abound in Arctic water; copepods in great numbers are there eating the diatoms, and crustaceans and fishes flock there to eat the copepods. Naturally the birds and seals are to be found there, eating the fishes and crustaceans. In the early season I have found great flocks of birds in the cold water, far from any ice. If ice is handy, they will roost on it rather than to dodge combing seas. Seals haul out on the ice to rest and most of the pup seals are whelped on the ice. Few seals are seen south of latitude 46°. Most of the sealing is done off Cape Bonavista, Newfoundland.

I submit herewith an ice and current chart which will indicate more clearly than I can tell in words what takes place in the vicinity of Grand Bank during the ice season.

PRELIMINARY REPORT ON OCEANOGRAPHIC OBSERVATIONS CONDUCTED ON THE U. S. REVENUE CUTTER "SENECA" IN 1914.

While the *Seneca* was engaged in ice-patrol duty on, and in the vicinity of, the Great Bank during the spring and summer of 1914, a series of oceanographic observations was conducted in cooperation with the United States Bureau of Fisheries. This work included the determination of the temperature, salinity, and density of the water at various depths, observations of the direction and velocity of ocean currents, both at and beneath the surface, and the collection of plankton by means of townets. A small beam trawl was also used for the collection of bottom forms.

The observations at stations 1 to 29, inclusive, were conducted by Dr. Bradley M. Patten, and those at stations 30 to 77, inclusive, by Mr. Harold W. Nightingale, both of the Bureau of Fisheries.

The positions of the 77 stations occupied during the work are shown on the ice and current chart of the *Seneca* report.

INSTRUMENTS AND METHODS.

Serial temperatures and water samples were taken at each station by the use of Eckman reversing water bottles with reversing thermometers attached. These were secured at intervals to a wire cable and tripped by messengers. As a rule, the results were satisfactory, but at times the Eckman bottles failed to operate when used in a high sea. The water samples obtained were preserved in citrate of magnesia bottles, and determinations of salinity were subsequently made by titration at the Bureau of Fisheries. The titrations of samples and determinations of salinity and density were made by Mr. Harold W. Nightingale.

Current observations were made by observed drift, and by means of Eckman current meters operated from the vessel while at anchor.

Collections of plankton were made at each station by the use of townets of various types, sizes, and mesh. Small nets of No. 20 bolting silk were employed to take the microplanktonic forms, and larger nets, 1 meter in diameter and of coarser mesh, were used for macroplankton. A shearboard, or Helgoland net, was used for the deeper towing with satisfactory results. A small beam trawl, 3-foot beam, was used for the collection of bottom fauna.

The results of the plankton investigations are withheld, for publication together with the results of subsequent investigations in the same field; several groups of organisms will then be reported on by experts in each group. The hydrographic data also will be discussed in a special report, but the results of the observations are presented in the following table for the information of those to whom they may be of interest:

Stations taken by the U. S. Revenue Cutter

Station No.	Date.	Time of day.	Position. Lat. N.	Position. Long. W.	Depth in fathoms.	Bottom. Character.	Bottom. Sample.	Water, physical data. Depth.	Water, physical data. Temperature.	Water, physical data. Salinity.	Water, physical data. Density.
			From Halifax, Nova Scotia, to Grand Banks.								
	1914.		° ′	° ′					° C.		
1	Apr. 4	7 p. m.	43 25	50 58	49	.....	.....	0	0.7	32.94	26.42
								15	0.4	32.94	26.44
								30	0.5	32.94	26.44
								46	0.3	32.94	26.47
2	Apr. 5	10 a. m.	43 15	50 18	32½	.....	.....	0	−0.5	33.04	26.55
								10	−0.2	32.97	26.50
								20	0.5	33.03	26.52
								30	0.5	.....	.....
3	Apr. 5	6.30 p. m.	42 54	49 30	700	.....	.....	0	−1.15	33.24	26.75
								35	5.5	34.22	27.01
								70	8.1	.....	.....
								100	0.4	34.83	27.96
4	Apr. 6	6.30 a. m.	42 53	49 19	1,100	.....	.....	0	−0.95	33.19	26.71
								50	−1.2	33.26	26.77
								100	0.0	34.60	27.80
								150	6.6	34.65	27.23
5	...do.	4 p. m.	43 30	49 21	250	.....	.....	0	−0.8	33.04	26.58
								80	−1.5	33.12	26.66
								160	−0.3	34.05	27.37
								250	0.8	.....	.....
6	Apr. 8	7 p. m.	43 41	48 32	1,400	.....	.....	0	0.8	34.02	27.30
								100	1.4	35.16	28.16
								200	3.75	34.74	27.62
								300	3.5	34.87	27.75
7	Apr. 9	...do.	44 25	48 15	1,800	.....	.....	0	1.6	33.78	27.05
								75	2.2	34.33	27.44
								150	3.65	34.72	27.61
								225	4.15	34.90	27.71
								300	3.7	34.90	27.76
8	Apr. 10	10.30 a. m.	44 28	48 55	350	.....	.....	0	−1.0	33.17	26.69
								75	−1.5	33.21	26.73
								150	−1.5	33.12	26.66
								225	0.0	34.42	27.65
								300	2.3	34.52	27.59
9	Apr. 11	9.30 a. m.	44 37	49 05	32	.....	.....	0	−1.3	33.12	26.66
								10	−1.1	33.13	26.66
								20	−1.3	33.17	26.70
								30	1.4	33.17	26.58
10	...do.	5.30 p. m.	44 35	48 35	500	.....	.....	0	−0.8	33.51	26.96
								50	−0.7	33.62	27.05
								100	−0.8	34.34	27.62
								150	2.6	34.52	27.56
11	Apr. 12	12.15 p.m.	44 56	48 23	1,100	.....	.....	0	0.5	33.62	26.99
								40	1.1	34.14	27.36
								80	2.4	34.54	27.60
								120	2.8	34.56	27.57
								160	2.8	34.63	27.62
			Surface series.								
	800 yards from berg							0	0.4	33.49	26.89
	600 yards from berg							0	0.3	33.58	26.97
	400 yards from berg							0	0.2	33.60	26.99
	300 yards from berg							.....	0.1	33.58	26.98
	200 yards from berg							.....	0.12	33.61	27.00
	20 feet from berg							.....	0.3	33.68	27.04
	20 feet from berg							.....	0.29	33.67	27.03
	20 feet / 20 feet opposite side							.....	0.1 / 0.1	.....	.....

"Seneca" from April to August, 1914.

Nets.				Currents.				Remarks.
Description.	Fathoms.	Time.	Speed.	Fathoms.	Flow.	Cms. sec.	Knots, hour.	
								The densities given in the following table are expressed in an abbreviated form. The actual densities are 1.02642, 1.02644, 1.02644, etc.
				0	SE.		.25	
								No tows at station 1; wind SW.; force 2.
No. 20 net	0							
No. 3 net	10			0	NE.		.25	The No. 20 net is a fine-meshed net used for microplankton. The No. 3 net has a coarser mesh and catches the larger organisms.
				0	E.		.25	
No. 20 net	0			0	N. 35° E.		.7	Wind SE.; force 3.
No. 3 net	10							
				0	N. 53° E.		.3	Wind SE.; force 6; barometer falling; no tows possible.
No. 20 net	0							Wind NE. by N.; force 1, at night after lying to. Ice not yet sighted.
No. 3 net	10							
No. 20 net	0				NW.		.5	Wind SE. by E.; force 2.
No. 3 net	10							
H.	200							H. net signifies Helgoland net.
No. 20 net	0			0	S.		1.00	Wind S. by W.; force 3 to 4.
No. 3 net	10							Iceberg search being stopped by fog. Late in day ran to westward and anchored on banks in shoal water.
1-m. net	60							
1-m. net	120							
H. net	180							
No. 20 net	0			0	SW.		.25	1-m. net signifies 1-meter net.
No. 3 net	10							
H. net	30							
No. 20 net	0							Nearly dead water; wind SSW.; force 2.
No. 3 net	10							
1-m. net	80							
H. net	180							
No. 20 net	0							No perceptible current; only wind drift; wind SW.; force 2.
No. 3 net	10							
H. net	70							
								About 1,000 yards from big iceberg. Series of surface temperatures and water samples from 800 yards to within 20 feet of the berg.

Stations taken by the U. S. Revenue Cutter

Station No.	Date.	Time of day.	Position. Lat. N.	Position. Long. W.	Depth in fathoms.	Bottom. Character.	Bottom. Sample.	Water, physical data. Depth.	Water, physical data. Temperature.	Water, physical data. Salinity.	Water, physical data. Density.
	From Halifax, Nova Scotia, to Grand Banks—Continued.										
	1914.		° ′	° ′					°C.		
12	Apr. 16	11.30 a. m.	43 45	55 0	1,700	.....	.....	0	4.0	33.73	26.80
								60	0.1	33.73	27.10
								120	4.1	33.73	26.79
								180	4.0	33.75	27.82
								240	4.4	.....	.....
13	Apr. 18	2.15 p. m.	43 31	60 1	52	.....	.....	0	−0.5	32.12	25.81
								17	− .15	31.94	25.66
								34	− .10	31.76	25.52
								51	0.0	.....	.....
14	Apr. 28	Noon	44 30	63 22	33	.....	.....	0	1.4	31.49	25.23
								15	0.2	31.47	25.29
								32	0.2	31.67	25.45
15	...do	8 p. m.	44 32	62 1	80	.....	.....	0	1.0	31.62	25.40
								25	1.2	32.10	25.73
								50	.....	.....	.....
								80	6.8	34.04	26.71
16	Apr. 29	6.15 a. m.	44 45	57 30	55	.....	.....	0	0.8	.....	.....
								25	0.5	31.51	25.28
								50	0.5	31.53	25.30
17	...do	4 p. m.	44 43	58 10	36	.....	.....	0	0.0	31.58	25.37
								20	−0.1	31.80	25.55
18	May 1	8 a. m.	44 5	51 37	40	.....	.....	0	0.5	32.83	26.35
								13	0.7	32.83	26.34
								26	.65	32.83	26.35
								40	0.7	32.84	26.35
19	...do	4.30 p. m.	43 31	50 0	30	.....	.....	0	0.7	33.01	26.48
								10	0.8	33.01	26.48
								20	0.8	33.01	26.48
								30	0.8	33.01	26.48
20	May 2	12.30 p. m.	42 50	48 55	1,500	.....	.....	0	1.6	33.64	26.93
								100	3.4	34.63	27.61
								200	3.5	34.63	27.61
								300	3.6	34.78	27.61
								400	3.55	.....	.....
	Surface temperatures and water-density series.										
	500 yards from iceberg							0	2.0	33.64	26.90
	350 yards from iceberg							0	2.0	33.64	26.90
	100 yards from iceberg							0	2.0	33.64	26.90
	20 yards from iceberg							0	1.7	33.64	26.93
	10 yards from iceberg							0	1.9	33.64	26.92
			° ′	° ′							
21	May 4	9 a. m.	41 31	48 22	2,000	.....	.....	0	0	14.5	26.74
								125	125	13.0	27.01
								250	250	5.0	28.34
								375	375	3.8	.....
								500	500	3.1	.....
22	...do	4.30 p. m.	41 55	47 21	2,000	.....	.....	0	13.9	35.59	26.68
								100	11.4	35.50	27.11
								200	7.8	35.50	27.72
								300	5.7	34.78	27.44
								400	4.9	34.88	27.60

"Seneca" from April to August, 1914—Continued.

Nets.				Currents.				Remarks.
Description.	Depth.	Time.	Speed.	Depth.	Flow.	Cms. sec.	Knots, hour.	
No. 20 net	0							
No. 3 net	3			0	NE		.25	Wind SW. by S.; force 3.
1-m. net	40							
H. net	80							
No. 20 net	0			0	W		0.6	Wind NNE.; force 4.
No. 3 net	3							
								Wind SSW.; force 2. Current dependent upon winds. Weather permitting, the ship will stop every 8 hours to run a section to Banquereau and the Grand Banks.
No. 20 and No. 3 net at circulatory pumps.	17							Current dependent upon winds; force 3.
No. 20 and No. 3 nets at circulatory pumps.	17							Wind W. by S.; force 3-4.
No. 20 and No. 3 nets at circulatory pumps.	17							Wind force 6-7; rising sea.
No. 20 and No. 3 nets at pumps.	17							Wind NW.; force 4. The filtration of the water from the circulatory pumps was carried out at a few intermediate stations with good results—in quantity of plankton.
No. 20 net	0							
No. 3 net	10							
B. trawl	30							Wind WNW.; force 4.
								Wind SSE.; force 1.
No. 20 net	0							
No. 3 net	10			0	NE		0.5	Wind S. by W.; force 3.
1-m. net	50							
H. net	100							
No. 20 net	0							
1-m. net	50			0	NE		0.5	Wind SSW.; force 4.
H. net	100							

Stations taken by the U. S. Revenue Cutter

Station No.	Date.	Time of day.	Position.		Depth in fathoms.	Bottom.		Water, physical data.			
			Lat. N.	Long. W.		Character.	Sample.	Depth	Temperature.	Salinity.	Density.
	From Halifax, Nova Scotia, to Grand Banks—Continued.										
	1914.		° ′	° ′					°C.		
23	May 5	4 p. m.	42 30	48 10	2,000	.....	.....	0	1.9	33.42	26.74
								125	2.2	33.42	26.72
								250	3.7	34.74	27.63
								375	3.75	34.70	27.56
24	May 10	1.30 p. m.	42 31½	50 0	1,500	.....	.....	0	8.4	34.34	26.76
								100	5.15	34.33	27.15
								200	1.7	34.20	27.36
								300	2.5	34.34	27.43
								400	3.0	34.58	27.57
25	May 12	2 p. m.	42 11	50 0	2,000	.....	.....	0	12.85	35.25	26.64
								100	7.6	34.56	26.79
								200	6.8	34.87	27.36
								300	4.6	34.70	27.51
								400	4.5	34.85	27.63
26	May 14	3 p. m.	42 37	49 55	.....	.....	.....	.....	.....	.....	.....
	Surface series of temperatures and densities near Iceburg No. 19.										
	Sample 1, 20 yards from berg							0	1.90	.....	.....
	Sample 2, 20 yards from berg							0	2.00 2.05 2.00	.....	.....
	Sample —, 20 yards from berg							0	2.35	.....	.....
	Sample 3, 20 yards from berg							.....	3.10	.....	.....
	Sample —, 100 yards from berg							.....	3.15	.....	.....
	Sample 4, 150 yards from berg							.....	3.00	.....	.....
	200 yards from berg							.....	3.00	.....	.....
	300 yards from berg							.....	3.05	.....	.....
	500 yards from berg							.....	3.15	.....	.....
	600 yards from berg							.....	3.20	.....	.....
	700 yards from berg							.....	3.25	.....	.....
	800 yards from berg							.....	3.15	.....	.....
			° ′	° ′							
27	May 16	9 a. m.	42 57½	54 36	2,400	.....	.....	0	5.8	33.13	26.11
								100	6.1	34.31	27.01
								200	4.8	.....	.....
								300	4.2	.....	.....
								400	4.2	.....	.....
28	May 16	9.30 p. m.	43 13	56 55	2,000	.....	.....	0	2.6	32.47	25.95
								50	4.1	33.73	26.78
								100	7.6	34.83	27.21
								200	4.7	34.33	27.19
								300	4.55	34.88	27.66
								400	4.2	35.79	28.30
29	May 17	9 a. m.	43 23	59 20	1,300	.....	.....	0	3.25	32.75	26.10
								100	3.2	34.05	27.12
								200	2.6	34.34	27.47
								300	3.5	34.65	27.57
								400	3.7	34.74	27.64
30	June 2	6 p. m.	40 54	47 38	2,170	.....	.....	0	14.6	35.25	26.33
								200	4.7	34.49	27.31
								300	4.6	34.85	27.62
								350	2.7	34.85	27.81
								400	3.2	.....	.....
31	June 3	2 p. m.	40 34	47 42	2,170	.....	.....	0	12.0	.....	.....
								50	11.4	34.94	26.68
								100	11.6	35.05	26.71
								200	7.3	34.63	27.11
								400	4.8	34.94	27.69

"Seneca" from April to August, 1914—Continued.

Nets.				Currents.				Remarks.
Description.	Depth.	Time.	Speed.	Depth	Flow.	Cms. sec.	Knots, hour.	
No. 20 net	0							
No. 3 net	10			0	NE		0.5	Wind S.; force 3.
1-m. net	50							
								Wind SE.; force 2.
No. 20 net	0							Wind NW.; force 2.
No. 3 net	10							
No. 20 net	0							Wind NE.; force 1.
No. 3 net	10							
No. 20 net	0							Calm sea.
No. 3 net	10							
No. 20 net	0			0	N. 113° E.		2.0	Rough weather.
No. 3 net	10							
1-m. net	75							
1-m. net	150							
H. net	200							
No. 20 net	0							
No. 3 net	10			0	N. 113° E.		2.0	Calm weather.
1-m. net	70							
1-m. net	140							
H. net	210							

Stations taken by the U. S. Revenue Cutter

Station No.	Date.	Time of day.	Position.		Depth in fathoms.	Bottom.		Water, physical data.			
			Lat. N.	Long. W.		Character.	Sample.	Depth.	Temperature.	Salinity.	Density.
	From Halifax, Nova Scotia, to Grand Banks—Continued.										
	1914.		° ′	° ′							
32	June 5	4.30 p. m.	41 40	47 58	1,900	.....	.....	0	7.5	33.10	25.87
								50	3.1	33.96	27.07
								100	3.8	33.33	26.50
								200	3.2	33.89	27.00
								400	3.8	34.76	27.63
33	June 7	3 p. m.	41 25	48 45	1,900	.....	.....	0	9.7	33.35	25.74
								50	2.6	33.42	26.69
								100	2.7	34.02	27.18
								200	2.9	33.42	26.65
								400	3.0	34.58	27.57
34	June 8	7 p. m.	42 16	48 48	1,700	.....	.....	0	7.0	33.24	26.06
								50	2.1	34.31	27.43
								100	3.3	34.67	27.61
								200	3.9	34.52	27.44
								400	3.4	34.76	27.67
35	June 9	10 a. m.	42 35	48 32	1,590	.....	.....	0	7.7	33.24	25.96
								6	6.3	33.24	26.15
								12	2.5	33.24	26.55
								30	2.2	.....	.....
								50	2.0	.....	.....
								100	3.2	33.24	26.47
								200	3.8	34.23	27.22
								400	3.6	34.79	27.68
36	June 10	2 p. m.	42 25	48 34	1,900	.....	.....	0	7.7	33.21	25.93
								10	6.3	33.26	26.16
								15	5.8	33.28	26.25
								20	4.4	33.42	26.52
								23	3.5	33.42	26.61
								25	2.1	33.71	26.96
								50	2.5	33.95	27.11
								100	3.2	34.05	27.13
								200	3.0	33.68	26.85
								400	3.5	34.72	27.63
37	June 11	7 p. m.	43 06	49 57	32	.....	.....	0	6.6	.....	.....
								15	5.9	32.90	25.93
								20	2.4	32.99	26.44
								23	−0.2	.....	.....
								25	−0.3	33.26	26.75
38	June 12	2 p. m.	42 13	49 27	1,500	.....	.....	0	9.0	32.99	25.57
								50	10.1	34.04	26.21
								100	10.1	33.39	25.66
								200	10.1	33.44	25.70
								400	10.1	34.76	26.76
39	June 13	4 p. m.	42 42	48 07	1,800	.....	.....	0	9.6	32.99	25.45
								30	7.6	34.56	27.00
								100	6.6	33.51	26.32
								200	6.6	33.51	26.32
								400	5.4	34.83	27.51
40	June 14	7 p. m.	42 26	49 11	1,640	.....	.....	0	5.7	32.92	25.97
								50	2.0	33.51	26.80
								100	2.5	33.68	26.89
								200	3.6	34.76	27.65
								400	3.0	.....	.....
41	June 15	3 p. m.	43 29	49 30	35	.....	.....	0	9.5	32.79	25.33
								5	8.2	32.79	25.53
								10	7.3	32.79	25.67
								15	2.3	32.94	26.31
								30	0.6	33.21	26.65
42	June 16	10 a. m.	45 03	52 30	52	.....	.....	0	4.5	32.77	25.98
								10	3.7	32.81	26.09
								24	3.0	.....	.....
								36	−0.1	32.86	26.40
								48	−1.0	.....	.....

"Seneca" from April to August, 1914—Continued.

Nets.				Currents.				Remarks.
Description.	Depth.	Time.	Speed.	Depth.	Flow.	Cms. sec.	Knots, hour.	
No. 20 net	0							
No. 3 net	10							
1-m. net	70							
1-m. net	140							
H. net	210							
No. 20 net	0							
No. 3 net	10			0	SW		3.0	Choppy sea.
1-m. net	70							
1-m. net	140							
H. net	210							
No. 20 net	0							
No. 3 net	10							
1-m. net	70							
1-m. net	140							
H. net	210							
No. 20 net	0							
No. 3 net	10							
1-in. net	70							
do	140							
H. net	210							
No. 20 net	0							
No. 3 net	10							
1-in. net	70							
do	140							
H. net	210							
No. 20 net	0							Good haul in beam trawl.
No. 3	10							
1 in	15							
B. trawl	32							
No. 20 net	0							
No. 3 net	10							
1-in. net	70							
do	140							
H. net	210							
No. 20 net	0							
No. 3	10							
1 in	70							
do	140							
H	210							
No. 20 net	0							
No. 3 net	10							
1-in. net	70							
do	140							
H. net	210							
No. 20 net	0							
No. 3	10							
1 in	20							
B. trawl	35							
No. 20 net	0							Beam trawl; haul good.
No. 3 net	10							
B. trawl	52							

Stations taken by the U. S. Revenue Cutter

Station No.	Date.	Time of day.	Position. Lat. N.	Position. Long. W.	Depth in fathoms.	Bottom. Character.	Bottom. Sample.	Water, physical data. Depth.	Temperature.	Salinity.	Density.
	From Halifax, Nova Scotia, to Grand Banks—Continued.										
	1914.		° ′	° ′					°C.		
43	June 16	7.30 p. m.	45 21	54 29	.....	.....	.....	0	4.8	32.70	25.89
								10	4.5	32.72	25.94
								20	3.2	32.72	26.07
								30	0.0	32.70	26.27
								40	−1.6	33.06	26.67
44	June 17	4 a. m.	45 21	55 53	25	.....	.....	0	4.5	32.38	25.67
								10	4.1	32.45	25.77
								15	3.5	32.47	25.85
								20	1.5	32.56	26.07
								25	1.2	32.57	26.10
45	...do.	10 a. m.	45 11	57 23	228	.....	.....	0	5.0	32.29	24.45
								55	1.5	32.94	26.37
								110	4.5	33.35	26.45
								165	4.3	34.52	27.39
								220	4.3	33.08	26.25
46	July 9	11 a. m.	47 50	52 13	85	.....	.....	0	7.2	31.96	25.02
								2	1.4	.....	.....
								5	−1.5	.....	.....
								10	−1.7	31.98	25.75
								20	−1.6	32.21	25.93
								40	1.3	33.24	27.40
								60	1.6	33.26	27.43
								80	1.5	33.42	27.77
47	July 9	9 p. m.	48 30	51 27	81	.....	.....	0	6.1	.....	.....
								10	5.8	32.01	25.24
								20	4.1	32.47	26.00
								25	0.3	.....	.....
								35	−1.6	33.22	26.76
								60	−1.6	.....	.....
								80	−1.6	31.96	25.73
48	July 10	8 a. m.	49 35	50 13	176	.....	.....	0	3.3	32.99	26.28
								5	3.1	.....	.....
								10	3.1	.....	.....
								25	−0.5	33.78	27.17
								40	1.0	33.13	26.57
								80	2.0	34.42	27.52
								120	3.1	32.94	26.25
								15	1.5	.....	.....
49	July 11	9 a. m.	51 01	50 08	176	.....	.....	0	3.3	33.21	26.45
								5	3.1	33.87	27.22
								10	3.1	34.69	27.80
								25	−0.5	34.69	27.89
								40	1.0	.....	.....
								80	2.1	.....	.....
								120	3.1	.....	.....
50	July 11	5 p. m.	51 00	51 15	142	.....	.....	0	3.6	32.72	26.03
								10	2.2	32.74	26.16
								20	−0.5	33.26	26.74
								30	−0.8	33.46	26.91
								50	−1.0	33.71	27.13
								70	−1.1	.....	.....
								105	−1.1	33.35	26.84
								140	−0.8	33.80	27.19
51	July 12	10 a. m.	51 50	52 28	170	.....	.....	0	3.2	32.83	26.16
								15	3.1	.....	.....
								25	0.4	32.95	26.27
								50	−0.4	33.66	26.50
								90	1.2	.....	.....
								130	2.2	34.70	27.74
								170	3.0	34.51	27.51
52	July 12	6.30 p. m.	52 39	53 24	220	.....	.....	0	0.5	32.03	25.71
								25	−0.8	32.83	26.41
								50	−1.5	32.92	26.50
								120	−1.0	33.22	26.74
								160	0.8	34.25	27.47
								200	2.5	34.54	27.59

"Seneca" from April to August, 1914—Continued.

Nets.				Currents.				Remarks.
Description.	Depth.	Time.	Speed.	Depth.	Flow.	Cms. sec.	Knots, hour.	
No. 20 net	0							Green Bank; good haul in beam trawl.
No. 3	10							
B. trawl	42							
No. 3 net	10							
1-in. net	15							
B. trawl	25							
No. 20 net	0							
No. 3 net	10							
1-in. net	70							
do	140							
H. net	210							
No. 20 net	0							
No. 20	10							
do	20							
1-M. net	20							
H. net	85							
No. 20 net	0							
No. 20 net	10							
No. 20 net	20							
1-M. net	25							
H. net	75							
No. 20 net	0							
No. 20	10							
do	20							
1 M	25							
H	95							
No. 20 net	0							
No. 20	10							
do	20							
1 M	75							
H	175							
No. 20 net	0							The temperatures below the surface run lower as the ship moves westward in the Labrador current.
No. 3	20							
No. 20	10							
1 M	70							
H	140							
No. 20 net	0							
No. 20	10							
No. 3	20							
1-M. net	75							
H. net	150							
No. 20 net	0							In Labrador current diatoms very abundant.
No. 20	10							
No. 3	20							
H. net	150							

Stations taken by the U. S. Revenue Cutter

Station No.	Date.	Time of day.	Position.		Depth in fathoms.	Bottom.		Water, physical data.			
			Lat. N.	Long. W.		Character.	Sample.	Depth.	Temperature.	Salinity.	Density.
	From Halifax, Nova Scotia, to Grand Banks—Continued.										
	1914.		° ′	° ′					°C.		
53	July 13	10 a. m.	52 17	53 56	118	.....	.....	0	0.8	34.91	28.00
								15	−0.7	32.70	26.30
								25	0.7	32.72	26.25
								50	0.6	33.62	26.99
								75	−1.1	33.82	27.23
								100	−0.4	33.89	27.25
54	July 14	6.30 p. m.	51 44	53 31	243	.....	.....	0	2.0	31.91	25.23
								25	0.5	32.54	26.11
								50	−0.5	33.71	27.11
								70	−0.2	33.84	27.20
								105	0.8	33.98	27.26
								140	1.7	34.69	27.76
								175	2.5	34.61	27.65
55	July 14	6.30 p. m.	49 42½	52 11	176	.....	.....	0	4.3	32.56	25.84
								10	4.2	.....	.....
								20	2.0	32.86	26.28
								50	−1.4	33.62	27.07
								70	−1.1	32.74	26.34
								100	0.8	34.22	27.03
								170	2.4	34.61	27.65
56	July 16	2 p. m.	46 50	52 17	65	.....	.....	0	8.2	32.47	25.28
								10	7.5	32.56	25.45
								15	7.1	32.86	25.74
								30	1.9	32.56	26.05
								35	−1.2	33.10	26.63
								40	−1.5	33.33	26.83
								45	−1.4	.....	.....
								55	−1.5	33.44	26.92
								60	−1.3	33.17	26.70
57	...do.....	6.30 p. m.	46 29	52 08	35	.....	.....	0	8.2	.....	.....
								8	7.3	32.56	25.48
	"Ship anchored."							16	3.7	32.74	26.03
								24	1.0	.....	.....
								32	−1.2	33.30	26.58
			° ′	° ′							
58	July 17	12.30 p. m.	45 59	51 56	40	.....	.....	0	9.2	32.65	25.27
								10	8.2	32.65	25.37
								20	4.5	32.74	25.95
								30	1.0	32.95	26.43
								40	−0.6	.....	.....
59	...do.....	7 p. m.	45 24	51 38	36	.....	.....	0	9.7	32.74	25.25
								5	9.4	.....	.....
								15	8.3	32.74	25.47
								20	−0.4	34.76	27.95
								25	−0.4	.....	.....
								30	2.1	.....	.....
								17	4.3	.....	.....
60	July 18	1 p. m.	44 50	51 29	36	.....	.....	0	9.2	33.26	25.74
								10	8.2	32.65	25.42
								20	4.5	32.79	26.00
								30	1.0	32.99	26.46
								35	−0.6	.....	.....
								7	8.9	32.65	25.31
								21	4.4	32.84	26.05
								22	4.0	33.01	26.22
								32	0.3	33.01	26.52

"Seneca" from April to August, 1914—Continued.

Nets.				Currents.				Remarks.
Description.	Depth.	Time.	Speed.	Depth.	Flow.	Cms. sec.	Knots, hour.	
No. 20 net	0							
No. 20	10							
No. 3	20							
1-M. net	60							
H. net	120							
No. 20 net	0							
No. 20	10							
No. 3	5							
1 M	100							
H. net	200							
No. 20 net	0				0			
do	20			0	140 T.		1.28	
No. 3 net	10							
1-m. net	100							
H. net	200							
No. 20 net	0							
No. 3 net	10							
No. 20 net	25							
1-in. net	25							
H. net	50							
No. 20 net	0							Current meter observations begun at station 57, and were made at alternate stations, viz, 57, 59, 61, 63, 65, and 66.
do	20							
No. 3 net	10							
Beam trawl	35							
				0	N		.25	9.02 to 9.17 p. m., July 16.
				30	N. by W		.242	Do.
No. 20 net	0			30	N. N. E		.302	10.07 to 10.22 p. m., July 16.
do	20			0	N		.20	Do.
No. 3 net	10			0	E		.16	11.05 to 11.20 p. m., July 16.
1-m. net	30			30	N. N. E		.329	Do.
H. net	40			0	S		.16	12.01 to 12.16 a. m., July 17.
				30	NE. by E		.253	Do.
				0	SSW		.30	1.10 to 1.26 a. m., July 17.
No. 20 net	0			30	ENE		.346	Do.
No. 3 net	10	Station 57		0	SSW		.40	2.08 to 2.23 a. m., July 17.
No. 20 net	20			30	NNE		.362	Do.
Beam trawl	36			0	SE		.30	3.07½ to 3.22½ a. m., July 17.
				30	N		.270	Do.
				0	SE		.50	4.11.40 to 4.26.40 a. m., July 17.
				30	N. by W		.242	Do.
				0	ESE		.50	5.3.10 to 5.18.10 a m., July 17.
No. 20 net	0			30	N. by W		.302	Do.
No. 3 net	10			0	ESE		.40	6.3.15 to 5.18.15 a. m., July 17.
No. 20 net	20			30	WNW		.241	Do.
1-m. net	30			0	ESE		.40	7.3.25 to 7.18.25 a. m., July 17.
Beam trawl	35			30	NW		.254	Do.
				0				7.45 to 8 p. m., July 17.
				30	W		.124	Do.
		Station 59		0	SSE		.065	8.46 to 9.01 p. m., July 17.
				30	N. 50° W		.120	Do.
				0	SSE		.02	9.46 to 10.01 p m., July 17.
				30	N. 50° W		.121	Do.

Stations taken by the U. S. Revenue Cutter

Station No.	Date.	Time of day.	Position.		Depth in fathoms.	Bottom.		Water, physical data.			
			Lat. N.	Long. W.		Character.	Sample.	Depth.	Temperature.	Salinity.	Density.
	From Halifax, Nova Scotia, to Grand Banks—Continued.										
	1914.		° ′	° ′					° C.		
61	July.....	6.30 p. m..	44 20	51 09	38	.....	.....	0	13.1	.....	.....
								5	12.5	32.74	25.65
								15	11.4	32.56	24.82
								17	7.8	32.70	25.51
								19	2.7	32.90	26.25
								20	1.6	32.92	26.36
								25	1.1	32.92	26.39
								35	0.7	32.95	26.74
62	July 19	12.30 p. m.	43 46	50 50	36	.....	.....	0	15.0	32.72	24.76
								10	13.3	32.72	24.58
								15	8.9	32.79	25.45
								18	3.3	32.92	26.22
								20	1.4	32.99	26.43
								30	1.5	33.03	26.45
63	...do.....	6.30 p. m..	43 20	50 26	36	.....	.....	0	15.1	32.61	24.12
								5	14.0	32.61	24.36
								10	12.2	32.70	24.78
								13	7.9	.....	.....
								15	4.9	.....	.....
								20	0.9	32.75	26.27
								30	0.4	33.01	.....
64	July 20	1 p. m.....	43 41	49 56	30	.....	.....	0	14.3	32.74	24.20
								10	11.4	32.65	24.88
								15	7.1	.....	.....
								18	3.8	33.06	26.28
								20	2.6	.....	.....
								30	2.4	33.15	26.49
65	...do.....	8 p. m.....	44 05	49 41	23	.....	.....	0	13.6	32.70	24.51
								5	13.4	.....	.....
								10	9.8	32.72	25.23
								13	7.8	32.72	25.53
								15	3.3	32.92	26.22
								20	1.8	33.15	26.53

"Seneca" from April to August, 1914—Continued.

Nets.				Currents.				Remarks.
Description.	Depth.	Time.	Speed.	Depth.	Flow.	Cms. sec.	Knots, hour.	
				0	SSW		.02	10.46 to 11.01 p. m., July 17.
				30	E		.119	Do.
				0	SSE		.20	11.47 to 12 p. m., July 17.
				30	N. 20° W.		.202	Do.
No. 20 net	0			0	NNW		.30	1.03 to 1.18 a. m., July 18.
No. 3 net	10			30	S		.241	Do.
No. 20 net	20			0	SE		.30	2.9 to 2.24 a. m., July 18.
1-m. net	25			30	NW		.238	Do.
Beam trawl	35			0	NNW		.30	3.05 to 3.20 a. m., July 18.
				30	NW		.201	Do.
		Station 59		0	E		.28	4.14.15 to 4.34.15 a. m., July 18.
				30	N. 50° W		.237	Do.
				0	E		.30	4.45 to 5 a. m., July 18.
				30				
				0	ENE		.40	5.45 to 6 a. m., July 18.
				30	N. 20° W		.08	Do.
				0	ENE		.30	6.45 to 7 a. m., July 18.
				30	N. 20° W		.196	Do.
				0	E		.40	7.40.55 to 7 a. m., July 18.
				30	N. 20° W		.200	Do.
				0	E		.10	7.50 to 8.05 p. m., July 18.
				30				Do.
				0	SE		.30	8.46 to 9.01 p. m., July 18.
				30	N. 10° W		.09	Do.
				30	N. 50° E		.07	9.45 to 10 p. m., July 18.
				0	SE		.40	Do.
				0	SSE		.40	10.45 to 11 p. m., July 18.
				30	S. 20° E		.202	Do.
				0	SSE		.40	11.46 to 12.01 a. m., July 19.
				30	S. 75° E		.123	Do.
				0	W. by N		.10	1.09 to 1.24 a. m., July 19.
				30	ESE		.252	Do.
		Station 61		0	W. by N		.20	2.06 to 2.21 a. m., July 19.
				30	SE		.269	Do.
				0	NNW		.10	3.08 to 3.23 a. m., July 19.
				30	S		.241	Do.
				0	NNW		.20	4.15.40 to 4.30.40 a. m., July 19.
				30	S. 20° W		.122	Do.
No. 20 net	0			0	N		.10	4.42 to 4.57 a. m., July 19.
No. 3 net	10			30	S. 55° W		.243	Do.
No. 20 net	20			0	N		.10	5.45 to 6 a. m., July 19.
1-m. net	20			30	W		.243	Do.
Beam trawl	36			0	N. by E		.10	6.45 to 7 a. m., July 19.
				30	N. 60° W			Do.
				0	ENE		.30	8 to 8.15 p. m., July 19.
				30	N. 50° W		.478	Do.
No. 20 net	0			0	ENE		.30	8.48 to 9.03 p. m., July 19.
No. 3 net	10			30	N. 50° W		.710	Do.
No. 20 net	20			0	E		.40	9.45 to 10 p. m., July 19.
1-m. net	20			30	N. 20° W		.790	Do.
Beam trawl	30			0	ESE		.40	10.46 to 11.01 p. m., July 19.
				30	E. 10° N		.415	Do.
				0	SE		.40	11.54 to 12.09 a. m., July 20.
				30	N		.363	Do.
				0	NNW		.10	2.06 to 2.21 a. m., July 20.
		Station 63		30	NE. by E		.334	Do.
No. 20 net	0			0	NNE		.20	3.5.20 to 3.20.20 a. m., July 20.
No. 3 net	10			30	S		.401	Do.
No. 20 net	20			0	NNE		.30	4.18 to 4.33 a. m., July 20.
1-m. net	20			30	S. 40° E		.376	Do.
Beam trawl	23			0	N. by E		.20	5 to 5.15 a. m., July 20.
				30	W. to E. through S.		.384	Do.
				0	N. by E		.20	6 to 6.15 a. m., July 20.
				30	E		.300	Do.
				0	NNE		.20	7.05 to 7.20 p. m., July 20.
				30	S. 20° E		.345	Do.

Stations taken by the U. S. Revenue Cutter

Station No.	Date.	Time of day.	Position.		Depth in fathoms.	Bottom.		Water, physical data.			
			Lat. N.	Long. W.		Character.	Sample.	Depth.	Temperature.	Salinity.	Density.
	From Halifax, Nova Scotia, to Grand Banks—Continued.										
	1914.		° ′	° ′					°C.		
66	July 21	1 p. m.	44 38	49 23	36	.....	.....	0	11.8	32.72	24.88
								10	10.6	32.74	25.10
								15	7.0	32.75	25.68
								17	4.0	33.10	26.30
								20	1.2	33.33	26.71
								25	−0.6	.....	.....
								35	−1.0	33.33	26.82
67	July 22	9 a. m.	45 07	49 05	32	.....	.....	0	11.8	32.77	24.92
								10	10.0	32.79	25.25
								15	7.0	32.81	25.72
								20	3.4	32.97	26.25
								25	0.4	33.10	26.57
								30	−1.3	33.37	26.89
								35	−0.5	.....	.....
68	do	4.30 p. m.	45 08	48 20	800	.....	.....	0	8.0	32.54	25.36
								25	3.9	33.77	26.91
								50	2.4	34.36	27.45
			Silt and globigerina.					100	2.7	33.17	26.47
								200	2.9	33.08	26.38
								400	3.4	34.76	27.67
69	July 23	2 p. m.	45 09	46 42	2,000	.....	.....	0	10.8	32.45	24.84
								10	8.1	32.48	25.31
								25	5.5	33.24	26.25
								50	1.9	34.04	27.23
								75	4.7	34.40	27.25
								100	4.6	34.63	27.45
								200	3.4	34.78	27.61
								400	3.9	.....	.....

"Seneca" from April to August, 1914—Continued.

Nets.				Currents.				Remarks.
Description.	Depth.	Time.	Speed.	Depth.	Flow.	Cms. sec.	Knots, hour.	
				0	NNE		.20	7.50 to 8.05 p. m., July 20.
				30				Do.
				0	ENE		.60	8.45 to 9 p. m., July 20.
				30	N. 50° W		.446	Do.
				0	ENE		.40	9.45 to 10 p. m., July 20.
				30	N. 40° W		.448	Do.
				0	E		.50	10.47 to 11.03 p. m., July 20.
				30	N. 10° W		.450	Do.
				0	SE		.50	12.6.30 to 12.21.30 a. m., July 21.
				30	NE		.426	Do.
				0	SW		.50	1.07 to 1.22 a. m., July 21.
		Station 65		30	NNE		.331	Do.
				0	SW		.50	2.9.40 to 2.24.40 a. m., July 21.
				30	E		.424	Do.
				0	WSW		.40	3.6.30 to 3.21.30 a. m., July 21.
				30	SE		.410	Do.
				0	WSW		.40	4.15 to 4.30 a. m., July 21.
				30	S. 40° E		.353	Do.
				0	NNW		.30	5.01 to 5.16 a. m., July 21.
				30	S. 30° E		.330	Do.
				0	NW. by N		.30	6.2.15 to 6.17.15 a. m., July 21.
				30	S. 50° W		.292	Do.
				0	NNE		.30	7.1.25 to 7.16.25 a. m., July 21.
				30	N. 80° W		.220	Do.
				0	N		.30	2.14 to 2.29 p. m., July 21.
				20	NE		.520	Do.
				0	N		.30	4.45 to 5 p. m., July 21.
				20	S		.420	Do.
				0	NE		.20	5.50 to 6.05 p. m., July 21.
				20	S. 10° W		.386	Do.
				0			.1	6.47 to 7.02 p. m., July 21.
				20	S. 40° W		.487	Do.
				0	SSE		.30	7.47 to 8.02 p. m., July 21.
				20	S. 50° W		.565	Do.
				0	SSW		.50	8.46 to 9.01 p. m., July 21.
		Station 66		20	N. 80° W		.598	Do.
				0	SE. by S		.40	9.47 to 10.02 p. m., July 21.
				20	S. 35° W		.563	Do.
				0	SSE		.40	10.46 to 11.01 p. m., July 21.
				20	N. 45° W		.485	Do.
				0	S		.40	11.54 to 12.09 a. m., July 21.
				30	N		.450	Do.
				0	SW		.60	1.12 to 1.27 a. m., July 21.
				30	NNE		.426	Do.
				0	NNW		.70	2.09 to 2.24 a. m., July 21.
No. 20 net	0			30	NE		.404	Do.
No. 3 net	10			0	NNW		.60	3.08 to 3.22 a. m., July 21.
No. 20 net	20			30	E		.363	Do.
H. net	30							
								Station 66 last of current meter observations.
No. 20 net	0							
No. 3 net	10							
No. 20 net	20							
1 m. net	75							
H. net	150							
No. 20 net	0							
No. 3 net	10							
No. 20 net	20							
1 m. net	100							
H. net	175							

Stations taken by the U. S. Revenue Cutter

Station No.	Date.	Time of day.	Position.		Depth in fathoms.	Bottom.		Water, physical data.			
			Lat. N.	Long. W.		Character.	Sample.	Depth.	Temperature.	Salinity.	Density.
	From Halifax, Nova Scotia, to Grand Banks—Continued.										
	1914.		° ′	° ′					° C.		
70	...do....	7 p. m.....	45 10	46 02	797	.....	.....	0	11.0	33.06	25.29
								25	8.7	32.95	25.58
								35	5.0	.....	.....
								50	3.0	34.22	27.29
								75	3.5	34.67	27.59
								100	3.7	34.76	27.64
								200	4.5	.....	.....
								400	3.4	33.80	26.91
71	July 24	11 a. m....	46 17	45 45	.....	.....	.....	0	11.0	33.24	25.43
								25	6.9	34.09	26.73
								50	3.4	34.67	27.60
								75	3.8	34.67	27.56
								100	3.6	.....	.....
								200	3.3	34.76	27.68
								400	3.1	34.85	27.77
72	...do....	8 p. m.....	46 55	45 12	100	.....	.....	0	11.5	32.95	25.11
								15	10.1	33.96	25.84
								25	6.6	.....	.....
								35	3.2	34.31	27.34
								50	3.1	34.67	27.63
								75	2.6	33.95	27.10
								100	2.6	34.67	27.68
73	July 25	11 a. m....	47 13	46 58	405	.....	.....	0	7.85	33.21	25.90
								25	4.3	33.58	26.67
								50	2.5	34.49	26.54
								100	2.6	34.69	27.69
								200	2.8	33.35	26.61
								400	2.95	33.42	26.65
74	July 25	8 p. m.....	47 7.4	48 19	70	.....	.....	0	7.9	32.34	25.21
								10	7.7	32.34	25.24
								15	3.8	32.52	25.86
								20	0.6	32.36	25.97
								25	−0.6	32.38	26.03
								50	−1.6	33.26	26.74
								65	−1.6	32.38	26.02
75	July 26	9 a. m.....	47 21	49 31	43	.....	.....	0	8.0	32.79	25.57
								10	7.7	32.79	25.61
								20	6.1	.....	.....
								25	3.2	32.88	26.20
								30	1.5	32.90	26.34
								40	−1.3	32.95	26.53
								43	−1.5	33.39	26.88
76	...do.....	2.30 p. m..	47 25	50 35	59	.....	.....	0	9.0	32.59	25.26
								10	7.0	32.61	25.56
								20	3.4	32.86	26.13
								25	1.7	32.79	26.25
								30	1.0	33.04	26.50
								40	−0.7	33.22	26.73
								60	−1.4	32.61	26.25
77	...do.....	7 p. m.....	47 35	51 37	72	.....	.....	0	9.5	31.69	24.58
								10	6.5	32.05	25.18
								15	3.2	33.31	26.55
								20	0.1	32.86	26.39
								25	−1.1	33.13	26.66
								50	−1.7	32.43	26.11
								70	−1.7	32.07	25.82

"Seneca" from April to August, 1914—Continued.

Nets.				Currents.				Remarks.
Description.	Fathoms.	Time.	Speed.	Fathoms.	Flow.	Cms. sec.	Knots, hour.	
No. 20 net	0							
No. 3 net	10							
No. 20 net	20							
1 m. net	75							
H. net	150							
No. 20 net	0							
No. 3 net	10							
No. 20 net	20							
1 m. net	100							
H. net	200							
No. 20 net	0							
No. 3 net	10							
No. 20 net	20							
1 m. net	50							
H. net	100							
No. 20 net	0							
No. 3 net	10							
No. 20 net	20							
1 m. net	100							
H. net	200							
No. 20 net	0							77 stations in all were taken on the several cruises of the U. S. revenue cutter Seneca from April to August, 1914.
No. 3 net	10							
No. 20 net	20							
H. net	50							
No. 20 net	0							Stations 1 to 45 were taken during the "ice patrol." Stations 46 to 77 were taken on the special northern cruise.
No. 3 net	10							
No. 20 net	20							
H. net	40							
No. 20 net	0							
No. 3 net	10							
No. 20 net	20							
H. net	50							
No. 20 net	0							
No. 3 net	10							
No. 20 net	20							
1-m. net	50							
H. net	60							

Current observations on the Great Bank, July 16 to 22, 1914.

[For longitude and latitude, see stations 57 to 67, preceding tables.]

Date.	Hour, St. Johns, Newfoundland, mean time.	Current.			
		Surface.		30 fathoms.	
		Direction.	Knots.	Direction.	Knots.
1914.					
July 16	9.02 p. m	?	0.25	N. by W	0.242
	10.07 p. m	?	.20	NNE	.302
	11.05 p. m	E	.17	do	.329
July 17	12.01 a. m	S	.17	NE. by E	.253
	1.10 a. m	SSW	.33	ENE	.346
	2.08 a. m	do	.40	NNE	.362
	3.07 a. m	SE	.33	N. by E	.270
	4.11 a. m	do	.50	?	.242
	5.03 a. m	ESE	.50	NNW	.302
	6.03 a. m	do	.40	WNW	.241
	7.03 a. m	do	.40	NW. by W	.254
	7.45 p. m	No drift		W	.124
	8.46 p. m	SSE	.065	NW	.121
	9.46 p. m	do	.02	NNW	.121
	10.46 p. m	do	.02	E	.119
	11.47 p. m	do	.20	NNW	.202
July 18	1.03 a. m	NNW	.30	?	.241
	2.09 a. m	SE	.30	NW	.238
	3.05 a. m	NNW	.30	do	.201
	4.14 a. m	E	.28	do	.237
	4.45 a. m	do	.3	?	
	5.45 a. m	ENE	.4	NNW	.08
	6.45 a. m	do	.3	do	.196
	7.40 a. m	E	.4	do	.200
	7.50 p. m	do	.1	?	
	8.46 p. m	SE	.3	N. by W	.09
	9.45 p. m	do	.4	NE	.07
	10.45 p. m	SSE	.4	SSE	.202
	11.46 p. m	do	.4	E. by S	.123
July 19	1.09 a. m	W. by N	.1	ESE	.252
	2.06 a. m	do	.2	SE	.269
	3.08 a. m	NNW	.1	S	.241
	4.15 a. m	do	.2	SSW	.122
	4.42 a. m	N	.1	SW. by W	.243
	5.45 a. m	do	.1	W	.243
	6.45 a. m	NE	.1	NW. by W	(?)
	8 p. m	ENE	.3	NW	.478
	8.48 p. m	do	.3	do	.710
	9.45 p. m	E	.4	NNW	.790
	10.46 p. m	ESE	.4	E. by N	.415
	11.54 p. m	SE	.4	N	.363
July 20	2.06 a. m	NNW	.1	NE. by E	.334
	3.05 a. m	NNE	.2	S	.401
	4.18 a. m	do	.3	SE	.376
	5 a. m	N. by E	.2	? (W. to E. through S.)	.384
	6 a. m	do	.2	E	.300
	7 a. m	NNE	.2	SSE	.345
	7.50 a. m	do	.2	?	
	8.45 p. m	do	.6	NW	.446
	9.45 p. m	do	.4	NW. by N	.448
	10.47 p. m	E	.5	N. by W	.450
July 21	12.05 a. m	SE	.5	NE	.426
				20 fathoms.	
	1.07 a. m	SW	.5	ENE	.331
	2.09 a. m	do	.5	E	.424
	3.06 a. m	WSW	.4	SE	.410
	4.15 a. m	do	.4	do	.353
	5.01 a. m	NNW	.3	SE. by S	.330
	6.02 a. m	NW. by N	.3	SW	.292
	7.01 a. m	NNE	.3	W. by N	.220
	2.14 p. m	N	.3	NE	.520
	4.45 p. m	NNE	.3	S	.420
	5.50 p. m	NE	.2	S. by W	.386
	6.47 p. m	do	.1	SW	.487
	7.47 p. m	SSE	.3	do	.565
	8.46 p. m	SSW	.5	W. by N	.598
	9.47 p. m	SE. by S	.4	SW. by S	.563
	10.46 p. m	SSE	.4	NE	.485
	11.54 p. m	S	.4	N	.450
July 22	1.12 a. m	SW	.6	NNE	.426
	2.09 a. m	NNW	.7	NE	.404
	3.08 a. m	do	.6	E	.363

REPORT ON PHYSICAL OBSERVATIONS.

(Made by Bureau of Standards Observer A. L. Thuras on board the U. S. revenue cutter *Seneca* while on the International Ice Patrol during the months of April, May, June, and July, 1914.)

The *Seneca* made four cruises, three to the southern location of the ice along the east edge of the Banks of Newfoundland; the fourth cruise occupied about a month, covering a distance as far as latitude 53° N., south over the Great Banks of Newfoundland and east to Flemish Cap.

The work consisted of observations of temperature of both water and air, barometric pressure, humidity, winds, clouds, weather, precipitation and ice conditions. Observations were taken with considerable care and for the most part in duplicate.

SURFACE WATER TEMPERATURES.

With the exception of a few days a continuous record of the sea water temperature was obtained while underway. A platinum resistance thermometer was placed in one of the main inlet pipes to the condenser, through which a continuous stream of sea water passed. The water was taken in at a depth of about 3 fathoms so that the small surface irregularities in temperatures were probably avoided.

APRIL CRUISE.

On leaving Halifax Harbor April 1, the temperature was 0.6° C. This was quite constant until shallower water was reached, about 80 miles from Halifax, when the temperature rose about a degree varying somewhat until about 50 miles more had been covered. At this place on leaving Sable Island Bank the temperature dropped again to 0°. The slight rise in temperature was noted between Emerald Bank and Sable Island Bank, where the depth varies from 30 to 50 fathoms.

From Sable Island Bank the temperature remained around 0° until position b (on the chart) was reached, where the temperature rose to 2.5° and kept rising until it reached 9.8° between positions (2) and (3). It then dropped off to 1° on reaching the west side of the Newfoundland Banks at about latitude 43° 20′ N. Crossing the banks the temperature dropped to −1.1°. On leaving the east edge between (7) and (8) the temperature suddenly rose to 11.8°. This temperature was obtained for 10 miles on course SE., when the temperature again dropped to −1.2°. A small variation from −1° to 1° was noted until leaving position (22) when the temperature rose irregularly to 2.5° about midway between (23) and (24). From here the temperature again began to gradually decrease to about −1.2°. This continued beyond position (25). On leaving the banks the temperature rose to

3.5° at position (26). Between positions (27) and (28) the temperature again dropped gradually to −1.2°.

The southern location of the ice at this season of the year had now been reached and the temperature did not vary much from 0°. Back across the banks on April 15, and about 50 miles farther north the temperature stood quite constant at about 1°. Coming to the western edge of the banks the temperature rose strata-like to about 7°. From here on across the gully the temperatures were as a whole variable, although sometimes for a distance of 15 miles quite constant.

From (51) on, the temperature became quite steady at 0.5° until reaching (53) where the temperature gradually increased to 2° and remained at this value to within 10 miles of the mainland, when it decreased again to 0.5° and was fairly constant to the coast.

MAY CRUISE.

On the way out from Halifax Harbor the temperature was variable around 2°. After passing Middle Ground the temperature began to slowly decrease until 0.5° was obtained on the east side of the gully (a deep channel starting from the mouth of the St. Lawrence). On crossing the gully the temperature rose to 3.5° dropping a little from longitude 55° 30′ to 55° W. and rising again beyond. On the banks the temperature stood steady at about 1.5°. At (7) the temperature began to decrease and at (8) it was 0.1°; there was then a slow rise to about 1.5°, remaining quite constant at this value until reaching the Gulf Stream at latitude 41° 40′, longitude 48° 50′, giving a temperature of 13°, increasing a little later to 14.6°. We again passed out of the Gulf Stream between positions (24) and (25). After a few days the Gulf Stream water was found several miles north of the above position. The winds were mostly from a southerly direction during this time. The temperature remained high most of the time until starting for Halifax on May 15.

On the way back the temperature was very irregular; at the banks it was 5.8° maximum, dropping gradually to about 3°, then just before entering the harbor the temperature rose to about 4°.

No definite changes in temperature could be attributed to shoal water. It seems from the varying temperature that the Gulf Stream had affected all of the water on the way back. This was in latitude 43° N.

JUNE CRUISE.

At the mouth of the harbor a temperature of 5.9° was obtained. Steaming ESE. a rise to 6.8° was noted about 40 miles from the mouth of the harbor in 120 fathoms of water. This continued for 15 miles when the temperature dropped to 4° and varied slightly while passing over Sable Island Bank. There was no definite change in temperature on leaving the banks this time. The temperature was very unsteady; there seemed to be a mixing of warm and cold water.

At about longitude 58° W. the temperature began to rise gradually but very irregulary until longitude 56° 40′ W. was reached, where a maximum temperature of 12° was obtained. There was then a slight drop for a distance of 40 miles. During this whole time the temperature was very unsteady, sometimes varying 2° or 3° in 1½ miles. A little east of position (2) the temperature began to rise quite rap-

idly. We had now reached the Gulf Stream and the temperature varied all the way from 11° to 17°.

At position (16) a cold area of water was found (4.6°), but the temperature soon increased to that of the Gulf Stream. This cold water was encountered while drifting toward (16) and underway toward (17). At position (28) a temperature of 7° was recorded, which continued quite constant for about 35 miles; the temperature then rose to 11° around position (33) but dropped to 6.4° at position (35).

North beyond latitude 42° N. the temperature was very irregular, varying from 4.5° to 13°.

On the Newfoundland banks beyond (78) the temperature began to decrease and averaged about 5° on Whale Deep, Green Banks, and St. Pierre Banks. At position (82) there was a rise in temperature across the gully, reaching 6.5°, then dropping again to 5°, coming to the Artimon Banks. This temperature was quite constant to the harbor, where the temperature increased to 8.3°.

Summary.—The temperature in Halifax Harbor is slightly warmer than just outside. There is a cold body of water along the coast out to where the water becomes more shallow in the vicinity of Sable Island Bank; here the temperature rises slightly. On the east edge of this shoal water the temperature goes down but rises again on reaching the large gully of deep water coming down through Cabot Straits and between Nova Scotia and Newfoundland. On the Newfoundland Banks the temperature again decreases, and the whole bank seems to be covered with water at a temperature lower than that where the bottom is deeper. On the east side of the bank in about 1,000 fathoms of water the temperature rises.

JULY CRUISE.

On leaving the harbor of St. Johns the temperature stood at 6.7°; at 50 miles the temperature was 6° and at position (7) it had decreased to 3.3°. Here there was an increase toward (8) to about 6°, remaining quite constant for a few miles, then decreasing to 2° at (9). The temperature then varied slightly until we passed into a field of ice at position (11) where it dropped irregularly toward (12) to 0.6°. Midway from (14) to (15) the temperature was again very irregular; numerous small bergs were passed. After leaving the ice the temperature was fairly constant, increasing to 8° on approaching St. Johns.

The temperature south over the banks increased gradually to 9.5° at position (21) and 15° at position (24). At (25) the temperature was 15.4° and remained quite constant across to (26). This position was evidently in the Gulf Stream, but there was no definite increase in temperature as noted in the April cruise. The temperature now gradually increased to 9.5° between (29) and (30), increasing to 11.7° a little beyond (31). At Flemish Cap the temperature was 11°.

Going east from Flemish Cap the temperature immediately began to drop and continued decreasing irregularly to 6.5° at (33); toward St. Johns the temperature increased to 9°.

Leaving St. Johns on July 28, the temperature stood at about 9°; along the Newfoundland coast it was very irregular, varying between

6 and 10°. Around Cape Race and beyond the temperature became quite steady at 10.3°. Along the southern coast of Newfoundland the temperature increased to 12°, and coming over the gully there was a slight rise until 14° was reached. About 20 or 25 miles from Halifax Harbor the temperature irregularly and quite rapidly dropped to 10.7°.

ATMOSPHERIC TEMPERATURES.

True temperatures of the air are difficult to obtain aboard ship, as the heat produced by the ship is not very easily avoided. The weather shelter used was placed on the bridge for a while but afterwards moved to the searchlight deck over the upper pilot house. Observations made here were satisfactory, agreeing well with those made by the dry bulb thermometer on the windward side of the vessel.

A thermograph was used in the weather shelter and a continuous record of the temperature was obtained. The ordinary thermograph is not very suitable for marine work as the salt spray and damp atmosphere corrode the metallic parts.

Marked differences were noted in temperatures taken at different levels. On the Newfoundland Banks north of the Gulf Stream decided reverses in the temperature gradient were obtained amounting to as much as 2.5° in 50 feet, the upper thermometer reading higher. This condition may be due to the warm moist air from the Gulf Stream blowing over onto the cold Labrador current, the lower strata of air being cooled by the cold water. Farther north this effect was not so marked as closer to the Gulf Stream.

On approaching the coast of Newfoundland with the wind blowing from the land the upper thermometer read 4° higher than the lower thermometer in a vertical distance of 60 feet. Temperatures were taken at close intervals and as soon as the wind shifted to the sea the temperatures of the two thermometers became equal. This was at a distance of 5 miles from land.

HUMIDITY.

Great care must be taken in the measurement of humidity, as errors are very easily made if the proper precautions are not taken. A sling psychrometer was used and operated on the windward side of the ship; consistent results were obtained. The humidity was always high. In a fog it was usually near 100 per cent, although seldom did both thermometers read exactly the same. Checks were made between the Assmann and sling psychrometers and they agreed very well.

PRECIPITATION.

The rain gauge was fastened to the searchlight platform above the bridge. This seemed to be the most satisfactory location, as at this place there was the least obstruction to catching the rain. The results are only approximate, as the horizontal projected area of the gauge changes considerably with large angles of roll.

The precipitation in April was quite low, 0.24 inch from April 4 to 17. In May the precipitation was 0.73 inch from April 29 to May 17. In June the rainfall increased to 2.17 inches from May 29 to June 17.

ATMOSPHERIC PRESSURE.

The atmospheric pressure was measured with a marine mercurial barometer, an aneroid, and a barograph. The mercurial could not be read at sea in rough weather; it was therefore used only to check up the aneroid when possible. The barograph gave a continuous record of the pressure and compared quite well with the aneroid. The barograph was a little sluggish in its action as the pen arm had to be screwed up rather tightly so that it would not leave the paper.

The pressure for the four months ranged between 29.22 and 30.49 inches of mercury. The largest and most rapid changes in pressure were observed in April and also the storms and high winds were the greatest in this month. The May variations in pressure were less and for some weeks in June the curves on the barograph sheets were almost straight lines. On the June cruise the greater part of the month was very pleasant weather with very few days of high wind velocity; we were also quite far south as noted on the chart. The average pressure for May was higher than that for April and the average for June was higher than the average in May.

TEMPERATURE EFFECTS AROUND ICEBERGS.

The bergs were usually passed at a distance of about 300 yards and underway. Coming up to this distance there was no definite rise or fall in temperature that would repeat itself with regularity. Sometimes there would be a gradual rise and at other times there would be a fall in temperature. Steaming by some bergs the temperature would be quite constant and regular; at others it would be very irregular. No definite temperature effects could be attributed to the presence of icebergs.

WATER TEMPERATURE GRADIENT.

Two platinum thermometers were placed against the inside hull of the ship, one a few feet below the water line and the other as low as possible. A vertical difference of only 9 feet could be obtained, but in this sensible differences in temperature were sometimes noted, amounting in the Gulf Stream to almost a degree.

Frequent readings were taken on approaching bergs, both in cold and warm water (5° C.), but no marked differences were observed. The upper thermometer almost always read higher than the lower thermometer, the difference varying from 0 to 0.9° C. This might be expected, as the general gradient of the sea water temperature is in this direction, the surface being usually warmer.

TEMPERATURES CLOSE TO BERGS.

At several times a small boat was used to obtain temperatures close around bergs. On April 12 a series of temperatures around a large berg was taken. At 800 yards the temperature was 0.4°, gradually going down to 0.1° at 200 yards; the temperature then rose a little, and at 20 feet it stood at 0.3°; on the opposite side of the berg at a distance of 20 feet the temperature was 0.1°. Around another

berg in warmer water the temperature on one side at 20 yards was 1.9° and on the opposite side 3.1°. Away from the berg irregular temperatures were obtained with no definite trend. At another berg in still warmer water temperatures on two sides at a distance of 50 feet were 4.9° and 5.2°. Temperatures were then obtained at every 30 yards to a distance of 1,000 yards. The temperatures increased very irregularly to 6°.

The effect of bergs on the temperature of the sea water is at most very small, even in the warmer water. The temperature on approaching bergs is often very irregular, with no definite decrease or increase. If there are temperature effects due to bergs they are not distinguishable from the irregular variations observed.

CHARACTERISTICS OF BERGS.

The most southern bergs, those in which we were interested, were found along the eastern edge of the Newfoundland Banks. Early in April they were located at about latitude 43° N., in May they had drifted farther south, and in June the bergs were found as far south as latitude 40° 55′ N. Here most of the bergs drifted into the Gulf Stream and were carried eastward. As the water is quite warm, the bergs disintegrate and melt very rapidly and are consequently unstable. There is a constant crackling sound, and often a loud report is heard, due possibly to the fractures caused by the immense strains produced by unequal expansion.

Bergs are most rich in color; at a distance they appear white, but close by some of the most intense blues and beautiful shades of green are seen in the crevices and cracks along the faces of the bergs. Sometimes streaks of brownish-yellow were observed, which are probably due to diatoms carried down from the north where they are found in abundance.

Echoes were obtained from all bergs having a perpendicular or nearly perpendicular face. Some echoes were heard at as great a distance as 1,000 yards, but the majority were inaudible at distances greater than 400 yards. One fantastically shaped berg, with steep sides and a high peak toward the center, gave repeated echoes.

A sample of ice from one of the bergs was obtained and the amount of dissolved air found to be about 1 per cent; this ice was quite clear and contained probably the minimum amount of air. Berg ice is white and nontransparent. It has no definite cleavage planes, but is covered with small lines which have no definite direction. The water obtained from the ice is fresh and very pure.

A remarkable optical phenomenon was observed one day when a berg which was ordinarily below the horizon was seen raised above it, at one time inverted and at another time erect. This phenomenon was observed near the Gulf Stream.

The phenomenon of ice blink was quite prevalent around ice fields. On clear nights, especially when the moon was up, the sky along the horizon in the direction of the ice was markedly lighter than the rest of the horizon; this effect could be noted before the ice was sighted.

Observations, Apr. 1 to Apr. 18, at 8 a. m., seventy-fifth meridian time.

Date.	Lat. N.	Long. W.	Dry.	Wet.	Humidity.	Vapor pressure.	Dew point.	Precipitation.
	° ′	° ′	° F.	° F.	Per cent.			
Apr. 4	43 03	52 30	39.0	35.3	70	0.166	30	0
Apr. 5	43 20	50 24	37.8	35.0	77	.175	31	0
Apr. 6	43 01	49 15	33.4	31.0	77	.143	27	0
Apr. 7	43 30	49 36	34.0	32.0	81	.156	29	0
Apr. 8	43 07	48 09	35.2	33.2	82	.166	30	0
Apr. 9	43 50	49 05	32.5	31.0	85	.156	29	0
Apr. 10	44 33	48 55	41.5	40.5	92	.240	39	0
Apr. 11	44 36	49 09	31.0	31.0	100	.172	31	0
Apr. 12	44 40	48 35	32.1	31.2	91	.164	30	0
Apr. 13	44 54	48 25	39.0	38.1	92	.218	37	0
Apr. 14	44 25	49 20	30.5	27.0	63	.106	21	0
Apr. 15	44 07	52 00	36.0	33.0	73	.133	25	0
Apr. 16	43 28	54 40	36.3	32.0	62	.132	25	0
Apr. 17	43 35	59 20	32.5	32.5	100	.184	33	0
Total precipitation								0

Temperatures in degrees Fahrenheit.
Relative humidity in percentage.
Vapor pressure in inches.
Precipitation in inches.
Barometric pressure in inches.
Positions in degree and minutes.

Observations, Apr. 1 to Apr. 18, at 8 a. m., seventy-fifth meridian time.

Date.	Lat. N.	Long. W.	Barometer. sea level.	Temperature.	Maximum.	Minimum.
	° ′	° ′		° F.	° F.	° F.
Apr. 4	43 03	52 30	29.92	37.5	37.5	32.0
Apr. 5	43 20	50 24	30.23	39.0	39.2	30.6
Apr. 6	43 01	49 15	30.31	33.1	40.1	32.1
Apr. 7	43 30	49 36	29.96	32.8	43.0	32.0
Apr. 8	43 07	48 09	30.32	35.5	35.5	32.0
Apr. 9	43 50	49 05	30.26	36.5	37.0	32.5
Apr. 10	44 33	48 55	30.02	39.0	40.5	37.0
Apr. 11	44 36	49 09	30.11	30.5	39.0	30.0
Apr. 12	44 40	48 35	30.40	34.5	34.5	31.0
Apr. 13	44 54	48 25	29.53	39.2	39.8	34.0
Apr. 14	44 25	49 20	30.21	30.4	30.8	29.0
Apr. 15	44 07	52 00	30.15	39.0	39.0	32.0
Apr. 16	43 28	54 40	30.39	39.2	39.8	27.0
Apr. 17	43 35	59 20	29.42	34.0	41.4	34.0

Observations, Apr. 1 to Apr. 18, at 8 a. m., seventy-fifth meridian time.

Date.	Lat. N.	Long. W.	Wind.		Clouds.		Weather.
			Direction.	Velocity.	Kind.	Amount.	
	° ′	° ′					
Apr. 4	43 03	52 30	NW	2	St. Cu	4	bc.
Apr. 5	43 20	50 24	WSW	3	Ci. St	6	bc.
Apr. 6	43 01	49 15	ESE	2	Ci	3	bc.
Apr. 7	43 30	49 36	W	8	St. Cu	10	oc.
Apr. 8	43 07	48 09	WSW	2		0	b.
Apr. 9	43 50	49 05	ESE	2	St. Cu	10	oc.
Apr. 10	44 33	48 55	S. by E	3	St	10	ocf.
Apr. 11	44 36	49 09	NW. by W	4	Nb	10	ochz.
Apr. 12	44 40	48 35	SSW	2	Ci	1	bc.
Apr. 13	44 54	48 25	S	4	A. Cu	10	ocf.
Apr. 14	44 25	49 20	W	4	A. Cu	6	bc.
Apr. 15	44 07	52 00	WSW	3	Ci. St	6	bc.
Apr. 16	43 28	54 40	E	2	At. Cu	5	bc.
Apr. 17	43 35	59 20	WNW	3	St	10	ocf.

Observations, Apr. 1 to Apr. 18, at 8 p. m., seventy-fifth meridian time.

Date.	Lat. N.	Long. W.	Barometer sea level No. 1206.	Thermometers.		
				Temperature No. 6992.	Maximum 17450.	Minimum 12078.
	° ′	° ′		°	°	°
Apr. 3	43 10	54 40	29.83	31.4	34.0	30.9
Apr. 4	43 23	50 50	30.09	33.1	40.4	33.0
Apr. 5	42 54	49 30	30.44	33.0	40.9	32.0
Apr. 6	43 32	49 25	29.63	41.4	41.4	33.1
Apr. 7	43 31	50 30	30.29	33.6	34.0	32.0
Apr. 8	43 41	48 32	30.35	34.2	39.1	33.1
Apr. 9	44 30	48 25	30.23	38.0	38.7	36.0
Apr. 10	44 27	49 21	29.91	35.5	39.5	35.5
Apr. 11	44 38	48 39	30.34	31.0	36.0	30.0
Apr. 12	44 55	48 28	30.08	35.3	43.3	31.2
Apr. 13	44 47	48 55	29.70	30.0	40.0	30.0
Apr. 14	44 15	50 20	30.31	33.1	33.7	30.0
Apr. 15	43 58	51 55	30.40	28.7	39.6	28.7
Apr. 16	43 45	57 00	29.66	37.2	39.8	27.5
Apr. 17	43 40	61 20	29.75	31.5	34.0	31.5

Observations, Apr. 1 to Apr. 18, at 8 p. m., seventy-fifth meridian time.

Date.	Lat. N.	Long. W.	Dry No. 7189.	Wet No. 7188.	Humidity.	Vapor pressure.	Dew point.	Precipitation.
	° ′	° ′	°	°	*Per cent.*			
Apr. 3	43 10	54 40	33.7	31.3	76	0.149	28	0
Apr. 4	43 23	50 50	32.9	31.4	85	.159	29	0
Apr. 5	42 54	49 30	33.3	30.7	76	.143	27	0
Apr. 6	43 32	49 25	44.0	43.0	92	.264	42	0
Apr. 7	43 31	50 30	35.0	31.5	68	.138	26	0
Apr. 8	43 41	48 32	35.3	32.8	77	.158	29	0
Apr. 9	44 30	48 25	39.0	38.6	97	.230	38	0
Apr. 10	44 27	49 21	36.3	36.6	100	.217	37	0
Apr. 11	44 38	48 39	30.6	29.2	85	.143	27	0
Apr. 12	44 55	48 28	36.5	35.0	87	.186	33	0
Apr. 13	44 47	48 55	32.8	28.5	58	.108	21	0
Apr. 14	44 15	50 20	35.5	31.2	62	.128	25	0
Apr. 15	43 58	51 55	31.0	27.0	60	.103	20	0
Apr. 16	43 45	57 00	40.2	39.0	92	.228	38	0
Apr. 17	43 40	61 20	30.2	30.2	100	.165	30	.24
Total precipitation								.24

Observations, Apr. 1 to Apr. 18, at 8 p. m., seventy-fifth meridian time.

Date.	Lat. N.	Long. W.	Wind.		Clouds.		Weather.	Fog in last 24 hours.	Maximum wind velocity in last 24 hours.
			Direction.	Velocity.	Kind.	Amount.			
	° ′	° ′							
Apr. 3	43 10	54 40	WNW	3	St. Cu	4	bc	0	7
Apr. 4	43 23	50 50	ESE	2		0	b	0	3
Apr. 5	42 54	49 30	WSW	2	Ci.	3	bc	0	4
Apr. 6	43 32	49 25	S	6	Nb	10	ocrz	0	6
Apr. 7	43 31	50 30	NW by N.	2		0	b	0	8
Apr. 8	43 41	48 32	WNW	L.	Ci. St	10	oc	0	3
Apr. 9	44 30	48 25	ESE	2	St. Cu	8	hg	0	2
Apr. 10	44 27	49 21	SSW	2	St.	10	ocq	19	4
Apr. 11	44 38	48 39	W	2		0	b	0	4
Apr. 12	44 55	48 28	SSE	2	Ci. St	3	bc	0	3
Apr. 13	44 47	48 55	WSW	7	St. Cu	10	oc	10	7
Apr. 14	44 15	50 20	WSW	3	St. Cu	8	bc	0	5
Apr. 15	43 58	51 55	NW	4	Ci.	0	b	0	5
Apr. 16	43 45	57 00	ESE	5	St.	10	ocrm	0	6
Apr. 17	43 40	61 20	N	6	St. Cu	8	bc	10	6
Total hours of fog								39	

Observations, Apr. 28 to May 18, at 8 a. m., seventy-fifth meridian time.

Date.	Lat., N.	Long., W.	Barometer, sea level.	Thermometers.		
				Temperature.	Maximum.	Minimum.
	° ′	° ′		°F.	°F.	°F.
Apr. 29	44 39	59 50	29.76	37.0	.....	.....
Apr. 30	44 38	54 55	29.55	32.0	32.0	31.0
May 1	43 20	51 30	29.35	34.6	35.5	33.5
May 2	43 02	49 23	29.58	38.0	39.0	35.0
May 3	42 15	48 55	29.67	41.5	41.5	33.0
May 4	41 31	48 22	29.64	59.8	59.8	56.0
May 5	42 15	47 35	29.53	50.0	60.0	50.0
May 6	42 15	48 00	30.19	35.8	50.0	35.0
May 7	42 20	47 57	30.04	48.0	48.0	37.5
May 8	42 28	47 50	29.93	53.0	52.0	47.0
May 9	42 30	47 43	30.43	40.0	43.0	39.0
May 10	42 50	49 50	30.38	42.0	42.0	37.5
May 11	42 25	49 37	30.22	54.2	54.2	51.5
May 12	42 10	49 52	30.24	60.0	60.8	54.0
May 13	42 11	49 49	30.19	55.0	56.2	44.0
May 14	42 05	49 25	30.26	42.0	52.0	37.5
May 15	42 20	50 40	30.23	54.0	64.0	51.0
May 16	43 00	54 45	30.06	43.6	43.6	43.6
May 17	43 25	59 20	30.37	44.0	44.0	35.0

Observations, Apr. 28 to May 18, at 8 a. m., seventy-fifth meridian time.

Date.	Lat., N.	Long., W.	Dry.	Wet.	Humidity.	Vapor press.	Dew point.	Precipitation.
	° ′	° ′	°F.	°F.	*Per cent.*		°F.	
Apr. 29	44 39	59 50	38.2	36.0	81	0.186	33	0.09
Apr. 30	44 38	54 55	32.9	31.0	81	.152	28	0
May 1	43 20	51 30	35.0	34.0	91	.185	33	0
May 2	43 02	49 23	34.0	32.0	81	.158	29	0
May 3	42 15	48 55	40.0	39.0	92	.228	38	0
May 4	41 31	48 22	59.4	55.0	76	.385	52	0
May 5	42 15	47 35	50.0	45.0	67	.241	39	0
May 6	42 15	48 00	40.4	39.4	92	.231	38	0
May 7	42 20	47 57	52.8	52.8	100	.399	53	0
May 8	42 28	47 50	53.0	52.0	94	.378	51	0
May 9	42 30	47 43	40.0	39.0	92	.228	38	0
May 10	42 50	49 50	40.3	40.0	97	.243	40	0
May 11	42 25	49 37	54.2	54.0	99	.412	54	0
May 12	42 10	49 52	58.8	57.8	94	.466	57	0
May 13	42 11	49 49	56.2	55.6	96	.432	55	0
May 14	42 05	49 25	39.5	39.5	100	.242	40	0
May 15	42 20	50 40	53.2	53.2	100	.405	53	0
May 16	43 00	54 45	44.0	44.0	100	.287	44	.12
May 17	43 25	59 20	44.0	40.0	70	.201	35	0
Total precipitation								.21

Observations, Apr. 28 to May 18, at 8 a. m., seventy-fifth meridian time.

Date.	Lat., N.	Long., W.	Wind.		Clouds.		Weather.
			Direction.	Velocity.	Kind.	Amount.	
	° ′	° ′					
Apr. 29	44 39	59 50	WNW	4	Ci.	2	bc.
Apr. 30	44 38	54 55	NW	6	Cu. Nb	9	bc.
May 1	43 20	51 30	WNW	4	St. Cu	10	oc.
May 2	43 02	49 23	NNW	1	Fr. Cu	2	bc.
May 3	42 15	48 55	SSE	2	St. Cu	10	ocrl.
May 4	41 31	48 22	SSE	3	Ci. Cu	2	bc.
May 5	42 15	47 35	NNE	2	St. Cu	5	bcz.
May 6	42 15	48 00	NNW	2	St.	10	ocf.
May 7	42 20	47 57	SSE	3	Ci. St.	8	bcz.
May 8	42 28	47 50	S by W	3	St. Cu	10	bcf.
May 9	42 30	47 43	.....	.....	.....	.....	.....
May 10	42 50	49 50	SE	2	St.	10	ocfd.
May 11	42 25	49 37	SSE	4	St.	10	ocf.
May 12	42 10	49 52	S	2	Ci.	4	bcz.
May 13	42 11	49 49	S	2	St.	10	ocz.
May 14	42 05	49 25	Calm	0	Ci. St.	5	bcf.
May 15	42 20	50 40	SSW	2	St. Cu	8	bcf.
May 16	43 00	54 45	WNW	2	Nb	10	ocr.
May 17	43 25	59 20	SSE	1	.....	0	bz.

Observations, Apr. 28 to May 18, at 8 p. m., seventy-fifth meridian time.

Date.	Lat. N.		Long. W.		Barometer sea level.	Thermometers.		
						Temperature.	Maximum.	Minimum.
	°	′	°	′		°F.	°F.	°F.
Apr. 29	44	45	57	15	29.67	31.0	38.5	31.0
Apr. 30	44	23	53	05	29.49	34.0	34.9	31.8
May 1	43	30	49	56	29.49	34.5	38.5	34.0
May 2	42	28	48	49	29.69	33.0	39.5	32.0
May 3	41	33	48	45	29.60	56.0	56.0	41.5
May 4	41	55	47	41	29.54	59.5	64.0	54.0
May 5	42	33	48	10	29.92	35.8	50.0	35.8
May 6	42	20	47	58	30.22	37.5	37.5	35.8
May 7	42	25	47	55	29.98	52.0	60.5	48.0
May 8	42	16	48	10	30.22	39.0	59.0	38.0
May 9	42	54	48	33	30.49	37.5	43.0	37.5
May 10	42	32	49	52	30.30	52.0	54.0	42.0
May 11	42	05	49	45	30.29	57.0	61.5	54.2
May 12	42	20	49	50	30.26	56.2	60.6	52.5
May 13	42	05	49	52	30.17	52.0	58.0	48.0
May 14	42	23	50	20	30.23	55.5	55.5	37.0
May 15	42	40	52	40	30.11	51.0	59.0	48.0
May 16	43	20	56	30	30.23	36.0	44.0	35.0
May 17	43	55	61	30	30.41	40.0	55.0	40.0

Observations, Apr. 28 to May 18, at 8 p. m., seventy-fifth meridian time.

Date.	Lat. N.		Long. W.		Dry.	Wet.	Humidity.	Vapor pressure.	Dew point.	Precipitation.
	°	′	°	′	°F.	°F.	Per cent.		°F.	
Apr. 29	44	45	57	15	31.8	29.5	77	0.139	26	0
Apr. 30	44	23	53	05	35.0	33.0	82	.166	30	0
May 1	43	30	49	56	34.8	33.8	90	.181	32	0
May 2	42	28	48	49	33.0	32.5	95	.178	32	.05
May 3	41	33	48	45	56.0	53.3	84	.376	51	0
May 4	41	55	47	41	59.0	56.0	84	.419	54	0
May 5	42	33	48	10	35.0	35.0	100	.203	35	.11
May 6	42	20	47	58	37.5	36.5	92	.205	35	0
May 7	42	25	47	55	52.3	52.0	98	.385	52	.04
May 8	42	16	48	10	38.0	37.0	92	.210	36	0
May 9	42	54	48	33	37.5	36.5	92	.205	35	0
May 10	42	32	49	52	51.0	51.0	100	.373	51	.08
May 11	42	05	49	45	56.5	55.5	94	.429	55	0
May 12	42	20	49	50	57.5	56.5	94	.445	56	0
May 13	42	05	49	52	52.0	51.0	94	.364	50	.04
May 14	42	23	50	20	57.6	56.0	91	.430	55	0
May 15	42	40	52	40	52.5	51.0	90	.355	50	0
May 16	43	20	56	30	37.2	37.2	100	.221	37	.10
May 17	43	55	61	30	40.6	39.0	88	.222	37	.10
Total precipitation										.52

Observations, Apr. 28 to May 18, at 8 p. m., seventy-fifth meridian time.

Date.	Lat. N.		Long. W.		Wind.		Clouds.		Weather.	Fog last 24 hours.	Maximum wind velocity last 24 hours.
					Direction.	Velocity.	Kind.	Amount.			
	°	′	°	′							
Apr. 29	44	45	57	15	NNW	6	A. Cu	4	bc	0	6
Apr. 30	44	23	53	05	WNW	4	St. Cu	10	oc	0	6
May 1	43	30	49	56	W	4	St. Cu	4	bc	0	5
May 2	42	28	48	49	NE	2		0	b	0	5
May 3	41	33	48	45	SE	4	St. Cu	7	bcrl	3	4
May 4	41	55	47	41	S	3	Cu. Nb	10	ocl	1	4
May 5	42	33	48	10	WNW	3	St	10	ocf	9	3
May 6	42	20	47	58	Calm	0	St	10	ocz	20	4
May 7	42	25	47	55	S	5	St. Cu	10	oc	0	5
May 8	42	16	48	10	NW	2	Ci. St	3	bc	13	5
May 10	42	32	49	52	SSE	3	Nb	10	czud	2	4
May 11	42	05	49	45	W by S	1	St. Cu	5	bc	10	4
May 12	42	20	49	50	SSW	1	Ci. St	4	bc	0	2
May 13	42	05	49	52	WNW	2	St	10	ocf	12	3
May 14	42	23	50	20	SSW	2	Ci. St	4	bcz	14	3
May 15	42	40	52	40	S	4	St	6	bcf	15	4
May 16	43	20	56	30	NNW	1	St	10	ocz	10	4
May 17	43	55	61	30	Calm	0		0	bzw	3	2
Total hours of fog										112	

Observations, May 29 to June 18, at 8 a. m., seventy-fifth meridian time.

Date.	Lat. N.		Long. W.		Barometer sea level.	Thermometers.		
						Temperature.	Maximum.	Minimum.
	°	′	°	′		° F.	° F.	° F.
May 29	43	25	60	30	30.28	39.0	43.4	38.5
May 30	42	20	56	20	30.22	41.8	41.8	38.5
May 31	42	20	52	30	30.06	48.0	48.0	38.5
June 1	42	20	50	55	30.01	61.0	61.0	54.2
June 2	40	55	48	15	30.35	66.0	66.0	63.5
June 3	41	02	47	38	30.31	54.0	59.0	51.0
June 4	40	35	47	35	30.30	60.0	66.0	56.0
June 5	41	56	47	30	30.36	67.2	67.2	59.0
June 6	42	00	48	10	30.20	54.0	54.0	47.0
June 7	41	33	48	34	30.11	51.5	58.5	51.0
June 8	41	05	48	00	30.06	52.5	52.5	50.0
June 9	42	30	48	25	30.03	51.0	51.0	46.5
June 10	42	30	48	40	29.93	50.0	55.0	47.0
June 11	42	23	48	40	29.99	51.0	51.0	45.0
June 12	42	52	49	53	29.86	52.7	52.0	49.0
June 13	42	13	49	01	29.99	55.0	56.0	54.0
June 14	42	40	48	15	29.83	55.5	55.5	51.0
June 15	42	40	50	00	30.09	56.2	56.2	45.0
June 16	45	03	52	29	29.91	43.0	48.0	43.0
June 17	45	17	56	40	29.71	48.0	48.0	42.5

Observations, May 29 to June 18, at 8 a. m., seventy-fifth meridian time.

Date.	Lat. N.		Long. W.		Dry.	Wet.	Humidity.	Vapor pressure.	Dew point.	Precipitation.
	°	′	°	′	° F.	° F.	Per cent.		° F.	
May 29	43	25	60	30	40.2	36.8	72	0.175	31	T.
May 30	42	20	56	20	43.0	38.5	65	.180	32	0
May 31	42	20	52	30	47.0	42.5	61	.196	34	0
June 1	42	20	50	55	61.5	60.0	92	.502	59	0
June 2	40	55	48	15	66.0	64.0	90	.574	63	.08
June 3	41	02	47	38	54.0	54.0	100	.417	54	.02
June 4	40	35	47	35	61.0	60.0	95	.527	60	0
June 5	41	56	47	30	67.0	65.0	90	.595	64	.17
June 6	42	00	48	10	54.6	54.0	97	.404	53	.02
June 7	41	33	48	34	53.0	53.0	100	.402	53	.27
June 8	41	05	48	00	52.5	52.5	100	.394	53	.27
June 9	42	30	48	25	52.0	51.0	94	.364	50	0
June 10	42	30	48	40	51.0	48.8	88	.329	48	.07
June 11	42	23	48	40	51.0	50.0	94	.351	49	0
June 12	42	52	49	53	56.5	56.0	97	.444	56	.06
June 13	42	13	49	01	55.0	55.0	100	.432	55	.20
June 14	42	40	48	15	55.0	55.0	100	.432	55	.10
June 15	42	40	50	00	56.0	54.0	88	.395	53	.03
June 16	45	03	52	29	43.5	43.0	96	.275	43	.15
June 17	45	17	56	40	48.0	46.0	86	.287	44	0
Total precipitation										1.44

Observations, May 29 to June 18, at 8 a. m., seventy-fifth meridian time.

Date.	Lat. N.		Long. W.		Wind.		Clouds.		Weather.
					Direction.	Velocity.	Kind.	Amount.	
	°	′	°	′					
May 29	43	25	60	30	N	4		0	b.
May 30	42	20	56	20	NNE	3	St. Cu	9	bc.
May 31	42	20	52	30	Calm	0	Cu. St	7	bc.
June 1	42	20	50	55	SW. by S.	5	Cu	7	bc.
June 2	40	55	48	15	S	3	Ci. St	4	bc.
June 3	41	02	47	38	SSE	2	Ci	6	bcz.
June 4	40	35	47	35	S	2	Ci	5	bcz.
June 5	41	56	47	30	S. by E	2	St	7	bc.
June 6	42	00	48	10	SSE	3		0	bf.
June 7	41	33	48	34	SSE	1	Nb	10	ocfr.
June 8	41	05	48	00	NE	2	Nb	9	bcz.
June 9	42	30	48	25	SE	1	Ci. St	6	bc.
June 10	42	30	48	40	SW	1	St. Cu	10	ocz.
June 11	42	23	48	40	S	3	St. Cu	6	bc.
June 12	42	52	49	53	SSW	4	St	10	ocf.
June 13	42	13	49	01	SSW	2	St	10	ocf.
June 14	42	40	48	15	SSW	4	St. Cu	10	ocfr.
June 15	42	40	50	00	ESE	1	Ci. Cu	5	bc.
June 16	45	03	52	29	ENE	2	St. Cu	10	oc.
June 17	45	17	56	40	SW by W.	5	St. Cu	10	oc.

Observations, May 29 to June 18, at 8 p. m., seventy-fifth meridian time.

Date.	Lat. N.	Long. W.	Barometer sea-level.	Thermometers.		
				Temperature.	Maximum.	Minimum.
	° ′	° ′		° F.	° F.	° F.
May 29	42 50	58 30	30.31	39.0	41.0	37.0
May 30	42 20	54 25	30.12	44.0	44.5	41.8
May 31	42 10	52 00	30.09	54.2	54.2	44.0
June 1	41 26	49 11	30.23	66.0	66.0	61.0
June 2	40 54	47 38	30.38	59.0	66.0	54.0
June 3	40 32	47 37	30.31	56.0	63.6	54.0
June 4	41 21	47 06	30.36	61.8	61.8	53.0
June 5	41 40	47 58	30.28	50.5	67.2	50.5
June 6	41 14	48 19	30.13	58.5	58.5	51.8
June 7	41 26	48 45	30.06	55.0	55.0	51.5
June 8	42 16	48 47	30.06	46.5	52.5	46.0
June 9	41 55	48 15	29.96	53.5	64.0	51.0
June 10	42 30	48 26	30.00	45.5	53.0	45.5
June 11	43 06	49 57	29.85	50.0	62.0	48.0
June 12	42 13	49 27	30.03	56.0	62.0	52.7
June 13	42 26	48 17	29.99	52.2	57.0	51.0
June 14	42 26	48 11	30.02	47.0	59.0	45.0
June 15	43 50	50 10	30.10	48.0	48.0	56.2
June 16	45 21	55 00	29.91	42.8	43.0	41.0
June 17	44 58	58 55	29.92	42.0	49.0	42.0

Observations, May 29 to June 18, at 8 p. m., seventy-fifth meridian time.

Date.	Lat. N.	Long. W.	Dry.	Wet.	Humidity.	Vapor pressure.	Dew point.	Precipitation.
	° ′	° ′	° F.	° F.	Per cent.		° F.	
May 29	42 50	58 30	40.0	36.0	68	0.168	31	0
May 30	42 20	54 25	46.0	40.6	61	.189	33	0
May 31	42 10	52 00	56.5	51.0	68	.310	46	0
June 1	41 26	49 11	67.0	65.0	90	.595	64	.08
June 2	40 54	47 38	61.5	60.0	92	.502	59	.02
June 3	40 32	47 37	56.0	52.0	80	.358	50	0
June 4	41 21	47 06	62.0	61.0	95	.527	60	.30
June 5	41 40	47 58	52.0	52.0	100	.387	52	0
June 6	41 14	48 19	59.0	58.0	94	.469	57	0
June 7	41 26	48 45	55.0	55.0	100	.432	55	.25
June 8	42 16	48 47	49.0	48.0	93	.323	47	0
June 9	41 55	48 15	53.5	52.5	94	.384	52	0
June 10	42 30	48 26	46.0	45.0	93	.288	44	0
June 11	43 06	49 57	50.0	50.0	100	.360	50	.02
June 12	42 13	49 27	56.0	52.0	77	.345	49	0
June 13	42 26	48 17	52.2	52.2	100	.389	52	.06
June 14	42 26	48 11	47.0	46.0	93	.296	45	0
June 15	43 50	50 10	48.0	47.0	93	.310	46	0
June 16	45 21	55 00	48.5	48.0	96	.327	47	0
June 17	44 58	58 55	44.0	44.0	100	.287	44	0
Total precipitation								.73

Observations, May 29 to June 18, at 8 p. m., seventy-fifth meridian time.

Date.	Lat. N.		Long. W.		Wind.		Clouds.		Weather.	Fog last 24 hours.	Maximum wind velocity last 24 hours.
					Direction.	Velocity.	Kind.	Amount.			
	°	′	°	′							
May 29	42	50	58	30	NNE	3	St. Cu	5	bc	0	6
May 30	42	20	54	25	N	1	St. Cu	10	oc	0	3
May 31	42	10	52	00	SSW	2	St. Cu	9	bc	0	3
June 1	41	26	49	11	WSW	3	St. Cu	4	bc	0	6
June 2	40	54	47	38	SSE	2	A. Cu	8	bc	0	3
June 3	40	32	47	37	S	2	A. Cu	5	bcz	2	3
June 4	41	21	47	06	NNE	1	Nb	10	oc	0	4
June 5	41	40	47	58	SSE	3		0	bcz	2	4
June 6	41	14	48	19	SSE	3	Ci	5	bc	5	4
June 7	41	26	48	45	SW	2	St. Cu	10	ocz	1	4
June 8	42	16	48	47	SE	1	Cu	5	bc	7	2
June 9	41	55	48	15	SSE	2	St. Cu	10	oc	0	4
June 10	42	30	48	26	WNW	2	St. Cu	5	bc	2	2
June 11	43	06	49	57	S	3	Nb	10	ocfr	2	4
June 12	42	13	49	27	SSW	2	St	10	ocf	21	4
June 13	42	26	48	17	SSW	2	St	10	ocf	22	3
June 14	42	26	48	11	WNW	1	St. Cu	10	oc	17	4
June 15	43	50	50	10	Calm	0	Ci. Cu	4	bc	0	2
June 16	45	21	55	00	ENE	3	St	10	ocf	1	4
June 17	44	58	58	55	W by S	6	St. Cu	9	bc	1	6
Total hours of fog										83	

Observations, July 9 to July 31, at 8 a. m., seventy-fifth meridian time.

Date.	Lat. N.		Long. W.		Barometer.	Temperature.	Dry.	Wet.	Precipitation.
	°	′	°	′		°	°	°	
July 9	47	35	52	40	29.84	45.5	45.5	44.0	
July 10	49	55	50	00	29.71	43.7	44.0	43.5	
July 11	51	07	50	20	29.85	38.0	38.0	37.5	T.
July 12	51	55	52	35	30.06	39.0	39.0	38.5	
July 13	52	15	53	50	29.80	38.0	37.0	36.0	
July 14	51	20	53	00	29.68	35.7	36.6	36.5	
July 15	48	35	52	05	29.70	45.5	45.5	45.2	
July 16	47	25	52	30	30.06	46.0	46.0	43.7	0.16
July 17	46	00	52	00	30.10	50.7	50.5	49.8	.05
July 18	45	05	51	45	30.16	54.0	54.0	54.0	T.
July 19	44	10	51	00	30.11	60.2	60.2	60.0	
July 20	43	20	50	05	30.05	61.5	61.5	61.3	
July 21	44	15	49	35	29.91	59.0	59.0	58.9	
July 22	43	00	48	50	30.13	51.0	52.0	51.0	
July 23	45	10	47	30	29.93	58.8	56.2	56.0	T.
July 24	45	55	45	45	29.81	57.5	57.5	56.8	.08
July 25	47	00	45	45	29.87	48.8	50.0	48.7	
July 26	47	25	49	50	29.99	49.2	49.0	48.0	
July 27	St. Johns, Nfld.				29.79	48.8	49.0	48.5	
July 28	47	20	52	40	29.72	55.0	56.0	54.5	
July 29	45	55	56	10	30.07	52.0	52.0	51.2	
July 30	45	05	60	05	30.20	56.0	56.0	52.0	
Total precipitation									.29

Observations, July 9 to July 31, at 8 a. m., seventy-fifth meridian time.

Date.	Lat. N.	Long. W.	Wind.		Clouds.		Weather.
			Direction.	Velocity.	Kind.	Amount.	
	° ′	° ′					
July 9	47 35	52 40	NW. by N.	4	St. Cu.	10	oc.
July 10	49 55	50 00	WNW	4	Ci. St.	2	bc.
July 11	51 07	50 20	NNW	3	St.	9	bcf.
July 12	51 55	52 35	S.	2	St.	8	bcz.
July 13	52 15	53 50	SSW	2	St. Cu.	10	bc.
July 14	51 20	53 00	NNW	4	St. Cu.	10	ocf.
July 15	48 35	52 05	SW	3	Nb.	10	ocr.
July 16	47 25	52 30	SSE	1	A. St.	10	oc.
July 17	46 00	52 00	SW	3	Ci. Cu	5	bc.
July 18	45 05	51 45	S.	3	St.	4	bcf.
July 19	44 10	51 00	SSE	2	St. Cu.	6	bcf.
July 20	43 20	50 05	S.	3	St. Cu.	5	bcf.
July 21	44 15	49 35	SE.	3	St. Cu.	8	bcf.
July 22	43 00	48 50	NNW	1	St. Cu.	8	bcf.
July 23	45 10	47 30	ESE	1	St.	5	bcf.
July 24	45 55	45 45	SSE	2	St.	5	bcf.
July 25	47 00	45 45	SSW	4	St. Cu.	2	bc.
July 26	47 25	49 50	SSW	1	Ci. St.	2	bc.
July 27	St. Johns, Nfld.		SSE	2	St. Cu.	8	bcf.
July 28	47 20	52 40	WSW	2	St. Cu.	10	oc.
July 29	45 55	56 10	E.	3	St. Cu.	7	bc.
July 30	45 05	60 05	ENE	4	St. Cu.	8	bc.

Observations, July 9 to July 31, at 8 p. m., seventy-fifth meridian time.

Date.	Lat. N.	Long. W.	Barometer.	Temperature.	Dry.	Wet.	Precipitation.
	° ′	° ′		°	°	°	
July 9	48 40	51 15	29.97	45.0	48.2	45.0	
July 10	50 35	49 40	29.64	39.0	39.0	38.5	T.
July 11	51 20	51 45	30.06	39.0	39.0	38.5	
July 12	52 35	53 35	29.89	35.2	35.2	35.0	0.02
July 13	52 13	53 10	29.70	35.7	35.7	35.6	.03
July 14	49 25	52 10	29.72	39.0	39.3	39.0	
July 15	(1)	(1)	29.93	46.8	46.8	42.0	
July 16	46 15	52 05	30.07	48.5	49.0	48.8	T.
July 17	45 20	51 40	30.15	54.0	54.5	54.0	
July 18	44 15	51 10	30.19	59.0	58.5	58.5	T.
July 19	43 20	50 25	30.06	61.5	61.5	61.4	
July 20	44 05	49 40	30.04	59.0	59.0	58.8	
July 21	44 50	49 10	29.98	52.0	52.1	52.0	
July 22	45 10	48 05	30.14	45.6	45.6	45.2	T.
July 23	45 30	46 10	29.91	54.0	53.8	53.6	.03
July 24	45 10	46 55	29.78	54.5	54.7	54.5	
July 25	47 20	48 45	29.95	51.8	51.8	49.5	.56
July 26	47 35	52 00	29.91	51.8	51.6	51.2	
July 27	(1)	(1)	29.79	48.8	49.0	48.5	.56
July 28	46 25	53 50	30.02	51.0	51.5	49.5	
July 29	45 33	58 10	30.12	53.0	52.8	49.8	
July 30	44 45	61 50	30.15	54.7	54.7	53.2	
Total precipitation							1.20

[1] St. Johns, Newfoundland.

Observations, July 9 to July 31, at 8 p. m., seventy-fifth meridian time.

Date.	Lat. N.	Long. W.	Wind.		Clouds.		Weather.	Fog last 24 hours.	Maximum wind, 24 hours.
			Direction.	Velocity.	Kind.	Amount.			
	° ′	° ′							
July 9	48 40	51 15	WNW	2	A. Cu	6	bc	0	5
July 10	50 35	49 40	WNW	5	Nb	10	ocd	0	8
July 11	51 20	51 45	N by W	1	St	10	ocf	18	3
July 12	52 35	53 35	S by E	2	St. Cu	10	ocd	21	3
July 13	52 13	53 10	NE	3	St. Cu	10	ocf	8	3
July 14	49 25	52 10	NW	2	Ci	4	bc	13	4
July 15	(1)	(1)	Calm	0	St. Cu	10	oc	1	4
July 16	46 15	52 05	SSW	2	St. Cu	10	ocf	9	2
July 17	45 20	51 40	SSW	2	Ci. St	3	bc	10	3
July 18	44 15	51 10	SSE	1	St	5	bcf	13	3
July 19	43 20	50 25	SSE	2	St	4	bcf	21	3
July 20	44 05	49 40	SSE	2	St. Cu	6	bcf	23	4
July 21	44 50	49 10	WNW	3	St. Cu	10	ocf	22	4
July 22	45 10	48 05	Calm	0	St	5	bcf	17	2
July 23	45 30	46 10	SSE	1	St. Cu	7	bcfd	21	2
July 24	45 10	46 55	SSW	2	St	6	bcf	11	3
July 25	47 20	48 45	SSW	3	Ci. St	3	bc	0	5
July 26	47 35	52 00	SSW	2	Ci. St	3	bc	4	3
July 27	(1)	(1)	ENE	1	St. Cu	10	ocz	10	2
July 28	46 25	53 50	N	2	Ci. St	3	bc	0	3
July 29	45 33	58 10	ENE	3	Ci. Cu	7	bc	0	4
July 30	44 45	61 50	ENE	3	St. Cu	10	oc	0	4
Total fog								222	

[1] St. Johns, Newfoundland.

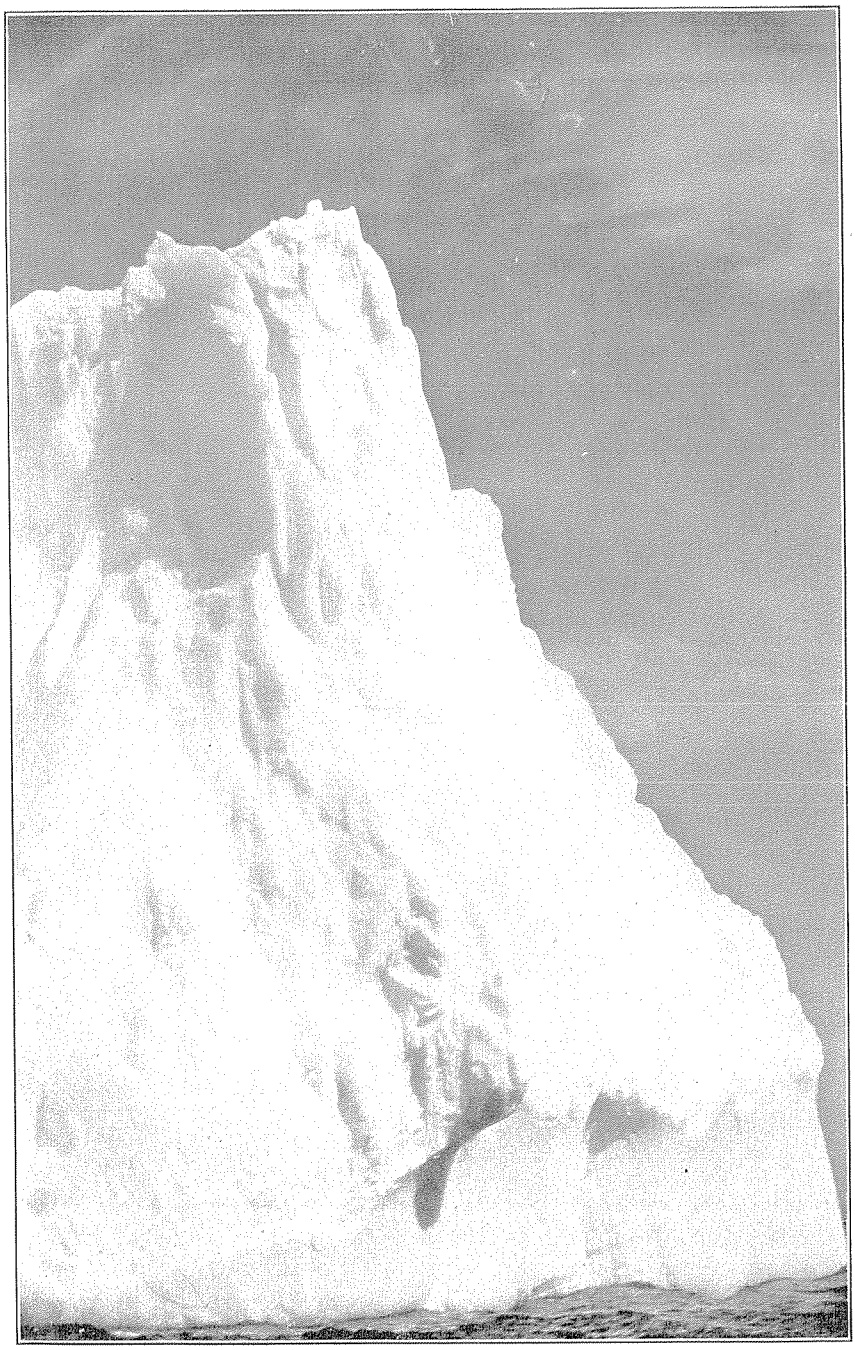


FIG. 1.—CLOSE VIEW OF A LARGE BERG, ABOUT 150 FEET HIGH.

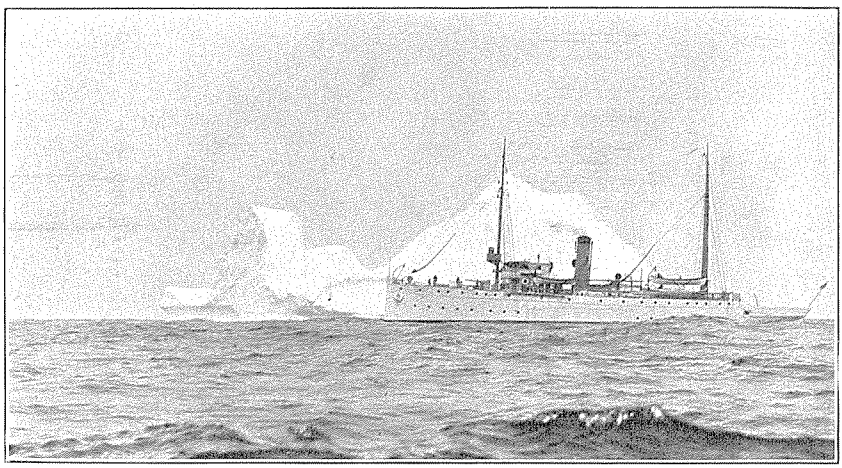


FIG. 2.—THE "MIAMI," PASSING A LARGE BERG.

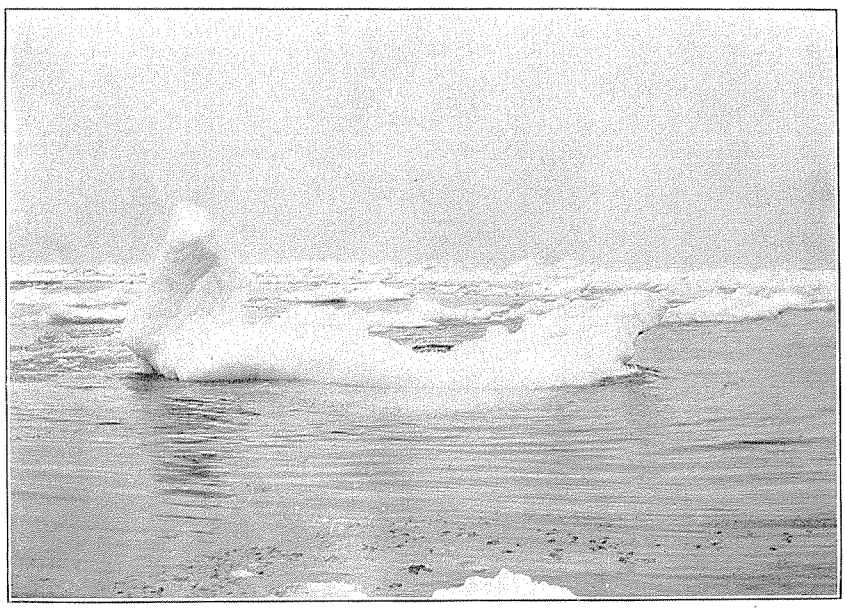


FIG. 3.—"NORTHERN SLOB."

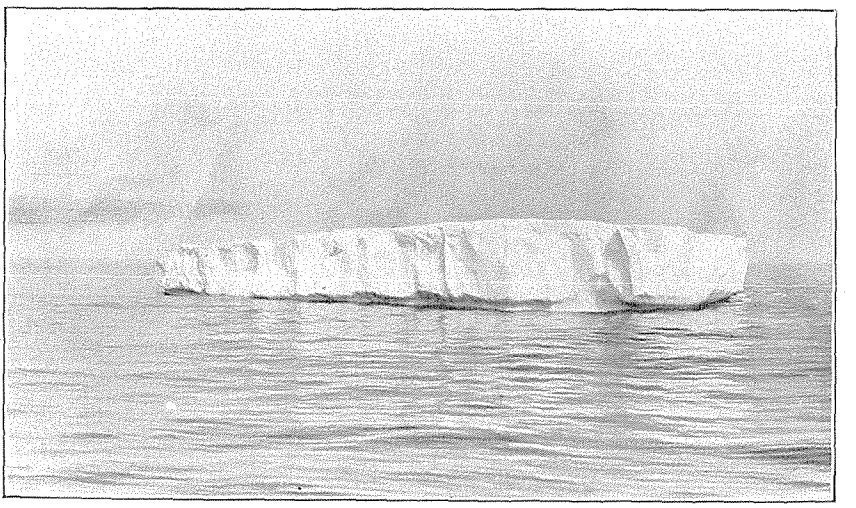


FIG. 4.—CHARACTERISTIC PAN-SHAPED BERG.

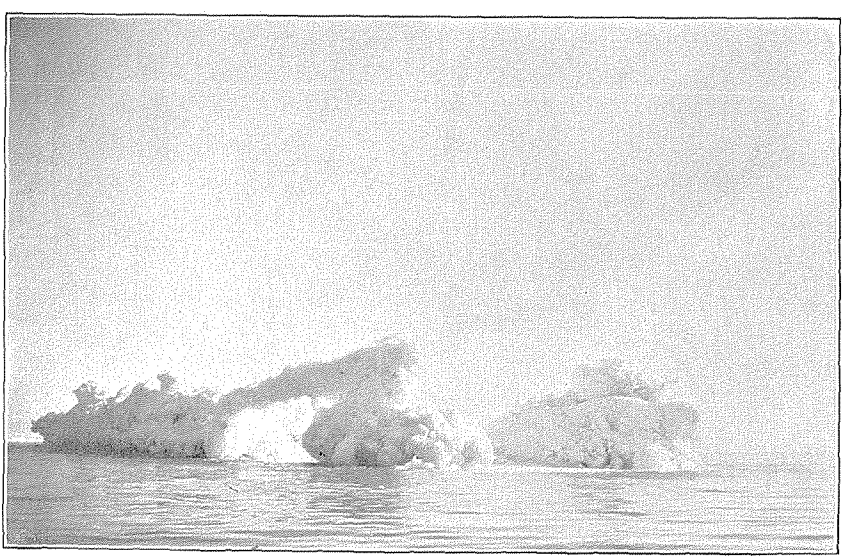


FIG. 5.—A FLOEBERG.

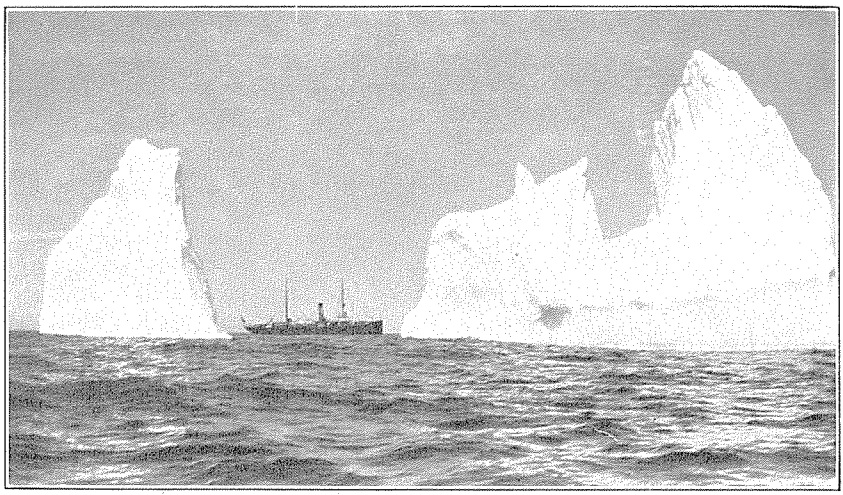


FIG. 6.—THE "SENECA," SEEN THROUGH A BREAK IN A LARGE BERG.

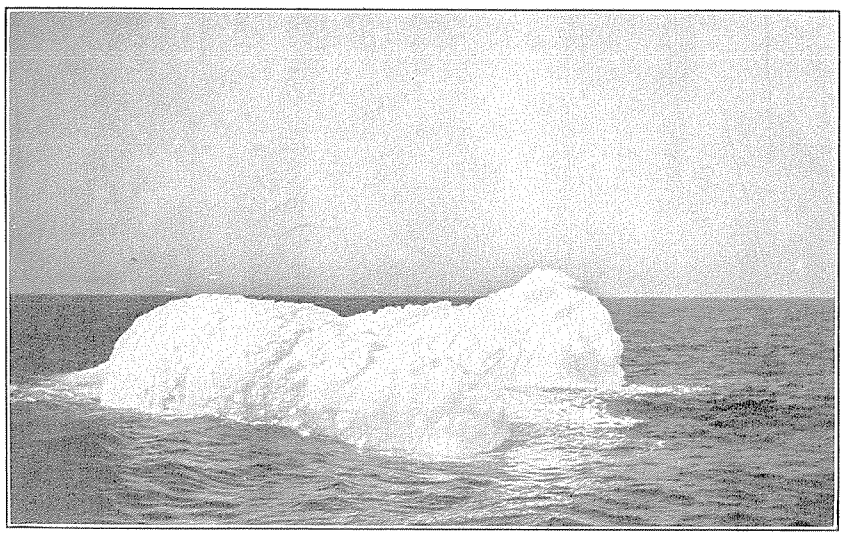


FIG. 7.—A DANGEROUS "GROWLER."

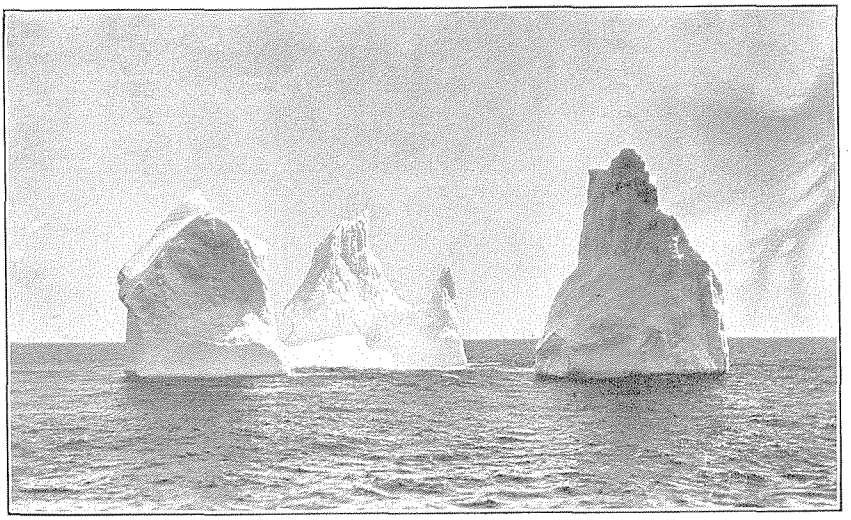


FIG. 8.—TYPICAL MID-SEASON BERG.

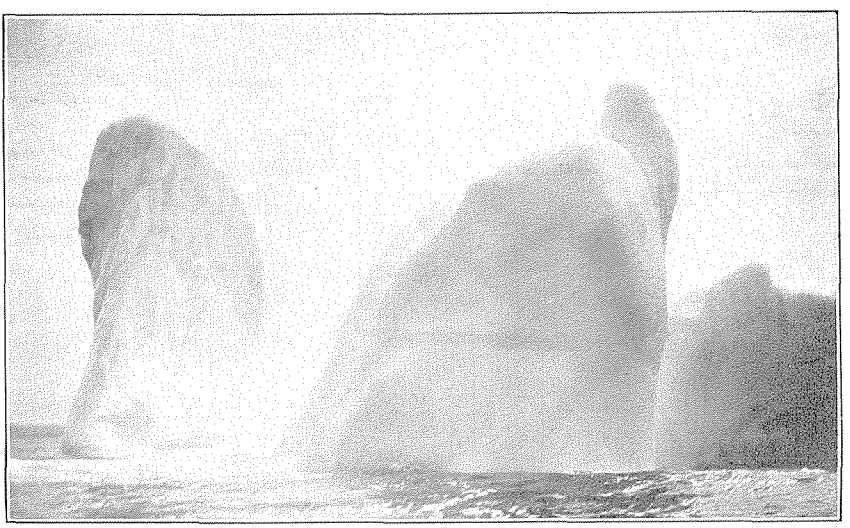
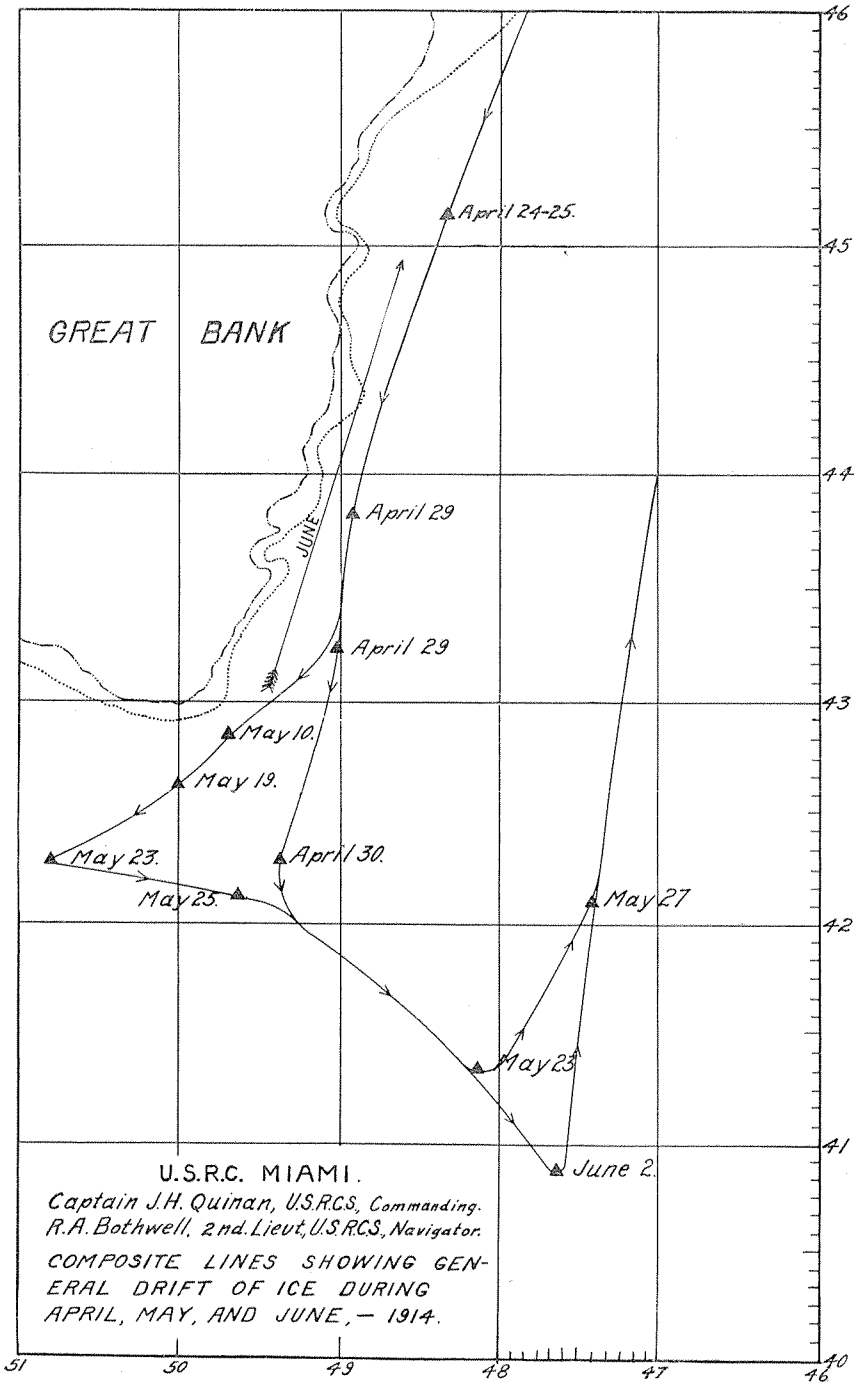


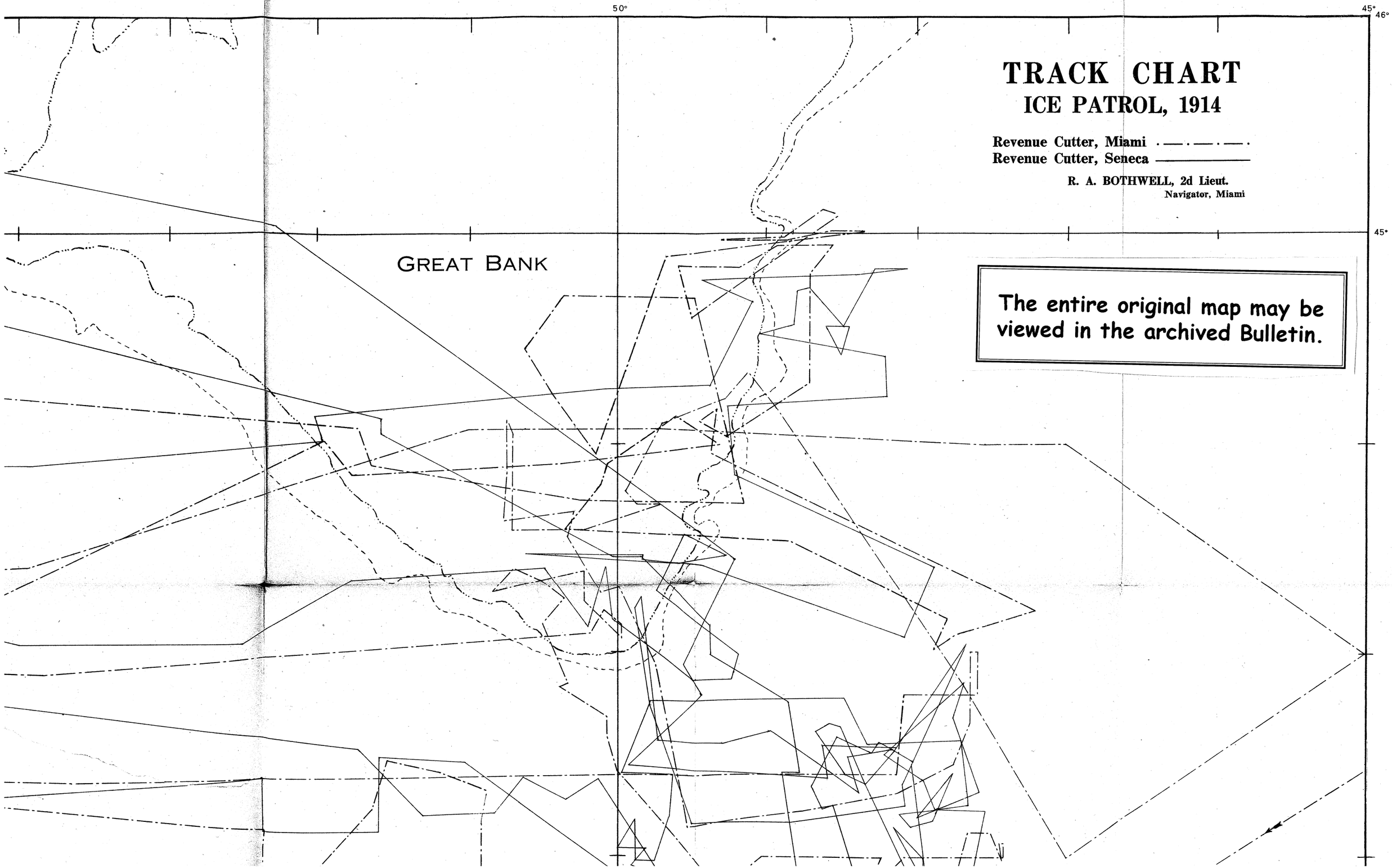
FIG. 9.—A BERG IN LAST STAGES OF DISINTEGRATION, JUNE 12, 1914.



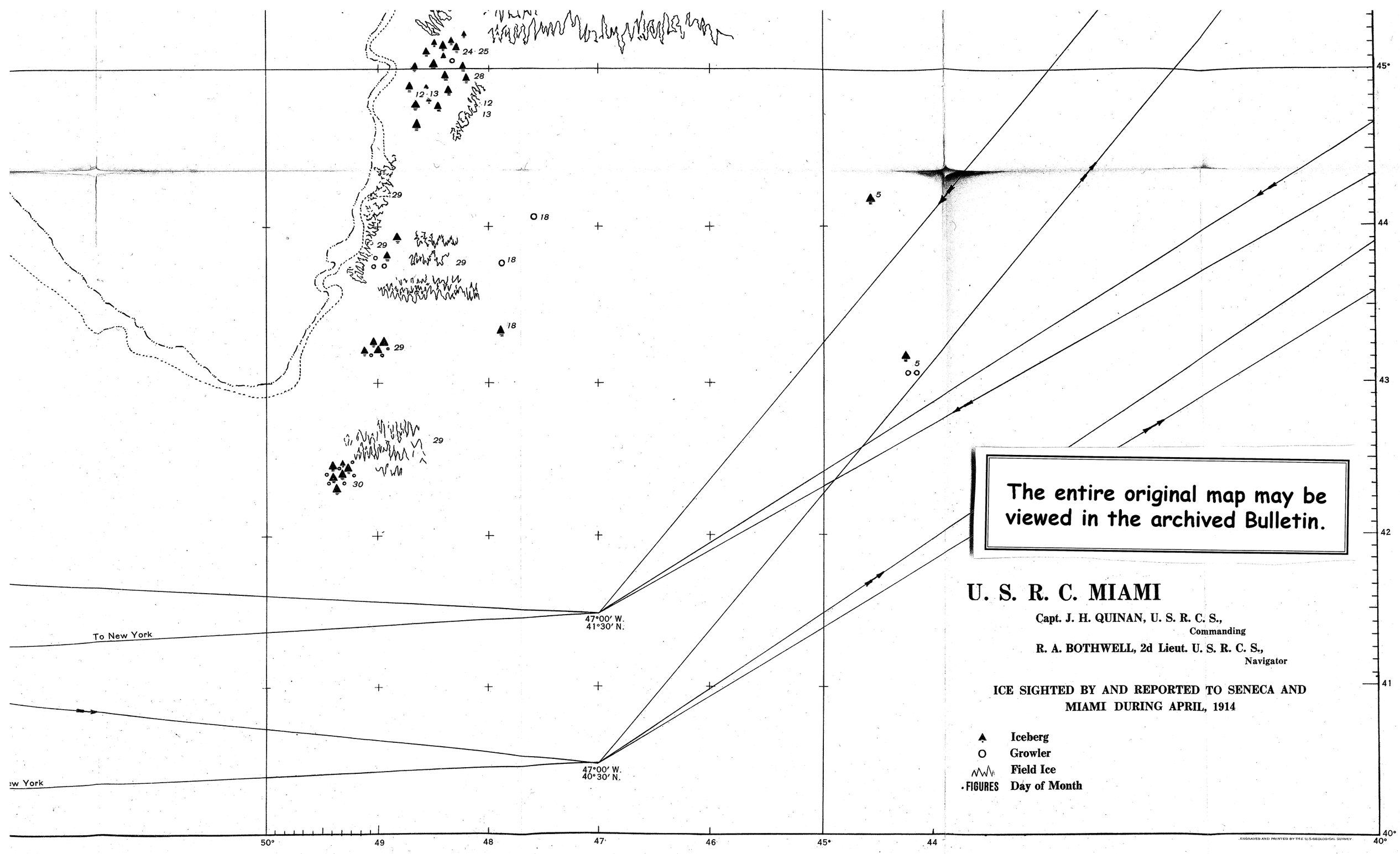
U.S.R.C. MIAMI.

Captain J.H. Quinan, U.S.R.C.S, Commanding.
R.A. Bothwell, 2nd. Lieut, U.S.R.C.S., Navigator.

COMPOSITE LINES SHOWING GENERAL DRIFT OF ICE DURING APRIL, MAY, AND JUNE, — 1914.



The entire original map may be viewed in the archived Bulletin.



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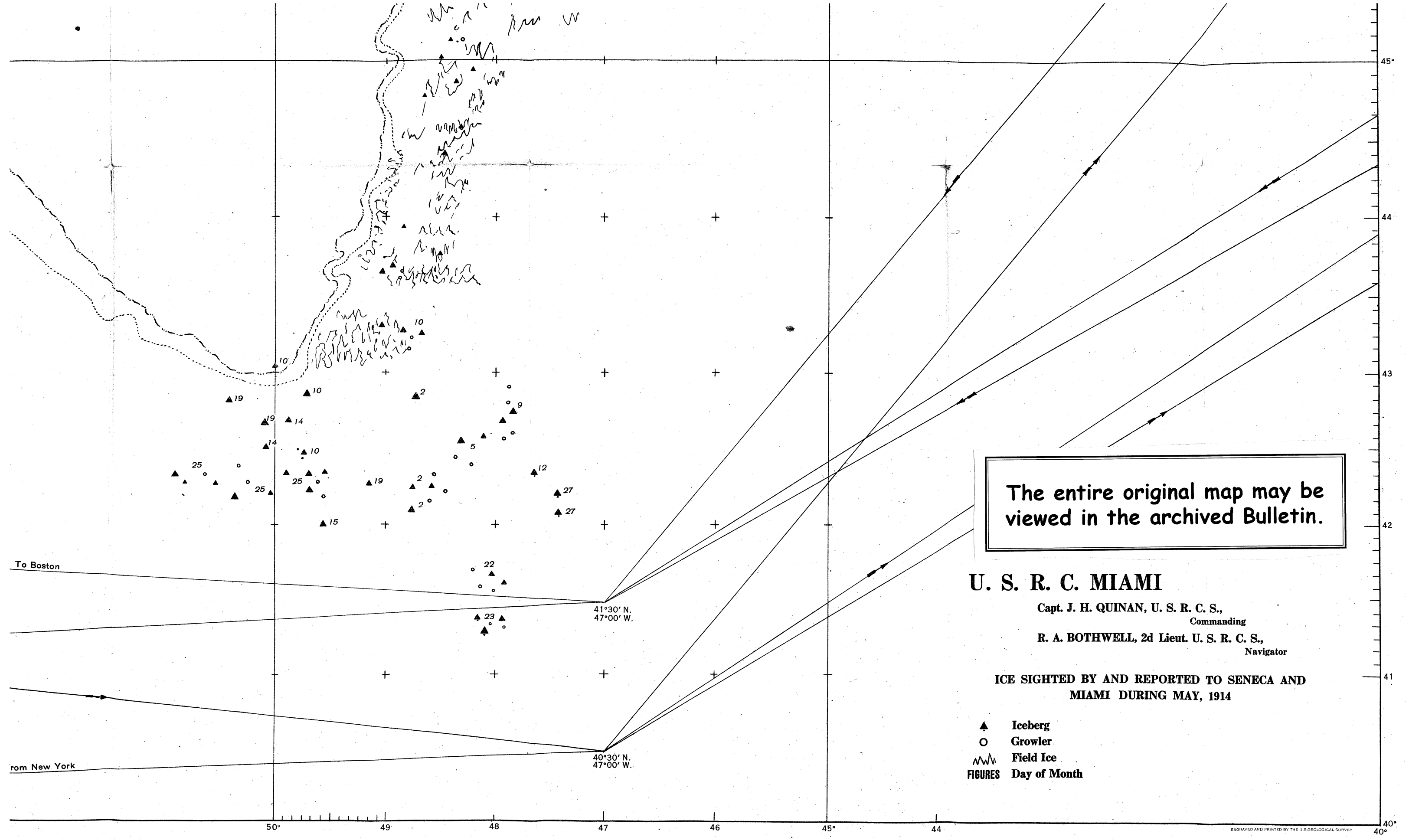

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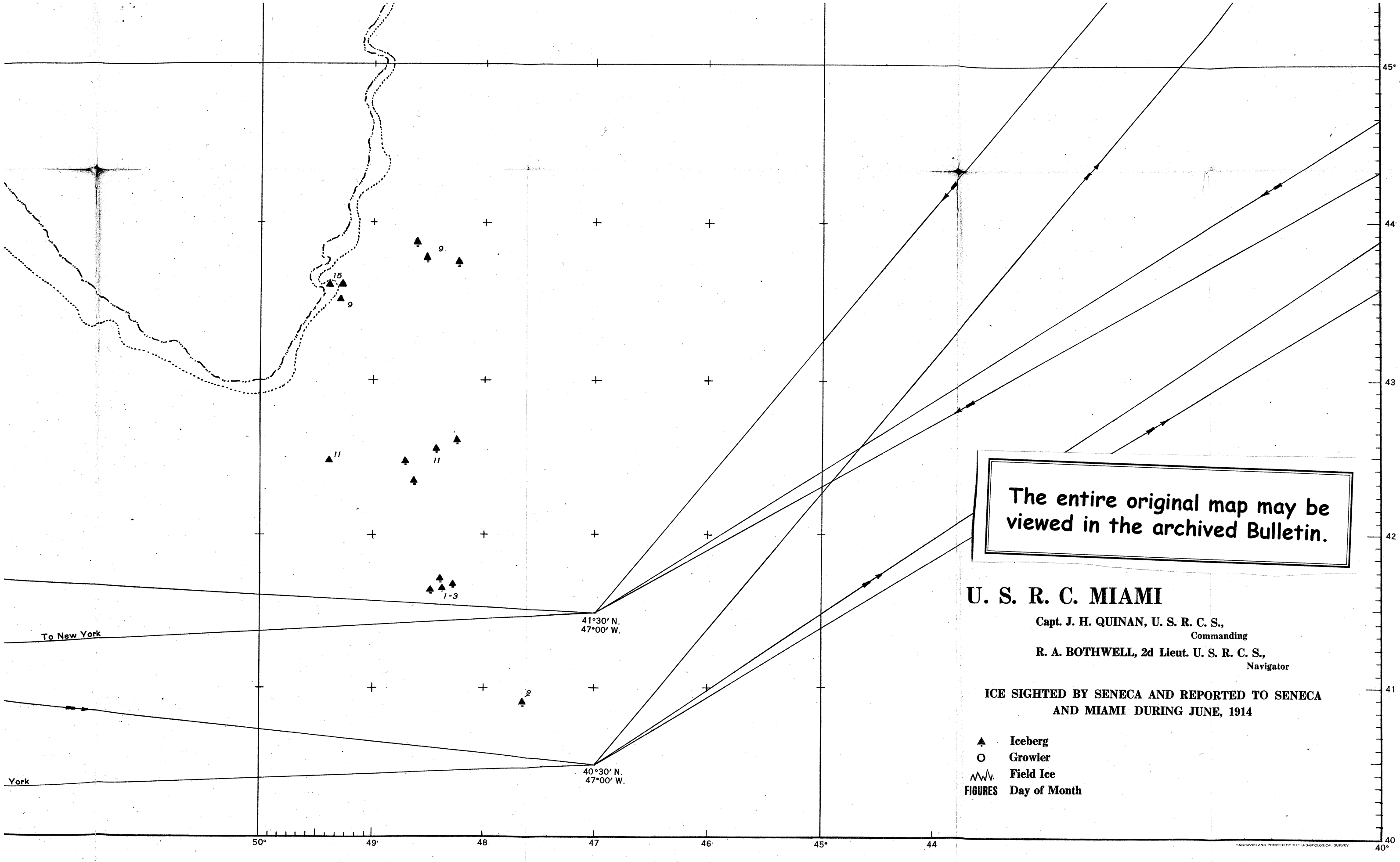

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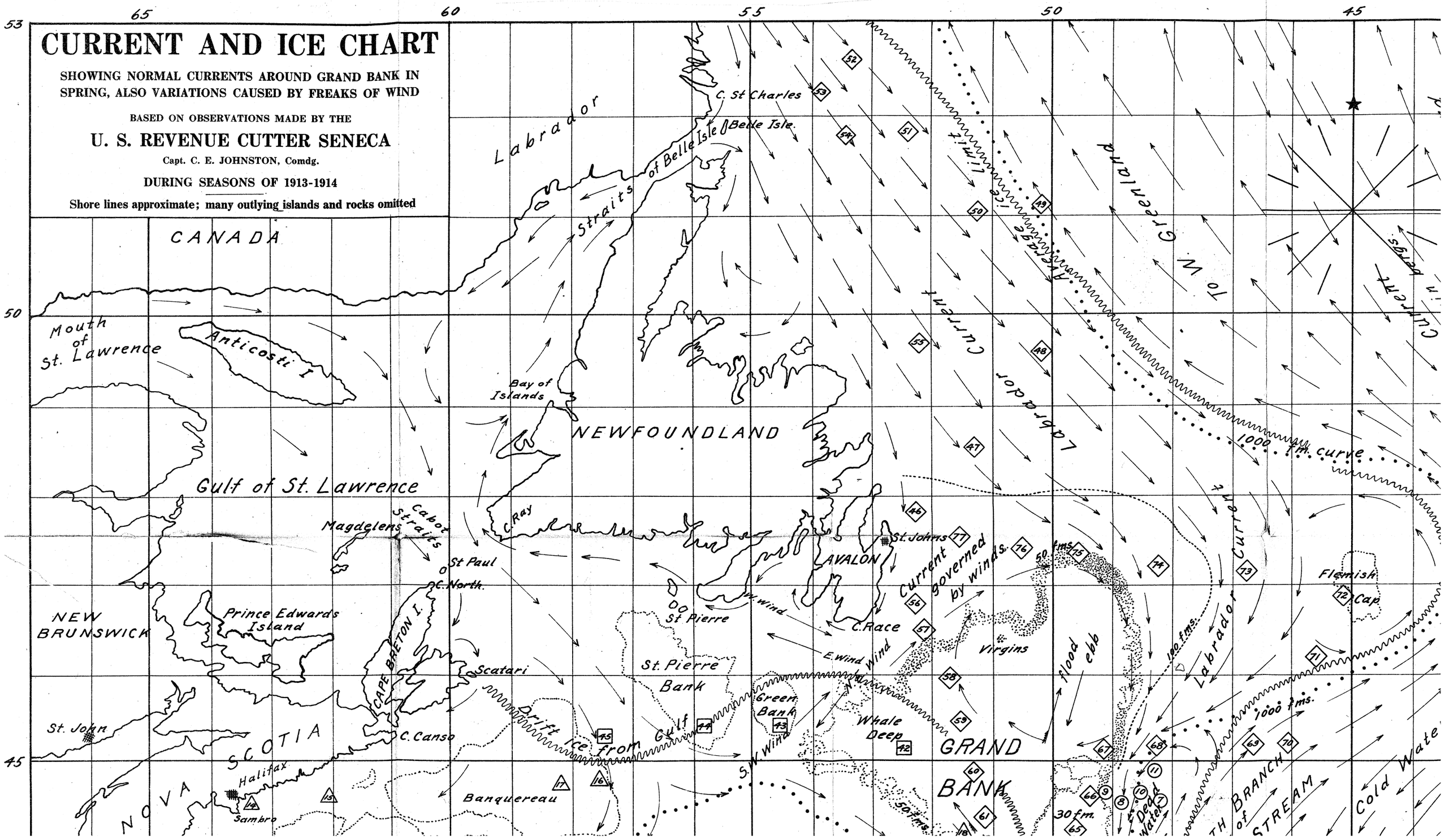

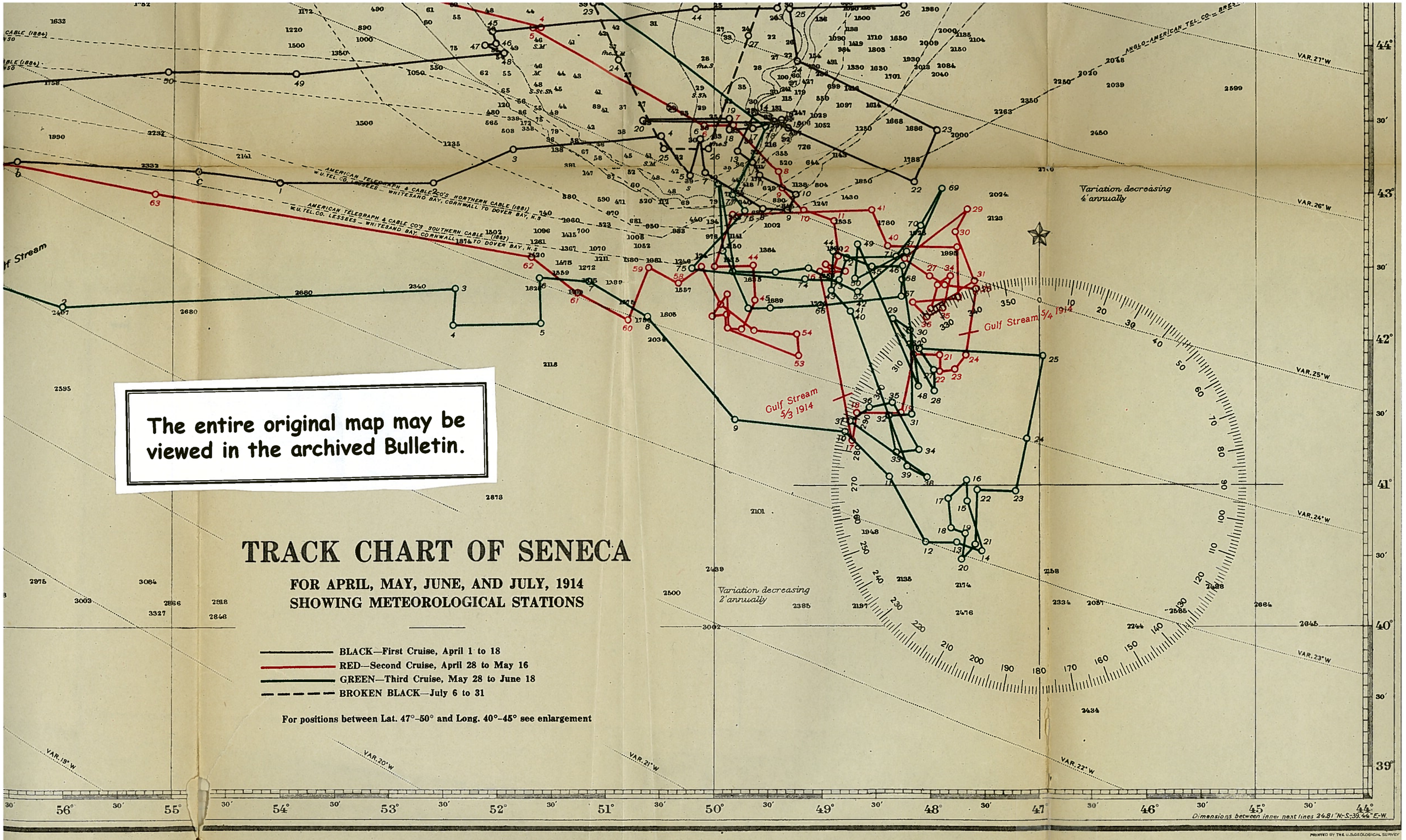

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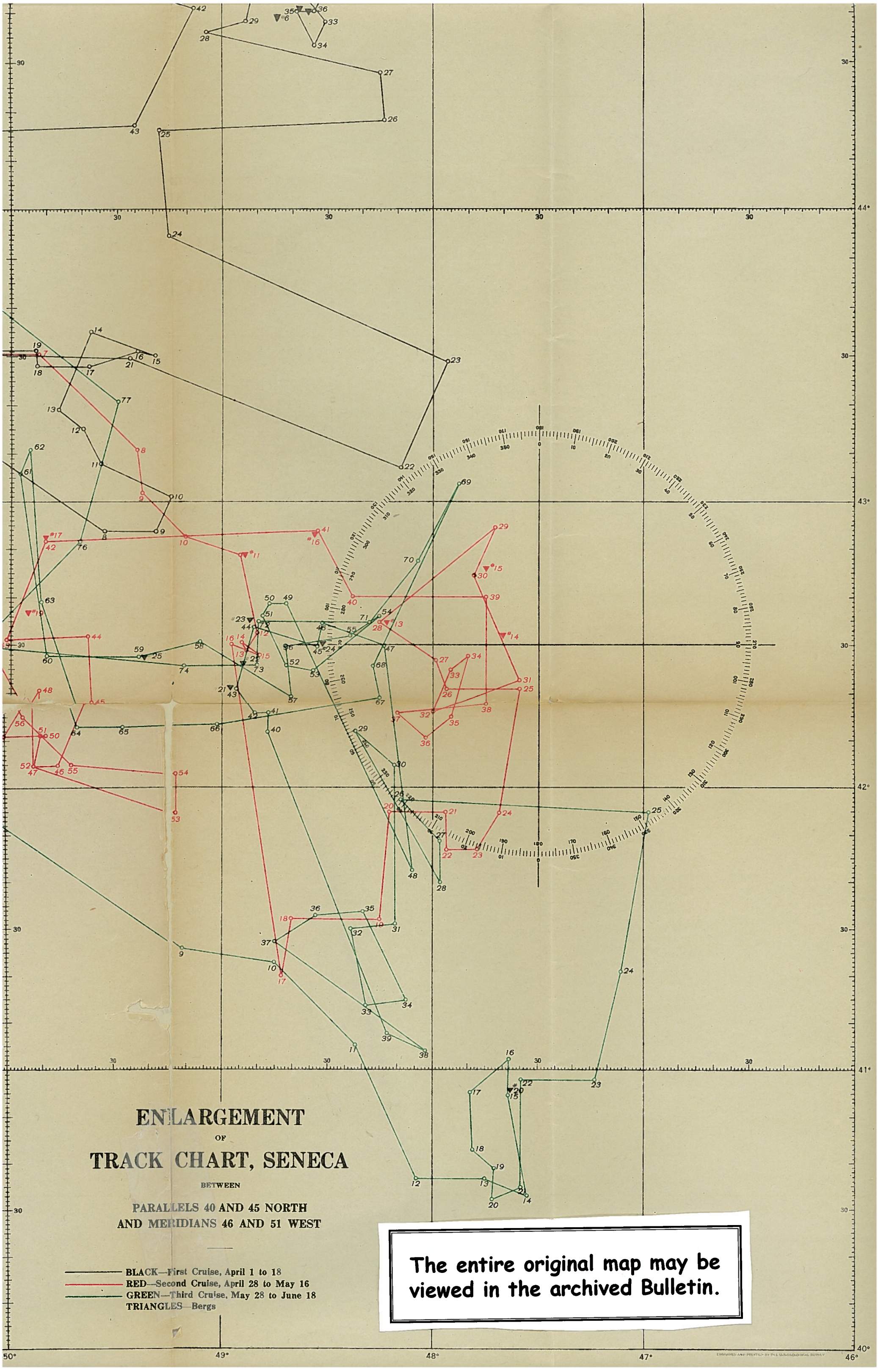

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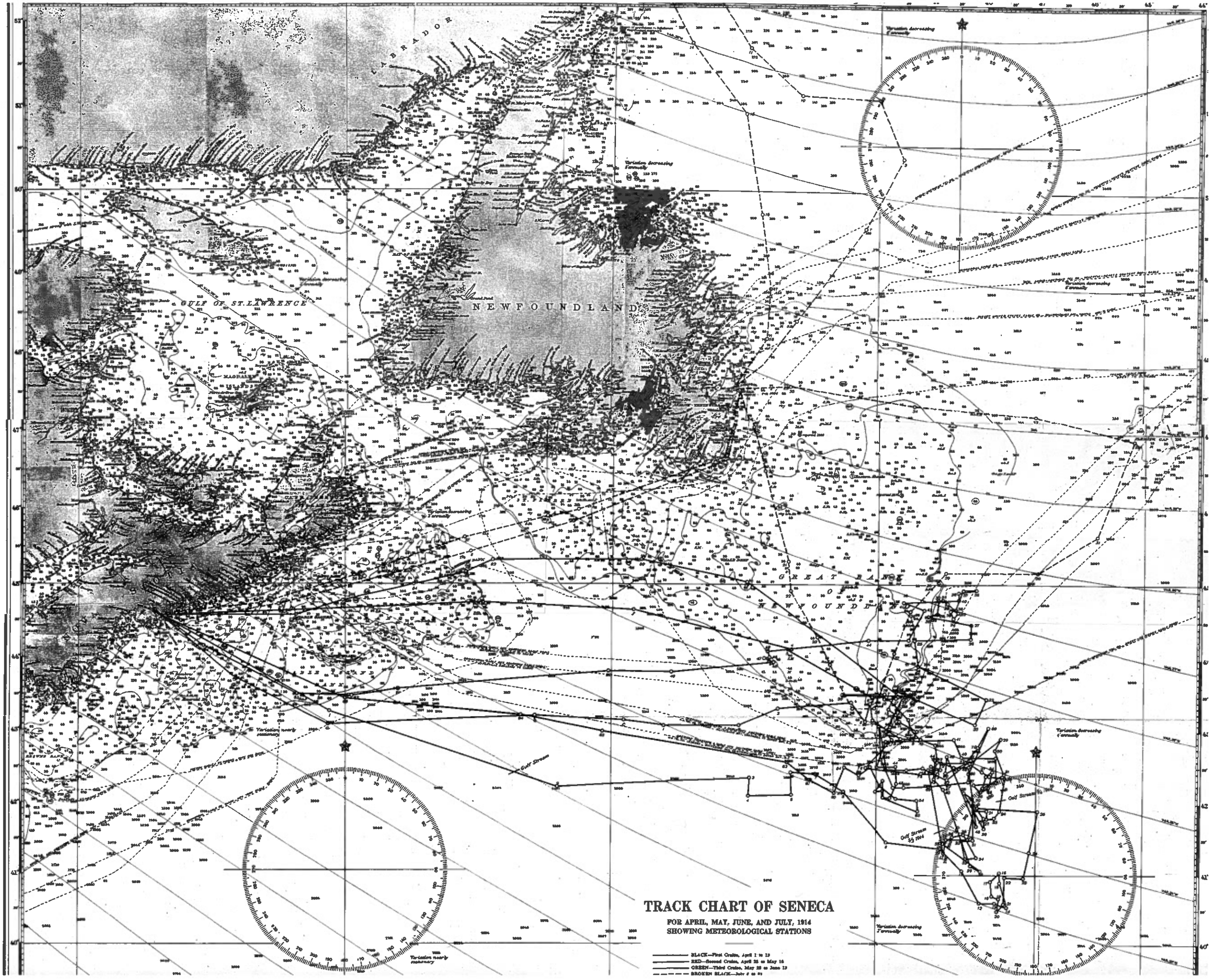

TRACK CHART OF SENECA

FOR APRIL, MAY, JUNE, AND JULY, 1914
SHOWING METEOROLOGICAL STATIONS