

Hydrographical Observations in the Labrador Current in 1913.

By Donald J. Matthews. (*Report on the work carried out by the ss. "Scotia," 1913. H.M. Stationery Office, London, 1914.*)

THE *Scotia* was sent out by the Board of Trade in the spring of 1913, under the command of Capt. T. Robertson, to make observations on the amount of ice collected in the Labrador Current to the northwards of the liner tracks, which might prove a danger to shipping later in the year. She was fitted with apparatus for hydrographical work to a depth of 550 fathoms and for meteorological and plankton investigations. The scientific staff consisted of Mr. G. I. Taylor (meteorologist), Mr. L. R. Crawshaw (biologist), and the writer.

The *Scotia* left Dundee on March 8th, but was much hindered by bad weather, and did not get clear of the Hebrides till March 23rd. She reached St. John's, Newfoundland, on April 14th, having passed a group of bergs on the Flemish Cap.

The *Scotia* left St. John's again on April 23rd, and steamed first southwards to Cape Race and then south-eastwards across the Banks to the deep water. The surface water had a temperature between 1.5° and 0° ; in the deep channel under the coast a minimum of -1.5° or less was reached at 40 fathoms and extended to the bottom in 90 fathoms off St. John's; near Cape Race the lower layers were somewhat warmer. This temperature distribution, with a minimum at some intermediate depth, is characteristic of polar waters; it was not found on the Banks. Warm salt water was encountered off the south-eastern edge of the Banks.

The next run was made northwards along the edge of the Banks and then eastwards beyond the Flemish Cap, and large numbers of icebergs were sighted in spite of almost continuous fog. The Labrador Current extended seawards as far as the western edge of the Flemish Cap; eastwards of this the bergs were melting rapidly in relatively warm high salinity water. Between the Cap and the Banks the polar water was underlaid by water with a salinity of over 34, but the vertical changes were irregular.

The *Scotia* then proceeded to Bonavista Bay, where the characteristic minimum, -1.7° , was found at 70 and 100 fathoms. From this point she worked northwards through or along the edge of pack ice to about 54° N. It had been intended to proceed as far as Hamilton Inlet, but a strong northerly gale made this impossible. The pack encountered during the more northern part of the run was very heavy and in places hummocky,

while behind it were countless large bergs driving more slowly before the wind. Observations made on the edge of the pack in about 53° N. showed salinities varying between 33 and 34 down to 100 fathoms, with a temperature minimum of about -1.3° between 25 and 50 fathoms. From 100 fathoms to the bottom in 200 fathoms there was relatively unmixed Atlantic water with salinity and temperature over 34.0 and 0° .

The next run was south-eastwards to the Flemish Cap. The edge of the Labrador Current was passed in about $50\frac{1}{2}^{\circ}$ N., $49\frac{1}{2}^{\circ}$ W., the temperature rising suddenly from 0° to 3° and the salinity from 33.9 to 34.7. Eastwards of the Flemish Cap the salinity and temperature now (May 24th) were much higher than nineteen days earlier, and far fewer bergs were sighted.

On May 28th a buoy fastened to a sinker and drag by 1000 fathoms of piano wire was put over close to a berg on the outer edge of the Labrador Current in about $45\frac{1}{2}^{\circ}$ N., 47° W. The berg was found to be drifting S. 52° E., 0.55 mile per hour, in a smooth sea with scarcely any wind.

The *Scotia* then proceeded to St. John's, passing no more bergs until close under the land.

The second cruise, from June 10th to July 19th, consisted of a series of diagonal courses as far as 44° W., between the parallels of Cape Race and Hamilton Inlet. The finer weather now made scientific work much easier, and a number of vertical series and current measurements were made. The outer boundary of the Labrador Current was clearly defined, at least northwards of the fiftieth parallel, by the isohaline of 34 and a change of temperature of three or four degrees. In conformity with the general rule for oceanic currents it followed the edge of the continental slope closely. Seaward of it the surface temperature and salinity increased eastwards very slowly from 4° to 7° or 8° , and from 34.0 to 34.8. Vertically the water was nearly homogeneous; the temperature fell from 6° or 7° at the surface to 4° at 50 or 100 fathoms, and then very slowly to 3° at 500 fathoms, while the salinity increased from 34.6 or 34.7 to 34.8 or 34.9. Current measurements with a buoy showed almost no motion.

The Labrador Current flowed over the continental shelf where the depths were less than 300 fathoms; it had a salinity of less than 33.5 and a temperature below 0° except where the surface layer had been heated by the sun, and the intermediate temperature minimum was well marked. In places Atlantic water with positive temperature and salinity over 34 underlay the polar water. Off the Labrador coast the pack had shrunk considerably since the previous run, and now lay westwards of the fifty-

fourth meridian. The effect of the melting of the ice showed itself in the decreased surface salinity.

Current measurements with anchored buoys showed weak and variable currents, and in some places the pack lay in an eddy which was actually moving northwards.

From the Labrador coast the *Scotia* proceeded out to the Flemish Cap and then in to Cape Race. On the Banks the surface temperature was as high as 8° , with less than 0° at from 35 to 50 fathoms, while in the deep channel under the land -0.9° was found at 20 fathoms and -1.70° at 50 fathoms. A buoy was anchored for 26 hours in 100 fathoms off Cape Race, where there is normally a set of about one mile per hour to the south and west; on this occasion the current was found to be setting slowly northwards.

The *Scotia* entered St. John's on July 19th and left again on the homeward voyage on July 24th. A digression was first made for current measurements on the southern part of the Banks. Two complete sets of measurements with the Ekman metre, each lasting about thirteen hours, at 5 fathoms and 25 fathoms, were made in 50° W. at two points about 60 miles apart; the ship was anchored in 30 fathoms in each case. The current was found to be tidal with a slight easterly resultant, which at 5 fathoms in $43^{\circ} 53' N.$ reached 1.4 miles in the course of a tide; at the other positions it was less than 0.5 mile. The direction changed regularly through south to west, north, and east.

The *Scotia* then proceeded to the Flemish Cap and Cape Farewell. The East Greenland pack, with about three small bergs, was followed from $59^{\circ} 6' N.$, $42^{\circ} 27' W.$, to $62^{\circ} 11' N.$, $39^{\circ} 42' W.$ Near the edge of the pack the character of the water changed very rapidly, so that some of the ice was floating in water of nearly 35 salinity, with a temperature of 8° . From this point the *Scotia* turned homewards and reached Dundee on August 24th.

During the year 1913 the ice was as a whole held up to the northwards of the forty-third parallel, and the *Scotia* observations make it seem probable that this was due to an easterly set of water from the region off the Cabot Straits and the coast of Nova Scotia, which covered the southern half of the Newfoundland Banks.

The observations were worked up and the report on the hydrographical work written at the Laboratory of the Marine Biological Association, and I wish to express my thanks to the Council and to Dr. Allen for putting apparatus and a table at my disposal for the purpose.

D. J. M.