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A WINTER INCURSION OF SLOPE WATER ON THE SCOTIAN SHELF

by

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## Introduction:

In the triangular area of the Western North Atlantic outlined by Nova Scotia, Bermuda and Chesapeake Bay, the water subdivisions are designated (Iselin, 1936) as "coastal water", "slope water", "Gulf Stream", and "Sargasso Sea". Off the Nova Scotia coast, "coastal water" extends out to the edge of the continental shelf, and the band of "slope water" extending from the edge of the continental shelf to the northern edge of the "Gulf Stream" is approximately 170 miles in width.

In the winter months, the transition from "coastal water" to "slope water" is, off the Nova Scotia coast, very sharply defined by temperature changes, and in particular by the vertical tendency of the isotherms which establish very intensive horizontal temperature gradients.

In February, 1949, the water temperature conditions off the Scotian coast were assessed, in a bathythermographic survey, under the joint auspices of the Naval Research Establishment at Halifax, N.S., and the Atlantic Oceanographic Group.

### The Bathythermographic Survey of February, 1949.

The details of the survey are shown in figure 1. Lowerings of a bathythermograph (BT) were made at 142 points to furnish detailed information of the vertical distribution of temperature at each of these points.

The observations were initiated at point A and continued at half-hour intervals through points B, C, D, E and F. A storm then forced the ship to run offshore for approximately thirty hours, after which the observations were renewed at point F through points G, H and finishing at point I.

#### The Vertical Distribution of Temperature in Section AB.

The vertical distribution of temperature in the section AB is illustrated in figure 2. Section AB extends from Lunenburg to cross La Have Bank and beyond the edge of the continental shelf. On the shelf the temperatures range from less than  $2.0^{\circ}\text{C}$ . to less than  $6.0^{\circ}\text{C}$ ., the higher temperatures being on the bottom. Beyond the edge of the shelf and at a depth of 100 metres, within a distance of ten miles, the temperatures increase rapidly from  $6.0^{\circ}\text{C}$ . to  $12.0^{\circ}\text{C}$ . and greater. The sharp horizontal temperature gradient marks the northern edge of the "slope water".

#### The Vertical Distribution of Temperature in Section DC.

The vertical distribution of temperature in the section DC is illustrated in figure 3. Section DC extends from Halifax to the west of Emerald Bank and beyond the edge of the continental shelf. In this section an incursion of "slope water" has taken place, as shown by the presence of bottom waters of temperatures as high as  $12.0^{\circ}\text{C}$ . on the Scotian Shelf. The temperature of the main body of coastal water ranges from less than  $2.0^{\circ}\text{C}$ . to  $7.0^{\circ}\text{C}$ . The incursion of "slope water" has occurred chiefly at depths greater than 50 metres and the trend of the isotherms illustrate the northerly extension of the "slope water" below these depths.

The portion of the section involved and affected by this incursion of slope water is approximately thirty miles long, and the area affected might easily be as much as 1000 square miles.

The Vertical Distribution of Temperature in Section EF.

The vertical distribution of temperature in the section EF is illustrated in figure 4. Section EF extends from Beaver Harbour past the western edge of Sable Island Bank and beyond the edge of the continental shelf. The temperatures of the coastal waters range from less than 1.0°C. to 8.0°C. Beyond the edge of the continental shelf a sharp horizontal temperature gradient is more pronounced in the surface layer where, over a distance of ten miles, the temperatures rapidly increase from 6.0°C. to greater than 11.0°C. There is some indication of the tendency of the warmer slope waters to extend northward over the edge of the continental shelf at depths of 100 metres. As the observations in this section were made following a storm, there is reason for suspecting that the incursion of slope waters observed in section DC occurred also in section EF previous to the storm. In any event, differential water movements, as between the upper fifty metres of water and lower fifty metres, could readily cause a marked incursion of "slope water" in this section.

Discussion.

The flooding of the continental shelf, south of Nova Scotia by incursions of offshore waters has been observed in the past (Leim and Hachey, 1935), but only in the late summer months. At no time, in seasonal cruises of the shelf, have bottom water temperatures been higher than 8.0°C. on the outer banks. Heretofore, most of our

winter cruises have been limited to the Scotian shelf, with the exception that in 1936, a co-operative effort between the Woods Hole Oceanographic Institute and the Fisheries Research Board of Canada, completed two sections extending from the Nova Scotia coast well beyond the edge of the continental shelf (Hachey, 1938). In these extended sections slope water temperatures, greater than  $7.0^{\circ}\text{C}$ . were some distance south of the edge of the shelf. The observations of 1939 are therefore of considerable significance in that they record an incursion of waters of vastly different temperature characteristics than those considered normal to the Scotian Shelf. The implication to fishery problems, and marine biological problems generally, are obvious.

The submarine physiography of the Scotian Shelf (Hachey, 1937) is an important factor in confining the major effect of such incursions to the area that has been named the Scotian Gulf. The submarine channel of depths greater than 75 fathoms (136 M.) is to be located between LaHave and Emerald Bank. This channel opens into the submarine Scotian Gulf which, with the exception of Sambro Bank, is of a depth greater than 75 fathoms (136 M.) Other than the Cansan Channel, which is limited in its penetration of the Shelf, this submarine channel opening into the Scotian Gulf is the only means through which slope water of depths of 50 fathoms (91 M.) or greater can be distributed on the Scotian Shelf. Hence it is to be expected that when incursions of offshore water take place, the distribution is related in part to the submarine physiography of the shelf.

Summary

1. An incursion of slope water on the Scotian Shelf was observed in the winter of 1949, and bottom water temperatures were as high as 12.0°C.

2. As to be expected, the incursion occurred in the vicinity of the submarine channel entering the Scotian Gulf, and at depths greater than 50 M.

3. This is the first occasion on the Scotian Shelf where extensive observations have located the slope water of such temperatures well northward of the edge of the continental shelf.

References

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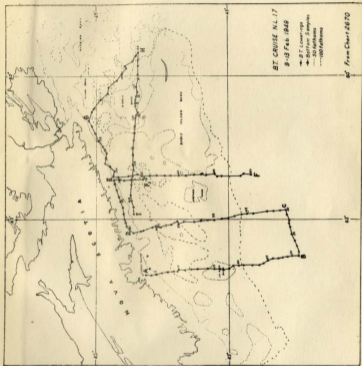


Fig. 1. Details of BT observations in February, 1949.

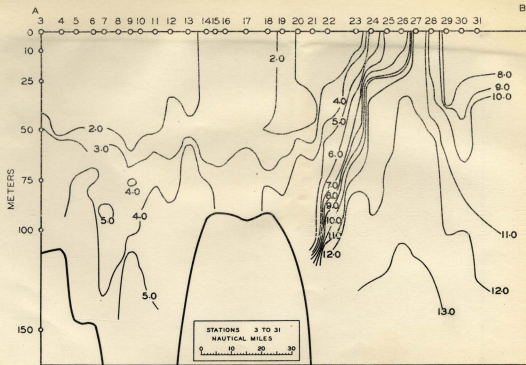


Fig. 2 Distribution of temperatures in section AB.

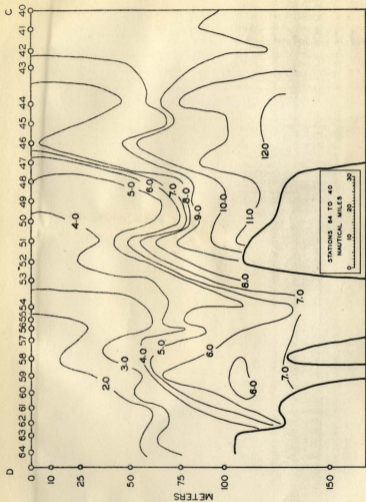


Fig. 3. Distribution of temperatures in section DC.

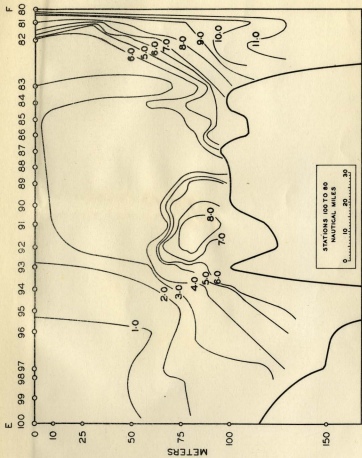


Fig. 4. Distribution of temperatures in section EF.