

(Photo: U.S. Coast Guard)

U.S.C.G. Cutter *Mendota* on International Ice Patrol during May 1948.

CANADIAN INTEREST IN ARCTIC OCEANOGRAPHY

By H. B. Hachey*

OCEANOGRAPHY, the science of the sea, is a composite subject, embracing all studies pertaining to the sea, and drawing freely upon mathematics and various branches of physics, chemistry, geology, and biology. While the foundations of the subject can be traced to earliest times, oceanography is a modern development, and as such is comprehensively dealt with in a recent publication, *The Oceans*.¹

From the cultural as well as the utilitarian point of view Canadian interest in arctic oceanography is gradually developing. The purpose of this paper is to outline the growth of that interest and to demonstrate how it develops logically from the study of oceanographical problems nearer at hand.

A Developing Canadian Interest

Carved deep in stone over the main entrance to the Parliament Buildings in Ottawa we find these words:

“The wholesome sea is at her gates
Her gates both east and west”.

Canada has an enormous length of coastline which is separated into three distinct regions by Alaska and Newfoundland†. Of these three regions, east, north, and west, the north or arctic coast is by far the longest.

*Chief Oceanographer, Canadian Joint Committee on Oceanography, St. Andrews, N.B., Canada.

†Newfoundland was not a part of Canada when this article was written.

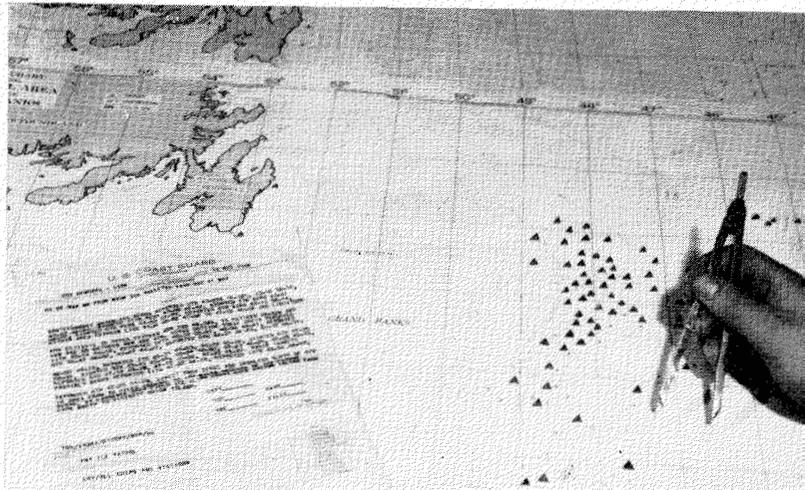
Interest in Canada's northern waters has waxed and waned in the past three centuries, and at one time, if the lines of the poet are to be taken at their face value, the northern coastline was almost forgotten. In recent years, attention has once more been focused on the almost limitless areas to the north, and among other problems, those of defence demand a more intimate knowledge of Canadian arctic waters, whether open or ice covered. The voyages of *St. Roch*² in recent years, including the completion of the Northwest Passage in both directions, demonstrate that, with modern equipment and navigational aids, oceanographic investigation of the most northerly waters is possible, although it is still adventurous and expensive.

The opening of the Hudson Bay Route to Churchill has focused some attention on the eastern Canadian Arctic, and various government facilities have been available for the charting of coastlines, sea-routes, and harbours, the assessment of weather and ice conditions, and the cataloguing of general hydrographic and biological conditions in selected areas. Only isolated oceanographical observations are available from the western Canadian Arctic secured through the few limited expeditions of government services and patrols of the R.C.M.P. Information on northern waters would be sparse indeed were it not for investigations by ships of the United States Coast Guard in the approaches to the Arctic—*General Greene* and *Marion* in the Labrador Sea, and *Chelan* in the Bering Sea. There still remains a wealth of interesting problems involving the hydrography of the Beaufort Sea, Viscount Melville and Lancaster Sounds, Foxe Basin and Channel, Baffin Bay, and the waters surrounding the Arctic Islands. Mapping of the continental shelf to the north, fundamental tidal problems, problems of fjord morphology, and the many aspects of marine biology offer an almost limitless field to oceanographers.

The furthering of oceanographic studies in Canadian waters is now mainly centred in the Canadian Joint Committee on Oceanography which is representative of the Fisheries Research Board of Canada, the Royal

Chart showing position of ice-bergs plotted from information provided by aircraft and ships. Such maps are the basis of "ice broadcasts" made twice daily during the season.

(Photo: U.S. Coast Guard)



Canadian Navy and the National Research Council. The Canadian Hydrographic Service** and the Canadian Meteorological Service are at present associated with the Committee through representation at meetings. Administrative work of the Committee includes supervision of the Atlantic Oceanographic Group with headquarters at St. Andrews, N.B., and the Pacific Oceanographic Group with headquarters at Nanaimo, B.C. Modern ships and equipment are available, but there is at present a shortage of trained personnel, so that some activities are restricted. The Committee maintains close contact with all Canadian organizations interested in the various phases of oceanography.

Arctic Ice and the Labrador Current

A supplement to the Pilot Chart of the North Atlantic Ocean, issued by the United States Hydrographic Office in May, 1948, summarizes the problem of arctic ice and its drift into the North Atlantic Ocean. Winds and currents combine to cause this southward movement of arctic ice along the east coast. The limits of the main body of field ice south of

**The Canadian Hydrographic Service now has full membership.

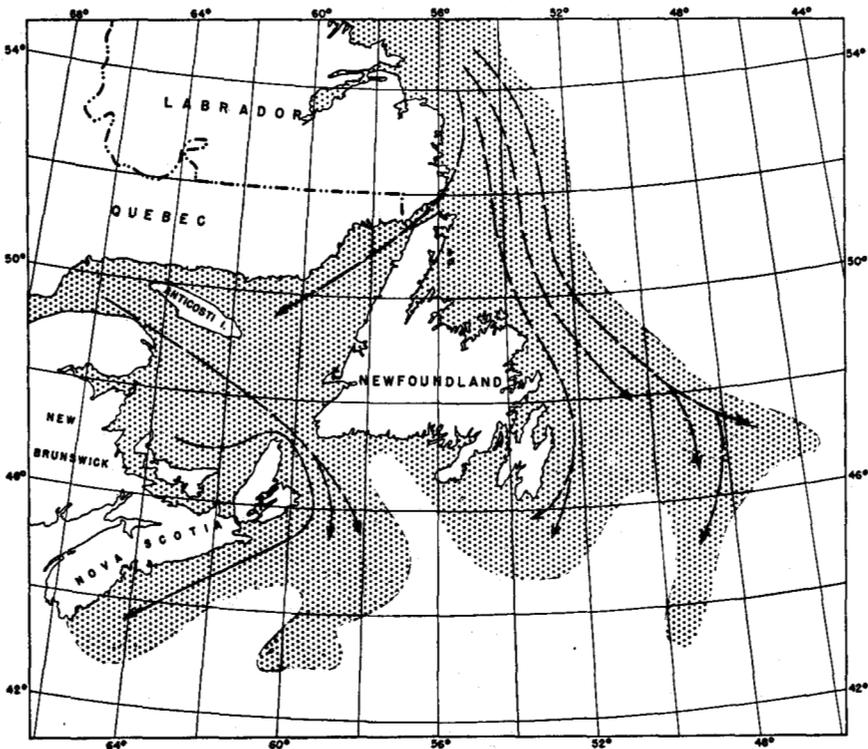


Fig. 1—Distribution of Field Ice, Atlantic Coast. (After Huntsman (1930), and U.S. Hydrographic Office Supplement to Pilot Chart of the North Atlantic Ocean 1948).

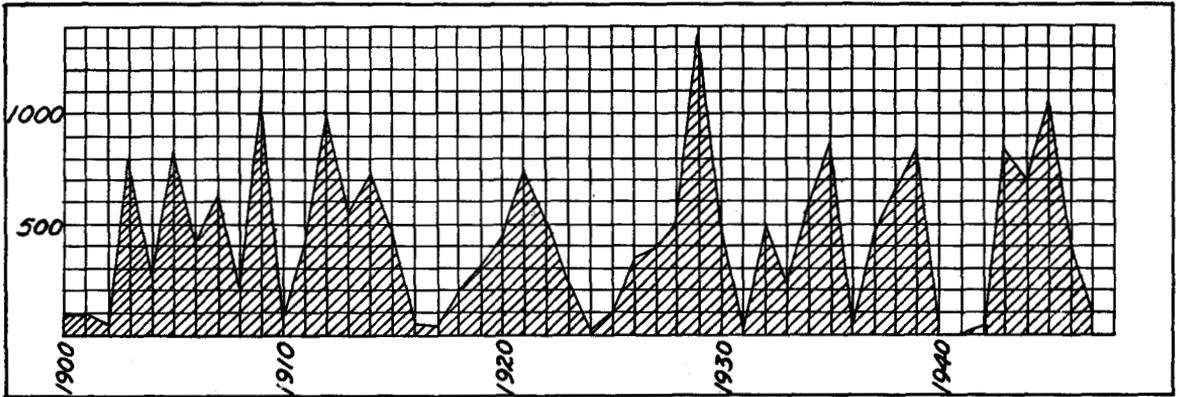


Fig. 2—Number of icebergs south of 48th Parallel, 1900-1947. (After U.S. Hydrographic Office Supplement to Pilot Chart of the North Atlantic Ocean, May 1948.)

Newfoundland are shown in *Figure 1*. This southward drift of ice in spring and summer is a menace to shipping, especially off Newfoundland where the concentration of traffic in an area of fog and ice has contributed to many marine disasters.

The two chief sources of ice encountered in the western Atlantic are Davis Strait and Foxe Channel. The pack-ice from Baffin Bay reaches Hudson Strait in late October or early November and is there joined by heavy floes from Foxe Channel. The combined streams move south along the Labrador coast arriving off Belle Isle in December. Heavy floes of true arctic type often extend 100 miles east of the entrance of the Strait of Belle Isle, and much of this ice enters the strait. From January until after March, currents and winds govern the distribution of this ice, often as far south as latitude 46°N . Large quantities of it may drift along the eastern edge of the Grand Banks, while some of it extends along the east coast of Newfoundland, around Cape Race and thence southward and southwestward over the neighbouring banks. Large quantities of ice which enter the Gulf of St. Lawrence through the Strait of Belle Isle leave it on the Cape Breton side of Cabot Strait and then spread out southward and southwestward toward Sable Island.

In the past thirty years, the International Ice Patrol, operated by the United States Coast Guard, has studied arctic ice and icebergs in the North Atlantic intensively. The fundamentals of iceberg formation and drift were fully studied during the *Marion* and *General Greene* expeditions to Davis Strait and Labrador Sea in the years 1928 to 1935. *Figure 2* shows the great variation from year to year in the number of icebergs found south of the 48th parallel. The United States Coast Guard has been



(Photo: M. J. Dunbar)

Dredge being hauled up during oceanographic expedition, Ungava Bay, Canada, 1947.

moderately successful in forecasting the number of icebergs reaching the shipping lanes in a given year. This forecast is based in part on a study of atmospheric pressure distribution, since the accompanying winds determine whether the bergs will ground on the Labrador shelf or move further southward into the North Atlantic shipping lanes.

The Labrador Current, which is responsible for the southward movement of this arctic ice, can be thought of as a river in the sea, with its source in the waters near Greenland. It flows southward along the Labrador coast with its axis over and parallel to the continental slope. The current retains its characteristics with remarkably little change all the way to the "tail" of the Grand Banks. What is not appreciated by the casual observer is that this current over-reaches its imaginary banks during the late winter and

early spring and consequently distributes great quantities of arctic water, modified to some extent by mixing, westward and southward, reaching even to the west of Nova Scotia. As summer progresses, with consequent warming of the surface waters, these waters of modified arctic characteristics are confined to sub-surface depths, forming what is referred to as the "cold water" layer of the Atlantic seaboard. The physical, chemical and biological character of our waters on the Atlantic coast is thus controlled to a large extent by the distribution of waters having their origin in arctic seas.

In an article entitled "Arctic Ice on our Eastern Coast", Huntsman³ points out the great importance of the subject of ice for all maritime enterprise. He stresses particularly the significance of the movements of arctic ice and arctic water of modified characteristics in determining the character of the fisheries on the Atlantic seaboard. More recently, at a time when the St. Lawrence Waterway project was being reconsidered, Kerry⁴ referred to floating ice as the "bugbear to winter navigation in the Gulf", and called for a study of the situation because of its national importance. Development of any fundamental study of ice and icebergs and the distribution of arctic water should, logically, begin with an effort to increase present knowledge of ice, meteorology and oceanography in the Canadian Subarctic.

Arctic and Atlantic Influence in Hudson Bay

Hudson Bay is in general comparatively well-known, but little serious study has been made of its waters along oceanographical lines. The first known attempt to determine the open-water temperatures and densities at various depths were made by Beauchemin in 1929⁵, while the first detailed examination of the hydrography of the region was made by

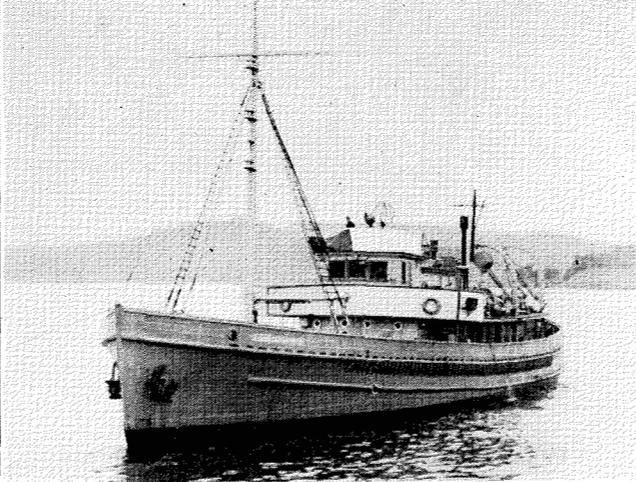
the present writer when officer-in-charge of the Hudson Bay Fisheries Expedition of 1930⁸. As an inland sea, with an area of approximately 200,000 square miles and a maximum recorded depth of 256 metres (141 fathoms), Hudson Bay is open to the influence of both Arctic and Atlantic water. Arctic water reaches Hudson Bay directly from Foxe Channel and indirectly from Davis Strait through Hudson Strait, where the inward movement is along the north side. Subarctic Atlantic water reaches Hudson Bay through Hudson Strait chiefly at sub-surface depths.

Observations in 1930 showed that below 50 metres (27 fathoms), the water temperatures were at least -1.8° C. with corresponding salinities from 31.50 o/oo to 33.08 o/oo. It was concluded that below 50 metres (27 fathoms) the waters were, for all purposes, dynamically dead, thus resulting in a cold, saline body of water which probably undergoes very little change from season to season. In 1948, the observations were repeated in a section from Hudson Strait to Churchill (Hachey and Bailey, unpublished). It was found that below 50 metres (27 fathoms), the water

An iceberg about a mile wide is seen breaking away from the Jakobshavn Glacier whence it will float away to Davis Strait.

(Photo: U.S. Coast Guard)





(Photos from H. B. Hachey)

H.M.C.S. *Cedarwood* and H.M.C.S. *Ekholi*, oceanographic vessels operating along the Pacific coast of Canada.

temperatures ranged from -1.0° C. to -1.8° C. with corresponding salinities from 32.01 o/oo to 33.48 o/oo. In comparison with 1930, the main body of water in Hudson Bay was therefore, in 1948, 0.5° C. warmer and of a salinity greater by 0.50 o/oo. More significance is to be attached to the increased salinities in 1948 which are indicative of increased Atlantic influence.

Greater Atlantic influence in the Greenland area has been discussed by Dunbar⁷ largely on the basis of variations in the West Greenland Current over a period of some years. The retreat of the southern limit of sea ice, the weakening of arctic water, important changes in marine fauna including commercial fishes, and the marked reduction in the transportation of floe ice from east to west Greenland waters are associated with increasing Atlantic influence in Greenland seas.

It would appear that the deep waters of Hudson Bay are not as dynamically dead as they were believed to be in 1930, but that this inland sea serves as an excellent "barometer" to record the rise and fall of Atlantic influence in subarctic areas. While Dunbar⁷ suggests that the peak of Atlantic influence has been reached and passed, the observations to this effect are not conclusive. Neither can we conclude that the peak of Atlantic influence in Hudson Bay was observed in 1948. In any event, Hudson Bay offers an excellent area for continued observations, particularly for studying phenomena associated with the pulsation of Atlantic influence in the Subarctic. The opportunity to study the vagaries of arctic influence through observations of the movements of ice and water from Foxe Basin and Channel is equally important.

The Fundamental Interest

The strengthening of Atlantic influence in the waters of Greenland and Hudson Bay infers a weakening of arctic influence and vice versa. Possibly this conflict of influences holds the key to the problem of the

southward movement of arctic ice and arctic water. A study of ice formation, and the movement of both ice and water in Baffin Bay, Davis Strait, and Foxe Channel and Basin may provide the necessary fundamental data. Today, as never before, the eyes of Canadians are turned to the North. As pointed out by Wilson⁸ the exploration, mapping and scientific study of the North American Arctic is now being pursued on a scale never before possible. An expanding Canadian interest in arctic and subarctic oceanography is, therefore, to be expected.

References

- ¹Sverdrup, H. U., Johnston, M. W. and Fleming, R. H. *The Oceans*. Prentice-Hall, Inc., New York, 1942, pp. 1-1059.
- ²Kemp, J. A. Through the Northwest Passage. *Proc. R. Canad. Inst.*, 5 (Ser. IIIA), 1946-47, pp. 47-48.
- ³Huntsman, A. G. Arctic ice on our eastern coast. *Bull. Biol. Bd. Can.*, XII, Jan., 1930, 12 pp.
- ⁴Kerry, J. G. G. The St. Lawrence Waterway. *Shipbuilding Register and Shipbuilder*, Montreal, September, 1948.
- ⁵Anderson, F. Canadian Hydrographic Service, *63rd Annual Report of the Marine Branch*, Dept. of Marine and Fisheries, Ottawa, 1931, pp. 106-136.
- ⁶Hachey, H. B. The general hydrography and hydrodynamics of the waters of the Hudson Bay region. *Contr. Can. Biol. and Fish.*, VII, (9), 1931, pp. 93-118.
- ⁷Dunbar, M. J. The state of the West Greenland Current up to 1944, *Joint Fish. Res. Bd. Can.*, VI, (7), 1946, pp. 460-471.
- ⁸Wilson, J. T. A Message from the Arctic Institute of North America. *Arctic* I(1), Spring, 1948, p. 3.

ROSTER OF ARCTIC SPECIALISTS

The Arctic Institute of North America is compiling a roster of persons with knowledge of the Arctic. It is to include scientists, traders, missionaries, administrators, explorers and others with experience in any part of the Arctic. The Directors of the Project would be glad to receive the names of any persons who should be added to the roster. Information may be addressed to the Director, Arctic Institute Roster, 1530 P Street Northwest, Washington, D.C.