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Temperatures and salinities in the eastern Newfoundland area in 1970

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Introduction

The 6 standard monitoring sections, taken each year at approximately the same dates in July-August across the Labrador Current east of Newfoundland, were occupied by the *Cape Freels*. Station 27, off Cape Spear, was occupied monthly or more often during the year. The section temperatures are compared with the lowest, average, and highest temperatures at each depth at each station in 1951-65 in July-August (unpublished) and also with temperatures in 1969 (Templeman, 1970) and for the St. John's-Flemish Cap section for 1966-69 (Templeman, 1967, 1968, 1969, 1970). Salinities are also compared with those in the above years.

Sections across the Labrador Current in July-August

Temperatures

In the Seal Islands, Labrador, section across Hamilton Inlet Bank (Fig. 1), surface temperatures were similar to the long-term average. The lowest temperatures at mid-depths near the coast were similar to the lowest of the 1951-65 period and were slightly lower than in 1969. The volume of water with temperatures below  $-1^{\circ}\text{C}$  was above average. Temperatures in the more offshore portion of the cold central area of the Labrador Current were lower than the average of the 1951-65 period but higher than the lowest recorded and the 1969 temperatures. Temperatures of the bottom water in Hawke Channel were slightly higher than the long-term average and higher than in 1969. The temperature at the crest of Hamilton Inlet Bank was

the highest recorded. Temperatures of the deep water seaward of Hamilton Inlet Bank at Stations 55A and 56 were similar to the highest recorded averages and considerably higher than in 1969, and at Station 57, the most seaward station, deep-water temperatures from 200 to 1000 m were higher than any previously encountered, and between 200 and 600 m considerably higher than in 1969.

In the section off Cape Bonavista and southward to the northern Grand Bank (Fig. 2), surface temperatures of the Cape Bonavista portion were slightly below the long-term average and below those of 1969 except at the most coastal station, and mainly slightly below 1969 in the Grand Bank section. Temperatures in the inshore central core of the Labrador Current were slightly lower than the 1951-65 average and approximately similar to those of 1969, and the volumes of water with temperatures of below  $-1^{\circ}\text{C}$  and  $0^{\circ}\text{C}$  were close to the average. The lowest temperature of the shoreward cold water and the lowest temperatures of the eastward-flowing branch of the Labrador Current near the Grand Bank were slightly below those of 1969. Except for the bottom temperatures at Stations 46 and 47, temperatures from 300 to 1000 m were the highest recorded and considerably higher than in 1969.

In the St. John's-Flemish Cap section (Fig. 3), surface temperatures were slightly below average and approximately similar to those of 1969 except at the inshore Station 27 where the surface temperature was high. The lowest temperatures of the shoreward central core of the Labrador Current were similar to the 1951-65 average and below those of 1969. The amount of water below  $0^{\circ}\text{C}$  was also close to the average but the temperature at the bottom at Station 27 in the Avalon Channel was the second highest recorded. Temperatures at the cold-water core of the eastern branch of the Labrador Current were close to the average and the extent of water with temperatures below  $0^{\circ}\text{C}$  a little greater than the average. Water temperatures in the upper layers above 150 m were average. Temperatures from 400 m downward in the Flemish Channel and those from 200 to 1000 m seaward of Flemish Cap were among the highest and sometimes, including the 200-800 m levels at Station 42A, the highest recorded in the period 1951-70.

In the section from St. John's to the southeast slope of the Grand Bank (Fig. 4), the lowest temperatures in the coldest part of the Labrador Current, near shore, were similar to the lowest recorded. The temperature near bottom at Station 27 and temperatures over the surface of the Grand Bank were near but mainly slightly above the average. The distribution of the coldest water of the eastern branch of the Labrador Current, which usually hugs the eastern slope of the Grand Bank, was highly unusual, swinging away from the bank and with a warmer water border fringing the bank. Temperatures at the centre of this cold water were average. Temperatures at the most eastern station (33F) were above average but lower than those of 1969.

In the section extending along the southwestern edge of the Grand Bank at about 75 m (Fig. 5), surface temperatures were close to the 1951-65 average and higher than in 1969. Temperatures in the cold water near bottom in the Haddock Channel were close to the highest of the 1951-65 period but lower than in 1969. Bottom temperatures over the surface of the Grand Bank were close to the average for 1951-65 and somewhat similar to those of 1969. In the cold eastern branch of the Labrador Current at the eastern edge of the bank, temperatures were higher and the volume and depth of water with temperatures below 0°C and below 2°C much less than usual. The temperatures of the water fringing the Grand Bank on its eastern slope were by far the highest recorded and this warm water intrusion separated the low temperature and the median temperature water of the Labrador Current.

In the section at 275 m along the southwestern slope of the Grand Bank and extending to St. Pierre Bank (Fig. 6), surface temperatures were above the average for the 1951-65 period and considerably higher than in 1969. Temperatures of the intermediate cold Labrador Current water from the Haddock Channel were below average and, in the coldest water of the eastern branch of the Labrador Current, above average and almost as high as the highest recorded. Temperatures of the higher temperature deep slope water between these two branches of the Labrador Current were well above average. The bottom temperatures were mainly above average, all at Stations 10, 15, and 19 higher than any previously encountered in the 1951-65, 1969 period. As in the previous section (and at the same station, 26F) a branch of the Labrador Current with intermediate temperatures, which

could be a return current passing northward, was apparent to the east of the slope separated from the main eastern branch by a warm water intrusion.

### Salinities

In these comparisons, salinities from 20 m to the surface are omitted because they are too much influenced by local and temporary precipitation and runoff to be very useful in year to year comparisons.

In the Seal Island section off southern Labrador (Fig. 1), at all stations except 55A, where there was some upwelling, salinities in the upper 100 m, at Station 53 the upper 150 m, and at Station 57 the upper 200 m were either the lowest or generally among the lowest 2 to 5 out of 16 or 17 years of records. Salinities were also in the lower half of records for the period at Station 55 for 150-250 m, at Station 55A for 50 m to 300 m, at Station 56 for 200 m, and at Station 57 for 250-500 m. The salinities at 200-250 m at Station 53 were close to the average. Seaward from this station, salinities were above average and usually in the upper quarter for the period at Station 54, 100 m and deeper; Station 55, 300 m and deeper; Station 55A, 400 m and deeper; at Stations 56 and 57 at 250 m and deeper. Salinities at Station 55A (500 m), at Station 56 (300-500 m) and at Station 57 (600-1000 m) were the highest in the records for 6-17 years.

In the section off Cape Bonavista and southward to the northern Grand Bank (Fig. 2), at all depths from 30 m and greater at Stations 43 and 44, depths down to 150 m at Stations 45 and 49, to 250 m at Stations 46 and 47, to 100 m at Station 48, and to 200 m at Station 50 were either the lowest encountered in the period under comparison (18 of 40) or were in the lowest quarter. Salinities in the deep water: bottom at Stations 45 and 47, 250 m to bottom at Stations 48 and 49, and 400 to 1000 m at Station 50, were either the highest or equal to the highest on record (9 of 12) or in the highest quarter. Similarly high deep-water salinities and low upper-water salinities prevailed in the northern Grand Bank portion of the section for which long-term comparisons are not available.

In the section from St. John's to Flemish Cap (Fig. 3), salinities at Station 27 (30-125 m), Station 28 (30-100 m), Stations 29, 36 and 37 (30-50 m), Station 35 (30 m to bottom), Station 37A (30 m), Stations 38 and 40 (30-150 m), Stations 39 and 42A (30-100 m), and Stations 41 and 42

(30-75 m) were all below average; 9 (8 at 30 m) of 44 the lowest encountered for the period 1951-70, and 33 of 44 in the lowest quarter. Deep-water salinities at Station 27 (150 m to bottom), Station 28 (bottom), Stations 34, 36 and 37 (75 m to bottom), Station 37A (50 m to bottom), Station 38 (200-800 m), Station 39 (150-750 m), Station 40 (200 m to bottom), Stations 41 and 42 (100 m to bottom), and Station 42A (150 m to bottom) were above average, 33 of 53 the highest or equal to the highest encountered for the period 1951-70 and 46 of 53 in the highest quarter. The deep-water salinities above 35‰ at Stations 38-42A, in Flemish Channel and on the eastern slope of Flemish Cap, were the highest in our records.

In the section from St. John's to the southeast slope of the Grand Bank (Fig. 4), salinities at Stations 27-32A (all depths from 30 m downward), Stations 33 (30-75 m), 33A (30-250 m), 33B (30-400 m), 33D (30-250 m) and 33F (30-150 m) were below average, 34 of 55 the lowest encountered for the period and 49 of 55 in the lowest quarter. Salinities in the deeper water of the eastern slope: Station 33 (100 m to bottom), Stations 33A and 33D (300 m to bottom), Station 33B (bottom), and Station 33F (200 m to bottom) were mostly above average, 6 of 20 the highest or equal to the highest encountered for the period and 10 of 20 in the highest quarter.

In the section at about 75 m extending along the southwestern slope of the Grand Bank (Fig. 5), salinities at all depths from 30 m downward at Stations 20B-26A and at depths of 30-200 m at Station 26F were the lowest (12 of 38) or among the lowest (1/8 to 1/4) of the salinities encountered in the period under comparison. At depths of from 30 m to bottom at Station 26B, 50 m to bottom at Station 26D, and from 300 to 600 m at Station 26F, salinities were equal to the highest or were the highest recorded (13 of 20) or were in the highest quarter recorded.

In the section at 275 m along the southwestern slope of the Grand Bank and extending to St. Pierre Bank (Fig. 6), salinities down to 100 m at Station 10, to 150 m at Station 13, to 75 m at Station 18 and at 30 m at Stations 16, 17 and 19 were usually either the lowest (7 of 15) or in the lowest quarter of salinities in the period under comparison. Salinities from 150 m to bottom at Stations 10, 15 and 17, 200 m to bottom at Stations 13 and 16, and from 50 m to bottom at Station 19 were either the highest or

equal to the highest on record for the period under comparison (11 of 24) or usually among the highest quarter of the records for the period. Data for Stations 26D and 26F of this section are the same as in Fig. 5.

The most noteworthy features of the 1970 sections were the warmer water and especially the unusually high salinities in the deeper water at the eastern slope of the continental shelf and banks. Judging from the location of occurrence of high salinities in the sections (Fig. 1-6), and from Dietrich (1965, fig. 11) there was an unusual degree of intrusion of Atlantic water into the eastern and deeper parts of the Labrador Current on the northeastern and eastern slopes of the Grand Bank. Also noteworthy were the unusually low salinities of the upper water layers and the separation of the cold core of the Labrador Current from the Grand Bank to the east of the Southeast Shoal. The latter must be highly unusual as it is the first time that it has occurred in 17 years of records since 1951.

#### Station 27, 1970

In Station 27 off Cape Spear (Fig. 7), except for January, surface temperatures throughout the year were above the 1950-62 average (Templeman, 1965). Also, the highest surface temperatures in July-August were well above those in 1969 (Templeman, 1970). Bottom temperatures except for February and December were above the 1950-62 average and were mostly similar to those of 1969. At intermediate levels, the lowest water temperatures, below  $-1^{\circ}\text{C}$ , were below the 1950-62 average and below those of 1969 and were evidently not produced locally but were brought in by the Labrador Current. The coldest water came through Station 27 in August and there was a much greater than usual persistence of a large volume of water with very low temperatures up to the beginning of December.

Upper layer salinities in late summer and in autumn were well below and surface salinities throughout the year usually below those of 1969. Otherwise, they were generally similar to those of 1969 except that water with a salinity below  $33\text{‰}$  sometimes extended to the bottom in 1970 but not in 1969.

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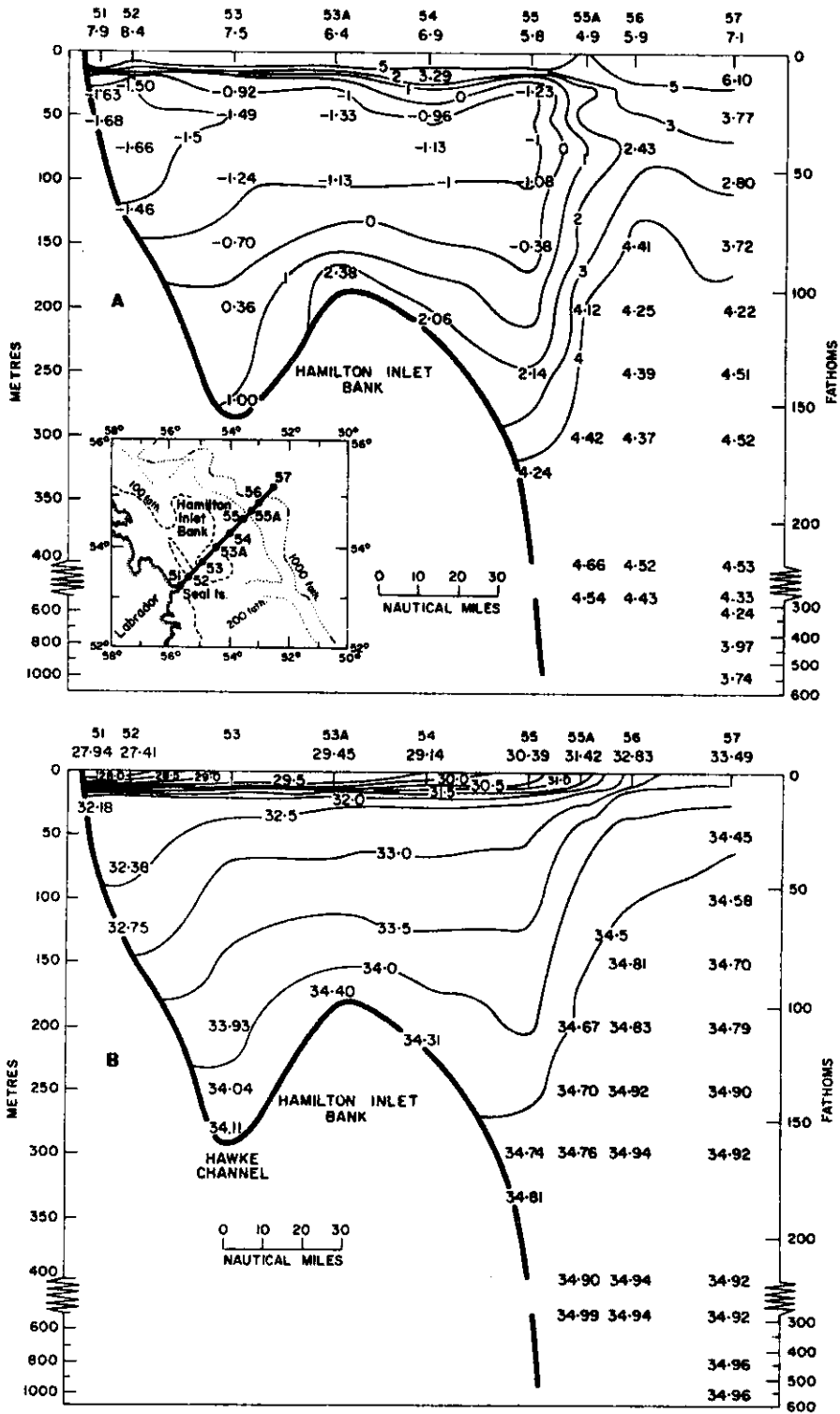


Fig. 1. Temperature ( $^{\circ}\text{C}$ ) above and salinity ( $\text{‰}$ ) below, Seal Island-Hamilton Inlet Bank section, 2-3 August 1970.



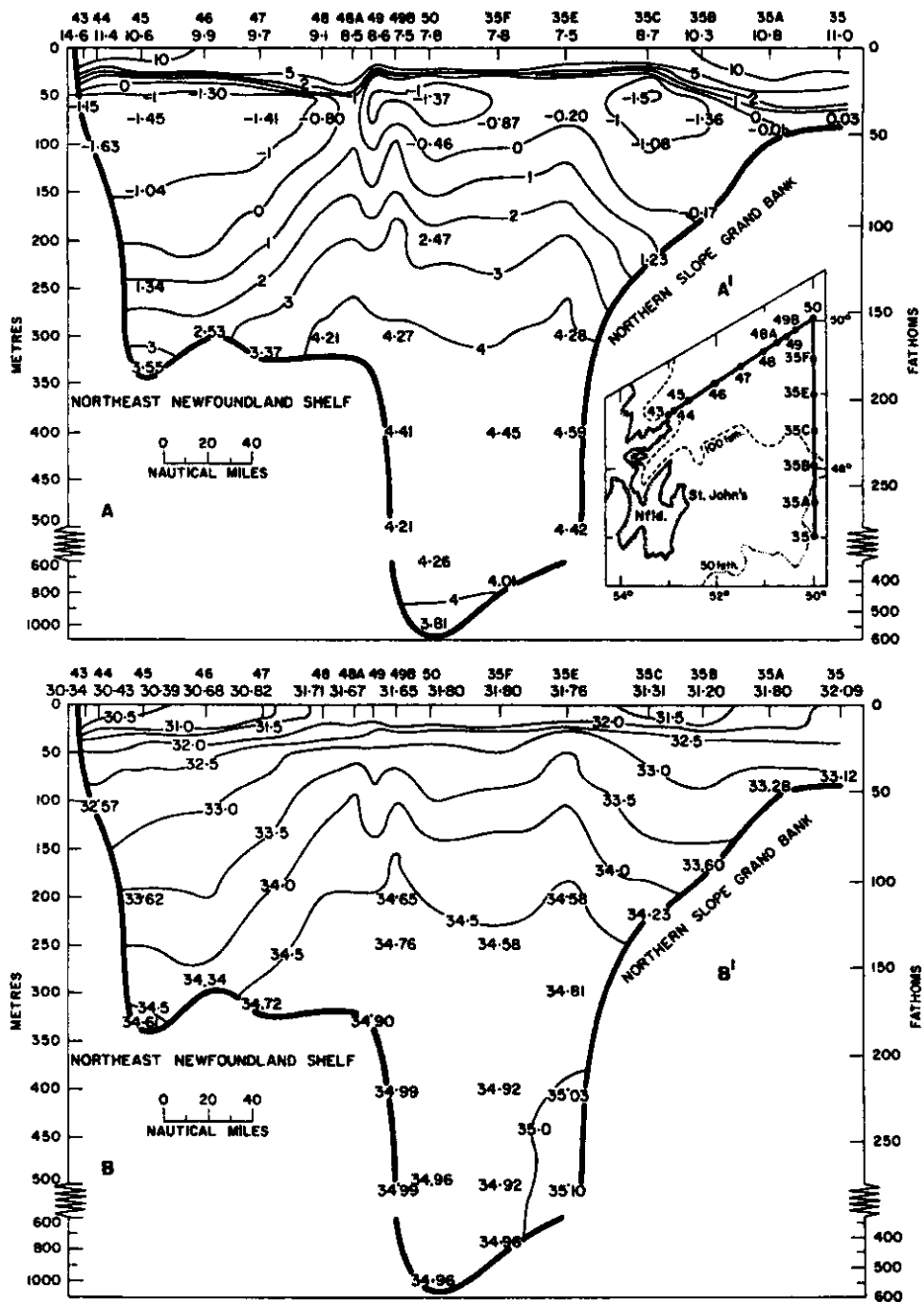


Fig. 2. Temperature ( $^{\circ}\text{C}$ ) above and salinity ( $\text{‰}$ ) below, for section off Cape Bonavista, and southward to northern Grand Bank, 28 July-1 August 1970.

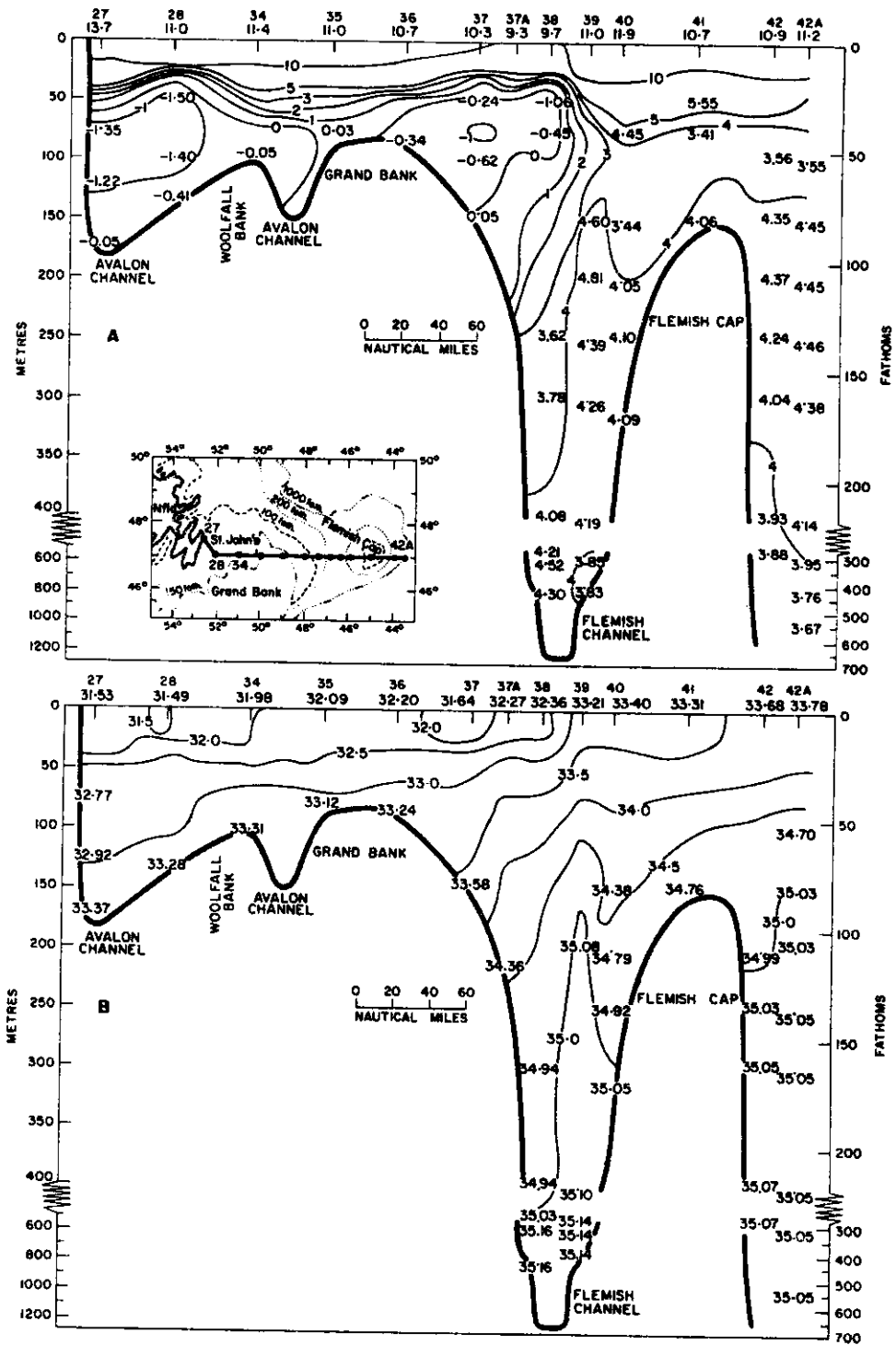


Fig. 3. Temperature (°C) above and salinity (‰) below, St. John's-Flemish Cap section, 27-29 July 1970.

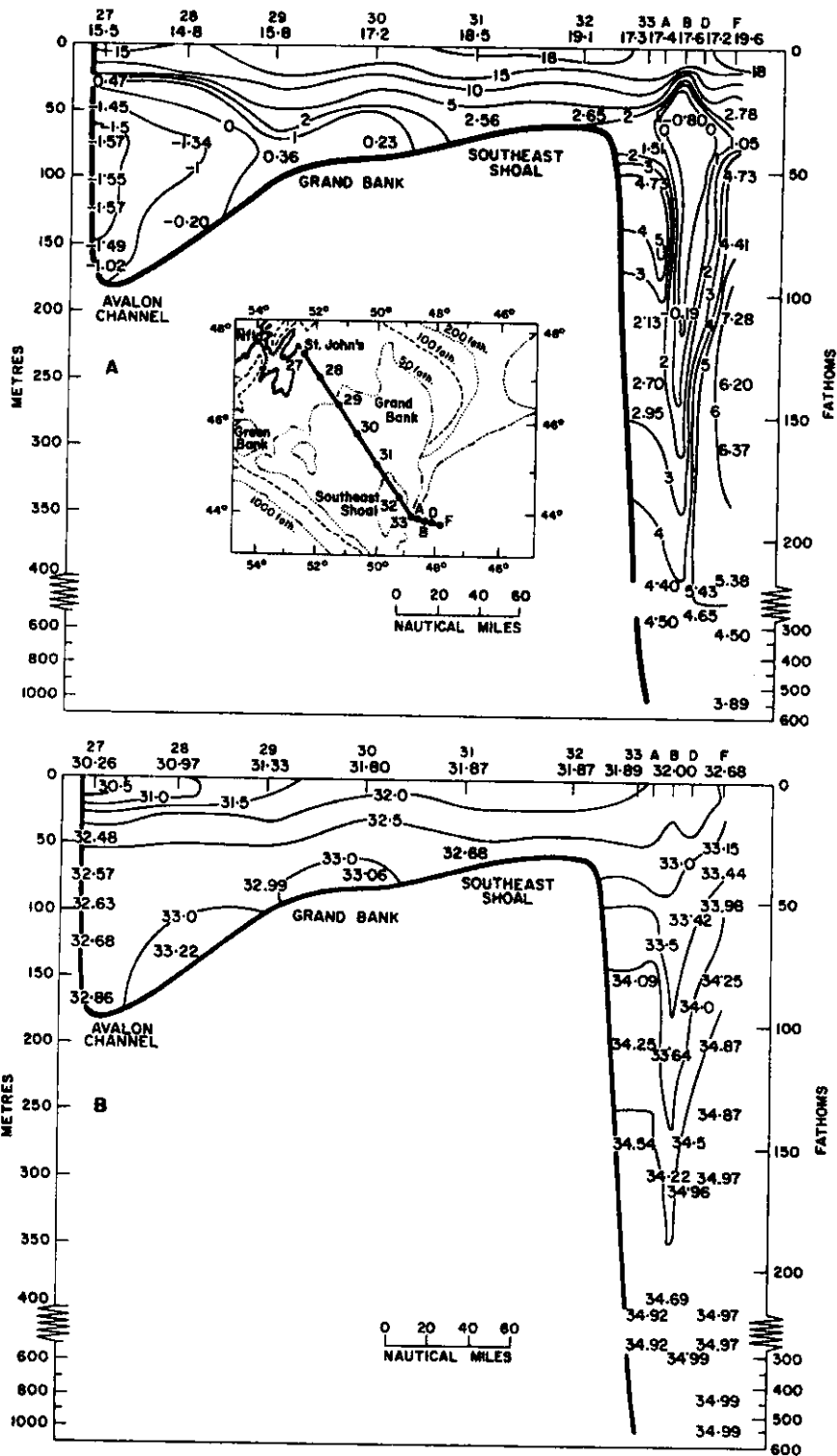


Fig. 4. Temperature ( $^{\circ}\text{C}$ ) above and salinity ( $\text{‰}$ ) below, St. John's-SE slope Grand Bank, 17-19 August 1970.

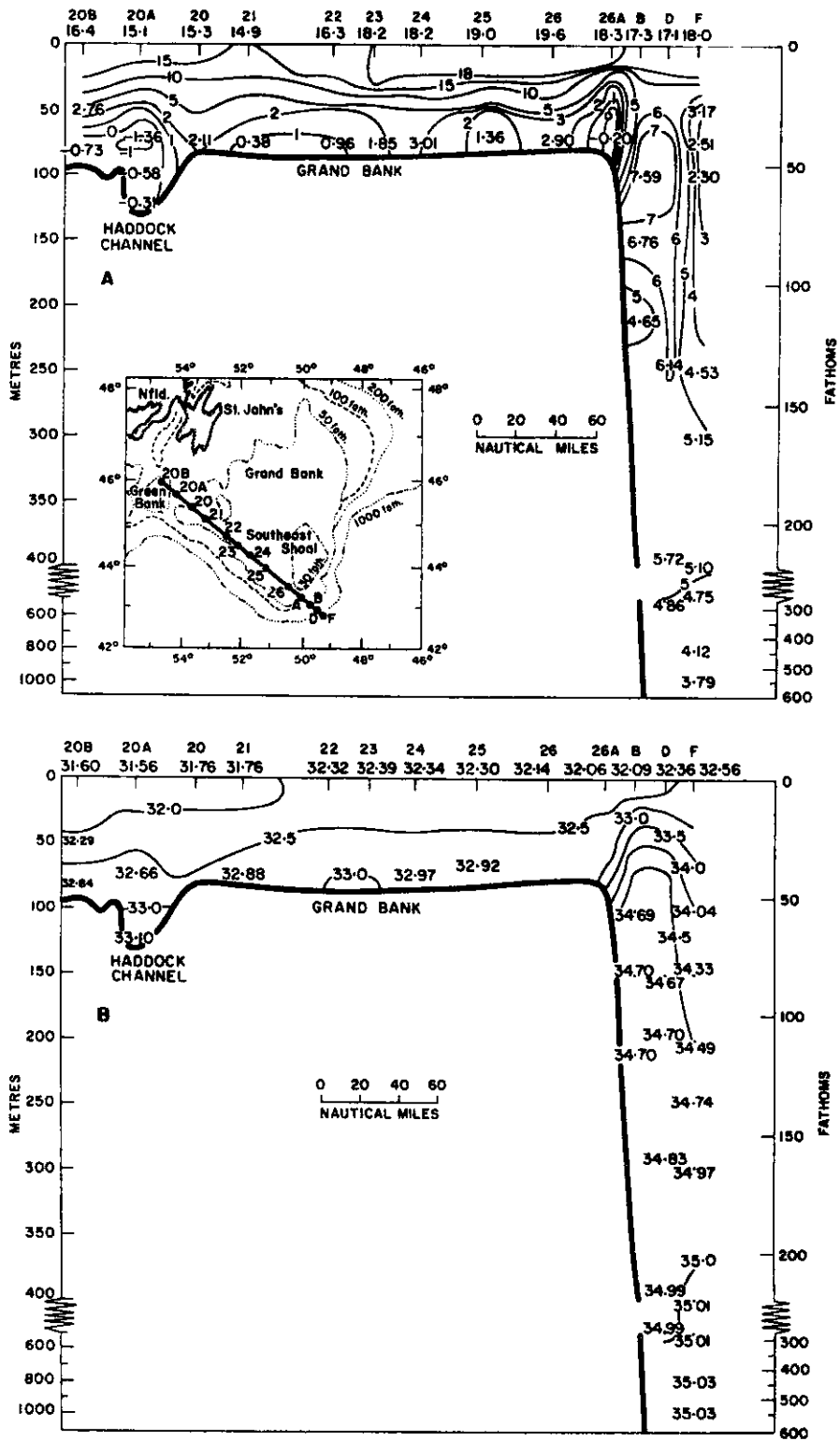


Fig. 5. Temperature ( $^{\circ}\text{C}$ ) above and salinity ( $\text{‰}$ ) below, Green Bank-SE Grand Bank, 20-23 August 1970.

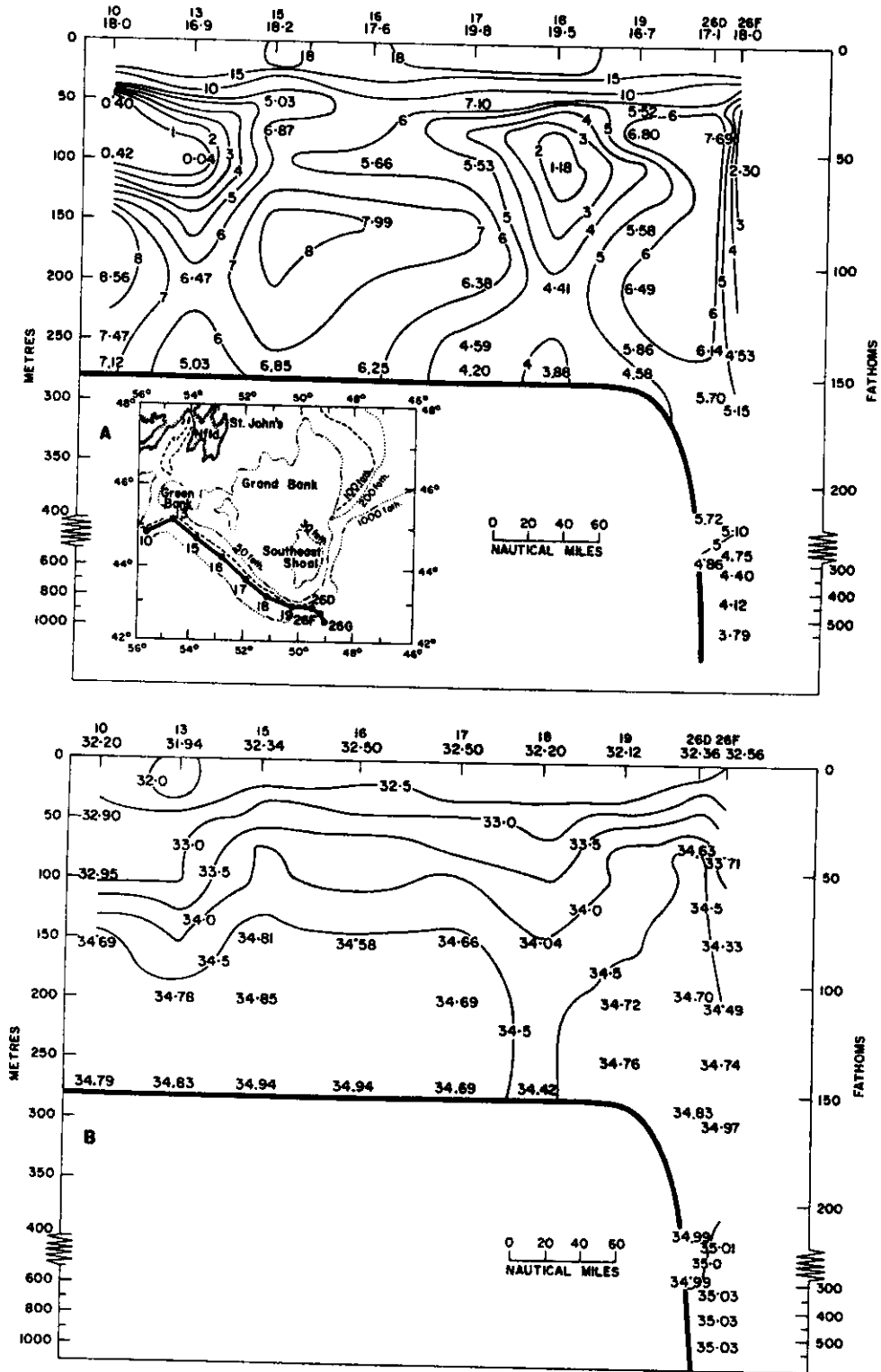


Fig. 6. Temperature ( $^{\circ}\text{C}$ ) above and salinity ( $\text{‰}$ ) below, SW slope Grand Bank-St. Pierre Bank, 20-23 August 1970.

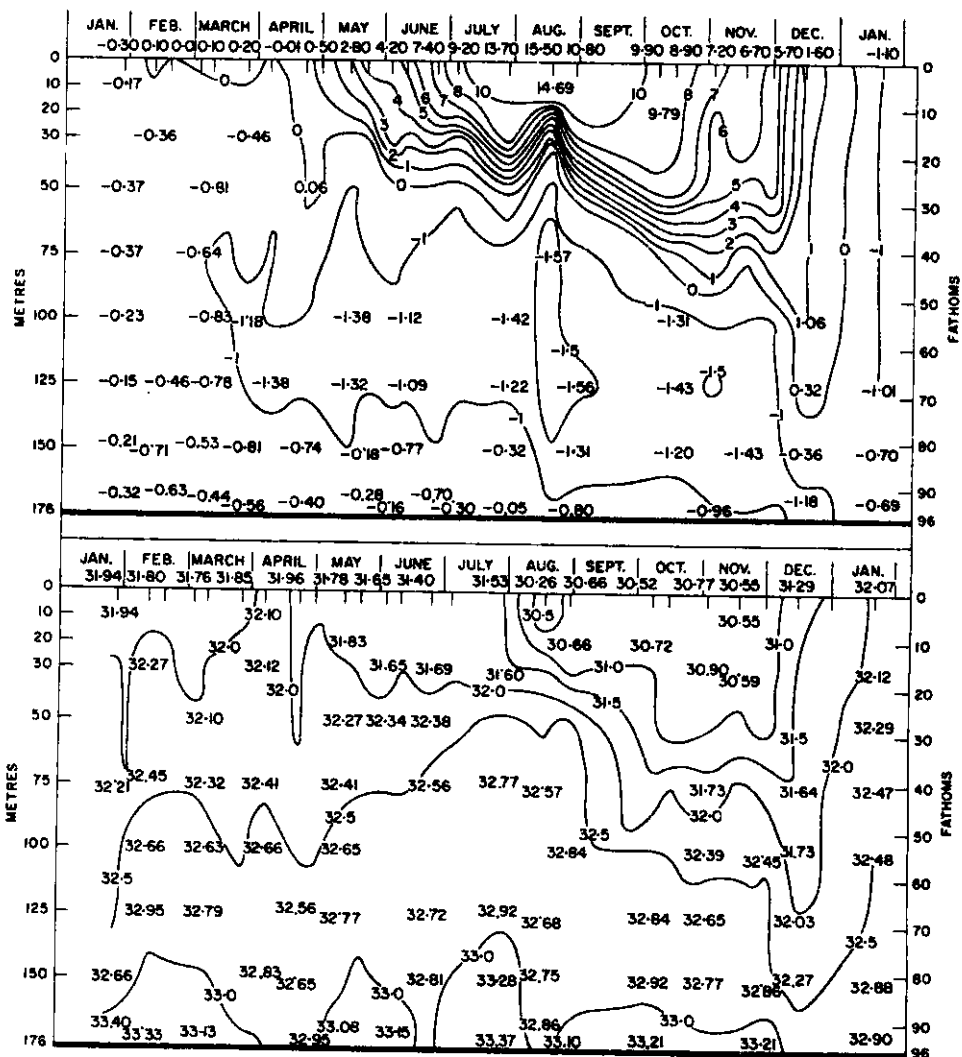


Fig. 7. Temperature ( $^{\circ}\text{C}$ ) above and salinity ( $\text{‰}$ ) below, January 1970 to January 1971, from surface to bottom at Station 27 (see Fig. 3, 4 inset), 2 nautical miles off Cape Spear near St. John's.