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Distribution and biological characteristics of the ommastrephid squid
Illex illecebrosus (LeSueur) on the Grand Bank, St. Pierre Bank and Nova Scotian Shelf
(Subareas 3 and 4) as determined by otter-trawl surveys 1970 to 1972

by

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Introduction

The migrant squid *Illex illecebrosus* (LeSueur) has long supported small inshore fisheries at the northern end of its western Atlantic range and trawl fisheries for the species on the continental shelf are of recent origin (see Mercer, 1973a).

Squires (1957) reviewed the seasonal distribution of the species in the Northwest Atlantic and demonstrated that squid arrive in the warmer waters of the southwestern, southern and eastern part of the Grand Bank in May prior to their arrival inshore at Newfoundland in late June or July. Inshore abundance and landings at Newfoundland have been found to correlate with relative abundance on the Grand Bank early in the season (Squires, 1957, 1959; Hodder, 1964; Mercer, 1966).

Data presented here were obtained on surveys designed to study relationships of populations on the Grand Bank, St. Pierre Bank and Nova Scotian Shelf from size distributions, maturities, parasite fauna and biochemical genetics and also to document distribution and abundance. The following account collates information on distribution in relation to hydrographic parameters and biological characteristics of squid in late May to early August of the years 1970 to 1972.

Materials and Methods

Survey method. All sets were made during daylight hours at standard depths assigned at 25 fath (46 m) intervals from 50 to 200 fath (91 to 366 m) on fixed transects chosen from those previously employed on groundfish survey cruises conducted by the St. John's Biological Station (Fig. 1). Replicates were run of several sets in order to increase squid sample sizes. Fishing gears employed were as follows:

1. A. T. Cameron cruise 173. Standard No. 41-5 braided polythene otter trawl. Belly to codend sections were lined with 19 mm knotless nylon liner and the codend was also lined with 4.8 mm nylon liner.
2. E. E. Prince cruises 75, 87, 102. Standard No. 36 braided polythene otter trawl. The cod-end and lengthening piece were lined with 6mm nylon netting for cruises 75 and 87 and 32 mm for cruise 102. For sets on Brown's Bank and LaHave Bank on E. E. Prince cruise 102 the gear employed was a pelagic Engel-net 1046 meshes in circumference at the mouth with mesh sizes tapered from 16 cm stretched in the wings to 4 cm stretched in the codend.

Comparative fishing results indicate that a ratio of 1.5:1 can be used to reduce No. 41 catches to equivalent catches for a No. 36 trawl (Jean, 1964).

Hydrography. Surface temperatures were taken and bathythermograph casts run 0-270 m for each set. Temperatures about 4 m off bottom were obtained using Knudsen bottles with attached mercury thermometers.

Squid measurements and maturities. Dorsal mantle lengths of all squid were measured to the nearest centimetre from the anterodorsal margin of the mantle to the apex of the tail fin. Maturities were classified according to the scale given by Mercer (1973b).

Results

Distribution and abundance

May 22-June 2, 1970 (A. T. Cameron cruise 173). Squid were taken in 11 of 50 otter-trawl sets (Fig. 2). The only squid taken on the Grand Bank were single specimens in sets at 134-141 m and 165-186 m (bottom temperatures 7.4 and 7.9°C) at Whale Deep and two large catches in 132-143 m at Eastern Gully: 32 specimens in 7.9°C on May 25 and 390 in 8.0°C on June 2. No specimens were trawled on St. Pierre Bank. On the northern two Nova Scotian Shelf transects the only squid taken was 1 in 137-146 m on Banquereau where the highest temperatures in the water column were only 4.1 and 3.5°C at the surface and bottom. On Western Sable Island Bank catches of 1, 6 and 10 specimens were made in 104-141 m in bottom temperatures 6.1 to 9.1°C. Three large catches of 218-390 specimens were taken in 137-240 m on LaHave Bank where bottom temperatures were 7.1-7.8°C.

July 23-Aug. 4, 1970 (E. E. Prince cruise 75). Squid were taken on all St. Pierre Bank and Grand Bank transects except at the Southern Tip where water temperatures were low (bottom temperatures 0.2-3.6°C) beneath the thin warm surface layer (Fig. 3). Largest catches were taken in the Eastern Gully in 95 m (353 specimens), 179-183 m (138 specimens), and 220-234 m (204 specimens). Surface night lights were effective in attracting squid to the vessel in this area.

On the Nova Scotian Shelf squid were taken on all transects with bottom temperatures ranging from 2.8 to 9.5°C. Largest catches were on Western Sable Island Bank in 106 and 230-234 m where 146 and 207 squid were taken respectively in 5.3 and 8.0°C. The transect fished on Brown's Bank (not shown in Fig. 3) yielded 54, 34 and 11 specimens respectively in depths 227-252 m, 135-139 m and 119 m where bottom temperatures were 6.7, 9.5 and 7.2°C respectively.

July 12-22, 1971 (E. E. Prince cruise 87). Squid were taken in all sets on the Grand Bank except those on the Southern Tip where bottom temperatures were -0.3 - 4.2°C (Fig. 4). Largest catches were 65-860 specimens in four sets from 135 to 274 m where bottom temperatures were 5.5 - 7.0°C.

Low catches were recorded in six of ten sets on St. Pierre Bank including two stations where negative bottom temperatures were obtained.

Squid were captured in 21 of 24 sets on the Nova Scotian Shelf with largest catches being 268 specimens in 181-183 m (bottom temperature 6.5°C) south of Sable Island and 186 specimens in 183-190 m (bottom temperature 5.1°C) on Banquereau. The transect fished on Brown's Bank (not illustrated in Fig. 4) yielded 7, 16, 23 and 27 squid in depths and temperatures 117-119 m (7.1°C), 135-137 m (8.5°C), 181-194 m (8.8°C) and 227-229 m (8.8°C).

June 22-July 2, 1972 (E. E. Prince cruise 102). Temperatures on the Southern Tip of the Grand Bank were warmer than those recorded on previous cruises and small catches of squid were made in three sets between 185 and 276 m, bottom temperatures 4.9-6.8°C (Fig. 5). On the Eastern Gully transect the only catches were 36 and 20 specimens in 135-137 and 181-186 m respectively where bottom temperatures were 8.2 and 8.1°C. Largest landings were 439 and 522 specimens in 135-139 m on the Southwest Edge (bottom temperature 3.7°C) and 25 and 156 specimens in 137-141 m at Whale Deep (bottom temperature 6.9°C).

While catches were small in the Western Gully large landings were made on the St. Pierre Bank transect, the largest catch being 473 specimens in 186 m (bottom temperature 6.0°C).

Catches were small on Banquereau and no squid were taken on LaHave Bank. Largest landings were 254 and 702 specimens in 137-139 m on Western Sable Island Bank (bottom temperature 11.7°C) and 58 and 75 specimens in 137-139 and 181-186 m (bottom temperatures 5.4 and 8.5°C) south of Sable Island.

The transect fished on Brown's Bank (not illustrated in Fig. 5) yielded 0 and 144 specimens in 117-143 m and 183-263 m where bottom temperatures were 8.9 and 9.4°C respectively.

Size distributions and maturities

All mantle length data were combined for each cruise for the Newfoundland Shelf and for the Nova Scotian Shelf (Fig. 6). The following notes compare observations by area and season beginning with samples taken earliest in the year.

Newfoundland Shelf. Both male and female squid taken May 22-June 2, 1970 show unimodal and slightly negatively skewed distributions, that for males being leptokurtic peaking at 13 cm and that for females being rather more flat-topped at 12-14 cm. Ranges were compact in both, 8-15 cm, and all specimens were immature.

In June 22-July 2, 1972 the mantle lengths were unimodal and leptokurtic for both sexes, ranges and modes being 11-17-22 and 11-17-23 cm respectively. All females were immature but a few males were in the maturing I class, the numbers being 1/24 at 20 cm, 2/5 at 21 cm and 1/1 at 22 cm. This contrasts with data obtained for inshore Newfoundland where only one of several thousand specimens examined in June and July had reached the maturing I stage (Mercer, 1973b).

In July 12-July 22, 1971 the length frequencies were unimodal, leptokurtic and positively skewed for both sexes; ranges and modes were 14-18-24 cm and 15-18-24 cm for males and females respectively. All specimens were immature.

Bimodality was also observed in samples taken July 23-August 4, 1970. Ranges were 9-22 cm and 9-23 cm for males and females respectively while modal classes were 16 cm and 18 cm for males and 16 cm and 18-19 cm for females. All specimens were immature except for 1 of 65 males at 19 cm which was in maturing stage I.

Nova Scotian Shelf. Both sexes of squid sampled May 22-June 2, 1970 showed a bimodal distribution, ranges being 7-14 cm for males and 8-14 cm for females. The group of smaller squid comprised the bulk of the catch, modes being at 9-10 cm for males and 10 cm for females. The second modal class, at 13 cm for both sexes, coincides with that observed on the Newfoundland Shelf. All squid were immature.

In June 22-July 2, 1972 the distributions were unimodal and leptokurtic but, compared with the Newfoundland Shelf samples, they were positively skewed and had lower modes. Ranges and modal classes were 11-15-21 cm and 11-15-23 cm for males and females respectively. Maturities were also further advanced than on the Newfoundland Shelf, with 9 maturing I specimens at 15-21 cm, 1 maturing II at 18 cm, and 1 mature at 19 cm.

In July 12-July 22, 1971 the length compositions were unimodal and leptokurtic, ranges and modes being 15-19-23 cm and 16-20-27 cm for males and females respectively. Modal classes were 2 centimetres higher than those observed on the Newfoundland Shelf, this being the only cruise for which such a circumstance obtained. All specimens were immature.

Heterogeneity evinced in samples obtained July 23-August 4, 1970 appear to reflect presence of at least three size groups. Length ranges were 10-21 cm for males and 9-23 cm for females. Modal classes appeared at 12, 16-17 and 20 cm for males, that at 16-17 cm comprising the larger part of the sample and coinciding with the lower of the two modal classes observed on the Newfoundland Shelf. Modal classes for females appeared at 13, 16-17, 20 and possibly at 22 cm. The first three coincide with those for female squid and, as for males, the second modal class apparently coincided with the smaller group of squid sampled on the Newfoundland Shelf. Twenty males at lengths 14-21 cm were classified in stage maturing I and one at 18 cm was in stage maturing II; the remainder were immature.

Sex ratios

Deviation from numerical equality of the sexes was checked by application of the χ^2 test. Females were more numerous in samples from both areas in all four cruises except that in the period July 12-22, 1971 on the Nova Scotian Shelf. However, only those samples taken July 23-Aug. 4, 1970 and June 22-July 2, 1972 showed a statistically significant deviation ($P < .05$).

Discussion

Distribution and abundance

Variability in catches reflects not only variation in actual abundance but also in availability to the gear. The species is pelagic and its catchability by otter trawl is considered to be low. In several instances squid were seen falling through the forward parts of the net and specimens were landed in vigorous undamaged condition as compared to the generally poor condition of specimens crushed amongst the catch in the codend. This is considered evidence that at least some of the squid taken were captured pelagically during retrieval of the trawl.

With the foregoing reservations some generalizations can be made regarding the observed squid distribution in relation to environmental parameters. It is evident that the zone occupied by Illex illecebrosus on the continental shelf is restricted by low water temperatures over shallower areas in the season under consideration. As noted previously, for instance, the only squid taken at the Southern Tip of the Grand Bank were in 185-276 m on June 30, 1972 in temperatures higher (4.9-6.8°C) than those obtaining in shallower depths or on other fishing dates. On the South West Edge of the Grand Bank catches were nil or low and dispersed over a wide depth range when isotherms roughly paralleled the surface; the large catches taken at 135-139 m on June 29, 1971 were in 3.7°C below a tongue of cold water overlying the shelf. The large catch at 132-143 m (8.0°C) on June 2, 1970 at the Eastern Gully apparently did not relate to a thermal barrier to dispersal. However, the largest catches trawled on other sampling dates were obtained in the shallowest depths yielding squid catches: in 8.2°C at 135-137 m, in 6.2°C at 135-137 m, and in 4.1°C at 91-95 m. In each case colder water obtained in shallower depths (5°C+ water was present at 95 m in a thin layer only). The general pattern observed on the foregoing three transects also applies to other areas. Squid concentrated at the edge of the continental shelf in waters generally warmer than 5°C in areas where vertical dispersal and horizontal movement to shallower areas on the shelf were impeded by overlying cold arctic water.

Size distributions, maturities and sex ratios

While samples were obtained in different years it is evident that, in both areas, sizes of squid sampled increased with lateness of the season. This is consistent with observations inshore at Newfoundland where squid growth can be followed in the changing modes of mantle length (Squires, 1957; Mercer, 1965, 1969).

Except for samples obtained July 12-22, 1971 squid on the Newfoundland Shelf were found to be larger than those on the Nova Scotian Shelf. This coincides with observations inshore at Newfoundland where larger squid are taken on the east coast than on the south coast (Mercer, 1965, 1966, 1969 and in prep.).

In comparing the unimodal leptokurtic distributions which obtained in the 1971 and 1972 samples, the skews were opposite for the two areas. This, and the small group of larger squid in the bimodal distribution on the Nova Scotian Shelf May 22-June 2, 1970 (which coincided with the modal class on the Newfoundland Shelf), I interpret as evidence for a slight admixture of the size groups sampled in the two areas. I have observed a similar phenomenon in comparing samples from the east and south coasts of Newfoundland (Mercer, 1969 and in prep.).

Bimodal and trimodal length compositions have also been observed throughout the season in some years at Newfoundland inshore sampling stations (Mercer, 1969 and in prep.). These I have hypothesized to relate to mixed age groups within a single year-class spawned over a protracted season and area (Mercer, 1969).

Maturation of squid at smaller sizes on the Nova Scotian Shelf than on the Newfoundland Shelf is consistent with the more rapid maturation of animals exposed to warmer temperatures as apparently occurs at inshore Newfoundland for Illex illecebrosus (Mercer, 1973b) and which has been demonstrated by controlled experimentation with the cuttlefish Sepia officinalis (Richard, 1966).

Any unquantified size selectivity in the fishing gear would be expected to bias the sex ratios in favour of females since they grow faster than the males (Squires, 1957; Mercer, 1965 and in prep.). Female squid are preponderant in commercial catches (taken by jigger) early in the season on the Newfoundland south coast whereas males generally predominate in early season catches on the east coast.

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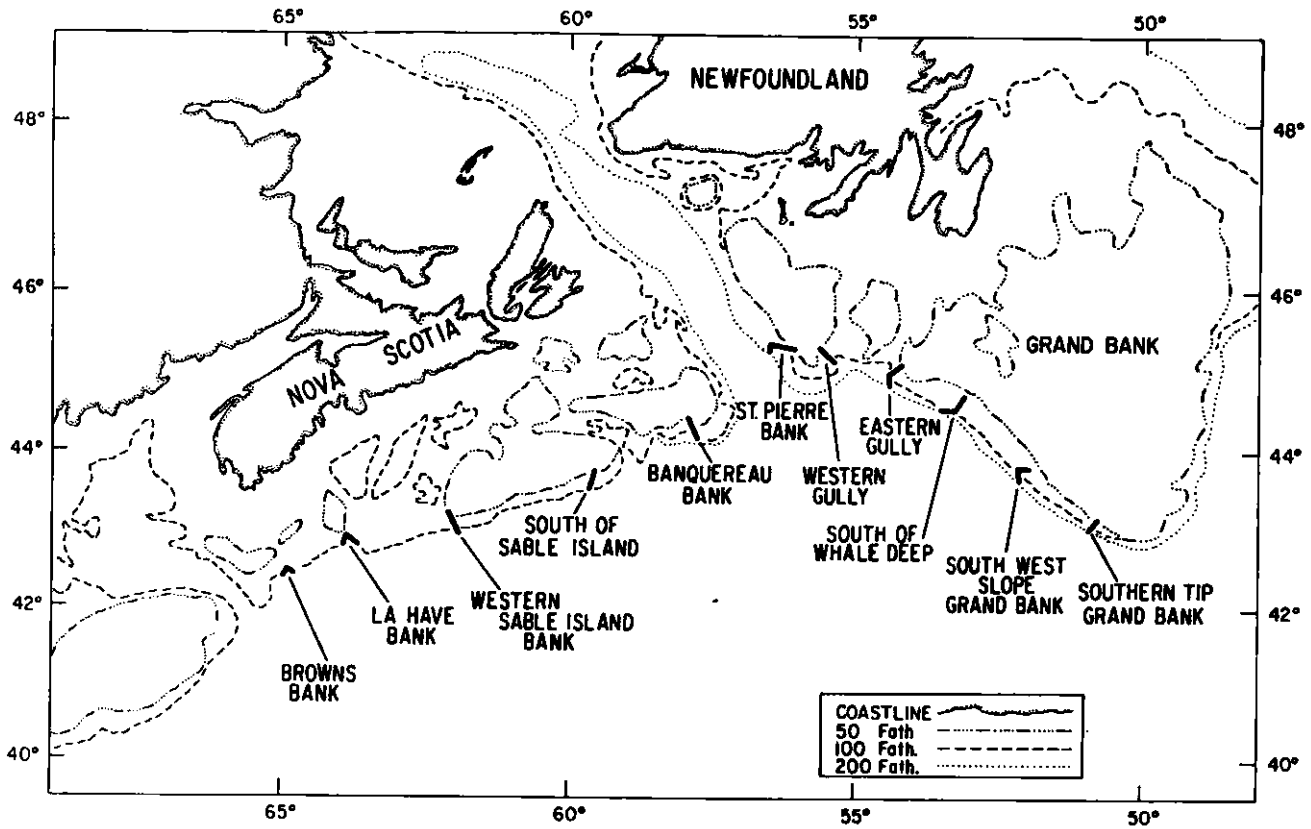


Fig. 1. Location and nomenclature of transects fished on squid survey cruises 1970-72.

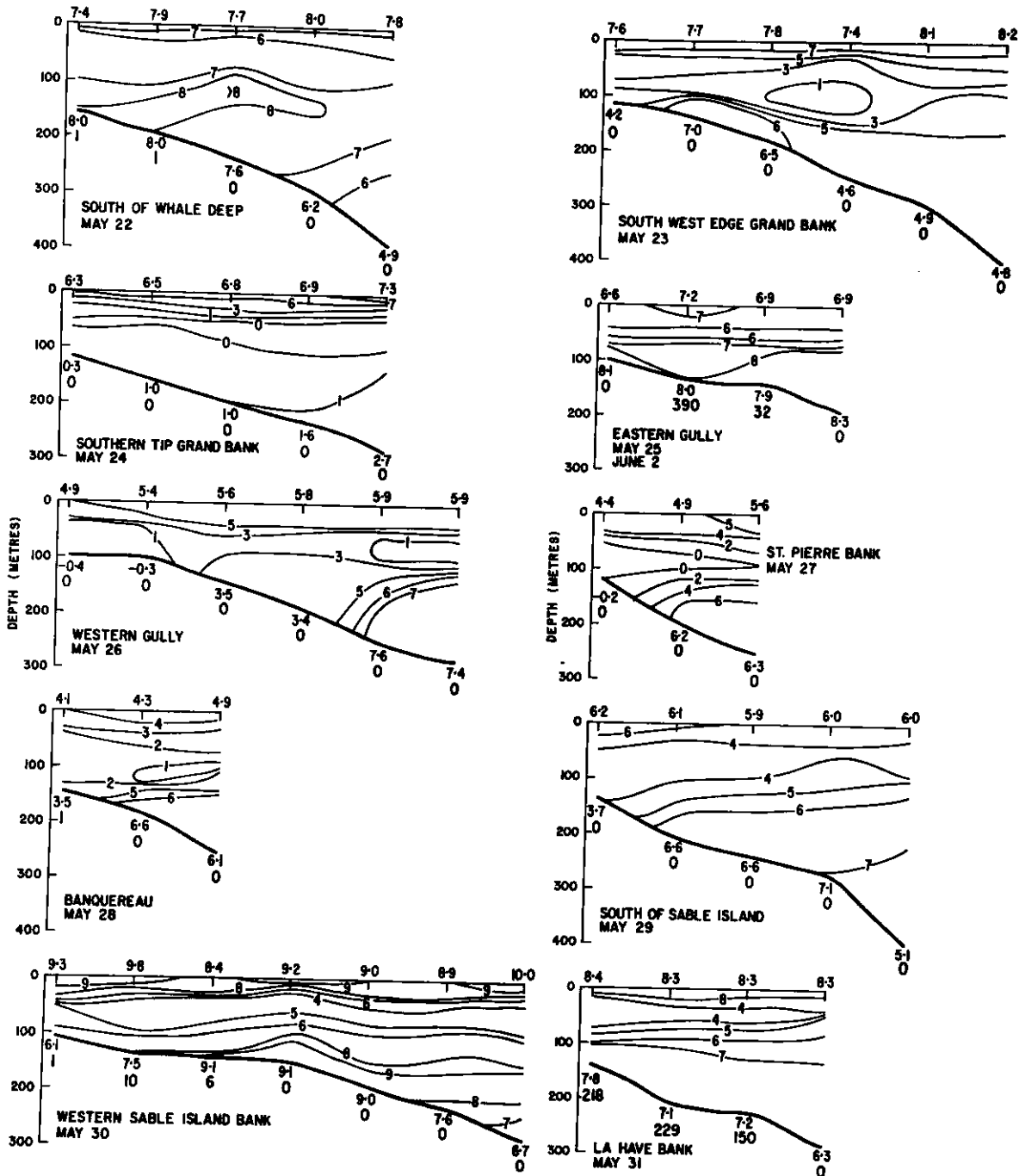


Fig. 2. Temperature profiles along the transects fished on A. T. Cameron cruise 173, May 22-June 2, 1970. Numbers below the bottom temperatures indicate numbers of squid taken in a 30-minute set; where sets were repeated all catch numbers are listed.

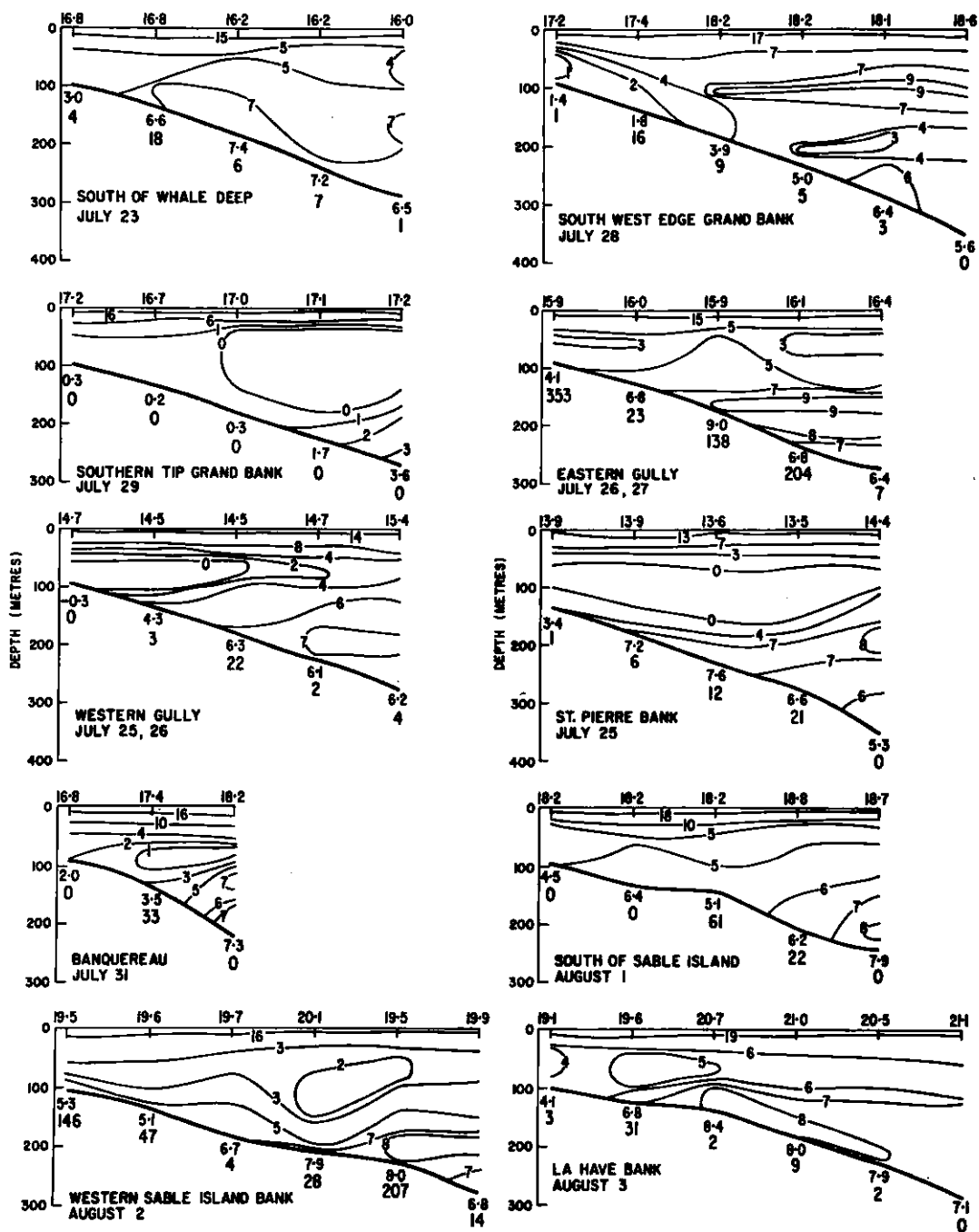


Fig. 3. Temperature profiles along the transects fished on E. E. Prince cruise 75, July 23-Aug. 4, 1970. Numbers below the bottom temperatures indicate numbers of squid taken in a 30-minute set; where sets were repeated all catch numbers are listed.

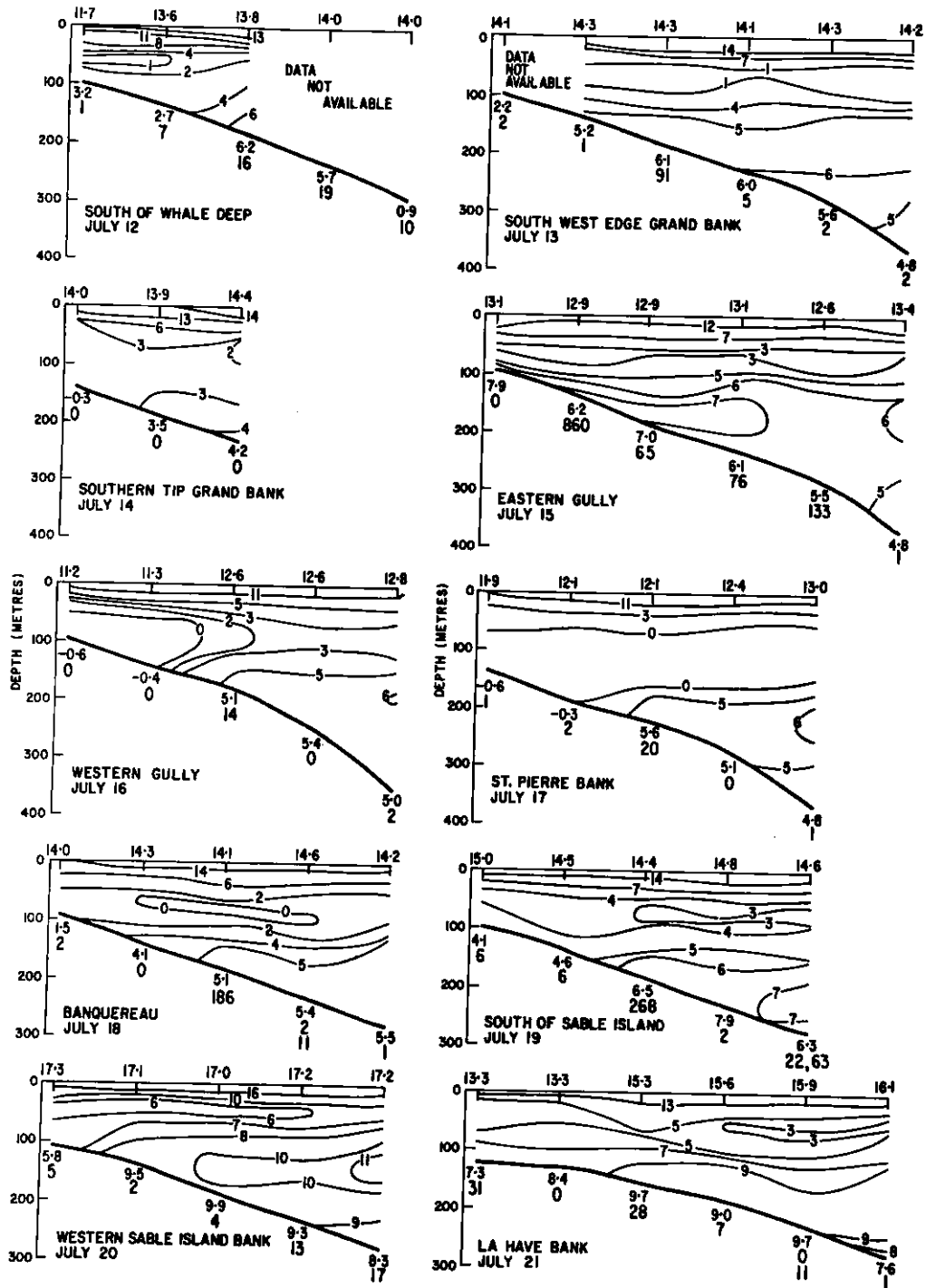


Fig. 4. Temperature profiles along the transects fished on E. E. Prince cruise 87, July 12-22, 1971. Numbers below the bottom temperatures indicate numbers of squid taken in a 30-minute set; where sets were repeated all catch numbers are listed.

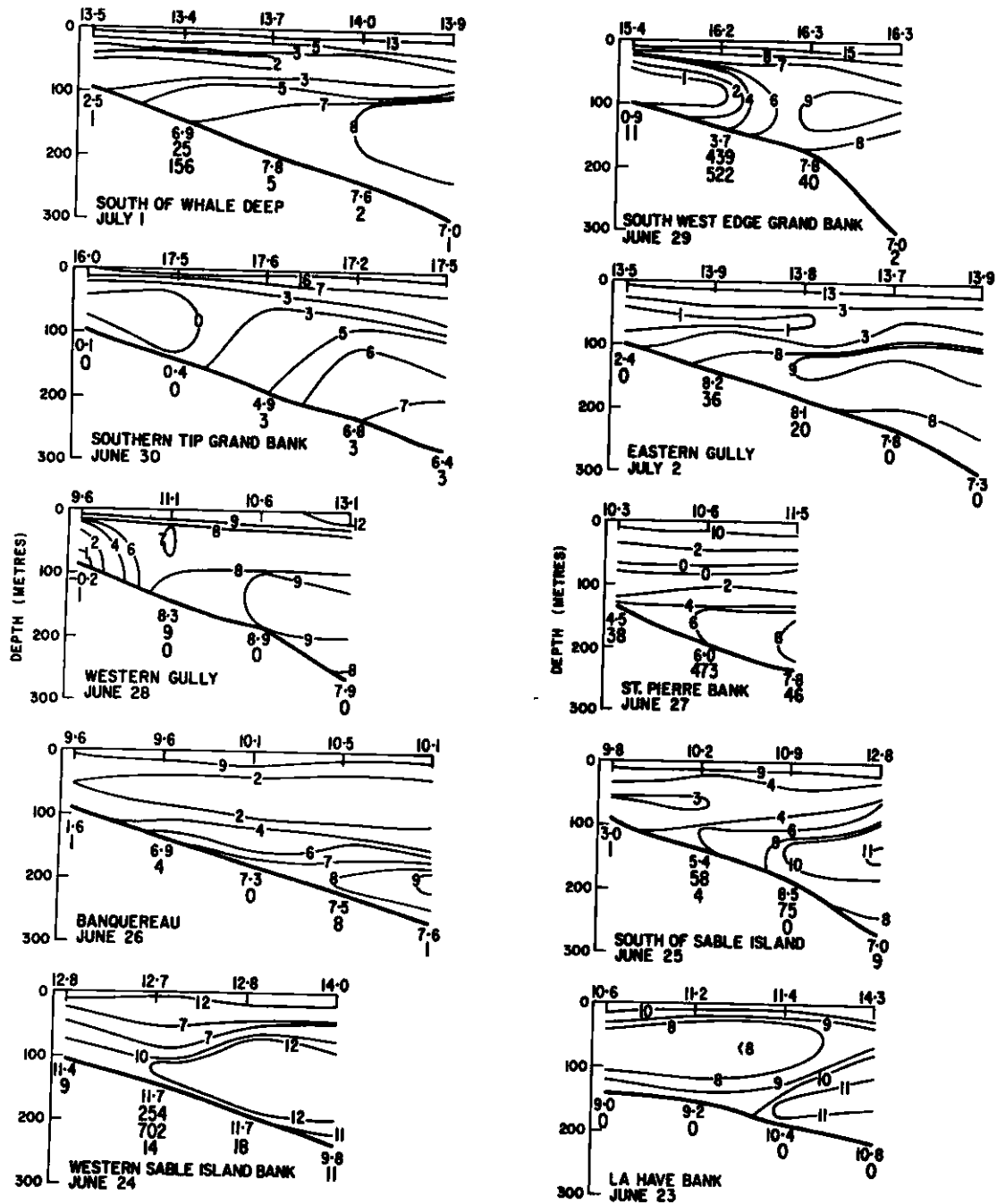


Fig. 5. Temperature profiles along the transects fished on E. E. Prince cruise 102, June 22-July 2, 1972. Numbers below the bottom temperatures indicate numbers of squid taken in a 30-minute set; where sets were repeated all catch numbers are listed.

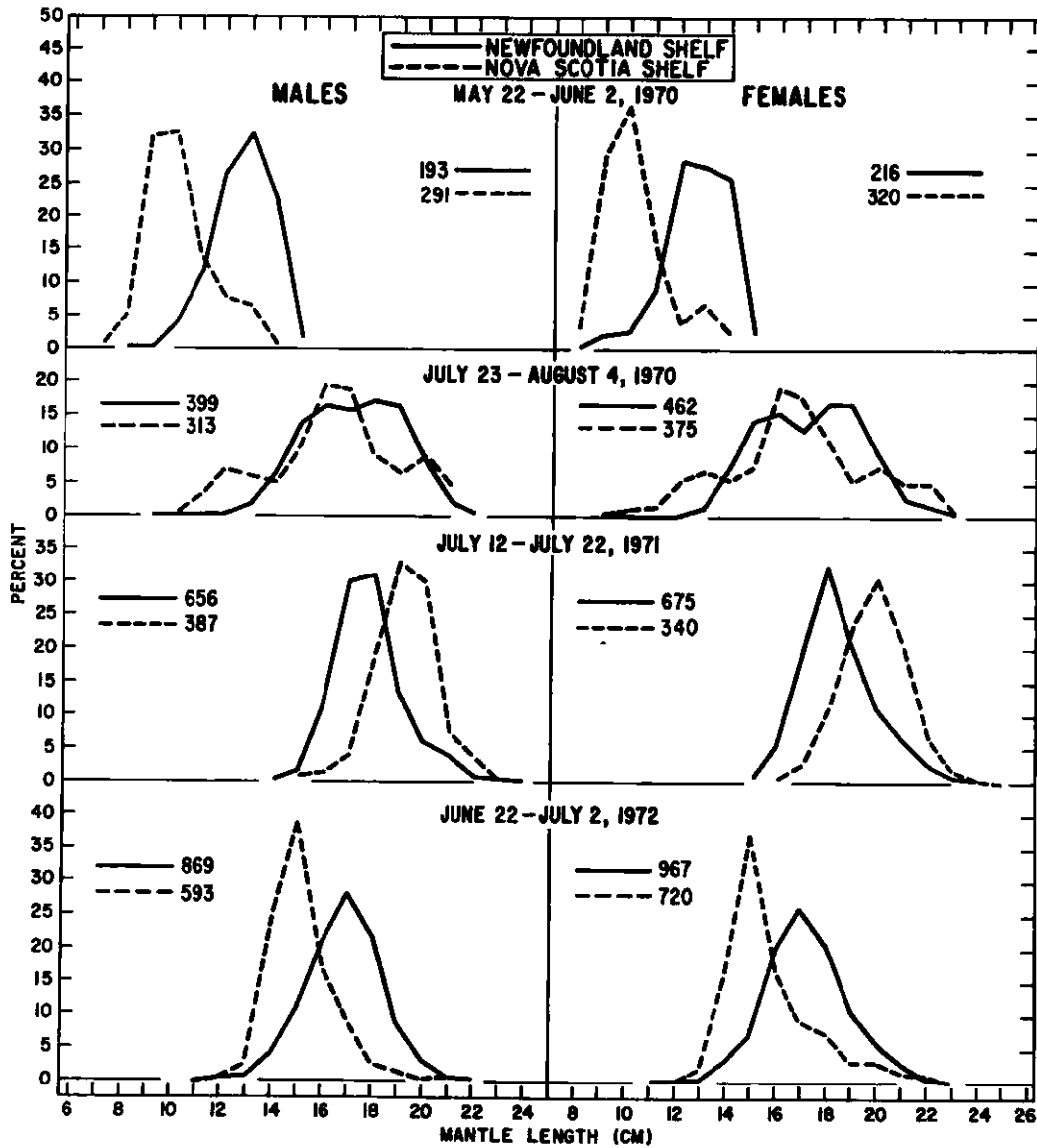


Fig. 6. Mantle length distributions of squid, *Illex illecebrosus*, trawled on the Newfoundland and Nova Scotia Shelf 1970-72.

