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Observations on capelin (*Mallotus villosus*) in Newfoundland waters

by

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INTRODUCTION

Annually capelin migrate towards the shores of Newfoundland and Labrador to spawn. Mass beach spawning of capelin occurs mainly in June off the east coast of Newfoundland and progressively later northwards along the coast. The Labrador coast spawning commences in mid-July. Off the west and south coast beach spawning begins at the end of May. The beach spawning lasts from four to six weeks at temperatures ranging from 5.5 to 8.5°C. When beach spawning is completed, spawning may continue in deeper waters near shore (TEMPLEMAN 1948, 1968). Capelin also spawn at the Southeast Shoal on the Grand Banks in June-July (PITT 1958). At this time mature capelin have also been trawled on the eastern slope of the Grand Bank and on the St. Pierre Bank.

Little information is available on the distribution and migration of capelin previous to the time they approach the different spawning grounds. The presence of the capelin on the Grand Banks, at the same time as along the coast, suggests that the inshore capelin may be discrete from those spawning offshore on the banks.

Several authors (e.g. TEMPLEMAN 1948, 1968, WINTERS 1970, DEVOLD, DEVOLD and WESTERGAARD 1972) suggest that the capelin resource off Newfoundland and Labrador must be large. However, the utilization of the capelin has been very limited, and no exact information exists on the size of this resource.

The aim of the present paper is to report some preliminary results of Norwegian capelin investigations carried out in Newfoundland waters in early summer of 1972, with emphasis on:

1) distribution and migration;
2) structure and size of the capelin resource;
3) catcability of capelin, especially the mature stock just prior to, and during the spawning season.

MATERIAL AND METHODS

The material is obtained from a survey carried out with R/V "Johan Hjort" from 17 May to 19 June 1972. The distribution and abundance of the capelin were studied from combined acoustic surveys and fish sampling with trawl.

R/V "Johan Hjort" was equipped with vertical echo sounders and horizontal ranging sonar. A Simrad echo integrator was linked to a Simrad EK 50 kHz echo sounder. The setting of the EK sounder was: Output power 1 kW, time varied gain (TVG) 20 Log R and receiver gain O dB. The source level was 121.8 dB, receiving voltage response 5.2 dB, the beamwidth 7^{o} and 13^{o} along and athwartship between the 3 dB points. The threshold on the integrator was set at 1, and the gain at 30 dB. In order to avoid saturation of the echo integrator the gain was adjusted when necessary.

Two integrator channels covered the depth intervals from 5 to 50 m, and from 50 m to the bottom. Echo integrator readings were made each nautical mile and average values for each five nautical miles were plotted on maps. When other fish species were recorded within the same depth interval, the echo abundance was divided between capelin and the other species. Both experimental fishing and analysis of the echo traces were used for dividing the total echo abundance (BLINDHEIM et al. 1971).

The method used to estimate the stock size is described by MIDTTUN and NAKKEN (1971), BLINDHEIM and NAKKEN (1971) and later applied by NAKKEN (personal communication), JAKUPSSTOVU and MIDTTUN (1972). DRAGESUND, GJØSÆTER and MONSTAD (1972). The constant C was calculated from the relation of MIDTTUN and NAKKEN (1971).

$$\rho = CM \qquad (1)$$

where ρ is given in number of fish or fish weight per unit area and M the integrator echo intensity.

Capelin were caught with a Norwegian capelin trawl with an opening of 12 x 12 fathoms, mesh size (stretched) ranging from 200 mm (wings and squares) graded down to 22 mm (cod end). An ordinary Granton bottom trawl with cover net equipped with bobbins was also available.

The capelin were examined fresh. Total lenght was measured to the nearest mm and grouped in half cm class intervals. Otoliths, taken stratified, were used for age determination and age-lenght keys were established. The maturity stages were classified according to a scale modified from NIKOLSKY (1963). The weight was estimated by measuring the volume of invidual fish using the displacement method.

Hydrographic stations with Nansens bottles were taken at six sections in different regions on the Grand Banks. Hydrographic stations with bathythermograph were taken at average intervals of 25 nautical miles along the survey route. The sea thermograph recorded the temperature at a depth of about 4 m during the whole survey. A map showing the general bathymetric features on the Grand Banks and names used in the text are given in Fig. 1. The survey routes and grid of stations are shown in Fig. 2.

DISTRIBUTION AND MIGRATION

Three surveys were carried out during the period of investigation. During the first survey, which was meant to give a brief information of the distribution, only scattered concentrations of capelin were recorded (Fig. 3). The survey did not cover the whole area, and the survey legs were too far apart to give a representative picture of the distribution. The second and third surveys (Figs. 4 and 5) showed that capelin were distributed through out the Grand Banks area from the ice border to the tail of the bank. Capelin were most consentrated in the northern part of the area surveyed, and at the Souteast Shoal. The capelin on the northern Grand Banks had moved slightly towards the south and west between the second and third survey.

During the day capelin were recorded in the midwater layer or just above the bottom, i. e. in depths ranging from 30 to 150 m. On the northern and central Grand Banks, they appeared in small and scattered shoals during the day, whereas at the Southeast Shoal they were recorded in denser shoals in daytime (Fig. 6). With diminished light in the evening, capelin came close to the surface and dispersed. At dawn the fish again clustered in shoals which soon migrated to deeper water.

The capelin in the northern area were mainly found in waters with temperatures below 0°C (Figs. 7 and 8). At the southern Grand Banks capelin were recorded in waters of temperatures above 1°C. At the Southeast Shoal the temperatures varied between 2. 5 and 3. 2°C.

STRUCTURE AND SIZE OF THE STOCK

In the samples collected south of $46^{\circ}30'$N, 97. 5% (weight percentage) of the capelin were mature fish. North of this latitude only 34. 7% of the capelin were mature. Fig. 9 shows the age and lenght composition of mature capelin in different areas on the Grand Banks. The 1969 year-class dominated in all areas, followed by the 1968 year-class. The age composition was very similar in the northern and western areas, whereas on the southern Grand Banks somewhat larger and older fish occured. Among the mature fish, females were by far the most frequently observed in the samples from the western and southern Grand Banks.

The age and lenght composition of immature fish is illustrated in Fig. 10. In the southern area the 1969 year-class strongly dominated, while farther north the 1969 and 1968 year-classes were equally represented. The 1971 year-class appeared in the catches mostly on the southern Grand Banks i. e. south of $46^{\circ}30'$N. The lenght composition of this year-class in different sampling areas is illustrated on Fig. 11.

During the first and the second survey the bulk of the fish were in maturity stages 1 and 2, whereas during the third survey capelin were nearer to spawning on the southern Grand Banks (maturity stages 3 and 4). Some of the capelin caught 18 June at the Southeast Shoal were already spent (maturity stage 5). In the northern area the maturing fish were still in stages 1 and 2 on 10 - 12 June.

The echo abundance of capelin in the area was estimated on the basis of the second and the third surveys (Figs. 4 and 5). The total abundance of capelin in the area covered was estimated to be about 0.8 million tons (Table 1), using a C of 1.9 tons/mm x(n. m.)^2. However, the calculation of C is somewhat inaccurant, and the results should be interpreted with come caution. The constant C was estimated to be 2.17 tons/mm x(n. m)^2 for maturing capelin in the Barents Sea. It is suggested that this figure was somewhat high and a value of about 2.0 tons/mm x (n. m)^2 seems reasonable.

The consentrations of mature capelin observed south of Cape Race, i. e. south of about 46°30' N and west of 52°20' W, during the second survey (Fig. 4) were not recorded there during the third survey (Fig. 5). Assuming that these capelin had moved farther west to spawn outside the area covered during the surveys, the stock size at the Souteast Shoal (south of 46°30' N and east of 52°20' W) was estimated to be 125 - 170 thousand tons (Table 1). The stock size north of 46°30' N was estimated to be 325 - 365 thousand tons, of which 34,7 % were mature.

CATCHABILITY OF CAPELIN

DEVOLD et al. (1972) held the opinion that off Newfoundland-Labrador a capelin shoal of 50 tons during summer and early autumn is a relatively large shoal. During this period of the year therefore, the catchability of capelin with purse seine is not the best. He concluded that pelagic trawl probably was the most suitable gear for catching capelin off Newfoundland and Labrador.

Experiences from other fisheries are that catchability is improving during the spawning migration. At this time the fish come together from different areas and are grouped in larger and denser shoals than during the feeding period. The present survey covered the period just prior to spawning. The conditions for fishing at this time should therefore be the best. Three Norwegian purse seiners accompanied R/V "Johan Hjort" during the survey. In the northern area the concentrations were not found to be dense enough for purse seining between 18 and 30 May. The conditions for purse seining were also poor at the Southeast Shoal from 18 May to 3 June. However, from the first week of June onwards, as concentrations became denser, purse seining might be a possibility. The conditions for trawling improved gradually during the first week of June at the Southeast Shoal, and throughout this month capelin are available for trawling with midwater trawl. The season, however, seemed to be relatively short since spawning already started 18 - 19 June, and probably would have been completed by the first half of July (DEVOLD et al. 1972).

CONCLUDING REMARKS

The behaviour of capelin off Newfoundland during the spawning migration is apparently somewhat different from that observed for the Barents Sea capelin. No dense shoals were observed during the spawning migration on

the Grand Banks towards the Southeast Shoal. The mature capelin were segregated from the immature part of the stock at the time the investigations were carried out, and gradually approached the spawning grounds in rather small shoals, showing up as a dense, but patchy scattering layer at the Southeast Shoal. In this shallow part of the bank, capelin find suitable spawning temperatures in about 50 m depth by mid-June, when spawning commences.

It is tentatively concluded that not all the capelin recorded south of 46°30'N during the second survey migrated to the Souteast Shoal for spawning. The concentrations recorded in the area south of Cape Race might have migrated westward to spawn either along the south coast of Newfounland, or at the St. Pierre Bank where spawning has been recorded in earlier years (PITT 1958, TEMPLEMAN 1968). No spawning concentrations could be observed in the Virgin Rock region, although the environmental conditions for spawning in this region might be suitable. It is difficult to state where the mature part of the capelin recorded on the northern Grand Banks migrated for spawning. It is suggested that most of the fish gradually approached the coast, Conception Bay, Trinity Bay and the area south of St. John's.
In contrast to the distribution of the maturing capelin in the Barents Sea, where the pre-spawners segregate from the immature part of the stock five to six weeks before they reach the Finnmark coast for spawning, both immature and mature fish were recorded off the east coast of Newfoundland. This may indicate that the wintering area, for maturing capelin approaching the east coast for spawning, is not far from the land and that the capelin do not undertake long distance spawning migration. WINTERS (1970) suggests that the most promising periods of the year during which coastal capelin can be commercially exploited are during the wintering period, and the spawning season. The present investigations indicated that the concentrations did not appear in shoals suitable for purse seining at the time the investigations were carried out, except at the Southeast Shoal. It might be that the conditions for purse seining will improve as the pre-spawning capelin move closer to the shore.

The resources of capelin in the area surveyed were relatively low compared with the abundance observed along the Finnmark coast in 1971 and 1972 just prior to spawning (DRAGESUND, GJØSÆTER and MONSTAD 1972). However, the abundance recorded may only be a small part of the total resource available off Newfoundland and Labrador. In order to obatin more information on the capelin resource in the northwest Atlantic, research has to be carried out farther north along the coast throughout the summer and early autumn.

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Table 1. Echo-abundance (in tons) of capelin on the Grand Banks in different areas in May - June 1972.

Date	Area			Total
	North of 46°30'N	South of 46°30' and east of 52°20'W	West of 52°20' and south of 46°30'N	
27.5-9.6	365	170	250	785
7.6-18.6	325	125	35	485

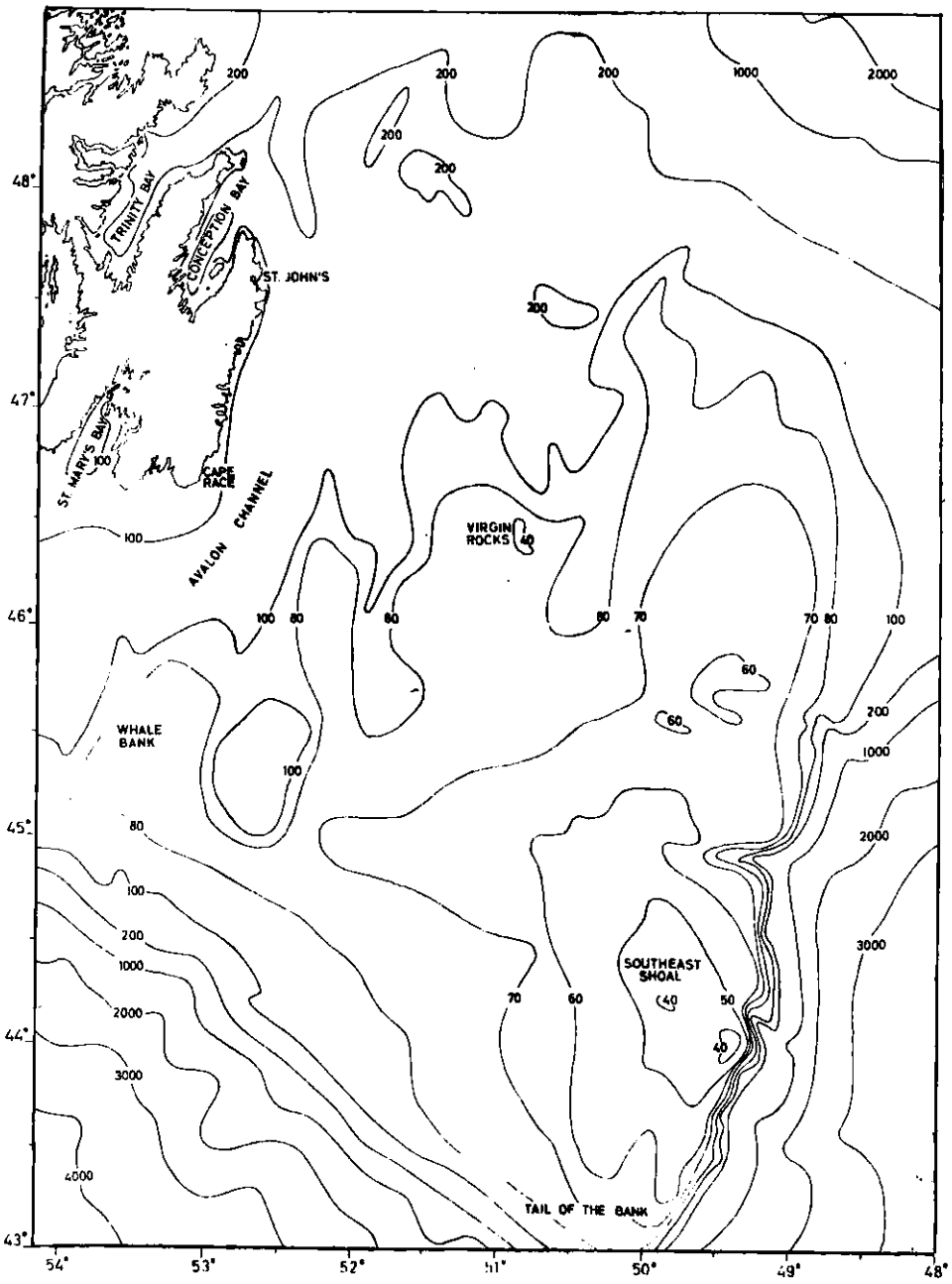

Fig. 1. Map showing the general bathymetric features of the Grand Banks (depths in m) and names used in the text.

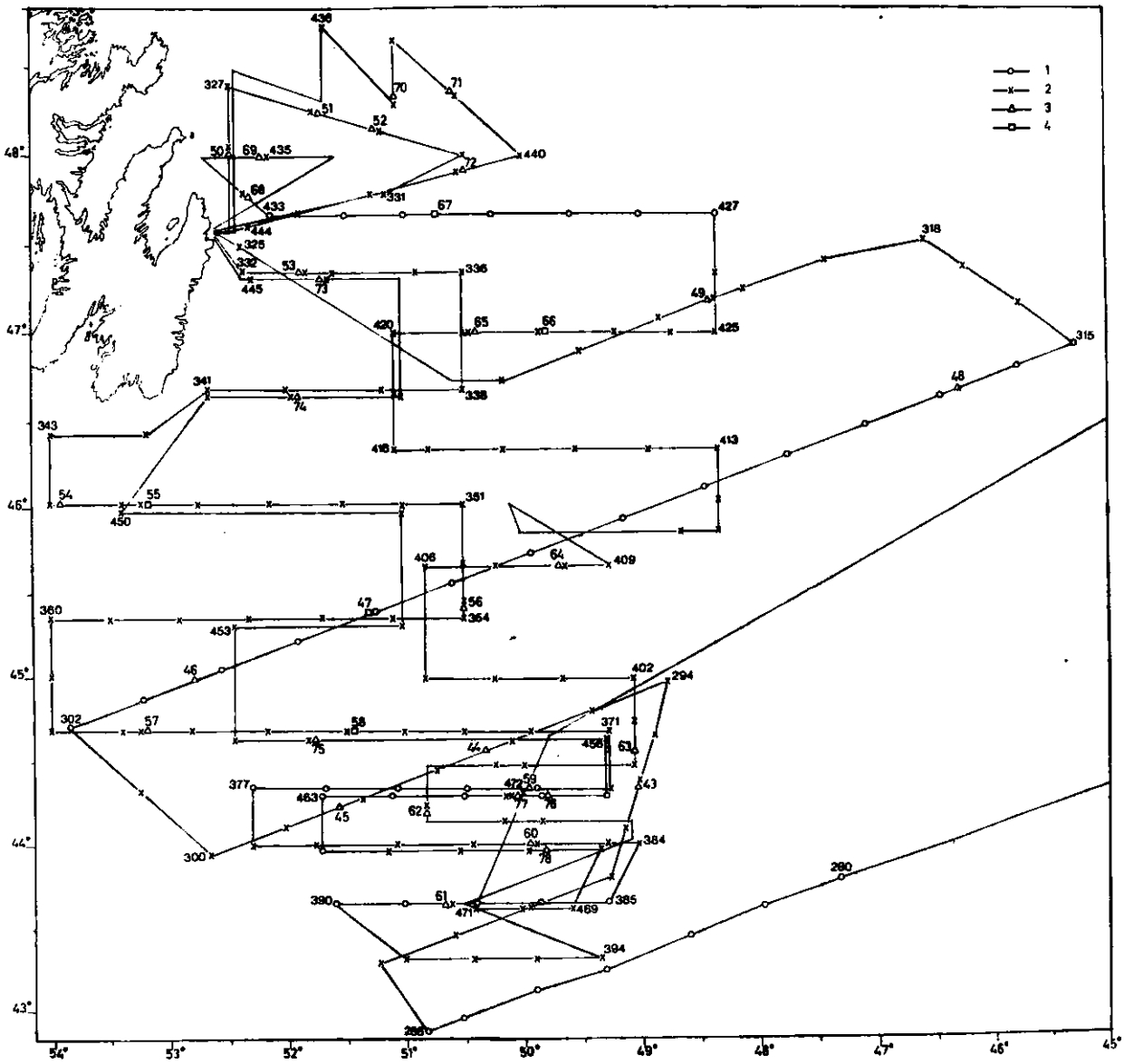

Fig. 2. Survey routes of R/V "Johan Hjort" and grid of stations 18 May to 19 June 1972, (1) hydrographic station with Nansen bottles, (2) hydrographic station with bathytermograph, (3) pelagic trawl station and (4) bottom trawl station.

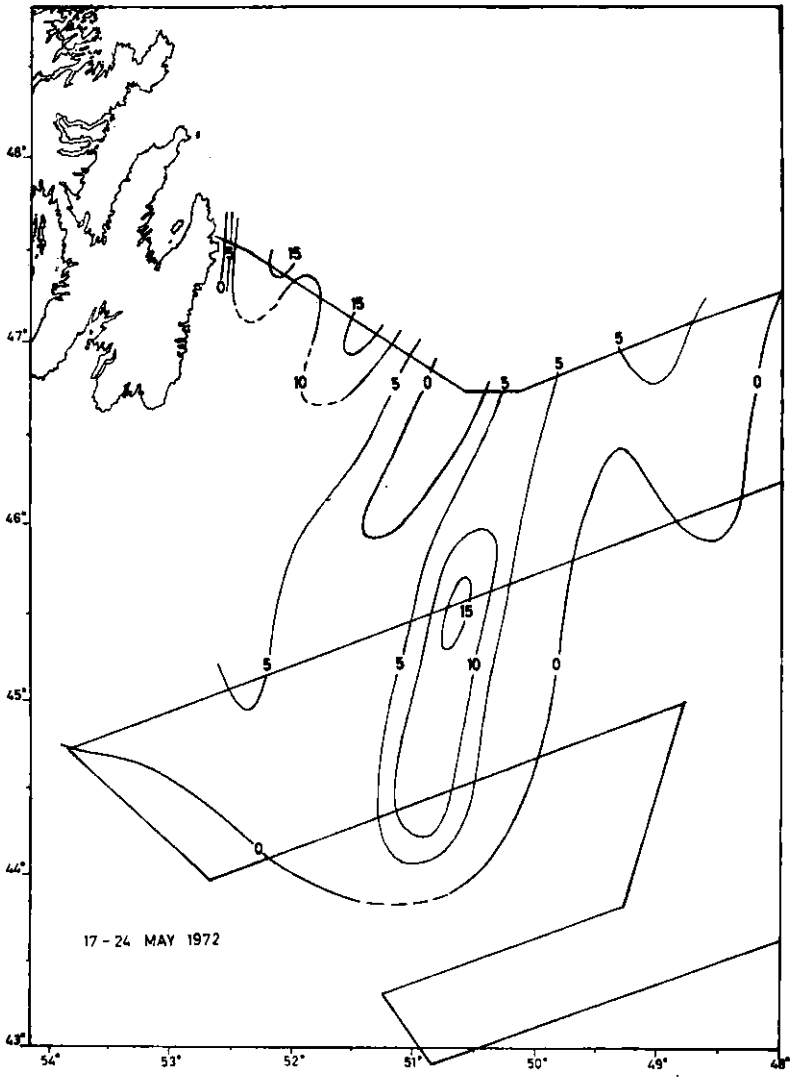

Fig. 3. Survey route and distribution of capelin 17-24 May 1972. The isolines indicate exho integrator readings.

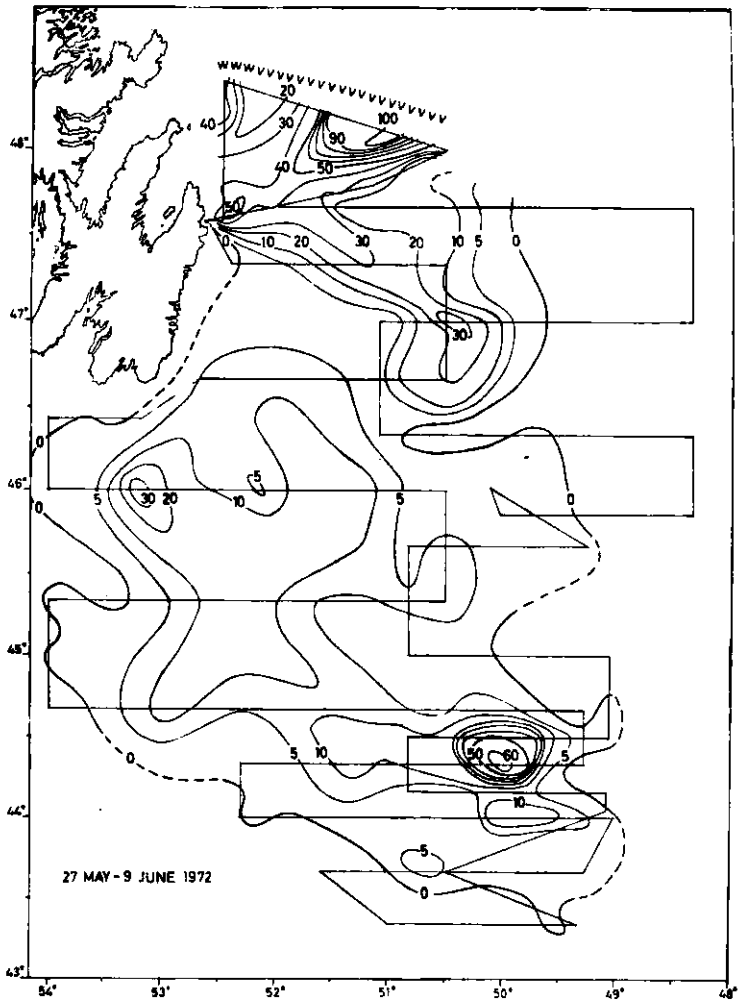

Fig. 4. Survey route and distribution of capelin 27 May - 9 June 1972. The isolines indicate echo integrator readings. The route taken from 7 to 9 June is the same as in Fig. 5.

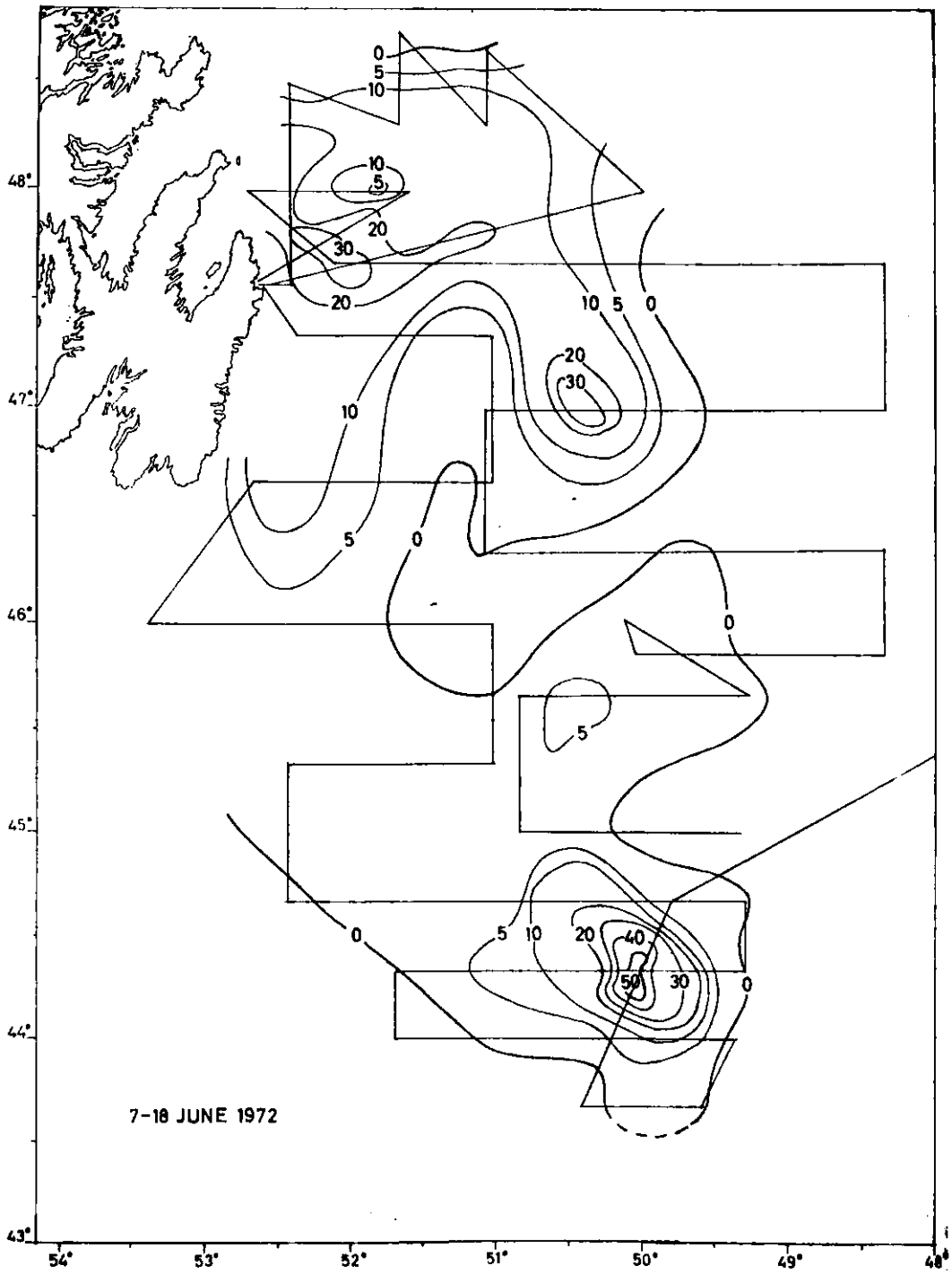

Fig. 5. Survey route and distribution of capelin 7-18 June 1972. The isolines indicate echo integrator readings. The route taken from 7 to 9 June is the same as in Fig. 4.

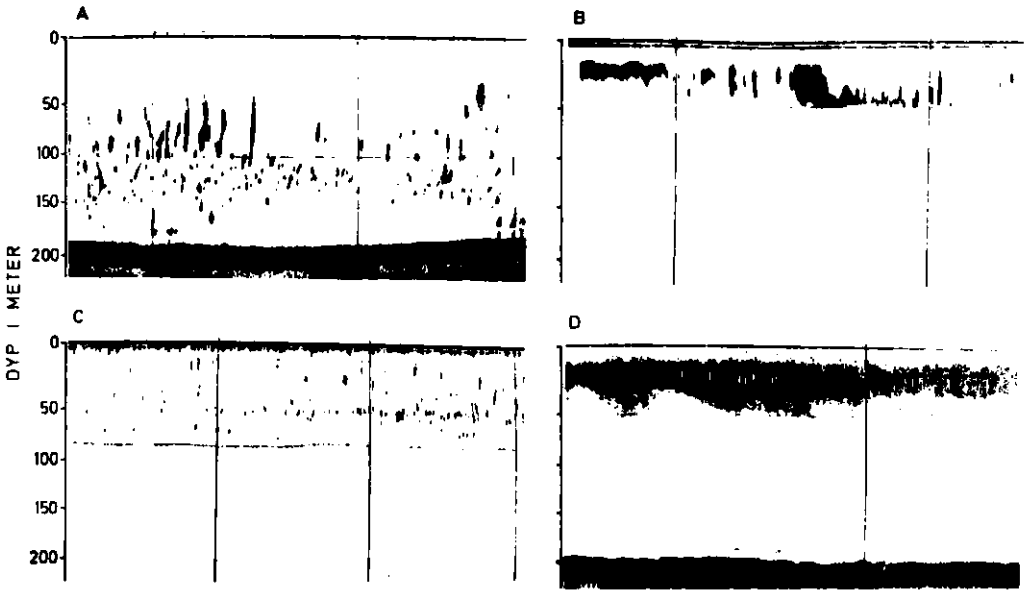

Fig. 6. Echo recordings of capelin (Simrad EK echo sounder) by day, (A) to (C) and by night (D). (A) is from the northern, (B) southern and (C) central Grand Banks.

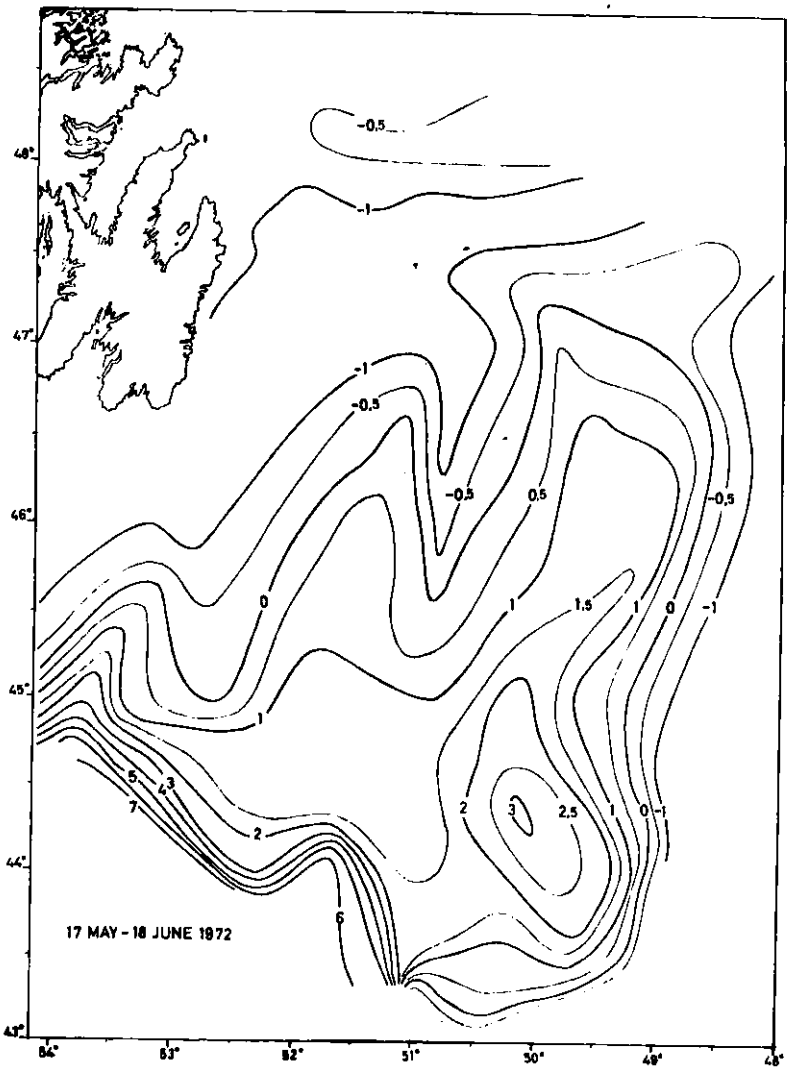

Fig. 7. Isotherms at the bottom 17 May - 18 June 1972.

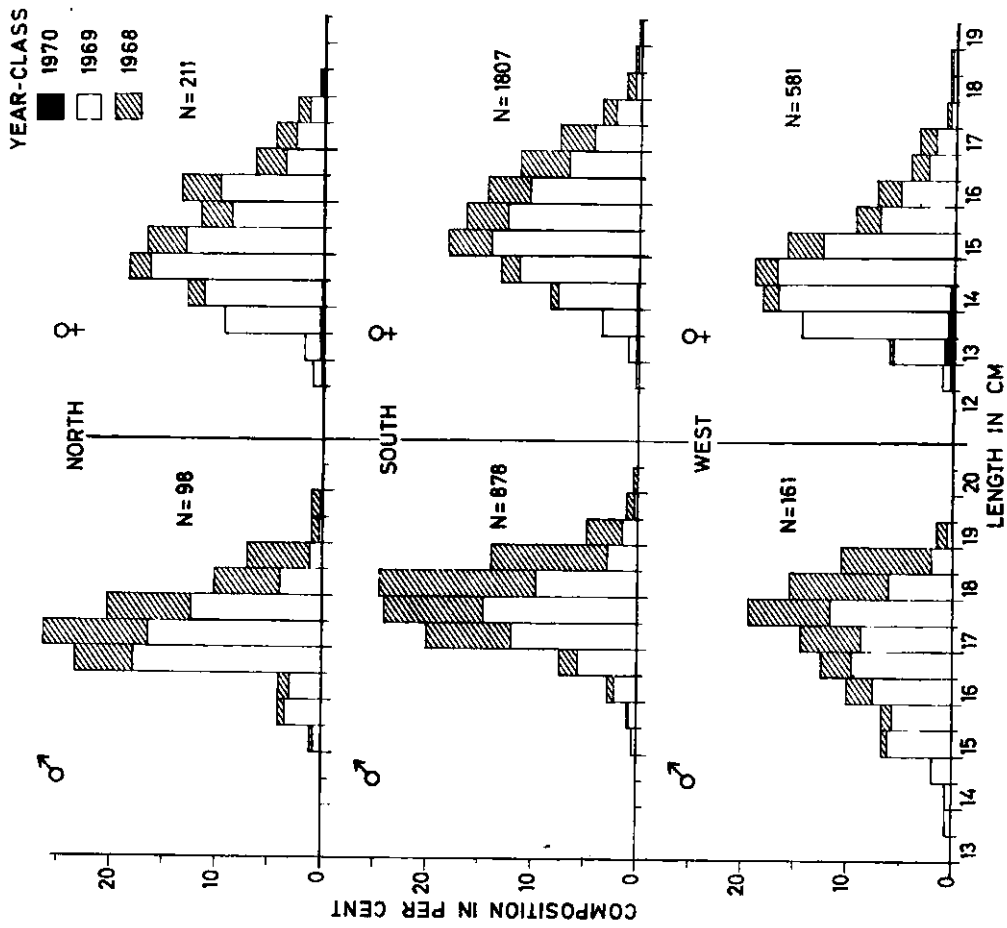

Fig. 9. Age and length composition of mature capelin (separated on male and females) on the Grand Banks in May - June 1972. The border between south and north is set at 46°30'N and for the western area at 52°W.

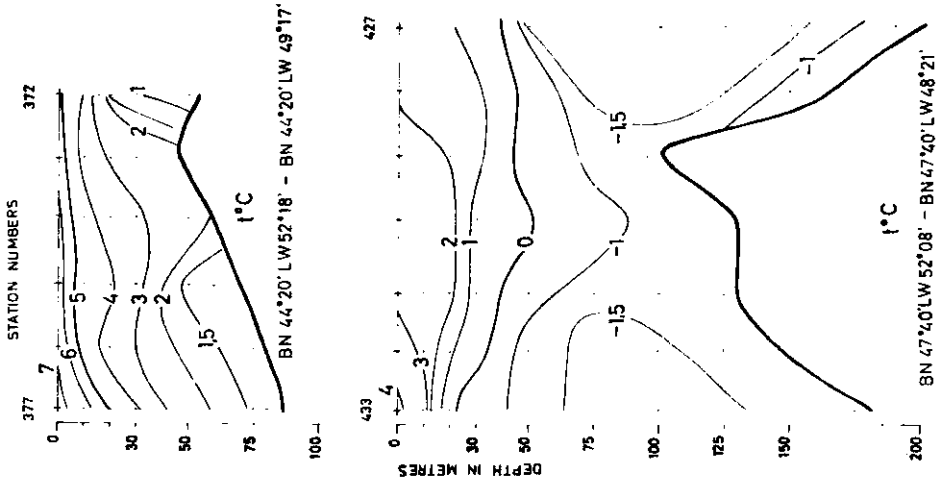

Fig. 8. Temperature in two sections on the Grand Banks in June 1972.

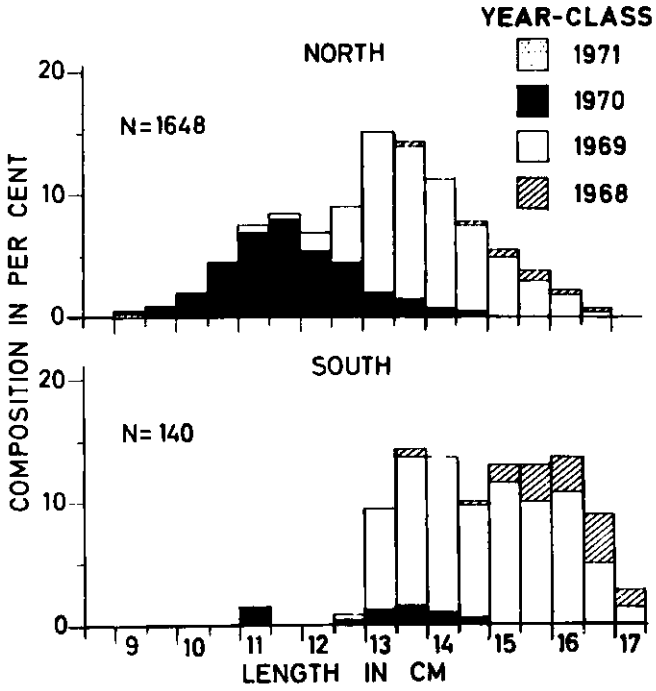

Fig. 10. Age and length composition of immature capelin on the Grand Banks in May - June 1972. The border between south and north is set at 46°30'N.

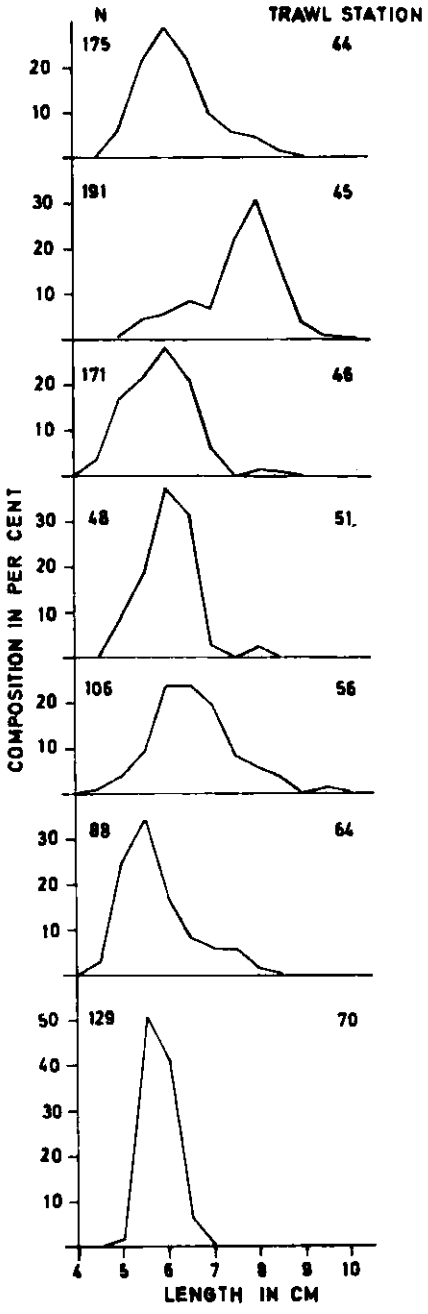

Fig. 11. Length distribution of the 1971 year-class of capelin on the Grand Banks in May - June 1972.