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A summary of Norwegian research carried out on capelin in Newfoundland and Labrador waters, 1969-1974¹

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Introduction

The knowledge about the biology and abundance of capelin in Newfoundland and Labrador waters is still only fragmentary. The scientists within the ICNAF Assessments Subcommittee are asked, however, to give their advice on the regulation of the capelin fishery in the ICNAF Area, and the aim of this paper is to summarize the information obtained during Norwegian surveys and fishery. The summary is based on:

- I. Survey results from:
 - (a) a survey with M/S *Havdrøn* and M/S *Sjørfold* for herring investigations in Newfoundland-Labrador waters in August-September, 1969 (Devold, 1970a);
 - (b) a survey with M/S *Selvåg Senior* for capelin investigations in Labrador waters in August-September, 1970 (Devold, 1970b).
 - (c) a survey with R/V *Johan Hjort* for capelin investigations in Newfoundland-Labrador waters in July-August, 1971 (Devold, F., Devold, N., and T. Westergaard, 1972).
 - (d) a survey with R/V *Johan Hjort* for capelin investigations in Newfoundland waters in May-June 1972 (Dragesund and Monstad, 1973).
- II. Data collected during the Norwegian fishery for capelin in Newfoundland waters conducted by the "Nordglobal" expedition in (a) 1973, and (b) 1974.

Some of the data from the surveys in 1969-1971 given in this paper were not presented in the reports from the surveys referred to above.

I. Survey results

- (a) 1969 (August-September)

During the survey in 1969 capelin were recorded off Labrador between 54°30'N and 52°30'N. A sample of capelin caught with purse seine on 30 August in position 54°30'N, 54°20'W was examined for age and length distribution. The 3-year-old capelin dominated (Fig. 1)². 82% of the capelin were males.

- (b) 1970 (August-September)

The survey route and grid of stations are shown in Fig. 2. The ship was equipped with echo-sounder and sonar and with purse seine and capelin trawl. Capelin were recorded over wide areas between ca. 52°15'N and

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² All age-data given in this paper is based on reading the otoliths by the "Greenland method" (Templeman, 1968).

54°30'N (Fig. 2). Length and age distributions split on capelin caught south and north of 54°N are shown in Fig. 3. The capelin caught south of 54°N were smaller and younger than the capelin caught further off the coast north of 54°N. The capelin caught south of 54°N were mainly 1 and 2 years old and of length 10 - 15 cm. North of 54°N 2 and 3 years old capelin of length 14 - 19 cm dominated.

The small capelin kept to the warmer upper layer day and night while the older capelin penetrated the cold intermediate layer two times in 24 hours. They kept to the bottom, outside the range of the purse seine in day. The shoals moved to the surface layer and dispersed after sunset. In the morning the capelin again formed shoals but very soon they moved to the bottom. It is therefore only a short time of the day in the Labrador area that substantial catches are available for purse seiners, and DEVOLD (1970 b) therefore concluded that the catches would be too small for a profitable purse seine fishery.

c) 1971 (July-August)

This survey covered both the Grand Banks east of Newfoundland and a great area further north off Labrador. The ship was equipped with echo sounder, sonar and echo integrator. The capelin were caught with trawl. The survey route and grid of stations are shown in Fig. 4.

Capelin were recorded over great areas between 46°30'N and 54°30'N. No capelin were recorded on the southern part of Grand Banks. This indicates that the spawning season on Southeast Shoal already was finished at the time the survey was done (middle of July), which is in agreement with the observations made during the Norwegian fishery on Southeast Shoal in 1973 and 1974 (DOMMASNES, MONSTAD and SANGOLT 1974, FUREVIK and WESTERGAARD, in preparation). The northern limit of the distribution could not be properly determined because of ice.

From Fig. 4 it is seen that dense and very dense concentrations of capelin were recorded over wide areas east of Newfoundland in the northern part of Division 3 L, off Notre Dame Bay in Division 3K and off the coast of Labrador in Division 2J. The recordings indicate that the abundance of capelin in area 2 - 3 K is at least of the same size as the abundance in the southern areas.

Age and length distributions are given in Fig. 5. The samples were taken during the period 13 July - 4 August. In several of the samples included in Fig. 5a - b - c some capelin of length 6-9 cm were recorded. These small capelin have not been included in the length and age distributions.

In the northern Grand Banks area (south of 48°30'N) 3 years old capelin dominated followed by 2 and 4 years old (Fig. 5a). Almost all the 3 and 4 years old capelin seemed to be postspawners.

In the area northeast of Newfoundland (between 48°30'N and 51°30'N) most of the capelin were 2 years old (Fig. 5b and Fig. 5c). The capelin caught far off the coast (east of 52°30'W) were a little older and greater

than the capelin caught further west and nearer the coast. It was difficult to determine maturity stages because the capelin had been frozen before examination. Most of the capelin were clearly immature but it is possible that some of the 3 years old and older capelin were postspawners.

In the area further north off Labrador only one sample for length distribution was taken (Fig. 5d). The capelin caught there was larger than the capelin caught further south (northeast of Newfoundland).

d) 1972 (May-June)

The results from the survey in 1972 was presented in some detail to the ICNAF Assessment Subcommittee at the annual meeting 1973 (DRAGESUND and MONSTAD, 1973) and therefore only a short summary will be given here.

During the first part of the survey (17-24 May) only scattered concentrations of capelin were recorded (Fig. 6). As will appear from Fig. 6 the survey legs were however too far apart to give a good picture of the distribution. The second and third part of the survey (Fig. 7 and 8) showed that capelin were distributed through out the Grand Banks area from the ice border to the tail of the bank. Capelin were most concentrated in the northern part of the area, especially during the second part of the survey (27 May-9 June), and at the Southeast Shoal. The capelin in the northern area had moved slightly to the south and west between the second and third part of the survey.

In the samples collected south of $46^{\circ}30'N$ almost all capelin were mature fish. North of this latitude only 34.7 % (weight percentage) were mature. Fig. 9 shows the age and length composition of mature capelin in different areas. The 3 years old capelin dominated, followed by the 4 years old. The age composition was very similar in the northern and western (west of $52^{\circ}W$) areas, whereas on the southern Grand Banks somewhat larger and older fish occurred.

Age and length composition of immature capelin for the northern and southern areas are shown in Fig. 10. The 2 years old were much stronger represented in the northern than in the southern areas.

The concentrations of mature capelin observed in the western area south of Cape Race during the second period (Fig. 7) were not recorded there during the third period (Fig. 8). DRAGESUND and MONSTAD (1973) tentatively concluded that these concentrations might have migrated westward to spawn either along the south-east coast of Newfoundland or at the St. Pierre Bank.

DRAGESUND and MONSTAD (1973) concluded that the resource of capelin in the area surveyed was relatively low compared with the abundance observed along the Finnmark coast in 1971 and 1972 just prior to spawning. It was noted, however, that the abundance recorded might only be a small part of the total resource off Newfoundland and

Labrador. The catch of Barent Sea capelin during the Norwegian winter fishery in 1971 and 1972 was of a level of 1.2 - 1.3 million tons.

II Norwegian fishery

a) 1973

A Norwegian fishery for capelin in Newfoundland waters started in 1973 on Southeast Shoal of Grand Banks. Data from the fishery were presented to the ICNAF Assessment Subcommittee at the annual meeting 1974 in a paper by DOMMASNES, MONSTAD and SANGOLT (1974). Fishing started 8 June with the factory ship "Nordglobal" and four trawlers present. Later the number of trawlers increased to 9. The fishing continued till the end of July all the time within 25 nautical miles of position $44^{\circ}00'N$ and $49^{\circ}40'W$ (Fig. 12) and only during daytime. All the catch was taken with trawl. The catches were fairly even during the period with a top in the middle of June. The total catch was 41 293 tons when fishing stopped at the end of July. All the capelin in the catch were mature.

Spawning started 15 June and had mostly finished 10 July. The distribution of maturity stages through the season is shown in Table 1. Most of the capelin were 4 years old, but also 3 and 5 years old fish were present (Fig. 11). A search for concentrations of capelin was made northward to Hamilton Bank in the beginning of August but nothing was found.

b) 1974

The Norwegian fishery in 1974 started around 20 May. As in 1973 the fishery was conducted by the factory ship "Nordglobal" and a number of trawlers. A detailed report from the fishery will be published later (FUREVIK and WESTERGAARD, in preparation), in this paper only a summary will be given.

The total Norwegian catch of capelin in Newfoundland waters in 1974 split on month and division is given in Table 2. The search for capelin started in Division 3 L east of Cape Race. About 60 tons of capelin were taken around position $47^{\circ}00'N$, $51^{\circ}20'W$ (Fig. 12). 21 May "Nordglobal" moved south of Cape Race to position $46^{\circ}23'N$, $53^{\circ}21'W$ (Fig. 12) and was in this position till 5 June. A total catch of about 2440 tons was taken from the area around this position. Most of the catches were taken with purse seine. 5 June "Nordglobal" moved to Southeast Shoal of Grand Banks (position $44^{\circ}24'N$, $50^{\circ}19'W$, Fig. 12) and the fleet fished in this area till 14 July when the quota of 43 000 tons was filled. The capelin were here taken with trawl.

The total catch per week is shown in Fig. 13. The catch in week no. 21 and 22 is taken in the area south of Cape Race. "Nordglobal" moved to Southeast Shoal in the middle of week no. 23 and most of the catch in this week is taken there. As illustrated in Fig. 13 the conditions for fishing gradually improved on Southeast Shoal until

week no. 26 (24-30 June) when the catch was above 10 000 tons. "Nordglobal" had to introduce some short stops in the fishery of capacity reasons when the conditions for fishing were most favourable.

In Table 3 is given the distribution of maturity stages split on week no. and fishing area. The capelin caught in Division 3 L south of Cape Race were prespawners, probably on spawning migration north and westwards towards the coast.

The spawning on Southeast Shoal started around middle of June. The last days before closure of the fishery (14 July) most of the capelin were spawning or spent. The fat content of the capelin through the season is shown in Fig. 14.

Length, age and sex compositions split on week no. and fishing area are given in Fig. 15.

A marked difference in the behaviour between the capelin south of Cape Race and the capelin on Southeast Shoal was noted. South of Cape Race the capelin had a shoaling behaviour more similar to what is observed in the Barents Sea under the spawning migration towards the coast of Finnmark. The capelin stood a little too deep for the rather small purse seines most of the fleet was equipped with and this explains why the catches were rather small. With larger and deeper nets the catches probably would have been much better.

On Southeast Shoal the capelin showed the same behaviour as observed in earlier years (DRAGESUND and MONSTAD, 1973. DOMMASNES, MONSTAD and SANGOLT, 1974).

At daytime the capelin appeared in dense concentrations near the bottom and the conditions for trawling were good. In the night the capelin came closer to the surface and dispersed. As in 1973 fishing therefore was restricted to daytime.

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Table 1. Sex composition and distribution (in percent) of maturity stages[†] in the samples from the fishing in 1973. (DOMMASNES, MONSTAD and SANGOLT, 1974.)

Week	Number of females	Stages			Number of males	Stages		
		3	4	5		3	4	5
23	29	100			21	50	50	
24	210	79.0	18.6	2.4	120	50	50	
25	587	70.2	18.2	11.6	221		100	
26	674	61.9	19.9	18.2	385		99.7	0.3
27	528	56.8	33.3	9.9	419		71.4	28.6
28	29	37.9	44.8	17.3	213		49.3	50.7

† Stage 0 is immature fish, stage 1-2 is maturing fish, stage 3 is mature fish (fully developed gonads). Stage 4 is spawning fish (running gonad products) and stage 5 is postspawners (empty gonads).

Table 2. Norwegian catch (metric tons) of capelin in Newfoundland waters 1974

Month	Division		Total
	3L	3 N	
May	1853		1853
June	648	23634	24282
July		17270	17270
Total	2501	40904	43405

Table 3. Sex composition and distribution (in percent) of maturity stages in the samples from the fishery in 1974 (FUREVIK and WESTERGAARD, in preparation)

Position of "Norglobal"	Week	Number of females	Stages					Number of males	Stages				
			0	1	2	3	4		5	0	1	2	3
47°05' N 51°20' W	20	50	25.8 74.2					38	100				
46°23' N 53°21' W	21	82	13.5 86.5					123	96.0 4.0				
44°24' N 50°19' W	22	249	3.0 4.3 92.7					279	1.4 97.2 1.4				
44°24' N 50°19' W	23	181	8.0 92.0					146	1.3 92.4 6.3				
44°24' N 50°19' W	23	71	100					106	78.4 21.6				
44°24' N 50°19' W	24	188	84.6 15.4					290	28.6 71.4				
44°24' N 50°19' W	25	46	7.1 35.7 53.6 3.6					58	16.6 75.0 4.2				
44°24' N 50°19' W	26	182	2.8 34.0 36.1 27.1					257	39.6 52.5 8.5				
44°24' N 50°19' W	27	97	1.2 13.1 61.9 23.8					600	8.9 62.1 29.0				

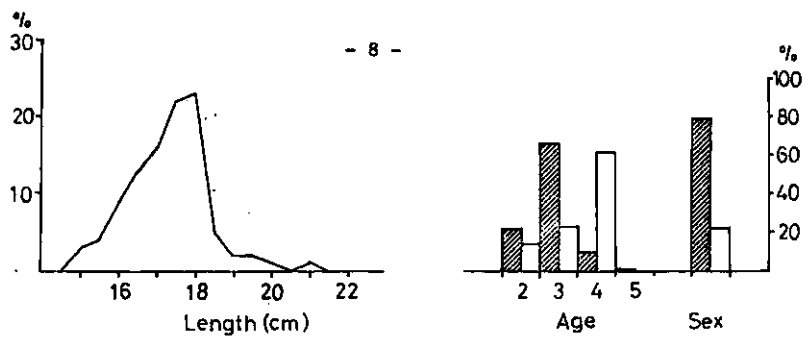


Fig. 1. Length distribution, age composition of females and males and sex composition of capelin caught 30 August 1969 in position $54^{\circ}37' N$, $54^{\circ}25' W$. Shaded column: males. White column: females.

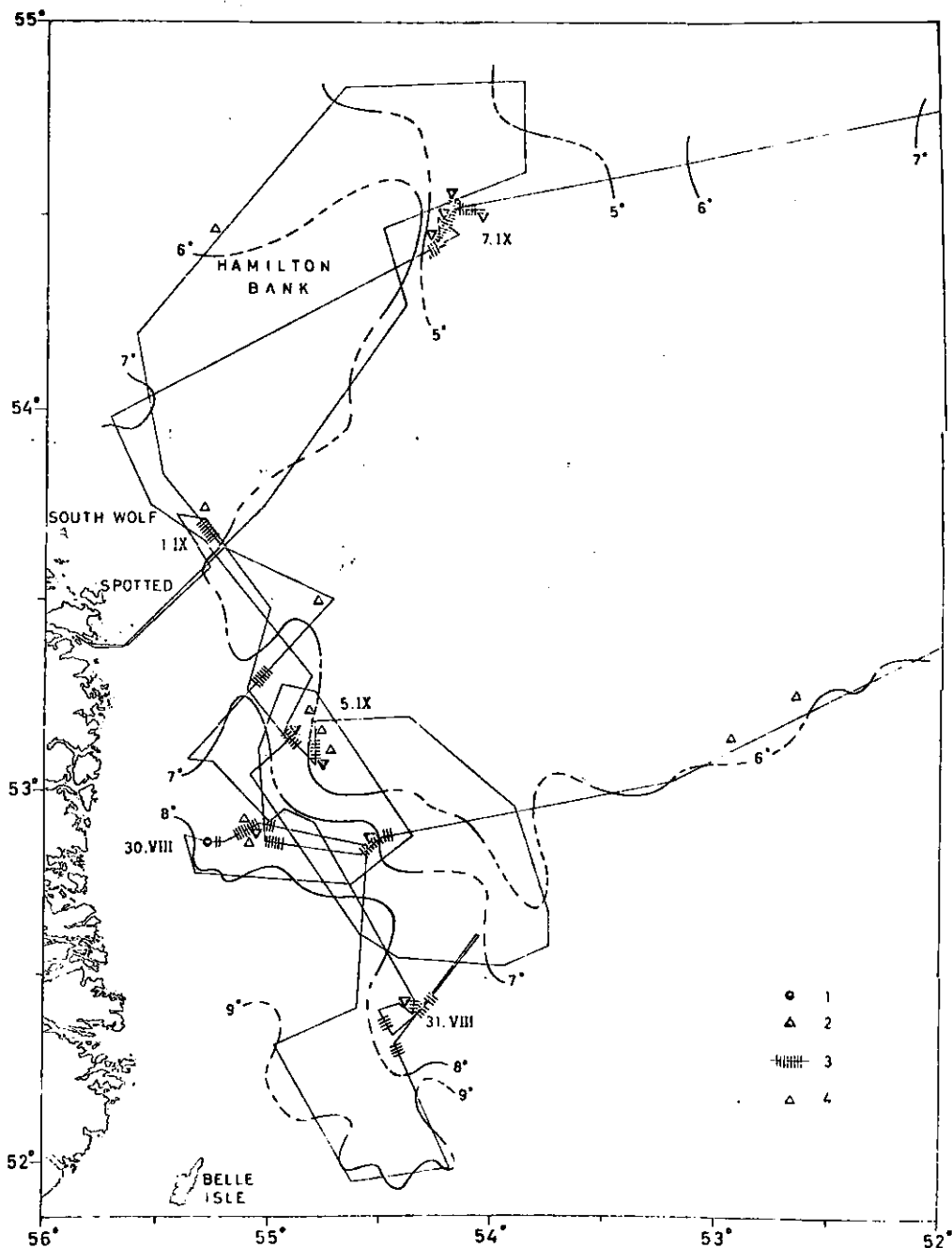


Fig. 2. M/S "Selvåg Senior", West Atlantic 29. August - 8. September 1970. 1) Bathy thermograph st., 2) purse seine st., 3) capelin recordings, 4) iceberg. Temperature in 4 m (DEVOLD 1970 b).

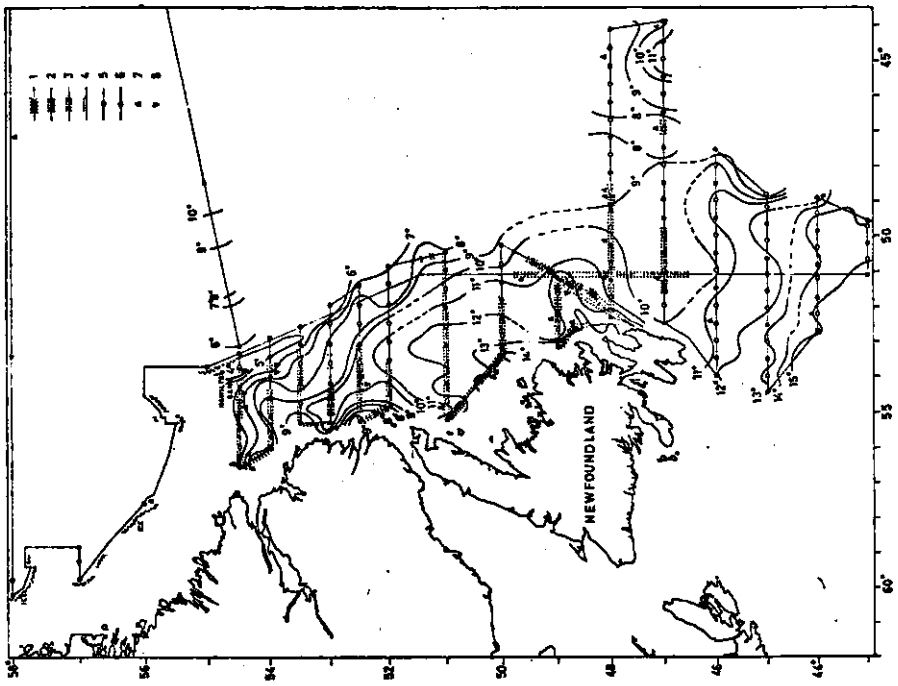


Fig. 4. R.V. "Johan Hjort", Labrador-Newfoundland July-August 1971. Route and grid of stations, temperature in 4 m. Capelin recordings: 1) Very dense, 2) dense, 3) scattered, 4) very scattered, 5) hydrographical station, 6) bathythermograph station, 7) pelagic trawlstation, 8) bottom trawlstation (DEVOLD, DEVOLD and WESTERGAARD 1972).

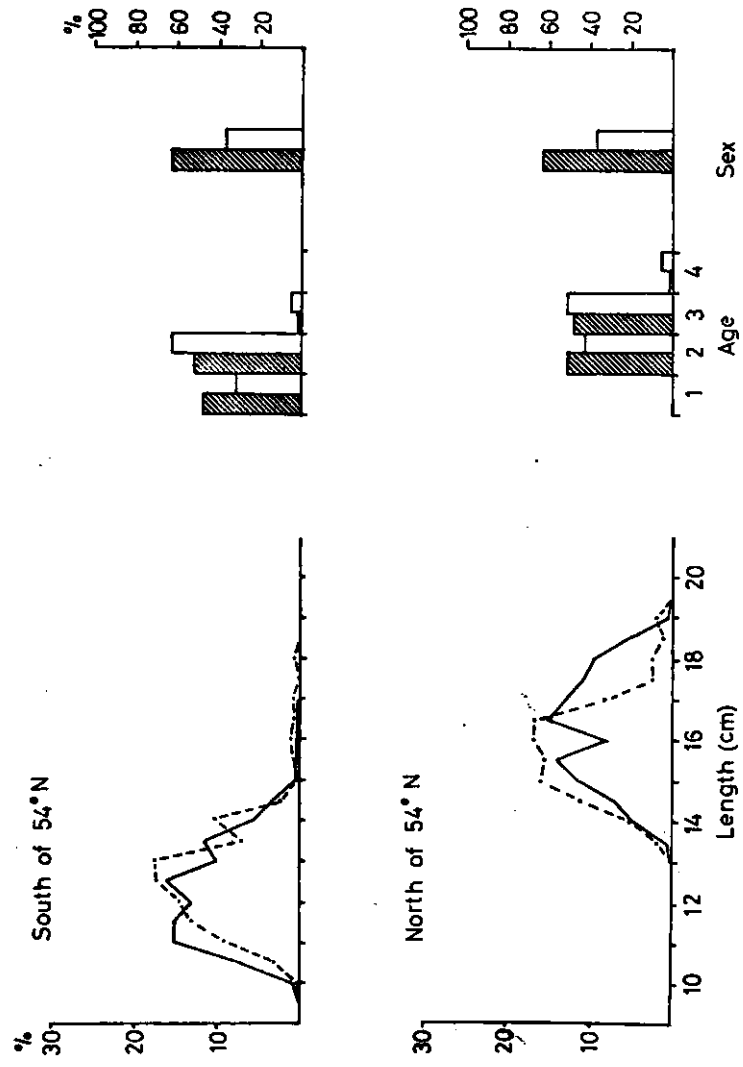


Fig. 3. Length and age composition of females and males and sex composition of capelin caught off Labrador August - September 1970. Whole line or shaded column: males. Broken line or white column: females.

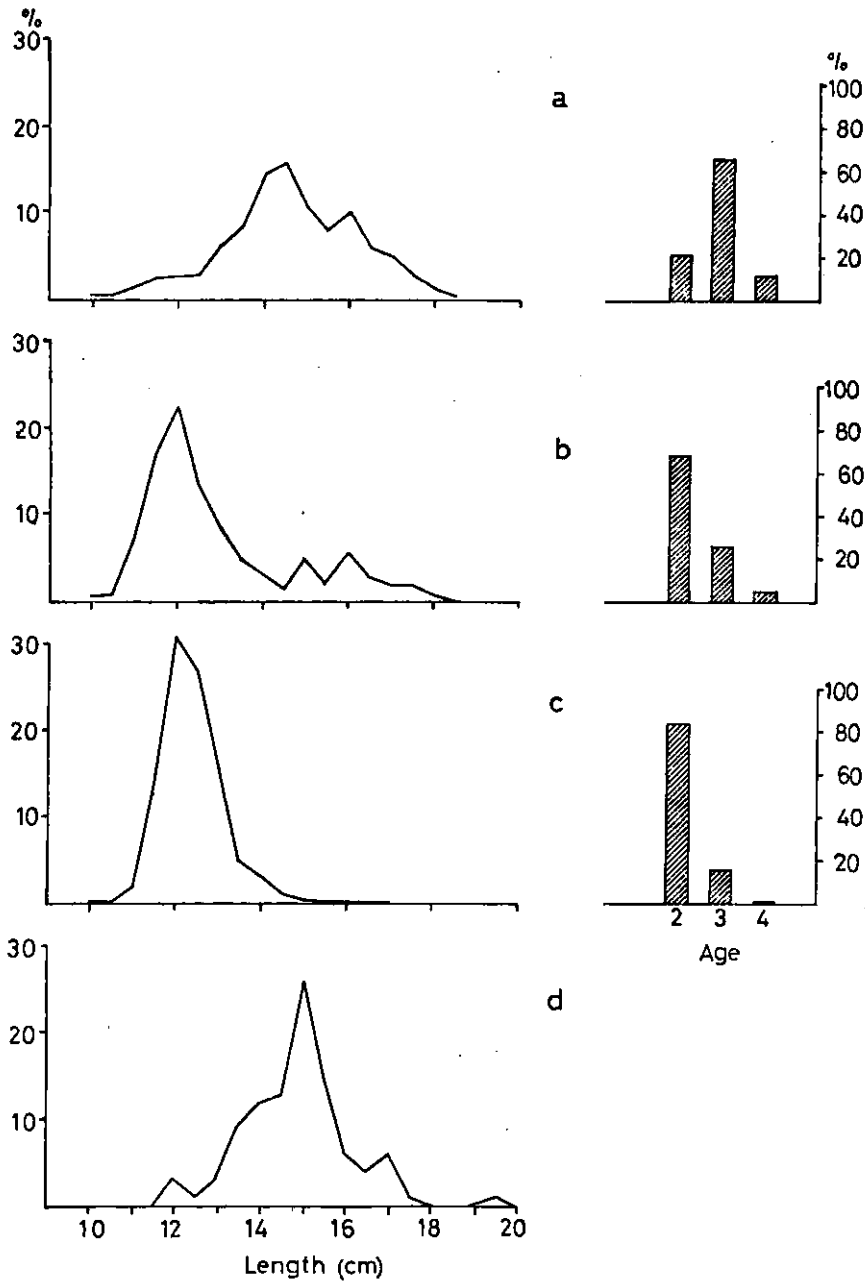


Fig. 5. Age and length composition of capelin caught in the period 13 July - 4 August 1971.

- a) South of 48° 30'N
- b) Between 48° 30'N and 51° 30'N, east of 52° 30'W
- c) Between 48° 30'N and 51° 30'N, west of 52° 30'W
- d) Off Labrador (54° 30'N - 56° 26'N).

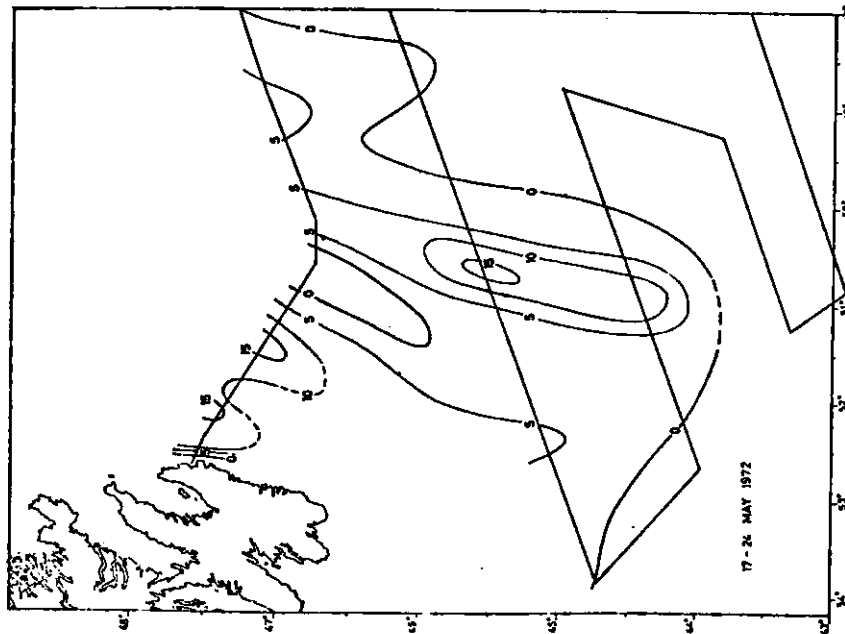


Fig. 6. Survey route of R/V "Johan Jørgen" and distribution of capelin 17 - 24 May 1972. The isotherms indicate echo integrator readings (DRAGESUND and MONSTAD 1973).

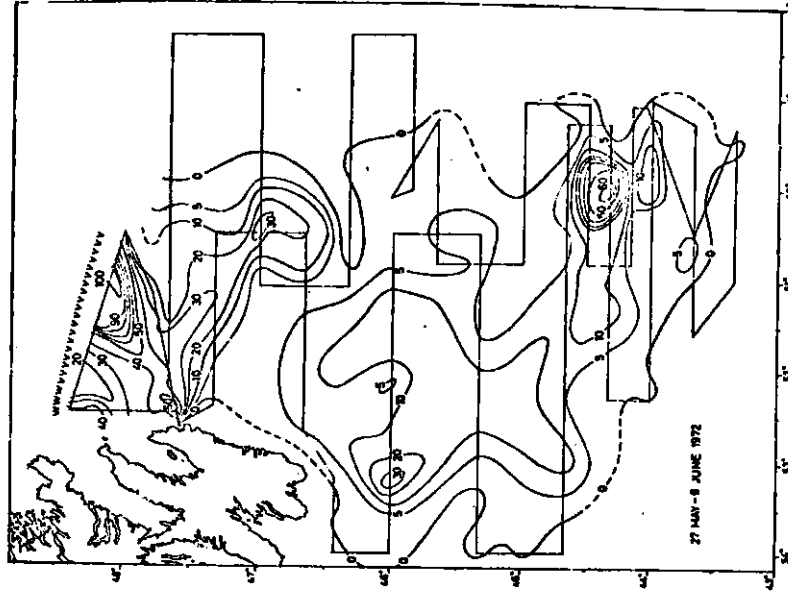


Fig. 7. Survey route and distribution of capelin 27 May - 9 June 1972. The isotherms indicate echo integrator readings (DRAGESUND and MONSTAD 1973).

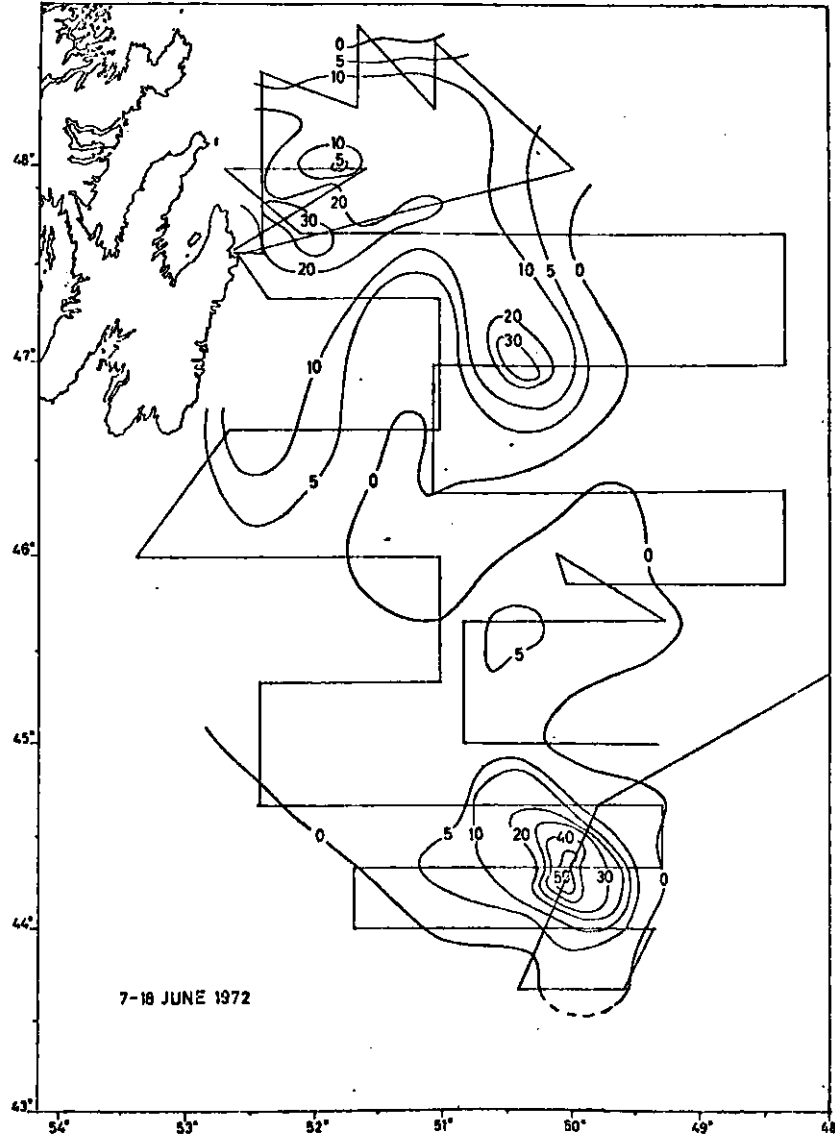


Fig. 8. Survey route and distribution of capelin 7 - 18 June 1972. The isolines indicate echo integrator readings (D. RAGSUND and ROSTAD 1973).

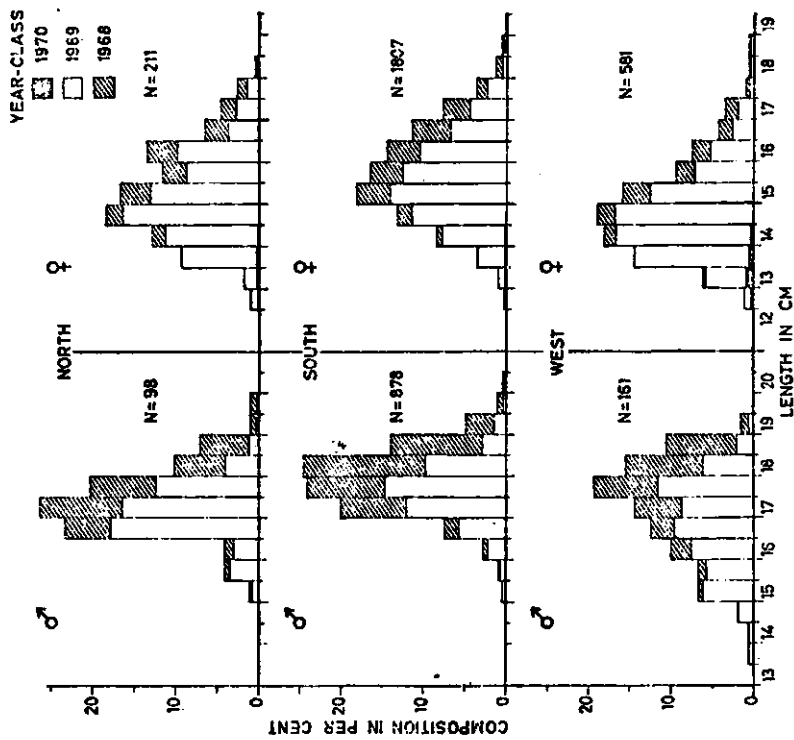


Fig. 9. Age and length composition of mature capelin (separated on male and female) on the Grand Banks in May - June 1972. The border between south and north is set at 46°30'N and for the western area at 52°W. (DRACHESUND and MONSTAD 1972)

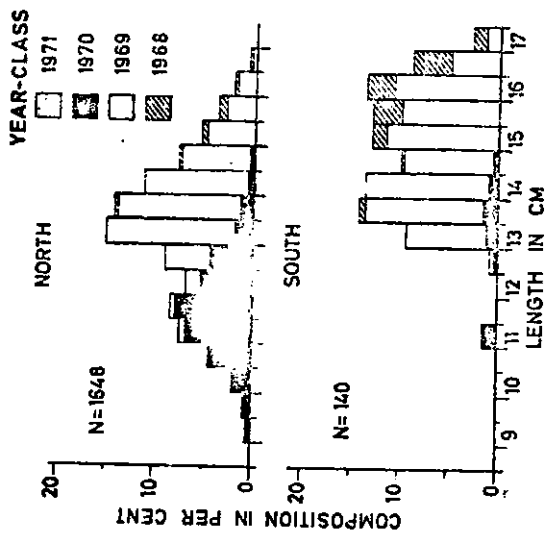


Fig. 10. Age and length composition of immature capelin on the Grand Banks in May - June 1972. The border between south and north is set at 46°30'N. (DRACHESUND and MONSTAD 1972).

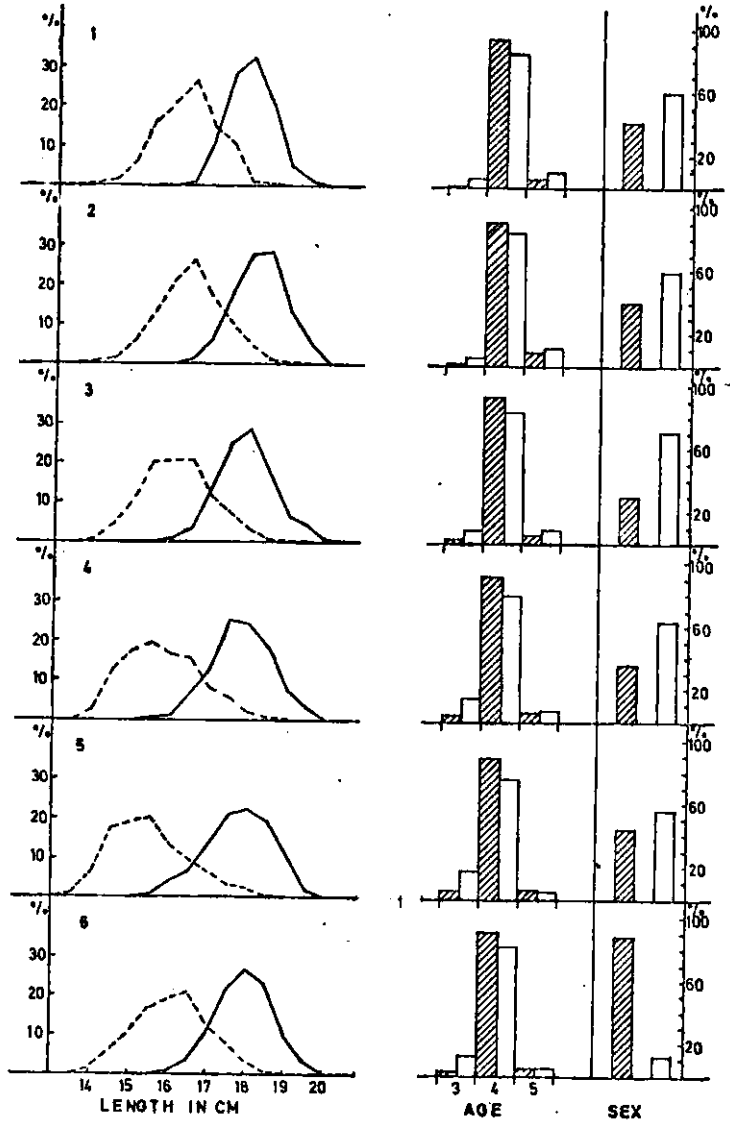


Fig. 11. Variations through the fishing season 1973 of the length and age distribution for females and males and the sex composition. Broken line or white column: females. Whole line or shaded column: males. 1,2 ... 6 represent the weeks 23 - 28. (DOMMASNES, MONSTAD and SARGOLT 1974).

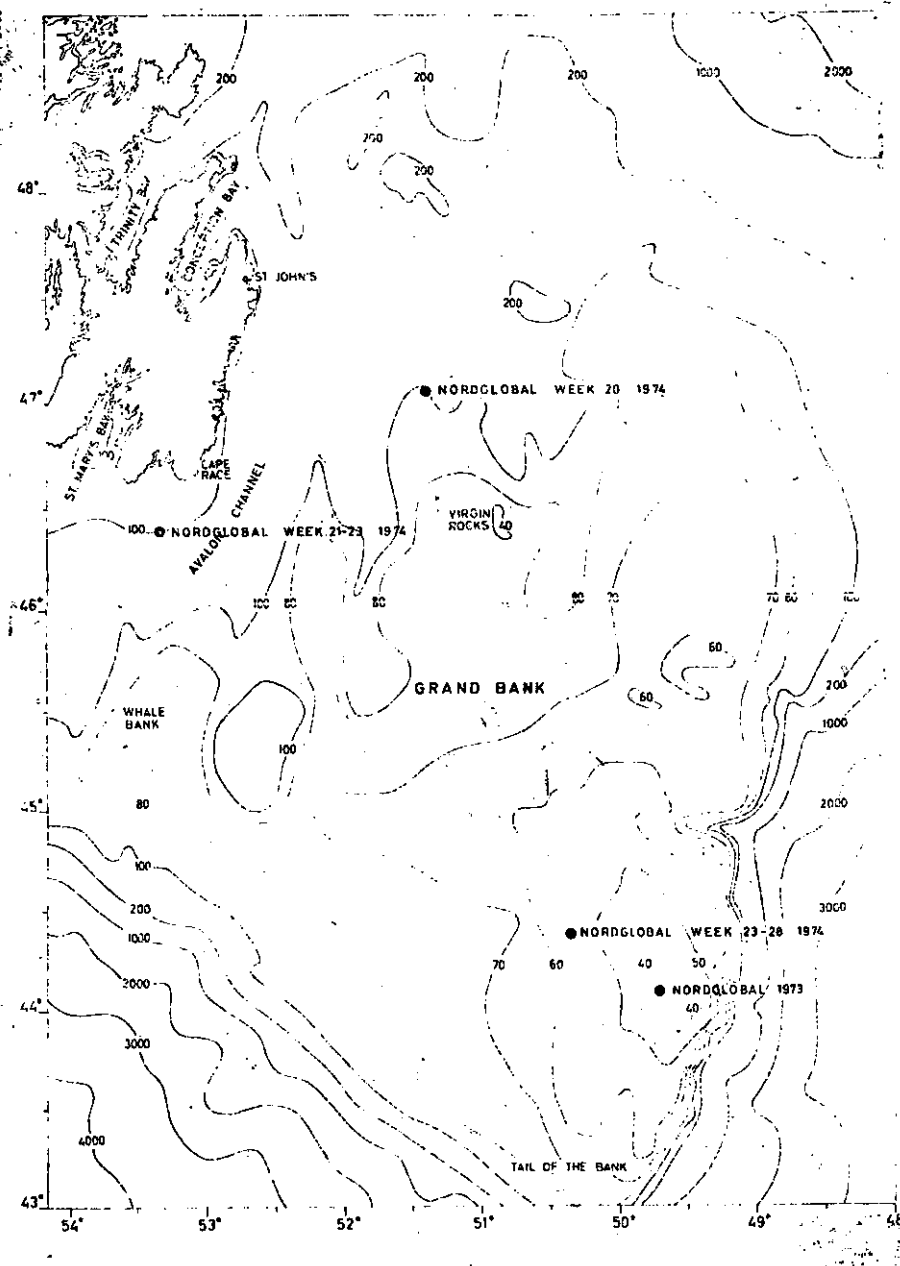


FIG. 12. "Nordglobals" position during the fishing seasons in 1973 and 1974.

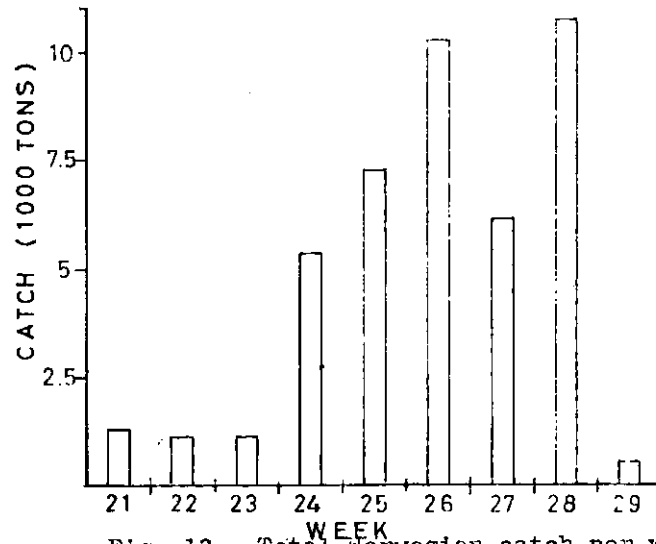


Fig. 13. Total Norwegian catch per week through the fishing season 1974 (FUREVIK and WESTERGAARD, in prep.).

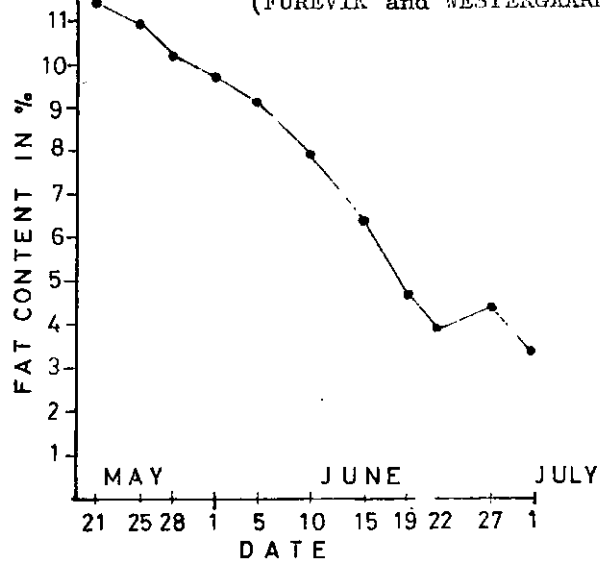


Fig. 14. Fat content of capelin through the fishing season 1974 (FUREVIK and WESTERGAARD, in preparation).

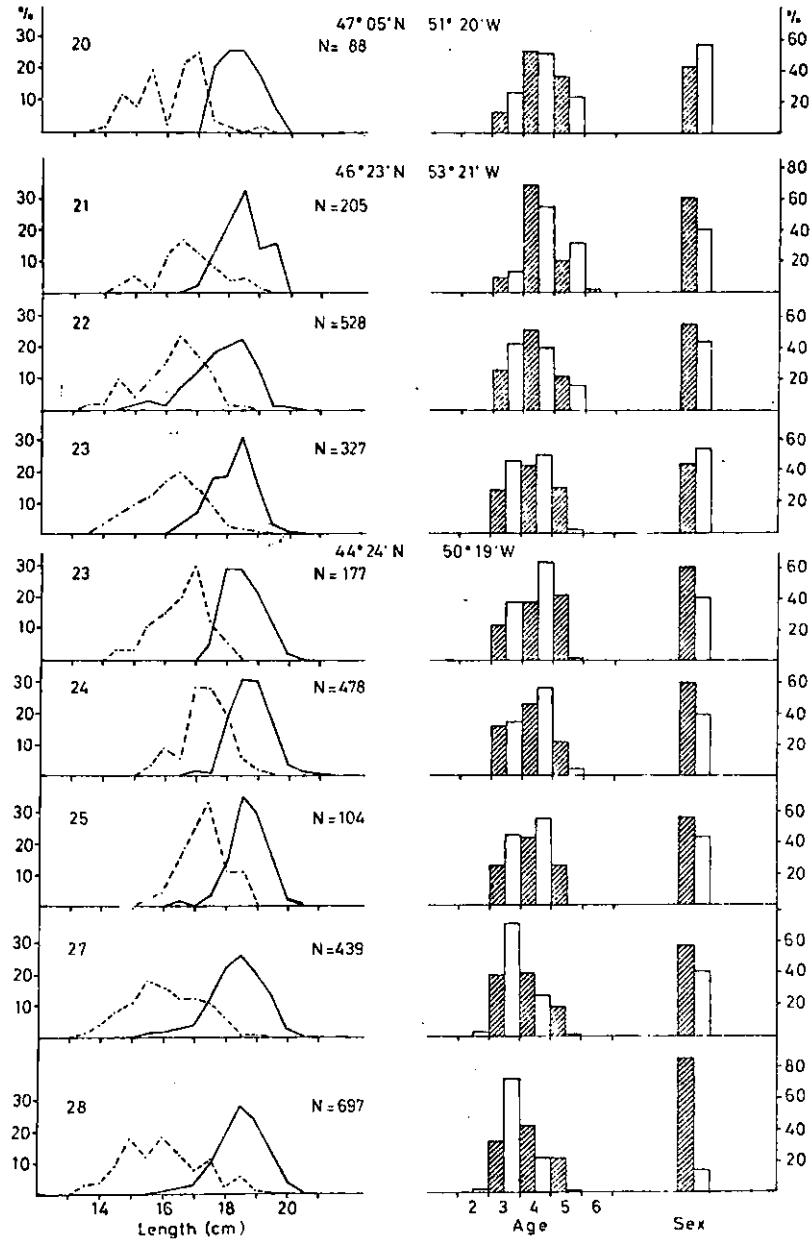


Fig. 15. Variations through the fishing season 1974 of the length and age distribution for females and males and the sex composition. Broken line or white column: females. Whole line or shaded column: males. 20, 21...28 represent week no. (PUR WIA og TOSTERGAARD, in preparation).

