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Some preliminary results on food and feeding of young capelin larvae.

by

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ABSTRACT

The gut contents of young capelin larvae sampled during a 24 hour period around a floating drogue were examined to study their feeding. The food consisted mainly of Calanus eggs (52%) and Calanus nauplii (42%). Compared to their abundance in plankton, Calanus eggs were by far preferred. The young larvae started to feed while still having large yolk-sacs, and the percentage of larvae feeding increased with decreasing yolk-sac size. No change in diet with age could be seen. Feeding started shortly after sunrise and declined at nightfall. A low percentage of larvae with gut content might indicate that the densities of food particles in plankton were too low to maintain survival and growth.

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INTRODUCTION

The capelin Mallotus villosus (Müller) has a circumpolar distribution and is found in the northern regions of the Pacific and the Atlantic. The Norwegian purse seine fishery on the Barents Sea capelin has steadily increased during the last decade and capelin is now one of the main resources for Norwegian fisheries. A peak in the catches was reached in 1972 with 1.6 mill. tons, (JANGAARD 1974, SÆTRE and GJØSÆTER 1975). The main fishery is based on the stock approaching the Finnmark and Murman coasts to spawn.

TEMPLEMAN (1948) carried out a detailed study on the development of the capelin larvae. However, food and feeding of the larvae in nature have not previously been studied. POZDNJAKOV (1960) and FRIÐGEIRSSON (1976) refer to hatching of capelin larvae in an aquarium, and they both suggest that the larvae start feeding while they still have yolk-sacs.

The aim of the present investigation was to study a) the food composition of the young capelin larvae, b) factors affecting their gut content, c) selection of food particles.

MATERIALS AND METHODS

The materials were derived from two sources:
1. Test station. An efficiency test on four high-speed plankton samplers was carried out 9-10 May 1971 near Honningsvåg (BJØRKE, DRAGESUND and ULLTANG 1974). Double oblique hauls to a depth of 30 m were made in a larval concentration marked by a floating drogue during a 24 hr period. Totally 1149 larvae were examined in order to compare feeding intensity with the time of day.
2. Larval surveys. The coast of Finnmark and Troms was surveyed four times from the middle of April to the middle of June. From the two latest surveys 50 larvae from one station were examined to see if a change in diet took place when the larvae grew older. The larvae were sampled with BCF Bongo Ø 20 cm (POSGAY et al., 1968)

in single oblique hauls from 25 m depth.

Both during the test and the larval surveys plankton were sampled as double oblique hauls from 30 to 75 m respectively with Clarke Bumpus plankton samplers with mesh size 90 µ. When present 50 larvae from each sample were examined. The larvae varied in length from 4.8 to 21.0 mm. Generally food items were classified as digested from the moment they started to disintegrate, and copepod eggs when they were empty.

RESULTS AND DISCUSSION

Composition of food

Nearly 17% of the larvae had gut content. Calanus eggs and nauplii constituted 52 and 42% respectively.

Of the 1149 larvae from the test station 178 or 15,5% had gut contents. The composition is given in Table 1. Calanus eggs and nauplii constituted 48 and 47% respectively of the contents and the remainder was unidentified matter. The largest food item was a Calanus nauplius stage V, though more than 90% of the nauplii were in stages I-III.

Table 1. Composition of food of 178 capelin larvae from test station.

Food items	Undigested food		Digested food		Total	
	Number	%	Number	%	Number	%
Calanus eggs	21	21,4	77	78,6	98	47,6
Calanus nauplii I-V	17	17,5	80	82,5	97	47,1
Unidentified matter	0	0	11	100,0	11	5,3

Of the 100 larvae from the survey stations 28% had gut content. The composition is given in Table 2. Calanus eggs constituted 86% of the gut content and the rest was copepod remains and unidentified matter.

Of all the larvae examined, nearly 17% had gut content. Calanus eggs and nauplii constituted 52 and 42% respectively.

Table 2. Composition of plankton and gut content of 50 capelin larvae from one station during two surveys. A=27 May, B=7 June, x=unidentified matter.

	A				B			
	In plankton		In diet		In plankton		In diet	
Items	Number pr. m^3	%	Total number	%	Number pr. m^3	%	Total number	%
Calanus eggs	300	6	17	90	200	3	7	78
Calanus nauplii stages I-V	500	10	0	0	600	9	0	0
Copepods	3800	78	1	(5)	5300	82	1	(11)
Others	300	6	1^x	(5)	400	6	1^x	(11)

The kind of food eaten by the capelin larvae was similar to that of Atlanto-Scandian herring larvae (BJØRKE 1971, BJØRKE 1976, SOLEIM 1942, RUDAKOVA 1971). However, with the capelin larvae Calanus nauplii constituted nearly 50% as opposed from 3 to 10% for the herring larvae (BJØRKE 1976, RUDAKOVA 1971).

SCHNACK (1972) found that herring larvae from the North Sea and western Baltic did not digest copepod eggs although they were found in the guts. This is in contrast to the investigation off Møre (BJØRKE 1976) where digestion of Calanus eggs by herring larvae was clearly observed. A percentage of 79% empty Calanus eggs (Table 1) indicates that they are digested also by the capelin larvae.

Feeding activity

Feeding started shortly after sunrise and declined at nightfall.

Fig. 1 shows the percentage of larvae with undigested gut contents during a 24-hour period, during which the cloud cover was 50%. No distinct pattern in feeding during daylight is to be seen, most probably because few of the larvae had gut contents. It seemed, however, that feeding started after sunrise and declined at nightfall, probably because there is insufficient light for feeding.

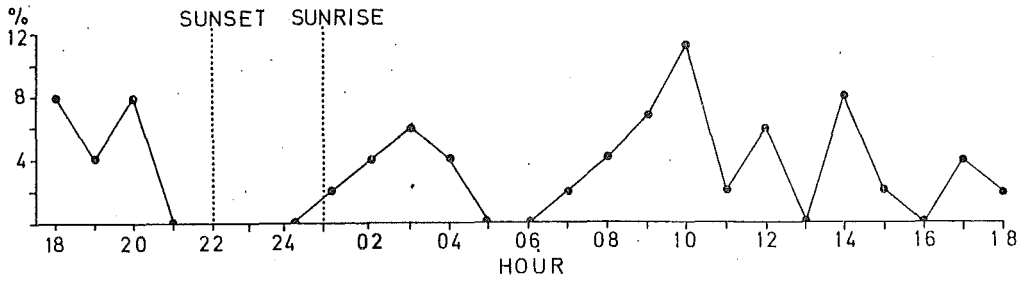

Fig. 1. Percentage of capelin larvae with undigested gut contents during a 24-hour period. Data from test station.

This corresponds with observations made on herring larvae (BAINBRIDGE and FORSYTHE 1971, BJØRKE 1976). The hatching of the capelin larvae starts in the middle of April and continues until the beginning of June (GJØSÆTER and SÆTRE 1974). Since most of the capelin spawning grounds in Norwegian waters are located north of 70°N, larvae hatched after the rise of the midnight sun in the middle of May theoretically can feed around the clock until the sun sets at the end of July. Larvae hatched at the beginning of the season, i.e. end of April, can feed theoretically 16-18 hours per day if cloud cover does not exceed 50%.

Total cloud coverage might reduce the time available for feeding. However, the observations on feeding of herring larvae between sunset and nightfall off Møre were made when cloud coverage was total (BJØRKE 1976). Therefore, if the visual treshold for feeding does not differ much between capelin and herring larvae, the capelin larvae in the upper 30 m will probably be able to feed between sunset and nightfall whether the cloud coverage is total or not. Depending on the location of the spawning ground and the incubation temperature nearly 50% of the capelin larvae in Norwegian waters

could hatch after the rise of the midnight sun (GJØSÆTER pers.com.). This might be of importance for the survival of the larvae.

Yolk-sac size and larval length

The length range of larvae with different yolk-sac sizes overlapped to a great extent, yet t-tests showed a significant increase in mean length with decreasing yolk-sac.

The yolk-sacs were classified as large, medium, small, absorbed and detatched. Fig. 2 shows the mean length, observed range and 95% confidence limits of 1141 larvae with different yolk-sac sizes. The range within each stage overlaps to a great extent, yet t-tests showed a significant increase in mean length with decreasing yolk-sac sizes. Overlapping in length with different yolk-sac sizes had also been observed by GJØSÆTER (pers.com.).

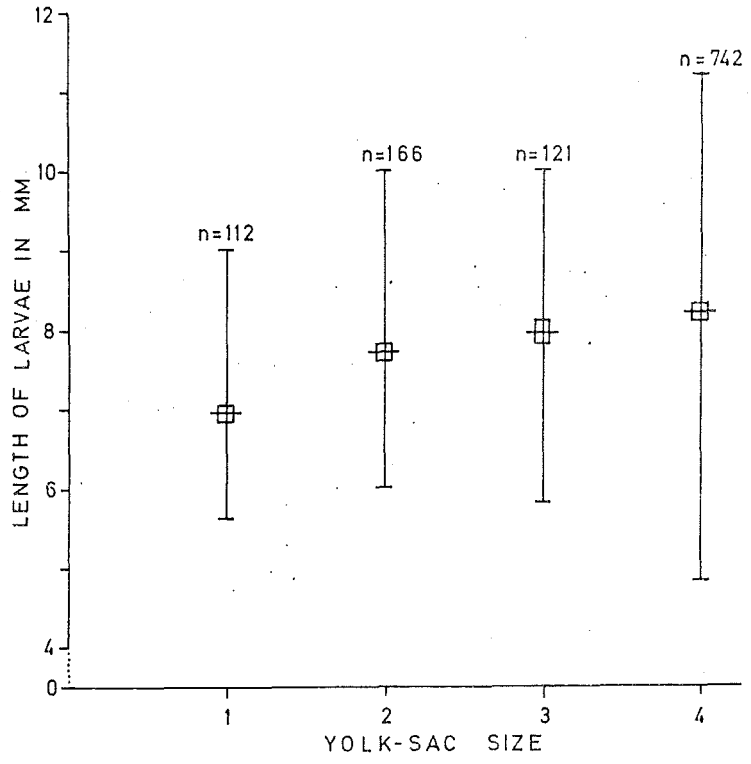

Fig. 2. Mean length, observed range and 95% confidence limit of capelin larvae compared to yolk-sac size.
1) Large, 2) medium, 3) small and 4) absorbed.

HEMPEL and BLAXTER (1963) and BLAXTER and HEMPEL (1963) found that herring females with large eggs generally produced larger and presumably stronger larvae with more yolk-sac reserves at hatching. The overlapping observed on capelin larvae might thus indicate differences in composition of the spawners. It might also indicate conservation of the yolk-sac by feeding as suggested by FRIÐGEIRSSON (1976).

Factors affecting gut content

Yolk-sac size

Larvae started to feed while still having large yolk-sacs. The percentage of larvae feeding increased with decreasing yolk-sac.

POZDNJAKOV (1960) refers to feeding of capelin larvae in an aquarium while still having yolk-sacs. It is thus conceivable that the ability to catch food would increase with decreasing yolk-sac. From the test station 2% of the larvae with large yolk-sacs had gut content as did 7, 18 and 19% of the larvae with medium, small and absorbed yolk-sacs, respectively (Data from Table 3).

Table 3. Number of larvae feeding and number of food items compared to yolk-sac sizes. Larvae from test station.

	Yolk-sac size			
	Large	Medium	Small	Absorbed
Total no. larvae	112	166	121	742
No. larvae feeding	2	12	22	142
Food items				
Calanus eggs	1	6	16	75
Calanus nauplii	0	6	10	81
Unidentified matter	1	0	0	10

None of the feeding larvae with large and medium yolk-sacs had more than one food particle in the guts, while 9 and 6% of the larvae with small and absorbed yolk-sacs, respectively, had two food particles. This could indicate increased ability to catch food for the individual larvae with small or absorbed yolk-sacs.

Food densities

The observed food densities seemed to be too low to maintain survival and growth.

In the present work plankton densities varied too little to give a useful comparison between food densities in the plankton and the number of food particles in the guts. The densities of Calanus eggs and nauplii at the test station were in average 1200 organisms per m^3 (Table 4). An investigation on young Atlanto-Scandian herring larvae off Møre (BJØRKE 1976) showed that up to 92% of the larvae caught at daylight in the 25-5 m interval had undigested gut content with prey densities of 500 and 4000 organisms per m^3. Only up to 11% of the capelin larvae from the test station had undigested gut content during daytime (Fig. 1). By including digested food particles up to 26% of the larvae had gut content. Total defecation might account for this low number. However, during a test on herring larvae, BLAXTER (1965) found that only about 10% of the larvae emptied their guts during fixation. Thus the low percentage of larvae with gut content in the present work might indicate that a food concentration of about 1200 organisms per m^3 is too low to maintain survival and growth of the capelin larvae.

Selection of food

Of the two most common food items, Calanus eggs and nauplii, eggs seemed to be preferred. This might be due to an "imprint" on Calanus eggs.

Three plankton samples taken at the test station were examined. Only minor changes in the composition and number of organisms per m^3 could be found. The average number of plankton organisms in the

three hauls and the diet of larvae caught immediately before the plankton hauls, are given in Table 4. Evidently Calanus eggs are selected from the plankton as they constituted 3% of the plankton and 54% of the diet.

Regarding the two main food items, Calanus eggs and nauplii, the first were by far preferred by constituting 8% of these two food items in the plankton and 55% of the diet, while the figures for Calanus nauplii were 92% and 45% respectively.

Table 4. Comparison of gut content and of surrounding plankton. See text. Data from test station.

	In plankton		In diet	
Items	Number pr. m^3	%	Number	%
Calanus eggs	100	3	21	54
Calanus nauplii	1100	30	17	44
Copepods	2300	64	-	-
Others	100	3	1	2

No change of diet with decreasing yolk-sac size could be noted (Table 3).

The mean length of the larvae from the test station were 7.97 mm, and 64% of them were without yolk-sac. The mean length of the larvae from the survey stations were 9.16 and 9.80 mm on the third and fourth survey respectively. Eighty-six per cent of these larvae were without yolk-sac and included larvae up to 21.0 mm in length, but no change in diet with length could be noted.

ROSENTHAL (1969) suggested after laboratory experiments that

herring larvae might gain preference for certain kinds of food items during the early life stages, depending on their success in catching their first food particle. He found that a change in the diet did not occur until 3-4 days after the other kind of food particles was added to the original ones. Thus the high percentage of Calanus eggs in the diet of the capelin larvae compared to the low percentage of the same item in the plankton could be due to an "imprint" on Calanus eggs as suggested by ROSENTHAL (1969).

The copepods in the plankton from the test station consisted mainly of copepodites of Calanus finmarchicus in the stages II, III and IV. The largest identified item in the diet was a Calanus nauplii stage V, and the Calanus copepodites present in the plankton were most probably too large to be ingested by the capelin larvae.

CONCLUSION

The food particles eaten by young capelin larvae consisted mainly of Calanus eggs and Calanus nauplii, 52 and 42% respectively. Calanus eggs seem to be preferred, probably because of an "imprint" on Calanus eggs. No change in diet with age could be seen.

Feeding started shortly after sunrise and declined at nightfall. Up to 50% of the larvae from the Norwegian spawning grounds can hatch after the rise of the midnight sun and will theoretically be able to feed around the clock. This could be of importance for the survival of the larvae.

The length range of larvae with different yolk-sac sizes overlapped to a great extent, yet t-tests showed a significant increase in mean length with decreasing yolk-sac size.

The larvae started to feed while still having large yolk-sacs. The percentage of larvae feeding increased with decreasing yolk-sac size.

The observed plankton densities varied too little to give a useful comparison between food densities in the plankton and the amount of food particles in the gut. However, the food densities seem to be too low to maintain survival and growth.

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