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THE FOOD OF THE MYCTOPHID FISH, *BENTHOSEMA GLACIALE* (REINHARDT), FROM WESTERN NORWAY

By

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ABSTRACT

Stomach contents were studied in *Benthosema glaciale* taken by midwater trawl in a fjord in western Norway. Copepods constitute the most important part of the identifiable stomach contents. Euphausiids were found during all seasons except summer, and more commonly in big than in small fish. The fish feed all the year, but most intensively during spring and summer. They seem to feed more in the evening than during the light hours of the day. The seasonal and diurnal variation in feeding may be related to the availability of food.

INTRODUCTION

Myctophids are one of the most abundant groups of mesopelagic fishes, and they play an important part in the marine food web. Yet little work has been done on their feeding behaviour and the composition of their food. PAXTON (1967), HARTMANN & WEIKERT (1969), SOLYANIK (1967), and HOLTON (1969) treat some aspects of the subject for a few species. Some notes on the food are also found in papers mainly treating systematics and distribution (e.g. BEEBE & VANDER PYL 1944).

On the food of *Benthosema glaciale* (REINHARDT), which is the most common myctophid species in the Atlantic north of about 35°N, only a few scattered notes exist. NORDGAARD (1915) found *Pareuchaeta norvegica* and *Parathemisto oblivia* in the stomach of a few specimens taken in Trondheimsfjorden. HOLT & BRYNE (1911) reported *Centropagus typicus*, *Pleuromamma robusta*, and chaetae from *Sagitta* sp. in three specimens from Irish waters. *Themisto libelula* and *Conchoecia borealis* have also been mentioned as food species (ANDRIYASHEV 1964). On feeding behaviour of this species, no data seem to exist.

This paper treats the food composition and the diurnal and seasonal variation in feeding of *B. glaciale* from Byfjorden and Herdlefjorden in western Norway.

MATERIAL AND METHODS

The material was collected with midwater trawls during the years 1967–1970. Details about methods of sampling and the area of the investigation are given by GJÖSÆTER (1973).

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About 420 fishes were used for studies of food. These were preserved in 5% formalin immediately after being captured to stop digestion of the stomach contents. The stomachs were removed and opened under a binocular microscope. The degree of filling was classified according to the following scale: 0: empty, 1: nearly empty, 2: half filled, 3: full, 4: extended stomach. The contents were determined to taxonomic groups and in some cases to species.

To study diurnal variation in feeding, the day was divided into morning (the first five hours after sunrise), day (from morning to sunset), evening (the first five hours after sunset), and night (from evening to sunrise). To study seasonal variations the year was divided into spring (March–May), summer (June–August), autumn (September–November) and winter (December–February). It should be noted that in the depths where *B. glaciale* mainly are found, the temperature s highest in winter/spring and lowest in summer/autum (LINDE 1970).

RESULTS AND DISCUSSION

Food species

Only copepods, euphausiids, and unrecognizable contents were found in the stomach of the specimens studied. Seasonal distribution of these groups and of empty stomachs are shown in Fig. 1, and the distribution in the different age groups of fish in Fig. 2. Copepods were the most common food item in all age groups and during all the seasons. Euphausiids were common during autumn and winter, but scarce in spring and absent during summer. Of 213 *B. glaciale*, one year or older with recognizable stomach contents, 83% had taken only copepods, 12% only euphausiids, and 5% both copepods and euphausiids. Copepods predominated

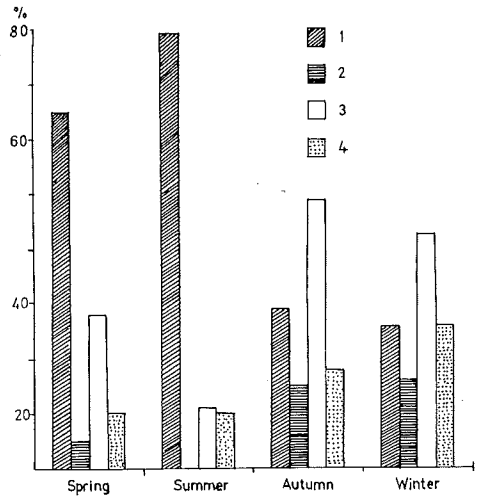

Fig. 1. Seasonal variation in stomach contents (0-group excluded). Number of fish with 1 copepods, 2 euphausiids, 3 unidentifiable contents, and 4 empty stomachs as percentage of specimens studied in each season.

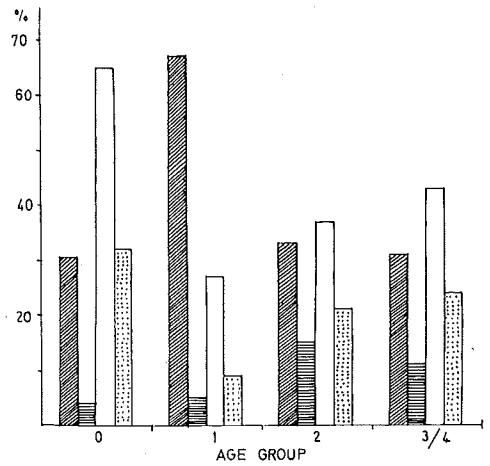

Fig. 2. Stomach contents in the different age groups. Symbols as in Fig. 1.

most in the smallest fish. This is most clearly seen when we consider only the months when euphausiids were found (Fig. 3).

Only parts of the food are determined to species, but the largest copepod species seem to be preferred. *Calanus finmarchicus*, *Metridia* sp., and *Pareuchaeta norvegica* were often found. Among the euphausiids *Thysanoessa* spp. predominated, but small specimens of *Meganyctiphanes norvegicus* (up to 21 mm) were also found.

About 35% of the fishes studied had unrecognizable contents in the stomachs. Since some food items may be dissolved beyond recognition faster than others, it is possible that this part of the contents had a species composition different from the recognizable contents.

In the investigated area the copepods constitute the greatest part of the plankton during the whole year, but they are most abundant during summer (RUNNSTRÖM 1932). Euphausiids are also found during the entire year, but *Thysanoessa* spp. are most abundant during winter (WIBORG 1971). The availability of these groups may, therefore, be the cause of the seasonal variation in their relative importance as food for *B. glaciale*.

PAXTON (1967) studied stomach contents in nine species of myctophids from California. Of 204 specimens with identifiable stomach contents 80% had eaten euphausiids, 12% copepods, 10% Sergestidae, 80% fish, and 1% had taken other prey. The species predominating in PAXTON's material (*Stenobrachius leucopsaurus*, *Lampanyctus ritteri*, *Triphoturus mexicanus*, and *Symbolophorus californiensis*) reach a greater size than *B. glaciale*, and this may be one reason for the predominance of relatively large food species. In all the more common species more than one kind of food organism at a time was very seldom found.

Degree of filling

Seasonal variation in the degree of filling for fish one year or older is shown in Fig. 4. Fish taken during spring had taken most food, those taken during summer somewhat less, and those from autumn and winter still less. This indicates that *B. glaciale* feeds during all seasons, but probably most intensively during spring and summer. The seasonal variation in temperature is small in the water layers were *B. glaciale* spends most of the day (LINDE 1970), and it seems improbable that there is any direct relationhip between temperature and feeding. GUNDERSEN (1953) has shown that the volume of zooplankton in the fjords of western Norway is highest during April–July. This is in good agreement with the time when the highest degree of filling was found, and the feeding intensity may, therefore, be directly related to the availability of the food organisms.

Diurnal variation in the degree of filling is shown in Fig. 5. It was highest in the evening, lower during the day, and lowest in the morning, but the differences were rather small. If the first two hours after sunset were considered separately, many empty stomachs and few filled were found.

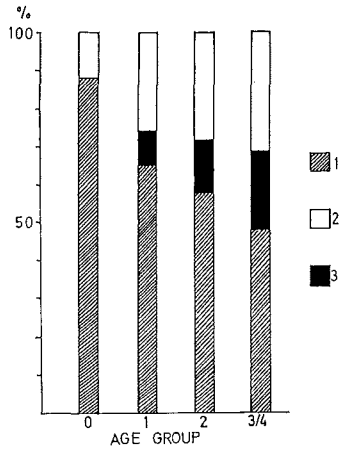

Fig. 3

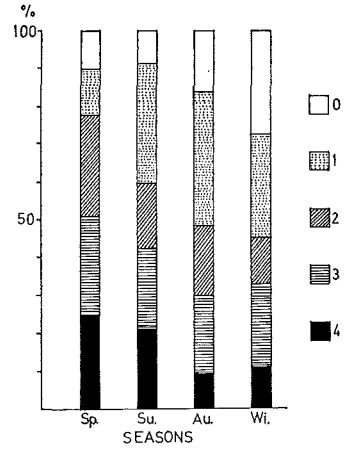

Fig. 4

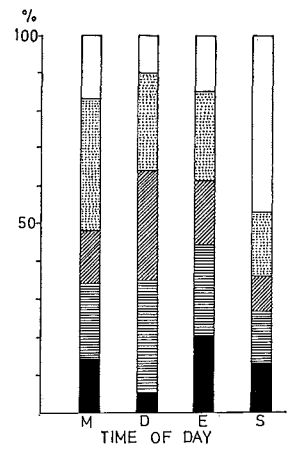

Fig. 5

Fig. 3. Ratio between fish with 1 copepods, 2 euphausiids, and 3 both copepods and euphausiids during September–March.

Fig. 4. Percentage distribution of the degree of filling (0–4) in spring (Sp), summer (Su), autumn (Au), and winter (Wi). The numbers indicate degree of filling.

Fig. 5. Percentage distribution of degree of filling in morning (M), day (D), evening (E), and during the first two hours after sunset (S). Symbols as in Fig. 4.

During and soon after a period with intensive feeding it is assumed that there are few fishes with empty stomachs and many with full or extended ones. There should also be a low percentage with stomach contents too digested for identification. Data from Fig. 5 and Table 1 therefore suggest that *B. glaciale* feeds most intensively during the evening, but the diurnal variation is probably not very great. *B. glaciale* has diurnal vertical migration, and one reason for feeding most intensively during evening may be that it then is found in water with higher concentrations of the food species than during the light hours of the day.

PAXTON (1967) found that the myctophid species studied by him fed both day and night, while HOLTON (1969) who studied feeding behaviour of *Triphoturus mexicanus*, one of the species also dominating in PAXTON's material, concluded that they took very little food during the day. This probably indicates that the diurnal rhythm in the feeding of a species may be different in different areas.

Table 1. Occurrence of unidentifiable stomach contents.

Time	N	Unidentifiable contents	
		Number	%
Morning	117	62	53.0
Day	59	26	44.1
Evening	134	23	17.2

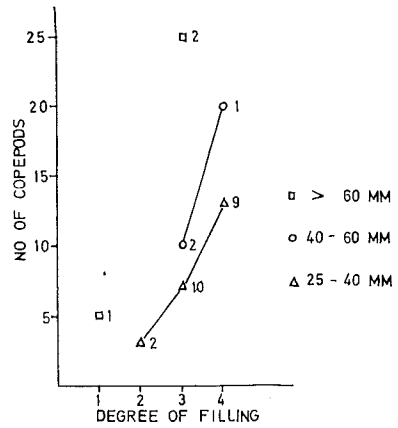

Fig. 6. Relation between number of copepods eaten and degree of filling in fish in various length groups. Numbers in the figure indicate number of fish in each group.

In studies of stomach contents of fishes, regurgitation of food after capture and the swallowing of prey in the trawl are often considered as important sources of error. There was no indication that this took place during this investigation. The same conclusion was reached by HOLTON (1969).

Stomach contents of the 0-group

The stomach contents were studied in 37 0-groups fishes in October and November when they had reached a length of 17–20 mm. Data on the composition of their food are included in Figs. 1 and 3. They had taken relatively more copepods than older fish, and the smaller species of copepods seemed to be preferred. But the remains of a euphausiid in one stomach showed that they are also able to take large prey. Phytoplankton was not found in any of the stomachs.

The mean degree of filling was somewhat lower than for the older age groups taken at the same time of the year (Table 2).

Quantitative measurements of the stomach contents

To get an approximate picture of the quantitative meaning of the different degrees of filling, fish with only slightly digested copepods of the genera *Calanus* and *Metridia* were grouped according to length and degree of filling. These two genera

Table 2. Degree of filling in 0-group fish.

Degree of filling	Number	%
0	12	32.4
1	10	27.0
2	8	21.6
3	5	13.5
4	2	5.4

were selected because they were common and of comparable size. The relationship between number of copepods and degree of filling in the different length groups is shown in Fig. 6, and a good correlation is indicated.

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