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Food of Epipelagic Myctophidae (Pisces) of the Tropical Atlantic

E.V. Greze

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The literature relating to the food of the family Myctophidae now 18*
numbers many tens of contributions by native and foreign authors, dating mainly from recent decades. The structure of the pharyngeal-branchiostegal apparatus, the feeding habits [8,12] and the quantitative and qualitative feeding characteristics [9,10,11] have been elucidated to a sufficient degree.

The vast majority of the contributions deal with the food of mesopelagic Myctophidae of various regions of the World Ocean. Considerably less has been done with regard to studying the trophic character of the epipelagic anchovies, which serve as the principal food of small free-swimming predators. One of the native investigators is T.A. Gorelova [1-4] who, in numerous articles, presents a comprehensive analysis of the food and feeding relationships of many species of both the meso- and epipelagic (or "near-surface") Myctophidae occurring in Pacific Ocean material. The near-surface Myctophidae of the Atlantic

* The figures in the right-hand margin are page numbers of the original (Tr.).

had not been studied in this context.

Material and methodology. The material consisted of samplings taken in the equatorial part of the Atlantic Ocean at the time of the 10th voyage of the Scientific Research Ship "Professor Vodyanitskii" in 1981. In order to catch the "near-surface" Myctophidae, lift nets made of capron* (an anchovy net with a mesh of 0.6 X 0.6 cm) were used. Catching was accomplished during the dark hours on illuminated drifting stations in the 15-20 cm surface layer.

The weighing method was used for processing the stomachs [6]. Before being dissected the fish was weighed and measured, after which its stomach, both with and without food, was weighed. The food bolus was also weighed. The trophic organisms obtained from the stomachs were identified and measured. Only the Copepoda and Amphipoda were determined to genus and species. The Euphausiacea were determined merely as the Order. The reconstructed masses were determined from the mass tables of zooplanktonic organisms [5,7]. The frequency of occurrence of the articles comprising the food was calculated on the basis of empty stomachs.

Analyses were made of the stomach contents of 297 specimens of Myctophum asperum, 115 specimens of M. nitidulum and 45 specimens of M. affine. These species predominate in the central eastern part of the tropical Atlantic. The young of the indicated species of

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*Del' in the Russian, which refers to a thick hemp, cotton or capron line for making various types of seines (Tr.).

Myctophidae were represented by unitary specimens in the catches.

Results of the investigations. The species of Myctophidae investigated are typical planktophages, as evidenced by the structure of the gill raker apparatus, on the one hand, and the wide aggregate of zooplankton used as forage, on the other.

Almost all the zooplanktonic groups were represented in the feeding spectra of the Myctophidae. The dominant forms were dissimilar in the different species, which has an adaptive meaning in terms of the feeding habits of species with adjacent or overlapping ranges.

One of the mass species of near-surface Myctophidae, that is, those ascending at night to the 30-meter surface layer for fattening, is Myctophum nitidulum. The picture of the feeding spectrum typifying it is one in which the Euphausiacea are clearly dominant in numbers and biomass. Forming a second major component were the Amphipoda (table 1), even though their biomass and relative numbers were less than the mass and numbers of the Euphausiacea. Both groups occurred in the stomachs with approximately the same frequency. The remaining groups of the zooplankton constituted a small percentage with respect to all of the indices. They included the Siphonophora, the Polychaeta, the Appendicularia, the Salpae, the Decapoda, the Ostracoda, the Bivalvia and the Chaetognatha. The biomass of the Copepoda amounted to only 5.2% of the mass of all the articles comprising the food, even though they were numerous and occurred in every third stomach. Of the Copepoda, accounting for the highest percentages of biomass

(0.43 - 0.51) and frequencies of occurrence (5.0 - 9.2) were Euchaeta marina, Undinula vulgaris and Candacia spp. Of the Amphipoda, the largest biomass was furnished by small crustaceans of the families Platyscelidae (frequency of occurrence 20.8% and biomass 7.6%) and Anchylomeridae (frequency of occurrence 4.2% and biomass 6.7% - the total mass of the food bolus). Myctophidae, found in the stomachs singly, could hardly be classified as a significant article of the diet. 19

In order to ascertain the differences in the composition of the food in fishes of various size groups, the existing material was divided into seven batches measuring between 35 and 85 mm (fig. 1). The previously shown peculiarity was also confirmed here: the Amphipoda and Euphausiacea were dominant in the feeding spectrum of the fishes of all of the linear batches. However, as will be seen in

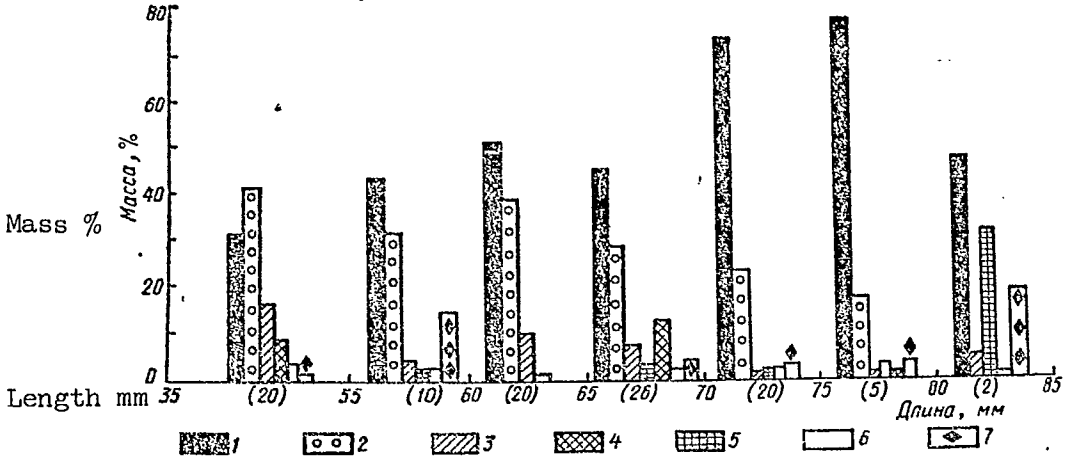

Fig. 1. Feeding spectra of variously sized batches of M. nitidulum: 1 - Euphausiacea, 2 - Amphipoda, 3 - Copepoda, 4 - fishes (Myctophidae), 5 - Salpae and Siphonophora, 6 - others, 7 - digested mass. In brackets: the numbers of specimens studied.

fig. 1, the relation between them altered with an increase in the sizes of the fishes: the biomass of the Amphipoda decreased, and that of the Euphausiacea increased. In fishes measuring 35-55 mm in length the ratio of the mass of the Euphausiacea to that of the Amphipoda equals 0.75; in fishes 55-70 mm long, it is 1.43, and in the large Myctophidae (more than 70 mm) the fraction represented by the Euphausiacea is 3.92 times greater than that of the Amphipoda. Probably, the phenomenon of feeding selectivity is present here.

The maximal and mean dimensions of the consumed Euphausiacea were found to be directly dependent on the sizes of the fishes. According to preliminary data, in the first batch of Myctophidae (35-55 mm) small crustaceans measuring 5-10 mm predominated in the food, in the Myctophidae 55-70 mm long the size of the crustraceans was 8-12 mm, and in the large fishes Euphausiacea measuring 10-25 mm were found. The sizes of the Amphipoda of all of the size groups were much more stable and ranged between 1 and 8 mm.

The feeding spectra of males and females of M. nitidulum differed only in the relation between the Amphipoda and the Euphausiacea (fig. 2): in the females the Euphausiacea constituted a biomass 2.5 times greater than that of the Amphipoda, whereas in the males, this value was 1.5. This is in order if we take into account that the females are somewhat larger than the males and consume a greater quantity of Euphausiacea than do the latter. As regards the Myctophidae swallowed as food, the frequency of their occurrence in the males was 7.7%, while

the biomass equalled 6.3% of the mass of all the articles in the food; in the females, a single myctophid was found, constituting a tenth of a percent of the food mass.

In the tropical Atlantic Myctophum asperum is fairly abundant. The feeding spectrum of this species includes a wide aggregation of zooplanktonic organisms (table 1). The Salpae constituted the greatest biomass (34%) of all of the organisms consumed. It is necessary to point out that in the stomachs that were investigated the degree of preservation of these organisms was low: usually they were in an advanced state of disintegration, with the result that more detailed identification of them was impossible. Digested food, consisting chiefly of a homogeneous brown-green mass accounted for about 36% of the mass of the food bolus. The latter could belong, for example, to both the Salpae and the Polychaeta, however, the absence of structural elements made identification of the item impossible.

The most numerous organisms in the fishes' stomachs were the Copepoda. However, they furnished only a small share of the biomass of the food organisms belonging to this taxonomic group, which consists of Oncaea conifera, O. vanusta and Candacia pachydactyla. The Salpae, with sizes ranging from 4 to 15 mm, constituted the largest portion of the biomass. The remaining groups of zooplanktonic organisms made up a small fraction of the feeding spectrum of M. asperum.

In order to ascertain the differences in the composition of the food in the variously sized fishes the material was divided into six

1 Кормовые объекты	M. nitidulum			M. aspe	rum		M. affine		
	2 численность	3 масса	4 частота встречаемости	2 численность	масса	частота встречаемости	численность	масса	частота встречаемости
Euphausiacea	34,2	53,6	60,8	3,8	7,2	15,5	7,7	19,3	60,0
Amphipoda	24,2	27,2	67,0	12,4	9,6	22,2	3,2	4,9	26,7
Copepoda	32,0	5,2	31,0	27,4	2,5	60,6	76,0	53,6	91,0
Decapoda	0,8	0,6	6,7	—	—	—	2,1	5,0	26,7
Siphonophora	1,4	1,0	5,8	8,3	4,6	23,6	—	—	—
Salpae	—	—	—	37,6	33,9	36,4	0,2	4,0	2,2
Polychaeta	—	—	—	—	—	—	2,6	8,1	31,1
Appendicularia	—	—	—	—	—	—	10,0	1,0	33,3
Myctophidae	0,8	4,7	5,8	—	—	—	—	—	—
5. Переваренная масса	—	5,6	—	—	35,8	44,8	—	—	—
6. Прочие	6,6	8,6	0,8—2,5	0,2—5,7	0,01—3,7	0,7—9,1	14,5	4,9	2,2—22,2

Table 1. Characteristics of the qualitative composition of the food of abundant species of Myctophidae belonging the the genus Myctophum, %

Key: 1. Items comprising the food, 2. Numbers, 3. Mass, 4. Frequency of occurrence, 5. Digested mass, 6. Others

linear batches (fig. 3). Myctophidae with lengths between 35 and 55 mm were lumped together in one batch on account of the insufficiency of material. Large fishes of more than 75 mm in length amounted to no more than two specimens, with Salpae accounting for 99% of their stomach contents. From the preliminary data (since the question of the qualitative feeding characteristics of this species calls for a

larger volume of material) a common mechanism is evident in the alteration in the composition of the food, namely a decrease in the share (by mass) of the Copepoda and Amphipoda in the food bolus as the sizes of the fishes increase. The fraction represented by the Salpae ranged from 12 to 46%, without showing a tendency to increase or decrease.

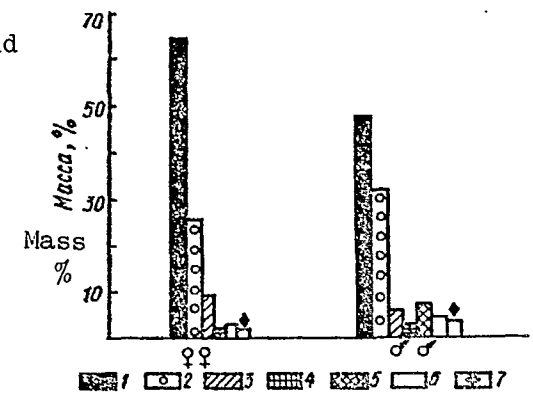

Fig. 2. Feeding spectra of males and females of M. nitidulum:

1.- Euphausiacea, 2 - Amphipoda, 3 - Copepoda, 4 - Salpae and Siphonophora, 5 - Myctophidae, 6 - others, 7 - digested mass. In brackets: the number of specimens studied.

The feeding spectra of males and females of M. asperum were almost identical and reflect the overall picture of the feeding spectrum of this species. In both sexes the largest share of the food consumed consisted of the Salpae (table 2) and the digested mass.

The third prolific species of the near-surface lanternfishes is Myctophym affine. Copepods clearly predominated in the feeding spectrum of this species. The Euphausiacea formed a second major component. Copepods were found in virtually all of the full stomachs (frequency of occurrence 91%) (see table 1). Copepoda spp. proved to be the most abundant food component: Euchaeta marina (32.6% by mass, with a 60%

frequency of occurrence, 26% of the total number of items consumed), with the other more or less significant articles in terms of biomass and frequency of occurrence being Candacia curta and Candacia pachydactyla (constituting respectively 4.8 and 5.7% of the total mass, with a 37.8 and 62.2% frequency of occurrence). 21

Of the diagrams presented in fig. 4, illustrating the dependence of the feeding spectrum of M. affine on the sizes of the fishes, those for Myctophidae measuring 30-40 mm are the most reliable. Since the material for the remaining size groups is less representative, we have lumped together the first two batches. Common in the food of fishes of all the size groups was an overwhelming preponderance of Copepoda (47-81% by mass), with the maximum percentage of mass of the Copepoda observed in individuals 20-30 mm in length (72%). The remaining zooplanktonic groups make up a very small portion of the total food consumed (3.1 - 4.8%).

It is interesting to trace the change in the role of the dominant copepods that takes place as the fish grows (table 3). In Myctophidae 20-30 mm in length Euchaeta marina and Candacia spp. form an approximately equal percentage of all the Copepoda (16.5 and 24.0%). In mature fishes that have attained their mean maximal length of 35 to 40 mm, the relation between these trophic organisms changes: Euchaeta marina constitutes 70.5% of all the copepods consumed, and consumption of Candacia spp. declines sharply to 7.4 - 9.1%. It is probable that the sizes of these copepods played a definite role here. 22 Both of the Candacia spp. were not more than 2.2 - 2.8 mm in size,

and E. marina, 2.3 - 3.9 mm. The larger fishes consumed larger zooplanktonic crustaceans. The sizes of the Euphausiacea consumed ranged from 2.5 to 10 mm (averaging 3 - 6 mm). They constituted the major share in the food bolus of fishes larger than 30 mm (averaging 24.2%).

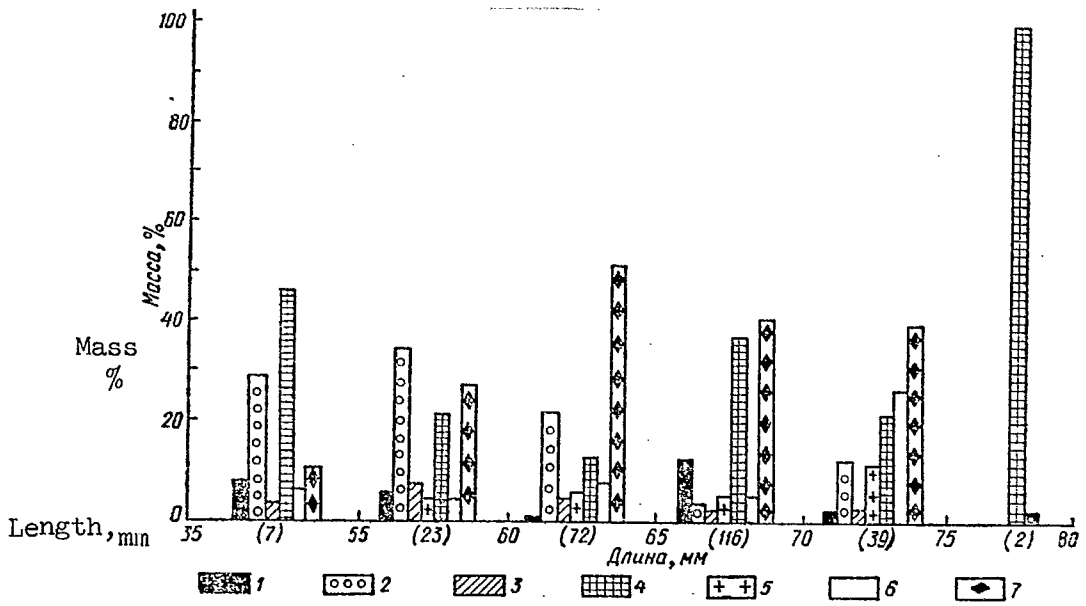

Fig. 3. Feeding spectra of variously sized batches of M. asperum:

1 - Euphausiacea, 2 - Amphipoda, 3 - Copepoda, 4 - Salpae, 5 - Siphonophora, 6 - Others, 7 - digested mass. In brackets: the number of specimens studied.

In the course of the investigations the feeding pattern of M. affine was ascertained. Here, no definite differences in the qualitative composition of the food consumed by the males and females were detected. The Salpae, indicated for the females, were found in a single stomach, that is, they occurred randomly.

Table 2. Composition of the food of males and females of M. asperum, %

Articles comprising the food	Males	Females
Euphausiacea	9.0	7.7
Amphipoda	8.6	6.5
Copepoda	2.9	1.4
Siphonophora	6.3	3.9
Salpae	38.4	33.1
Digested mass	29.1	41.6
Others	5.7	5.8

Conclusions. In terms of their feeding pattern, the prolific species of Myctophidae of the tropical Atlantic that were studied: Myctophum nitidulum, M. asperum and M. affine, are typical planktophages.

M. nitidulum displays a clear feeding preference for euphausiids and amphipods. They constitute an overwhelming majority in mass (53.6 and 27.2% respectively), numbers (34.2 and 24.2%) and frequency of occurrence (60.8 and 67.0%). The remaining zooplanktonic groups (Siphonophora, Polychaeta, Appendicularia et al.) form a small percentage in terms of these indices. With an increase in the sizes of M. nitidulum the relation between the dominant Euphausiacea and the Amphipoda alters: the share of the Amphipoda decreases and that of the Euphausiacea increases.

In the food of M. asperum the Salpae predominate; their mean sizes are 4 - 15 mm and they constitute 34% of the mass of the food

consumed. Accounting for a slightly larger percentage (36%) is the homogeneous (digested) mass, which can be equally attributed to the Salpae and the Polychaeta. The remaining zooplanktonic groups constitute a minor share of the feeding spectrum. With an increase in the sizes of the fishes the quantity of amphipods and copepods in the food bolus decreases. The share of the Salpae ranges from 12 to 46%.

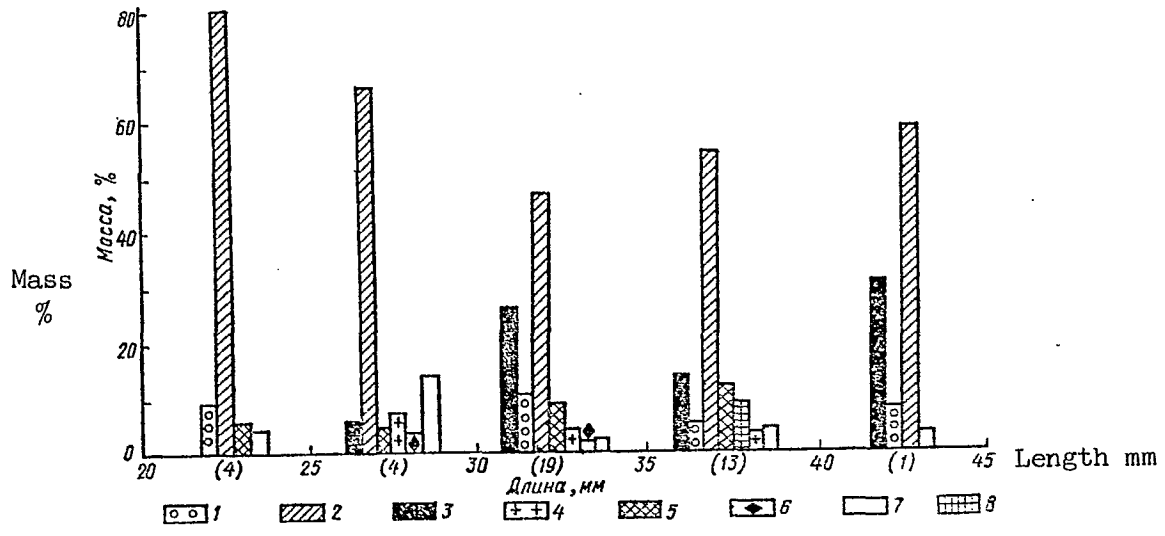

Fig. 4. Feeding spectra of variously sized batches of M. affine:

1 - Amphipoda, 2 - Copepoda, 3 - Euphausiacea, 4 - Decapoda, 5 - Polychaeta, 6 - Appendicularia, 7 - Salpae, 8 - Others. In brackets: the number of specimens studied.

The smallest species of those which were studied, M. affine. 23 consumes mainly copepods. They were found in every stomach and constituted 54% of the food consumed, the Euphausiacea accounting for

19.3% of the mass. Of the Copepoda, the dominant forms were Euchaeta marina and two species of Candacia, the relation between which changes as the sizes of the fishes increase: there is a decline in the role of the genus Candacia, and the mass of Euchaeta marina constitutes 70.5% of the mass of all of the copepods.

Table 3. Dependence of the quantitative relation between the Copepoda in the food, expressed in %, on the linear dimensions of the fishes.

1 Пищевые организмы	2 Размеры рыб, мм		
	20,0—30,3	30,0—35,0	35,0—45,0
Euchaeta marina	24,0	43,3	68,1
Candacia curta	16,5	10,5	7,1
C. pachydactyla	23,1	17,9	9,1
	36,4	28,3	15,7
3 Прочие	9*/1	20/1	16/2

Key: 1. Food organisms
2. Sizes of fishes, mm
3. Others
*4. Shown to the left of the diagonal line is the total number of stomachs dissected, to the right of it - the number that were empty.

The differences in the qualitative composition of the food consumed by the males and females are not well defined in all three species. In the females of Myctophum nitidulum the Euphausiacea constitute a mass in the feeding spectrum 2.5 times greater than that of the Amphipoda; in the males this relation equals 1.5. This is explained by the differences in the sizes of the males and females (the latter are larger than the males). The feeding spectra of the males and females of M. asperum and M. affine are almost identical and fully reflect the overall feeding pattern of these species.

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E. V. GREZE

FEEDING OF EPIPELAGIC MYCTOPHIDAE (PISCES) OF THE TROPICAL ATLANTIC

Summary

Each of Myctophidae species studied possesses characteristic features: the Myctiphum nitidulum food consists mainly of euphausiids (53,6% in mass) and amphipods (27.2%), food of M. asperum — of salps (34%), that of M. affine — of copepods (54%). The remaining groups of zooplankton (Siphonophores, Polychaeta, Decapods, Appendiculariae) constitute an insignificant portion of the diet. Food product correlation changes with fish growth, the share of large objects increasing. Males and females of these species do not reveal significant differences in food composition.

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