A C T A I C H T H Y O L O G I C A E T P I S C A T O R I A

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A STUDY ON THE FOOD AND FEEDING HABITS OF *TRACHURUS TRACHURUS, TR.TRECAE, TR.PICTURATUS* AND *CARANX RHONCHUS* IN THE REGION OF CAPE BLANC

BADANIA NAD POKARMEM I ODŻYWIANIEM SIĘ OSTROBOKÓW *TRACHURUS TRACHURUS, TR.TRECAE I TR.PICTURATUS* ORAZ CHROPIKA *CARANX RHONCHUS* W REJONIE CAPE BLANC

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The author reports his study on the changes in the food composition during the growth of fishes in length, the 24-hour rhythm of feeding and the food convergence.

INTRODUCTION

Three species of the genus *Trachurus* mentioned in the title and *Caranx rhonchus*, related to them, coexist in the region of C. Blanc. The feeding of these fishes in the Eastern Atlantic has little been studied hitherto. *Trachurus trachurus*, the most abundant of them, is comparatively best known in this respect. Among other writers, Davies (1957), Demidov and Drakina (1970), Vyskrebencev (1970), Nekrasov (1970), Lipskaja (1972a) and Kompowski and Ślósarczyk (1975) wrote about the feeding of this species in the region of the south-western Africa. As regards the region of waters adjacent to the north western coast of Africa, this problem was dealt with by Aloncle (1964), Semenova (1960), Overko (1964 and 1971), Lipskaja (1972a), Wysokiński (1973a) and Boely, Wysokiński and Elwertowski (1973).

The food of *Trachurus trecae* was investigated by Lipskaja (1972b), Wysokiński (1973) and Boely, Wysokiński and Elwertowski (1973).

Caranx rhonchus was studied in this respect by Wysokiński (1973) and Boely, Wysokiński and Elwertowski (1973).

The least information has been collected about the food of *Trachurus picturatus*, which in all respects is the least-known form of the four species mentioned. This species may soon become of great importance to fisheries on account of its mass occurrence in mid-oceanic shoals in the central-eastern Atlantic (Raźniewski and Wysokiński, 1974). Only Gail (1955) provided some scanty data on the food of this fish caught off the Moroccan coast.

The objective of the present study is to deepen and complete the knowledge of the food and feeding habits of these fishes.

MATERIAL AND METHOD

Fishes for this study were obtained from pelagic trawlings carried out by Polish trawlers in the shelf region of north-western Africa in 1972–1974*. Altogether 52 samples consisting of 1392 specimens were taken in the region extending from C. Blanc to about 25°30′N, further referred to as the region of C. Blanc. The other 3 samples were taken in the region situated near Ifni (Fig. 1). The fishes examined are specified in Table 1.

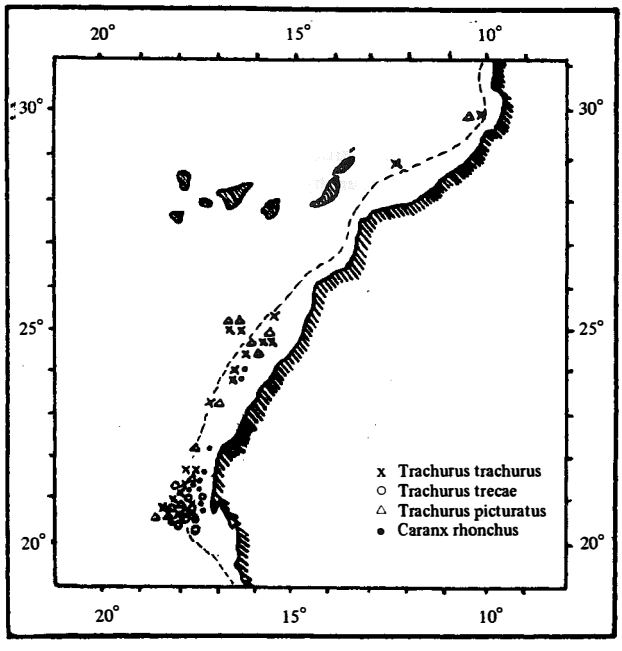

Fig. 1. Places where samples were taken

* I wish to express my heartfelt thanks to the crews of the trawlers and to MrMr B. Habashi, J. Płociak and J. Wojciechowski for help with collecting materials.

Table 1

Number of stomachs examined and their division into "empty" and "filled" ones

Species	Region	No. of stomachs examined	No. of empty stomachs	No. of filled stomachs	Season
Trachurus trachurus	Cap Blanc	665	177	488	I–VI
	Ifni	49	35	14	IX, II
Trachurus picturatus	Cap Blanc	215	110	105	II, III
	Ifni	28	–	28	X
Trachurus trecae	Cap Blanc	193	93	100	VIII, X, I–III,V
Caranx rhonchus	Cap Blanc	244	175	69	I–IV, V
Total	Cap Blanc	1394	590	804	– –

The times of catches are given according to the local time and they concern exclusively the so-called time of effective trawling, i.e. from the moment of the complete running-out of the trawl lines till the commencement of their hauling in.

The fishes examined were measured (l.t.) and weighed after the removal of their entrails. The alimentary tracts were fixed in 4% formaldehyde. Only the contents of the stomachs, sharply distinguished from the remaining parts of the alimentary tract, were analysed. The contents of the intenstines were not examined, as this was aimless on account of their far advanced digestive processes. In addition, the filling of stomachs and the degree of food digestion provide a fairly good picture of the intensity of feeding in the period directly preceding the catch of the fishes. As the measure of stomach filling I adopt the index of stomach filling according to Fortunatova (1964), calculated by the formula

$$\text{index of stomach filling} = \frac{\text{sum. of food mass}}{\text{sum. of fish body mass without entrails}} \cdot 10^4$$

Large numbers of fish scales, 2–7 mm in diameter, were found in many stomachs; they filled the cardia and oesophagus. These scales, probably swallowed when the fishes stayed in the trawl, could not be regarded as food and therefore were not included in the present considerations (Lipskaja, 1972a, and Kompowski and Ślósarczyk, 1975, observed a similar phenomenon).

The stomach contents were sorted under the binocular microscope into particular components, which were next weighed. If a stomach was filled abundantly with fine organisms, the contents were weighed as a whole, the composition of a sample weighing 0.1–0.2 g was examined and next the results were converted into values for the whole amount of the stomach contents.

ENVIRONMENTAL CONDITIONS

The hydrological conditions in the region of C. Blanc are dependent on the cool Canary Current and a warm branch of the Equatorial Countercurrent. The hydrological front at the contact of these two water masses shifts seasonally to the north and to the south. The northernmost range of this front (20–21°N) falls in July and August (Wysokiński, 1973b; León, Braun and Escanez, 1974). Thus, a considerable part of the region discussed is under a permanent influence of the Canary Current. The hydrological conditions of this region are also strongly influenced by the upward movements of water masses (Woźniak, 1969) caused by the north-easterly trade winds blowing along the coast of Africa. Bernikov (1969) distinguishes two hydrological seasons of the year in the region discussed, a cool (December-June) and a warm (July – November). The upwelling and the hydrological front favour a high biological productivity of the region and this attracts fishes, which gather here in large numbers to feed and spawn. A Soviet investigation (Petrova, 1971) showed that the plankton biomass of this region undergoes fluctuations in the annual cycle, being the highest in the warm period. Both over the continental shelf and in the open ocean this period is very favourable for the feeding of fishes. Petrova (op. cit.) and Wiktor (1969) found that copepods make up the dominating group of zooplanktonic organisms occurring right through the year. Larvae of *Branchiostoma lanceolatum,* making an appearance towards the end of the cool period (April) and most abundant from June to August, come in second as regards importance and are followed by the Tunicata (mainly *Thalia democratica*), which appear in spring. The zoea and megalopa larval stages of higher crustaceans as well as the *Mysidacea, Euphausiacea, Amphipoda* and *Chaetognatha* are less numerous. The small number of the *Euphausiacea* during the greater part of the year is characterisitc. Only in March and April it increases intensely and, according to Wiktor (1969), reaches 80 percent of the organisms in a sample.

RESULTS

A. *Trachurus trachurs* – C. Blanc and Ifni regions.

The food of this species is markedly differentiated. The following groups of food were found in the stomachs of fishes: 1. *Copepoda* (*Calanoida* and *Cyclopoida*)*,

* The underlined groups of animals are the basic components of food.

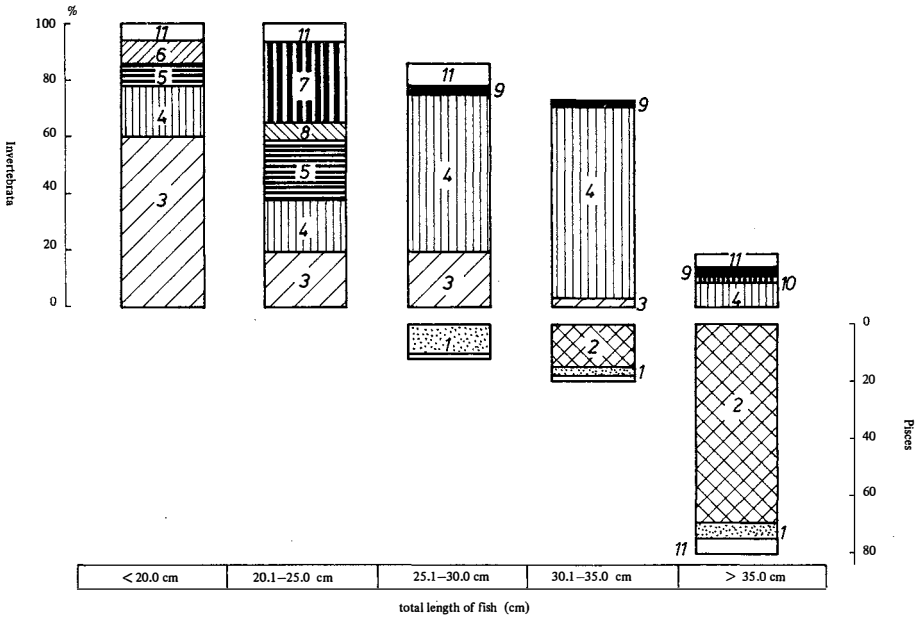

Fig. 2. Changes in the food composition of *Trachurus trachurus* from the C. Blanc region in relation to the fish length. In percentages of stomach contents weight. 1. *Maurolicidae* (*Gonostomidae*), 2. *Myctophidae*, 3. *Copepoda*, 4. *Euphausiacea*, 5. *Isopoda*, 6. *Leptostraca*, 7. *Branchiostoma lanceolatum*, 8. *Mysidacea*, 9. *Cephalopoda*, 10. *Decapoda* (*Macrura natantia*), 11. other organisms

2. *Euphausiacea*, 3. *Mysidacea*, 4. *Decapoda* (*Macrura natantia*), 5. *Malacostraca larvae* (*zoëa, mysis, megalopa, phyllosoma*), 6. *Isopoda*, 7. *Leptostraca* (*Nebalia sp.*), 8. *Cumacea*, 9. *Ostracoda*, 10. *Amphipoda*, 11. *Polychaeta*, 12. *Chaetognatha*, 13. *Cephalopoda*, 14. *Pteropoda*, 15. *Tunicata* (*Salpae* – chiefly *Thalia democratica*), 16. *Branchiostoma lanceolatum*, and 17. *Pisces* (*Maurolicidae, Myctophidae, Carangidae*, undetermined).

The *Copepoda, Euphausiacea* and fishes were the main food components. The diet of *Trachurus trachurus* changed clearly with its body length (Fig. 2). Specimens less than 20 cm in length fed mainly on small copepods, which formed about 60% of the weight of their stomach contents, and the *Euphausiacea* came in second (18%). The food of bigger fishes (20.1–25.0 cm) was more differentiated. In this class of horse mackerel the four most important components were *Branchiostoma lanceolatum* – 26.6%, *Isopoda* – 22.8%, *Copepoda* – 20.7 and *Euphausiacea* – 15.9%. In the next two length classes (25.1–30.0 and 30.1–35.0 cm) the dominant component of food consisted of the *Euphausiacea*, which constituted 57 and 71% of the weight of food, respectively. At the same time fishes begin to appear in the food, chiefly those of the families *Maurolicidae* (*Gonostomidae*) and *Myctophidae*. They become the main component in the horse mackerel over 35 cm in length, in which they form 85% of the weight of stomach

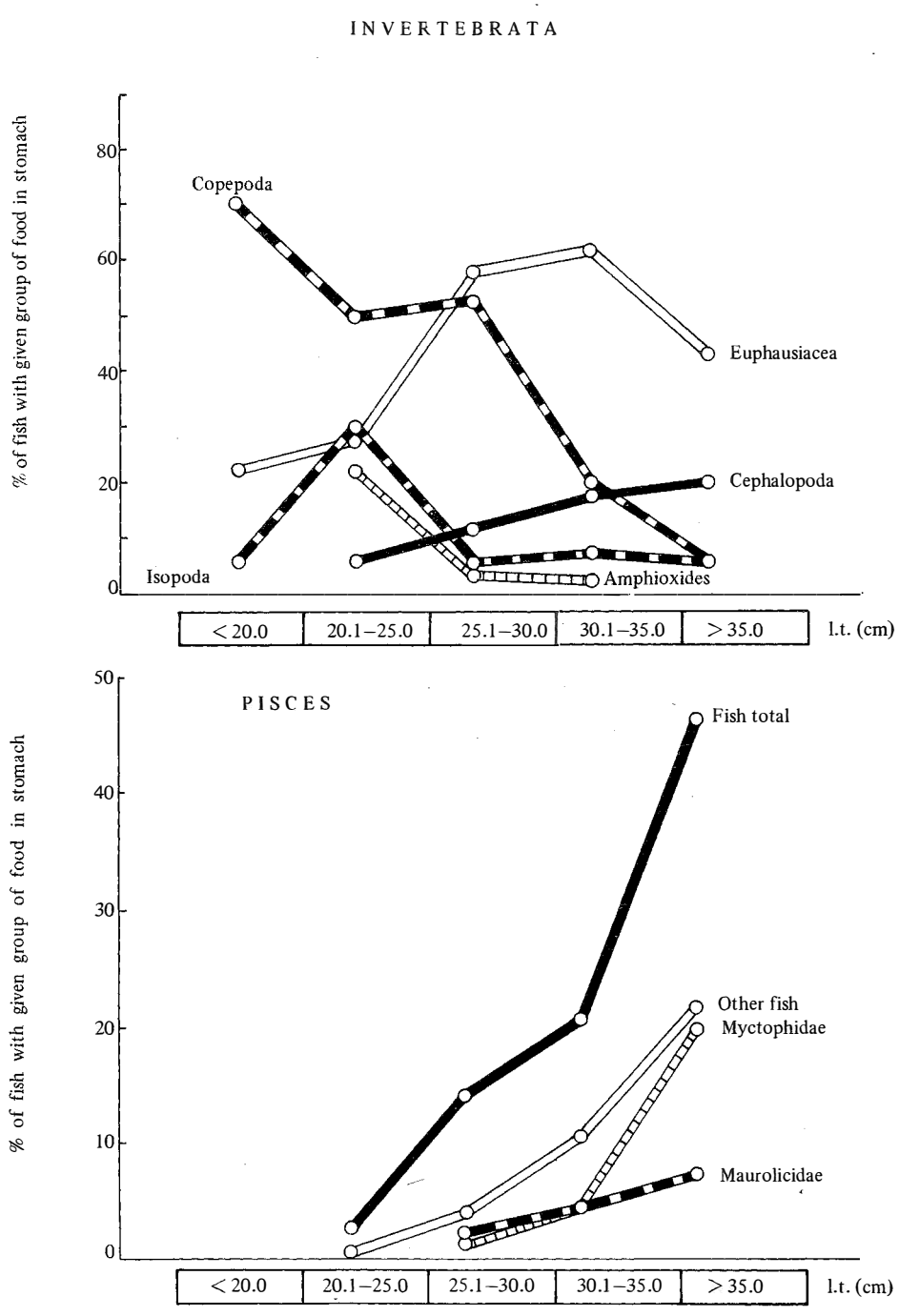

Fig. 3. The occurrence of important food groups in *Trachurus trachurus* of different length in the C. Blanc region

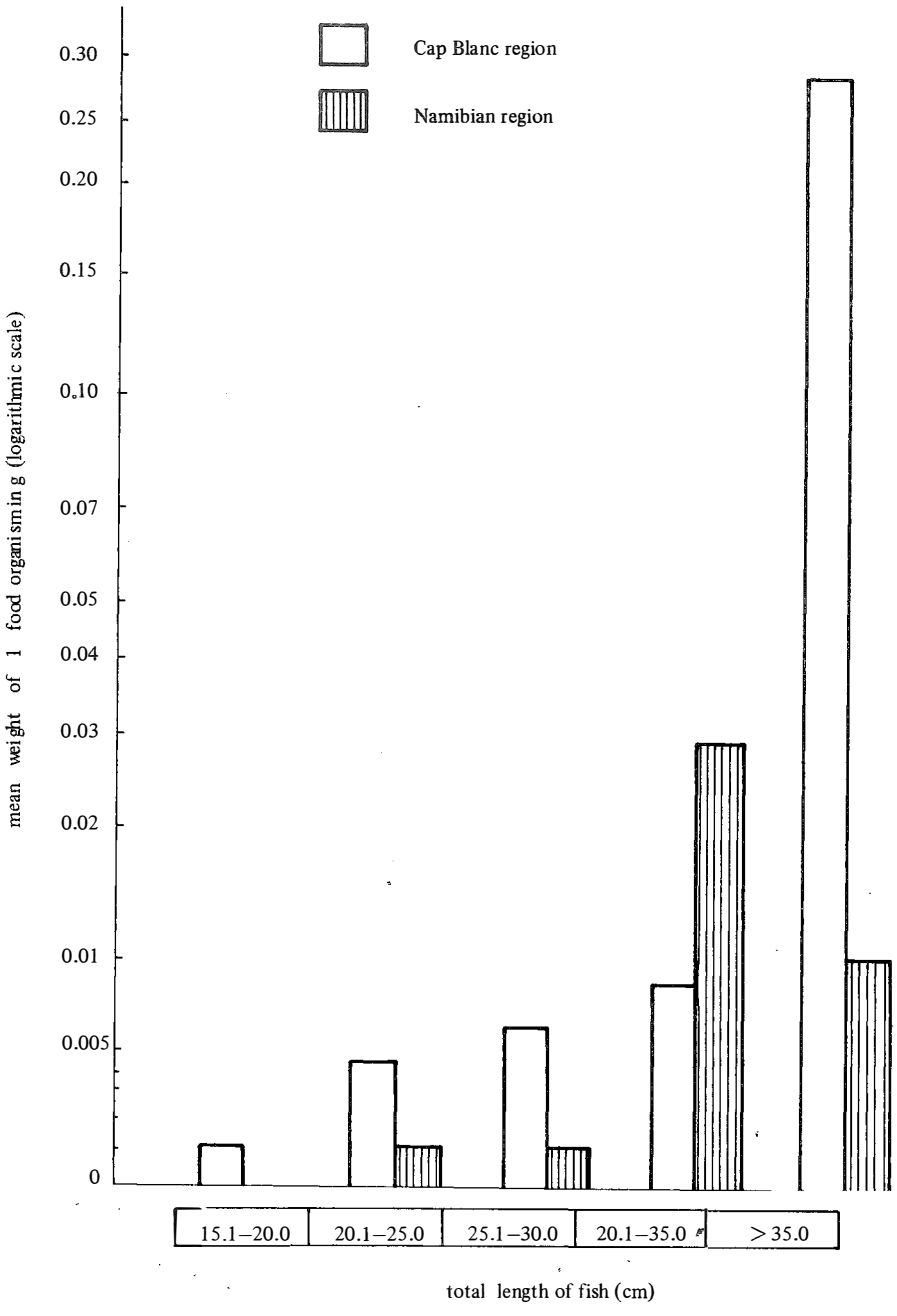

Fig. 4. Mean weight of organisms eaten by *Trachurus trachurus* relative to its length

contents. The other components are big *Euphausiacea* (25–30 mm long), squids and shrimps. The observation of the frequency of particular food groups reveals similar tendencies in them (Fig. 3).

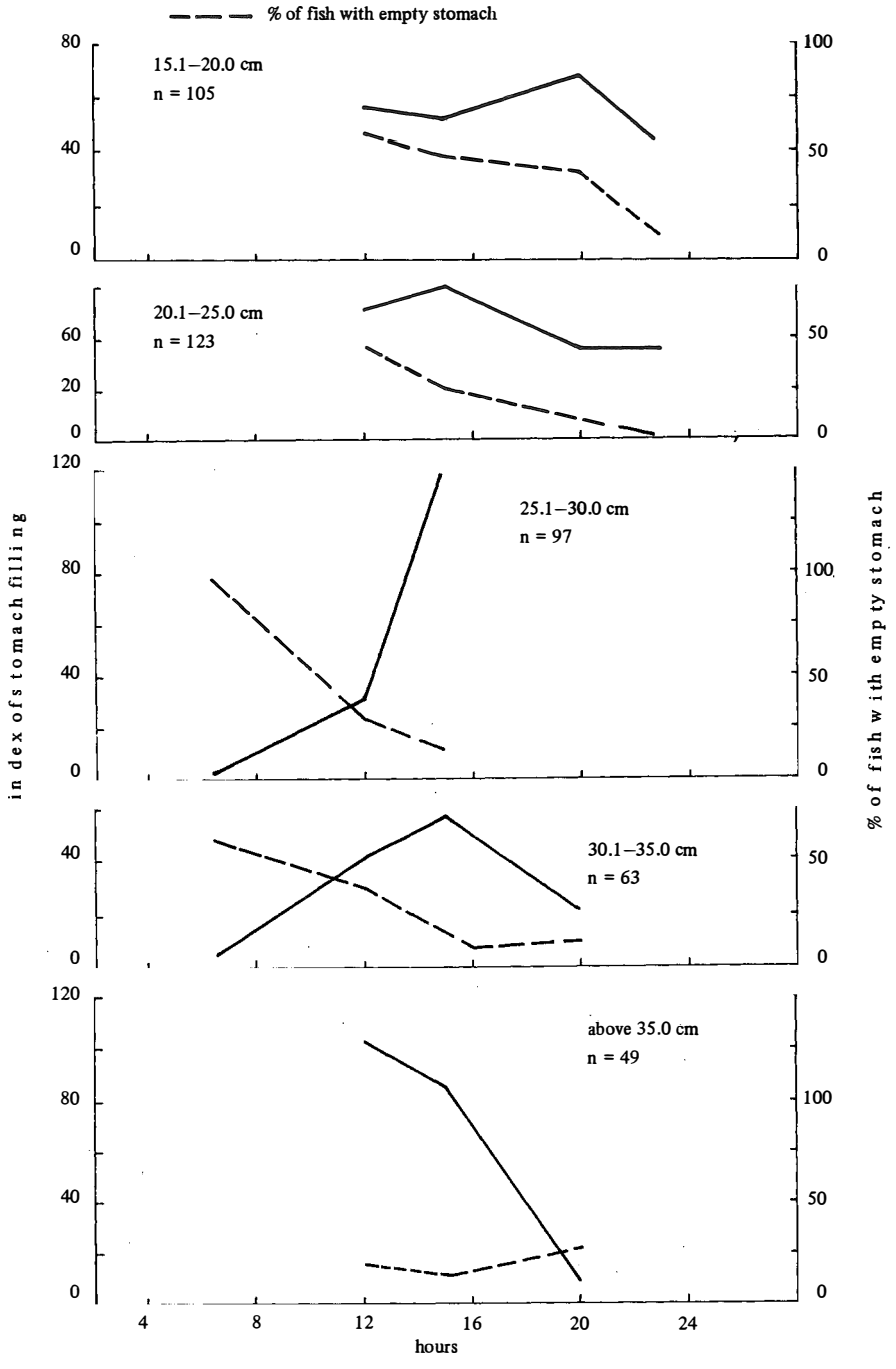

Fig. 5. Feeding intensity of *Trachurus trachurus* in the course of the day in the C. Blanc region in the first three months of 1973

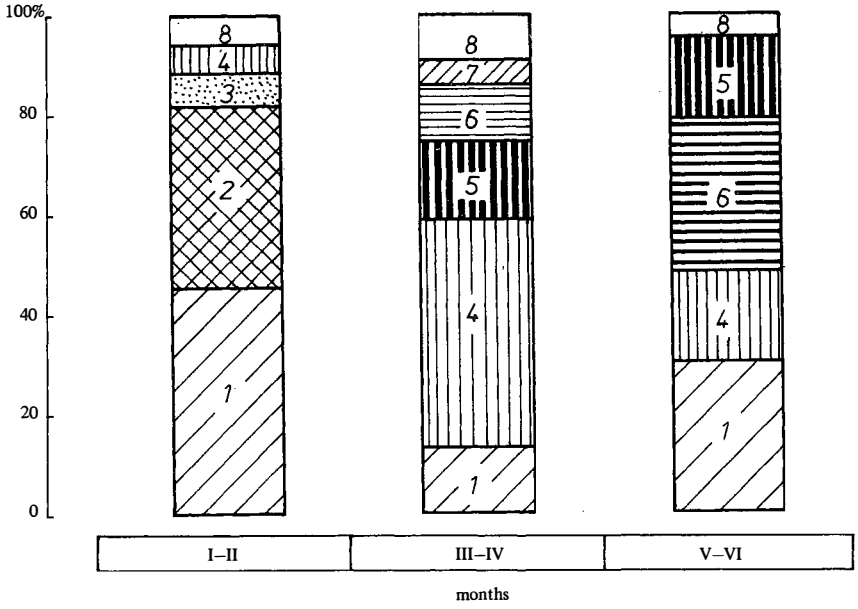

Fig. 6. Food composition of *Trachurus trachurus* in the C. Blanc region in different months. Percentages of stomach contents weight for specimens 20.1–30.Ocm in length. 1. *Copepoda,* 2. *Pisces,* 3. *Malacostraca* larvae, *Euphausiacea,* 5. *Branchiostoma lanceolatum,* 6. *Isopoda,* 7. *Mysidacea,* 8. other organisms

The range of sizes of particular organisms eaten by the horse mackerel was fairly wide. The copepods were 0.5–6.0 mm in length, *Euphausiacea* 6–30 mm, *Mysidacea* about 15 mm, *Leptostraca* 10 mm, isopods 3–10 mm, myctophids 5–12 cm, maurolycids 3–8 cm, Salpae 15–18 mm and cephalopods 3–5 cm. The average size of the organisms which made up the diet of the horse mackerel naturally changed with its length. Their weight grew from about 0.001 g in the specimens 15.1–20.0 cm long to 0.3 g in those above 35 cm in length. It is interesting that in the shelf area of Namibia the horse-mackerel feeds on smaller organisms than in the C. Blanc region (Fig. 4). This may partly be caused by the fact that the horse mackerel from the Namibian region have finer gill rakers (Kompowski 1975).

It has been observed that horse mackerel feed chiefly in the daytime. Most of the specimens caught by night had their stomachs empty or only slightly filled with undigested remains. This is well seen from Fig. 5, which shows that the indices of stomach filling, low in the morning hours, reach the highest values about noon and decrease in the evening. On the other hand, the percentage of non-feeding fishes (with empty stomachs), the highest in the morning, decreases gradually, but nearly all fishes have some amounts of food in their stomachs in the evening, although their average filling is already rather

small at this time. In big horse mackerel (above 25 cm long) the peak of feeding intensity is more distinct than it is in smaller fishes, which still feed intensely in the evening.

Unluckily, the author had not at his disposal the material concerning the full annual cycle, but even in a half-year period (January – June) it was possible to observe the seasonal changes in the food composition. They are given in Fig. 6 only for horse mackerel 20.1–30.0 cm in length, which occurred most numerously in the material. In January and February they chiefly ate copepods (46.2% of the weight of stomach contents). This component was found in 87.7% of specimens with filled stomachs. Fishes of the families *Maurolicidae* and *Myctophidae* came in second (35.8%). In March and April the copepods formed only 13% of the weight of stomach contents, but they still occurred in 42.1% of filled stomachs. The *Euphausiacea* made up the main portion of the food in this period (45.6% with a frequency of 53.2%). *Branchiostoma lanceolatum* and isopods were also present (15.5% and 11.9%, respectively). In May and June the share of *Euphausiacea* fell to 18.2% and the bulk of food consisted of copepods (31%) and isopods (30%).

The Ifni region is represented in the author's materials by two samples only, taken in November 1972 and February 1973 and consisting of 48 fishes altogether, 22.5–42.5 cm long, most of which unfortunately had their stomachs empty. Remains of unidentified crustaceans were found in 6 out of the 14 filled stomachs, fish remains in 6, *Euphausiacea* in 3, and *Calanoida* and larval decapods in 1.

B. *Trachurus trecae* – C. Blanc region.

The following food groups were found in the stomachs of the fishes examined: 1. *Copepoda,* 2. *Euphausiacea**, 3. *Mysidacea,* 4. *Malacostraca larvae* (*mysis, zoëa, megalopa*), 5. *Cephalopoda,* 6. *Salpae,* and 7. *Pisces* (*Trichiuridae, Merluccius sp.,* undetermined).

The *Euphausiacea* made up the basic component of the food and were mainly taken by fishes 16–30 cm long. Copepods formed a low percentage of the stomach contents. Presumably, however, the role that copepods play in the diet of *Trachurus trecae* is no less important than their role in the diet of *Trachurus trachurus.* Soviet studies (Lipskaja, 1972b) showed that in the region of Cape Palmas (Gulf of Guinea) and also in the shelf region of Namibia *Trachurus trecae* feeds chiefly on copepods. It should also be mentioned that most of the specimens examined in the present study were caught in March and so in the period when the *Euphausiacea* dominate in the plankton. The bigger horse mackerel, more than 30 cm in length, mainly ate small fishes (up to 35 mm long), squids and salpae (Figs. 7 and 8).

Trachurus trecae, like *Trachurus trachurus,* feeds mostly in the daytime. The mean index of stomach filling of the fishes caught from 11.15 p.m. till 7.25 a.m. was 6.88 and therefore very low. On the other hand, the value of this index for the fishes caught between 9.45 a.m. and 1.50 p.m. was 95.00. The percentage of fishes which had their stomachs empty was 70.9 by night and fell down to zero in the daytime (Table 2).

* The underlined groups of animals are the basic food components.

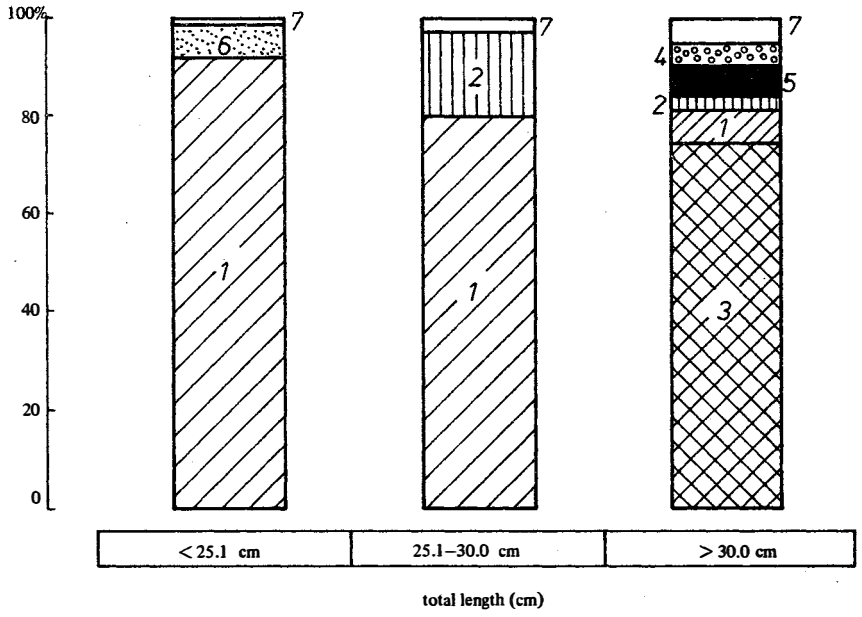

Fig. 7. Food composition of *Trachurus trecae* from the C. Blanc region relative to the fish length. In percentages of stomach contents weight. 1. *Euphausiacea*, 2. *Copepoda*, 3. *Pisces*, 4. *Tunicata*, 5. *Cephalopoda*, 6. *Pisces* larvae et juvenales, 7. other organisms

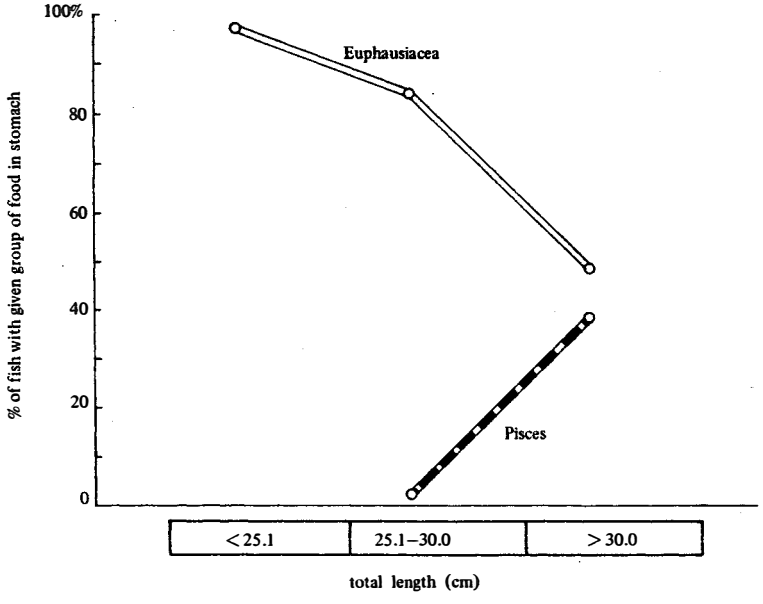

Fig. 8. The occurrence of important food groups in *Trachurus trecae* of different length in the C. Blanc region

Table 2

Feeding intensity of *Trachurus trecae* relative to time of day

Time of day acc. to local time	No. of stomachs examined	No. of:		Mean index of stomach filling	Range of length (l.t.) in fishes examined (cm)
		empty stomachs	filled stomachs		
$23^{15}-7^{25}$	55	39 (70.9%)	16 (29.1%)	6.88	14.1–35.5
$9^{45}-13^{50}$	43	– –	43 (100%)	95.00	17.1–31.4

C. *Trachurus picturatus* – C. Blanc and Ifni regions.

The list of the groups of organisms observed in the diet of this species includes: 1. *Copepoda**, 2. *Euphausiacea*, 3. *Malacostraca larvae* (zoëa, mysis, megalopa, phyllosoma), 4. *Isopoda*, 5. *Decapoda* (*Macrura natantia*), 6. *Ostracoda*, 7. *Amphipoda*, 8. *Cephalopoda*, 9. *Tunicata* (*Pyrosoma, Salpae*), 10. Pisces (*Maurolicidae, Myctophidae, Trichiurus sp.*, and others), and 11. fish eggs.

As can be seen from Figs. 9 and 10, copepods, larval malacostracans, euphausiaceans, cephalopods and fishes were the basic components of the diet of this species. The fishes less than 25 cm in length fed chiefly on copepods (71.3% of the weight of stomach contents) and malacostracan larvae (25%). The diet of specimens in the length class from 25.1 to 30.0 cm was more differentiated. It was composed of euphausiaceans (34.3% of the stomach contents weight), fishes, chiefly maurolicids and myctophids (33.9%), decapods (7.4%), copepods (8.1%) and malacostracan larvae (7.2%). The bigger *Trachurus picturatus*, exceeding 30 cm in length, mostly took squids, which were present in all the filled stomachs of fishes in this length class and formed 68% of the stomach contents weight. Their diet included, in addition, tunicates (*Salpae* and *Pyrosoma sp.*), which occurred in 85% of the filled stomachs but formed only 13% of their contents, big euphausiaceans (20–30 mm), which constituted 7.8% of the contents, and isopods. The data concerning this length class are little reliable on account of the small number of stomachs examined. Fishes probably form a remarkable proportion of the food of big *Trachurus picturatus*, as may be judged from the food composition of this species in the region of Ifni.

In Trachurus picturatus the intensity changes in the 24-hour feeding cycle were not as distinct as they were in the previous species (Table 3). The percentage of empty stomachs decreased during the daytime and, as in *Trachurus trachurus*, was the lowest in the evening. However, the filling of stomachs did not reach the highest values at noon but in the evening. Thus, the 24-hour feeding rhythm in this case is similar to that in the low length classes of *Trachurus trachurus*. This may be due to the fact that the length of the

* The underlined groups of animals are the basic food components.

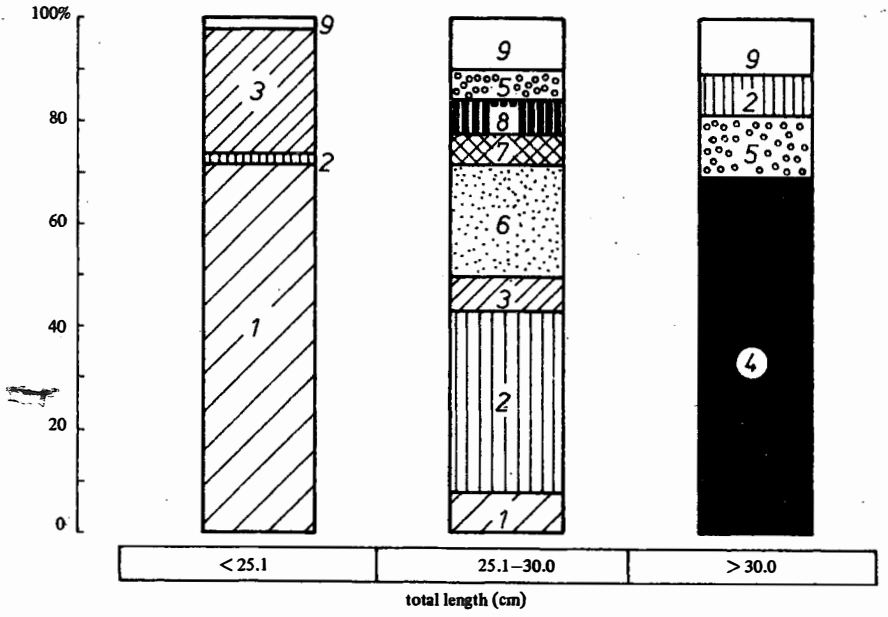

Fig. 9. Food composition of *Trachurus picturatus* from the C. Blanc region relative to the fish length. In percentages of stomach contents weight. 1. *Copepoda*, 2. *Euphausiacea*, 3. *Decapoda* larvae. 4. *Cephalopoda*, 5. *Tunicata*, 6. *Maurolicidae* (*Gonostomidae*), 7. *Myctophidae, Decapoda*, 9. other organisms

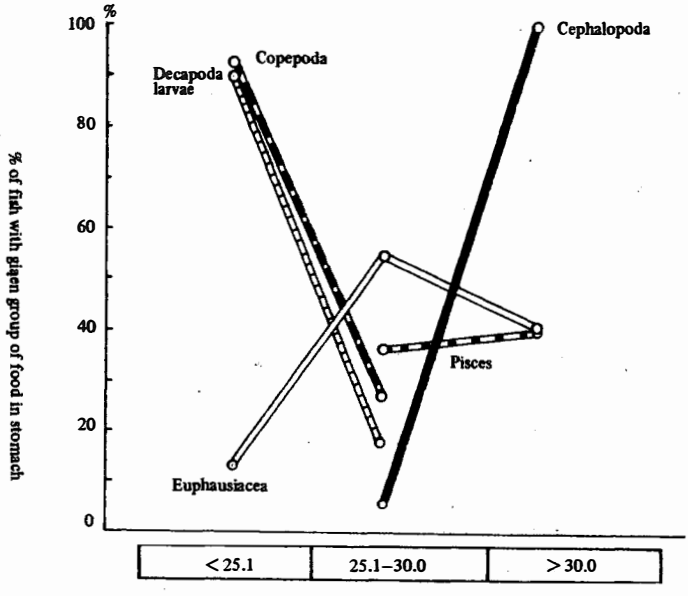

Fig. 10. The occurrence of important food groups in *Trachurus picturatus* of different length in the C. Blanc region

Table 3

Feeding intensity of *Trachurus picturatus* relative to time of day

Time of day acc. to local time	No. of stomachs examined	No. of:		Mean index of stomach filling	Range of length (l.t.) in fishes examined (cm)
		empty stomachs	filled stomachs		
4^{00}–9^{00}	35	26 (74.2%)	9 (25.8%)	19.75	22.0–27.3
10^{00}–13^{00}	40	33 (82.5%)	7 (17.5%)	15.67	23.6–26.9
13^{00}–17^{00}	90	50 (55.6%)	40 (44.4%)	78.82	19.9–32.0
17^{00}–21^{00}	47	2 (4.3%)	45 (95.7%)	106.77	20.0–35.6

specimens of *Trachurus picturatus* examined was also rather small and did not generally exceed 25 cm.

The only sample taken in the Ifni region, on 12 October 1972, consisted of big fishes, 31-45.5 cm in length (Table 4). Their stomachs contained almost exclusively fishes (*Maurolicus muelleri*), 3–8 cm long, or their remains. In addition to fishes, several isopods were found in three stomachs. The smallest specimens of this sample (31–35 cm) had their stomachs poorly filled and then with remains of fishes only, their index of filling being 8.6, whereas in the stomachs of the large horse mackerel (35.1–45.5 cm) there were fishes, which were slightly digested, and the high index of stomach filling averaged 170.16.

D. *Caranx rhonchus* – Cape Blanc region.

The groups of organisms distinguished in its food are as follows: 1. *Euphausiacea**, 2. *Mysidacea*, 3. *Isopoda*, 4. *Malacostraca larvae* (*megalopa*), 5. *Pisces larvae et juv.*, 6. *Pisces* (*Maurolicus muelleri*, *Carangidae*), 7. *Branchiostoma lanceolatum*, and 8. *Tunicata*.

Branchiostoma lanceolatum, euphausiaceans and fishes were the main components of the food of *Caranx rhonchus*. It was striking that the diet included no copepods, which occurred to a various degree in the food of the species discussed above. This might be explained by the fact that the material analysed contained no specimens less than 23 cm in length, because no such fishes had been caught. However, neither did Wysokiński (1973) find any copepods, although he studied the food of still smaller specimens of *Caranx rhonchus* (from 18 cm upward).

The stomachs of fishes 23–30 cm long contained chiefly *Branchiostoma lanceolatum* – 68.3% of the stomach contents weight. The rest consisted of isopods (11%), small fishes and their larvae, and *Mysidacea*. Larger fishes (30.1–35 cm) fed nearly exclusively

* The underlined groups of animals are the basic food components.

Table 4

Food of *Trachurus picturatus* in Ifni region

Length, l.t. (cm)	No. of fishes examined	Mean index of stomach filling	Components (%)							Total
			Maurolicus muelleri		Other fishes		Fish remains		Other components	
			Percentage of weight	Frequency of occurrence	Percentage of weight	Frequency of occurrence	Percentage of weight	Frequency of occurrence	Frequency of occurrence	Percentage of weight
31.0–35.0	6	8.6	–	–	–	–	100.0	100.0	–	100.0
35.1–45.5	22	170.16	87.7	77.3	8.6	9.1	3.7	31.8	13.6	100.0
Total	28	151.08	86.8	60.7	8.5	7.1	4.7	46.4	10.7	100.0

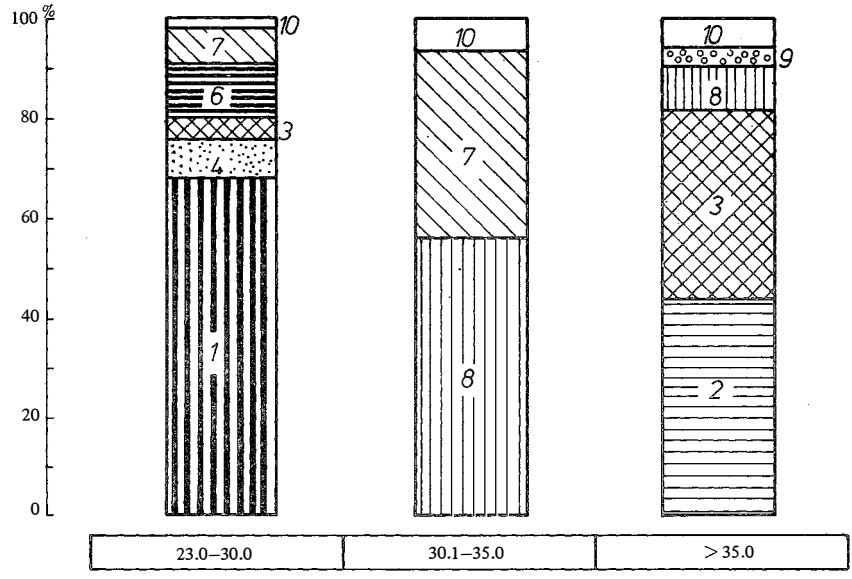

Fig. 11. Food composition of *Caranx rhonchus* from the C. Blanc region relative to the fish length. In percentages of stomach contents weight. 1. *Branchiostoma lanceolatum*, 2. *Maurolicus mulleri*, 3. *Carangidae*, 4. various fishes, 6. *Isopoda*, 7. *Mysidacea*, 8. *Euphausiacea*, 9. *Tunicata*, 10. other organisms

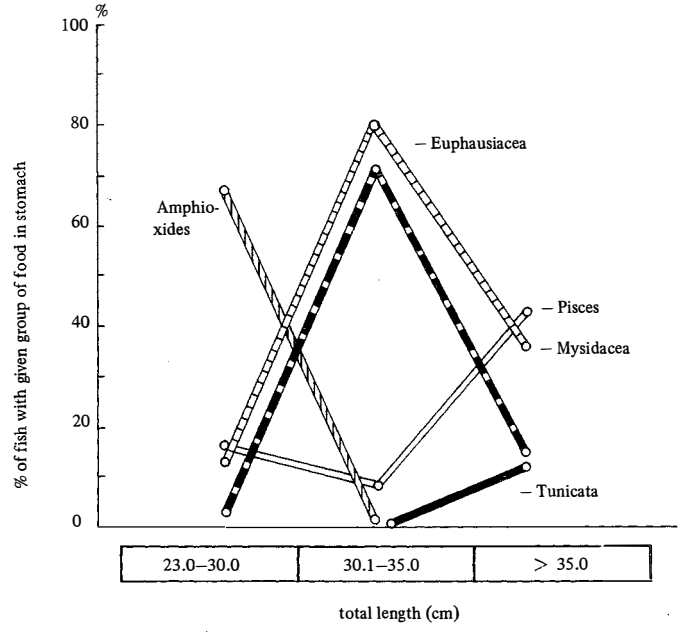

Fig. 12. The occurrence of important food groups in *Caranx rhonchus* of different length in the C. Blanc region

on the *Euphausiacea* (56.5%) and *Mysidacea* (37.6%). The largest specimens of *Caranx rhonchus,* 35.1–54.5 cm long, took chiefly fishes of the families *Maurolicidae* (44.5%) and *Carangidae* (33.7%) and big euphausiaceans, 25–30 mm long (8.7% – Fig. 11). The changes in the frequency of particular food components occurring as *Caranx rhonchus* grows in length (Fig. 12) provide a picture similar to that of the changes in the stomach contents composition expressed in percentages of weight. Wysokiński (1973) observed strikingly similar changes in the mode of feeding occurring with the growth of *Caranx rhonchus.* In his opinion, this species is considerably more predatory than are the species of the genus *Trachurus*.

The 24-hour rhythm of feeding of *Caranx rhonchus* was very conspicuous (Table 5). In the night, i.e. between 10 p.m. and 7 a.m. the fishes did not feed at all. Some strongly digested remains were found only in very few stomachs. The mean index of stomach filling was as low as 1.3. At noon (11 a.m. – 2 p.m.) the fishes fed most intensely, 97% of stomachs were filled with food and the mean index of stomach filling reached a very high value of 168,7.

Table 5

Feeding intensity of *Caranx rhonchus* relative to time of day

Time of day acc. to local time	No. of stomachs examined	No. of:		Mean index stomach filling	Range of length (l.t.) in fishes examined (cm)
		empty stomachs	filled stomachs		
$22^{00}-7^{00}$	160	152 (95.0%)	8 (5.0%)	1.32	22.3–44.5
$11^{00}-14^{00}$	33	1 (3.0%)	32 (97.0%)	168.65	30.0–54.55
$19^{30}-20^{30}$	49	23 (46.9%)	26 (53.1%)	40.84	22.9–29.9

DISCUSSION

The lists of organisms eaten by the species under study in the shelf region of north-western Africa can be extended on the basis of the data obtained by other investigators. For example, in this shelf region *Trachurus trachurus* consumes, in addition to the animals recorded by us, ctenophorans, phytoplankton and, as regards fishes, *Engraulis hepsetus, Pellonula vorax,* and *Triglidae* (Overko, 1971). *Trachurus trecae* feeds also on siphonophores, chaetognatha, algae, engraulids, amphipods, ostracods, oikopleurans, polychaetes, molluscs and rhizopods (Semenova, 1960; Lipskaja, 1972b; Boely et al., 1973). The following forms were besides met with in the food of *Caranx rhonchus: Engraulis sp., Scomber colias, Brachydeuterus, Sardinella* and cephalopods (Wysokiński, 1973a).

The results presented in this paper clearly show great resemblance between the diet of the three above-discussed species of the genus *Trachurus.* Younger specimens (up to

30 cm long) are typical zooplanktonphages. At first they feed on microplankton, chiefly copepods and larvae of higher crustaceans, and next change their diet, which now consists of mesoplankton: euphausiaceans, fish larvae, mysidaceans and salpae. Occasionally they also take *Branchiostoma lanceolatum*. The older specimens, above 30 cm in length, eat macroplankton, i.e. big euphausiaceans, and nekton – chiefly fishes and, to a smaller degree, cephalopods.

The feeding of *Caranx rhonchus* differs from that of the three previous species mainly in the absence of copepods from the diet of its even relatively small specimens (18–22 cm) and in its earlier changing of its diet for ichthyofauna. It is hard to decide now whether the absence of copepods from the food of *Caranx rhonchus* was due to its avoiding these crustaceans (food preference) or whether it resulted from the stay of these fishes in the regions of the African shelf or in water layers where copepods did not occur (availability).

The food concurrence of these species is remarkable and particularly well seen in the fishes feeding in the same place (Fig. 13).

The seasonal changes in feeding, which can be observed in *Trachurus trachurus*, in a great measure reflect the seasonal changes in the zooplankton composition. For example, copepods, which are a constant constituent of the zooplankton, occur also

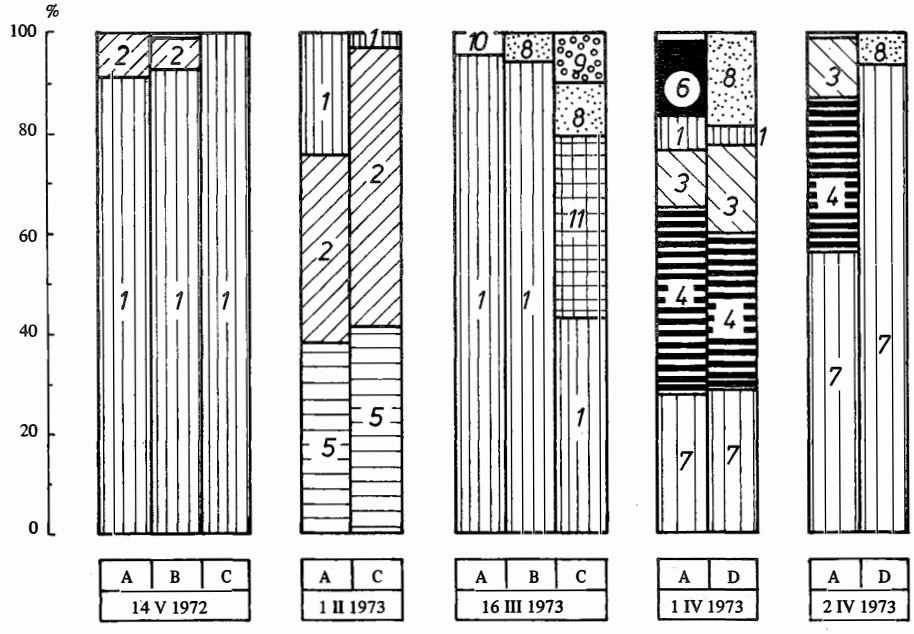

Fig. 13. Food concurrence of different species of *Trachurus* and *Caranx rhonchus* derived from the same houls in the C. Blanc region. In percentages of stomach contents weight. A – *Trachurus trachurus*, B – *Trachurs trecae*, C – *Trachurs picturatus*, D – *Caranx rhonchus*. Components: 1. *Euphausiacea*, 2. *Copepoda*, 3. *Mysidacea*, 4. *Isopoda*, 5. *Malacostraca* larvae, 6. *Leptostraca*, 7. *Branchiostoma lanceolatum*, 8. *Pisces*, 9. *Salpae*, 10. other organisms, 11. unidentified

constantly in the food of this fish. The largest numbers of euphausiaceans are observed in its food in March and April, i.e. in the period of mass occurrence of these crustaceans in the region of C. Blanc. The adult lancelet, which is a typical benthic form, also appears in a large number at that time. However, this does not mean that then the horse mackerel becomes a benthophage. Presumably, this is the time of the migration of the lancelet to the depths of the ocean connected with reproduction, which is evidenced by the mass occurrence of the larvae of these animals in the composition of the plankton starting from April, as has already been mentioned in the description of the environment. At that time the lancelet occurs also in the diet of *Caranx rhonchus*, being very often accompanied by isopods. In May and June, after the period of the greatest abundance of euphausiaceans, their proportion in the food also decreases. Now the diet is made up chiefly of copepods, isopods and lancelets.

The existence of food preference in these fish species is probable. For instance, although tunicates (*Thalia democratica*) abound in the plankton, they play a slight role in the diet of the horse mackerel, while, on the contrary, they are an important component of the diet of another pelagic fish living in this region, *Scomber colias* – (Habashi and Wojciechowski, 1973). The phenomenon of food preference was also observed by Carlisle (1971) in the Pacific horse mackerel *Trachurus symmetricus*. On the other hand, Overko (1971) claims that *Trachurus trachurus* shows no distinct food preference and feeds on available organisms which prevail in the regions of their occurrence.

All the four species show a distinct 24-hour rhythm of feeding. They feed chiefly in the daytime, and hardly ever by night. Judging by *Trachurus trachurus*, which has been studied most closely, this rhythm is marked most distinctly in larger fishes, which feed on nekton. In smaller fishes, whose diet consists mainly of microplankton, there is no distinct single peak of feeding activity in the afternoon. These fishes have probably several peaks of activity. Lipskaja, (1972a) observed such a situation just in small-sized horse mackerel feeding on copepods. A confirmation of the 24-hour course of feeding activity described above can be found in the observations made by Lipskaja, (op.cit.), Demidov and Drakina (1970), Vyskrebencev (1970), Overko (1964) and Kompowski and Ślósarczyk (1976). According to Boely et al. (1973), only *Caranx rhonchus* feeds in the daytime, whereas *Trachurus trachurus* and *Trachurus trecae* take their food chiefly by night.

The concurrence of food between the four species described and some other fishes is the most conspicuous in the case of *Scomber colias*. It may be stated on the basis of the studies carried out by Semenova (1960) and Habashi and Wojciechowski (1973) and a comparison of these studies with the present results that euphausiaceans, copepods, *Branchiostoma lanceolatum* and *Maurolicus muelleri* are common important components of the food of the above-mentioned fishes. They also show a food concurrence with *Sardinella aurita*, which feeds, in a great measure, on euphausiaceans and copepods (Semenova, 1960; Pham Thuoc and Szypuła, 1973). The food concurrence can also be observed, though to a lower degree, between the horse mackerel and some other fishes, e.g. *Pagellus coupei* (Lê-trong Phân and Kompowski, 1972) and *Trichiurus lepturus* (Wojciechowski 1972), which at least in certain periods of life, take euphausiaceans or *Branchiostoma lanceolatum*.

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BADANIA NAD POKARMEM I ODŻYWIANIEM SIĘ OSTROBOKÓW *TRACHURUS TRACHURUS, T. TRECAE* I *T. PICTURATUS* ORAZ CHROPIKA – *CARANX RHONCHUS* W REJONIE CAPE BLANC

Streszczenie

Zbadano treść żołądków 1392 ryb złowionych na szelfie pn.-zach. Afryki w latach 1972–1974 (tab. 1, rys. 1).

Głównymi składnikami pokarmu *Trachurus trachurus* były *Copepoda, Euphausiacea* i ryby *Maurolicidae, Myctophidae, Carangidae*). Wraz ze wzrostem długości ciała dominujące komponenty pokarmowe zmieniały się w sposób następujący: *Copepoda, Euphausiacea* i ryby (rys. 2 i 3). *Trachurus trachurus* z wód szelfu Afryki północno-zachodniej odżywia się większymi organizmami pokarmowymi niż *Trachurus trachurus* z szelfu Afryki pd.-zach. (rys. 4). Żerowanie odbywa się głównie w dzień, z maksimum intensywności przypadającym u ryb starszych w godzinach południowych. U ryb mniejszych nie ma wyraźnego maksimum lub jest ich kilka (rys. 5). Sezonowe zmiany w składzie pokarmu (rys. 6) są odbiciem sezonowych zmian w składzie zooplanktonu.

Trachurus trecae odżywiał się głównie drobnymi *Euphausiacea* (mniejsze osobniki) lub rybami, głowonogami i dużymi *Euphausiacea* (osobniki większe) – rys. 7 i 8. Dobowy rytm żerowania był podobny jak u *Trachurus trachurus.* (tab. 2).

W miarę wzrostu długości *Trachurus picturatus,* głównymi komponentami pokarmu tego gatunku są kolejno: *Copepoda* i larwy *Malacostraca*; *Euphausiacea* i drobne ryby (*Maurolicidae* i *Myctophidae*); *Cephalopoda* i ryby (rys. 9 i 10, tab. 4). Dobowy rytm żerowania u tego gatunku jest podobny do dobowego rytmu żerowania *Trachurus trachurus* z niższych klas długości (tab. 3).

Caranx rhonchus odżywia się większymi organizmami, niż poprzednio omawiane gatunki. Brak w pokarmie *Copepoda.* W miarę wzrostu długości głównymi komponentami stają się kolejno następujące organizmy: *Branchiostoma lanceolatum* i larwy ryb; *Euphausiacea* i *Mysidacea;* ryby (*Maurolicidae* i *Carangidae*) – rys. 11 i 12. Dobowy rytm żerowania jest u chropika bardzo wyraźny. Maksimum intensywności żerowania przypada na godziny południowe (tab. 5).

Istnieje bardzo duże podobieństwo w odżywianiu się trzech omawianych gatunków z rodzaju *Trachurus*. Zbieżność pokarmowa między nimi jest duża i szczególnie wyraźna u ryb złowionych w tym samym miejscu (rys. 13). Stwierdzono także pewną zbieżność pokarmową omawianych gatunków ryb ze *Scomber colias, Sardinella aurita* oraz *Pagellus coupei* i *Trichiurus lepturus*.

Nikłe występowanie *Tunicata* w pokarmie wszystkich czterech omawianych gatunków w zestawieniu z obfitym występowaniem tej grupy zwierząt w planktonie oraz w pokarmie *Scomber colias* świadczy o istnieniu wybiórczości pokarmowej u tych gatunków.

А. Комповски

ИССЛЕДОВАНИЯ КОРМА И ПИТАНИЯ СТАВРИД TRACHURUS TRACHURUS, TRACHURUS TRECAE, TRACHURUS PICTURATUS И CARANX RHONCHUS В РАЙОНЕ КАП-БЛАН

Р е з ю м е

Исследовали содержание желудков 1392 рыб, выловленных в районе шельфа Северо-Западной Африки в 1972–1974 гг. (табл. I, рис. I).

Главными кормовыми компонентами Trachurus trachurus были Copepoda, Euphausiacea и рыбы Maurolicidae, Myctophidae, Carangidae . Одновременно с увеличением длины тела преобладающие кормовые компоненты изменялись следующим образом: Copepoda, Euphausiacea и рыбы (рис. 2 и 3). Trachurus trachurus на шельфе Сев.-Зап. Африки питается более крупными кормовыми организмами, чем Trachurus trachurus на шельфе Юго-Западной Африки (рис. 4). Рыба питается главным образом днём, максимум наблюдается в полуденное время у рыб старшего возраста. У меньших рыб нет отчётливого максимума или же есть их несколько (рис. 5). Сезонные изменения в составе корма (рис. 6) являются отражением сезонных изменений в составе зоопланктона.

Trachurus trecae питался преимущественно мелкими Euphausiacea или рыбами, головоногими и крупными Euphausiacea (рис. 7 и 8). Суточный ритм питания был таким же, как у Trachurus trachurus (табл. 2).

По мере роста длины Trachurus picturatus главными компонентами корма этого вида становились последовательно: Copepoda и личинки Malacostraca; Euphausiacea и мелкие рыбы (Maurolicidae и Myctophidae); Cephalopoda и рыбы (рис. 9 и 10, табл. 4). Суточный ритм питания этого вида является подобным суточному ритму питания из низких размерных групп (табл. 3).

Caranx rhonchus питается более крупными организмами, чем рассмотренные выше виды. Отсутствовала в корме Copepoda . По мере увеличения длины главными компонентами корма становятся следующие организмы: Branchiostoma lanceolatum и личинки рыб; Euphausiacea и Mysidacea; рыбы (Maurolicidae и Carangidae), рис. 11 и 12. Суточный ритм питания Caranx rhonchus является довольно отчётливым. Максимум интенсивности питания приходится на полуденные часы (табл. 5).

Существует весьма большое сходство в питании трёх рассматриваемых видов рода Trachurus. Кормовое сходство между ними является большим и особенно отчётливым у рыб, выловленных в том же самом месте (рис. 13). Установлено также некоторое кормовое сходство рассматриваемых видов рыб с Scomber colias, Sardinella aurita, а также Pagellus coupei и Trichiurus lepturus.

Небольшое количество Tunicata в корме всех четырёх рассматриваемых видов в сопоставлении с обилем этой группы животных в планктоне и в корме Scomber colias свидетельствует о существовании кормовой селективности у этих видов.

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