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Studies on food organisms of pelagic fishes as revealed by the 1979 North Atlantic Eel Expedition

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ABSTRACT: The extent to which pelagic fishes occurring in the Sargasso Sea and adjacent parts of the Atlantic prey on leptocephali (Anguilliformes) was investigated. Most of the fishes examined (c. 95 %) were collected using a commercial pelagical trawl. The stomach contents of about 1000 fishes (25 species of 10 families), mostly belonging to the suborders Myctophoidei, Stomiatoidei and the order Anguilliformes, were examined. The remains of invertebrates, mainly crustaceans, molluscs, tunicates, chaetognaths, and siphonophores were found in 28.8 % of the stomachs. Fishes, mostly myctophids or fish remains, were observed in 11.2 % of the stomachs; 18.7 % contained unidentified items and 40.6 % were empty. Leptocephali (*Ariosoma* spp. and *Gnathophis* sp.) were found in the alimentary tract of 0.5 % of the fishes examined, exclusively represented by the myctophid, *Ceratoscopelus warmingii*. This report indicates that the Sargasso Sea population of *Anguilla* leptocephali, economically the most important eel, is not seriously affected by predation of oceanic fish species considered in this study.

INTRODUCTION

The literature available contains few data concerning predation by fishes on leptocephali (Petersen, 1905; Schmidt, 1932; Marshall, 1957; Haedrich & Nielsen, 1966; Matsui et al., 1970; Matthews et al., 1977; Borodulina, 1981). Leptocephali were found, among other organisms, in the stomachs of various fishes. There has definitely been no report on the extent to which leptocephali are eaten by fishes in the Sargasso Sea, the birthplace of the European and American eel, where these larvae are most abundant. Such investigations might provide some data on the possible influence of fishes as predators on the leptocephali populations in the Sargasso Sea before they migrate either to the European or to the American continent.

The following contribution provides some information on this question. An opportunity to conduct this study was given during an expedition to the Sargasso Sea in 1979. A considerable collection of fishes, caught with a commercial midwater trawl, was available for examination (Post & Tesch, 1982).

MATERIALS AND METHODS

The fish examined were collected during the 1979 Eel Expedition by the German research vessel "Anton Dohrn". The fishing area in the Sargasso Sea and the route to the

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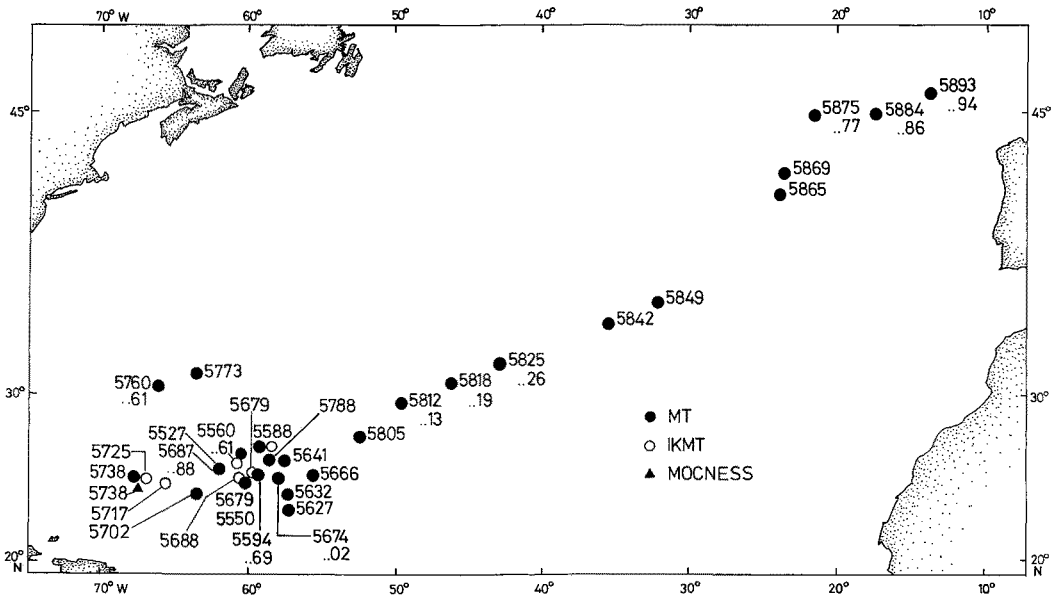

Fig. 1. Position of the hauls during the expedition to the Sargasso Sea and adjacent waters

European continent, as well as the station positions (Tesch, 1982) at which the fishes were collected are shown in Figure 1.

Most of the fish (95 %) were collected at depths of 0 to 2000 m using a commercial midwater trawl (MT) with 1600 front meshes and an inlet of 4 mm mesh at the cod end (Post & Tesch, 1982). The rest were caught in an IKMT net at depths from 0 to 150 m and in a MOCNESS from 0 to 500 m (Schoth & Tesch, 1982).

Most hauls (77 %) were made from the late afternoon until night; the others were daytime hauls. Approximately 22 % of the fish collected were examined on board shortly after the hauls. The other 78 % of the fish were preserved in a solution of neutralized formaldehyde (4 %) and seawater. Later, the formalin was removed and replaced by 70 % isopropanol, in which the material was kept for further investigations. By a longitudinal ventral incision the alimentary tract of the fish could be opened and the contents identified. The items found were categorized as follows: leptocephali, other fishes, crustaceans and other invertebrates (Chaetognatha, Cephalopoda, Gastropoda, Siphonophora, Tunicata). Crustaceans were divided, according to body length, into two categories: small crustaceans, < 10 mm (copepods, small amphipods, ostracods), and large crustaceans, > 10 mm (decapods, large amphipods, euphausiids). For the identification of the fish species found in the stomachs of predators the presence of otoliths was often useful.

Bauchot (1959) described the vertical distribution of two "serrivomerid leptocephali" at depths from 0–300 m. Tesch (1980) reported depth preferences at 300–600 m during daytime and 35–125 m at night for *Anguilla anguilla*. Schoth & Tesch (1982) described the vertical distribution of 0-group eel larvae (*Anguilla* spec.) in the Sargasso Sea, and found leptocephali between 0–100 m (mostly between 50 and 100 m) at night

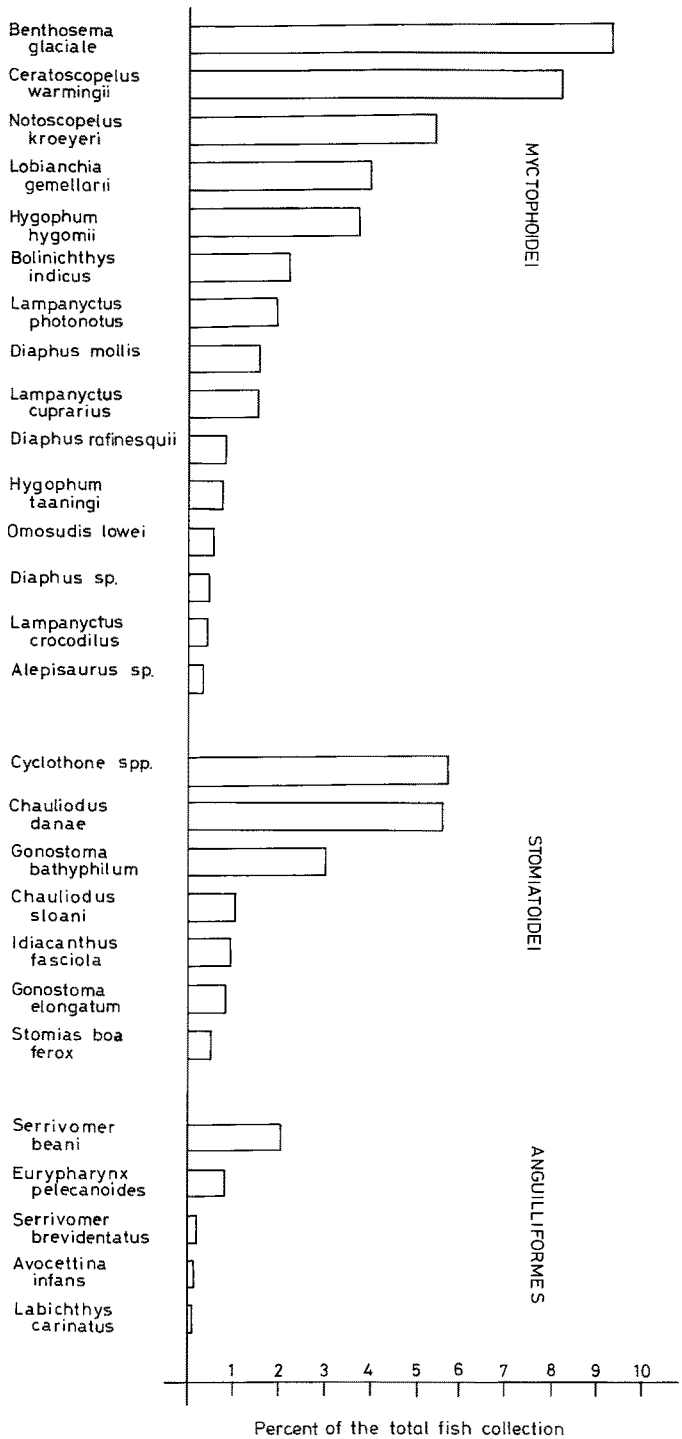

Fig. 2. Frequency (% of total catch) of the most dominant fishes caught during the Eel Expedition 1979

and from 150 to 200 m during daylight. Kleckner & McCleave (1982) noted the occurrence of *Anguilla rostrata* leptocephali at depths ranging from 340 to 750 m during daytime.

The pelagic fishes chosen for examination in this study were from depths corresponding to those at which leptocephali are known to occur, or fishes suspected of having similar vertical migration patterns to those of the leptocephali. Another criterion for the choice of fish used for examination was their frequency of collection during the expedition (Fig. 2).

RESULTS AND DISCUSSION

Myctophidae

Ceratoscopelus warmingii (Table 1) was the most frequently investigated species in this study (c. 30 %) and was therefore chosen to start with in the results reported. This myctophid which occurs in the tropical and subtropical regions of the Atlantic is known to feed primarily on small zooplankton as well as on large crustaceans and small fishes. The vertical distribution of *C. warmingii* at night was reported to range from 20 to 200 m, with maximum abundance in the upper 100 m (Nafpaktitis et al., 1977).

A large variety of taxa of different sizes was found in the stomachs of *C. warmingii*. The largest group consisted of small crustaceans, including copepods (calanoids), ostracods, and small amphipods. Larger crustaceans were represented by amphipods, euphausiids and decapods. Other invertebrates observed include siphonophores, chaetognaths, cephalopods, gastropods and polychaetes. Fish, frequently identified as myctophids, were found in 9 % of the stomachs. Ingested myctophids sometimes reached a total length of up to half or more of the predator's body length. Thus, a 56 mm *C. warmingii* individual can at least triple its empty stomach length (approximately 10 mm). Clarke (1978) reported that *C. warmingii* takes items of up to 10 % of its body weight.

Fish scales were also noted in the stomachs; however, they were not recorded under the fish category if no other fish remains were found in the stomach. This is because fish scales are found in the water and can probably be consumed directly (Hopkins & Baird, 1975) or by net feeding (Anderson, 1967). Apart from the items mentioned above, fish eggs and, in one case, a black oil lump were found in the stomachs of *C. warmingii*.

No significant difference was noted between the day and night catches as far as stomach content was concerned. This supports Clarke's (1978) findings on the feeding pattern of *C. warmingii*. Fish with empty stomachs were found either in deep-water hauls (>300 m) or in hauls made at sunrise.

C. warmingii caught in the upper layers (0–150 m) contained more fish (up to 30 %) than those caught in deep layers (>600 m). No difference was found in the stomach contents of males and females. Parasites, probably nematodes, were frequently detected in the stomach or the visceral cavity.

The most important finding was that, of all fishes examined, only *C. warmingii* had preyed on leptocephali. Five *C. warmingii* individuals (three originated from the same haul) contained one leptocephalus each in the alimentary tract.

Three of these leptocephali were identified as *Ariosoma* spp. (the most intact measured 79 mm) and were found in the stomach and partly in the mouth of the

Table 1. Sampling data and the stomach content of *Ceratoscopelus warmingii* (Lütken); * numbers represent percentage of fish stomachs examined (for more information see text)

Station No.	Date	Net	Time of the haul	Depth of the haul (m)	No. of examined fish	♀ (%)	Standard length (mm, $\bar{X}\pm$s.d.)	Stomach content* leptocephali	fish	crustacean small (<10 mm)	crustacean large (>10 mm)	other inverte-brates	uniden-tified	empty
5527	21/3	MT	1900–2009	400– 600	20	50	55.20±5.66	–	–	10	–	–	15	75
5550	23/3	MT	1944–2044	30– 150	27	50	59.11±4.13	–	30	19	15	4	26	7
5561	24/3	MT	2123–2223	400– 600	26	42	62 ±4.14	1 unidentified	27	27	12	–	35	–
5588	26/3	MT	1910–1955	400– 600	12		59.92±4.17		18	42	8	25	17	–
5596	27/3	MT	1909–2009	40– 100	99	29	58.25±6.01	1 *Ariosoma* sp. 1 *Gnathophis* sp. 1 *Ariosoma* sp.	13	49	–	–	26	12
5627	31/3	MT	415– 645	400–1800	9		55.63±5.11	–	11	44	11	–	33	–
5632	31/3	MT	1920–1950	35– 100	2		54 ±1.41	–	–	+	–	–	+	–
5666	3/4	MT	1710–1825	300– 800	2		64.5 ±0.71	–	–	–	+	–	–	–
5679	5/4	IKMT	936–1056	75– 425	2		22.5 ±3.54	–	–	+	–	–	+	–
5687	6/4	MT	410– 725	300–1800	34	34	57.62±9.62	–	3	50	6	12	12	18
5725	10/4	IKMT	1707–1922	20–1800	1		55	1 *Ariosoma* sp.	–	–	–	–	–	–
5738	12/4	MOCNESS		0– 50	1		45	–	–	+	–	–	–	–
5738	12/4	MT	456– 716	600– 800	3		57.67±3.06	–	–	–	–	–	–	+
5760	15/4	MT	425– 705	300–1800	40	35	53.34±9.89	–	5	48	–	18	20	8

predators. The fourth leptocephalus, *Gnathophis* sp., 90 mm, was found in the oesophagus of the predator. The fifth, an unidentified leptocephalus, was found together with a 30 mm long myctophid in the stomach of the predator. Small plankton were also present in the stomachs of three of the five *C. warmingii*. All five leptocephali were found in the alimentary tract of fishes which had been caught in the late afternoon or at dusk.

Other myctophids: c. 140 specimens (adults and subadults) collected from Stations 5550 to 5894 were examined and are listed as follow: *Benthosema glaciale* (Reinhardt); *Bolinichthys indicus* (Nafpaktitis & Nafpaktitis); *Diaphus* sp.; *Diaphus rafinesquei* (Taning); *Lobianchia gemellarii* (Cocco); *Notoscopelus kroeyeri* (Gjösaeter); *Hygophum reinhardtii* (Lütken); *Hygophum taaningi* (Bekker); *Hygophum hygomii* (Lütken); *Lampanyctus photonotus* (Parr); *Lampanyctus cuprarius* (Taning); *Lampanyctus lineatus* (Taning); *Lampanyctus crocodilus* (Risso); *Lampadena urophaos atlantica* (Maul); *Notoscopelus caudispinosus* (Johnson); *Lepidophanes gaussi* (Brauer); *Symbolophorus veranyi* (Moreau); *Bolinichthys indicus* (Nafpaktitis & Nafpaktitis); *Electrona risso* (Cocco).

The majority of items from the stomachs of these myctophids was identified as small crustaceans. The different taxa and sizes found were much less diverse than those observed in *C. warmingii*. Empty stomachs were found in 5 of 8 *Benthosema glaciale* individuals examined and 25 (43 %) of 58 specimens of *Lampanyctus* (*L. cuprarius, L. lineatus* and *L. crocodilus*). Nearly all of the 79 specimens of the other myctophids showed items in their stomachs.

Serrivomeridae

Serrivomer beani (Gill & Ryder) was the most frequently collected eel (731 specimens) during the expedition, and 97 % were taken deeper than 1000 m (Post & Tesch, 1982). 17 of the 23 *S. beani* examined had empty stomachs (Table 2). Only large decapods were identified in the others.

The single specimen of *S. brevidentatus* (Roule & Bertin), 489 mm, examined was found to have an empty stomach.

Nemichthyidae

Nemichthyid eels have been captured from the surface down to 2000 m (Nielsen & Smith, 1978). Post & Tesch (1982) give depths of catches of 400 m and less for *Nemichthys scolopaceus* and 1200 m and more for *Labichthys carinatus*, and *Avocettina infans* during this expedition. However, the last mentioned species was also found during a previous cruise after sunset at depths of 160 to 600 m.

Stomachs of snipe eels examined during this study were either empty or contained only whole shrimp and shrimp remains (Table 2). This supports the findings of Mead & Earle (1970).

Eurypharyngidae

Eurypharynx pelecanoides (Vaillant) specimens were collected only in hauls deeper than 1200 m; however, one specimen was reported to have been caught at 345 m (Post & Tesch, 1982). Stomach examinations indicated that *E. pelecanoides* preys mostly on large decapods (Table 2). Remarkable is the occurrence of pieces of *Sargassum* algae in the stomachs of three *E. pelecanoides* specimens. It is unknown whether these entered

Table 2. Sampling data and the stomach contents of 13 fish species collected with commercial midwater trawl; * numbers represent percentage of fish stomachs examined (for more information see text)

Fish species	Station No.	Date	Depth of haul (m)	No. of examined fish	♀ (%)	Standard length (mm: range and $\bar{X}\pm$s.d.)	Stomach content*						
							lepto-cephali	fish	crustacean small <10 mm	crustacean large >10 mm	other inverte-brates	uniden-tified	empty
Serrivomer beani	5594–5842	27/3–28/4	15–2000	23	13	344–760	–	–	–	8.7	–	17.4	74
Nemichthys scolopaceus	5666–5813	27/3–29/4	15–2000	3	–	374–877	–	–	–	++	–	–	+
Eurypharynx pelecanoides	5594–5849	27/3–12/4	15–1800	18	–	282–566	–	–	–	47.4	–	21	31.6
Avocettina infans	5594–5849	27/3–29/4	15–2000	4	–	500–650	–	–	–	++	–	–	++
Labichthys carinatus	5594–5825	27/3–26/4	15– 200	3	–	470–704	–	–	–	++	–	–	+
Gonostoma bathyphilum	5632–5884	31/3– 4/5	410–1920	78	60.3	142.93±19.52	–	2.6	9	1.3	–	23	64
Gonostoma elongatum	5527–5738	21/3–12/4	15–1800	36	25	170.39±50.99	–	6	–	19	–	8	67
Chauliodus danae	5550–5818	23/3–25/4	0–2000	217	15.2	104.42±22.59	–	16	1.4	13.8	–	3.7	65
Chauliodus sloani	5588–5877	26/3– 3/5	35–2000	16	6	224.38±45.21	–	38	–	–	–	12	50
Stomias boa ferox	5893	5/5	0–1950	18	–	92.33±12.94	–	83.3	–	–	–	–	16.6
Idiacanthus fasciola	5550–5725	23/3–10/4	20–1800	22	36	215.78±29.7	–	13.6	–	–	–	13.6	73
Omosudis lowei	5632–5760	31/3–15/4	20–1800	18	11	80.5 ±40.71	–	22	–	–	11	22	44
Scopelogadus m. mizolepis	5527–5674	21/3– 4/4	30–1200	26	40	55.54± 8.16	–	–	19	–	–	46	35

the stomach during net-feeding or before. These findings do not support Böhlke's (1966) opinion that *Eurypharynx* probably feed extensively on plankton and small fish.

Gonostomatidae

Gonostoma elongatum (Günther) occurs in the Bermuda region at depths of 200 to 275 m and 400 to 450 m at night (Grey, 1964). The length of the individuals examined ranged between 110 and 277 mm; thus, both adult and semi-adult fishes were included in the hauls. Identified stomach contents were primarily large crustaceans, occasionally some fish but no small crustaceans (Table 2). The percentage of empty stomachs was remarkably high in hauls made early in the morning, late in the afternoon or at dusk. Females with ovaries containing well developed eggs were found, but their stomachs were empty.

Gonostoma bathyphilum (Vaillant) was one of the most frequently collected species (1085 individuals) during this expedition. Most of the fish collected from deep waters at sunrise contained well digested material or were empty. It appears that *G. bathyphilum* preys on smaller organisms (small-sized crustaceans) than *G. elongatum* does; however, fish were also found in the stomachs of *G. bathyphilum* (Table 2). Of the mature females, 65 % had empty stomachs.

Chauliodontidae

Chauliodus danae (Regan & Trewaves) feed mainly on fish and crustaceans. In the daytime they stay in waters deeper than 500 m, at night in the upper waters and at the surface (Morrow, 1964). A high percentage of empty stomachs was frequently recorded (Table 2). Items identified in the stomachs were predominantly either fish, such as myctophids and stomiatids, or large crustaceans (euphausiids and large decapods). The large items were often about half the total body length of the predator.Morrow (1964) hypothesized that *C. danae* do not feed on large prey often. In the present investigation, large prey was found more frequently than small prey in the stomachs of *C. danae*.

Chauliodus sloani (Bloch & Schneider) is found in the North Atlantic during the day at depths of 1000–1800 m. At night, it inhabits the upper 800 m. It feeds chiefly on invertebrates and small fishes (Morrow, 1964). Fish observed in the stomachs examined were identified as myctophids and *C. danae*. Other items were not identified. While *C. danae* was found to consume small- and large-crustaceans also, *C. sloani* seems to feed solely on fish (Table 2).

Stomiatidae

Stomias boa ferox (Reinhardt) seems to be most abundant in the upper water layers, from 300 m up to the surface (Morrow, 1964). Fishes or fish remains were found in most of the examined stomachs (Table 2). All were identified as myctophids. No other items were found, though Morrow (1964) mentioned fishes of the genus *Stomias* also feeding on crustaceans.

Idiacanthidae

Idiacanthus fasciola (Peters): Gibbs (1964) has reported that of the 162 „Dana" collections of *I. fasciola*, nearly four-fifths were taken in waters shallower than 200 m.

The fishes examined here were also collected from deep hauls (20–1800 m) however, they might have been caught in shallower waters during the heaving of the net. The majority of fish was found to have empty stomachs (Table 2). Items discovered were fish remains only. Seven ripe females, found among the fishes examined, had empty stomachs.

Omosudidae

Omosudis lowei (Günther). The vertical distribution of *O. lowei* specimens (5 to 53 mm long) ranged from 400 to 1000 fathoms (Rofen, 1966). Eight of the 18 specimens examined had empty stomachs (Table 2). Rofen (1966) mentioned that, without exception, all *Omosudis* taken off Bermuda contained food.

Stomachs contained either fish, squid, or both. There were crustaceans remains only in one case. In one specimen, four fishes and one squid were found crowded in the stomach but intact. This indicates the enormous capacity of food ingestion by *O. lowei.* Items were frequently found in the stomachs intact. Rofen (1966) suggested that the stomach of *O. lowei* is used for storage, and digestion does not start until food enters the intestine. It seems that *O. lowei* preys almost exclusively on fish and squid.

Melamphaidae

Scopelogadus mizolepis mizolepis (Günther). Adults of this species are known to be found at 500 m and below. Half-grown fishes occur between about 150 and 300 m (Ebeling & Weed, 1973). The fishes used in this study were taken at different depths from the upper layers to 1200 m. Many of the specimens examined had stomachs that were either empty or contained very well digested items. The items identified were predominantly small crustaceans (Table 2).

Other families

Fishes of 11 other genera (10 families), which are listed below, were additionally investigated but not described in more detail as only few individuals of each family could be obtained for examination. None of these fishes contained any leptocephalus in the alimentary tract. The genera are: *Anoplogaster, Argyropelecus, Balistes, Bonapartia, Coccorella, Cyclothone, Eustomias, Paralepidida, Photostomias, Sternoptyx, Stomias.*

CONCLUSIONS

The present investigation on the stomach contents of oceanic fishes from the Sargasso Sea does not show any preference for leptocephali in the respective diets. Moreover, there are indications supporting the assumption that the occurrence of leptocephali in the myctophid alimentary tracts resulted from net feeding rather than natural feeding. One argument is the fact that three of the five *Ceratoscopelus warmingii* containing leptocephali were taken in the same haul. It is also noteworthy that all five leptocephali were found either in the stomach, in the oesophagus, or even partly in the

mouth of the predator. They were fairly intact and could, except in one case, be identified. This means that they could have entered the alimentary tract of the fish shortly before it arrived on board, i.e. during the haul. In many of the fishes examined, the stomachs decreased in fullness during the late afternoon and at dusk. Since the five myctophids mentioned above were caught at this time of day, it is possible that the occurrence of the leptocephali resulted from net feeding. However, *C. warmingii* feeds on large prey day and night (Clarke, 1978), which weakens this argument.

On the other hand, there are arguments against the net feeding hypothesis. Fish are known to vomit prey items when caught by net. This might explain why leptocephali were found partly in the oesophagus or mouth. While Holton (1969), Collard (1970) and Anderson (1967) considered the possibility of net feeding, Hopkins & Baird (1975) reported no evidence of net feeding, even when a fine mesh cod end was used. They suggested that the diet determinations for mesopelagic fishes are not heavily biased by net feeding. Clarke (1978) reported little indication of net feeding during his investigation of mesopelagic fishes. Based upon the observations mentioned above, it remains uncertain whether the leptocephali were taken by the predators in the net or before.

Matsui et al. (1970) found many leptocephali of *Anguilla obscura*, measuring 41–48 mm in length, in the stomachs of skipjack tuna *(Katsuwonus pelamis)* and concluded that tuna must be a predator on leptocephali. Schmidt (1932) mentioned that the sunfish *(Mola mola)* feeds heavily on *Anguilla* leptocephali in the northern Atlantic. During the present study, none of the predators contained more than one leptocephalus in the stomach. This fact also suggests that the predators examined have no particular preference for leptocephali. *Anguilla* leptocephali may be even less affected, since none of the leptocephali consumed belonged to this genus.

It is notable that many ripe predatory females had empty stomachs, which means less predation would improve the chance for survival of leptocephali. Besides, leptocephali due to their transparency and agile forward and backward swimming capability (own observation and Kracht pers. comm.) are presumedly difficult to prey on.

To summarize, the present examination of the stomach contents of pelagic fishes did not indicate any reduction of the *Anguilla* leptocephalus stock in the Sargasso Sea by the fishes investigated here.

Nevertheless, the present study did not include other organisms that may reduce the population of leptocephali. According to Tesch (pers. comm.), small leptocephali were found in the stomachs of arrow worms (*Sagitta* spp.). This observation was also reported elsewhere. Large decapods or euphausiids could also prey on leptocephali since they prey on crustaceans, chaetognaths and fishes (Chace, 1940).

It may seem curious that *Anguilla* invariably spawns in the Sargasso Sea, one of the nutritionally poorest regions of the Atlantic. It is possible that in such an impoverished habitat, the scarcity of natural enemies enhances the chances of survival for larval eel populations.

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LITERATURE CITED

Anderson, R., 1967. Feeding chronology in two deep-sea fishes off California. M. S. Thesis, Univ. South California, Los Angeles, 22 pp.

Bauchot, M.-L., 1959. Etude des larves leptocephales du groupe *Leptocephalus lanceolatus* strömman et identification a la famille des serrivomeridae. – Dana-Rep. *48*, 54–131.

Böhlke, J. E., 1966. Family Eurypharyngidae. In: Fishes of the western North Atlantic. *5*, 610–617. (Mem. Sears Fdn mar. Res. 1.)

Borodulina, O. D., 1981. Food composition of the yellowfin Tuna *Thunnus albacares* (Bonnaterre) (Scombridae) in some habitats. – Vopr. Icht. *21*, 1006–1015.

Chace, F. A., 1940. Plankton of the Bermuda oceanographic expeditions. – Zoologica, N. Y. *25*, 117–209.

Clarke, T. A., 1978. Diel feeding patterns of 16 species of mesopelagic fishes from Hawaiian waters. – Fish. Bull. U.S. *76*, 495–513.

Collard, S. B., 1970. Forage of some eastern Pacific midwater fishes. – Copeia, 348–354.

Ebeling, A. W. & Weed, W. H., 1973. Family Melamphaidae. In: Fishes of the western North Atlantic. *6*, 421–477. (Mem. Sears Fdn mar. Res. 1).

Gibbs, R. H. Jr., 1964. Family Idiacanthidae. In: Fishes of the western North Atlantic. *4*, 512–522. (Mem. Sears Fdn mar. Res. 1.)

Grey, M., 1964. Family Gonostomatidae. In: Fishes of the western North Atlantic. *4*, 78–238. (Mem. Sears Fdn mar. Res. 1.)

Haedrich, R. L. & Nielsen, J. G., 1966. Fishes eaten by *Alepisaurus* (Pisces, Iniomi) in the southeastern Pacific Ocean. – Deep-Sea Res. *13*, 909–919.

Holton, A. A., 1969. Feeding behavior of a vertically migrating lantern fish. – Pacif. Sci. *23*, 325–331.

Hopkins, T. L. & Baird, R., 1975. Net feeding in mesopelagic fishes. – Fish. Bull., U.S. *73*, 908–914.

Kleckner, R. C. & McCleave, J. D., 1982. Entry of migrating American eel leptocephali into the Gulf Stream system. – Helgoländer Meeresunters. *35*, 329–339.

Marshall, N. B., 1957. Tiefseebiologie. VEB Fischer, Jena, 334 pp.

Matsui, I., Takai, T. & Kataoka, A., 1970. Leptocephalae of the eel *Anguilla obscura* found in the stomachs of Skipjack Tuna *Katsuwonus pelamis* caught near New Guinea. – J. Shimonoseki Univ. Fish., *19* (1).

Matthews, F. D., Damkaer, D. M., Knapp, L. W. & Bollette, B. B., 1977. Food of western North Atlantic tunas *(Thunnus)* and lancetfishes *(Alepisaurus)*. – NOAA Tech. Rep. *NMFS SSRF-706*, 1–19.

Mead, G. W. & Earle, S. A., 1970. Notes on the natural history of snipe eels. – Proc. Calif. Acad. Sci., *38* (5), 99–103.

Morrow, J. E. Jr., 1964. Family Stomiatidae. In: Fishes of the western North Atlantic. *4*, 290–310. (Mem. Sears Fdn mar. Res. 1.)

Nafpaktitis, B. G., 1977. Fishes of the Western North Atlantic. *7*, 1–258. (Mem. Sears Fdn mar. Res. 1.)

Nielsen, J. G. & Smith D. G., 1978. The eel family Nemichthyidae (Pisces, Anguilliformes). – Dana-Rep. *88*, 1–71.

Petersen, C. G. J., 1905. Larval eels *(Leptocephalus brevirostris)* of the Atlantic coasts of Europe. – Meddr Kommn Havunders. (Fiskeri) *1* (5), 1–9.

Post, A. & Tesch, F.-W., 1982. Midwater trawl catches of adolescent and adult anguilliform fishes during the Sargasso Sea Eel Expedition 1979. – Helgoländer Meeresunters. *35*, 341–356.

Rofen, R. R., 1966. Family Omosudidae. In: Fishes of the western North Atlantic. *5*, 462–481. (Mem. Sears Fdn mar. Res. 1.)

Schmidt, J., 1932. Dana's Toqt Omkring Jorden 1928–1930. Gyldendal, Kopenhagen, 368 pp.

Schoth, M. & Tesch, F.-W., 1982. Spatial distribution of 0-group eel larvae (*Anguilla* sp.) in the Sargasso Sea. – Helgoländer Meeresunters. *35*, 309–320.

Tesch, F.-W., 1980. Occurrence of eel *Anguilla anguilla* larvae west of the European continental shelf, 1971–1977. – Envir. Biol. Fish. *5*, 185–190.

Tesch, F.-W., 1982. The Sargasso Sea Eel Expedition 1979. – Helgoländer Meeresunters. *35*, 263–277.