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# Feeding Spectrum and Food Relationships of Short-finned Squid (*Illex illecebrosus* Lesueur 1821)

by

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## Abstract

A list of food components, among which 4 types, 5 classes, 17 orders and 17 generic or specific names are singled out, is given. Major groups of food organisms are described in detail. Euphausiids predominate in feeding of the short-finned squid on the Nova Scotia shelf, Georges Bank and the USA shelf. The fish and squids occupy the second and third places respectively both by percent of occurrence and the role in the food mass volume. Meganictiphanes norvegica is predominant among euphausiids, and families Myctophidae and Merluceidae (Osmeridae in the area of Grand Bank) prevail among the fish; the cannibalism predominate in the feeding on squids. The role of each of major food components changes in the process of ontogenesis. With age the squid turns to consumption on fish and squids from feeding on crustaceans; the squid functions as a secondary and tertiary consumer of the third and fourth trophic levels in the trophic chain of the shelf. Major and unique role of the short-finned squid in the ecosystems of the continental slope and shelf is that the squids function as a provider of energy from epi- and mesopelagial to the typically benthic and near-bottom communities.

## Introduction

The short-finned squid is an abundant species widely distributed in the Northwest Atlantic. During the life history the

species performs active vertical and horizontal migrations (Squires H.J., 1957, 1967; Clarke M.R., 1966; Roper C.F.E. et al., 1969, 1975; Lu C.C., Roper C.F.E., 1979; Minet J.P., Dupony, 1980; Hurley G.V., Dawe E.G., 1980; Dawe E.G., 1982). A number of numerous fish species, birds and marine mammals prey on this species (Templeman W., 1944; Vladykov V.D., 1946;1947; Sergeant D.E. and H.D.Fisher, 1957; Sergeant D.E., 1962; Squires H.J., 1957, 1967; Scott W.B., Tibbo S.N., 1968; Zuev, Nesis, 1971; Vinogradov V.I., 1972; Katona S.K. et al., 1978; Dupony H. et al., 1982).

The short-finned squid is an actively attacking predator. Major food items include crustaceans, fishes and squids (Squires, H.J., 1957; Mercer M.C., 1965; Burukovsky R.N., Froerman Yu.M., 1974; Mercer M.C. and Paulmier, 1974; G.P.Ennis and P.W.Collins, 1978; T.Amaratunga et al., 1979; O'Dor R.K. et al., 1979; Vinogradov and Noskov, 1979; Wallace I.C. et al., 1980; T.Amaratunga, 1980).

All the above-mentioned indicate the real importance of the species in the ecosystem of the area under study. Nevertheless, an approach to the feeding studies of this species, except aquarium experiments, is rather formal that may possibly be explained by certain difficulties in identification of squid stomach contents.

The objective of this paper is to give a detailed description of feeding spectrum (typical as a whole for the species) and an analysis of its changes in the process of ontogenesis.

A comparison between our materials and literature data made it possible to present a qualitative scheme of food relations of the species.

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## Materials and Methods

The squids, which feeding spectrum was considered in the

given paper, were caught with a bottom and midwater trawls on the shelf and continental slope, and in the open part of the Northwest Atlantic between Cape Hatteras and Grand Bank during the period from 1968 to 1981. The depths ranged between 30 and 500 m.

Samples were taken during all the seasons of the year, however maximum of material was collected during summer and fall (628 and 200 stomachs, respectively). A total of 1012 stomachs were analysed for studying of feeding spectrum. Unfortunately, the material on feeding of pre-recruits in the open ocean was only partly examined, and so the most common information on this problem presented in the given paper. The material on feeding spectrum collected at daily stations on Emerald Bank, Sable Island Bank and Banquereau Bank in May 1979 and on Georges Bank in November 1977 was incompletely analysed. These data will be presented in subsequent papers.

The contents of each stomach were examined under light microscope. The components found were sorted out according to their systematic category. The remains, by which species-specificity may be identified and the size of organisms be reconstructured, were sketched, counted and, if possible, measured.

**Food organisms were identified to the smallest taxon level however this could not be made in all cases as the food was heavily broken with squid beak and radula.**

The materials were analysed according to the methods suggested by Turpaeva (1953) and Shorygin (1952).

To reveal the role of different food components in the feeding of short-finned squids an index of frequency of occurrence (percent of occurrence) and percentage in the food mass volume were used. All the stomachs containing food were utilized for analysing of frequency of occurrence. The percentage of each food component in the food mass volume was estimated as its weight proportion to stomach contents weight, for this more than 3/4 full stomachs with freshly eaten food were used. Data on total and particular food indices were not given in this paper.

## Characteristic of food components of the short-finned squid

The organisms consumed by the short-finned squid belong to the four taxonomic types namely Mollusca, Arthropoda, Chaetognata and Chordara, among which five classes and 17 orders are singled out. Due to the known difficulties most of preys were identified to the family level, however, we succeeded in identifying of 11 species and genera and in finding out another seven taxa of this rank in the literature on feeding of this species. All these organisms are listed below.

### A list of food components found in the feeding spectrum of the short-finned squid, Illex illecebrosus (Le Sueur, 1821)

Mollusca
- Cephalopoda
- Teuthida
- Illex illecebrosus
- Loligo pealei
- (3) Histioteuthidae
- ? Sepiida
- Gastropoda
- Pteropoda

Arthropoda
- Crustacea
- Copepoda
- Centropages sp.
- Candacia armata
- Scolicithrix danae
- (3) Euchaeta norvegica
- (2) Euchirella rostrata
- (1) Mysidacea
- Anisopoda
- Amphipoda
- Hyperiidae
- Phronima atlantica
- (2) Parathemisto sp.
- Gammaridae
- Stomatopoda
- Euphausiida
- Meganictiphanes norvegica
- Thysanoessa sp.
- Decapoda
- Natantia
- Penaidea
- Sergestidae
- Caridea
- (1) Pasiphaedae
- Crangonidae
- Pandalidae
- Brachyura

Chaetognata /Sagitta/

Chordata
- Pisces
- Myctophiformes
- Myctophidae
- Clupeiformes
- Astonesthidae

Osmeridae

(1) Mallotus villosus

Gonostomatidae

Macrouriformes

Macrouridae

Perciformes

Zoarcidae

Macrozoarces americanius

Cheilodipteridae

Seorpaeniformes

Scorpaenidae

Sebastes marinus

Cottidae

(1) Triglops pingeli

Gadformes

Merluciidae

Merluccius bilinearis

(1) Gadus callarias

(1) Melanogrammus aeglefinus

Fish eggs

(1) according to Squires H.J., 1957

(2) according to Mercer M.C. and Paulmier, 1974

(3) according to Amaratunga T. et al., 1979

Cephalopoda

Fragments of mantle, arms, tentacles with suckers, and gladius, beaks, lenses occurred in the squid stomachs. The absence of cephalopoda intestines was most frequently recorded. However fragments of male spermatophoreous complex, spermatophore, liver, ink sac, stomach, and heart were found in the stomachs of large pre-spawning females (240-290 mm long) filled by 100% with squid. Fragments of mantle and arms reached 12.0x6.5 mm. A reconstruction of sizes of consumed squids by their beaks, sucker, gladius, lenses and spermatophores shows that mantle length of consumed squid of the same species is always 50-60 mm

smaller than the length of mantle of attacking squid.

Of consumed cephalopoda Illex illecebrosus was predominant in the Nova Scotian shelf area while Loligo pealei was of great importance in the feeding of short-finned squid in the south-western range of species (the U.S. shelf and Georges Bank). Among the cephalopoda the short-finned squid accounted for 75.5% of occurrence and the long-finned squid for 24.5%. Eggs of Sepiida were only once recorded. The short-finned squid can eat several squids during one feeding since maximum number of beaks found in a stomach amounts to 9 with a mean of 2 and maximum number of pairs of squid lenses is equal to 5.

Crustacea

Crustaceans are represented by seven orders in the food of Illex.

Copepoda

Six species of copepod were recorded in the feeding of Illex (see A list of food components). Maximum number of copepod individuals found in one stomach was 12 with a mean of 2. In most cases copepods were observed to be unbroken in the stomachs of Illex, and,perhaps, they got by chance into the food mass of squids as the latter consumed the larger animals.

Amphipoda

Amphipods are represented by two suborders Gammaridae and Hyperiidae. Among all the amphipods identified the larvae of Gammaridae were predominant (85.7%). The larvae have unsegmented cephalothorax, and their number may be easily counted in the food mass composition. Maximum number of larval Gammaridae found in one stomach amounts to 240 with a mean of 137. The remains of adult amphipods are most frequently represented by a typical chela Phronemidae.

Euphausiida

Euphausiids are represented by two genera Meganyctiphanes

and Thysanoessa in the feeding of Illex. The organisms were mainly identified by well-preserving mandibles and eyes as well as by fragments of appendages, carapace, telson and maxillas. Of all identified euphausiids Meganyctiphanes norvegica is most frequently observed (94.55%). In different situations squids are appeared to utilize different ways in feeding on euphausiids. In certain cases the squid bites through euphausiid in the middle part, and a great amount of remains of copulatory organ is observed in a stomach. Usually, in the stomachs of squids feeding in such a way the recorded number of for example sperm globules of females is 3-4 times greater than the number of eyes and 6-7 times greater than the number of mandibles.

In other cases, the squid eats mainly cephalothorax, and a great number either of eyes or mandibles is observed in a stomach while organs of middle and posterior parts of a body are found in small number.

About 114 euphausiids were recorded in full stomachs of the squid. The size and weight of individuals reconstructured by mandibles indicate that the squids feeding on dense concentrations of euphausiids consume approximately 20 to 40% of biomass of preys while the remaining 60-80% of their biomass are rejected, and, perhaps, benthic or near-bottom predators prey on these "remainders".

Decapoda

The suborder Natantia is represented by two tribes and four families in the feeding of Illex (see A list of food components).

Among other shrimps (75% of all shrimps identified) Sergestidae, inhabitants of the pelagial, were most frequently found in the stomachs. Mandibles and appendages are commonly observed among the remains. The maximum number of Sergestidae found in one stomach amounts to 6. Shrimps Granganidae and Pandalidae, bottom inhabitants, rarely occurred in the stomachs. Besides common remains of shrimps, Caridea eggs were recorded in the stomachs of Illex. Sometimes squids are likely to eat mature females. Among the remains of Brachyura, fragments of appenda-

ges and carapace were most frequently observed in the squid stomachs. It was impossible to identify the crabs to the smaller taxonomic unit.

Pisces

The fish belong to 6 orders and 10 families. Soft tissues, bones, vertebrae, lenses, jaws, fin rays and gill archs were found in the stomachs.

The silver hake eggs were observed in the four stomachs. One stomach was completely filled with silver hake eggs at maturity stage IV. It is quite possible that the squid has eaten the gonad discarded from a fishing vessel. Large fragments of spinal column of Myctophidae (10.0x5.5 mm, 9.2x4.2 mm, 12.3x2.8 mm) and guts of these fishes were recorded in stomachs of squids above 23 cm in mantle lengths. Transit food components in the fish guts removed from the squid stomachs were represented by remains of euphausiids and copepods. Judging from the fact that, for instance, 5 guts, 4 caudal fins, jaws, and lenses of Myctophidae were observed in the stomach, large squids could eat these small fishes either completely or almost completely. Among the remains of other fishes no caudal fins and guts were recorded, and pectoral vertebrae most frequently observed. This confirms literature data that the squid captures the fish and makes some bites behind the head in the area of pectoral part of spinal column and rejects the other parts (Zuev, Nesis, 1971) or eats only head and soft tissues (Wallace et al., 1980).

Myctophidae (45% of number of fish identified) and silver hake (20%) predominate in the squid feeding.

Measurements of jaws lenses, vertebrae and otoliths show that the length of consumed fishes ranges between 30 and 120 mm. The remains of fishes having 160-200 mm in length were very seldom found. In most cases these remains were identified as grenadiers, which lengths were large due to the long tail. In August 1973 on the northeastern slope of Georges Bank the author observed Illex of 25-30 cm attacking herring 23 cm in length which was placed as a bait in the water.

The squid moving with a fin forward made three circles

round the herring and then, swimming nearby, changed sharply the direction and captured the fish. During 15-17 min the squid ate the herring and then pushed away the fish and slowly swimmed. Examination of herring showed that the squid bit off the fish 16 times in the area of back behind the head. The weight of consumed fish was about 55-60 g. The maximum number of fishes consumed by one squid amounts to 13 with a mean of 2.

## Feeding spectrum of the short-finned squid

Mean-species spectrum of feeding.

Euphausiids predominate in the feeding of the short-finned squid from the areas of Nova Scotia, Georges Bank and the U.S. shelf. The fish, and squids are less frequently recorded and constitute smaller proportion in the food mass volume (table 1).

Amphipods, shrimps and a number of other food organisms are of minor importance in the Illex feeding. It is worth of noting that shrimps occurs in the feeding more frequently, compared to amphipods, but are of minor importance in the food mass volume.

Seasonal changes in feeding spectrum.

In spring and summer euphausiids prevail in occurrence and role in the food mass volume (fig.1). Between March and August according to their occurrence the fish and squids occupy the 1st and 2nd places, respectively. According to the role in the food mass volume these ratios are maintained at previous level in spring while in summer the fish and squids are almost equally represented in the food mass with some prevalence of squids.

Of secondary food items amphipods prevail in spring and summer. In fall the role of the fish and juveniles of the squid increases in the squid feeding. In fall the fish predominate considerably in occurrence and slightly by the role in the food mass volume. At this period shrimps occur most frequently in the feeding. In fall squids are frequently recorded in the Illex feeding but in small amounts. In winter euphausiids become again predominant in the feeding, and degree of cannibalism increases

(especially in the U.S. shelf area where the squids of all age groups are recorded at this period). At this period the fish are observed in 30% of squids, but the amount of the fish does not exceed 5% of the food mass volume.

Daily rhythm of changing of feeding spectrum.

Daily rhythm of changing of feeding spectrum is analysed based on the material collected mainly in the period between May and October, i.e. during the active feeding period of Illex. Euphausiids predominate in the feeding from 4.00 to 20.00 (local time) (fig.2). At this period the ocean surface is usually highly lighted, and dense concentrations of adult euphausiids are formed within the near-bottom water layers, i.e. they are most available for Illex. In the twilight and night-time periods euphausiids usually migrate towards the upper water layers and their concentrations disperse, and the squids commence to feed to a larger extent on the fish and their own juveniles. At night and in the morning shrimps increased in importance as prey components, and amphipods in the evening. Periods 24.00-4.00 and 16.00-20.00 are singled our as cannibalism peaks (fig.2).

Age changes in the feeding spectrum.

The first 3-4 months of life history the short-finned squids are observed in the waters of epi- and mesopelagial outside the shelf. Unfortunately, no data on feeding of larvae and juveniles less than 30 mm mantle length are still available. Usually most stomachs removed from these squids were empty. Fat drops and remains of crustaceans and chaetognaths were found in several stomachs. The feeding spectrum of squids of 35 to 104 mm in mantle length is under study at present, and so only general information on their feeding is given here (table 2). The remains of chaetognaths, crustaceans (amphipods, shrimps and euphausiids), cephalopoda and fishes were recorded in several stomachs of this group of squids. Chaetognaths predominate, in occurrence. Cephalopoda were recorded three times, however they were only once identified as squid of family Cranchiidae. A detailed analysis of feeding spectrum of pre-recruits will be presented later.

On attaining 105-134 mm in size the short-finned squid migrates towards the shelf waters. At this period and during the period of growth to 195-224 mm euphausiids were prevailing in the squid diet (table 2, fig.3). The fish and juveniles of the short-finned squid become dominating food items for squids above 22-23 cm in mantle length. The change in availability of food organisms occurs at growth stage between 16 and 20 cm. At this developmental stage of squids maximum number of consumed euphausiids increases from 10-15 to 114 specimens(fig.4). On reaching 18-19 cm in size Illex begins to feed on larger fish compared to the early ontogenesis stages, however the number of consumed fishes decreases markedly (fig.4-5). Of secondary items amphipods and shrimps predominate in the feeding of Illex of 16-17 cm (fig.3).

Predators of short-finned squid

(a review)

During the three expeditions aimed at studying of biology and abundance of short-finned squid pre-recruits outside the shelf area, an attempt was made to record the predators feeding on Illex in this area. However, none of the fish species preyed on squids was reported from the trawl catches. In March-April along the northern edge of the Gulf Stream shoals of dolphins (about 20-30 specimens in a shoal) were observed from time to time (once or twice in a month), and schools of small whales recorded in a square 42°30 N - 43°11 N and 46°30 W - 46°50 W in April. The largest school was recorded in this square at surface water temperature of 15.0°C on 21 April 1982. The school occupied the area of about 10 sq. miles. Dolphins and whales may feed on squid juveniles in the area between the continental slope and the Gulf Stream, however no data confirming this fact are available.

In the Grand Bank area the major predator for Illex at recruit stage is Globicephala melaene preying exclusively on squids (Squires H.J., 1957; Sergent D.E., 1962; Mercer M.C., 1975).

Among the fish species feeding on Illex are Thunnus thyn-

nus (Butter M., 1971), Squalus acanthias (Templeman W., 1944), Delphinapterus leucas (Vladykov V.D., 1946, 1947), Xiphias gladius (Scott W.B., Tibbo S.N., 1968), Merluccius bilinearis and Urophycis chuss (Vinogradov V., 1972), Lagenorhynchus acutus (Katona S.K. et al., 1978), Melanogrammus aeglefinus, Sebastes mentella, Pollachius virens, Gadus morhua (Dupony H. et al., 1982).

The short-finned squid is an important food item for seabirds. In the Georges Bank area the squid was found in the stomachs of 6 species, namely Puffinus gravis, Puffinus diomedea, Puffinus griseus, Fulmarus glacialis, Larus marinus, Larus argentatus (Tsygankova Z.K., 1981 and her verbal communications). The first three species are the major consumers of Illex. Illex occurs in above 80% of stomachs of these birds; that accounts for 50-60% of biomass of sea organisms consumed by birds. The occurrence of Illex in the feeding of Fulmarus glacialis accounts for above 70% that constitutes in biomass about 50% of the total food of this species. Illex (only beaks), and perhaps by transit along with consumed fishes, is rarely represented in the feeding of L.marinus and L.argentatus.

In the Grand Bank area P.gravis, P.diomedea and F.glacialis prey on Illex (Tsygankova Z.K., unpublished data).

Maximum size of the short-finned squids found in the bird stomachs reached 18-19 cm. The bulk of consumed squids is represented by juveniles about 11-12 cm in mantle length. The bird species mentioned above feed from the ocean surface and do not dive deeper than 1 m. This fact confirms the assumption concerning the high abundance of juveniles within the near-surface layer of epipelagial and should be taken into account when the assessment surveys will be carried out.

## Conclusions

(Food relations of the short-finned squid)

From the second month of life history to its termination Illex as a member of a minimum of three communities (epi- and mesopelagial of the open ocean, continental slope and shelf waters) functions as a typical predator. The feeding spectrum

of the squid is represented by marine animals belonging to the 4 types, 5 classes and 17 orders. These are plankton and nektonic organisms which form the composition of pelagic (Copepoda, Sagitta, larval Natantia, larval Stomatopoda, larval Amphipoda, larval Euphausiida, Cranchiidae, Histioteuthidae, Myctophidae, etc.), near-bottom and pelagic ( adult Euphausiidae, Penaidea, young short-finned squids, Osmeridae, Macrouridae, Scorpaenidae, Merluceidae, etc.), and bottom (Anisopoda, Brachyura, Caridea, etc.) complexes. Illex feeds on phytophagan, zooplanktophagan and predators, i.e. the feeding of Illex is represented by consumers of the first, second and third orders, and the squid itself belongs to a consumer of the third and fourth trophic levels. Illex functions principally as a predator of the third trophic level outside the shelf area and continental slope. At this stage of life cycle the squid has many potential predators, but owing to the fact that these predators concentrate mainly in the area of continental slope and on the shelf, the squid mortality at the pre-recruit stage is in our opinion, of insignificant magnitude.

Migrating to the continental slope and shelf zone Illex finds there the major food items (euphausiids and young fishes), but numerous predators of the IV trophic level prey on the squid. A transition from one ecosystem, where the species has practically no predators and competitors, to another ecosystem, where strict limits of competitive relationships are observed for this species and numerous predators prey on the squid, is likely to affect "painfully" the squid abundance. For example, in the Scotian area during Illex migration to the shelf silver hake become major predator and competitor of the squid as mixed aggregations of both species feed on euphausiids and eat one another. During a transition period from the second to the third and subsequent stages of gonad development ( maturity scale according to Burukovsky et al., 1979) the availability of food items changes and the larger near-bottom and pelagic fishes, including secondary predators, become of great importance in the feeding of Illex, but simultaneously cod, haddock and pollock prey actively on the squid itself.

The high level of cannibalism in the short-finned squid is observed from time to time:

1. During the formation of anomalously dense aggregations within 15-20 days (anomalous cannibalism).
2. For pre-spawning females consuming mature males after or during the coupling (forced-expedient cannibalism) (Froerman, unpublished data).

The unique role of the short-finned squid, and perhaps of other squids, in the trophic interrelation of the shelf ecosystem is that these species neither swallow nor eat completely the prey unlike the majority of other predators. Above 50% of biomass of preys killed in the pelagial become "by means of" squids the food for near-bottom and mainly bottom organisms. Taking into account that every year after the spawning Illex itself dies in the near-bottom layer waters the role of this species in transmission of energy from pelagial to benthos is extremely important for the regulation of energy balance of the shelf and slope communities.

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Table 1 Mean-species values of percent of occurrence and proportion of major food items in food mass volume for short-finned squids from NAFO Divs 4,5 and 6

| Food items | Percent of occurrence, % | Percent in food mass volume, % |
|---|---|---|
| Total Crustacea | 73.54 | 60.29 |
| Euphausiida | 61.64 | 55.42 |
| Amphipoda | 3.60 | 4.88 |
| Decapoda | 6.39 | 1.92 |
| Total Pisces | 40.93 | 25.20 |
| Total Cephalopoda | 24.15 | 14.23 |
| Teuthidae | 24.01 | 14.23 |
| Others | 4.57 | 0.28 |
| No. of stomachs | 985 | 537(1) |

(1) Above half full stomachs with freshly eaten food.

Table 2 Change in feeding spectrum of short-finned squid in process of ontogenesis

| Mantle length, mm | 35-64 | | 65-104 | | 105-134 | | 135-164 | | 165-194 | | 195-224 | | 225-254 | | 255 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Food items | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 |
| Cephalopoda | (3)- | | | | (1) 2.63 | 0.21 | (14) 6.64 | 0.92 | (48)20.78 | 16.49 | (94)31.86 | 20.27 | (42)30.22 | 27.67 | (38)52.78 | 19.82 |
| Teuthida | (3)- | | | | (1) 2.63 | 0.21 | (14) 6.64 | 0.92 | (46)19.91 | 16.49 | (94)31.86 | 20.27 | (42)30.22 | 27.67 | (38)52.78 | 19.82 |
| Sepiida | | | | | | | | | (2) 0.87 | | | | | | | |
| Crustacea | (9)- | | (1)- | | (37)97.37 | 94.79 | (212)100.95 | 93.13 | (159)68.83 | 68.33 | (215)72.88 | 60.17 | (75)53.96 | 34.22 | (34)47.22 | 11.07 |
| Euphausiida | (1)- | | (1)- | | (33)86.84 | 86.46 | (178) 84.76 | 80.67 | (140)60.61 | 64.10 | (188)63.25 | 58.63 | (59)42.45 | 31.78 | (23)31.94 | 10.89 |
| Amphipoda | (3)- | | | | (3) 7.90 | 8.33 | (19) 8.57 | 10.40 | (3) 1.30 | 0.56 | (3) 1.02 | 0.24 | (2) 1.44 | | (1-) 1.39 | |
| Hyperiidae | | | | | | | (2) 0.96 | | | | (3) 0.34 | | | | | |
| Gammaridae | | | | | | | (17) 8.09 | | (1) 0.43 | | | | | | | |
| Stomatopoda | | | | | | | | | (2) 0.87 | | | | | | | |
| Copepoda | | | | | | | (1) 0.48 | | | | (6) 2.03 | 0.03 | (4) 2.88 | | (2) 2.78 | |
| Anisopoda | | | | | | | (3) 1.43 | | | | | | | | | |
| Decapoda | (1)- | | | | (1) 2.63 | | (11) 5.24 | 2.06 | (14) 6.05 | 3.67 | (18) 6.10 | 1.27 | (10) 7.19 | 2.44 | (8)11.11 | 0.18 |
| Natantia | (1)- | | | | | | (8) 3.81 | 2.06 | (6) 2.59 | 2.24 | (17) 5.76 | 1.27 | (10) 7.19 | 2.44 | (8)11.11 | 0.18 |
| Brachyura | | | | | (1) 2.63 | | (3) 1.43 | | (8) 3.46 | 1.43 | (1) 0.34 | | | | | |
| Sagitta | (11)- | | (2)- | | | | (2) 0.95 | | (5) 2.27 | | (3) 1.02 | | (1) 0.72 | | | |
| Pisces | | | (2)- | | (5)13.16 | 5.00 | (44) 20.95 | 5.83 | (85)38.80 | 14.30 | (123)41.35 | 19.56 | (85)61.15 | 38.11 | (52)72.22 | 68.39 |
| Myctophiformes | | | | | | | | | | | (9) 3.05 | | (8) 5.76 | | (10)13.89 | |
| Clupeiformes | | | | | | | | | | | (1) 0.34 | | (2) 1.44 | | (2) 2.78 | |
| Macroiformes | | | | | | | | | | | (3) 1.02 | | (1) 0.72 | | | |
| Perciformes | | | | | | | | | (1) 0.43 | | (2) 0.68 | | (1) 0.72 | | (3) 4.17 | |
| Gadformes | | | | | | | | | (1) 0.43 | | (4) 1.35 | | (4) 2.88 | | (2) 2.78 | |
| Fish eggs | | | | | | | | | (2) 0.87 | | (1) 0.34 | | (1) 0.72 | | | |
| Unidentified remains | (1)- | | (2)- | | | | (2) 0.95 | | (6) 2.60 | | | | (2) 1.44 | | (2) 2.78 | |
| No. of stomachs | 13 | | 4 | | 38 | 24 | 210 | 136 | 231 | 134 | 295 | 170 | 139 | 45 | 72 | 28 |

1 - percent of occurrence of food items

2 - percent of food items in food mass volume

(x)- recorded amount of occurrences of a given item in squid stomachs

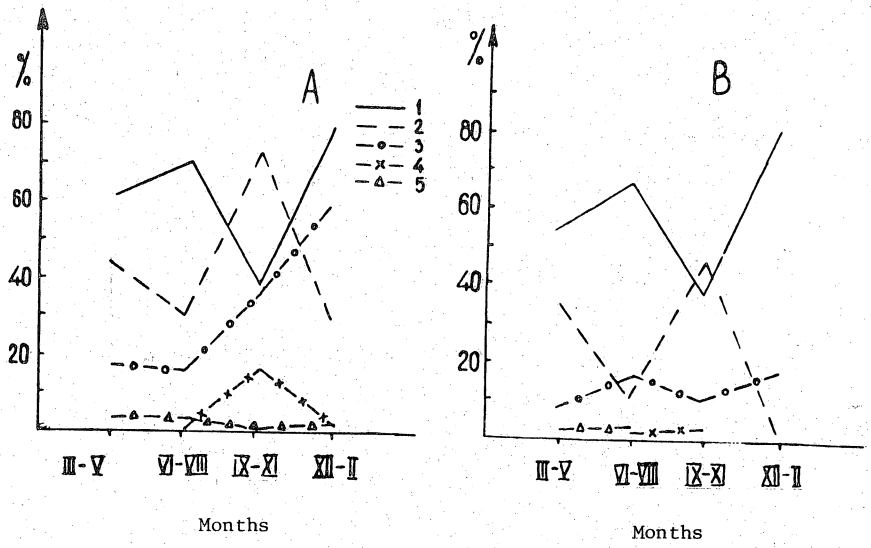


Fig.1 Seasonal changes in feeding spectrum of the short-finned squid.

A - percent of occurrence

B - percent in the food mass volume

1 - Euphausiidae, 2 - Pisces, 3 - Teuthida, 4 - Natantia, 5 - Amphipoda.

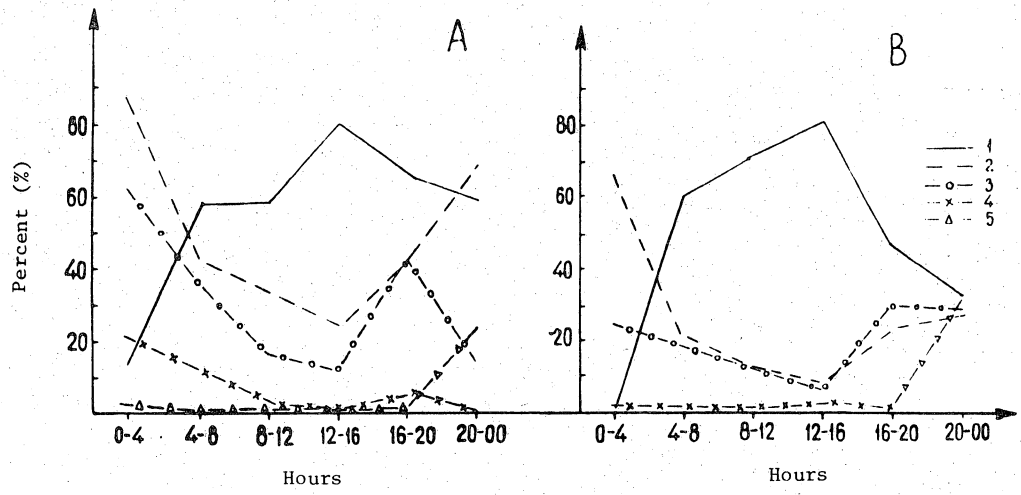


Fig.2 Daily variability in feeding spectrum of the short-finned squid.

A - percent of occurrence

B - percent in the food mass volume

1 - Euphausiidae, 2 - Pisces, 3 - Teuthida, 4 - Natantia, 5 - Amphipoda.

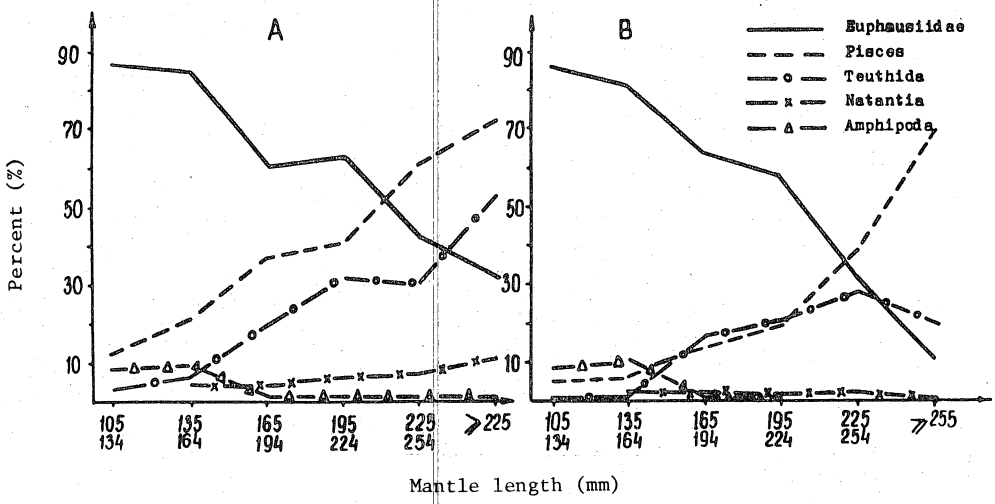


Fig.3 Age variations in the bulk of feeding spectrum of the short-finned squid.

A - percent of occurrence

B - percent in the food mass volume

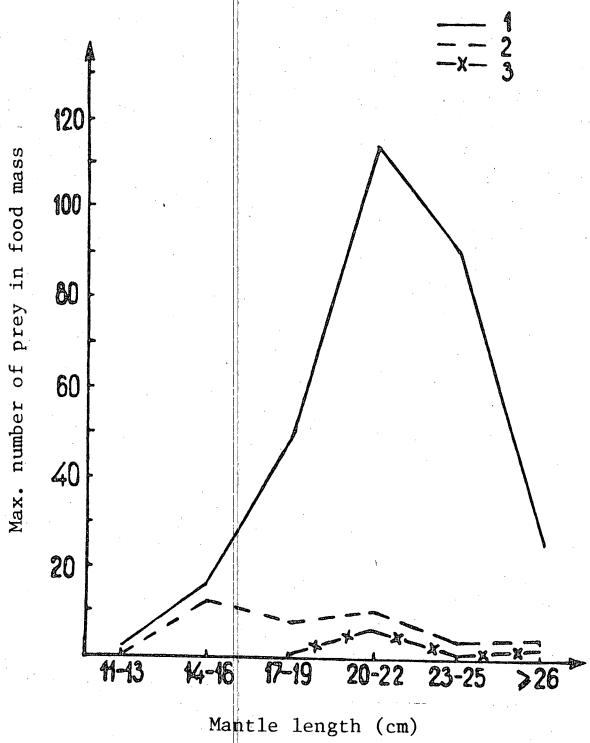


Fig.4 Change in amount of preys consumed in course of one feeding in the process of ontogenesis of the short-finned squid.

1 - Euphausiidae, 2 - Pisces, 3 - Natantia.

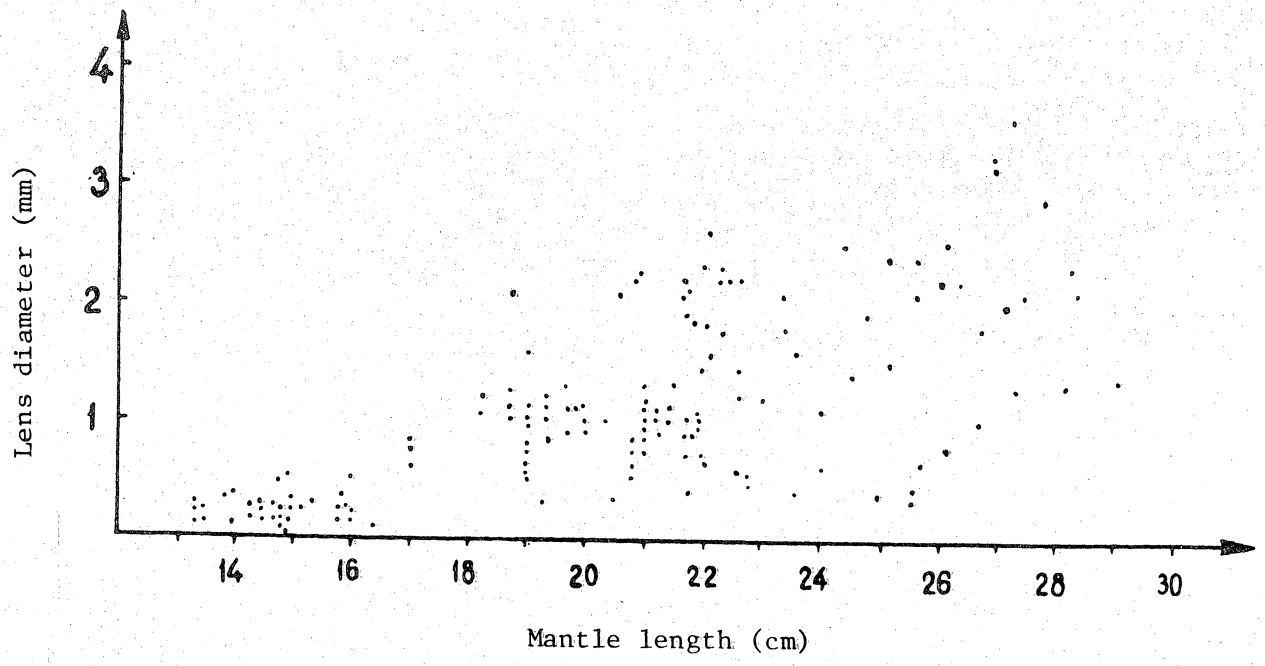


Fig.5 Diameter of lenses of fishes removed from squid stomachs.