

Northwest Atlantic



Fisheries Organization

Serial No. N914

NAFO SCR Doc. 84/IX/117

SCIENTIFIC COUNCIL MEETING - SEPTEMBER 1984

On Feeding of Two Squid Species in the Northwest Atlantic

by

V. I. Vinogradov

Atlantic Research Institute of Marine Fisheries and Oceanography (AtlantNIRO)
5 Dmitry Donskoy Street, Kaliningrad, 236000, USSR

Abstract

Feeding studies of short-finned (Illex illecebrosus) and long-finned (Loligo pealei) squids were conducted during the May to November period of 1976 on the Nova Scotian shelf, on Georges Bank and in adjacent waters. The analysis of 2 604 sp. of Illex and 578 sp. of Loligo showed that the food composition of both species was predominated by fish and squids. Cannibalism was more typical of short-finned squids and the fish were a prevalent food items in the long-finned squids' diet. In all areas and at all depths, coefficients of stomach fullness for larger short-finned squids were 1.5-2 times higher than for smaller specimens, although the feeding intensity of both groups was low. The feeding intensity of immature long-finned squids was higher than that of mature specimens.

Introduction

Short-finned (Illex illecebrosus) and long-finned (Loligo pealei) squids have long been the target of the fisheries for coastal states and member-countries of NAFO. In recent years the increased interest to squids' ecology has been reflected in the papers of many researchers including Zuev, Nesis, 1971; Summers, 1971; Mesnil, 1976; Tibbets, 1977; Ennis, Collins, 1978; Amaratunga, 1980; Dupouy et al., 1982. The subject discussed in the paper by Vinogradov, Noskov, 1979, has been further developed based on the data from feeding studies on squids carried out on the Nova Scotian shelf, on Georges Bank and in adjacent waters in the May to November period of 1976.

SPECIAL SESSION ON SQUIDS

Materials and Methods

Sampling of stomachs for feeding studies of squids was made on board the research vessels "Belogorsk", "Kvant" and "Stvor" in May through November 1976, during the trawl surveys of Scotian shelf, Georges Bank and adjacent waters.

Sampling locations are shown in the figure .

Methods described in our paper (Vinogradov and Noskov, 1979) and in "Methodic manual... 1974" were used to preserve stomachs, to sort them out by size groups, to determine composition of stomachs' contents, to identify food items to species, and to calculate coefficients of stomach fullness.

Results

Food composition and feeding intensity of squids

2 604 specimens of Illex and 578 specimens of Loligo were examined for food composition and feeding intensity of various size groups (Table 1). The analysis showed that the both species had prevalence for three groups of food organisms: squids, fishes and crustaceans (Table 1). The diet of Illex included for the most part squids (68% by weight); other groups were less important (euphausiids - 14%, fishes - 11%). Fishes (40%) and squids (35%) were common as food for Loligo, the proportion of shrimps being 17% by weight. Diets of short-finned and long-finned squids are the topic of the papers by Froerman (1983) and Vovk (1983). These authors reported that Illex and Loligo mainly consumed fishes, squids and crustaceans. Their food composition varied depending on the area, season and mantle length (Vinogradov, Noskov, 1979). In the given paper an attempt is made to represent the feeding of short-finned and long-finned squids during the May to November period of 1976 by area, length group and depth.

Short-finned squid. On Emerald Bank, in June the food composition of immature (10-18 cm) and mature squids was mainly represented by euphausiids and other crustaceans (Table 2), however, the diet of mature specimens often included squids (27% by weight). Occurrence of large numbers of euphausiids, particularly in smaller squid stomachs (27% by weight), can

be attributed to extensive aggregation of this crustacean in the environment; hence, a high coefficient of stomach fullness - 37‰ (Table 2).

In September, the feeding intensity of squids on Browns Bank decreased, especially that of small, immature squids, who fed mainly on the fish (60%). The feeding intensity of large squids was considerably higher; their food was represented equally by mysids (46%) and squids (44%).

In May, the feeding intensity of both small and large short-finned squids on Georges Bank was low, with the fish being a predominant food.

In September, the feeding intensity of small and large squids increased on Georges Bank. Diets of small and large squids included primarily the fish (93%) and squids (84%) respectively.

In October, on Georges Bank young squids fed on euphausiids (80%), and large specimens consumed squids (83%). Compared with September, the feeding intensity of small squids decreased, and that of large squids - increased (50‰) (Table 2). In November, cannibalism was again common to large squids, however, the feeding intensity decreased 2.5 times compared with October (Table 2).

In September and October, in the Long Island area, both small and large squid specimens took squids as food. Although the coefficient of stomach fullness of young squids was approximately similar in September and October, and did not exceed 31‰, the feeding intensity of large squids considerably increased in October (151‰) compared with September (14‰).

It should be noted that in all areas the feeding intensity of small squids was somewhat lower (33‰) on the average than that of large specimens, although large squids had slightly more empty stomachs (54%) than small squids (50%).

Similar results were obtained in the experiments of O'Dor et al. (1980), and by Ennis and Collins (1978). These

authors recorded a large number of empty stomachs beginning in September, and identified very small squids as a main source of food which influenced the future abundance of squids.

Long-finned squids. The feeding of long-finned squids was studied in September and October of 1976. The results showed that young squids (8-15 cm) fed on crustaceans (primarily euphausiids and shrimps), fishes and squids, and in some areas (Nuntacket area, October) only on fishes and squids which gave a higher coefficient of stomach fullness (to 120‰). The feeding intensity of squids from other areas did not exceed 36‰ (Table 3).

Large mature specimens of short-finned squid mainly consumed the fish and squids with shrimps being a favoured food on Georges Bank in October. In September, in Nuntacket area where the diet was made of fish, the feeding intensity was low (39‰).

The feeding intensity of small squids was 1.5 times higher (36‰) than that of large specimens with a larger number of empty stomachs (Table 3).

Changes in food and feeding intensity with depth

During the study of changes in food and feeding intensity with depth certain peculiarities were observed in some areas. On Nova Scotia, in 100 to 240 m depths the food of short-finned squids of varying sizes mainly consisted of crustaceans (with euphausiids prevailing), although the diet of larger specimens included approximately 30% of squids (Table 4). The feeding intensity did not exceed 39‰.

On Georges Bank, in 43 to 350 m depths the bulk of the food of short-finned squids of different sizes was made of squids (Table 4). The feeding intensity of both large and small squids increased with depth, and in 101 to 150 m depths it did not exceed 36‰ for small and 44‰ for large specimens (Table 4).

In the Long Island area, in 30 to 124 m depths long-finned

squids fed mainly on squids and fish although at small depths the diet of large squids included a considerable proportion of bottom crustaceans (39%). The feeding intensity of small specimens was higher and amounted to 36-37‰ (Table 4). Such changes in food composition and feeding intensity with depth on Georges Bank and in adjacent waters, as well as on Scotian Shelf were observed with respect to silver hake, red hake and other fish species.

A change of productive zones, formed as a result of interaction between the Gulfstream waters with cold Labrador waters at 100-150 m depths, can be related to aggregation of meso- and macroplankton (Sheldon et.al., 1977), and its transport to Georges Bank (Bigelow, 1926), where it concentrates in upper layers (Samyshev, Sushin, 1975) varying in total biomass values by year (Noskov, Romanchenko, 1979).

Summary

The diet of immature short-finned squids (10-18 cm) included for the most part euphausiids, fishes and squids in proportions depending on month and area.

Cannibalism was typical of large short-finned squids (19-25 cm) everywhere, except for Scotian shelf. The feeding intensity (to 150‰) and cannibalism were the highest in mature squids in southern areas.

In the food of immature long-finned squids (8-15 cm) in all areas the fish predominated, although euphausiids and squids were a common food item. The highest recorded feeding intensity (120‰) was in October, in the Nuntacket area, with the fish and squids as major food organisms.

Large long-finned squids (16-30 cm) southwards of Georges Bank consumed fishes, but in September and October the bulk of their diets was represented by squids and shrimps respectively.

In 100 to 240 m depths of Scotian shelf short-finned squids showed prevalence for euphausiids, and in 43 to 350 m depths of Georges Bank and in adjacent waters - for squids.

In all areas and in all depths coefficients of stomach full-

ness were 1.5-2 times higher for large squids compared with those for smaller specimens.

Food of long-finned squids differed with depth insignificantly and consisted of squids, the fish and bottom crustaceans, the feeding intensity being higher in immature specimens.

References

- Amaratunga T., 1980. Preliminary estimates of predation by the short-finned squid Illex illecebrosus on Scotian shelf. NAFO SCR Doc. 80/31. Ser. No.63, pp. 1-13.
- Bigelow H.B., 1926. Plankton of the offshore waters of the Gulf of Maine. Bull. of the U.S. Bureau of Fisheries. Washington. vol. 40, part 2(968), pp. 1-509.
- Dupouy H., Amaratunga T. and Coelho L., 1982. Preliminary data on predation of fishes on squid (Illex illecebrosus) on the Scotian shelf (NAFO Div. 4VWX). NAFO SCR Doc. 82/VI/43. Ser.No. 532, pp. 1-8.
- Ennis G.P. and Collins P.W., 1978. Food and feeding of the short-finned squid (Illex illecebrosus) during its seasonal occurrence inshore at Newfoundland and a brief review of the trophic relationships of the species. ICNAF Res.Doc. 78/II/7, Ser.No. 5159, pp. 1-9.
- Froerman Yu.M., 1983. Feeding spectrum and food relationships of short-finned squid (Illex illecebrosus LeSueur, 1821). NAFO SCR Doc. 83/IX/82, Ser.No. N748, pp.1-22.
- Mesnil B., 1976. Growth and life cycle of squid, Loligo pealei and Illex illecebrosus. ICNAF Res.Doc. 76/VI/65. Ser.No. 3852, pp. 1-20.
- Methodic manual for studies of food and feeding relationships between the fish in natural environment. 1974. Izd. "Nauka". M., 251 p.

- Noskov A.S., Romanchenko A.N., 1979. Composition, distribution and abundance of Georges Bank zooplankton in summer 1965 to 1977. In: "Problems of fisheries oceanology of the World Ocean" (Theses of rep. at the Vth All-Union Conf.), Kaliningrad, pp. 50-52.
- O'Dor R.K., Burward R.D., Vessey E. and Amaratunga T., 1980. Feeding and growth in captive squid, Illex illecebrosus, and the influence of food availability on growth in the natural population. ICNAF Res.Doc. 80/IX/16 Ser. No.5342, pp. 1-15.
- Samyshev E.Z., Sushin V.A., 1975. Regularities of zooplankton growth in Georges Bank area. Trudy AtlantNIRO, vyp. 58, pp. 89-96.
- Summers W.C., 1971. Age and growth of Loligo pealei, a population study of the common Atlantic coast squid. Biol.Bull., 147, pp. 189-201.
- Sheldon R.W., Sutcliffe W.H.Jr, Paranjape M.H., 1977. Structure, pelagic food chain and relationship between plankton and fish production. - J. Fish. Res. Board Can. No. 34, pp. 2344-2353.
- Tibbets A.N., 1977. Squid fisheries Loligo pealei and Illex illecebrosus, off the northwestern coast of the United States of America, 1963-74. ICNAF Sel.Pap. No.2, pp. 85-109.
- Vinogradov V.I. and Noskov A.S., 1979. Feeding of short-finned squid, Illex illecebrosus, and long-finned squid, Loligo pealei, of Nova Scotia and New England, 1974-75. ICNAF Sel.Papers No.5, pp. 31-36.
- Vinogradov V.I., 1982. Food and feeding relationships between silver hake Merluccius bilinearis (Mitchill) and red hake Urophycis chuss (Walbaum) on Georges Bank and in adjacent waters. Synopsis of thesis to pursue a Doctor's degree. M., pp. 1-23.

Table 1 Food composition (% by weight) of short-finned and long-finned squids in the Northwest Atlantic (Subareas 4, 5, 6) in May-November 1976

Food organisms	Short-finned squids	Long-finned squids
Evadne spp.	-	+
Calanus finmarchicus	-	+
Mysids	1	+
Cirolana spp.	+	-
Anonyx spp.	-	+
Gammarids	+	+
Euphausiids	14	6
Shrimps	-	17
Crabs	-	+
Decapoda	1	-
Non-identified crustaceans	5	2
Total crustaceans	21	25
Squids	68	35
Round herring	-	1
Myctophidae	1	-
Non-identified fishes	10	39
Total fish and squids	79	75
Clione limacina	+	-
Diacria trispinosa	+	-
Chaetognatha	-	+
Sagitta	+	+
Echinodermata	-	+
No. of examined stomachs	2 604	578

Table 2 Food composition (% by weight) of short-finned squids by length, season and area of Northwest Atlantic in May-November 1976

Food organisms	: Emerald Bank, : July		: Browns Bank, : Sept		: Georges Bank : May : Sept : Oct : Nov			: Long Island area : Sept : Oct		: For all areas
Immature squids 10-18 cm (mantle length)										
Euphausiids	64	-	-	-	80	-	27	-	57	
Decapoda	2	-	-	-	-	-	-	-	2	
Non-identified crustaceans	30	10	-	-	-	-	-	-	25	
Total crustaceans	96	10	-	-	80	-	27	-	84	
Squids	4	30	-	7	20	-	62	100	15	
Myctophidae	-	-	-	-	-	-	4	-	-	
Non-identified fish	+	60	100	93	-	-	7	-	1	
Total fish and squids	4	90	100	100	20	-	73	100	16	
Examined stomachs	520	32	40	38	40	-	86	40	796	
empty, %	49	78	90	58	50	-	24	52	50	
Coeff. of stomach fullness,‰	37	9	2	10	6	-	27	31	33	
Mature squids 19-25 cm (mantle length)										
Cirolana spp.	-	-	-	-	+	-	-	-	+	
Gammarids	-	-	-	-	+	-	-	-	+	
Mysids	-	46	-	1	-	-	-	-	1	
Euphausiids	48	10	-	1	-	-	-	+	7	
Decapoda	5	-	-	1	-	-	-	-	1	
Non-identified crustaceans	18	-	-	-	-	-	-	-	3	
Total crustaceans	71	56	-	3	+	-	-	+	12	
Squids	27	44	-	84	83	80	72	87	75	
Myctophidae	-	-	-	3	2	-	-	-	1	
Non-identified fish	2	-	100	8	15	20	28	13	11	
Total fish and squids	29	44	100	95	100	100	100	100	87	
Diacria trispinosa	-	-	-	1	-	-	-	-	1	
Clione limacina	-	-	-	1	-	-	-	-	+	
Clione limacina	-	-	-	1	-	-	-	-	+	
Sagitta	-	-	-	-	-	-	-	+	+	
No. of examined stomachs	520	60	40	672	247	60	89	120	1808	
empty, %	51	22	87	60	62	33	35	57	54	
Coeff. of stomach fullness,‰	28	23	10	20	50	20	14	151	37	

Table 3 Food composition (% by weight) of long-finned squids by length and area of the Northwest Atlantic in September and October 1976

Food organisms	Georges Bank		Nuntacket area		Long Island area		For all areas
	Sept	Oct	Sept	Oct	Sept	Oct	
Immature squids, 8-15 cm (mantle length)							
Evadne spp.	-		+	-	-	-	+
Calanus finmarchicus	-		+	-	-	-	+
Mysids	-	7	-	-	-	-	+
Anonyx spp.	-	-	-	-	1	-	+
Gammarids	+	-	-	-	-	-	+
Euphausiids	-		49	-	1	25	10
Shrimps	-	39	-	-	31	-	3
Crabs	-	-	-	-	+	-	+
Non-identified crustaceans	20	-	-	-	-	-	3
Total crustaceans	20	46	49	-	33	25	16
Squids	67	7	1	45	19	55	42
Non-identified fish	10	47	50	55	47	20	41
Total fish and squids	77	54	51	100	66	75	83
Chaetognatha	-	-	-	-	1	-	+
Sagitta	+	-	-	-	-	-	+
Echinodermata	3	-	-	-	-	-	1
No. of examined stomachs	158	60	46	60	51	80	455
empty, %	41	67	50	72	6	56	48
Coeff. of stomach fullness,‰	18	6	36	120	31	28	36
Mature squids 16-30 cm (mantle length)							
Shrimps	-	60	-	-	-	-	40
Non-identified crustaceans	-	-	22	-	-	-	1
Total crustaceans	-	60	22	-	-	-	41
Squids	100	20	-	-	-	28	22
Non-identified fish	-	20	78	-	-	64	35
Round herring	-	-	-	-	-	8	2
Total fish and squids	100	40	78	-	-	100	59
No. of examined stomachs	9	60	4	-	-	50	123
empty, %	44	33	25	-	-	46	39
Coeff. of stomach fullness,‰	2	28	39	-	-	16	22

Table 4 Food composition (% by weight) of short-finned and long-finned squids by depth and length (short-finned squids, small - S=10-18 cm, large - L=19-25 cm, mantle length; long-finned squids, small - S=8-15 cm, large - L=16-30 cm, mantle length)

Food organisms	Short-finned squids												Long-finned squids														
	Scotian shelf						Georges Bank and adjacent waters						Scotian shelf						Georges Bank and adjacent waters								
	100 m		155-240 m		43-95 m		101-150 m		163-350 m		30-92 m		104-124m		100 m		155-240 m		43-95 m		101-150 m		163-350 m		30-92 m		104-124m
S	L	S	L	S	L	S	L	S	L	S	L	S	L	S	L	S	L	S	L	S	L	S	L	S	L	S	L
Mysids	-	72	-	-	-	-	1	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gammarids	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Euphausiids	94	4	63	45	4	-	-	27	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6	-	22
Shrimps	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Decapoda	-	-	2	5	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	39	-
Non-identified crustaceans	-	-	30	18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	1	-
Total crustaceans	94	76	95	68	4	1	27	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	15	40	22	
Squids	6	23	4	30	90	72	61	78	100	95	43	22	22	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Myctophidae	-	-	-	-	-	1	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Non-identified fish	-	1	1	2	5	26	8	20	-	4	41	38	56	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total fish and squids	6	24	5	32	96	98	73	98	100	99	84	60	78	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Diacria trispinosa	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Clione limacina	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Echinodermata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
No. of examined stomachs empty, %	40	60	512	520	124	624	80	364	40	240	375	124	80	70	40	48	48	72	60	19	56	38	58	45	47	64	
Coeff. of stomach fullness, %	7	23	39	28	12	21	36	44	21	40	36	22	37	-	-	-	-	-	-	-	-	-	-	-	-	-	-

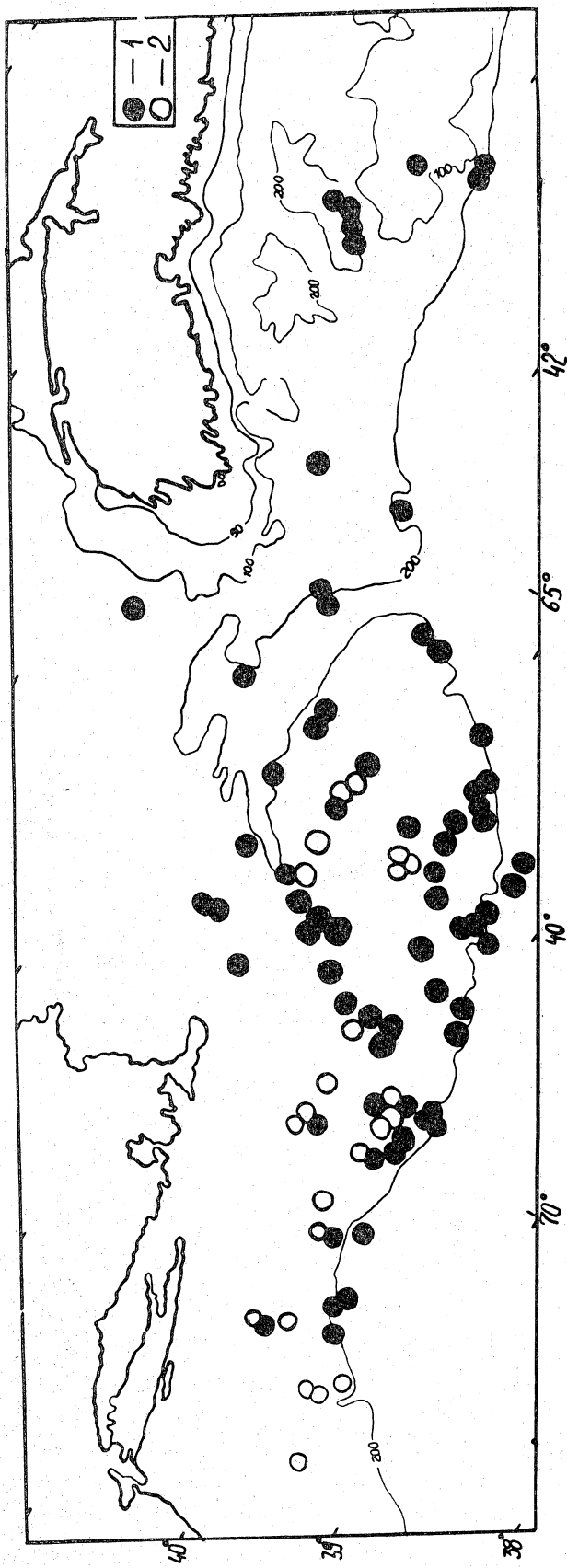


Fig. 1 Stations for sampling stomachs for feeding studies of short-finned (1) and long-finned (2) squids of Nova Scotia, Georges Bank and adjacent waters.