Indian J. Fish., ***51***(1) : 17-24, Jan.-Mar., 2004

Food and feeding habits of the pelagic shrimp, *Oplophorus typus* from the deep scattering layer along the west coast of India

P.K.KARUPPASAMY AND N.G.MENON
Central Marine Fisheries Research Institute,
Cochin-682018, India

ABSTRACT

The food and feeding habits of the pelagic shrimp, *Oplophorus typus*, an inhabitant of deep scattering layer from the west coast of India were studied during the period, October 1998-May 2001. Difference in food preference had been noticed between seasons and at different bathymetric realms. *O.typus* preferred food items such as detritus, chaetognaths, crustacean remains, fish remains, shrimp remains, euphausiids, diatoms, copepods and foraminifera. Diurnal variations in the feeding intensity as well as preference of food items were noticed.

Introduction

Knowledge on the diet of shrimps is important in studies of food webs, trophodynamics, resource partitioning and ecological energetics. Food is an important factor in the biology of fishes and shellfishes governing their growth, reproduction and migration. Variations in the seasonal and diurnal abundance of the favourite food organisms in any region may influence the horizontal and vertical movements of the fish stocks. An understanding of the relationship between shrimps and their favourite food items and their seasonal distribution may help to locate the potential feeding grounds which may in turn be helpful for exploitation of this resources.

Knowledge of the predator-prey relationship is essential for the prediction and exploitation of fish stocks. Gut content analysis and features of the alimentary system provide information on food, feeding habits and selective feeding if any. Generally, decapod crustaceans are predators or omnivores and can utilize various kinds of food. They may scavenge on decomposing dead material in addition to taking live pray. Gut contents of pelagic shrimps are usually found macerated and hence mostly unidentifiable. Studies on food and feeding habits of some of the pelagic shrimps such as, *Acanthephyra eximia*, *A. quadrispinosa*, *A. pelagica*, *A. purpurea*, *Oplophorus gracilirostris*, *O. spinosus*, *Systellaspis debilis*, of the Oplophoridae were carried by Omori (1974), Cartes (1993) and Burukovskij, (1994).

However no concerted attempts were made so far to study the biology of this species from Indian waters. Hence

a through study on the food and feeding habits of this species was made in the present study.

Materials and methods

Samples of *O. typus* collected by the Isaac Kidd- Mid water Trawl (IKMT) net on board FORV Sagar Sampada during October 1998 – May 2000 in the south west coast of India were utilized for the study. A total number of 412 specimens were used for the analysis of food and feeding habits of this species. Generally, it is difficult to identify the food items species wise, due to the nibbling action of mandibles on the food and mastication of food inside the stomach by the action of gastric mill. The identification of food organisms was based mainly on broken shell remains, spines, setae etc. The gut contents were grouped as detritus, chaetognaths, crustacean remains (other than shrimps i.e, crab parts, decapods and other crustaceans), fish remains, shrimp remains (exclusively of shrimps and shrimps parts), euphausiids, diatoms, copepods and foraminifera. Various methods used in the study of stomach analysis of fishes were critically discussed by Hynes (1950) and Pillay (1952).

The stomach was cut open and the contents were examined under a microscope. Percentages of occurrence of the various food items were calculated for individual shrimp. Depending on the relative volume of each food item, points were given and volume of each food item was calculated. The percentage occurrence of individual food item in the stomach content was determined by taking in to account of total number of occurrence of all the food items. The indices of preponderance were then computed to indicate the food preference of *O. typus* at different time intervals during the periods of study.

Results

Composition of food

O. typus feeds mainly on detritus, crustacean remains, and Chaetognaths. The food abundance as per the Index of Preponderance was: 1. detritus (decomposed animal and plant matter and their remains mixed with unidentified materials) 2. crustacean remains(mostly small crab bits, mysid bits and other unidentifiable crustacean bits) 3. chaetognaths 4. shrimp remains (fragments of pereopod, antennae, mandibles, telsons jointed with uropods) 5. fish remains 6. euphausiids 7. diatoms 8. copepods and 9. foraminifera (Fig.1).

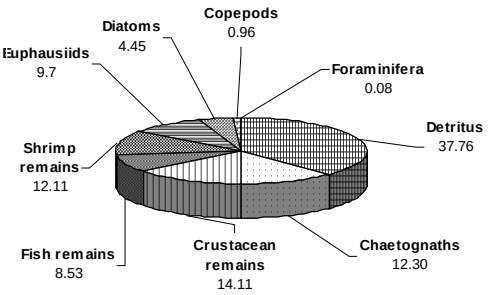

Fig. 1. Food comoposition of *O. typus*

Detritus, crustacean remains, euphausiids and diatoms were observed in the stomach of *O. typus* during the entire period of investigations. The other food items, which appeared during certain months were chaetognaths, fish remains, shrimps remains, copepods, and foraminifera. The monthwise details of Index of Preponderance (here after referred as Index) for each food item as well as the annual Index are given in Table 1.

The most predominant food item of *O. typus* was detritus (Index: 37.76), which was observed in all months. It ranked first among the food items in

TABLE 1. *The average Index of preponderance of food item in the stomach contents of* O.typus *in the IKMT catch during October 1998 to May 2000*

Month	April	May	June	October	December	Total
Detritus	50.07	18.94	18.21	27.42	74.16	37.76
Crustacean remains	11.39	10.55	20.95	24.71	2.97	14.11
Chaetognaths	12.02	12.43	19.57	-	17.5	12.30
Shrimp remains	2.93	5.34	25.92	26.34	-	12.11
Euphausiids	1.15	23.86	3.71	19.51	0.26	9.7
Fish remains	19.2	16.4	5.6	1.43	-	8.53
Diatoms	2.64	8.85	5.06	0.59	5.11	4.45
Copepods	0.6	3.21	0.98	-	-	0.96
Foraminifera	-	0.42	-	-	-	0.08
Sample size	211	94	43	33	31	

April, October and December. Crustacean remains formed second among the food items with an Index of 14.11 during October 1998- May 2000. It ranked second among the food items in June with an Index of 20.95 and ranked third in October with an index of 24.71. The third important food item of this species was chaetognaths with an Index of 12.30. The maximum Index of 19.57 was noticed in June occupying third position among food items. Chaetognath formed the second important food item in December with an index of 17.5. Shrimp remains ranked fourth in the order of abundance with an Index of 12.11. It formed second important food item during October with an Index of 26.34. Euphausiids ranked fifth in the order of abundance with an Index of 9.7. It ranked first among the food items in May with an Index of 23.86. Fish remains consisted of scales, bones, spines, otoliths and eye lenses of fishes. They constituted sixth important food item with an Index of 8.53 and formed one of the important food items during May and April with an Index of 19.2 and 16.4 respectively. Diatoms were present throughout the period of observation and occupied seventh place with an Index of 4.45. Copepods ranked eighth among the food items with an index 0.96. They were present as a food item during April (0.6), May (3.21), and June (0.98) only. Foraminifera were found in very small quantities during May with an Index of 0.08 and ranked the last among the food items.

Males : Detritus formed (Index of 43.53) the major food item of male *O. typus*, which fed mainly on detritus in April (34.94) followed by chaetognaths (22.72) and fish remains (17.72). This trend continued in May also, with detritus (28.59) forming first preferable item followed by euphausiids (22.07) and chaetognaths (15.65). In October detritus (39.06) and euphausiids (30.90) contributed the major feed. In December their most preferred food item was detritus (71.53) followed by chaetognaths (13.62) and diatoms (10.22) (Table 2).

Females : Like males, the main food for females was also detritus (37.05). In April, it prefered mainly detritus (65.2) and fish remains (20.68). During May it fed mainly on euphausiids (25.65) and fish remains (25.27). During June they

TABLE 2. *Index of preponderance of food items of males and females of* O. typus

Month	April		May		June		October		December		Total (Avg)	
Sex	M		F		M		F		M		F	M
F	M		F		M		F					
Detritus	34.94	65.2	28.59	9.28	-	18. 21	39.06	15.77	71.53	76.78	43.53	37.05
Chaetognaths	22.72	1.32	15.65	9.21	-	19.57	-	-	13.62	21.37	13	10.29
Crustacean remains	17.70	5.08	3.74	17.36	-	20.95	27.17	22.24	4.63	1.32	13.31	13.39
Euphausiids	0.06	2.25	22.07	25.65	-	3.71	30.90	8.12	-	0.53	13.25	8.05
Fish remains	17.72	20.68	7.52	25.27	-	5.6	2.87	-	-	-	7.03	10.31
Shrimp remains	1.31	4.55	10	0.69	-	25.92	-	52.68	-	-	2.83	16.77
Diatoms	4.43	0.85	12.11	5.59	-	5.06	-	1.19	10.22	-	6.69	2.54
Copepods	1.12	0.07	0.32	6.10	-	0.98	-	-	-	-	0.36	1.43
Foraminifera	0	0	0	0.85	-	-	-	-	-	-	-	0.17
No. shrimps observed	118	93	39	53	-	43	25	8	15	16	198	214

M = Males F = Females

consumed shrimp remains (25.92), crustacean remains (20.95), chaetognaths (19.57) and detritus (18.21). Shrimp remains (52.68) and crustacean remains (22.24) were the major food items during October. In December it mainly consumed detritus (76.78) followed by chaetognaths (21.37) (Table 2).

Variation of food in relation to day and night

The food and feeding habits of oceanic pelagic shrimp, *O.typus* hauled by IKMT during day and night were compared for studying the diurnal variations. Though there was noticeable difference in selectivity of food items during day and night, detritus formed the major component of the food irrespective of the time factor.

In day hauls (06-18 hrs), the dominant food items were detritus (Index, 30.32) and chaetognaths (Index 18.98), which together contributed to half of its food requirments. The other prey items present in the order of abundance were crustacean remains (15.9), fish remains (14.78), shrimp remains (13.92) and other components. Detritus (34.77) and euphausiids (15.51) formed about half of the food requirements of *O. typus* in the night hauls (18-06 hrs). The other major components in the gut contents of *O. typus* were crustacean remains (11.75), chaetognaths (10.78) fish remains (10.13) and others. Foraminifera were eaten in less quantity during day hauls. It is observed that chaetognaths, crustacean remains, fish remains and shrimp remains were consumed more in the day time and less in night time. The euphausiids, diatoms and copepods had higher index during night hauls than the day hauls (Fig.2).

Males : During day males prefer mainly detritus (34.34) followed by chaetognaths (29.71) and fish remains (15.12). It is very interesting to note that the male *O.typus* did not feed on shrimp remains during nighttime. Detritus formed almost one-third during night.

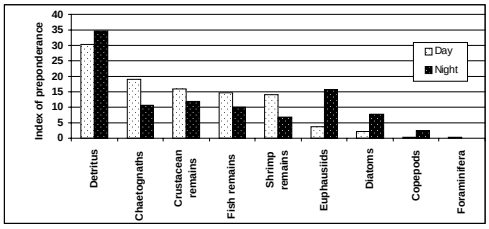

Fig. 2. Relative abundance of food item in *O.typus* during day and night hauls.

Night samples of male showed that they prefer detritus (37.64) followed by crustacean remains (18.84) euphausiids (12.61) diatom (12) and fish remains (9.47) (Fig. 3).

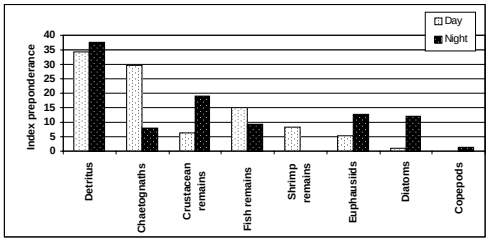

Fig. 3. Relative abundance of food item in male of *O.tupus* during day and night hauls

Females : Female *O. typus* prefered detritus, which, contributed to one-fourth of their food requirements. Both detritus and crustacean remains put together contributed to 50% of the food requirements. Detritus formed one of the most important food items during night. Detritus (31.89) and euphausiids (18.42) together formed about 50% of the food. The other items preferred by *O. typus* during night was shrimp remains (13.46) chaetognaths (13.41) and fish remains (10.29) (Fig. 4).

Food in relation to depth

Variations in food preferences of *O. typus* in different depth zones were studied. The samples were analyzed for 8 depth zones namely, 0-100 m, 100-200 m, 200-300 m, 300-400 m, 400-500 m,

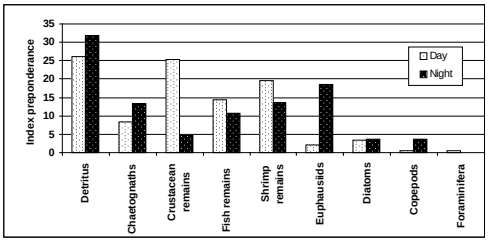

Fig. 4. Relative abundance of food item in females of *O.typus* during day and night hauls

500-600 m, 600-700 m and 700-800 m.

In general, *O. typus* feed on various organisms in different depths. In lower depth of 0-100 m, they fed mainly on detritus (Index of 59.19) and chaetognaths (18.48). At the depth range of 100-200 m, they fed on detritus (21.4), shrimp remains (19.04), fish remains (18.96), crustacean remains (12.08), diatoms (12.07) and others. They fed mainly on euphausiids (33.35), detritus (18.91), shrimp remains (15.02), crustacean remains (14.61) and others in the depth range of 200-300 m. In the 300-400 m depth range, detritus (37.12) and fish remains (20. 73) followed by almost equal representation of chaetognatha and crustacean remains (17.68) formed the main food items. Chaetognaths (60) and fish remains (40) were the two food items present in the samples collected from the depth of 400-500 m. In the deeper waters of 700-800 m depth range, *O.typus* fed mainly on crustacean remains (31.44), detritus (29.05), shrimp remains (21.43) and euphausiids (15.45) and others, in the order of abundance (Table 3).

Feeding intensity

The maximum feeding intensity in *O.typus* was observed in June (62.79%) followed by December (45.16%). During the other months they were found in poorly fed condition with percentage varying between 30.3 (October) and

TABLE3. *Index preponderance of* O. typus *in different depth zones.*

Depth range (m)	0-100	100-200	200-300	300-400	400-500	700-800	Avg
Detritus	59.19	21.4	18.91	37.12	-	29.05	27.61
Chaetognaths	18.48	10.73	05.75	17.46	60.00	-	18.74
Shrimp remains	03.00	19.04	15.02	03.17	-	21.43	16.94
Crustacean remains	03.67	12.08	14.61	17.68	-	31.44	13.25
Euphausiids	01.21	05.40	33.35	00.38	-	15.45	09.3
Fish remains	03.43	18.96	06.70	20.73	40.00	01.44	08.54
Diatoms	06.81	12.07	04.59	02.6	-	01.19	04.54
Copepods	04.21	00.32	01.07	00.58	-	-	01.03
Foraminifera	-	-	-	00.28	-	-	00.05
Sample size	56	78	76	173	1	28	412

40.28 (April) (Fig. 5). During the entire period of the observation, actively fed shrimps formed 38.59%. Both sexes were found to be poorly fed during most of the times. (Males 63.64%; Females 59.35%).

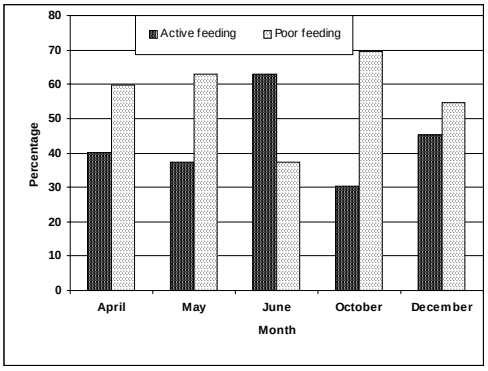

Fig. 5. Feeding intensity of *O. typus* in relation to months

Feeding intensity was found to be high during early morning hours of 04-08 hrs (53.25%), followed by the late evening hours of 16-20 hours (43.16%). It was lowest during 08-12 hours (20%) and 20-24 hours (20.15%) (Fig. 6).

The feeding intensity of *O.typus* in various depths showed that maximum active feeding was recorded in depths of

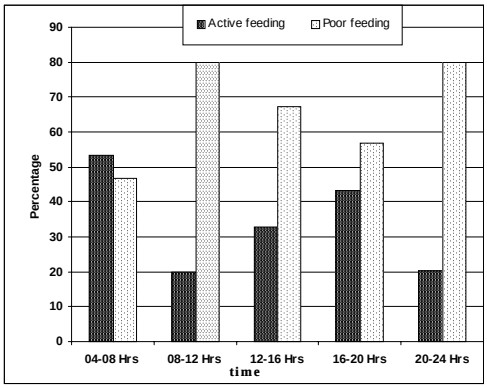

Fig. 6. Feeding intensity of *O. typus* in relation to time

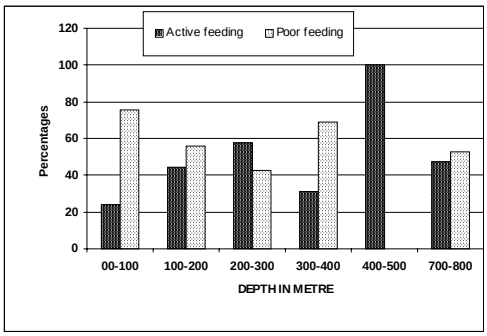

Fig. 7. Feeding intensity in *O. typus* in relation to depths

400-500 m (100%) followed by 200-300 m (57.64%), 700-800 m (47.34%) and 100-

200 m (44.45%). In 0-100 m and 300-400 m depth ranges they were found to be poorly fed with 75.89% and 68.79% respectively (Fig. 7).

Discussion

O. typus appear commonly and abundantly in the DSL and make diurnal migration from surface to a depth of 300-400 m and vice versa. The concentration and migration of *O.typus* is influenced by the availability of the prey organisms. Menon (1990) stated that the major constituents of DSL are euphausiids, decapods, larval crustaceans, siphonophores, medusae, copepods, pteropods, heteropods, amphipods, ostracods, prochordates, chaetognaths and larval, juvenile and adult fishes. The present findings suggest that *O.typus* feed selectively and the important food items are detritus, crustacean remains, chaetognaths, and shrimps remains. Flock and Hopkins (1992) observed that Sergestids are zooplanktivores, with crustaceans as the predominant food.

Detritus formed the major diet of *O.typus* (37.76). However, variation was seen during different seasons. Detritus has been considered to be lightly nutritive food, since the material has considerable amount of associated bacterial biomass (Wiernick, 1984). Flock and Hopkins (1992) stated that olive coloured debris as one of the food component of Sergestides. According to Donaldson (1975*) Sergetes joponicus* was mainly feeding on detritus. The present study shows that detritus formed the most important food item of *O.typus.*

Crustacean remains formed the second dominant food item of *O. typus* (14.11) and it was found to be in abundance during October (27.71) and June (20.95). Chaetognaths formed the third major food item *(*Index of 12.30) with maximum values in June (19.57). The present result confirms the observations of Srinivasan (1990 and 1996) who reported that the density of the chaetognaths population which play a key role in the food chain was very rich along the west coast and they are abundant during June-September. Shrimp remains constituted (12.11%) fourth important food item of *O. typus* followed by euphausiids and fish remains. Diatoms formed a minor constituent of the food items during May. Omori (1974) observed that diatoms and dinoflagellates formed one of the constituent foods of *Oplophorus quadrispinosa.*

Acknowledgements

The authors are thankful to Prof (Dr.) Mohan Joseph Modayil, Director CMFRI-Cochin for his encouragements. The authors are also grateful to the Department of Ocean Development (DOD), New Delhi, for funding the project and providing facilities on board FORV Sagar Sampada.

References

Burukovskij, R.N. 1994. On the biology of shrimps *Oplophorus noraealandiae (* De Man, 1931) from Namibian waters (Crustacea, Decapoda, Oplophoridae) *Arthropoda - Selecta.*, **3** (1 & 2): 3 - 12.

Cartes, J.E. 1993. Day - night feeding by decapod crustaceans in a deep - water bottom community in the Western Mediterranean, *J. mar. biol. Ass. UK.*, **73**: 795 - 811.

Donaldson, H.A. 1975. Vertical distribution and feeding of Sergestid shrimps (Decapoda: Natantia) collected near Bermuda. *Mar. Biol.*,

31: 37 - 50.

Flock, M. E. and T. L. Hopkins 1992. Species composition, vertical distribution and food habits of the Sergestid shrimp assemblage in the eastern gulf of Mexico. *J. Crustacean Biology,* **12**(2): 210 - 223.

Hynes, H.B.N. 1950. The food of the Fresh water sticklebacks (*Gasterosteus aculeatus* and Penaeidae (Crustacea, Decapoda). *Fish. Publ. Colon. off.*,London. **17**: 1 - 229.

Menon, N.G. 1990. Preliminary investigation of the Fish Biomass in the Deep Scattering Layer of the EEZ of India. *Proc. First Workshop. Scient. Result. FORV Sagar Sampada,* DOD/ICAR (CMFRI & CIFT), Cochin, 5-7 June, 1989, P. 273 - 280.

Omori, M. 1974. The biology of pelagic shrimps in the ocean. *Adv. Mar. Biol.,* **12**: 233 - 324.

Pillay, T.V.R. 1952. A critique of the methods of study on food fishes. *J. Zool. Soc. India,* ***4*****:** 185 - 200.

Srinivasan, M. 1990. Studies on the quantitative distribution of chaetognaths from the Indian seas collected during the cruise 1-44 of FORV Sagar Sampada. *Proc. First Workshop Scient. Result. FORV Sagar Sampada,* DOD/ICAR (CMFRI & CIFT), Cochin, 5-7 June 1989, P. 81 - 84.

Srinivasan, M. 1996. Spatial and temporal distribution of Chaetognatha from the Eastern Arabian Sea. *Proc. Second Workshop. Scient. Result. FORV Sagar Sampada,* P. 139 - 148.

Wiernick, C. 1984. Assimilation efficiency by *Procambarus clarkii* fed Elodea (Egesia densa) and its product of decomposition. *Aquaculture,* **36**: 203-215.