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Food and feeding habits of *Nemipterus japonicus* (Bloch) from Malabar coast, Kerala

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ABSTRACT

Food and feeding habits of *Nemipterus japonicus* from the Malabar region was studied by analysing 12164 specimens. The study showed that it is a demersal carnivore and the diet consisted of fishes, crustaceans, molluscs, polychaetes and miscellaneous food items. The trophic spectrum of *N. japonicus* is composed of 34 food items. All size groups preferred crustaceans. Penaeid shrimps, *Acetes* spp. and deep sea shrimps were the dominant crustacean components observed in the diet. Anchovies, scads, lizard fishes and *Lactarius lactarius* were the major teleost fishes that formed the diet of *N. japonicus*. The species showed preference for teleost fishes as they grew**.** The species initially feeds on a great variety of organisms, but as it grows slowly becomes more active predator, feeding mainly on large crustaceans and fishes. Crabs and squilla were seen mostly in juveniles and pre-adult fishes. Fishes dominated the stomach during January-March and crustaceans during all other months. Feeding intensity was poor during most of the months, variations were however observed in relation to different stages of maturity.

Keywords: Food and feeding, Malabar coast, *Nemipterus japonicus*

Introduction

Threadfinbreams are a major demersal finfish resource exploited along the Indian coast for human consumption. They are caught by trawling upto a depth of 120 m and are considered a valuable demersal resource due to its export demand. On an average, they form 5% of the total marine landings in India. In Kerala, the threadfinbreams form a major marine resource contributing to about 7% of the total marine catch. The fishery of threadfinbreams in Malabar area is represented by *Nemipterus japonicus* and *Nemipterus randalli* and the former contributes more than 40% of the threadfinbreams catch in this region. Information on the food and feeding habits of *N. japonicus* was given by Krishnamoorthi (1971), Murty *et al*. (1992a, b; 2003) and Manojkumar (2004). The present study was carried out considering the predominant occurrence of *N. japonicus* in the fishery and also due to the importance of studying the food and feeding habits of this resource in describing ecological role of the species. The present study is also useful in discussing prey-predator relationships of this species from Malabar region.

Materials and methods

Random samples of *N. japonicus* collected at weekly intervals during 2005 and 2012 from the fish landings at Puthiappa and Beypore landing centres formed the material for the study. A total of 12164 specimens in the length range of 79-295 mm were analysed for this purpose. The total length and maturity stage of the fish were recorded and the stomach contents were analysed using the Index of Relative Importance (IRI) (Pinkas *et al.,* 1971). The intensity of feeding was determined based on the degree of distension of the stomach due to feeding and the amount of food items contained in it. The stomachs were classified as gorged, full, ¾ full, ½ full, ¼ full, trace and empty and the data for the study period was pooled and classified as poorly fed (empty and trace), moderately fed (¼ full and ½ full) and heavily fed (¾ full, full and gorged). Since no difference in the food and feeding habits of male and female was noticed, the data of both the sexes were combined in the study.

Results

The trophic spectrum of *N. japonicus* is composed of 34 dietary items, which are classified into five general categories *viz.*, fishes, crustaceans, molluscs, polychaetes and miscellaneous items and IRI of food elements for the study period is presented in Table 1.

Crustaceans

Crustaceans (IRI= 56.86) were the most important prey category. *Metapenaeus dobsoni* (30.49), *Acetes* spp. (IRI= 21.76), deep-sea shrimps (IRI=2.66), and benthic

Table. 1. Index of Relative Importance of different food items of *N. japonicus* along the Malabar coast during 2005-2012

Prey items	Jan	Feb	Mar	Apr	May	Jun	Aug	Sep	Oct	Nov	Dec	Average
Fishes												
Ambassis sp.	-	0.09	0.00	0.29	-	-	-	-	-	-	-	0.03
Bregmaceros mcclellandi	6.30	1.33	1.53	9.34	4.55	2.77	-	-	0.51	-	-	2.39
Cynoglossus spp.	2.14	3.44	0.37	0.17	2.70	0.78	-	-	-	-	-	0.87
Decapterus russelli	0.18	0.27	1.87	0.00	0.43	0.45	-	-	0.06	-	-	0.30
Eel	0.07	-	0.01	-	0.18	-	2.12	0.83	3.04	2.89	0.59	0.89
Eel larvae	-	-	0.16	0.13	-	-	0.28	0.54	0.00	0.00	19.59	1.88
Fish larvae	6.74	-	-	-	0.00	-	1.61	2.67	1.44	-	0.13	1.14
Flat heads	7.89	11.86	14.27	2.82	0.07	1.60	-	-	-	-	0.13	3.51
Horse mackerel	-	-	-	-	0.48	-	-	-	-	-	-	0.04
Lactarius lactarius	-	-	1.26	11.79	0.09	0.00	5.58	3.50	17.23	12.55	1.13	4.83
Indian mackerel	-	-	-	-	-	-	-	-	-	0.06	-	0.01
Nemipterus japonicus	0.31	0.15	-	0.10	-	1.45	0.68	2.12	0.83	3.04	2.89	1.05
Nemipterus randalli	-	-	-	-	-	0.07	-	0.28	0.54	-	-	0.08
Saurida tumbil	0.34	5.02	0.91	0.55	3.69	1.16	-	1.61	2.67	1.44	-	1.58
Silverbellies	0.35	2.61	1.11	8.48	6.98	1.90	-	-	-	-	-	1.95
Stolephorus spp.	11.34	8.55	21.38	17.77	19.16	5.25	-	5.58	3.50	17.23	12.55	11.12
Trypauchen vagina	0.07	0.11	0.13	-	-	-	-	-	-	-	-	0.03
Fish total	35.73	33.41	43.00	51.43	38.33	15.41	10.27	17.12	29.82	37.22	37.03	31.71
Crustaceans												
Acetes spp.	28.16	21.95	19.46	6.60	1.87	9.22	39.66	26.57	21.60	17.71	46.54	21.76
Crabs	1.91	1.95	0.08	0.33	3.71	5.89	0.13	-	0.08	-	0.09	1.29
Deep sea shrimps	-	0.66	0.24	0.09	3.44	6.20	3.98	5.97	0.13	6.04	2.47	2.66
Parapenaeopsis stylifera	-	-	-	-	2.20	-	-	-	-	-	-	0.20
Metapenaeus dobsoni	24.54	19.20	22.54	36.51	38.55	45.61	34.84	36.74	41.00	24.12	11.74	30.49
Shrimp larvae	-	0.08	-	-	-	-	-	-	-	-	-	0.01
Squilla	1.74	0.15	0.01	0.79	0.39	1.31	-	-	0.08	-	0.52	0.45
Crustaceans total	56.35	44.00	42.32	44.31	50.16	68.24	78.62	69.28	62.89	47.87	61.36	56.86
Molluscs												
Cuttle fishes	2.38	2.76	1.11	0.42	0.31	-	1.24	0.35	-	-	0.74	0.85
Octopus	2.77	15.79	9.02	0.08	6.17	0.19	-	-	-	1.35	-	3.22
Squids	2.73	2.68	2.15	1.60	1.72	16.00	9.87	13.25	7.29	7.92	0.54	5.98
Molluscs total	7.88	21.23	12.28	2.10	8.20	16.18	11.11	13.60	7.29	9.27	1.28	10.04
Polychaetes	-	0.44	0.42	1.89	3.05	0.17	-	-	-	5.64	0.22	1.07
Miscellaneous items												
Medusae	-	-	-	0.08	-	-	-	-	-	-	-	0.01
Detritus	-	-	1.60	0.20	0.25	-	-	-	-	-	-	0.19
Jellyfish	0.04	0.91	-	-	-	-	-	-	-	-	-	0.09
Nereis	-	-	-	-	-	-	-	-	-	-	0.12	0.01
Others	-	-	0.37	-	-	-	-	-	-	-	-	0.03
Miscellaneous total	0.04	0.91	1.97	0.28	0.25	0.00	0.00	0.00	0.00	0.00	0.12	0.33

crabs (IRI=1.29) dominated the gut contents. Crustaceans formed the main food in all the months. Penaeid shrimps were represented by *Parapenaeopsis stylifera* and *M. dobsoni* and its peak occurrence was noticed during April-October. *Acetes* spp. were the second main crustacean component and it was present during most of the months with peak abundance during August-September and December-January. Deep-sea shrimps, represented by *Solenocera crassicornis* and *Solenocera choprai* also formed dominant food item with peak in May-September and November. Small sized crabs dominated by *Thalamita* spp. were present in the diet with peak abundance during January-February and May-June. Presence of shrimp larvae and squilla were observed in negligible quantities and their average IRI was 0.01 and 0.45 respectively.

Fishes

Fishes formed the second important food element of *N. japonicus* and was observed throughout the year. Species of fishes identified in the stomachs were**:** lizardfishes (*Saurida tumbil)*, *Bregmaceros mcclellandi*, silver bellies (*Leiognathus bindus* and *Secutor insidiator*), flatheads (*Platycephalus* spp.), *N. japonicus*, *N. randalli*, *Cynoglossus macrostomus*, larvae of eel, scads (*Decapterus russelli*), *Lactarius lactarius*, *Stolephorus* spp., horse mackerel, *Rastrelliger kanagurta,* eel, fish larvae and *Ambassis* sp. The average composition of all fishes for the period had an IRI value of 31.71. The IRI value for fishes were highest during April (51.43) and least in August (10.27). *Stolephorus* spp. was the dominant food

item of *N. japonicus* with an IRI value ranging from 3.5 (October) to 21.38 (March) and the average IRI for this food item was 11.12. *Stolephorus* spp. were represented by *Stolephorus devisi* and *Stolephorus commersonii*. The second food item that dominated the stomach were *L. lactarius* with an IRI value of 4.83 and IRI value ranged between 0.09 (May) and 17.23 (October). Flatheads were the third dominant fish food item present in the stomach of *N. japonicus* and its IRI value ranged from 0.13 (December) – 14.27 (March). The IRI values of other fish items present in the stomach were *Ambassis* sp. (0.03), *B. mcclellandi* (2.39), silverbellies (1.95), eel larvae (1.88), *S. tumbil* (1.58), fish larvae (1.14), *N. japonicus* (1.05), silverbellies (0.93), eel (0.89), *Cynoglossus s*pp. (0.87), *D. russelli* (0.30), horse mackerel (0.04), *N. randalli* (0.08), Indian mackerel (0.01), and *Trypauchen vagina* (0.03).

Molluscs

Molluscs represented by squids (*Loligo duvauceli*, *Loligo edulis* and *Loligo singhalensis*), cuttlefishes (juveniles of *Sepia pharaonis* and *Sepiella inermis*) and octopus (*Octopus membranaceus* and *Octopus aegina*) were present in the diet in almost all the months and average IRI for this item was 10.04. Highest IRI value for this item was observed in June (16.18) and minimum in December (1.28). The IRI values of squids, cuttlefishes and octopus were 5.98, 0.85 and 3.22 respectively.

Polychaetes

Polychaetes ranked fourth among the food organisms with an average IRI value of 1.07. The IRI value of polychaetes ranged between 0.17 (June) and 5.64 (November). The species of polychaetes found in the stomach were *Ancistrosyllis constricta, Polydora* sp. and *Cirratulus cirratus.*

Miscellaneous items

Medusae, detritus, jellyfish, nereis and unidentified zooplankton were the miscellaneous food items observed in the stomach and average IRI value of this group was 0.33. Miscellaneous food items were present in the diet occasionally and highest IRI value was observed in March and lowest in November. As their contributions were low, they were considered as secondary inclusion in the diet.

Seasonal variations in feeding

The diet composition of *N. japonicus* varied throughout the year (Table1). In the pre-monsoon season, crustaceans (45.20) and fishes (41.54) were the dominant food items found in the gut, followed by molluscs (10.95), polychaetes (1.45) and miscellaneous items (0.85). Among the teleosts, *Stolephorus* spp., followed by flatheads, *B. mcclellandi* and *L. lactarius* contributed significantly (Table 2). Juveniles of *S. tumbil* appeared only in monsoon. Significant seasonal difference in the number of major prey categories was observed. The variation was mainly between monsoon and post-monsoon seasons. During monsoon, crustaceans ranked first (IRI = 72.05) followed by fishes (IRI=14.27), and molluscs (13.63). *Acetes* spp. (25.15) and *M. dobsoni* (39.06) were the dominant crustacean components found in the stomach in monsoon season. Proportion of *Stolephorus* spp. (3.61) and *L. lactarius* (3.03) was also significant in the diet. However, *B. mcclellandi*, flatheads and silverbellies were less preferred in the monsoon season. Squids were dominant in the stomach in monsoon season while, polychaetes and miscellaneous food items were negligible in monsoon. In the post-monsoon season also crustaceans were the dominant food item present in the stomach with an IRI value of 57.12, followed by fishes (34.95), molluscs (6.43), polychaetes (1.46) and miscellaneous items (0.04). In the post-monsoon season, *Stolephorus* spp. (IRI= 11.16) were highly preferred, but was only next to *M. dobsoni* (IRI= 25.35) and *Acetes* spp. (IRI= 28.50). Proportion of squids were considerably reduced in the post-monsoon season due to the increasing consumption of *Acetes* spp. and penaeid shrimps.

Food in relation to size

The preference of different food items in relation to size of fish was studied (Fig.1). Crustaceans were the most preferred food item of juveniles and as the size of fish increased it gradually showed preference for fish items. Teleost fishes started to appear in the stomach of *N. japonicus* of 100 mm size and above. The occurrence of fishes in the stomach was found to increase with the size of fish. The presence of penaeid shrimps, deep sea

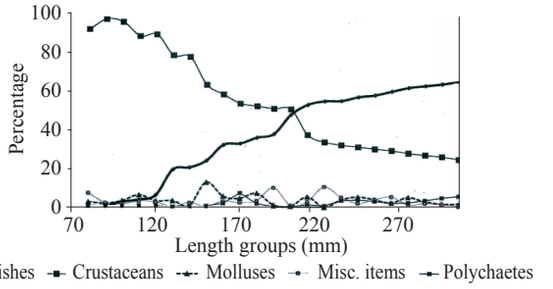

Fig. 1. Food composition of *N. Japonicus* in relation to size along the Malabar coast

Table 2. Food composition of *N. japonicus* in relation to different seasons during 2005-2012

Prey items	Pre-monsoon	Monsoon	Post-monsoon
Fishes			
Ambassis sp.	0.10	-	-
B. mcclellandi	4.19	0.92	1.70
Cynoglossus spp.	1.67	0.26	0.53
D. russelli	0.64	0.15	0.06
Eel	0.05	0.98	1.65
Eel larvae	0.07	0.27	4.90
Fish larvae	-	1.42	2.08
Flat heads	7.25	0.53	2.01
Horse mackerel	0.12	-	-
L. lactarius	3.29	3.03	7.73
Indian mackerel	-	-	0.02
N. japonicus	0.06	1.42	1.77
N. randalli	-	0.12	0.14
S. tumbil	2.54	0.92	1.11
Silverbellies	4.79	0.63	0.09
Stolephorus spp.	16.71	3.61	11.16
T. vagina	0.06	-	0.02
Fish total	41.54	14.27	34.95
Crustaceans			
Acetes spp.	12.47	25.15	28.50
Crabs	1.52	2.01	0.52
Deep sea shrimps	1.11	5.38	2.16
P. stylifera	0.55	-	-
M. dobsoni	29.20	39.06	25.35
Shrimp larvae	0.02	-	-
Squilla	0.34	0.44	0.58
Crustaceans total	45.20	72.05	57.12
Molluscs			
Cuttlefishes	1.15	0.53	0.78
Octopus	7.77	0.06	1.03
Squids	2.04	13.04	4.62
Molluscs total	10.95	13.63	6.43
Polychaetes	1.45	0.06	1.46
Miscellaneous items			
Medusae	0.02	-	-
Detritus	0.51	-	-
Jelly fish	0.23	-	0.01
Nereis	-	-	0.03
Others	0.09	-	-
Miscellaneous total	0.85	0.00	0.04

shrimps, crabs and stomatopods were observed as the fish grew beyond 180 mm and it was the common crustacean component found in the diet with increase in size of fish. Young ones of squids, cuttlefishes and octopus were occasionally present in the stomach contents of fish above 80 mm. Polychaetes and miscellaneous items were observed in the stomach of fishes above 90 mm.

Feeding intensity

The percentage occurrence of different degrees of fullness of stomach in different months during 2005-2012 is given in (Fig. 2.) Fishes with poorly fed stomachs were observed during all the months and on an average it formed 68.18%. The presence of fishes with empty stomachs in highest percentage indicates that there is no regular periodicity in the intensity of feeding in different months. Fishes with heavily fed stomachs was highest during January-April, June and in October, which indicates that the feeding intensity was highest during these months.

The percentage of conditions of feeding in relation to different maturity stages is presented in Fig 3. Fishes with actively fed stomachs were observed more in spent fishes (68.70%) and least in mature fishes (4.40%). Moderately fed stomach fluctuated between 21.5% in mature fishes and 31.2% in indeterminate fishes. Poorly fed stomachs were more in mature fishes (55.20%) and least in spent fishes (5.80%). In general, feeding intensity was high in indeterminate, maturing and spent fishes and poor in mature fishes.

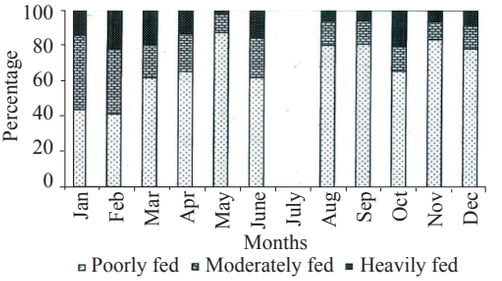

Fig. 2. Monthly feeding condition of *N. Japonicus* along Malabar coast

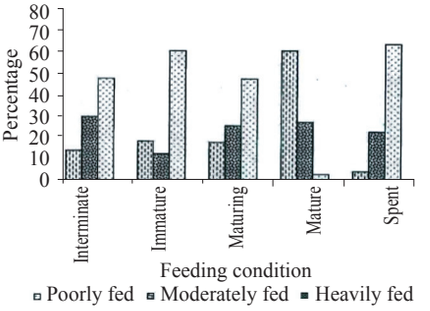

Fig. 3. Feeding condition of *N. Japonicus* in relation to different stages of maturity

Discussion

The present study shows that *N. japonicus* is a benthic carnivore that relies primarily on benthic crustaceans and fishes. Among crustaceans, *Acetes* spp., penaeid shrimps, deep sea shrimps, squilla, crabs and shrimp larvae formed the principal diet. Penaied shrimps found in the gut contents were *M. dobsoni* and *P. stylifera*. Presence of squilla and crabs were found occasionally in young and pre-adult fishes. Rao and Rao (1991), described food items *viz*., squilla, crabs, prawns, teleosts, cephalopods, amphipods, polychaetes and other

miscellaneous items in their order of importance in the gut of *N. japonicus*. This is supported by other studies from India (Kuthalingam, 1965; Krishnamoorthi, 1971; Gopal and Vivekanandan, 1991). According to Krishnamoorthi (1971), *N. japonicus* is actively predacious and possibly a sight feeder, feeding on crustaceans, molluscs, annelids and echinoderms. Kuthalingam (1965) from Mangalore coast observed that *M. dobsoni* and *P. stylifera* to be the dominant food of *N. japonicus*. In contrast, Russel (1990) from Australia observed that cephalopods, mainly squid and cuttlefish formed the dominant food followed by finfishes and other benthic crustaceans. George *et al.* (1968*)* reported from Cochin the presence of echinoids, amphipods and polychaetes in the diet of *N. japonicus*. In the present investigation squilla and polychaetes, were rarely observed in the diet. *L. duvauceli* was also important in the present study as observed by Russel (1990) from Australia. Cannibalistic behaviour was also observed in this species. Teleosts were also found to be major groups in the diet of *N. japonicus*. The major fishes observed were anchovies, scads, lizard fishes, flatheads, *L. lactarius* and fish larvae in the gut contents. The present study also recorded *S. tumbil, N. randalli, Leiognathus* spp. and *B. mcclellandi*. These results showed that even though *N. japonicus* preferred benthic crustaceans, it could also consume a broad spectrum of teleosts.

IRI for fishes were highest during March-April. During all other months crustacean components dominated in the diet. Monthly difference in the diet of *N. japonicus* was most probably in accordance with the seasonal variations in prey species abundance, which in turn determine their availability. Results of this study showed ontogenetic variations in the trophic spectrum of *N. japonicus*. The smallest individuals feed mainly on crustaceans, whereas larger individuals consume more teleost fishes. This shows that the fish become more icthyophagous with age. This shift in the diet pattern of *N. japonicus* was observed at a length of 200 mm. The absence of planktonic organisms in the stomach of adults in contrast to the young ones is due to the different habitats of fish (Qasim, 1971). The increasing variety of resources consumed with increase in size of predators is a common pattern among marine organisms including invertebrates (Rangeley and Thomas, 1987; Mascaro and Seed, 2001).

Feeding intensity of *N. japonicus* was not related to size (Krishnamoorthi, 1971). Predominance of empty stomachs was observed throughout the season. High proportion of empty stomachs in the present study as well as earlier studies (Krishnamoorthi, 1971; Gopal and Vivekanandan, 1991) may be due to non-availability of preferred food items during certain months. The similarity the present observation of dominance of empty stomachs in both juvenile and spent fishes also support the view that feeding intensity is not size dependent in *N. japonicus.*

The highest similarity in feeding between the pre-monsoon and post-monsoon seasons is an indication of possible competition. Similarly, feeding similarity between different length groups was observed to be higher. This indicates that most of the length groups share same prey groups. This is in agreement with the work of Rao and Rao (1991) from Visakhapatnam. Mixed feeding exhibited by *N. japonicus* was mainly due to individual preference to certain prey types and seasonal variations in the availability of prey in the ecosystem as suggested by MacArthur and Pianka (1966).

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