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Observations on the diet of the silverbelly *Leiognathus brevirostris* (Valenciennes 1835) from Kerala coast

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Abstract

Gut contents of the silverbelly *Leiognathus brevirostris* from the fishing grounds off Kerala was studied. The study showed that the fish is a demersal planktophagus and benthophagus carnivore feeding mainly on planktonic crustaceans, diatoms, nematodes, polychaetes, benthic foraminiferans, mud and miscellaneous food items. There was no significant seasonal variation in the types of food consumed by the fish, but there was a significant ontogenetic variation in the trophic spectrum. The young ones fed mainly on planktonic copepods, amphipods, diatoms and *Coscinodiscus* whereas the larger ones consumed more worms, benthic foraminifera, *Squilla* and cuttlefish. Feeding intensity was seasonal, but independent of length of fish. The monsoon is the period of active feeding and showed highest gastrosomatic index.

Keywords: *Leiognathus brevirostris*, ontogenetic variation, feeding intensity, planktophagus, benthophagus, carnivore, gastrosomatic index

Introduction

Information on gut contents of marine fishes is necessary for understanding community ecology, structure and stability of food webs, trophodynamics, resource partitioning, functional role of different fishes in aquatic ecosystems and ecological energetics (Wootton, 1999; Cruz-Escalona *et al*., 2000; Post *et al*., 2000; Bacheler *et al*., 2004; Hajisamae *et al*., 2004; Abdel-Aziz and Gharib, 2007). Silverbellies are one of the major demersal finfish resources exploited along the east and west coasts of India. Several authors reported the diet of silverbellies from the Indian coast particularly from the southeast coast of India (Chacko, 1944a and b, 1949; Vijayaraghavan, 1949; James and Badrudeen, 1975). The present work is aimed to investigate the diet of *Leiognathus brevirostris* distributed along the Kerala coast and to find out the seasonal and ontogenetic variation in the feeding intensity and types of prey consumed by the fish.

Material and Methods

Fortnightly collections of *L. brevirostris* were made during March 2005 to February 2007 from fish landings at Neendakara (Quilon), Ambalapuzha (Alleppey), Thoppumpady (Cochin), Azhikode and Chettuva (Thrissur). A total of 1252 specimens (554 males, 502 females and 196 indeterminates) in the length range of 38.5 mm to 162.8 mm were analysed. The total length (to the nearest 1mm), total weight (to the nearest 0.1 g), sex and maturity stages were recorded and stomach contents were analysed. Some empty stomachs were shrunken and contained mucus, while others were expanded but completely empty; the latter type is believed to occur in fish which have recently regurgitated (Daan, 1973). Regurgitated stomachs were discarded.

Both qualitative and quantitative analyses of diet were carried out. Each stomach was emptied into a petridish and examined under a binocular microscope (Jimmy *et al*., 2003). Attempts were made to identify the food items up to the possible taxonomic level depending on the state of digestion (Fischer and Bianchi, 1984). Since food items of silverbellies were minute in size, weight and volume displaced by each food item was negligible. Hence Index of Preponderance (Natarajan and Jhingran, 1961) and Index of Relative Importance (Pinkas *et al.,* 1971)

methods were not applied. To analyse the amount of each food item in the gut the method of Platell and Potter (2001) was modified by evenly spreading all contents from each gut in the counting cell chamber and examining under microscope. Analysis was done using frequency of occurrence and numerical methods as described by Hyslop (1980). In the frequency of occurrence method, the occurrence of food items was expressed as the percentage of total number of stomach containing food. In the numerical method, the number of each food item was expressed as the percentage of total number of food items found in the stomach. Both these methods have been used by a number of researchers for providing a definite and measurable basis for grading different food items (Ugwumba, 1988; Durr and Gonzalez, 2002; Shalloof and Khalifa, 2009).

To assess changes in the diet with fish size, the fishes were divided into six size classes from 30-49 mm to 130-149 mm. Stomach contents of juveniles (indeterminate sex group of length range 30 - 50 mm) were analysed separately to determine the ontogenetic variations in feeding habits. Seasonal studies on the diet was also carried out by compiling the months of the study period into the following three seasons: pre-monsoon (February, March, April and May) monsoon (June, July, August and September) and post-monsoon (October, November, December and January).

Feeding intensity was determined based on the degree of distention of stomach and the amount of food items in it. The stomachs were classified as gorged, full, ¾ full, ½ full, ¼ full and empty and the data were pooled and classified as poorly fed (¼ full and empty) and actively fed (½ full, ¾ full, full and gorged). Month and length group based determination of condition of feed was carried out. Stomach fullness data were analysed to study the feeding activity and to measure the intensity of feeding in relation to season and size. The data were statistically tested using two-way contingency table by Chi-square test (Sokal and Rohlf, 1981). Different prey types were pooled into seven general categories and analysed using two way contingency tables. Gastro-somatic index (GSI) was recorded using the equation,

$$GSI = \frac{\text{weight of stomach}}{\text{weight of fish}} \times 100$$

Results

The monthly composition of food items of *L. brevirostris* is shown in Table 1. The trophic spectrum of *L. brevirostris* composed of 15 dietary items which were classified into seven general categories: Copepods, Semi-digested smaller, larval and post larval shrimps, foraminiferans, nematodes, polychaetes, cephalopods and miscellaneous items.

Table 1. Monthly numerical percentage (N%) and frequency of occurrence (F%) of various food items of *L. brevirostris*

Month	n	Copepods		Semi-digested matter		Larval and post-larval shrimps		Nematodes		Polychaetes		Foraminiferans		Miscellaneous	
		N%	F%	N%	F%	N%	F%	N%	F%	N%	F%	N%	F%	N%	F%
March	65	45.76	93.04	25.00	56.26	13.83	25.61	5.34	36.50	6.15	20.00	1.51	5.60	2.71	95.60
April	92	49.64	96.35	27.85	69.22	12.52	16.23	1.65	12.30	4.35	45.13	3.20	4.23	3.32	85.21
May	95	54.73	92.66	22.37	75.33	14.64	10.21	1.51	25.60	4.01	26.14	1.71	9.35	1.03	88.22
June	82	56.97	100.0	25.88	82.11	10.91	36.20	0.66	25.30	3.95	12.35	0.89	10.21	0.75	86.34
July	52	55.70	100.0	20.06	56.21	16.26	68.23	3.84	26.35	1.28	14.65	1.58	11.60	1.29	94.31
August	165	44.52	100.0	20.77	91.01	10.57	53.20	8.04	32.12	10.78	19.36	2.40	3.60	2.92	85.24
September	105	40.17	96.25	21.68	93.67	14.41	45.12	10.54	36.20	7.72	5.60	1.20	5.42	2.84	96.86
October	63	38.04	100.0	19.09	81.37	13.82	13.21	13.94	12.50	7.56	2.30	2.50	8.04	2.34	85.28
November	175	41.79	91.08	21.00	85.21	13.79	16.30	10.47	13.60	6.19	2.60	3.71	4.04	3.82	93.28
December	93	40.41	92.06	19.85	45.11	15.38	6.30	10.53	10.10	6.71	1.30	2.10	3.63	3.92	92.18
January	102	44.18	94.00	22.72	67.35	12.30	6.30	8.10	6.35	6.15	4.50	3.60	3.57	1.39	91.60
February	163	47.44	100.0	22.89	75.25	09.33	12.00	9.68	8.20	5.56	5.60	2.68	3.26	2.45	95.20
Average		6.62	96.26	22.43	73.15	13.15	25.74	7.02	20.43	5.87	13.28	2.26	6.02	2.40	90.44

Crustaceans formed the main food in all the months. In occurrence, copepods, *Calanus* sp. *and Eucalanus* sp. were the major items where it occurred in more than 90% of the examined fish in all the months. The larval and postlarval (PL) stages of penaeid prawns formed the second preferred food. From June to September, nearly 50% of individuals showed presence of these food items but during the months of December and January, only negligible percentage of stomachs showed their presence. Amphipods (*Melita* sp., *Eriopisa* sp. and *Podoceros* sp.) and *Squilla* was also observed in small quantities (included under miscellaneous category).

The semidigested matter was present in all months. On an average, nearly 75% of stomachs showed the presence of semidigested matter. Nematodes formed the third important food of *L. brevirostris* in terms of numerical percentage and were recorded throughout the year. Polychaetes represented by *Nereis* sp. and *Eunice* sp. were present in the diet in all months and occupied the 4th position in the order of preference in terms of numerical percentage. The benthic foraminiferans showed occurrence in nearly 6% of stomachs and occupied the last position in the order of preference in both the numerical and frequency methods.

Miscellaneous items consisted of amphipods, *Squilla*, diatoms, *Coscinodiscus*, cuttlefish (*Sepia* sp.), mud, sand grains, fish scales and small molluscan shell pieces. More than 85% of stomachs exhibited the presence of more than one type of miscellaneous food item though the numerical percentage was very low in various months. Having the highest percentage frequency of occurrence, this component occupied the 2nd position but 6th in the order of preference in the diet of *L. brevirostris* while considering the numerical percentage. Generally, results of the two methods of analyses indicated the importance of copepods as the major food of *L. brevirostris*.

Seasonal variation in diet composition: The two-way contingency table analysis (Chi-square test) revealed that there is no significant difference in number of major prey types consumed by the fish between seasons (df = 10; P = 0.05).

Ontogenetic variation in diet composition: *L. brevirostris* changed its diet from planktonic micro-crustaceans, predominantly calanoid copepods, during young stages to nematodes, polychaetes, *Squilla* and cuttlefish with increasing size. The diet of the smallest length class 30-49 mm (juveniles) composed mainly of copepods (Table 2). Fish of the next higher length classes 50-69 mm and 70-89 mm had less percentage of copepods and more percentage of larval and post - larval shrimps, polychaetes, nematodes and cuttlefish. The adults of length class of 90-109 mm to 130-149 mm consumed low percentage of copepods, and higher percentage of larval and post-larval shrimps, *Squilla*, polychaetes, nematodes and cuttlefish. It was noticed that, along with an increase in the consumption of benthic food, there was a rise in the occurrence of sand, mud, scales and shell pieces in the stomach. Molluscs represented by young cuttlefish were occasionally present in the

Table 2. Percentage (N% and F%) of various food items in 20 mm length groups of *L. brevirostris*

Length group (mm)	n	Copepods		Semi-digested matter		Larval and post-larval shrimps		Nematodes		Polychaetes		Foramini-ferans		*Miscellaneous	
		N%	F%	N%	F%	N%	F%	N%	F%	N%	F%	N%	F%	N%	F%
30-49	97	42.21	100.0	18.12	42.12	10.25	85.32	09.12	23.10	0.98	12.00	1.23	25.32	18.09	90.32
50-69	102	36.25	96.32	17.45	36.21	12.36	75.45	11.36	42.31	2.61	19.00	1.36	26.32	18.71	100.0
70-89	240	28.35	97.00	19.65	32.50	10.65	63.25	13.56	43.22	2.52	25.00	02.1	18.51	23.19	93.21
90-109	206	26.35	72.10	16.35	38.00	11.25	71.00	16.32	56.23	6.30	46.30	02.6	12.36	20.83	96.00
110-129	181	25.65	45.20	17.16	29.36	12.25	76.31	17.03	41.23	4.28	38.20	3.68	16.21	19.95	100.0
130-149	125	24.58	50.21	16.35	35.01	13.25	68.11	18.65	49.22	3.61	39.60	01.2	10.63	22.38	100.0
Average		30.56	76.81	17.51	35.53	11.66	73.24	14.34	42.55	3.37	30.02	2.02	18.23	20.39	97.84

*scales, mud particles, sand grains, small molluscan shell pieces, amphipods, diatoms, Squilla, Coscinodiscus, cuttlefish

stomach of fish above 70 mm. The two way contingency table analysis (chi-square test) on the relationship between size groups of fish and number of major prey types showed significant variation (X^2 = 20.46; df = 10; P = 0.05).

Feeding intensity: Fig. 1 shows that poorly fed fishes were observed in all the months with peak during September to November and March. The numbers of actively fed fishes were high during June, July, August, December and January. Two way contingency analysis showed significant variation in the feeding intensity (X^2 = 14.82; df = 2; P = 0.05).

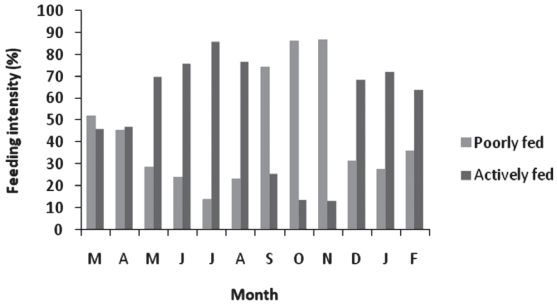

Fig. 1. Monthly feeding intensity of *L. brevirostris*

The percentage of feeding intensity in relation to various length groups is presented in Fig. 2. Generally, fishes with actively fed stomach were recorded more in smaller length groups (30-49 mm to 90-109 mm) and the lowest in larger length groups (130-149 mm). Poorly fed fishes were more in larger length groups and were less in smaller fishes of size range 30-49 mm. However, two way contingency analysis did not show statistically significant changes in the feeding intensity in relation to various size classes of the fish (df = 5; P = 0.05).

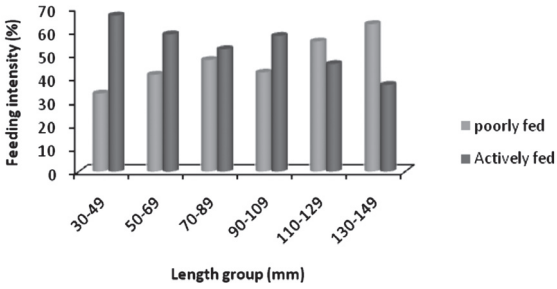

Fig. 2. Feeding intensity of *L. brevirostris* in relation to different length groups

Gastrosomatic Index: GSI showed a trend similar to that of feeding intensity with highest values in peak monsoon period (June and July) and in December and January (Fig. 3). The lowest values were during February - April and September - November.

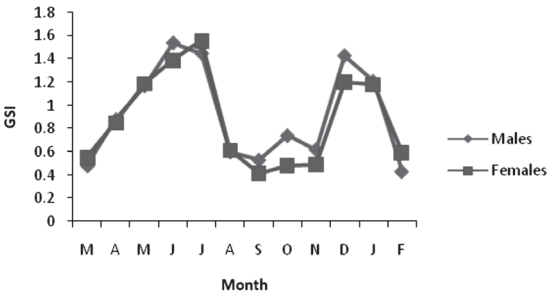

Fig. 3. Gastrosomatic indices of males and females of *L. brevirostris* during March 2005 to February 2007

Discussion

The present report shows that plankton constituted the main diet of *L. brevirostris*. The occurrence of benthic prey and the near consistent occurrence of sand grains and mud throughout the year indicate that the species is a bottom grazer as well. *L. brevirostris* is a planktophagus and benthophagus carnivore feeding on a mixed diet of 15 prey items consisting of planktonic crustaceans, diatoms, worms, benthic foraminiferans, mud, sand and a variety of miscellaneous items. The presence of fish scales and the total absence of any other solid part of fish in the diet suggests that the scales might be accidental ingestions in *L. brevirostris*. The result of the present study shows close similarities with earlier observations on the diet of *L. brevirostris* from Indian waters (Chacko, 1944 a and b, 1949; Tiews *et al.*, 1968; James and Badrudeen, 1975). James and Badrudeen (1975) reported *Lucifer* as the food item of *L. brevirostris* from Palk Bay and Gulf of Mannar but it was not encountered in any sample in the present study.

In the present study, no significant seasonal variation in the prey types consumed was recorded which is in agreement with the finding of James and Badrudeen (1975) on *L. brevirostris* from Palk Bay and Gulf of Mannar and on *L. dussumieri* from Gulf of Mannar (James and Badrudeen, 1981).

Significant ontogenetic variation existed in the trophic spectrum of *L. brevirostris*. Phytoplankton was absent in the stomach of fish above 90 mm length. As the mouth size severely limits the size of prey which can be ingested (Stickney *et al.*, 1974; Stickney, 1976), the diet of fish is related to their digestive morphology and mouth structure. As the fish grow, the size of mouth increases proportionately, their swimming capacity is modified, and their energy requirements vary (Qasim, 1971; Stergiou and Fourtouni, 1991; Platell *et al*., 1998). Thus larger fish have different diet requirements from smaller ones and attempt to satisfy by consuming a larger variety of prey types. The increasing variety of food consumed by predators as they grow is a common feature among marine organisms, including invertebrates (Rangeley and Thomas, 1987; Mascaro and Seed, 2001). Ontogenetic dietary shift was reported in *Leiognathus decorus* by Wright (1989), Hajisamae *et al*. (2004) and Hajisamae *et al*. (2006) in *Sillago sihama*; Manojkumar (2008) in *Nemipterus mesoprion* from Malabar coast; and Wongchinawit and Paphavasit (2009) in *Scatophagus argus*. However, the present study differs from the finding of James and Badrudeen (1975) on *L. brevirostris* collected from Palk Bay and Gulf of Mannar that the dietary items of the fish did not change as the fish grew in size.

Significant seasonal variation was reported in the feeding intensity of *L. brevirostris.* The monsoon is the period of active feeding whereas pre and post-monsoon periods showed reduced feeding. Most of the fish collected during post-monsoon and pre-monsoon months were in advanced stages of sexual maturity with body cavity fully occupied by ripe mature gonads. The reduced feeding activity during this time may be an indication of intense spawning along the Kerala coast.

Most of the fish collected during monsoon were having maturing gonads (personal observation) and showed intense feeding which may be a preparation for the forthcoming spawning season. From August end to November and in February and March, most of them possessed fully mature and ripe gonads but with poorly fed stomachs. During these seasons, the abdominal cavity was fully occupied by ripe gonad and the stomach was empty and small in size. According to Helene and Richard (2006), many environmental factors which influence the feeding intensity in fish is closely related to reproductive season.

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