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Food and Feeding Habits of *Johnius carutta* (Bloch, 1793) off Visakhapatnam, East-coast of India

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Abstract

Specimens of *Johnius carutta* (Bloch, 1793) collected from off Visakhapatnam during 2008-09 were used for gut content analysis. *J. carutta* was observed to be euryphagic, carnivorous, benthic, moderate feeder feeding mostly on teleost fish, free living crustaceans, polychaetes and molluscs. Analysis of gut revealed contents different food items with dominance of squilla (17.72%) followed by *Acetes* spp. (11.40%), shrimps (10.81%), teleost fish (9.10%), polychaetes (7.10%), crabs (5.10%) and crustacean appendages (3.20%). Quantitative analysis revealed the non-penaeid shrimp *Acetes* spp. (32.51%) dominating the food items followed by squilla (15.20%), shrimp (11.50%), fish (9.73%), polychaetes (8.63%), crustacean appendages (6.10%) and crab (3.90%). The composite index values indicated that squilla (35.62) is the most preferred food followed by *Acetes* spp. (18.03), teleost fish (16.62), shrimp (10.38) and polychaetes (6.26). The average gastro-somatic index values are relatively low during pre-monsoon (1.27%), moderate during monsoon (1.74%) and relatively high during post-monsoon (1.95%).

Keywords: *Johnius carutta,* gastro-somatic index, composite index

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Introduction

Sciaenids contributed to 5.65% of the total marine fish production in India during 2010 (CMFRI, 2010). The species *Johnius carutta* is a commercially important sciaenid occurring in the trawl catches off Visakhapatnam. Food and feeding habits of sciaenids have been investigated earlier in respect of *Otolithes ruber* (Pillai, 1983), *O. cuvieri* (Manojkumar, 2003), *Otolithoides brunneus* (Ghosh et al., 2009), *Johnius macrorhynus* (Telvekar et al., 2006), *Johnieops sina* (Nair, 1980), *J. vogleri* (Muthiah, 1982), *Pennahia aneus* (Gandhi, 1982) and *P. macrophthalmus* (Lal Mohan, 1985). Food and feeding habits of *O. cuvieri* from Ratnagiri and *J. sina* along Cochin coast was studied by Sandhya et al. (2014) and Venugopal et al. (2014) respectively. The investigations on food and feeding habits of *J. carutta* from west coast of Madras province were carried out by Jacob (1948), from east coast of Waltair by Rao (1964) and from west coast by Suseelan & Nair (1969). The present work was taken up during 2008-09 from Visakhapatnam coast to understand the status of food and feeding habits of *J. carutta*.

Material and Methods

A total of 3406 samples of *J. carutta* were collected from the trawl catches of Departmental Research Vessel CIFTECH-1 within 35-40 m depth off Visakhapatnam (17º 10′ to 18º 10′ N and 82º 50′ to 84º 10′ E) from January 2008 to December 2009. The intensity of feeding was determined based on the degree of fullness of stomach and points were allotted to the classified stomachs *viz.,* empty (0), trace (10), ¼ full (25), ½ full (50) and full (100) (Bapat & Bal, 1952). The sum of allotted points based on different degrees of fullness of stomach was divided by the number of stomach samples in that month or length class. In order to estimate the seasonal food preference; the Occurrence method (Hynes, 1950) and Numerical method (Bal & Rao, 1990) were adopted. The composite index values were calculated using Index of preponderance method (Natarajan & Jhingran, 1961). Gastro somatic index

(GaSI) values in percentage were calculated for different months for length groups of fishes as GaSI = weight of the stomach x 100 / total weight of the fish (Desai, 1970). Food items in advanced stage of digestion were classified merely as shrimp, fish or crab. Identified food items were categorized into six different groups *viz.*, teleost fishes, crustaceans, polychaetes, molluscs, brachiopods and miscellaneous items.

Results and Discussion

J. carutta length ranging from 110 to 249 mm were used for the gut content study. No morphological characteristics for determination of sex was observed and sex was identified by observing the gonads on incision of abdominal cavity. No significant difference was observed in the food items of either sex. Empty guts were observed in fishes during most of the months. The qualitative analysis of food items indicated that *J. carutta* was euryphagic. Free living crustaceans formed the major food in which squilla, shrimps, *Acetes* spp. and small crabs dominated. Other crustaceans identified were *Parapenaeopsis* spp., *Metapenaeus monoceros, Penaeus monodon, Aristeus* spp., *Solenocera* spp., *Argulus* spp., *Albunea symnista,* hermit crab, megalopa (crab larvae), shrimp post larvae, amphipods, isopods and copepods. The remaining food organisms identified were under different categories *viz.,* teleost fish, polychaetes, molluscs, brachiopods and miscellaneous items (Table 1).

Analysis of percentage occurrence of different food items reveals that squilla (17.72%) dominated followed by *Acetes* spp. (11.40%), shrimps (10.81%), fish (9.10%), polychaetes (7.10%), crabs (5.10%),

Table 1. Identified food items in the gut contents of *Johnius carutta*

Teleost fish	Crustaceans	Polychaetes	Molluscs	Brachiopods	Misc. food items
Blennies ***	*Acetes indicus* * & #	*Nereis* spp. *, ** & ***	Molluscan remains ***	*Lingula* spp. *	Sea anemone * & ***
Callichelys spp.*	*Albunea symnista**	*Arenicola* spp. *	**Gastropods**	*Corbis* spp. ***	Ascidians * & ***
Cynoglossus spp. *	*Aristeus* spp. *	*Eunice* spp. ***	*Murex virgineus* *		Foraminiferans (protozoans) ** & ***
	Argulus spp.*	phyllodocids ***	*Sinum* spp. *		Radiolarians (protozoans) **
Conger spp. (juvenile eel) *	*Cypridina* spp. ***		*Nerita* spp. *		Elver (eel larvae) ***
Gazza spp. *	*Elamena* spp. (Decopod) ***		*Umbonium* spp. #		Echinoids ***
Leiognathus spp. *	*Lucifer* spp. **		Pteropods #		Fish scales * , ** & ***
*Lepturacanthus savala**	*Metapenaeus monoceros* *		*Dentalium* spp. ***		Eggs **
*Polynemus indicus**	*Parapenaeopsis* spp. *		*Hemifusus* (Foot of gastropod) *		Semi-digested food *
Sardinella spp.*	*Penaeus monodon* *		Lamellibranchs ***		Digested food/ organic matter *
Saurida spp. *	*Philyra* spp. (Decapod) ***		**Cephalopods**		Sand grains * & **
Sciaena spp. **	*Solenocera* spp. *		*Loligo* spp. *		
	Squilla woodmasoni * & ***		*Sepia* spp. *		
Stolephorus spp. **	Penaeid prawns *** & #				
Trichiurus spp.*	Prawns *, ** & ***				
Fishes #	Isopods * & ***				
Teleost remains ***	Amphipods (Gammarus) *, **, *** & #				
	Copepods (*Paracalanus* spp.) *, ** & ***				
	Lepas *				
	Portunid crabs #				
	Hermit crab * & ***				
	Megalopa				
	Shrimp post larva *				
	Crustacean remains * & ***				
	Decapod remains ***				
	Crab remains ***				
	Stomatopods ***				

Food items reported by: (Present author)*, (Jacob, 1948)**, (Rao, 1964)*** and (Suseelan& Nair, 1969) #

crustacean appendages (3.20%). The highest occurrence of these food items were reported in the month of April (44.44%) followed by August (24.65%), May (21.74%), January (27.27%), September (14.75%), February (11.67%) and January (9.09%) respectively. Digested food (19.70%) contributed the most and amphipods (2.20%), gastropods (2.20%) and semi-digested food (2.50%) was relatively low. Occurrence of remaining food constituents *viz.*, eel (1.59%), isopods (1.59%), brachiopods (1.44%), sea anemones (1.44%), copepods (1.17%), *Solenocera* (0.58%), hermit crab (0.58), cephalopods (0.43%) and sea squirts (0.43%) were irregular and collectively contributed to 9.24% (Table 2).

Quantitative analysis (number) reveals the non-penaeid shrimp *Acetes* spp. (32.51%) dominated the food items followed by squilla (15.15%), shrimp (11.48%), fish (9.73%), polychaetes (8.63%), crustacean appendages (6.06%) and crab (3.86%) (Table 2).

Table 2. Number and percentage occurrence of different food items of *Johnius carutta* during 2008-09

Food items	Occurrence (%)	Number (%)
Squilla	17.72	15.15
Fish	9.10	9.73
Eel	1.59	1.45
Polychaetes	7.10	8.63
Shrimp	10.81	11.48
Acetes spp.	11.40	32.51
Solenocera spp.	0.58	1.01
Crab	5.10	3.86
Hermit crab	0.58	0.37
Crustacean appendages	3.20	6.06
Amphipods	2.20	1.93
Isopods	1.59	1.56
Copepods	1.17	1.29
Gastropod	2.20	1.38
Brachiopod (Lingula)	1.44	1.29
Cephalopods (squid tentacle/mantle)	0.43	0.28
Sea anemone	1.44	1.65
Sea squirts	0.43	0.37
Digested food/Organic matter	19.74	0.00
Semi digested food	2.50	0.00

The highest number of these food items were observed during the month of August (60%) followed by April (66.67%), May (21.05%), January (fish and polychaetes 75.76%, June (22.73%) and February (11.27%) respectively. The contribution of other food items ranged from 1 to 2% and collectively contributed about 12.58%. Amphipods, small crabs, eel, gastropods, isopods and copepods substantially dominated in different months ranging from 7.9 to 14%. Percentage contribution of different degrees of fullness of stomachs and their dominance in different months was depicted in Fig. 1 and 2 respectively.

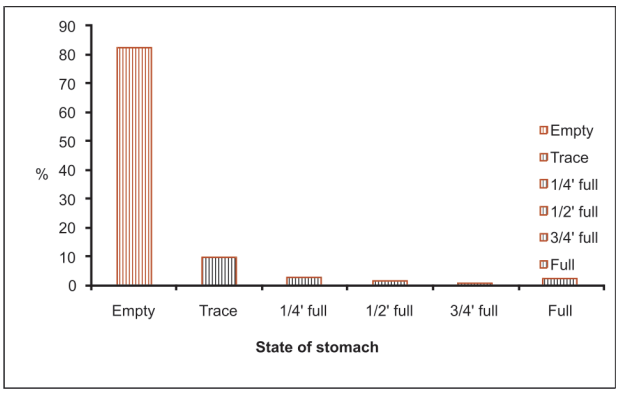

Fig. 1. Contribution of different states of stomach fullness of *Johnius carutta* during 2008-09

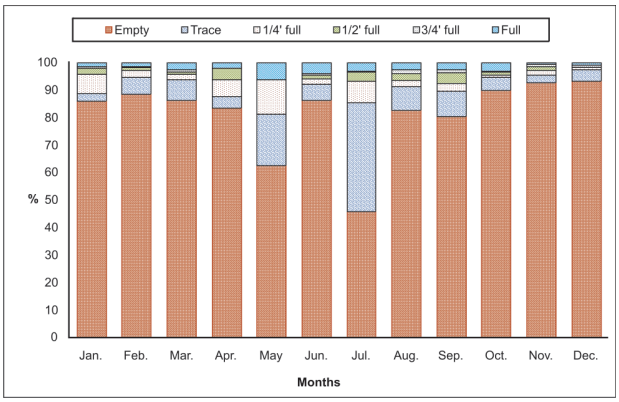

Fig. 2. Month-wise stomach content volume based on fullness of *Johnius carutta* during 2008-09

The composite index values indicated that squilla (35.62%), *Acetes* spp. (18.03%), fish (16.62%), shrimps (10.38%) and polychaetes (6.26%) were the preferred food in decreasing order and formed the steady food item for 9-12 months; peak occurrence of squilla was in the month of April (88.89%) followed by August (80.42%), January (71.83%), December (39.13%) and September (21.59%) respectively. The contribution of remaining food items was 13.10% which fluctuated during different months. The

contribution of small crabs were relatively low (2.45%) but was represented continuously in food spectrum (Fig. 3).

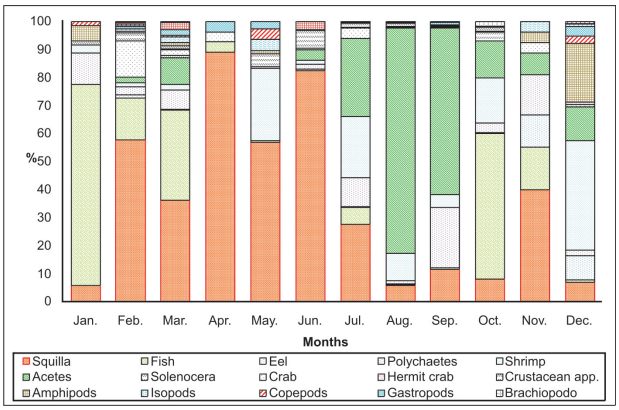

Fig. 3. Month-wise index of preponderance of different food items (pooled) of *Johnius carutta* during 2008-09

High gastro-somatic index values were reported in February (3.50%) followed by March (3.46%) and April (2.74%). The minimum and maximum GaSI values were noticed during February (1.22%) and October (2.24%). Average GaSI values were relatively low (1.27%) during spawning season (February-May); moderate (1.74%) and relatively high (1.95%) during post-spawning (June-September) and pre-spawning seasons (October-January) respectively (Fig. 4). Empty stomachs were dominated in the size-wise groups *viz.*, 16-16.9 (20.12%), 17-17.9 (18.93%), 15-15.9 (15.66%) and 18-18.9 cm (12.40%). Lowest GaSI values were reported in the size-wise groups *viz.*, 18-18.9 (0.29%), 17-17.9 (0.34%), 16-16.9 (0.76%) and 15-15.9 cm (0.83%). Based on the average gonado-somatic index (GSI) values, Swamy Kumar et al. (2013) reported the spawning season of *J. carutta* was during pre-monsoon (3.05%) i.e. February-May; whereas GSI values were relatively low during post-spawning (0.60%) than the pre-spawning (0.89%) (Fig. 5). It may be due to the ripe gonads that high GSI (3.05%) value was recorded during spawning season and relatively low GSI (0.60%) value during post-spawning due to the shrunken, flaccid and wrinkled gonads. Low GaSI values observed in the present study during spawning season further corroborate the feeding intensity is in agreement with gonadal maturity. Studies revealed that the highest percentage of empty stomachs occurs during reproduction; owing to a significant decrease in food intake (Morte et al., 2001). According to Mathialagan & Sivakumar (2012) low feeding activity during peak breeding season can be attributed to fully developed gonads, permitting limited space in the stomach. Gulati (1987) opined that fully developed gonads which occupy a larger part of body cavity, block the distensibilty of stomachs which may be responsible for low feeding intensity during breeding season. All those earlier findings reported by Gulati (1987), Morte et al. (2001) and Mathialagan & Sivakumar (2012) corroborate the observations found in this communication.

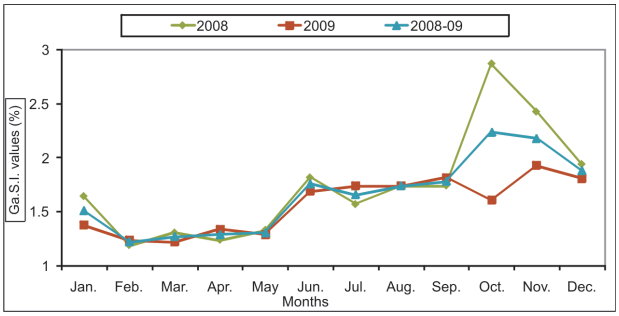

Fig. 4. Variations in gastro-somatic index of *Johnius carutta* (pooled) during 2008-09

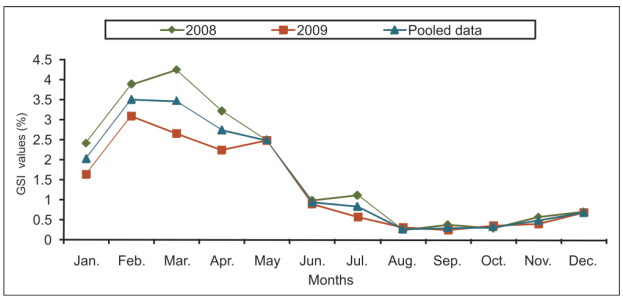

Fig. 5. Variations in gonado-somatic index of *Johnius carutta* (pooled) during 2008-09

The average feeding points estimated in different length groups indicated that the feeding activity intensified with increase in size of fish. The feeding points of 2.1 increased to 8.5 from 11-11.9 to 20-20.9 cm length group, after which it showed a declining trend (Fig. 6). During spawning season (pre-monsoon), 99% of gut samples were empty. Feeding intensity in points observed in different months indicated that feeding activity was relatively low during spawning (pre-monsoon) and relatively high during post-spawning (monsoon) (Fig. 7).

Percentage frequency of degree of fullness of stomach in different length groups of fishes showed

that trace (22.9%), 1/4 full (13.3%), 1/2 full (2.4%), 3/4 full (1.2%) and full (5.7%) stomachs dominated the length groups of 12-12.9, 22-22.9, 15-15.9, 18-18.9 and 20-20.9 cm respectively. Empty stomachs ranged from 73 to 88% in length groups of 22-22.9 and 15-15.9 cm. Stomachs of 1/4, 1/2, 3/4 full and full were relatively low in initial (11-14.9 cm), moderate in middle (15-118.9 cm) and high in terminal (19-22.9 cm) length groups respectively.

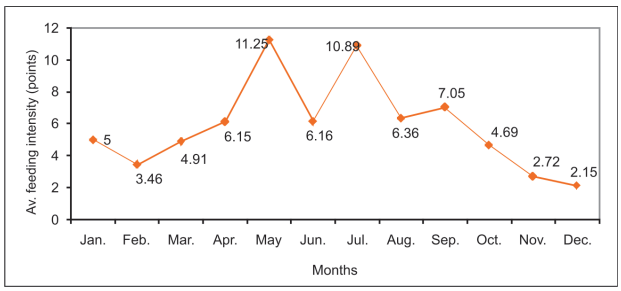

Fig. 6. Month-wise feeding intensity (points) of *Johnius carutta* during 2008-09

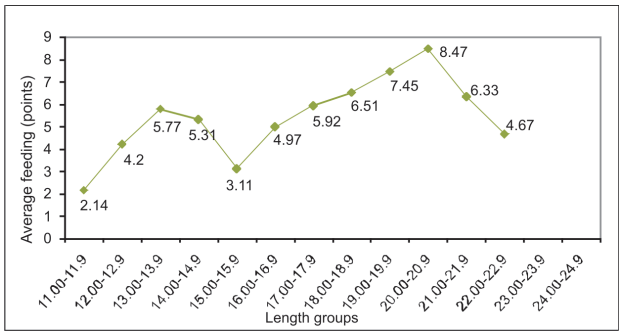

Fig. 7. Average feeding points in different size groups of *Johnius carutta* during 2008-09

Percentage occurrence of different food items in relation to length groups of fishes showed that squilla occurred maximum and dominated among other food constituents including *Acetes* spp. in almost all length groups. Highest occurrence of squilla (25.93%) was recorded in the 15-15.9 cm length group followed by teleost fish (12.5%) in the 22-22.9 cm range, *Acetes* spp., shrimps and crabs (25% each) in the 11-11.9 cm length range and polychaetes (12.12%) in the 13-13.9 cm range. Occurrence percentages of shrimps and *Acetes* spp., fish and polychaetes were relatively high in initial (11-14.9 cm) and middle (15-18.9 cm) length groups respectively, whereas crabs were reported moderate quantities in all the length groups. Occurrence value of other food items was irregular, insignificant and fluctuated in different length groups.

Numerically, *Acetes* spp. (53.85% in 12-12.9 cm) dominated among various food items recorded followed by squilla (40% in 15-15.9 cm), shrimp (40% in 11-11.9 cm), teleost fishes (18.18% in 17-17.9 cm) and polychaetes (16.82% in 13-13.9 cm) in respective length groups mentioned. Except in length group 15-15.9 cm, *Acetes* spp. always dominated in guts of fishes of all other length groups. Almost all varieties of food items were reported in 16-18.9 cm length groups. Crabs occurred relatively high (20% in 11-11.9 cm), moderate (6.9% in 21-21.9 cm) and low (4.85% in 17-17.9 cm) in respective groups. Except amphipods (57.14% in 22-22.9 cm length group), the numbers of all other food constituents are insignificant and seen irregularly in different length groups.

Based on composite index values, squilla (73.55%), *Acetes* spp. (58.82%), shrimp (40.0%), teleost fish (23.75%), crabs (20.0%) and polychaetes (16.46%) were the preferred food in their order for fishes in the length groups of 15-15.9, 12-12.9, 11-11.9, 17-17.9, 11-11.9 and 13-13.9 cm respectively. Relatively low composite index values of crab ranging from 0.37 to 20.0 were recorded in different length groups and formed continuous food of *J. carutta* except in the length groups 22-22.9 to 24-24.9 cm. Shrimps and *Acetes* spp. dominated in guts of initial length groups (11-11.9 to 14-14.9 cm) whereas squilla, fish and polychaetes dominated the middle length groups (15-15.9 to 20-20.9 cm).

The intestine of *J. carutta* is relatively short and straight, hence this species can be classified as carnivorous fish. Both empty (82.6%) and trace (9.8%) stomachs together constituted 92.4% of total stomach samples analyzed. This is a clear indication that *J. carutta* is a moderate feeder. However, gorged stomachs were observed in the present study only in four specimens in which a lone hermit crab was present in the stomach weighing 5.48 g. Sand grains observed in the present study was also reported earlier by Jacob (1948) along with benthic organisms in relatively low quantities could have been taken accidentally while burrowing in sand to prey upon benthic organisms.

Jacob (1948) recorded copepods (*Paracalonus* spp.), *Lucifer* spp., foraminiferans, radiolarians, larval crabs, *Gammarus*, prawns, polychaetes, *Stolephorus* spp., *Cynoglossus semifasciatus*, *Sciaena* spp., fish scales, eggs and sand grains as food items in the stomach of *J. carutta*. He also reported one instance of cannibalism. According to Karandikar & Thakur

(1951), sciaenids are carnivorous, feeding on fish, crustaceans, molluscs and annelids. Rao (1964) observed that food organisms of *J. carutta* mostly composed of benthic fauna and also reported caridean prawns and squilla Suseelan & Nair (1969) reported that *J. carutta* is a carnivore, feeding mainly on free-living crustaceans like penaeid prawns, *Acetes indicus*, portunid crabs and amphipods, fishes and molluscs like pteropods and gastropods (*Umbonium* spp.).

Some of the food organisms of *J. carutta* observed in the present study have been reported by the earlier researchers *viz*., among teleost food items, *Stolephorus* spp. and *Cynoglossus* spp. (Jacob, 1948); among crustaceans, *Acetes* spp. and amphipods (Suseelan & Nair, 1969); *Squilla woodmasoni*, hermit crab and crustacean remains (Rao, 1964); prawns, amphipods, copepods and megalopa (Jacob, 1948; Rao, 1964); among polychaetes, *Nereis* spp. (Jacob, 1948; Rao, 1964). The food items of *J. carutta* from Visakhapatnam coast among teleost fish (*Callichelys* spp., *Cynoglossus* spp., *Conger* spp., *Gazza* spp., *Leiognathus* spp., *Lepturacanthus savala*, *Polynemus indicus*, *Sardinella* spp., *Saurida* spp., *Stolephorus indicus*, *Trichiurus* spp.), Crustaceans (*A.indicus, Albunea symnista*, *Aristeus* spp., *Argulus* spp., *Metapenaeus monoceros*, *Parapenaeopsis* spp., *Penaeus monodon*, *Solenocera* spp., Lepas), Polychaetes (Arenicola spp.), Gastropods (*Murex virgineus, Sinum* spp., *Nerita* spp., *Hemifusus* (foot of gastropod), Cephalopods (*Loligo* spp., *Sepia* spp.) and Brachiopods (*Lingula* spp.) was not reported by Rao (1964) who investigated the feeding habits of the same species from Visakhapatnam coast. However, some of the food items of *J. carutta* reported by Rao (1964) among teleost fish (Elver and Blennies), Crustaceans (*Cypridina* spp., *Elamena* spp., *Philyra* spp.), Gastropods (*Dentalium* spp., Lamellibranchs), Brachiopods (*Corbis* spp.) and Foraminiferans were not observed in the present investigation. The differences in food organisms observed by different workers from same geographical location could be attributed to their availability in that habitat.

The present study provides the information on the food composition and feeding habits of *J. carutta* along Visakhapatnam coast. The data used in the present study can also be used for the estimation of its trophic level and as an input to create trophic models which would be useful to understand complex coastal ecosystem and can be a key input for management.

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