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Food and feeding of yellow tail scad *Atule mate* (Cuvier 1833) from Andaman waters, India

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ABSTRACT

Carangids are fast swimming carnivores and pursuit predators. The knowledge of food and feeding is essential to have an idea of vertical as well as horizontal distribution and ecology. A study on food and feeding of *Atule mate* was carried out from the Andaman Islands. The sampling was conducted from January 2019 to December 2019. The feeding intensity observed as relatively high with dominance of ¾ and ½ filled stomachs. The feeding intensity was higher in smaller fishes and was discernible from the length group-wise analysis of the Gastrosomatic index, where the highest average GaSI value for length class was 120-129 mm (2.39) followed by 160-169 mm (2.07). The food comprised of copepods, shrimps, fish scales, fish bones, Lucifer, cephalopods, fish eye, algal remains, tree bark remains and fish remains (*Stolephorus* sp., leiognathids, clupeids and carangids). Copepods were the dominant food item with 25.7%, followed by shrimp parts 22.2% and the least were algal remains and tree bark with 0.06% and 0.18 %. The present study shows that the species is a carnivore with two feeding patterns: the juveniles feed mainly on copepods and shrimp parts, while adults prefer fishes and cephalopods to feed.

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1. Introduction

The coast of Andaman and Nicobar Islands is a very important part of the Indian EEZ, with 1434 species of fish recorded under 576 genera belonging to 165 families, out of which approximately 400 species are commercially important (Rajan et al. 2013). Carangids are one of the largest families under the order Perciformes and are represented by 62 species under 20 genera from the Indian coast (Joshi et al. 2011) and 48 species from the Andaman coast (Rajan et al. 2013). Carangidae is a diverse family of trevallies, jacks, amberjacks, scads, pilot fish, kingfish and rainbow runners. They are characterised by two anterior spines with anal fin separated from the rest of the fin and they possess small cycloid scales and enlarged scutes along the straight portion of lateral line (Honebrink, 2000). They inhabit coastal, marine and estuarine waters of tropical, subtropical and temperate regions of the globe. The fishery is mainly by gears such as trawlers, gill net, seine nets and hook and line from different ocean realms during day and night (Sivakami 1996). Carangids are one of the most economically important food fish worldwide due to their wide distribution and high demand from sea food industry (Azim et al. 2017).

Food plays an important role in the life of the organisms for growth, reproduction and maintenance, which can give an idea on the determination of trophic level in the food chain and migratory as well as shoaling behaviour of fishes (Chacko 1949, Sen et al. 2011). The knowledge of food and feeding of a species also contributes to understanding the vertical and horizontal distribution of the fishes in space and time (Sivakami, 1996). Food has a greater role in the distribution, growth, behaviour, migration and reproduction of fishes in the aquatic environment. It is the key factor maintaining throughout their life span and in the future. The knowledge of gut content analysis is important in aquaculture industries in establishing a diet for rapid growth, better condition and reproduction of the fishes for that feeding preference in the wild must be known (Priyadharsini et al. 2013). Carangids are fast swimming carnivorous fishes that exhibit two types of feeding, plankton feeding and fish feeding, as they are pursuit predators (Honebrink 2000). Kingston et al. (1999) found that *Atule mate* in the Gulf of Mannar displayed two distinct feeding patterns: juveniles primarily consumed crustaceans, while adults preyed on fish. *Atule mate* is a commercially important carangid fish resource of the Indian coast and one of the much-demanded food fish among common people. The present study was undertaken to find the food and feeding of *A. mate* from Andaman waters.

2. Materials and Methods

The samples for the present study were collected from the Junglighat fish landing centre, South Andaman. A total of 702 specimens of *Atule mate* were analysed (219 male, 216 female and 267 juveniles) for the present study. The sampling was conducted bimonthly for one year, from January 2019 to December 2019. The specimens were brought into the laboratory, and the total length and weight of the fish were measured to the nearest mile metre and gram by using a measuring scale and electronic weighing balance. The specimens were dissected carefully for biology, the abdomen of the fish were split open and the feeding intensity was recorded by observing the degree of fullness. The stomach is designated as full when it is filled with food and the wall of the stomach is thin and intact or transparent. Similarly, the stomachs were classified as ¾ full, ½ full, ¼ full depending upon the relative fullness of the stomach and space filled stomach cavity (Kingston et al. 1999). The stomach is termed as 'trace' when food content is less than one-fourth of the capacity and a shrunken stomach without any food item can be designated as 'empty'. The fish was regarded as an active feeder when the stomach was full and ¾ full; when it was ½ full it was considered as moderate feeder and poor feeder when

¼ full, trace and empty stomachs were encountered. The stomachs were removed carefully, the weight was noted and preserved in 4% formaldehyde for further study.

The gastrosomatic index (Qasim 1957) was carried out by using this formula

$$GaSI = \frac{\text{Weight of the stomach(g)}}{\text{Total weight of the fish (g)}} \times 100$$

The individual stomachs were opened and contents were spread in a petri plate and observed under a stereo microscope and analysed quantitatively as well as qualitatively by volumetric and occurrence methods. The index of preponderance method (Natarajan and Jhingran 1961) was used to understand the relative importance and grading of all the food items.

$$\text{Index of preponderance } I_i = \frac{V_i O_i}{\sum V_i O_i} \times 100$$

where V_i & O_i are the volume and occurrence of the food item, respectively.

3. Results and Discussion

3.1 Feeding intensity and Gastrosomatic index

Moderate to high feeding intensity was observed in *Atule mate*, 29% of the stomachs were ¾ full followed by ½ full with 26% (Fig. 1). Least encountered were trace and empty stomachs with 6% and 7%.

Length-wise data of the Gastrosomatic index showed that the length class of 120-129 mm showed the highest Gastrosomatic index (2.39) followed by 160-169 mm with 2.08 and the least in length class of 210-219 mm with 0.80 (Fig. 2).

High feeding intensity was observed in July-August, followed by May-June and low feeding intensity was observed in March-April samples. The Gastrosomatic index was maximum in July-August, followed by May-June and the least was observed in March-April. It is because the juvenile fishes were dominant in May-June and July August and they were actively fed. Lower feeding intensity was observed in March-April due to spawning.

Similar results were found by Ashwini et al. (2016) in *Decapterus russelli* from Mangalore coast. Manojkumar (2007) found no profound difference in season wise feeding intensity but a gradual decrease in feeding intensity was observed from post-monsoon to pre-monsoon. Jiaswar and George (1991) state that immature fishes feed more vigorously because it is the most active phase of growth. According to Sivakami (1996), lower feeding intensity in carangids with a higher percentage of an empty stomach is seen in breeding season, she added that various carangid species show a profound interrelationship between feeding and breeding periodicity.

3.2 Diet composition

The diet composition of *Atule mate* showed that the species is carnivorous in nature and major food items were copepods, shrimps, fish scales, fish bones, lucifer, cephalopods, algal remains, tree bark, *Stolephorous* sp., Leiognathids, clupeids and carangids and other fish remains. Among fish remains, only bony fishes were recorded in the gut of *A. mate*. The unidentified fish and other fish parts were included in the fish remains.

The index of preponderance for the different food items revealed that copepods were the dominant food item with

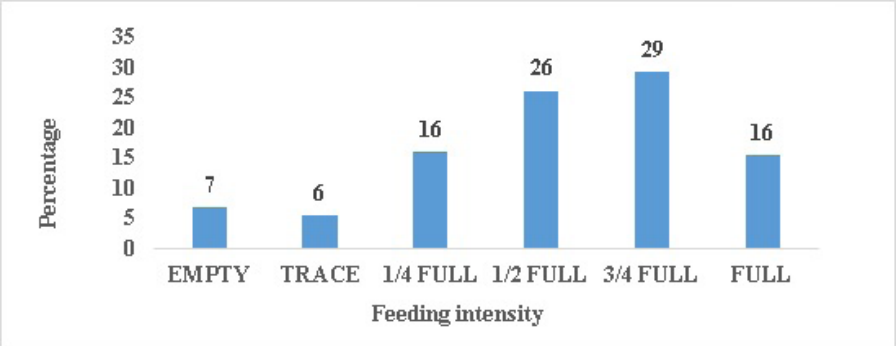

Fig. 1. Feeding intensity of *Atule mate*

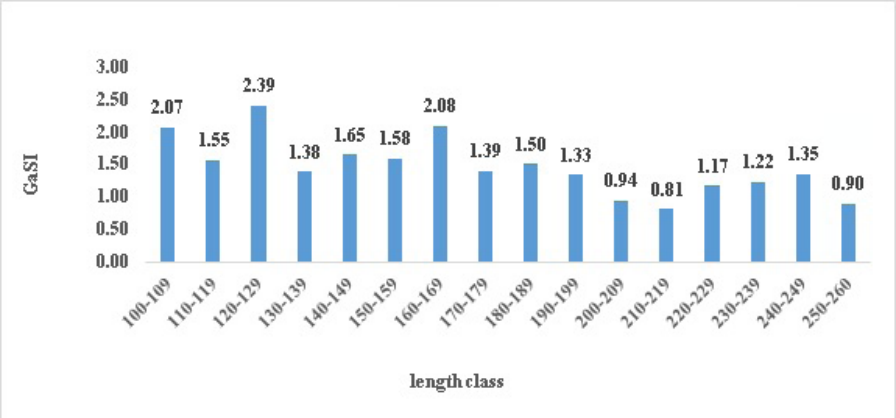

Fig. 2. Length-class wise Gastro Somatic Index of *Atule mate*

Table 1. Diet composition and Index of Preponderance of *Atule mate* from January 2019 to December 2019

Food Items	% Of Occurrence (Oi)	% Of Volume (Vi)	Vioi	Index of Preponderance	Rank
Copepods	24.0	7.4	176.7	25.8	I
Fish Remains	11.1	12.3	136.6	19.9	III
Stolephorous sp.	0.3	9.8	2.8	0.4	IX
Leiognathids	0.2	8.8	2.1	0.3	X
Clupeids	0.6	11.3	6.5	0.9	VIII
Carangids	0.3	4.4	1.5	0.2	XI
Shrimp Parts	23.9	6.4	152.5	22.2	II
Fish Scales	19.1	5.9	112.5	16.4	IV
Fish Bones	14.5	4.4	64.0	9.3	V
Cephalopods	0.4	19.6	8.5	1.2	VII
Lucifer	4.7	4.4	20.6	3.0	VI
Algae Remains	0.4	1.0	0.4	0.1	XIII
Tree Bark	0.3	4.4	1.3	0.2	XIII

25.8% (Table 1), followed by shrimp parts (22.2%). The least encountered food items were tree bark and algal remains, with 0.18% and 0.06%, which happened to be due to accidental feeding.

The bimonthly analysis of preponderance index showed that copepods dominated in May-June and July-August with 69.1% and 52.2% and the least were reported in January- February (Table 2). In the case of shrimp parts the highest was reported in the month of September- October with 40.8% and the least reported in January-February. The fish remains were maximum in January and February with 41.3% and the occurrence of copepods was least in these months. The presence of cephalopods was found in November to April and absent in the remaining months.

The food habits of *A. mate* were studied by Kingston et al. (1999) from the Gulf of Mannar, and they found that crustaceans and fish remains were the dominant food item. Similar observations were reported on other carangid species, *Selaroides leptolepis,* from Palk Bay and Tuticorin Coast by Tandon (1960) and Venkatraman and Natarajan (1988) that this species prefers to feed on Crustaceans and fishes. Sreenivasan (1974) from Vizhinjam Bay reported that *Megalaspis cordyla* feeds predominantly on fishes, crustaceans and molluscs. Ashwini et al. (2016) reported that *Decapterus russelli* is a carnivore and feeds mainly on fish and crustaceans. According to Sivakami (1996) carangids are pelagic carnivores and preferably feed on fishes and crustaceans. Gasoline and Brook (1960) called *Atule* and *Decapterus* genus as planktivorus fishes and they described *Atule mate* particularly as "Voracious plankton feeders". Honebrink (2000) described carangids as fast swimming carnivores and mainly piscivorous mode of feeding.

3.3 Comparison of diet composition of juveniles and adults of *Atule mate* from January 2019 to December 2019

The food and feeding of different length groups in *A. mate* showed that juveniles (100-149 mm) mainly feed on crustaceans (Fig. 4). The preferable food items of juvenile fishes were copepods, shrimp parts, fish remains and lucifer. Copepods were the dominant food item with 46.4%, followed by shrimp parts 29.7%. In contrast, higher length group (150-260 mm) selects fishes and cephalopods to feed. Kingston (1999) recorded similar observations in *A. mate* from the Gulf of Mannar. He found that juveniles have high diet breadth and preferred crustaceans (57.7%), whereas adult fishes preferred fish, especially clupeids to feed. In *Megalaspis cordyla,* similar results were observed by Sreenivasan (1974) from Vizhinjam Bay. Dadzie (2007) observed that *Parastromatus niger* of Kuwait waters showed an inverse proportion of crustacean diet with length of the fish. Juvenile stomachs had higher amounts of crustaceans than adults. According to Sivakami (1996) the preferential feeding of planktonic crustaceans in carangid juvenile fishes is due to the rich oil content present in them, which is important for body growth and development of gonads and to reduce the direct competition with adult fishes.

Atule mate is a carnivorous fish that feeds mainly on planktonic crustaceans in early life stages and in later stages, they prefer fish remains and cephalopods. Feeding intensity was found to be high in juveniles and minimum

Table 2. Bimonthly diet composition of *Atule mate* from January 2019 to December 2019

Food Items	Jan-Feb	Mar-Apr	May-Jun	Jul-Aug	Sep-Oct	Nov-Dec
Copepods	1.7	5.7	69.1	52.2	24.5	15.2
Fish Remains	41.3	37.7	0.0	0.0	11.5	32.9
Stolephorous sp.	0.7	0.0	0.0	0.0	0.3	2.6
Leiognathids	1.9	0.0	0.0	0.0	0.0	1.0
Clupeids	4.3	0.0	0.0	0.0	3.5	0.3
Carangids	0.0	1.2	0.0	0.0	0.0	0.7
Shrimp Parts	5.8	15.1	20.1	36.7	40.8	7.0
Fish Scales	22.3	21.3	5.1	1.0	6.5	23.6
Fish Bones	15.3	18.4	0.0	3.3	4.5	10.8
Cephalopods	5.9	0.5	0.0	0.0	0.0	3.3
Lucifer	0.9	0.0	5.7	6.8	4.6	1.7
Algae Remains	0.0	0.0	0.0	0.0	2.1	0.0
Tree Bark	0.0	0.0	0.0	0.0	1.7	1.0

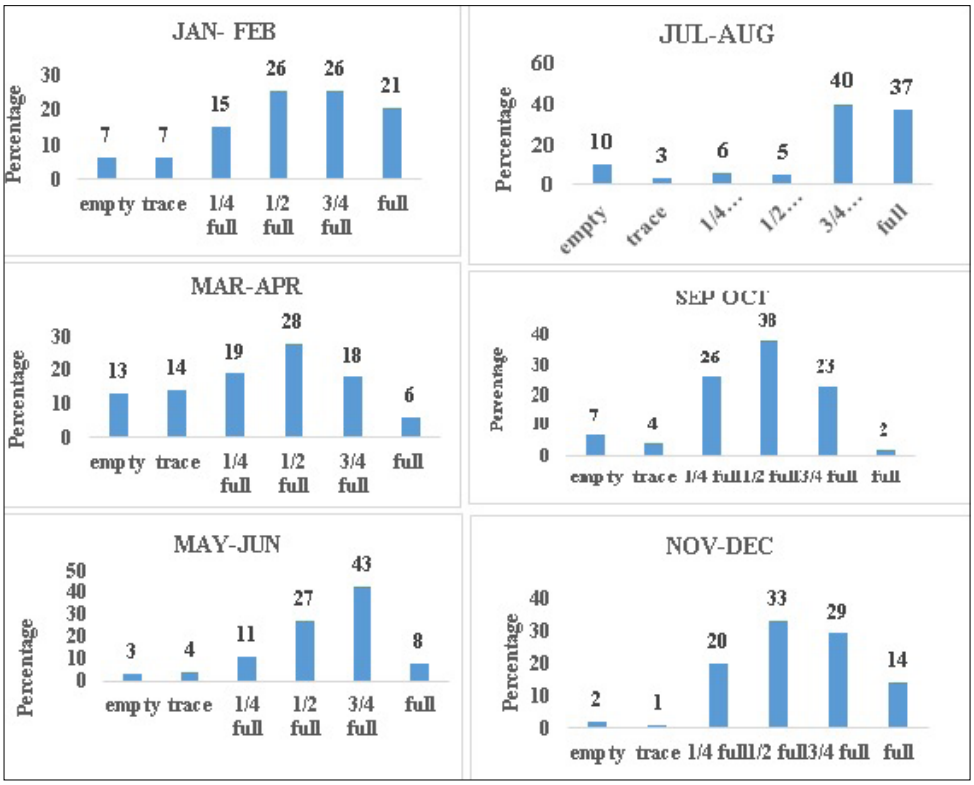

Fig. 3. Bimonthly feeding intensity of *Atule mate*

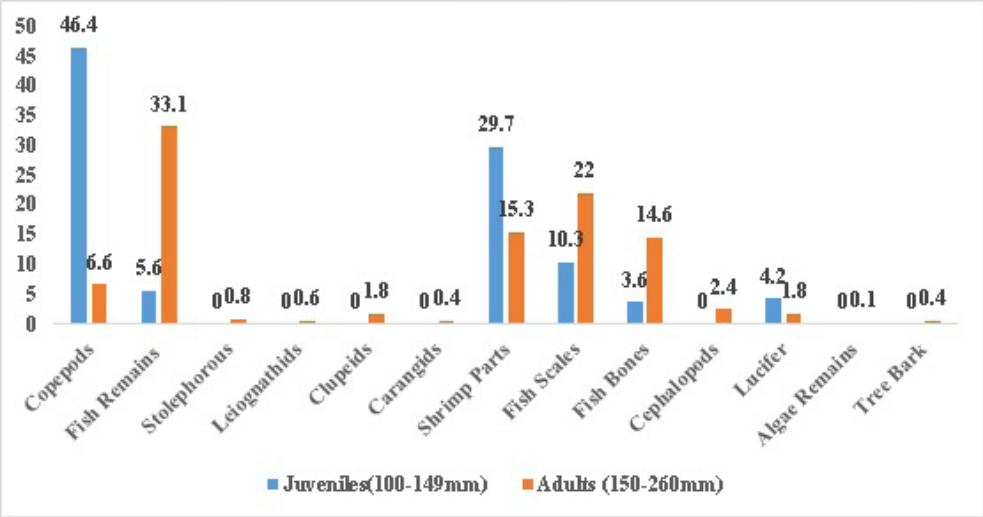

Fig. 4. Diet Composition in Juveniles and adults of *Atule mate* from January 2019 to December 2019

during spawning season. The crustaceans in the juvenile fishes indicate that they are bottom feeders and adult fishes prefer small fishes; hence they follow the pelagic mode of feeding. The present study has shown that adult individuals were dominated during January-April landings, and they chose fish over food items. While juvenile fishes dominated the landings from May to August and the copepods dominated the diet. This can be attributed to the changes in food preferences during the transition from juvenile to adulthood.

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