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Note

Stomach content analysis of the Indian mackerel *Rastrelliger kanagurta* (Cuvier) from Calicut, Kerala

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ABSTRACT

The food and feeding of the Indian mackerel *Rastrelliger kanagurta* was studied from Calicut based on 1,551 fishes ranging in size from 100 to 280 mm total length (TL) collected from both multi-day trawlers and ring net during the period January to December 2006. There was a preponderance of empty stomachs in all the months. The dominant food item was copepod. Sand and foraminiferans also formed part of the stomach content. The fish, *Bregmaceros* sp. was noticed for the first time in the adult mackerel.

Keywords : Indian mackerel, *Rastrelliger kanagurta,* Stomach content analysis

Analysis of gut content is widely used to ascertain the food and feeding habit of a fish species. Accurate description of diets and feeding habits provides the basis for understanding the trophic interactions in aquatic food webs (Vander Zanden *et al*., 2000). Ecosystem based management studies of fisheries is gaining importance and trophodynamics is an integral part of the same. The studies on the food and feeding of the Indian mackerel *Rastrelliger kanagurta* by various workers till the year 1960 have been reviewed by George (1962). The studies made thereafter are those of Rao (1962), Noble (1965), Rao (1965), Venkataraman and Mukundan (1971) and Luther (1973). It could also be seen that there is no published information on the feeding habits of Indian mackerel from Calicut after the study by Venketaraman (1961). The fishery has undergone various changes in recent years. The landing of mackerel in trawl net, ring seine, multi-day fishing by trawlers and the extension of the fishing beyond the conventional fishing ground are some of the recent developments in the fishery. The multi-day trawlers are operated 50-70 km away from the shore at a depth up to 120 m. The ring nets are also operated at a depth of 50 m and go up to 25 to 30 km away from the shore.

In 2006, out of the 2,972 t mackerel landed at Calicut, around 27 % was contributed by multi-day trawlers and 51 % by ring seine. The present study was undertaken with a view to provide a quantitative estimation of the diet of *R. kanagurta* in the present context of the fishery scenario and to compare the results with the studies on this species conducted earlier from this area as well as from other areas of the Indian coast.

The mackerel samples were collected from the landings in trawl net, ring net and gill net at Puthiappa landing centre, Calicut, twice a week depending on the availability from January to December 2006. The size of the fish in the samples varied from 100 to 280 mm total length. Total length, weight, sex, stage of maturity and feeding condition of a total of 1,551 fishes were recorded. Monthly range of sample size varied from 16 fishes in July to 305 fishes in February. For the quantitative study of the food contents, stomachs of 163 specimens in well fed condition (with its intensity above ½ full) were analyzed. There was no fishery in August and in July.

The intensity of feeding was assessed visually based on the distension of the stomachs and was classified as empty, ¼ full, ½ full, ¾ full and full. The empty and ¼ full stomachs were considered as poorly fed and others as actively fed. The wet weight of the stomach contents was taken using an electronic balance to the nearest mg. The total volume in ml of individual stomach content was taken by displacement method using a graduated cylinder. The point (volumetric) method as suggested by Pillay (1952) was employed for the estimation of various food items.

The relative value of different organisms in the diet was evaluated by the Index of preponderance (Natarajan and Jhingran, 1961), $I = ViOi \times 100/\Sigma ViOi$ where Vi and Oi are the percentage volume and occurrence of particular food item 'i' respectively.

The empty stomach ratio (ESR) was estimated in terms of percentage (ESR = Number of empty stomachs/Number of total stomachs) x 100 and the Repletion index (Ri) using

the formula Ri = (Weight of stomach contents (g)/ Total length of fish (mm)) x 100, following Roux and Conand (2000). They were of opinion that the use of length avoids the influence of the fat level, state of the gonads and the weight of the food in the stomach. The statistical analysis was done with the help of SPSS version 10.0

The feeding intensity was generally poor. Eighty six percentage of the fish analyzed had either empty or ¼ full stomach indicating a poorly fed condition. The ESR ranged from 9.7 in September to 78.6 in October with an average of 41.3. The ESR showed wide fluctuation with increase and decrease in alternate months. The estimated ESR in different size groups of male and female also did not show a clear trend. Instead, it showed high fluctuation in both the sexes. Monthly Ri showed the highest value in March followed by June and December. The lowest value was found in October followed by January and September. The Ri showed the highest value at 260 mm and another at 175 mm. The lowest value was at 145 mm followed by 215 mm. Analysis of variance showed that the feeding intensities between months and those between sexes were not significant (p>0.05).

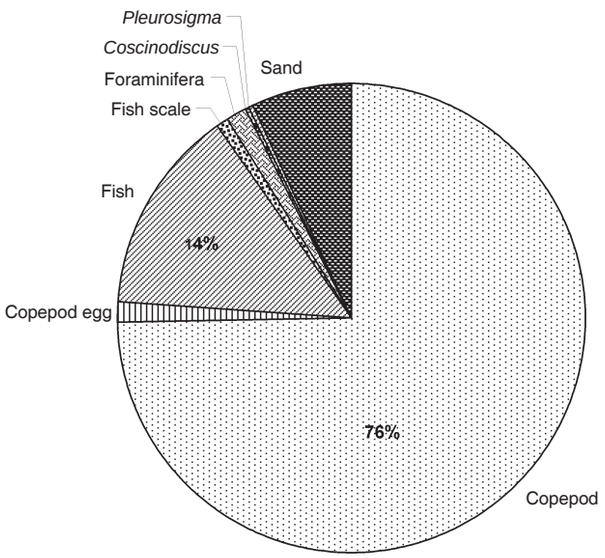

Fig.1. Average food composition in *R. kanagurgta*

The food consisted of zooplankton, phytoplankton, fishes *etc*. In addition to these, a few stomachs contained sand also (Fig. 1). Among zooplankton, copepod was the most dominant item. It formed around 75 % of the total food item and was present throughout the year. Along with it, copepod eggs were also noticed in January and June which formed 1.3 %. Foraminiferans constituted 1.3 % and was noticed during February-April. Phytoplankton noticed in the diet were *Coscinodiscus* sp., *Pleurosigma* sp. *etc*. These were observed in February, April and May. However, their percentage contribution to the total food content was very low (0.4 %). The fish item noticed in the stomach was *Bregmaceros* sp. with size ranging from 30-35 mm and each stomach contained 2 to 5 fishes. This was noticed in the stomach in January and February (Table 1). It was present in samples obtained from multi-day trawl net as well as ring net. Fish scale was noticed in January, October and November. The stomachs were full with scales and slimy substance. Sand was present from February to May only. The different food items when analysed against months, it was found that the variation noticed in a month was not significant at 5 % level except for sand particles.

Table 1. Details of occurrence of *Bregmaceros* sp. in the stomach of *R. kanagurta*

Date	25.1.06	27.1.06	3.2.06	10.2.06	17.2.06
Gear	Ring net	Trawl	Trawl	Trawl	Trawl
Depth (m)	20-30	23-40	40-50	40-48	90-100
Sample no.	86	71	124	26	20
With food	39	63	73	24	17
With fish	6	11	4	7	4
Size range of mackerel (cm)	5-16	18-24	18-21.5	17.5-24	22-26

The monthly average volume of stomach varied from 0.35 ml in October to 3.83 ml in March and the volume of the stomach content of individual fish varied from 0.1 to 7 ml. The average weight of food consumed in a month varied from 0.356 g in October to 3.86 g in March and the weight of individual stomach content ranged from 0.1 to 7.41 g (Table 2). The pooled data of both the sexes showed that copepods ranked first (Table 3) followed by fish in the second place. Sand and foraminiferans ranked third and fourth places respectively.

Table 2. Volume and weight of stomach contents of *R. kanagurta* having feeding condition ½ full and above

Month	Sample	Volume (ml)		Weight (g)	
	no.	Range	Mean	Range	Mean
January	26	0.3-4.0	1.64	0.36-4.58	0.56
February	24	0.1-7.0	1.35	0.12-7.41	1.44
March	16	2.0-6.0	3.83	2.54-6.37	3.86
April	18	0.8-3.0	1.6	0.78-2.73	1.69
May	17	1.0-2.0	1.57	1.0-2.58	1.9
June	7	3.0-4.0	3.25	2.83-4.25	3.24
September	10	0.2-1.0	0.55	0.18-1.44	0.62
October	7	0.1-0.6	0.35	0.1-0.6	0.356
November	22	0.2-3.0	1.12	0.19-2.82	1.2
December	14	1.0-2.0	1.67	1.0-2.0	1.67

The study on the feeding intensity of mackerel from Calicut area shows that there was a predominance of empty stomachs in all the months. The fact that there was no

Table 3. Index of preponderance of food items of *R. Kanagura*

Food item	% F	% V	%V %F	%	Index
Copepod	76.5	74.9	5729.85	92.8	1
Copepod egg	3.9	1.3	5.07	0.1	5
Fish	20.6	14.3	294.58	4.8	2
Fish scale	2.9	0.7	2.03	0.0	0
Foraminifera	9.8	1.5	11.64	0.2	4
Coscinodiscus	2.0	0.2	0.4	0.0	0
Pleurosigma	1.0	0.2	0.2	0.0	0
Sand	18.6	7	130.2	2.1	3
Total			6173.97		

significant variation in the feeding condition between months over the period and also between sexes suggests that this was found throughout the period irrespective of sexes. According to Noble (1965), in mackerel from Karwar, stomach with negligible quantity of food or occasionally empty stomachs were observed only in November.

Analysis of food and feeding of mackerel by previous workers showed that mackerel is a plankton feeder (Venketaraman, 1961; George, 1962; Kutty, 1965; Noble, 1965; Rao, 1965). The present study also showed that copepod was the major food item in almost all the months in spite of the expansion of fishing ground to distant and deeper area compared to earlier periods, when fishing was mainly from inshore area.

The presence of sand grains and fish scales in mackerel stomach has been reported by Devanesan and Chidambaram (1948), Bhimachar and George (1952) and Kutty (1965). Pradhan (1956) found that mackerel impounded in the 'rampan' net had 80-90% of sand grains in their stomach. According to Kutty (1965), the presence of sand grains, formaniferans, fish scales and molluscan shell bits noticed in the stomachs of mackerel from Bombay waters suggested that the fish in all probability fed on the bottom ooze in the sea. According to Devanesan and Chidambaram (1948), mackerel supplements its diet of planktonic organisms by feeding occasionally on dead and decaying fishes at the bottom and at times, fish scales and sand grains. In the present study also, sand grains were observed in the stomachs of mackerel caught not only in the trawl net but also in the ring net. Moreover, the stomach contents were dark greenish in colour when sand grain was present. The analysis of variance of food contents between months indicated that the presence of sand was at significant level. Foraminiferans also formed a constituent of gut content whenever sand was observed. All these suggest that the entry of sand into the stomach was not fortuitous, but due to bottom feeding habit of the fish occasionally as indicated by Kutty (1965) as well as Devanesan and Chidambaram (1948).

Chidambaram (1944) and Devanesan and Chidambaram (1948) observed young mackerel feeding on fish, especially *Stolephorus* sp. indicating the carnivorous habit of the young fish. Venketaraman and Mukundan (1971) also supported this view based on their observation of fish, parts of fish and fish scale in the stomachs of young mackerel of size 64-113 mm. Kutty (1965) observed *Trypauchen vagina, Acetes indicus etc.* in the stomach and opined that this might be selected by sight. In the case of *Scomber scombrus,* Steven (1949) noted that the fish obtain smaller organisms of their diet by filtration and the larger organisms by selective visual feeding. It is possible that the larger organisms in the food of the Indian mackerel are also ingested through visual selection.

According to Luther (1973), fish and the gritty material noticed in the stomach of mackerel might have gained access into the stomach when the fish was in the bag end portion of the seine nets. In the present observation, it is possible that the fish *Bregmaceros* sp. found in the stomachs was not an accidental entry but it must have been preyed upon by the mackerel as there was no fishery for this species. In some of the stomachs, they were in a partially digested condition. Moreover, this prey was found in the stomachs of mackerel caught by both trawl net and ring net. Therefore as pointed out by Kutty (1965), this prey must also have been selected by sight. This is further fortified by the observation of Bhimachar and George (1952) who stated that mackerel adopt feeding selectivity and accordingly they divided the plankton into two kinds, edible and non-edible. They found that mackerel avoided non-edible plankton such as salps, medusae, ctenophores, stomatopod larvae, chaetognaths and *Noctiluca*. Pradhan (1956) was also of the opinion that in mackerel, there is a certain amount of selectivity in feeding. In the present study also, the above mentioned non-edible plankton was not observed even once. Moreover, in the present observation, the fish item was found in adult fish unlike the observation made by Chidambaram (1944) and Devanesan and Chidambaram (1948). This also indicates that, not only juveniles but adults also resort to piscivorous feeding at times. More over, the occurrence of *Bregmaceros* sp. in the mackerel stomach noticed in this study is not reported so far and hence is the first record also.

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