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Biology of the Indian mackerel *Rastrelliger kanagurta* from south Andaman, India

Purkayastha, A.[1], Venu, S.[1, 2*], Ramees, M.P.V.[1], Kalita, S.[1] and Kashyap, K.[1]

[1] *Department of Ocean Studies and Marine Biology, Pondicherry University, Port Blair 744112, Andaman and Nicobar Islands*
[2]*Department of Marine Biology Microbiology and Biochemistry, School of Marine Sciences, Lakeside campus, CUSAT, Fine Arts Avenue, Kochi - 682016, Ernakulam, Kerala*
**E.mail: svenu.omb@pondiuni.ac.in*

ABSTRACT

The distribution and diversity of Scombrids, along with the biology of *Rastrelliger kanagurta* from Andaman coastal waters, was studied through regular surveys in the Junglighat fish landing centre from December 2019 to March 2020. Ten species of Scombrids from 7 genera were recorded, with maximum landing being yellowfin tuna, followed by narrow-barred Spanish mackerel. The tunas and mackerels, which landed from fishing grounds, spread along Middle Andaman to the South Andaman coast. Interview Island (II), Mayabundar (MB), Baratang (BR), Long Island (LI), Ross Island (RI), Chidiyatapu (CY) and Wandoor (WD) were the fishing grounds exploited by the fishermen during this Inter Monsoon period. It has been observed that the regions near RI contributed to the highest landings followed by MB, and the least contribution was seen to be from CY. It was observed that II holds higher species diversity as well as abundance. In Margalef's, species richness index was maximum for II followed by MB. Shannon-Weiner's diversity index showed that the most diverse groups of Scombrids were landed from II and MB. Bray-Curtis plot and Multidimensional Scaling (MDS) was established to represent the similarity of the different fishing grounds. Analysis of length frequency for Indian mackerel has demonstrated that length class 216-223 mm and 210-216 mm dominated the landings of Long Island and Baratang, respectively. Average feeding intensity was observed with a higher Gastrosomatic Index for the length classes of 216-223 mm for samples from LI and 209-2016 mm for BR samples. The food is mainly composed of crustaceans, fishes, semi-digested fishes, scales, semi-digested shrimp, larvae etc.

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1. Introduction

Scombridae are bony fishes belonging to Class Perciformes, which includes primarily tunas and mackerels with 15 reported genera and about 54 species of epipelagic marine fishes. The currently accepted classification (Collette et al. 1984) of mackerels and tunas within the suborder Scombroidei is primarily based on classical morphological studies of Kishinouye (1923), Godsil (1954) and Johnson (1986). Scombrids are marine migratory fishes that generally inhabit the tropical and subtropical waters of the world. They are characterized by deeply forked tails, small finlets behind both the dorsal and anal fins and a fusiform elongate body and moderately compressed body in some genera. The family Scombridae is divided into two sub-families Gasterochismatinae and Scombrinae (Collette and Chao 1975). They possess many morphological and physiological adaptations that are of great interest to biologists. Mackerels, bonitos and tunas form the basis of important commercial and recreational fisheries throughout the world's tropical and temperate waters. In the pelagic realm, Scombrids show one of the major radiations among all the other marine teleosts (Nelson 2006). In India, 9 genera with 19 species of scombrids have been reported, with 16 species observed in the Andaman and Nicobar Islands. The landings of fish species are mostly for commercial exploitation for domestic consumption and a negligible portion is marketed to other parts of the country. Previous studies on documentation and diversity from the present region are very few and limited to some of the scattered reports (Rao 2003, 2009; Rajan et al. 1993, 2013, 2016).

Food forms the basis of all body functions performed by individual taxa and populations (Bal and Rao, 1990). Feeding on a daily basis is one of the leading concerns for fishes to survive and it devotes a significant share of its energy in search of food (Hajisamae et al. 2003). Detailed information on food, feeding ecology and trophic inter-relationships are necessary to understand the life history traits of fishes like growth, breeding, and migration as well as the functional role of all the other fishes found together within aquatic ecosystems (Bal and Rao 1984, Blaber, 1997, Wootton 1998). Apart from all the above parameters, the information obtained is used to analyse diversity, distribution patterns, feeding, breeding and nursery grounds of commercial fish species (Selvam et al. 2015).

The commercial fishery for Scombrids in the Andaman Islands consists of 16 species, which are seasonal in abundance. The fishery will generally shift from one fishing ground to another according to the seasons. Thus, the fishery and change in the fishing site will directly show the pattern of species distributed across various areas and the diversity in a particular season. The food preferences of the species will differ in different fishing grounds and so different stocks, if any, can be determined by identifying the food items. There are not much information available on the habitat-wise distribution and life history traits of Scombrids from this region.

2. Materials and Methods

A detailed survey of the Junglighat fish landing centre and fish market of Andaman and Nicobar Islands was carried out (Fig. 1). The study was conducted for a period of four months from December 2019 to March 2020. The survey

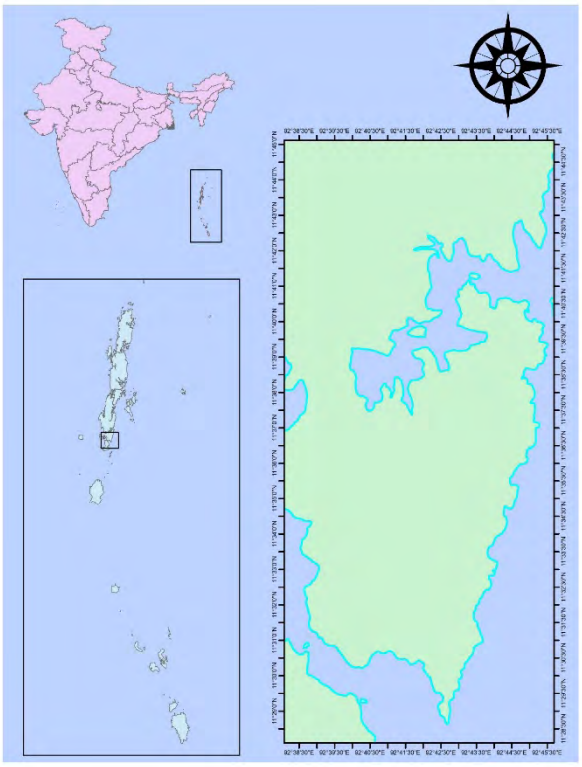

Fig. 1. Map Showing sampling site

included direct observations of the landings and interactions with the fishermen regarding species composition and total landings of Scombrids. The crafts and gears used for fishing were recorded along with the coordinates of the fishing ground they operated. The locations or fishing grounds were Interview Island (II), Mayabundar (MB), Baratang (BR), Long Island (LI), Ross Island (RI), Chidiyatapu (CY) and Wandoor (WD).

Samples were collected after the completion of all the landings. Images of specimens were taken focusing on the important identifying characters. The morphological characters such as colour and body markings were noted in the field for proper identification. Large fishes (tunas and larger mackerels) were photographed with labels for identification and their morphometric measurements were taken in the field. Smaller samples were collected and preserved in 10% formalin. Specimens were identified upto species level using various morphometric measurements and meristic counts (Munro, 2000; Fischer and Bianchi, 1984). The distribution of different scombrids species was estimated through the information collected from fishers, including the quantitative values from various fishing grounds.

Diversity indices of the observed species based on taxonomy were studied with respect to the geographical distribution of different species. These analyses were carried out based on the presence/absence data of species observed in various locations. Diversity indices such as the Shannon-Weiner diversity index (H'), Margalef's species richness (d), Number of species (S) and Number of Individuals (N) were calculated. All the diversity studies were carried out using PRIMER package version 6.2 developed by the Plymouth Marine Laboratory, UK (Clarke and Gorley, 2006).

Fish specimens for food analysis were collected from the landing centre. Specimens were cleaned, and total length (nearest mm), and total weight (nearest g) were recorded. The distribution of length-frequency was estimated among different length classes for specimens from two locations. The data was used to plot a bar graph depicting the frequency and length class variation.

The specimens were also dissected to observe stomach and gonads for their maturity stages and feeding intensity. The weight of gut (nearest g) and degree of stomach fullness were recorded. The gravimetric method was followed to analyse the stomach contents and mean relative weight of food content was calculated as described by Hyslop (1980). Based on the food available and size of the stomach, feeding intensity was measured as empty, trace, ¼, half, ¾, and full (Sivadas and Bhaskaran, 2009). The gastrosomatic index was also calculated by taking the weight of the gut and using the formula:

$$GaSI = \frac{\text{Weight of the Stomach(g)}}{\text{Total Weight of the Fish (g)}} \times 100$$

The gut was further analyzed for the food composition, which was then separated into major identifiable categories.

3. Results and Discussion

3.1 Species composition

The study has shown that targeted fishing was conducted using motorised and mechanised crafts from Junglighat fish landing centre. Ten species from 7 genera of Scombrids from Junglighat landing centre and fish market. A total of 6276.12 kg of Scombrids landed. The landing of tuna dominated by 3816.51 kg, followed by mackerels with a landing of 2459.61 kg. The gears used were mostly gillnets exclusively for tunas, along with trawl nets and hook and line. The species composition of tunas and mackerels showed quite a variation, with the maximum landing being 37.61% of yellowfin tuna followed by 16.91% of narrow-barred Spanish mackerel and the least being dogtooth tuna with a landing being very negligible (Fig. 2). Similar observations were recorded by Al-Zibdah and Odat (2007) from Gulf of Aqaba that Tuna were the dominating group in the overall landing.

3.2 Ten-days average fish landings

The day-wise analysis of landings has shown that Day-8 had the maximum landings of 1948.12 kg (Fig. 3), followed by Day-9 with 1039.8 kg, and the least was recorded in Day-6 with 57.6 kg of landings.

Analysis of the landings per craft (10 days average landings) have shown that Day-3 had the maximum number of crafts (Fig. 4), 39 with a landing of 307.76 kg, while Day- 6 had the least number of crafts with 8 and 57.6 kg of landings. Further, it was also seen that Day-8 had the maximum landings of 1948.12 kg with 22 crafts.

3.3 Fishing ground wise landings

As observed from the landings, the Scombrids showed a wide range of species being distributed across the various

fishing grounds around the Andaman Islands. It has been noted that the tunas and mackerels which landed during the study period cover the area from Middle Andaman to South Andaman Islands. These regions include Interview Island (II) on the west coast (Fig. 5), followed by Mayabundar (MB) within Auston Strait, Baratang (BR), Long Island (LI) in the east coast along with Ross Island (RI), Chidiyatapu (CY) and Wandoor (WD). Based on the data, it has been observed that the regions near Ross Island contributed to the highest landings of 2371.45 kg, followed by Mayabundar 890.65 kg, and the least contribution was seen to be from Chidiyatapu with landings of 10.3 kg.

3.4. Taxonomic Diversity Indices

Species diversity and distribution were also observed, which showed a wide range of fishing areas being covered from the Middle Andaman to the South Andaman Islands. The various fishing grounds that were primarily covered depended on the availability of the target fishes. Thus, it has been noted that change in fishing grounds during the study period can result from the change in migration pattern (Panikkar, 1951) of the target fishes or devoid of the target fishes in the former fishing ground. Hence, fishers changed their fishing areas, thereby giving a variation in the distribution of the different species.

It was observed that Interview Island (II) holds the greatest number of species as well as individuals with regular landings (2.6 ± 3.627), followed by MB with 2.1 ± 2.726 (Fig. 6).

Margalef's species richness index analysis have shown that Interview Island and Mayabundar were seen to be widely rich in terms of species composition. The 'd' value was maximum for II with 1.166 ± 1.559 followed by MB (0.986 ± 1.315) and the least for CY and WD (0.144 ± 0.456).

Shannon-Weiner's diversity index have shown that

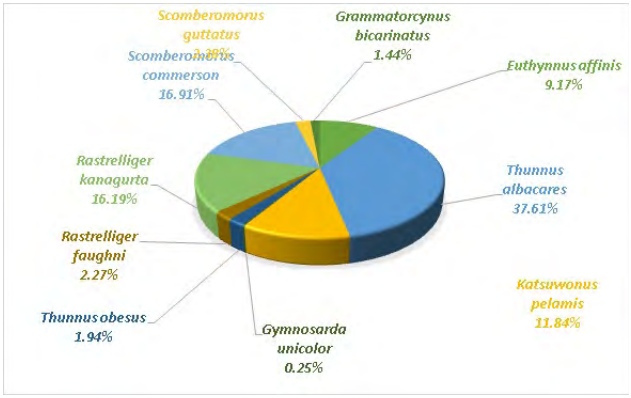

Fig. 2. Species composition of Scombrids in the fish landings

Interview Island (0.727 ± 0.965) and Mayabundar (0.622 ± 0.834) constitute the most diverse groups of Scombrids (Fig. 8). The lowest H' value was observed for CY and WD with 0.069 ± 0.219.

Bray-Curtis plot showed similarity of the different fishing grounds with 10% similarity of Ross Island with other areas (Fig. 9). On the other hand, 100% similarity was observed for MB and II as well as WD and BR. MB and II showed 40% similarity with the other grounds, LI showed 48%, and CY had around 80% similarity with WD and BR.

Multidimensional Scaling (MDS), was also established to represent the similarity of the different fishing grounds (Fig. 10). From the plot using distance matrix, it was observed that RI showed the slightest resemblance with other areas, whereas distinct similarity was seen with other fishing grounds.

The data collected was further analyzed for diversity indices, where it was observed that Interview Island had the highest diversity (H' mean value of 0.727 with standard deviation of 0.965), species richness (d mean value of 1.166

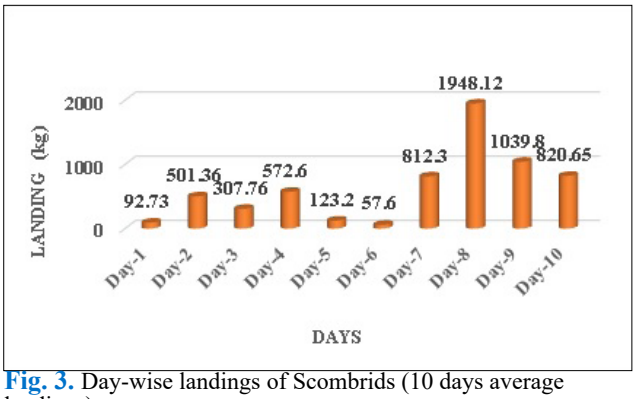

Fig. 3. Day-wise landings of Scombrids (10 days average landings)

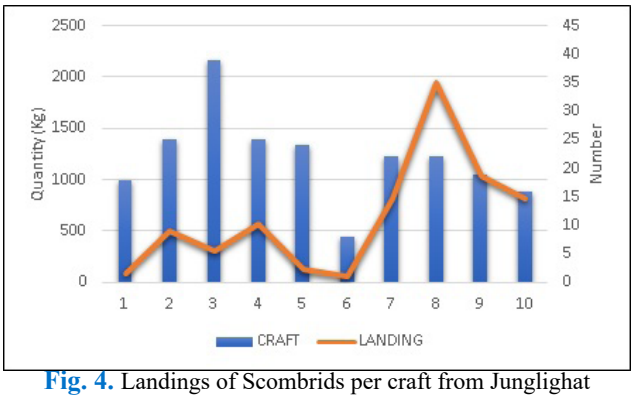

Fig. 4. Landings of Scombrids per craft from Junglighat

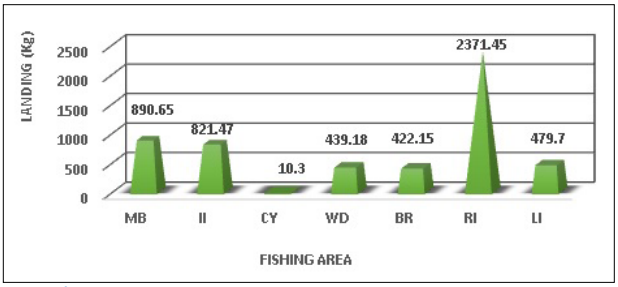

Fig. 5. Fishing ground-wise distribution of Scombrids

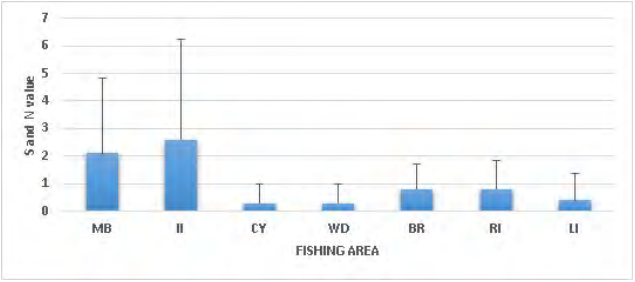

Fig. 6. Number of species (S) and Number of Individuals (N) value across different fishing areas

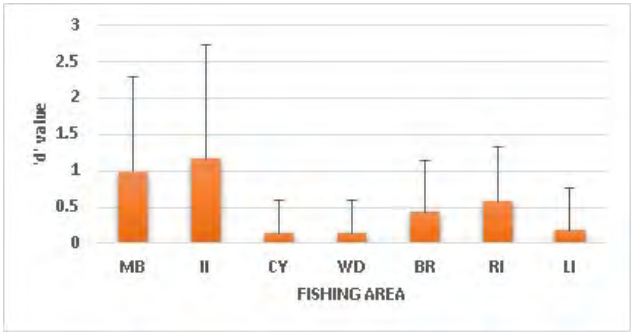

Fig. 7. Margalef's species richness (d) index from different fishing areas

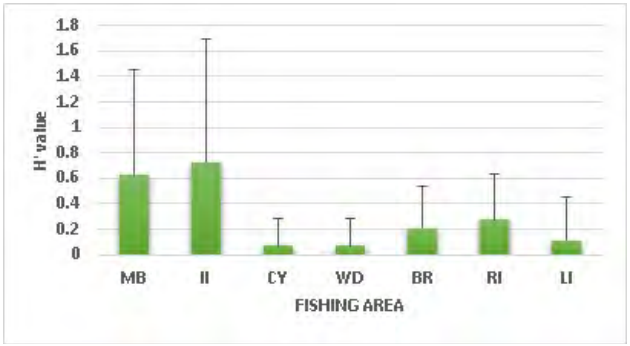

Fig. 8. Shannon-Weiner's diversity index (H') of scombrids from different fishing areas

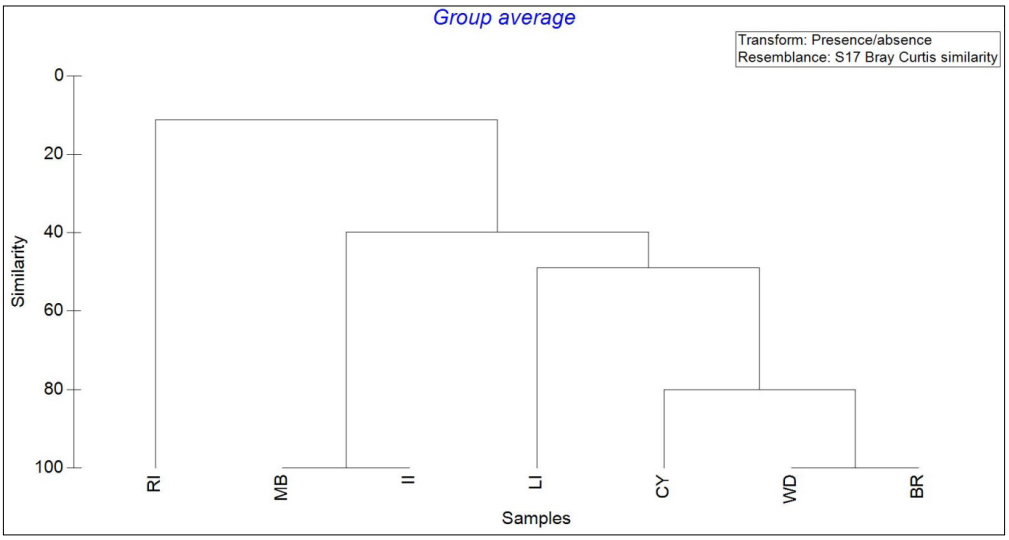

Fig. 9. Dendrogram for Bray-Curtis showing degree of similarity among various fishing grounds

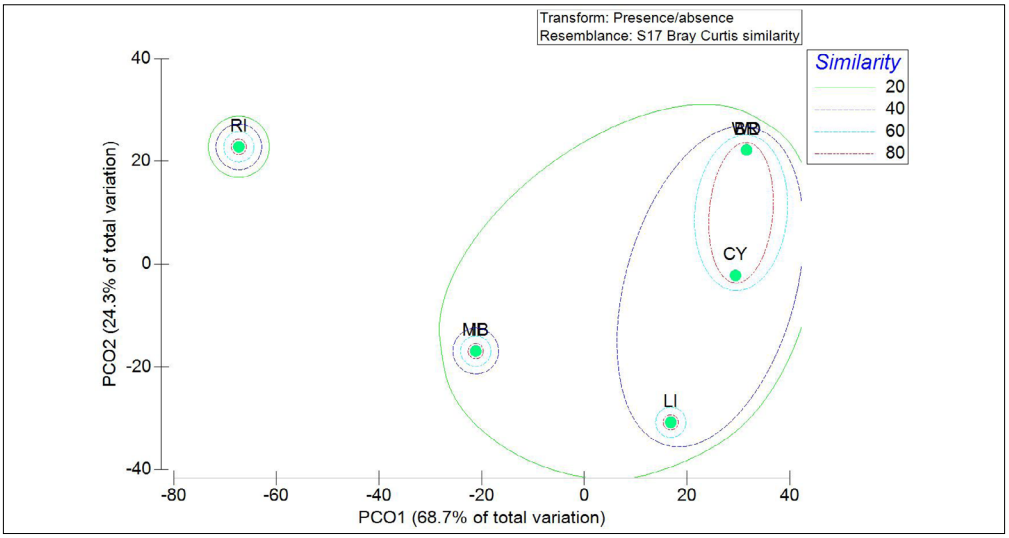

Fig. 10. Multidimensional Scaling (MDS) highlighting the range of similarity between the different fishing grounds

with a standard deviation 1.559), and number of species and individuals (S & N mean value of 2.6 with standard deviation 3.627). Mayabundar was also seen to have similar values with slight variations, while the rest of the areas had very low values. The reason being Interview Island and Mayabundar had such values is its rich composition of almost all scombrids caught from these locations. At the same time, other areas lacked such diverse variation and were specific to certain species.

3.5 Length-Frequency of Rastrelliger kanagurta

Analysis of length-frequency for Indian mackerel from two different locations showed slight variations in both the sampled sites (Fig. 11). Landings from Long Island showed a dominant length-frequency at length class 216-223 mm, whereas 210-216 mm for Baratang.

3.6 Feeding Intensity of Rastrelliger kanagurta

During the present study, most of the individuals were

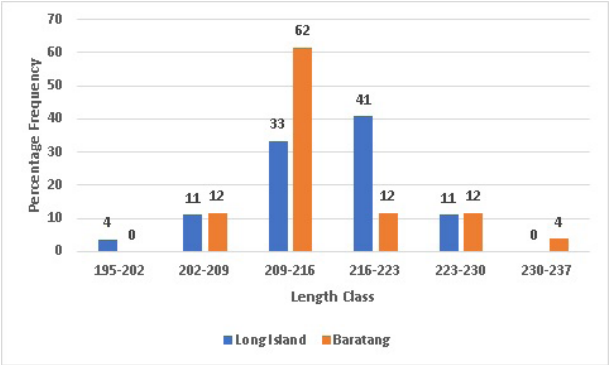

Fig. 11. Length frequency distribution of *Rastrelliger kanagurta*

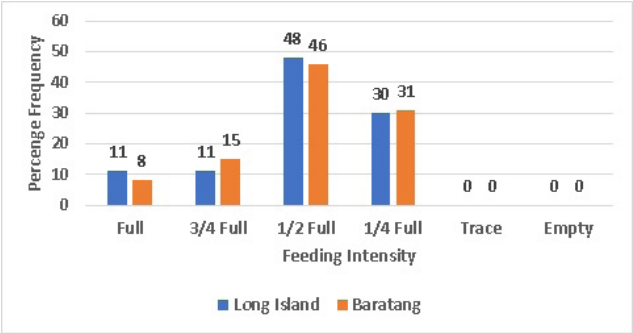

Fig. 12. Feeding intensity of *Rastrelliger kanagurta*

observed to have half-filled stomachs (48%) and 46% from Long Island and Baratang, respectively. Trace and Empty stomachs were not recorded during the study. The feeding intensity of *R. kanagurta* shows they are moderately fed, and similar observations were reported by Aye (2020) from Palaw and adjacent coastal waters.

3.7 Gastrosomatic Index Rastrelliger kanagurta

The Gastrosomatic Index was observed to be higher for the length classes of 216-223 mm (3.2) for samples from Long Island and 209-2016 mm (4.5) for Baratang samples (Fig. 13).

3.8 Food compositon of Rastrelliger kanagurta

The food mainly composed of crustaceans, fishes, semi-digested fishes, scales, semi-digested shrimp, larvae etc (Fig. 14). The prey composition of Long Island samples were mainly fish scales (48%) and semi-digested fishes (36%). The prey composition of samples collected from Baratang was observed to be primarily crustaceans (47%) and semi-digested shrimp (22%). Gut content analysis revealed the organism as a carnivore as many scales and shrimp were observed. Long Island specimens had a large proportion of fish scales and semi-digested fishes, whereas the gut content of fishes from Baratang showed a high density of shrimps and other larvae. The reason for such variation might be the fact that both these areas are completely different, although there was not much difference in the size and weight of the fish from both locations. The fishing ground near Baratang lies towards the western coast and is in the form of an estuary; hence, the number of shrimp and other larvae might have been abundant in such steady waters. The area near Long Island is towards the open ocean on the eastern coast, where the fishes might have fed on other smaller fishes in the pelagic zone. Shivadas and Bhaskaran (2009) from the Calicut coast found that copepods and fishes were the major food items in *R. kanagurta*, Venkataraman (1961) and George (1952) reported that mackerels are plankton feeding fishes. According to Chidambaram (1944) Juvenile fishes prefer to feed on other fishes, especially *Stolephorus* sp. and he added that young fishes are carnivorous in nature. Kutty (1965) indicated the presence of fish scale in the diet of mackerel, it is because fish feeds on decaying fish remains in the bottom.

From the present study it was found that tunas were the dominat group in the scombrids landing from Andaman waters and the fishing ground near Interview island holds the maximum diversity of scombrids. The biology of *Rastrelliger kanagurta* showed that they were moderately fed and they prefer copepods and fishes to feed.

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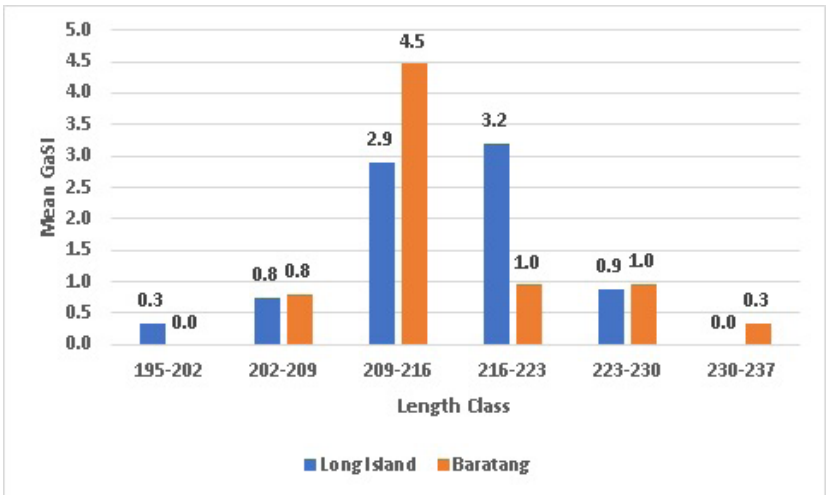

Fig. 13. Gastrosomatic Index of *Rastrelliger kanagurta*

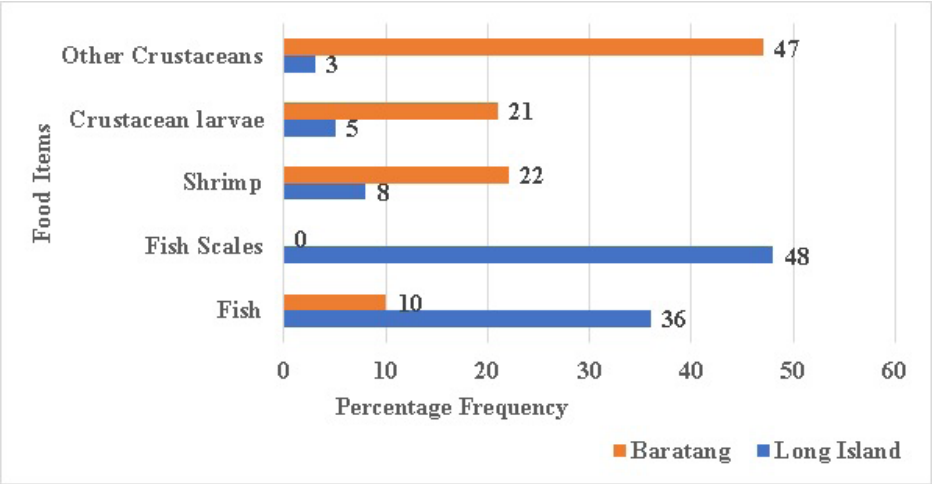

Fig. 14. Food compositon of *Rastrelliger kanagurta*

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