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Food and feeding habits of short mackerel (*Rastrelliger brachysoma*, Bleeker, 1851) from Palaw and adjacent coastal waters, Taninthayi region, Myanmar

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Abstract

Food and feeding habits of *Rastrelliger brachysoma* was investigated from April 2018 to March 2019 in Palaw and adjacent coastal waters, Taninthayi Region. The size range of *R. brachysoma* was from 10.5 cm to 24 cm. The length group of 16.5-19.5 cm size group was abundantly found during the sample collection. The feeding intensity of *R. brachysoma* was higher at 19.5-21.44 cm size group than those of other size groups. Maximum and minimum of gastro-somatic index (G_{SI}) were estimated 2.9 and 1.4 in October and July, respectively. Average percentage of feeding intensity of *R. brachysoma* was 51.7% (actively fed), 32.1% (moderately fed) and 16.03% (poorly fed). According to the relation to maturity stages, feeding was active in mature specimens and was poor in ripen stages. Diatoms were the most dominant food items, comprising with the average percentage of 51% of all food items, followed by dinoflagellates 17%, copepods 15%, protozoan and other zooplankton 9%, blue-green algae 4%, larvae 2%, fish eggs and fish scale 2%. Therefore, diatoms, dinoflagellates and copepods were the main food items in the diet of *R. brachysoma*. The results indicated that *R. brachysoma* was pelagic feeders which consumes plankton as the main feed.

Keywords: Length group, maturity stages, pelagic feeders, *Rastrelliger brachysoma*

Introduction

The study of the feeding habits of fish and other animals based upon analysis of stomach content has become a standard practice ^[1]. Feeding is one of the leading concerns of daily living in fishes, in which the fish devotes a significant portion of its energy searching for food. Detailed data on the diet, feeding ecology and trophic inter-relationship of fishes is fundamental for better understanding of fish life history including growth, breeding and migration ^[2]. On the other hand, it has great importance in fisheries providing information on distribution pattern and the nursery and feeding grounds of target fish species ^[3]. The feeding habits of most marine fishes are roughly grouped into the following three major categories: carnivorous, omnivorous and herbivorous. According to the feeding habits of pelagic fish, they can be categorized as surface, mid and bottom feeders ^[1]. Mackerel (*Rastrelliger* spp) is a filter feeder and normally feeds at the surface. They are mainly plankton feeders that feed on both phytoplankton and zooplankton especially diatoms, dinoflagellates, blue green algae, copepods, larvae, nauplii, protozoa and fish egg. Adult Mackerels have sharp teeth and hunt small crustaceans such as copepods as well as fish, shrimp and squid. The analysis of gut contents of fish provides important insight into fish feeding patterns and quantitative assessment of food habits is an important aspect of fisheries management ^[4]. Feeding intensity of fishes vary with the time of the day, size of fishes, monthly, seasonally, different ecological factors and various food materials present in the water ecosystems ^[1]. In general, growth of a fish is influenced by the quality and quantity of food materials available and consumed. Several studies on the food and feeding habits of the *Rastrelliger* species were from the Indian waters (Ganga, Sivadas and Bhaskaran, Supraba *et al.*, Azar *et al.*) ^[4, 13, 15, 16], from the Thailand waters (Senarat *et al.*) ^[12], from the Massawa coast (Nath *et al.*) ^[11]. Stomach content studies of Myeik waters were reported in *Rastrelliger* species by Lett Wai Nwe ^[10]. The objective of the present study is to identify the food or prey items in the stomach of *R. brachysoma*, to determine the percentage of prey items in the diet of *R. brachysoma* and the natural plankton population in the study areas, to know the feeding activity of *R. brachysoma*

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in various size groups and to get a better understanding of the feeding intensity in relation to season, length group and maturity of fish.

Materials and Methods

The short mackerel, *Rastrelliger brachyosoma* was monthly collected from six stations Palaw (Lat 12° 57' 57.70" N, Long 98° 37' 28.68" E), Shat-pon (Lat 12° 58' 19.25", N Long 98° 38' 37.72" E), Ngar-kyun (Lat 13° 2' 13.55", N Long 98° 19' 57.55" E), Zayat-seik (Lat 13° 6' 26.40" N, Long 98° 19' 38.10" E), Pyin-bu-nge (Lat 13° 7' 5.09" N, Long 98° 30' 17.90" E) and Pyin-bu-gyi (Lat 13° 12' 1.70" N, Long 98° 26' 58.54" E) during April 2018 to March 2019. The total length of fish and mature stages were recorded before remove the gut. Then, the belly of fish was cut open. After that, stomachs were preserved in 5% formaldehyde solution. For the analysis, the formalin preserved stomachs were cut open and the contents were removed. Firstly, stomach contents were placed into petri disc. The stomach content of each fish was made up to a known volume (10 ml) by adding the water into the measuring cylinder to know the volume of contents. After mixing well, subsample of 1 ml was taken by pipette and components of the guts were analyzed under the microscope. Each item of species was analyzed into genus level; the identification of food items was based on the classification system used by Tomas [5], Newell & Newell [6], Yamaji [7], Than Aye *et al.* [8], Tin Tin Kyu [9] and Lett Wai Nwe [10].

The number and occurrence method were used in the analysis of food items. To calculate the numerical method, the number of individuals in each food category was counted and expressed as a percentage of the total individuals in all food

categories. Occurrence method is the simplest way of recording the food relating to the number of guts containing one or more individuals of each food item and number were expressed as percentage of all guts those containing food. This method gave the information on the preference of food items. The percent occurrence of different food items of food in different months were computed by gravimetric methods [1].

$$\text{Percent by number} = \frac{\text{Numbers of individual food item}}{\text{Total number of different food items}} \times 100$$

Feeding intensity: The intensity of feeding was determined based on the degree of fullness of stomach and amount of food items in it and categorized as poorly fed (when the volume of food was empty), moderately fed (when the volume of food content was 0.1 ml-1.4 ml) and actively fed (when the volume of food content was 1.5 ml). Feeding intensity in relation to month, length group and different stages of maturity of fish were also studied.

Gastro-somatic Index (GaSI)

The monthly feeding intensity was determined on the basis of the value of gastro-somatic Index (GaSI). It was calculated using the method by Santoshkumar Abujam *et al.* [17] and Biswas [18].

$$\text{GaSI} = \frac{\text{Weight of food contents}}{\text{Weight of fish}} \cdot 100$$

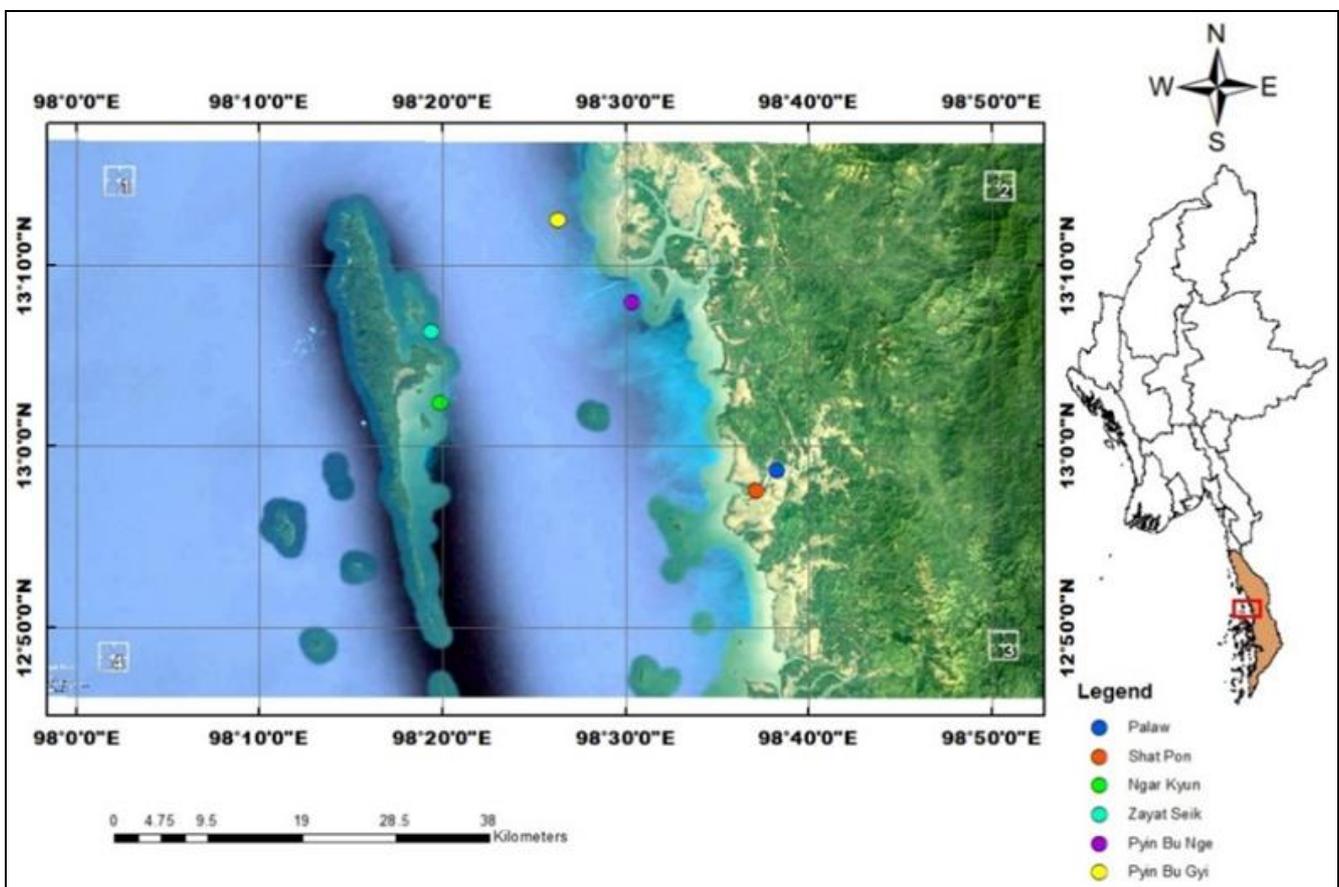


Fig 1: Map showing the study area from Palaw and adjacent coastal waters, Taninthayi Region

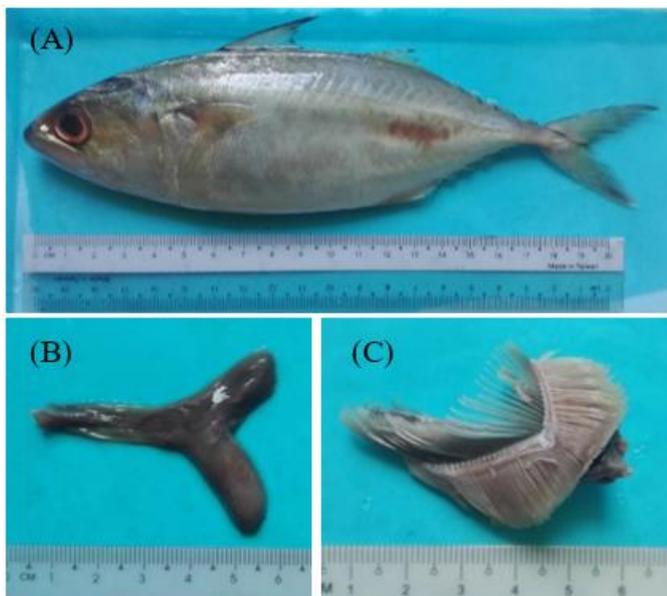


Fig 2: (A) Morphology, (B) stomach shape and (C) gillraker of *Rastrelliger brachysoma*

Results and Discussion

Types of food

Diatoms

Thirty species of diatoms, namely, (*Cyclotella sp.*, *Laudaria sp.*, *Planktoniella sp.*, *Melosira sp.*, *Coscinodiscus sp.*, *Hemidiscus sp.*, *Rhizosolenia sp.*, *Probosica sp.*, *Guinardia sp.*, *Eucampia sp.*, *Bacteriastrum sp.*, *Chaetoceros sp.*, *Bellerochaes sp.*, *Ditylum sp.*, *Helicotheca sp.*, *Odontella sp.*, *Triceratium sp.*, *Lampricus sp.*, *Thalassionema sp.*, *Diploneis sp.*, *Navicula sp.*, *Pleurosigma sp.*, *Gyrosigma sp.*, *Amphora sp.*, *Bacillaria sp.*, *Fragilariopsis sp.*, *Nitzschia sp.*, *Pseudonitzschia sp.*, *Surirella sp.* and *Tabellaria sp.*) were found in the stomach of *Rastrelliger brachysoma*.

Dinoflagellates

Five species of dinoflagellates, (*Prorocentrum sp.*, *Triposolenia sp.*, *Dinophysis sp.*, *Ceratium sp.* and *Protooperidinium sp.*) were observed in the gut of *Rastrelliger brachysoma*.

Blue green algae

Only one species of blue green algae, namely, *Anabaena sp.* contributed in the gut of *Rastrelliger brachysoma*.

Protozoan and other zooplanktons

Five species of protozoan and other zooplankton (*Tintinnopsis sp.*, *Globigerina sp.*, *Favella sp.*, *Tulbergella sp.* and *Acetes sp.*) were also observed in the stomach of *Rastrelliger brachysoma*.

Copepods

Eight species of copepods, namely, *Acrocalanus sp.*, *Microsetella sp.*, *Eucalanus sp.*, *Acartia sp.*, *Euterpina sp.*, *Labidocera sp.*, *Calanopia sp.*, and *Clytemnestra sp.*, were found in the stomach content of *Rastrelliger brachysoma*.

Larvae

Two species of larvae (bivalve larvae and nauplius larvae of copepod) were found in the stomach of *Rastrelliger brachysoma*.

Fish eggs and fish scales

Fish eggs were observed in all months, except in April, May

and December. Fish scales were occurred in August, September, October, November, December and January.

1.2. Gastro-somatic Index (GaSI) of *Rastrelliger brachysoma*

The range of gastro-somatic index (GaSI) of *Rastrelliger brachysoma* was 1.34-2.89 in males and 1.49-2.9 in females. The highest gastro-somatic value in males was recorded in October (2.89) while lowest value was in June (1.34). For females, the value was high in October (2.9) and low in July (1.49). The male and female of GaSI values were increasing from September to December and decrease June and July. The peak of gastro-somatic index was found from September to December in both male and female. It was observed from the analysis of GaSI that the basic food items were highest in the gut of *R. brachysoma* during September-December when the aquatic vegetation was at its peak. The gastro-somatic index (GaSI) of *R. brachysoma* in different months during the period of this investigation is illustrated in Figure 3.

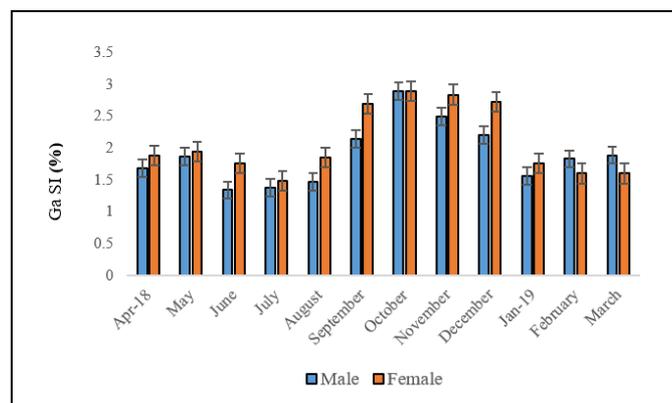


Fig 3: Average gastro-somatic value of male and female of *Rastrelliger brachysoma*

Food composition of *Rastrelliger brachysoma*

The stomach contents of *Rastrelliger brachysoma* consisted of different food items and were divided into eight main groups, namely, diatoms, dinoflagellates, blue green algae, protozoan and other zooplankton, copepod, larvae, fish scale and fish egg. In the stomach of *R. brachysoma*, diatoms were the most dominant food items, comprising with the average percentage of 51% of all food items, followed by dinoflagellates 17%, copepods 15%, protozoan and other zooplankton 9%, blue-green algae 4%, larvae 2%, fish eggs and fish scale 2%. The variation in monthly percentages in number of different food categories in the stomach content of *Rastrelliger brachysoma* is shown in Figure 4. In the present study, diatoms were the most dominant food items in all months in the stomach of *R. brachysoma*. This result was nearly similar with the previous study of Lett Wai Nwe [10] from Myeik waters. According to the observation of the percentage in number, dinoflagellates was the second most important food item in the gut of *R. brachysoma*. This result agrees with the earlier reports of Senarat *et al.* [13] from the Upper Gulf of Thailand and Lett Wai Nwe [10] from Myeik waters. The copepods contributed as the major food group after diatoms and dinoflagellates in the gut of *R. brachysoma*. Lett Wai Nwe [10] also reported that *R. brachysoma* mainly feed on copepods and these species were mainly found from Myeik waters. However, Senarat *et al.* [12] observed copepods as minor food items from the Upper Gulf of Thailand. Only small portions of fish egg and fish scale were irregularly encountered in the diet of the *R. brachysoma*. Similar finding was described in the previous study of Lett Wai Nwe [10] from

Myeik waters. According to the analysis of stomach contents of *R. brachysoma* in the present study, it feed upon different kinds of plankton including the macroplankton which were found at the surface water. And also, *Rastrelliger brachysoma* was plankton and pelagic feeder [10, 12].

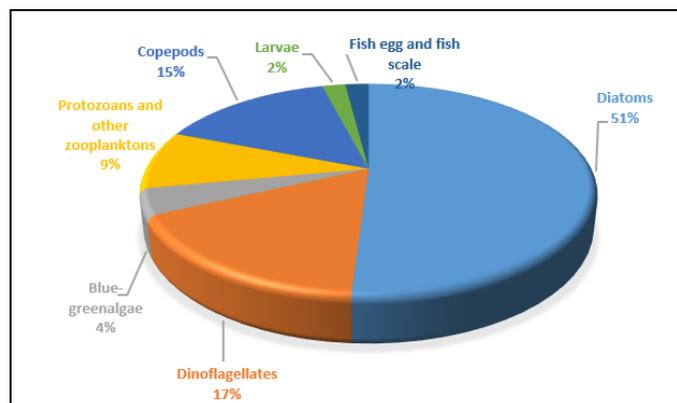


Fig 4: The variation in monthly percentages in number of different food categories in the stomach content of *Rastrelliger brachysoma*

Feeding intensity in relation to month

Stomach contents of fish based on the degree of fullness of the stomach was classified as actively fed, moderately fed and poorly fed. Monthly percentage occurrence of different stomach conditions of *Rastrelliger brachysoma* is presented in Figure 5. Average percentage of feeding intensity of *R. brachysoma* was 51.7% (actively fed), 32.18% (moderately fed) and 16.03% (poorly fed). The monthly percentage of active feeding intensity of *R. brachysoma* varied from the lowest, 25.37%, in May to highest, 86.48%, in October. The percentage of fish in moderately fed was found to be lowest, 8.10%, in October and highest of 43.3% in March. Moderately feeding intensity of fish was found to be highest in almost all months, except October. The poorly feeding intensity was high in August (34.21%) and low in October (5.40%).

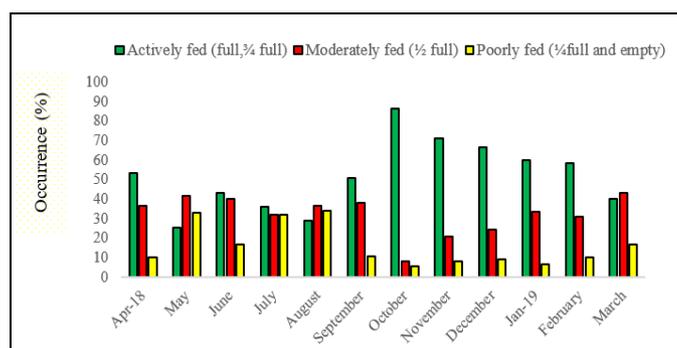


Fig 5: Monthly percentages occurrence of feeding intensity of *Rastrelliger brachysoma*

Feeding intensity in relation to the length groups

Percentage occurrence of feeding intensity in relation to the length groups of *Rastrelliger brachysoma* is presented in Figure 6. Maximum percentage of actively fed (60%) was recorded in the 18.5-20.44 cm length group and minimum (7.5%) in the 24.5-26.44 cm length group. The moderate feeding condition ranged from the minimum, 25% in the length group of 10.5-12.44 cm and the maximum, 50% in the 22.5-24.44 cm length group. The range of poorly fed fish was varied from the minimum of 4% in the 18.5-20.44 cm and

maximum of 55% in the 24.5-26.44 cm length group. According to the study on feeding intensity in relation to length group, the middle length group of *R. brachysoma* (12.5-14.44 to 20.5-22.4 cm) fed better than the smaller and large size groups. The smaller and large size groups of fish (10.5-12.44 and 22.5-24.44 cm) fed moderately. The stomach with poorly feeding intensity was found more in the larger size group (24.5-26.44 cm). These results were similar with the findings of Senarat *et al.* [12] who reported that the active and moderate feeding conditions increased with increasing size groups of *Rastrelliger brachysoma*.

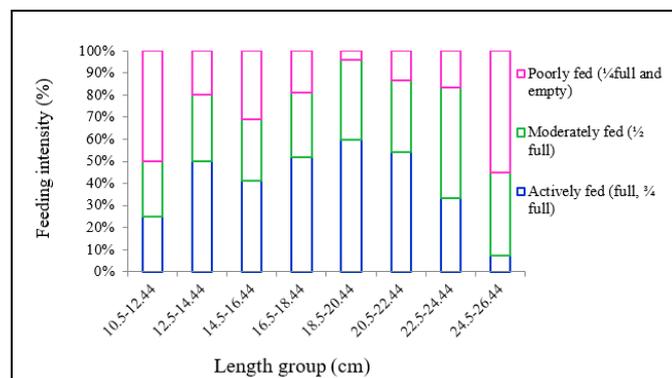


Fig 6: Feeding intensity in relation to length groups of *Rastrelliger brachysoma*

Feeding intensity in relation to maturity stages

Feeding intensity of *Rastrelliger brachysoma* in relation to maturity stages is shown in Figure 7. In *Rastrelliger brachysoma*, the highest percentage (44.4%) of moderately fed fish was observed in immature stage. It was found that 37.0% of immature fish were actively fed and 18.5% were poorly fed. For early maturing fish, active feeding intensity was observed in 53.33% of fish, followed by poor feeding intensity (20%) and moderate feeding intensity (26.66%). For maturing fish, active feeding intensity was observed in 54.54% of fish, followed by poor feeding intensity (9.09%) and moderate feeding intensity (36.36%). For mature fish, active feeding intensity was observed in 30% of fish, followed by poor feeding intensity (25%) and moderate feeding intensity (45%). As for ripen fish the percentage of actively fed, poorly fed and moderately fed were 11.26%, 47.88% and 40.84%, respectively. Maximum percentage of moderate feeding intensity (30.61%) was observed in spent stage. The percentage of spent fish with poorly feeding condition and actively feeding condition were 40.81% and 28.57%, respectively. Bhimachar and George [3] described mackerel feed well when they are immature (Stage I). When it starts maturing (Stage II) feeding also increases and at Stage III of maturity it is observed to be highly intense. Later, in Stage IV, a slackening in feeding appears, and in advanced stage of sexual maturity (Stage V) feeding is poor. Observations on the feeding intensity in relation to different stages of growth show that, the mackerel feeds well when it is small, and while growing it feeds more and while maturing it feeds the most, according to the findings of Noble [14]. With regard to the present observation of feeding intensity in relation to stage of growth, immature and spent stages of *Rastrelliger brachysoma* fed moderately than other stage of maturity. Stomach with active feeding condition was observed more in mature fish. Most of the ripen fish fed poorly.

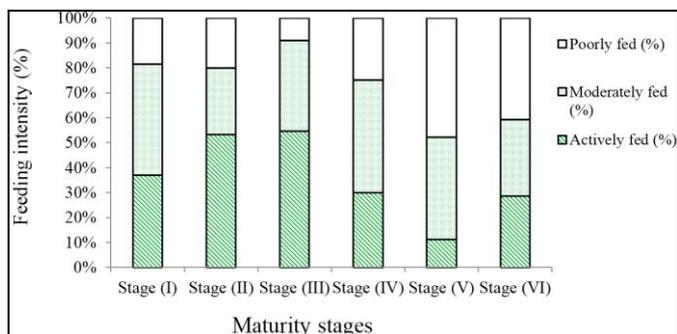


Fig 7: Feeding intensity in relation to maturity stages of *Rastrelliger brachysoma*

Conclusion

The short mackerel, *Rastrelliger brachysoma* fed on variety of food categories. Eight groups of food items, such as diatoms, dinoflagellates, blue-green algae, protozoans and other zooplanktons, copepods, larvae, fish scale and fish egg were recorded. Diatoms are the main food constituents. Dinoflagellates and copepods are the next important food items. According to the analysis of stomach condition, *Rastrelliger brachysoma* is omnivores and pelagic feeders. According to the analysis of feeding condition, it has active feeding habits. Observations on the feeding intensity in relation to different stages of growth show that, the mackerel feeds well when it is small, and while growing it feeds more and while maturing it feeds the most.

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