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Food spectrum and analysis of Indian shad *Rastrelliger kanagurta* from Visakhapatnam coast, Andhra Pradesh

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Abstract
Indian mackerel, *Rastrelliger kanagurta* is one of the commercially vital pelagic fish in east and west coast of India. The present study was analysis the food spectrum of *R. kanagurta* at different stations of Visakhapatnam coast, i.e., Station 1. Bangarammapalem, Station 2. Rambilli and Station 3. Bheemunipatnam from July 2016 to June 2017. This species was found to be mainly feed on zooplankton goes to 37%, phytoplankton 26%, fish egg and larvae 10.5%, shrimp larvae 11% miscellaneous matter 9% and semi-digested matter 5.5% in case of males and females goes to zooplankton was 36%, phytoplankton 25%, fish egg and larvae 11%, shrimp larvae 11.5% miscellaneous matter 9.5% and semi-digested matter 7% was observed in this study. The study clearly explains that the *R. kanagurta* is a plankton feeder. The present results showed that majority of the guts are empty and range goes to 31-55%, followed by ¼ full was 11-26%, ½ full was 10.5-19%, ¾ full goes to 8-14%, full was 6-13.4% and gorged ranges between 2.5-8.5% in males in different months. In females it was showed that mostly are empty and ranges between 32-51%, followed by ¼ full was 15-30.5%, ½ full was 10.9-19.2%, ¾ full was 8-15%, full was 6-14% and gorged goes to 2.5-6.2% in study period. The feeding intensity was higher during August in case males and females and poor feeding during May and June and remain months are moderate feeding was noticed.

Keywords: *Rastrelliger kanagurta*, food spectrum and composition

Introduction
Indian mackerel, Rastrelliger kanagurta is one of the vital marine food fish resources of India and this species is second important after oil sardine. It is one of the major marine fishery resources to the total marine fish yield in the country [1]. Visakhapatnam coast, is located in North Eastern part of Andhra Pradesh between 17º 15' and 18º 32' Northern latitude and 82 º 54' and 83º 30' in Eastern longitude. Investigation of the food spectrum and analysis of fishes was imperative toll in fishery management [2]. *R. kanagurta* is a high commercial value fish followed by sardines. The mackerel's fishery particularly *R. kanagurta* was most delicious fish and it has occupied a major role in human consumption fishes due to their taste and culinary properties [2]. Investigation on the food spectrum and composition will throw more light on the migratory and shoaling habits of pelagic species of fish, and it is particularly important for a species of high commercial value.
Food spectrum and analysis of fishery in their natural habitat enriches the understanding of the fishery management particularly feeding biology [3, 4]. The nature of food composition of a fish helps in finding out the distribution of a fish population in the ecosystem without any competition [5]. Information of diet composition of various fish species and a thorough their survey of literature indicates that such knowledge is highly essential for successful management of a fishery [6]. Sometimes the rate of feeding has a bearing on the spawning of the fish with the ecological factors [7]. Nature offers a variety of food organisms for fishes, such as zooplankton, phytoplankton, insects and their larvae, shrimp / prawn larvae, eggs of different organisms [8].
Study of the gut contents of fishes helps to understanding to how the animals live in water, which type of food may influence their abundance, distribution and growth. Study of the nutrition requirements is also helpful to obtain the best growth of their life cycle in fishes. Pillay [9] reported that the fishes and their gut contents regards to survival.

There is an influential need for conservation and rehabilitation of its declining fishery and information on the food and feeding habits of the fish is essential for its domestication. Knowledge of food and feeding data has manifold advantages for the ecosystem-based management and exploitation of valuable fishery. Hence, the present study would throw some light in this direction.

Materials and Methods

The three stations Visakhapatnam coast i.e., Station 1. Bangarammapalem, Station 2. Rambilli and Station 3. Bheemunipatnam were visited at regular monthly intervals to collect fish samples from July 2016 to June 2017. The fish were subjected to analysis in fresh condition after reaching the laboratory within hours after collection in the field. For assessing the food spectrum and analysis of the guts were removed by cutting open the abdomen after taking the necessary measurements. The analysis of different food items of fish was analysed by the estimation method suggested by Pillay [9] and the points-method of Bapat and Bal [10] was followed. Points were assigned as 1.25 for gorged stomach, 1.00 for full stomach, 0.75 for 1/3 full stomach, 0.50 for½ full stomach, 0.25 for ¼ full stomach and 0.00 for empty stomach. The weight of the fish and their stomach weight were recorded.

The Gastro somatic index of individual fish was calculated using the following formula.

$$\text{Gastro Somatic Index (GSI)} = \frac{\text{Weight of the stomach}}{\text{Weigh of the fish}} \times 100$$

Results and Discussion

The food spectrum and analysis of Rastrelliger kanagurta (120 males and 120 females) was given (Fig. 1 and 2) and the stomach contents were made up of 6 categories. The gut content revealed that food items are mainly composed zooplankton, phytoplankton, fish egg and larvae, shrimp larvae, miscellaneous matter and semi-digested matter. The percentage of zooplankton goes to 37%, phytoplankton was 26%, fish egg and larvae was 10.5%, shrimp larvae was 11% miscellaneous matter was 9% and semi-digested matter goes to 5.5% in case of males and females goes to zooplankton was 36%, phytoplankton was 25%, fish egg and larvae was 11%, shrimp larvae was 11.5% miscellaneous matter was 9.5% and semi-digested matter 7% was observed in this study. Further, the present results showed that empty guts range goes to 31-55%, followed by ¼ full was 11-26%, ½ full was 10.5-19%, ¾ full goes to 8-14%, full was 6-13.4% and gorged ranges between 2.5-8.5% in males. In females showed that empty guts ranges between 32-51%, followed by ¼ full was 15-30.5%, ½ full was 10.9-19.2%, ¾ full was 8-15%, full was 6-14% and gorged goes to 2.5-6.2% in study period. The feeding intensity was higher during August in case males and females and poor feeding during May and June. During the remain months are moderate feeding was noticed.

The food items of zooplankton was crustaceans (Copepoda and Cladocera) and Phytoplankton was Bacillariophyceae (diatoms) and chlorophyceae (green algae) was major groups. After zoo and phytoplankton it was noticed that fish eggs, fish larvae, scales of fish, broken appendages shrimp larvae, miscellaneous matter and semi-digested matter formed minor food constituents of *R. kanagurta*.

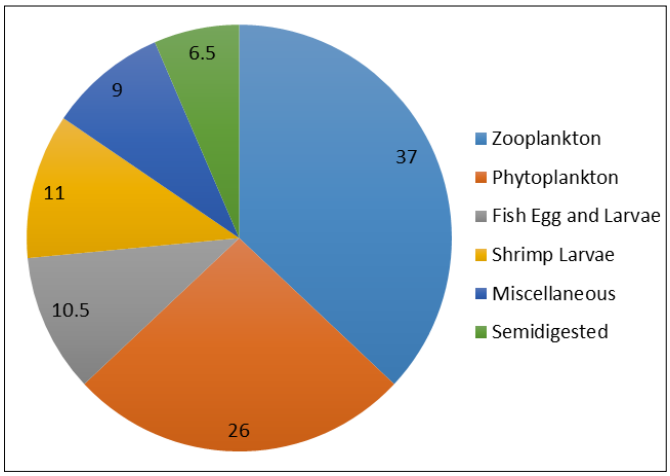

Fig 1: Composition of food items of Rastrelliger kanagurta male in the 2016-17.

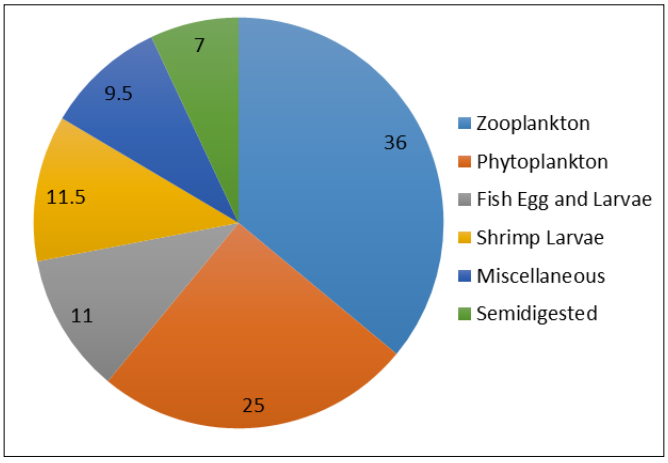

Fig 2: Composition of food items of Rastrelliger kanagurta female in the 2016-17.

Feeding ecology is an imperative role of life cycle to understanding of the fish and fishery and their requirements. Food quality and abundance was helps to understanding of the any natural or anthropogenic involvement [11]. Studies of food intake and growth of the various species is expected to yield in capture fishery levels valuable information for assessing the role of the particular species in the marine food web [12]. The combined information and rate of evacuation, diet information can be used in assessments of the total food consumed and their utilization of fish [13]. Qasim [14] was reported dynamics of gut contents of fishes from Indian waters put emphasis on the data analyses. Qasim and Jacob- was studied diet composition of different groups of marine fishes. The food and feeding habits are varied in different fishes and spend its life cycle and adapt in different habitats in different seasons [16]. Bhaumik and Sharma [17], was observed gut contents of selected food fishes of Hooghly estuary.

Mann [18] reported that the phytoplankton production is little bit high in rainy season and remain period its goes to normal levls in different ecosystems. Venu and Revathy, [19] reported that crustaceans are primary and Polychaetes formed the second most important food item in stomach content of *Sillago sihama* and also semi digested matter was also recorded in their study. Sekadende *et al*., [20] studied that *R. kanagurta* was be carnivore, fed predominantly on fish was 60.6%, particularly *S. commersonnii*, followed by penaeid shrimps and other juvenile fishes.

Hulkoti *et al*., [21] studied that the food composition indicates that *R. kanagurta* was mainly on zooplankton and phytoplankton. Rao [22] also reported in Kakinada, Waltair coast and the food of *R. kanagurta* was zooplankton and phytoplankton. Hulkoti *et al*. [21] studied that the gut content consisted approximately 41.56% zooplankton, 37.64% phytoplankton, 7.08% algae, 7.74% miscellaneous items and 5.98% semi-digested matter respectively. Lanthaimeilu and Bhattacharjee [23], reported that the feeding activity were decreased as the gonadal development in fully mature stage. Omnivore fishes prefer invertebrate prey like zooplankton, when this food items may not available they consider phytoplankton [6, 24]. Biological studies including food and feeding habits and their mechanism in fishes are of great concern in the management fisheries. Fishes are directly depend upon their surrounding aquatic environment for their food requirements and are highly adopted in their food and utilizing most of the readily available food items in the marine environment.

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