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Study on food selection of *Labeo rohita* (Hamilton, 1822) by determining electivity index in periphyton based and periphyton free monoculture pond

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Abstract
Feeding preferences of rohu *Labeo rohita* (rohu) were studied in two environments i.e. substrate free and substrate based (with bamboo substrate) in a traditional fish pond. In order to determine the food selectivity under two different food environments, lvlev's Electivity Index was used. Initially it preferred zooplankton, but as the fish grows in size it shifted to both food resources i.e. plankton and periphyton in substrate based system. The fish fed a range of food items, including Chlorophyceae like *Cosmarium*, *Closterium* etc., Bacillariophyceae like *Navicula*, *Diatoma* etc., Euglenophyceae like *Phacus*, *Euglena* etc., Cyanophyceae like *Aphanocapsa*, *Gloeocapsa*. Bacillariophyceae were preferred next to Chlorophyceae. Feed selectivity study with lvlev's index revealed that fingerlings and adults of rohu differ sharply in selection of food items. When the fish was introduced into periphytic system, it prefers to consume periphyton over plankton.

Keywords: *Labeo rohita*, Electivity index, feed selectivity, gut content, periphyton, plankton

1. Introduction

Rohu (*L. rohita*) is the most important among the Indian major carp (IMC) species used in carp polyculture practice. The fish is an Indo-Gangetic riverine species, and a natural inhabitant of the riverine system of northern and central India, and the rivers of Pakistan, Bangladesh and Myanmar. The species has also been introduced in many other countries, including Sri Lanka, the former USSR, Japan, China, Philippines, Malaysia, Nepal and some countries of Africa. The compatibility of rohu with other carps like catla (*Catla catla*) and mrigal (*Cirrhinus mrigala*) made it an ideal candidate for carp polyculture systems (Jhingran, 1991) [9]. Its high growth potential, coupled with high consumer preference, have established rohu as the most important freshwater species cultured in India, Bangladesh and other adjacent countries in the region.

L. rohita, with a contribution of 15% to world's freshwater aquaculture production (FAO, 2009) [7] has few scattered reports on feeding strategies on natural organisms under semi or shallow aquatic environments. Its basic food comprises of plankton from water column (Das and Moitra, 1955; Dewan *et al*., 1991; Jhingran and Pullin, 1985; Wahab *et al*., 1994) [4, 5, 10, 20]. On the basis of gut content analysis, it was reported as zooplankton feeder (Miah *et al*., 1984) or both zoo and phytoplankton feeder (Wahab *et al*., 1994) [20] or periphyton feeder (NFEP, 1997; Ramesh *et al*., 1999; Azim *et al*., 2001a) [15, 19, 2]. Recently, Muhammad *et al*. (2006) found differential size dependent diet composition and divergent dietary preference between *L. rohita* and *Cyprinus carpio* in semi intensive ponds. Khan and Siddique (1973) [11] also studied food selection and feeding relationship of *L. rohita* with *C. catla* and *C. mrigala* and concluded *L. rohita* as zooplankton feeder in fingerling and phytoplankton feeder in adult stage.

Despite the fact that many culture techniques of fish production have been developed, the heavy loss still remains a major hindrance mainly due to the lack of proper feeds at the early stage. There are a few researches so far done on food selection of this fish. Considering the fact of insufficient information of this important aspect, the present investigation was undertaken to determine the pattern of food and feeding preferences of rohu by calculating the electivity index in two different food environments, i.e., substrate free (plankton) and substrate based (plankton and periphyton) under natural condition.

2. Material and Methods

2.1 Experimental set up and gut sampling

The study has been performed in a conventional fish pond in rural Bolpur of Birbhum district, West Bengal, India. The pond was divided into two areas with fine nylon net fixed in bamboo poles. For colonization of periphytic organisms, bamboo poles (natural substrate, lengths 2.7±0.23 m & diameters 5.5±0.38 cm) were implanted in the pond at a distance of 1meter from each other in one half (substrate based) before one month of introduction of fish into the pond and another half (substrate free) of the pond was without bamboo poles. Fishes were released in both experimental plots. *Labeo rohita* at fingerling stage with average weight 9.44±1.42 g and average total length 7.8±0.83 cm were released 15 days ahead of first sampling. A total of 15 fish from each experimental plot during every sampling were collected in 30 days intervals. A total of six sampling was done. All fish were collected before 9:00 AM from the experimental pond with the help of fish net. Before gut collection, every fish was weighed and total length was recorded. The guts were cut from pharynx region to first constriction of alimentary canal. This length is around 4.5-12.6 cm proportionately to the total body length of the fish. Immediately after collection, guts were transferred to 10% formalin. In laboratory, gut contents were removed with scalpel visible up to naked eyes. These were then preserved in 4% formalin in 5ml glass vials for further analysis.

2.2 Resource sampling

Two resources (plankton and periphyton) from substrate based area and one resource (plankton) from substrate free area were considered. Sampling of all resources was done at the same time of gut collection. Plankton samples were collected randomly with plankton net (0.20µm mesh size) filtering approximately 30 Liter water every time and transferred to a 15ml glass vial. Periphyton samples were randomly scrapped from an area of 10 cm^2 from bamboo surfaces, then mixed and stored in a 15ml glass vial. All samples of plankton and periphyton were preserved in 4% formalin for further analysis.

2.3 Identification and Quantification of samples

Calculations of gut contents and resource samples were done following Lackey's (1938) [12] drop count methods under an inverted microscope (Victory plus, Dewinter, Italy). Organisms were identified up to generic level and wherever possible identified up to species level using standard manuals (Pentecost 1984, Edmondson 1992, Perumal & Anand 2009) [16, 6, 17]. In case of gut content, the whole gut contents collected from each gut were analyzed.

2.4 Food Selectivity Study

Ivlev's (1961) [8] electivity index was used to measure the selection of available food organisms by fish: $E_i = St_i - P_i/St_i + P_i$ where E_i = electivity index for species I, St_i = relative proportion of species i in the diet, P_i = relative proportion of species i in the environment. E values vary from -1 to +1, values around 0 indicate no selection, a value of +1.0 indicates strong positive selection, and -1.0 indicates strong avoidance.

3. Result

3.1 Plankton and Periphyton population: Four major phytoplanktonic groups consisting of 32 genera were identified from pond waters throughout the study period. Among these groups Chlorophyceae and Bacillariophyceae were dominant. Five genera of zooplankton were also identified belonging to Crustacea and Rotifera. In case of periphytic organism 39 genera were identified belonging to four major algal groups (Bacillariophyceae, Chlorophyceae, Cyanophyceae and Euglenophyceae) and 6 genera of zooplankton were also identified belonging to Crustacea and Rotifera.

3.2 Gut content: Gut contents identification showed a wide variety of food organisms present in the diet of rohu at fingerling and adult stages. Gut contents of the fish collected from two food environment of the pond revealed quite similar patterns of selection of food organisms. It was observed that the diets of fish throughout the experimental period were dominated by phytoplankton qualitatively and quantitatively. Zooplankton was recorded in the gut content during the fingerling stages. About 25 genera of phytoplankton and 4 genera of zooplankton were recorded in the gut content of rohu.

3.3 Electivity index: Electivity indices were calculated for each food organism recovered from gut contents of rohu. The fingerlings and adults of rohu showed sharp difference in selection of food items through electivity index, although, there was a more or less similar trend in food selection in both the food environments. In fingerling stages it showed negative electivity for most of the phytoplanktonic organisms but showed positive electivity for Cyanophyceae like *Aphanocapsa*, *Chroococcus*, Chlorophyceae like *Scenedesmus*, *Closterium*, Euglenophyceae like *Phacus*, *Euglena* and zooplankton like Crustacea and Rotifers. But in case of adults it showed positive electivity for most of the phytoplanktonic organisms like *Aphanocapsa*, *Gloeocapsa*, *Chroococcus*, *Oscillatoria* from Cyanophyceae, *Cosmarium*, *Closterium*, *Scenedesmus*, *Kirchneriella*, from Chlorophyceae, *Navicula*, *Diatoma* from Bacillariophyceae and *Phacus*, *Euglena* from Euglenophyceae but negative selection for all zooplanktonic organisms.

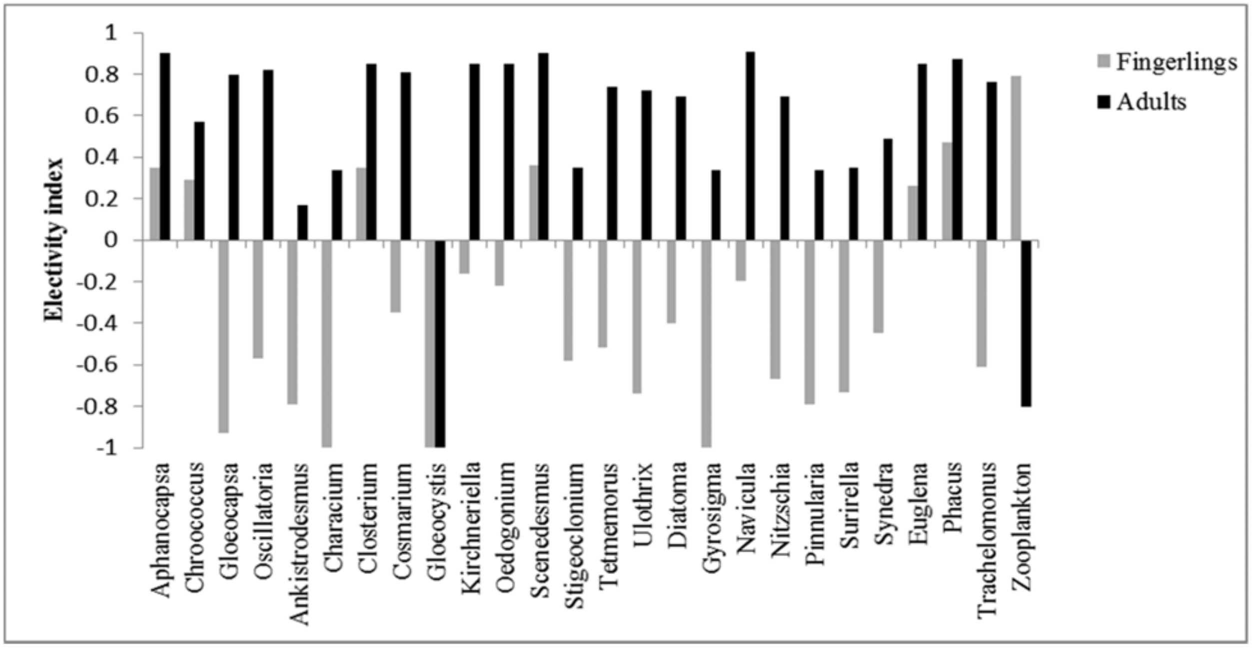

Fig: Selectivity of food organisms from Substrate Based area

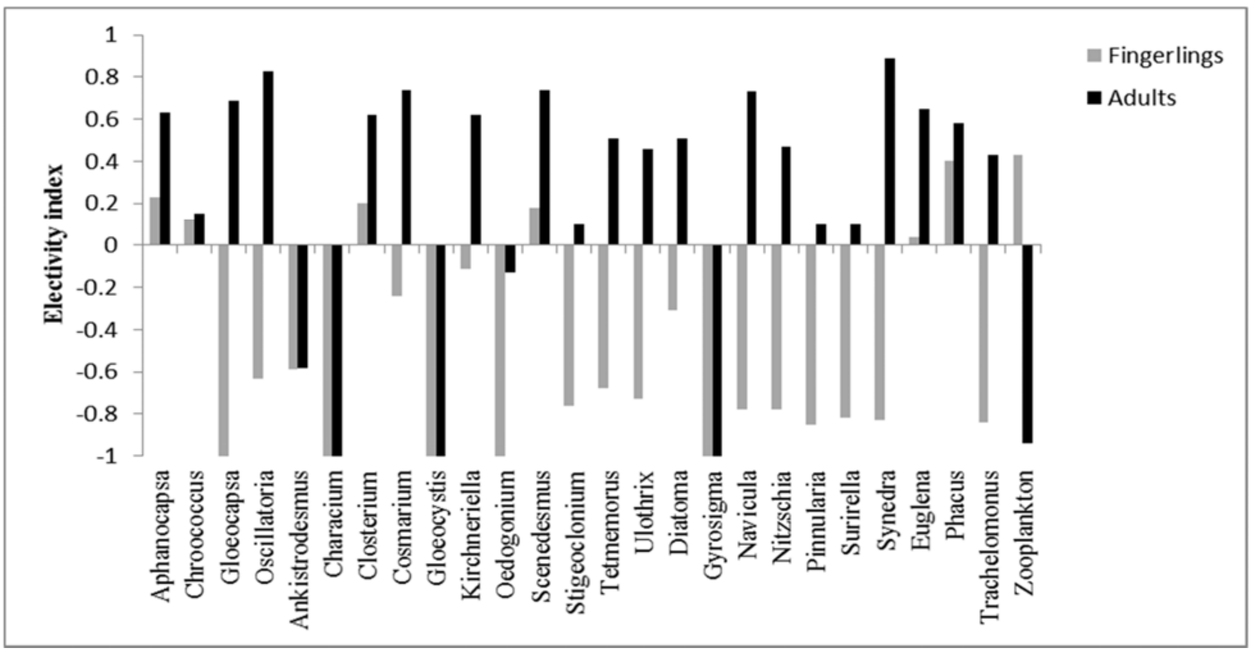

Fig: Selectivity of food organisms from Substrate Free area

4. Discussion

Electivity index of fish feeding was measured by using the results for the entire sampling period of the study. This might provide a generalized idea about the feeding behaviour of the fish. Plankton identified from gut contents of fingerlings and adults of this fish were more or less similar to the findings of Khan and Siddique (1973) and Rahman *et al*. (2008) [11, 18]. lvlev's index revealed that rohu sharply differs in selection of food categories in case of fry and fingerling stage. However, the present investigation recommended that rohu, irrespective of fingerling and adult stage, exerted a positive preference for phytoplankton. The earlier reports with rohu as active periphyton feeder (Azim *et al*. 2004) [3] did not consider gut analysis to confirm diet selectivity of rohu. Under substrate based environments, it was repeatedly reported that growth of rohu is faster than substrate free environment. Azim *et al*. (2001a) [1] reported that its growth was 77% higher in substrate based pond than substrate free ponds. Azim *et al*. (2001b) [2] significantly observed that periphyton biomass decreases with increasing biomass of rohu in substrate based environment. The present investigation supports these previous findings and suggests that rohu extends its feeding niche to periphyton along with plankton in substrate based system leading to accelerated biomass growth. Although rohu has been reported as exclusively plankton feeder, these observations suggest rohu as periphyton feeder in substrate based system. From the present study, electivity index also support such selection of periphyton by rohu when subjected to periphytic environment.

5. Conclusion

Very little work on the biology and feeding ecology of rohu, *Labeo rohita* has been done and much more study is needed, especially in the field of feeding behavior and feeding mechanisms. It could be concluded that rohu feeds on plankton and also on periphyton when introduced into periphytic system and it is chiefly a phytoplanktivorous fish throughout its ontogeny. In other words, in substrate based environment, substrate acted as facilitator for food shifting of rohu from plankton to periphyton. Further studies on the dynamics of food organisms in such a plankton-periphyton system could help understand the energy and nutrient transfer of rohu in a substrate-based environment.

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