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DIET SELECTIVITY OF *LABEO ROHITA* (HAMILTON, 1822) IN PERIPHYTON BASED AND PERIPHYTON FREE POLYCULTURE POND: AN EXPLANATION THROUGH ELECTIVITY INDEX

Sandip Majumder[1], Neha Majumdar[2], Surjya Kumar Saikia[1], Samar Kumar Saha[2] and Pinki Ghosh[3*]

[1]Fish Biology and Aquatic Ecology Laboratory, Department of Zoology, Visva-Bharati University, Santiniketan, West Bengal, India, Pin-731235.
[2]Fish Biology Research Unit, Department of Zoology, Visva-Bharati University, Santiniketan, West Bengal, India, Pin-731235.
[3]Fisheries Laboratory, Department of Zoology, Visva-Bharati University, Santiniketan, West Bengal, India, Pin-731235.
*Corresponding author e-mail: pinkighosh0504@gmail.com

ABSTRACT
Diet selectivity of rohu *Labeo rohita* was studied in two food environments i.e. substrate free and substrate based in a traditional earthen fish pond. In order to investigate the food selectivity under two different food environments, lvlev's Electivity Index was calculated. The study revealed that, during early in life rohu preferred zooplankton, but as the fish grows in size it shifted to both food resources i.e. plankton and periphyton in substrate based system. In the periphytic polyculture system, the fish prefers to consume the periphytic food resources. The present investigation revealed that rohu prefers to consume food organisms of algal origin which are from the four major algal groups (Chlorophyceae, Bacillariophyceae, Cyanophyceae and Euglenophyceae) during the later stage of life of the fish.

KEY WORDS: Electivity index, feed selectivity, gut content, *Labeo rohita*, Periphyton , Polyculture,

INTRODUCTION

Labeo rohita (rohu), with a contribution of 15% to world's freshwater aquaculture production (FAO, 2009) 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). 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) or periphyton feeder (NFEP, 1997; Ramesh *et al*., 1999; Azim *et al*., 2001a). 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) also studied food selection and feeding relationship of *L. rohita* with *Catla catla* and *Cirrhinus mrigala* and concluded *L. rohita* as zooplankton feeder in fingerling and phytoplankton feeder in adult stage. Though many culture techniques of fish production have been developed but heavy loss still remains a major problem 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 in polyculture system by calculating the electivity index in two different food environments, i.e., substrate free where plankton is the only available food and substrate based where both plankton and periphyton are the food resources.

MATERIALS AND METHODS

Experimental set up

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 on submerged substrates, bamboo poles (natural substrate, lengths 2.67±0.25 m & diameters 5.4±0.33 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 (average weight 8.49 ±1.15 g, average total length 7.2 ± 0.79 cm) along with *Catla catla* (average wt. 8.87 ±1.82 g, average length 7.2 ± 0.73 cm) and *Cirrhinus mrigala* (average wt. 4.49 ± 0.71 g, average length 5.1 ± 0.59 cm) were introduced in both the halves of the pond to make them polyculture environment.

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Gut sampling

During every sampling 15-20 rohu from each experimental plot were captured with help of fish net in 30 days intervals. A total of six sampling were done. All fish were collected before 9:00 AM from the experimental pond. 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.

Resource sampling

Two resources (plankton and periphyton) from substrate based area and one resource (plankton) from substrate free area were considered. Samplings of all resources were 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.

Identification and Quantification of samples

Calculations of gut contents and resource samples were done following Lackey's (1938) 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). In case of gut content, the whole gut contents collected from each gut were analyzed.

Food Selectivity Study

Ivlev's (1961) 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.

RESULTS

Planktonic and Periphytic organisms of the pond water: Four major phytoplanktonic groups consisting of 40 genera were identified from pond waters throughout the study period. Among these groups Chlorophyceae and Bacillariophyceae were dominant. 12 genera of zooplankton were also identified belonging to Crustacea, Rotifera, Cladocera and Copepoda. In case of periphytic organism 37 genera were identified belonging to four major algal groups (Bacillariophyceae, Chlorophyceae, Cyanophyceae and Euglenophyceae) and 12 genera of zooplankton were also identified belonging to Crustacea, Rotifera, Cladocera and Copepoda.

Gut content organisms of rohu: 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 fishes 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. In periphytic culture system a total of 39 genera of phytoplankton belonging to Chlorophyceae, Bacillariophyceae, Cyanophyceae and Euglenophyceae and 12 genera of zooplankton belonging to Crustacea, Rotifera, Cladocera and Copepoda were recorded in the gut content of rohu. In planktonic culture systems a total of 36 genera of phytoplankton belonging to Chlorophyceae, Bacillariophyceae, Cyanophyceae and Euglenophyceae were recorded from the gut of rohu and 12 genera of zooplankton were also identified belonging to Crustacea, Rotifera, Cladocera and Copepoda. The fraction of these food items used by the fish showed great variation with the progress of the season.

Electivity index: Electivity indices were calculated for each food organism recovered from gut contents of rohu (Figure 1 and 2). 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 although; there was a more or less similar trend in food selection in both the food environments.

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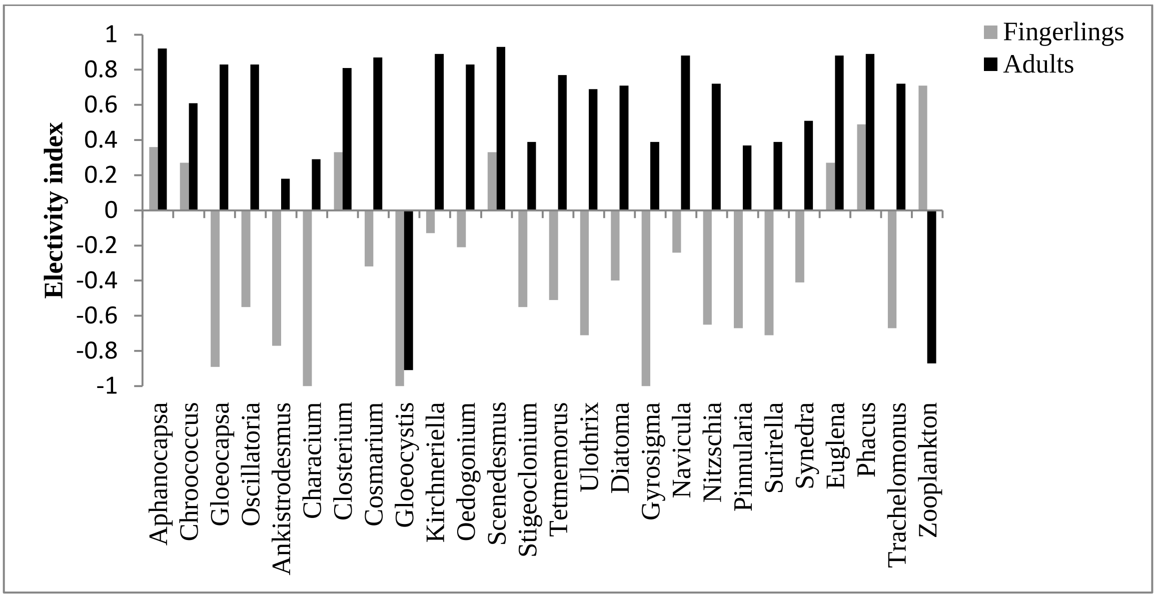

Figure 1: Electivity indices of food organisms in substrate based pond environment

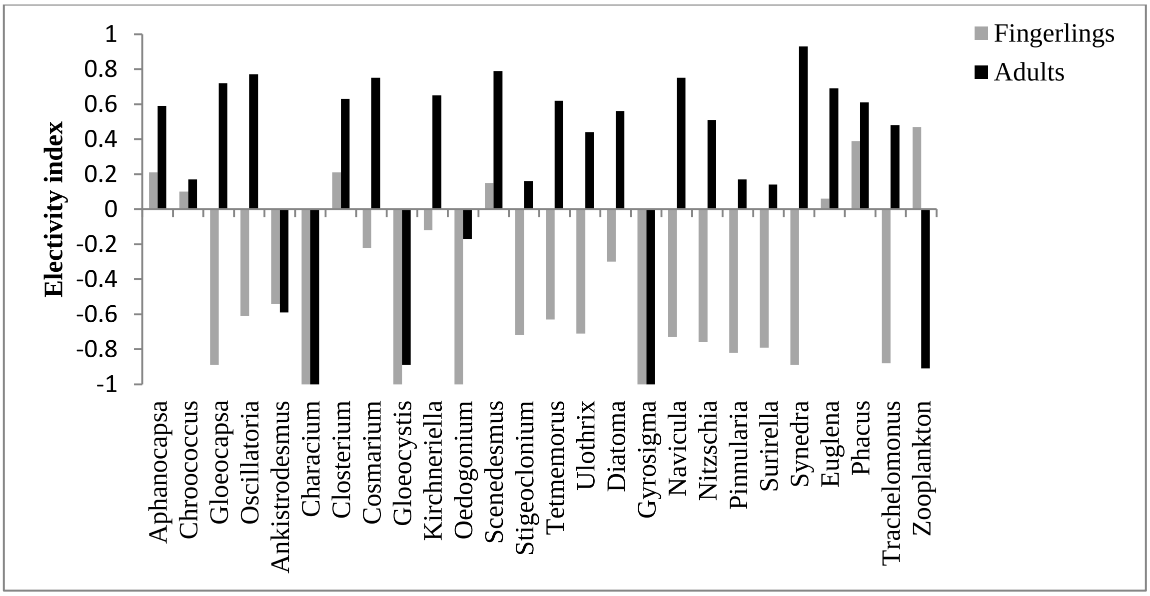

Figure 2: Electivity indices of food organisms in substrate free pond environment

In fingerling stages it showed negative electivity for most of the phytoplanktonic organisms but showed positive electivity for Cyanophyceae like *Aphanocapsa*, *Chroococcus*, Chlorophyceae like *Scendesmus*, *Closterium*, Euglenophyeae 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*, *Scendesmus*, *Kirchneriella*, from Chlorophyceae, *Navicula*, *Diatoma* from Bacillariophyceae and *Phacus*, *Euglena* from Euglenophyeae but negative selection for all zooplanktonic organisms.

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DISCUSSION

To obtain a rational idea about the feeding behaviour of the fish, Electivity index of was calculated by using the results for the entire sampling period of the study. 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). lvlev's index revealed that rohu sharply differs in selection of food categories in case of fry and fingerling stage. However, the present investigation revealed 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) 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) reported that its growth was 77% higher in substrate based pond than substrate free ponds. Azim *et al*. (2001b) 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 concur with the findings of Majumder *et al*. (2016) who suggested 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 because it is easier for the fish to graze on the two dimensional layer of the natural substrate. On evaluating Ivlev's (1961) electivity index, Khan and Siddique (1973) found high and positive electivity index for Chlorophyceae and Bacillariophyceae. But the present investigation found positive electivity indices for all the four major algal groups (Chlorophyceae, Bacillariophyceae, Cyanophyceae and Euglenophyceae) during the later stage of life of the fish. The study revealed planktivorous nature of feeding of rohu mostly on algal food organisms from both periphytic and planktonic environments.

Contrary to Khan and Siddique (1973), the present investigation found that rohu feed on phytoplankton throughout the life even in the early stage of life. But at early stage it consumes zooplankton in higher quantity and phytoplankton in less quantity. It is evident that the periphytic fish ponds were dominant in periphytic life forms. Fish can easily graze on the sessile food items more efficiently in comparison to the filter feeding from the water column (Dempster *et al*. 1993). Moreover, the gradual increase in size and the body weight of the fish with progress of time might have some influence on feed preference for algal organisms in case of rohu.

CONCLUSION

The present study concluded that rohu feeds on both the plankton and periphyton when introduced into periphytic system and it is chiefly a phytoplanktivorous fish throughout its life. In substrate based environment, substrate acted as facilitator for food shifting of rohu from plankton to periphyton and it is evidenced that periphyton acts as the major food resource in substrate based environment. Further studies on the dynamics of food organisms in substrate based and substrate free system could help to understand the energy and nutrient transfer of rohu as periphyton feeder.

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