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Natural food resources and niche breadth of *Barilius bendelisis* (Hamilton) (Pisces, Cyprinidae) in river Dikrong, an upland riverine ecosystem in India

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Abstract. The food items and feeding habits of the Indian Hill Trout, *Barilius bendelisis* (Hamilton) from the River Dikrong in Arunachal Pradesh, India was examined between January and February of 2001. Fish samples were caught in the morning, noon, afternoon and evening, using cast net. Analysis of gut content revealed that the fish is periphytophagous and feeds mainly on bacillariophycean algae, showing more feeding intensity at noon hours of the day. The fish in general displayed wider niche breadth (around double) at noon (0.52) in comparison to morning (0.25) and also to evening (0.20) hours. Different size groups of *B. bendelisis* reflected resource selectivity in the same environment.

Key words: bacillariophyceae; gut analysis; periphyton; Arunachal Pradesh

Resumo. Recursos alimentares naturais e amplitude do nicho de *Barilius bendelisis* (Hamilton) no rio Dikrong, um ecosistema riverino de montanha na India. Os itens alimentares e os habitos da alimentaçao da truta *Barilius bendelisis* (Hamilton) no rio Dikrong em Arunachal Pradesh, Índia foram examinados entre Janeiro e Fevereiro de 2001. As amostras foram coletadas pela manha, meio-dia, tarde e noite usando uma tarrafa. Analise dos conteúdos estomacais revelou que a espécie é perifitófaga e que se alimenta principalmente de algas bacilarioficeas, apresentando uma maior intensidade na atividade alimentar no período do meio dia. A espécie apresentou em geral um nicho mais amplo (aproximadamente o dobro) no meio dia (0.52) em comparação com a manha (0.25) e ainda com o anoitecer (0.20). Diferentes classes de tamanho de *B. bendelisis* refletiram seletividade dos recursos num mesmo ambiente.

Palavras chave: bacilarioficeas; análise do conteúdo estomacal, perifíton; Arunachal Pradesh

Introduction

Barilius bendelisis (Hamilton), commonly known as Indian Hill Trout, is an upland water fish of South East Asia. It belongs to the family Cyprinidae and dwells in shallow, clear and cold water (Gurung *et al*. 2005). It is highly endemic as well as endangered in the rivers of Himalayan region (Kurup *et al*. 2004). In northeastern India, it is commonly distributed in hilly streams and rivers (25°C) of Himalayan region. The fish plays significant role in the capture fishery in several parts of the Himalayan region of Arunachal Pradesh, inhabiting shallow lotic and seasonal lentic water bodies where Indian major carps and exotic carps cannot be raised successfully. Such areas include shallow flooded watersheds, seasonal flood plains and smaller river-fed ponds. Though extensive studies have been done on food and feeding ecology of common carp (*Cyprinus carpio* L.) (Das *et al*. 2007, Saikia & Das 2008) in the rice fields from this part of Himalayan region, *B. bendelisis* being a demanding ornamental as well as potential food fish has hardly received any research attention for such studies.

Except from a few scattered reports on habitat characterization, no records on the feeding habits and food composition of *Barilius bendelisis* exists (Farswan *et al*. 1989, Shehgal 1999, Johal *et al*., 2001). The present study is, therefore, an important contribution to the knowledge of the

feeding habit and food composition of this species, in order to develop a culture system in its natural environment. This paper deals with organisms found in the gut content of the fish collected directly from an eastern Himalayan river named *Dikrong* situated in the district of Papumpare, Arunachal Pradesh, India.

Material and Methods

The sampling of *B. bendelisis* was done between the months of January and February 2001. Random sampling in selected areas of Dikrong River was carried out once in a week using a cast net at morning (6:00 — 8:00), noon (12:00 — 13:30) and afternoon (14:45 — 15:00) hours of each day of sampling. The sampled fishes were identified using the taxonomic keys (Nath & Dey 2000) and immediately fixed in 8 % formalin. On an average 50 fishes were collected and examined during each sampling period. Total length of each fish was measured in centimeter and the gut was carefully dissected out. The gut was then cut lengthwise and gut contents were scraped gently using a soft brush. The gut contents were preserved in 5% formalin for further analysis. Microscopic observation and identification of food organisms was carried out up to generic level following standard procedures (Turner 1978, Pantecost 1984, Edmondson 1992). The quantitative analysis of gut contents was done according to Windell and Bowen (1978) and Bowen (1983). Data were expressed in proportion as fraction of 1.0 (Haroon & Pittman 2000). Niche breadth (B) for the fish was determined using the following formula:

$$B = \frac{1}{\sum pj^2} \text{ (Levins 1968)}$$

where,pj = proportion of individuals found.

Fish samples were grouped in to two sizes vis-a-vis small sized fishes (SSF) which ranged between 6.0 and 10.0 cm and large sized fishes (LSF) ranging from11.0 to 13.0 cm. Gut contents of SSF and those of LSF were examined separately. Temporal study on food organisms was done with all fishes sampled irrespective of the size groups.

Results

The qualitative and quantitative data of the gut contents for each size group was determined. These are presented in Table I, where can be seen that 10 genera of bacillariophyceae, 14 genera of chlorophyceae, 1 genus of protozoa and 3 genera of rotifers were observed in the gut of *B. bendelisis*.

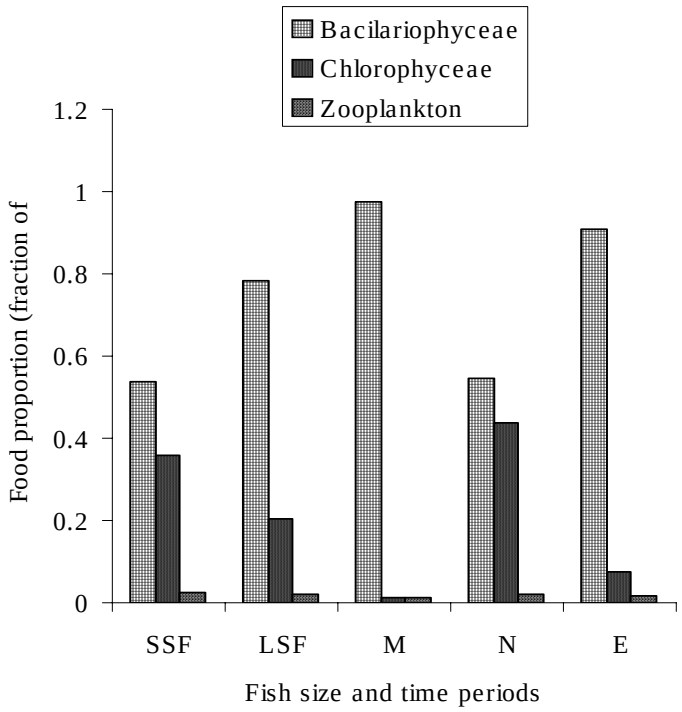

Figure 1. Proportion (fraction of 1.0) of available food organisms in the gut of *B.bendelisis* (Ham.) from Dikrong River, India. SSF, Small size fish; LSF, Large size fish; M, Morning; N, Noon; E, Evening

Table I. Proportion of available food organisms in the gut of *B. bendelisis* (Ham.) from Dikrong River, India

Genus	Size group		Time		
	SSF	LSF	Morning	Noon	Evening
(i) Bacillariophyceae					
Navicula	0.1566	0.3534	0.5364	0.1206	0.4512
Pinnularia	0.1897	0.0802	0.3180	0.0976	0.0731
Gomphonema	0.0772	0.0727	0.0920	0.1072	0.0558
Melosira	0.0290	0.0059		0.0080	0.0101
Cymbella	0.0793	0.0768	0.0249	0.0925	0.0774
Tabellaria	0.0069	0.0004		0.0022	
Surrirella		0.0004	0.0057		0.0006
Atthiya		0.0017			0.0026
Fragillaria	0.0531	0.1279		0.1056	0.1430
Amphora	0.0241	0.0638		0.0134	0.0953
(ii) Chlorophyceae					
Scenedesmus		0.0104			0.0153
Closterium	0.0310	0.0234		0.0415	0.0185
Euastrum	0.1083	0.0025		0.0498	
Cosmarium		0.0231		0.0501	
Spirogyra	0.1359	0.0340		0.1018	
Zygnema		0.0087		0.0019	
Ulothrix	0.0372	0.0046	0.0115	0.0265	
Microspora	0.0241	0.0147		0.0469	
Oedogonium		0.0013		0.0032	
Clostriopsis		0.0277			0.0419
Netrium		0.0004		0.0096	
Desmidium	0.0041	0.0399		0.0987	
Hyalothece		0.0059			
Pleurotaenium	0.0172	0.0059		0.0093	
(iii) Zooplankton					
Difflugia	0.0221	0.0084		0.0223	0.0069
Keratella	0.0041	0.0084	0.0115		
Polyarthra		0.0013			0.0020
Testudinella		0.0042			0.0064

Table II. Levins' niche breadth (B) of food organisms in the gut of *B. bendelisis* (Ham.) from Dikrong River, India

Size group		Time		
SSF	LSF	Morning	Noon	Evening
0.5012	0.1982	0.2519	0.5176	0.2014

The intensity of food consumption by fishes was higher in the morning (0.98) and evening (0.91) hours but moderate at noon (0.55) (Figure 1). Though *Navicula* was preferred by both SSF and LSF during morning (0.54) and evening (0.45) hours, the LSF showed comparatively more inclination (0.35) towards *Navicula* than to SSF. The proportion (fraction of 1.0) indicated that LSF

consumed more bacillariophyceae (0.7832) than SSF (0.5369). However, the fishes avoided *Surirella* (<0.006) irrespective of size groups and feeding hours. The SSF consumed Chlorophyceae mostly (0.36) in comparison to LSF (0.20). At noon hours, Chlorophyceae constituded a moderate proportion (0.44) of the gut content but a negligible proportion in the morning (0.01) and evening (0.08) hours. On the other hand, zooplankton represented a low poor proportion of gut content (<0.03).

The SSF exhibited wider niche breadth (0.5012) than the LSF (0.1982). The fish in general displayed wider niche breadth (around double) at noon (0.52) in comparison to morning (0.25) and also to evening (0.20) hours (Table II).

Discussion

Substrates like stones and rocks harbour the highest density of bacillariophyceae community in lotic systems (Nautiyal *et al*. 2000). Observation of higher proportion of bacillariophyceae in the gut of both size groups indicates that *B. bendelisis* browses on stone and rock substrate. Nautiyal *et al*. (2000) also reported *Navicula* as being common on such substrates thus explaining why the LSF might have preferred it to other food organisms. The narrow niche breadth indicates an increased specialization of the fish and this might be due to increased size and competitive ability of the species (Haroon & Pittman 1998). In contrast, wider niche breadth of SSF displayed its opportunistic habit. However, both size groups consumed chlorophyceae moderately and periphyton less frequently. The moderate consumption of chlorophyceae may be due to their mixed form of occurrence (suspended/attached) while from the less frequent consumption of periphyton, it can be presumed that the fish nibbled only on the available periphytic forms. Similarly, zooplankton was scarcely seen in the gut. This may be explained either by its pseudoperiphytic nature (Sladeckova 1962) or by its accidental consumption.

The functions of Levin's niche breadth against feeding time for *B. bendelisis* showed a high degree of specialization on natural food in the morning and evening hours. The fish specialized on bacillariophyceae (Fig. 1) where *Navicula, Pinularia* and *Fragillaria* species contributed significant fraction of the food composition. However, wider niche breadth at noon hours reflects maximum food selection and feeding activity of the fish on available food resources. The reason for variations of niche breadth could be due to the resource selectivity by the individual from the environment (Petraitis 1979). The peak feeding response at noon hours is in conformation with the findings of Haroon and Pittman (1998), thus supporting an environmental effect on the resource utilization by the fish. The low magnitude of difference (30%) of niche breadth between both size groups in the same environment at a given time is enough to consider them as non-competitors and is also indicative of differences in resource selectivity. Thus, a selection of these size groups for sequential stocking in experimental or cultural set up may not lead to intraspecific competition. However, the whole study could not reflect a generalized niche breadth for the fish because of limited replications, consideration of less variable size groups of fish and long time interval taken as feeding hours.

The results of the present matrices are 'virtual' since other competitions in the environment are usually considered close to absent during such types of study (Haroon & Pittman 2000). Thus, depending on the competitive stress in presence of other species of fish, this relationship may be subject to change.

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