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Diet of Threatened Fish *Pethia shalynius* (Yazdani and Talukdar 1975) in the Umiam River, Northeast India

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Abstract

Relative length of gut, gastrosomatic index, index of preponderance and gut contents were analysed to determine the feeding habit of *Pethia shalynius* (Yazdani and Talukdar 1975), an endemic and threatened hill stream fish of Northeast India. A total of 577 individuals were collected from the Umiam River, Barapani, Meghalaya for the present analysis. There were more than one relative gut lengths indicating an omnivorous form of feeding habit. Gastrosomatic index ranged from 1.645±0.127 to 5.281±0.499. Index of preponderance showed that detritus (76.28%) was the most preferred food item followed by phytoplankton (16.75%), nematodes (2.90%), insects (1.84%), plant matter (1.18%), zooplankton (0.94%) and unidentified algae (0.10%). Gut content analysis revealed that the food composition consisted of detritus, phytoplankton, nematodes, zooplankton, insects, plant matter and unidentified algae. The present investigation of *P. shalynius* adds more information to our understanding of its feeding habit which will be useful for the culture of this fish, which is an omnivorous bottom feeder.

Keywords: *Pethia shalynius*, Northeast India, diet, relative gut length, gastrosomatic index

Introduction

Pethia shalynius (Yazdani and Talukdar 1975), or shalyni barb, is a hill stream, highly endemic and important species known for its food and ornamental value. In Meghalaya and Assam in India the size of this fish ranges from 6.3 to 7.0 cm in total length (Manorama et al. 2014). The habitat of the fish is situated between 1,000 to 1,400 metres above sea level and could be the possible reason for the constrained distribution of the species (Manorama et al. 2014). *Pethia shalynius*, earlier an abundant fish in the wild in Meghalaya, has now been categorised as "vulnerable" according to IUCN (2015).

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Knowledge on the food organisms of fish is essential for the prediction and exploitation of its stocks in nature. The environment plays an important role in deciding on the nature of food of an organism, and this issue is interesting to discuss from a specific and ecological viewpoint in order to understand the organism-food relationship (Bhuiyan et al. 2006). Seasonal variations bring change to the feeding habit of fishes. Consumption of food as well as digestion rate are directly associated with change in temperature which also influences the degree of accessibility to food organisms. It is important to identify the contents of the stomach as this helps us to collect information on feeding, consumption, digestion and their environment (Gomos et al. 2002). Fish food selection can be traced on a periodical basis since it differs temporally (Carman et al. 2006). Fishes are highly adaptable in their feeding habits and utilise food which is readily available. The significance of the analysis of the feeding pattern to assess the role of the environment on the fish has been studied by several workers (Mercy et al. 2002; Mondol et al. 2005; Chen and Kuo 2009). Studies on the wild feeding habits of fish allow us to classify the different ecological relationships, categorisation and composition of feeding contents, and consistency of the food chain (Post et al. 2000; Bacheler et al. 2004; Abdel-Aziz and Gharib 2007). Information obtained from the food consumption of fish may help in the detection of food preference and in turn construction of trophic representation as a useful tool to know the complex ecosystem (Lopez and Arcila 2002). The study of fecundity study, an important biological parameter, depends upon the supply of food (Nikolsky 1969). The size of the stomach in fishes is closely related to the feeding habit and particularly to the size of the prey (Mookerjee and Das 1945). Information on the relative length of the gut in fishes in relation to fish diet is limited (Dasgupta 2002). Besides, there is a close relationship between digestive tract length and food taken by fish (Rahman et al. 2012). There has been limited work on the food and feeding of *P. shalynius* from the Umiam River, Barapani, India. The objective of the present work is to study the relative length of the gut, gastrosomatic index, index of preponderance and gut content analysis of *P. shalynius*, an important hill stream fish of Meghalaya, India. The data obtained from this study will be helpful in planning required steps for conservation of this endemic and threatened species.

Materials and Methods

Study area

The study was carried out on the Umiam River, which is located around 15 km from Shillong the capital of Meghalaya, northeast India. The Umiam River emerges from the west of Shillong peak in the East Khasi Hills district. It flows through Ri-Bhoi and turns northwest. The water of this river is dammed for the Umiam Hydel Project and the waters from this reservoir are drained away through a tunnel to fall into the streams forming the tributaries of the Umtrew River. These streams flow in the western direction and meet the waters from the Umiam River which is further being diverted by the Umiam Hydel Project. *Pethia shalynius* specimens were collected from the Umiam River, Barapani (25°40’00”N and 91°54’20”E) between January 2010 and December 2010 every month. Fish were taken to the Fish Biology Laboratory, North Eastern Hill University, Shillong and maintained in 5% formaldehyde solution for further analysis.

All the fish were measured to 0.1cm for length and 0.1g for weight. A total of 264 males and 313 females of *P. shalynius* specimens were collected from the study site. The gut was removed from the samples and the items in the gut studied. Contents were examined under a binocular microscope at 10x (Olympus Co. Model No. CH20i) and identified to the lowest possible systematic level.

Relative gut length (RGL)

Relative gut length was determined using the method described by Al-Hussainy (1949):

RGL = GL / TL

where, GL = Gut length; TL = Total Length.

Gastrosomatic index (GaSI)

Gastrosomatic index was estimated following the method of Khan et al. (1988):

GaSI = Weight of the gut / Total weight of the fish x 100

Index of Preponderance

Index of Preponderance provides a summary of the frequency of occurrence and quantity of different food items. In this method, a combination of quantitative and qualitative differences in food items is taken into account. The index of preponderance was calculated using the method of Natarajan and Jhingran (1961):

$$I_i = V_i O_i / \sum V_i O_i \times 100$$

where, I_i = Index of Preponderance; V_i = percentage volume of a particular food item '*i*';

O_i = percentage of specific food item '*i*' occurred.

Gut content analysis

Gut content analysis was determined by investigating the monthly changes in feeding habits. Both the qualitative (volumetric) and quantitative (occurrence) methods were adopted for analysis of gut content (Hynes 1950).

Volumetric method

In this method, food items were expressed in percentage by volume as observed visually (Pillay 1952). After removal of the gut from the fish, distilled water was added to a 5 mL vial containing the guts and shaken continuously followed by examination and identification of food items under a compound microscope. An average of ten drops from each individual was examined and food items were recorded and expressed in percentage.

Frequency of occurrence

All the gut contents were observed, followed by the identification of each of the food items. The occurrence of the individual food items present in the guts was recorded and represented as a percentage of the total number of food items analysed (Hynes 1950).

Results

Relative gut length

The mean RGL values of *P. shalynius* specimens were found to be >1 throughout the year (Table 1). The highest value (1.583±0.041) was recorded in February and lowest (1.283±0.107) in October, while in females the highest value (1.692±0.077) was found in April and the lowest (1.150±0.149) during October.

Table 1. The mean seasonal variation of relative gut length (RGL) and gastrosomatic index (GaSI) of *Pethia shalynius* in the Umiam River, Meghalaya, India.

Months	Sex	N	RGL±SE	GaSI ±SE
Jan	M	21	1.397±0.053	2.230±0.131
	F	25	1.346±0.044	1.935±0.106
Feb	M	19	1.583±0.041	3.563±0.343
	F	24	1.355±0.037	3.443±0.363
Mar	M	24	1.307±0.038	2.258±0.433
	F	27	1.428±0.057	2.469±0.272
Apr	M	20	1.433±0.028	2.969±0.399
	F	23	1.692±0.077	5.281±0.499
May	M	25	1.479±0.022	2.336±0.286
	F	27	1.420±0.045	2.838±0.394
Jun	M	24	1.392±0.095	1.687±0.202
	F	29	1.494±0.024	1.645±0.127
July	M	21	1.348±0.055	1.669±0.209
	F	32	1.497±0.059	2.915±0.334
Aug	M	18	1.339±0.072	2.005±0.157
	F	25	1.364±0.040	1.888±0.089
Sep	M	26	1.360±0.042	1.781±0.150
	F	23	1.445±0.040	1.926±0.137
Oct	M	27	1.283±0.107	1.890±0.205
	F	29	1.150±0.149	1.877±0.407
Nov	M	18	1.560±0.076	2.463±0.257
	F	25	1.380±0.042	1.923±0.151
Dec	M	21	1.515±0.039	4.541±0.386
	F	24	1.439±0.081	3.088±0.416

*M, male; F, female; N, number of samples; SE, standard error

Gastrosomatic index

Temporal mean GaSI values ranged from 1.687±0.202 in June to 4.541±0.386 in December in males, and 1.645±0.127 in June to 5.281±0.499 in April in females. The highest value was observed in December for males and April for females, while the lowest value was recorded in June for both sexes (Table 1).

Index of preponderance

The index of preponderance of various food items indicated that detritus (76.28%) was the most preferred food item (Table 2) followed by phytoplankton (16.75%), nematodes (2.90%), insects (1.84%), plant matter (1.18%) and zooplankton (0.94%) respectively.

Table 2. Index of preponderance of different food items of *Pethia shalynius* in the Umiam River, Meghalaya, India.

Food items	% Occurrence (O*i*)	% Volume (V*i*)	V*i* O*i*	V*i*O*i* / ∑ V*i*O*i* x 100
Phytoplankton	24.81	23.11	493.406	16.85
Zooplankton	2.86	9.65	27.60	0.94
Nematodes	9.09	9.35	84.99	2.90
Insects	7.40	7.28	53.87	1.84
Plant matter	6.60	5.24	34.58	1.18
Detritus	49.23	45.37	2233.57	76.28
Total	100	100	2928.08	100

Gut content analysis

The percentage composition of each food item present in the gut is shown in Table 3. The food items were classified into detritus, phytoplankton, nematodes, zooplankton, insects and plant matter. Detritus comprised 49.23% of the diet in the gut and forms the most important food item. Phytoplankton ranked as the second most preferred food item with a total content of 23.41% in the gut. It was dominated by five classes viz, Bacillariophyceae, Chlorophyceae, Euglenophyceae, Myxophyceae and Xanthophyceae (Table 3). Bacillariophycea was dominated by *Pinnularia* followed by *Navicula*. Chlorophyceae was dominated by *Spirogyra* followed by *Scenedesmus* sp. (1.60%). Euglenophyceae was represented by two genera *Euglena* and *Trachelomonas.* Myxophyceae and Xanthophyceae were represented by only one genus each: *Oscillatoria* and *Tribonema* respectively. Some of the algae which could not be identified were recorded as unidentified algae (1.40%). Apart from nematodes (9.09%) other important food items in the gut were: insects (7.40%), zooplankton (2.86%) and plant matter (6.60%).

Table 3. Occurrence frequency (%) of different food items present in the gut of *Pethia shalynius* in the Umiam River, Meghalaya, India.

Group	Genus	% occurrence
Bacillariophyceae	*1. Tabellaria* sp.	0.80
	2. Fragilaria sp.	0.62
	3. Synedra sp.	0.98
	4. Eunotia sp.	0.98
	5. Achnanthes sp.	0.36
	6. Navicula sp.	1.87
	7. Pinnularia sp.	2.76
	8. Stauroneis sp.	0.53
	9. Gomphonema sp	0.62
	10. Cymbella sp.	0.80
	11. Amphora sp.	0.98
Chlorophyceae	*12. Scenedesmus* sp.	1.60
	13. Netrium sp.	0.27
	14. Closterium sp.	0.36
	15. Euastrum sp.	0.36
	16. Cosmarium sp.	0.27
	17. Desmidium sp.	0.53
	18. Spondylosium sp.	0.71
	19. Spirogyra sp.	2.58
	20. Mougeotia sp.	0.18
	21. Microspora sp.	0.80
	22. Oedogonium sp.	0.71
	23. Bulbochaete sp.	0.45
	24. Cladophora sp.	0.53
	25. Hydrodictyon sp.	0.18
Euglenophyceae	*26. Euglena* sp.	0.89
	27. Trachelomonas sp.	0.71
Myxophyceae	*28. Oscillatoria* sp.	0.53
Xanthophyceae	*29. Tribonema* sp.	0.45
Rotifera	*30. Lepadella* sp.	0.36
	31. Lecane sp.	0.62
Cladocera	*32. Chydorus* sp.	0.27
Copepoda	*33.* Nauplii	0.36
	34. Cyclops sp.	0.27
	35. Diaptomus sp.	0.18
Rhizopoda	*36. Arcella* sp.	0.80
	Nematodes	9.09
	Insects	7.40
	Plant matter	6.60
	Unidentified algae	1.40
	Detritus	49.23

Monthly changes in diet composition

Monthly feeding rhythms were analysed from the different food items in the fish gut as shown in Fig. 1. Detritus formed the major part of the food items occurring in the gut throughout the year with composition ranging from 39.02% in October to 85.71% in August. This was followed by phytoplankton which had a composition range of 16.67% in January to 29.54% in March. The composition of nematodes in the gut varied from 4.23% in June to 12.12% in May, while that of zooplankton was 1.69% in April to 12.20% in October.

The highest (8.33%) percentage of occurrence of insects in the gut was observed in January, while the lowest (2.82%) was recorded in June. In this study, plant matter composition in the gut varied from 1.41% in June to 13.64% in February.

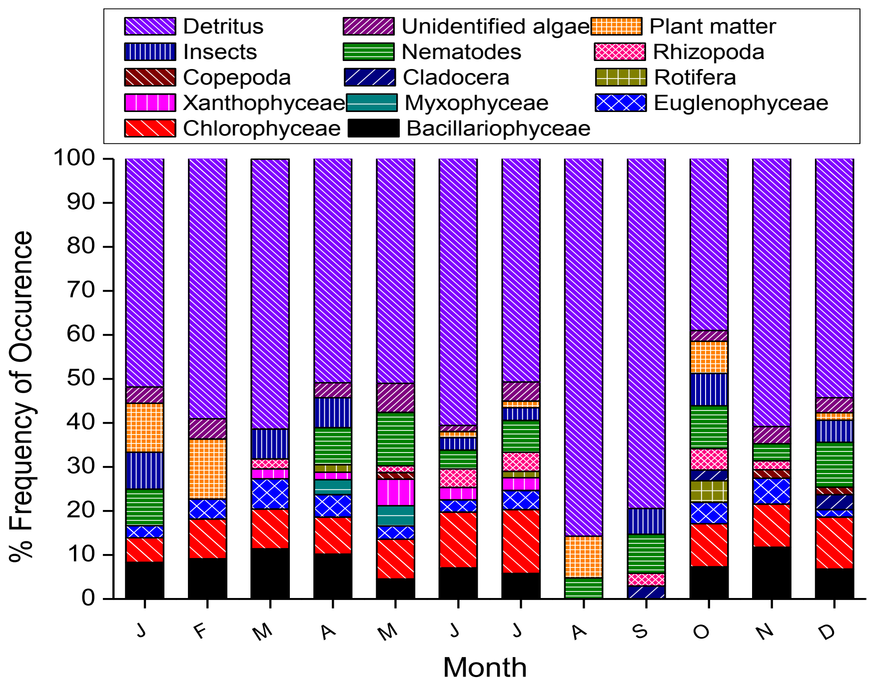

Fig. 1. Monthly change in percentage frequency of occurrence of different food items in *Pethia shalynius* from Umiam River, Meghalaya, India.

Discussion

Continuous research on the diet of freshwater fish species is carried out because it forms the basis for fisheries management programmes (Oso et al. 2006). There is a direct bearing of the alimentary canal structure on the diet of fish. The relatively high RGL value observed in the present study indicates an omnivorous type of food habit. Das and Moitra (1963) reported that the RGL value is generally low in carnivorous fish, high in fishes which are omnivorous and higher in all herbivorous fish.

It has been reported in *Macrognathus pancalus* Hamilton 1822 that the well-developed elongated thick muscular wall of the stomach allows the mechanical function of food maceration in addition to working as a significant site for digestion (Serajuddin and Rustam 2005). The long and coiled gut of *P. shalynius* indicates its adaptation for better digestion and absorption of plant materials. Dasgupta (2004) showed that RGL values get higher with increase of vegetable matter in food and decrease with the increase of animal matter. Generally, the length of the intestine of omnivorous fishes varies between 0.7 to 4 times the total length of the animal (Al-Hussaini 1949). Jayaprakas et al. (1979) observed that in *Etroplus maculatus* (Bloch 1795), the intestine was 0.75 times as long as the length of the fish, lending support to the omnivorous feeding habit. Dasgupta (1991) studied the food and feeding habit of *Tor putitora* (Hamilton 1822) from Garo Hills and found an average RGL value of 1.3. Dasgupta (2004) also observed that *Puntius sophore* (Hamilton 1822) had RGL value of 1.68, *Cyprinus carpio* Linnaeus 1758 had 1.36 and *Parapocryptes serperaster* (Richardson 1846) had 1.80 which indicates the omnivorous nature of the fish.

The gastrosomatic index was generally low during June and July which marked the period of low feeding activity and this happens to be the spawning period. The low feeding seems to be closely related with maturation of gonads, breeding and spawning. The low feeding activity during peak breeding may be attributed to fully developed gonads, limiting the space in the stomach for intake of food. The variation was more pronounced in females as compared to males because the ovaries occupy more space compared to testes. The gastrosomatic index was directly related to the low feeding activity during the spawning period of *P. shalynius*. Observations made by Rajkumar et al. (2007) in *Catla catla* (Hamilton 1822) showed that the feeding intensity was high in winter months and reduced during summer months. Kurup (1993) reported that low feeding intensity in *Labeo dussumieri* (Valenciennes 1842) is synchronised with their spawning season. Similar observations were made in *Pampus argenteus* (Euphrasen 1788) where the low GaSI were observed from May to September during the spawning period (Dadzie et al. 2000). Bindu and Padmakumar (2008) also found low food intake during the monsoon coinciding with the breeding season and intense feeding during the pre-monsoon period in *Etroplus suratensis* (Bloch 1790) in Vembanad Lake.

In the present study, it was observed, that *P. shalynius* feeds on a few types of food and therefore can be categorised as stenophagic. Similar stenophagic feeding habit of spiny eel, M*acrognathus pancalus* Hamilton 1822 and *M. aral* (Bloch and Schneider 1801) feeding on earthworms, insects, micro-crustaceans and the larvae of other aquatic invertebrates has been reported by Abujam and Biswas (2010). Moreover, food and feeding habits of fish had been reported to change according to the availability of food (Desai 1992). Gut content analysis revealed that the food items of *P. shalynius* consist of detritus, phytoplankton, nematodes, zooplankton, insects, plant matter and unidentified algae based on the frequency of occurrence and volumetric method. Food items can be divided into four main categories based on their importance viz. basic (detritus), secondary (phytoplankton), incidental (nematodes) and obligatory (insects, zooplankton, plant matter and unidentified algae).

This study showed that this species is a bottom grazer as the content of the detritus was high in the gut. Detritus plays a significant role in the diet of fishes in freshwater systems (Bowen 1981). Detritus feeders ingest good quantities of sand particles, which act as a grinding mill in the degradation of the plant matter. Qualitatively as well as quantitatively, the diet composition of *P. shalynius* was represented by detritus and phytoplankton temporally. Gut content analysis revealed a closer relationship with the phytoplankton than other food items observed. Similar findings have been reported by Pathani and Das (1979) in *Puntius conchonius* (Hamilton 1822), Sharma (1988) in *Tor tor* (Hamilton 1822), Mamun et al. (2004) in *Amblypharyngodon mola* (Hamilton 1822) and Oso et al. (2006) in *Sarotherodon galitaeus* (Linnaeus 1758) and *Oreochromis niloticus* (Linnaeus 1758). For studies based on the natural food of fish, it is vital to consider the seasonality effect because the food web is affected by temporal variations of biotic factors and this leads to change in diet of the fish (Wotton 1990). Other aspects may further control the quantity and nature of food present in the fish gut such as the seasonal and inter-annual variation both on availability as well as feeding ecology, absorption rates and territory (Bowen 1996).

Conclusion

It is worth mentioning here that basic knowledge on the diet of a species is important for determining its sustainable development for management and conservation. Moreover, this study may help facilitate the selection of the species for potential culture because it is less subject to interspecies competition because of its preference for detritus over other food items as its natural food. The study revealed that the *P. shalynius* is an omnivorous, bottom feeder in nature and that the environment plays an important role in governing the food and feeding habits of the species.

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