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RESEARCH ARTICLE ARAŞTIRMA MAKALESİ

NEW CHARACTERIZATION OF FEEDING HABITS OF *Puntius sophore* (Hamilton, 1822) THROUGH MORPHOMETRY

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Abstract: *Puntius sophore* has been studied for its morphometric relationship to food types (phytoplankton and zooplankton). It was observed that the mouth area of the fish did not show significant correlation to food types. The gut analysis suggested that it feeds on both food types with large portion of zooplankton at a later stage. On the basis of gut content corresponding to total length of the fish, the food habit of *P. sophore* has been grouped into three total length categories as category I or herbivorous (TL, 5.0-7.0cm), II or omnivorous (TL, 5.0-7.0cm) and III or omnivorous with more tendency towards zooplankton (TL, 7.6-8.5cm). The F test showed significant differences for Relative Gut Length ($p<0.05$), and both the food types ($p<0.01$) of corresponding categories.

Keywords: Herbivorous, Omnivorous, Small indigenous fish, Relative gut length

Özet: **Morfometrik Metodla *Puntius Sophore* (Hamilton, 1822)' nun Beslenme Alişkanliklarinin Yeni Karakterizasyonu**

Bu çalışmada, *Puntis sophore'* nun besin çeşitleri (zoo ve fitoplankton) ile morfometrik ilişkileri çalışılmıştır. Balığın ağız açıklığı besin tipleriyle belirli bir korelasyon göstermediği gözlemlenmiştir. Bu balığın hem zooplankton hemde fitoplanktonlarla, bir sonraki evrede ise büyük miktarda zooplanktonlarla beslendiği yapılan barsak analizleri ile tespit edilmiştir. Balığın total vücut uzunluğuyla ilişkili olarak barsak içeriğinin temelinde *P. sophore*' nin besin alışkanlığı üç kategoriye göre gruplandırılmıştır. Bunlar; kategori I yada herbivor (toplam uzunluk 5.0-7.0 cm), kategori II yada omnivor (toplam uzunluk 5.0-7.0 cm) ve kategori III yada zooplankton ağırlıklı omnivor (7.6-8.5 cm) beslenme alışkanlığıdır. F-testi ilişkili kategorilerin besin tiplerinin her ikisinde ($p<0.01$) ve Nispi Barsak Uzunluğu için ($p<0.05$) belirli farklılıklar gösterdi.

Anahtar Kelimeler: Herbivor, Omnivor, Küçük bölgesel balık, Nisbi barsak uzunluğu

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Introduction

Small indigenous fish species (SIS) are highly valuable source of macro and micronutrients. Since SIS are eaten in whole or without loss of nutrients from cleaning or as plate waste (Roos et al, 2007), their contribution on micronutrients intake by human is higher than large carps. Vitamins and minerals are also found to be much more in these fishes than in large carps (Roos et al, 2007; Thilsted et.al., 1997).

P. sophore (Hamilton, 1822) is a tropical SIS found in all over India and commonly distributed throughout Pakistan, Nepal, Bangladesh, Myanmar, Thailand and Yunnan region in China. It is very much famous as food fish in Bangladesh (Rahman, 2005). In spite of its popularity and endemic nature, it received very little interest from fishery science, especially on food and feeding habits. Other contemporary *Puntius sp.* like *P. sarana*, *P. ticto* or *P. gonionotus* have extensive reports on their food habits (Islam *et al*., 2006; Mondol et al., 2005; Pethiyagoda, 1991). No extensive and conclusive reports on food habit of *P. sophore* are available. Shafi and Quddus (1982) briefly reported it as surface dweller fish and feeds on small insects, algae and planktons. Bashar (2011) reported it as larvivorous and herbivorous and Phukon and Biswas (2012) reported it as omnivorous and column feeder. According to Mookerjee et al. (1946) its food is composed of 40% algae, 15% higher plants, 30% protozoa, 15% insects. All these studies were based only on gut analysis and lack uniformity in suggesting the food habit of the fish. For small fishes, the only way to confirm the food habit is to correlate gut content to body morphometry of the fish. There is hardly any report on food habit of the fish in relation to its morphometry. Present study aimed to understand if there is any relationship of body morphometry to food habit of *P. sophore.*

Materials and Methods

Collection of fish

Samples of *P. sophore* were collected from different ponds of Bolpur, of Birbhum district, West Bengal, India in the month February to March, 2012. The place is located between 23° 32' 30" (right above the tropic of cancer) and 24° 35' 0" north latitude and 87° 5' 25" and 88° 1' 40" east longitudes.

Morphometry

Different morphometric characters were documented from freshly collected fishes. Weights are measured in grams (gm) and all lengths are measured in centimeters (cm). The Table 1 gives details of morphometric measures documented.

Condition factor

The "coefficient of condition (K)" was measured to verify the relative condition of the fish during study. It explains relative condition or degree of well-being of a fish which is an important factor affecting on different results. It was measured as-

$$K = \frac{W \times 100}{L^3}$$

Where

K= condition factor

W= weight of fish in grams

L= length of fish in cm

Mouth dimensions

The mouth dimensions of the fish studied were maximum vertical (M_V) and horizontal (M_H) mouth openings. The mouth area (M_A) was determined from M_V and M_H following Erzini et al., (1997).

$$M_A\ (cm^2) = O.25\pi\ (M_V M_H)$$

Collection of guts and gut content analysis

Guts were carefully dissected out from fish body and preserved in 10% formalin for further study. The gut of each fish was then dissected out and gut contents were removed on a petri disc. Organisms were identified as algal and animal group under compound microscope at 100× and 400×. Organisms from each gut were counted under microscope and expressed as percentage of the total number of organisms in all fields examined.

Relative Gut Length

The length of gut (GL) of every individual fish was recorded in cm before collection of gut content. Relative gut length (RGL) to body length was expressed as-

$$RGL=GL/TL$$

Statistical analysis

Pearson correlation coefficient (r) is computed to understand correlation within morphometric measures and between food types from the gut and morphometric measures. One way ANOVA is performed to understand differences between means. Significance levels are fixed at $p<0.05$ and $p<0.01$. The software SPSS 16.0 was used to perform all statistical analysis.

Results and Discussion

Body morphometry of the fish

The morphometric data and condition factor (K) are reported in Table 2. The specimens have TL ranging from 5.8 to 8.5 cm and Wt from 2.301 to 8.097 gm. The corresponding maximum gut lengths were from 18.3 to 35.5 cm. The mean values of LUP, StL, M_A were 0.4(±0.06), 0.4(±0.06) and 0.16 (±0.03).

Mouth dimensions and body size

The fish has very narrow range of vertical and horizontal mouth openings (Table 1). The vertical mouth openings ranged between 0.5-0.6 mm and horizontal mouth opening ranged between 0.3-0.4 mm. Maximum mouth area observed was 0.19 mm^2 (Table 2).

Pearson correlation was computed with mouth area for all body measures and the correlation was found significant for TL, StL, BD, HD, Wt and LUP (Table 3). RGL was not significantly correlated to M_A.

Table 1. Morphometric measures accounted for *P. sophore*

Character	Code	Description
Weight (g)	Wt	Weight of the fish
Total length (cm)	TL	Distance between the anterior most extremity of the body (tip of snout or upper lip) and the posterior most extremity of the body(tip of the caudal fin lobe).
Standard length (cm)	SL	Distance between the anterior most extremity of the body (tip of snout or upper lip) and the base of caudal fin.
Head length (cm)	HL	Distance in a straight line between the anterior most part of the snout or the upper lip and the posterior most edge of the opercular bone.
Head depth (cm)	HD	Distance between the occiput (point on the mid dorsal line which joins the head with the trunk) and the ventral side of the head.
Body depth (cm)	BD	Vertical distance between ventral and dorsal profile at widest part of the body.
Length of upper jaw(cm)	LUP	Total length of the upper jaw
Snout length (cm)	StL	Distance in a straight line between the anterior most part of the snout or the upper lip and the anterior margin of the orbit
Mouth opening (cm)		
Vertical	M_V	Fully expanded vertical mouth opening
Horizontal	M_H	Fully expanded horizontal mouth opening

Table 2. Morphometric measurements of *P. sophore*

Variables	Min	Max	Mean	SD (±) it is correct
Weight	2.3	8.1	5.4	1.7
TL	5.8	8.5	7.4	0.77
SL	4.5	6.7	5.9	0.65
HL	1.3	1.8	1.5	0.15
HD	1.3	2	1.7	0.18
LUP	0.3	0.5	0.4	0.06
StL	0.3	0.5	0.4	0.06
Mv	0.5	0.6	0.6	0.05
M_H	0.3	0.4	0.35	0.05
GL	18.3	35.5	27.4	5.05
MA	0.12	0.19	0.16	0.03
RGL	2.6	5.15	3.69	0.79
K	2.4	2.9	2.6	0.15

For abbreviations, see table 1.

Table 3. Correlation between morphometric measures to mouth area, plant and animal originated food availability in *P. sophore.*

Morphometry	Pearson r	p (2 – tailed)	Significance level
Mouth Area			
TL	+0.777	0.003	**
RGL	- 0.408	0.188	NS
StL	+0.823	0.001	**
Wt	+0.816	0.001	**
HD	+0.703	0.011	*
BD	+0.717	0.009	**
SL	+0.537	0.072	NS
LUP	+0.630	0.028	*
GL	+0.005	0.988	NS
Plant food			
TL	- 0.598	0.040	*
RGL	+0.856	0.000	**
MA	- 0.499	0.099	NS
StL	- 0.643	0.024	*
Wt	- 0.568	0.054	NS
HD	- 0.441	0.151	NS
BD	- 0.373	0.232	NS
SL	+0.279	0.380	NS
LUP	+0.603	0.038	*
GL	+0.582	0.047	*
Animal food			
TL	+0.612	0.034	*
RGL	- 0.882	0.000	**
MA	+0.450	0.142	NS
StL	+0.651	0.022	*
Wt	+0.562	0.052	NS
HD	+0.451	0.141	NS
BD	+0.394	0.205	NS
SL	+0.310	0.327	NS
LUP	+0.650	0.022	*
GL	- 0.596	0.041	*

For abbreviations see table 1. * $p<0.05$; ** $p<0.01$; NS, not significant

Food types

Food type in the gut content

The total phytoplankton populations in the gut contents of fishes were mainly represented by filamentous algae, diatoms like *Nitzschia sp, Melosira sp, Synedra sp, Desmidium sp, Calothrix sp, Oscillatoria sp, Closterium sp, Scenedesmus sp, Navicula sp, Oedogonium sp,* etc.

The zooplankton populations in the gut contents of fish were represented by crustecea, cladocera, rhizopoda, actinopoda, copepods. Some nematodes and eggs of trematod were also present. Few unidentified parts from animal origin were also recorded from the gut.

Correlation of food type to morphometric measures

The Pearson correlation for food types to morphometric measures are shown in Table 3. The TL and StL are negatively correlated to plant food types ($p<0.05$), whereas RGL, GL and LUP are positively related to plant food types ($p<0.01$).

With animal food types, RGL and GL are negatively correlated (RGL, $p<0.01$; GL, $p<0.05$) and TL, StL and LUP are positively correlated ($p<0.05$). The nature of curve of the food abundance (plant and animal originated) plotted against total length (Figure 1.) showed decreasing trend of plant originated food category in the gut with increase in total length. With animal food types, the graph progresses slowly during initial period but steeply at later stages.

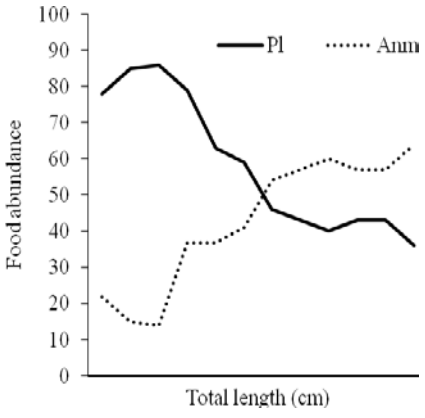

Figure 1.

Morphometric measurements of *P. sophore* showed significant correlation with the fish size, especially between total length and mouth area. The position, shape and size of the mouth are related to diet of fish. Fishes feeding at the surface or in the middle of the water column frequently have a dorso-terminal or terminal mouth. In bottom feeding fishes, mouth is sub-terminal in position. Mouth of *P. sophore* is terminal and teeth absent in the jaw. Slightly longer Upper jaw (maximum 0.5cm) indicates it to be column feeder. Absence of teeth in mouth and lack of stomach with very long and highly coiled intestine suggest herbivorous feeding nature of this fish. But the gut analysis from present study clearly showed that the fish not only feeds on phytoplankton but also receives large portion of zooplanktons at longer total length. This indicates that fish adopts omnivorous nature as it grows. Such results concur with the observation of Phukan and Biswas (2012) who suggested it to be omnivorous.

The positive and significant correlation of mouth area to total length in *P. sophore* could be due to increased feeding as it grows. Feeding activity, growth, mouth area and prey type are significant in fish (Karpouzi and Stergiou, 2003). Large size fish have larger mouth area. As in present study, mouth is not significantly correlated to food types and hence, such positive correlation to total length could be indicative of its increased feeding activity as it grows. Snout length also shows similar pattern of feeding nature in this fish. Intake of food might have caused increased body weight of the fish. Though body weight has been criticized as unreliable measure for fish growth due to sexual maturity, during the present study fish without eggs only were considered for study.

The fish basically preferred Bacillariophyceae and chlorophyceae from plant originated food materials and few minor phyla along with some protozoa from animal originated food materials.

From Pearson correlation, it is evident that the fish has reduced preference to plant food with increase in the total length. With increase snout length, the reduced preference to plant food items indicated it to be an omnivorous or carnivorous in the later stages of growth. The positive correlation of gut length to plant food type suggests it to be herbivorous in nature at maximum gut length. An elongated gut helps in digesting plant originated food materials. However, of all morphometric categories, RGL showed highest positive correlation to plant food types. As RGL is ratio of gut length to total length, this relation

was influenced by positive correlation of gut length to plant food types.

For animal originated food types, total length exhibits positive correlation indicating fish grows faster when it received animal food from the environment. Animal food has always direct effect on growth on fish than plant food (Smith, 1980). However, as total length increases, the RGL decreases and therefore, it shows negative correlation to animal food type. Indirectly, here, the growth of gut length and total length are not proportionate. At early stage of growth, the fish received plant originated food items. In the later stages, rapid growth of the fish was reflected through increased total length but not gut length resulting smaller RGL. This is why at later stage gut length exhibited negative correlation to animal food types. Indirectly, smaller the RGL the fish tends to accept animal originated food items. Dasgupta (2004) reported average RGL value is 0.70 in carnivorous fishes, 4.77 in herbivorous, 1.37 in omnivorous and 3.70 in planktivorous fishes.

When plotted against total length (Figure 2.), it was obvious that the fish rejected animal food when total length was short; however, with increase in total length, animal food items were preferred. At the highest total length (8.5cm), the fish received only 40% of plant food items whereas animal food items increased to 60%. It is evident that the fish received plant food items (70-90%) up to total length 7.0 cm, thereafter the tendency towards plant food item declined and at a total length of 7.59cm both the food items were preferred equally and at a length of 8.5cm only 40% plant food items were chosen. Therefore, considering the food preference based on total length, the food habit of fish *P. sophore* can be grouped into three total length categories – (i) 5.0-7.0cm (ii) 7.1-7.59cm (iii) 7.6-8.5cm. These groups with corresponding food items and RGL and differences (one way ANOVA) among them are also shown in Table 4.

Conclusion

Thus, the fish is herbivorous in nature when it attains a total length of 5.0-7.0cm. The average RGL at this stage is 4.6. It tends to exhibit omnivorous feeding habit (50% animal and 50% plant food) for total length 5.59-7.1cm. The RGL for such feeding nature is 3.9. Beyond that, up to 8.5cm, though the fish retains omnivorous nature, it receives substantial amount of zooplankton (60%). The corresponding RGL is 3.44.

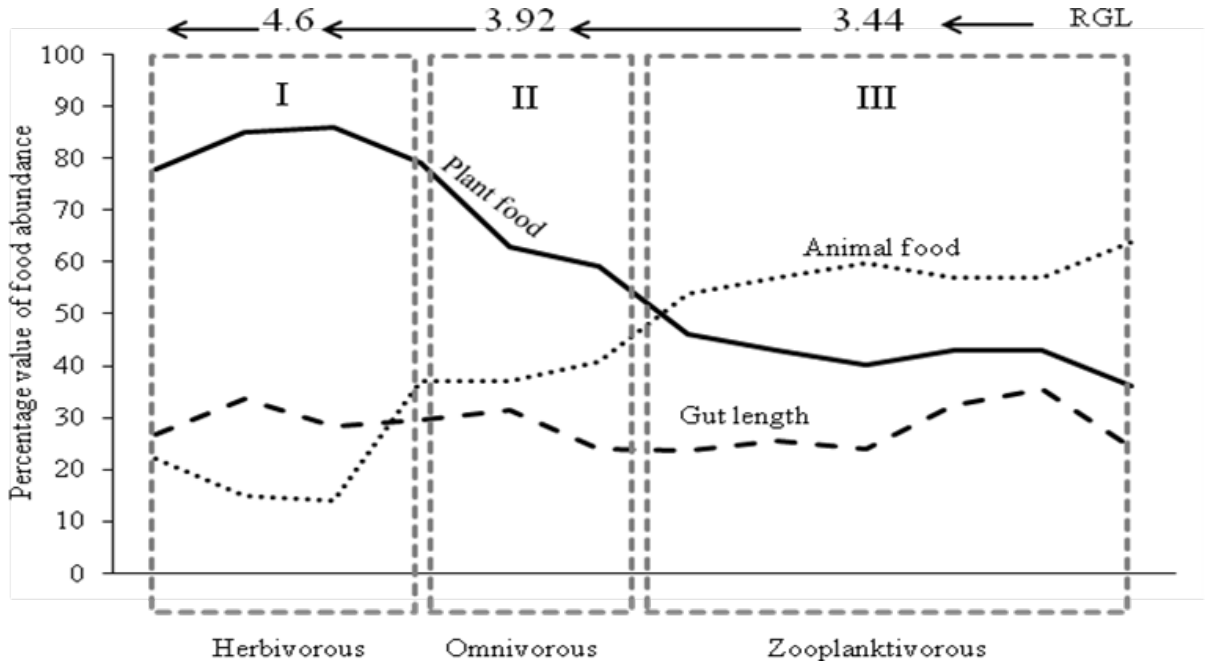

Figure 2.

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