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Research Article

Seasonal Feeding Biology of Catfish, *Pachypterus atherinoides* (Bloch, 1794) with Special Reference to Lentic and Lotic Ecosystem

Arun Jana[1], Godhuli Sit[1], Angsuman Chanda[1]

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ABSTRACT

The study of food and feeding biology is extremely crucial in fishery. *Pachypterus atherinoides* (Bloch, 1794) is a good food and ornamental catfish in the world. The present study aims to examine the seasonal variation of feeding habits of *P. atherinoides* in both lentic and lotic ecosystems. The study was conducted over two years in selected lentic and lotic aquatic ecosystems of the Jhargram and Paschim Medinipur districts of West Bengal, India. The study reveals that *P. atherinoides* shows carni-omnivorous nature. Pearson's correlation represents gastro-somatic index, relative gut length, and hepato-somatic index have significant positive correlation among them. Based on posthoc tests, it has been observed that the gastro-somatic index, relative gut length, and hepato-somatic index vary significantly both seasonally and in both lentic and lotic ecosystems. This study would help aquaculturists in the culture, captive breeding, and conservation of *P. atherinoides* and also help researchers in the biometric study of another fish.

Keywords: Carni-omnivorous, Catfish, Feeding biology, Lentic, Lotic, *Pachypterus atherinoides*

ORCID IDs of the author:
A.J. 0000-0003-3547-6247;
G.S. 0000-0002-5821-7937;
A.C.0000-0003-1781-5057

[1]Natural and Applied Science Research Centre, Post Graduate Department of Zoology, Raja Narendra Lal Khan Women's College (Autonomous), MidnaporePaschim Medinipur, West Bengal, India

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Correspondence:
Angsuman Chanda
E-mail:
chandaangsuman182@gmail.com

INTRODUCTION

The study of food and feeding behaviors is extremely crucial in fishery biology. Fish mostly obtain their energy from food, which has a big impact on their population size, growth rate, and overall health. Because they enable fish to consume all of the potential food in water bodies without competing with one another and living in communities with other fish, diet and feeding habits are crucial in aquaculture (Victor *et al.*, 2014). To determine the fullness of the stomach and the feeding status of the species, the gastrosomatic index (GaSI) is used and the relative gut length (RGL) is applied to determine the eating habits and to measure a certain relationship with the length and life stage of the fish species. The RGL value is often used to predict a wide range of food groups and show which foods different fish species like to eat. The study of fish-eating habits and gut content analysis has several objectives, including learning about their food preferences, determining whether they obtain enough food seasonally, and determining when feeding intensity peaks and troughs. The study of a species' feeding ecology can indicate how the creature has evolved ecologically to manage the challenge. It is also vital for the species' propagation to get a better understanding of its feeding behavior, as this information can be used to exploit natural fish food. The HSI measures the liver weight to body weight ratio. An indicator of eating and metabolism status is the HSI biomarker. Changes in HSI and GSI values are good indicators of fish with compromised reproductive function. HSI and GSI can go up during Vitelogenesis. *Pachypterus atherinoides* (Bloch, 1794), often known as Indian potasi, is a common catfish belonging to the family Schibeidae found in rivers and ponds throughout India (except Kerala), Pakistan, Bangladesh, Nepal, Myanmar, Bunna (Menon, 1999). It has high nutritional and also ornamental value. The fish meal of the species contains energy 343

Kcal, moisture 16 gm, protein 58gm, fat 09 gm, mineral 17 gm, calcium 1597 mg, phosphorus 595 mg, Iron 41 mg each 100 gm (Gopalan *et al*., 2004). Aquarists are attracted to it because of its bright color and small size. This species has been gradually decreasing due to pollution, habitat destruction, selective captive breeding, removal from aquatic bodies for their carnivorous nature, and also the high preferences of exotic catfish [African catfish *Clarius gariepinus* (Burchell, 1822) and Thai catfish *Pangasius sutchi* due Fowler, 1937]. Globally , there has been very little research on the feeding biology of *Pachypterus atherinoides* (Bloch, 1794). In India, except for Gogai *et al*., 2020, there is no study on the feeding biology of this species. However, they did not observe seasonal feeding behavior and habitat/ecosystem differentiation, and they did not study both lentic and lotic ecosystems. In West Bengal, some aspects of various indigenous fish species have been studied by different researchers (Dasgupta, 2004; Chattopadhyay *et al*., 2014; Gupta and Banerjee, 2014; Jana et al., 2021; Jana *et al*., 2022A; Jana *et al*. 2022B; Sit *et al*. 2020; Chanda and Jana., 2021; Sahil *et al*., 2022; Sit *et al*. 2022A; Sit *et al*. 2022B; Sit *et al*., 2023A; Sit *et al*., 2023B) but not to observe the feeding habit of the said species. The interspecific interaction and productivity of water bodies can be determined by studying fish feeding habits. Fish nutrition and feeding have an impact on their development, reproduction, and health (Srivastava *et al*., 2014). Most research on the food and feeding habits of fish from diverse habitats has shown that those species varied in time and place, as well as at different stages of growth, emphasizing the need for more research into a species' food and feeding habits.

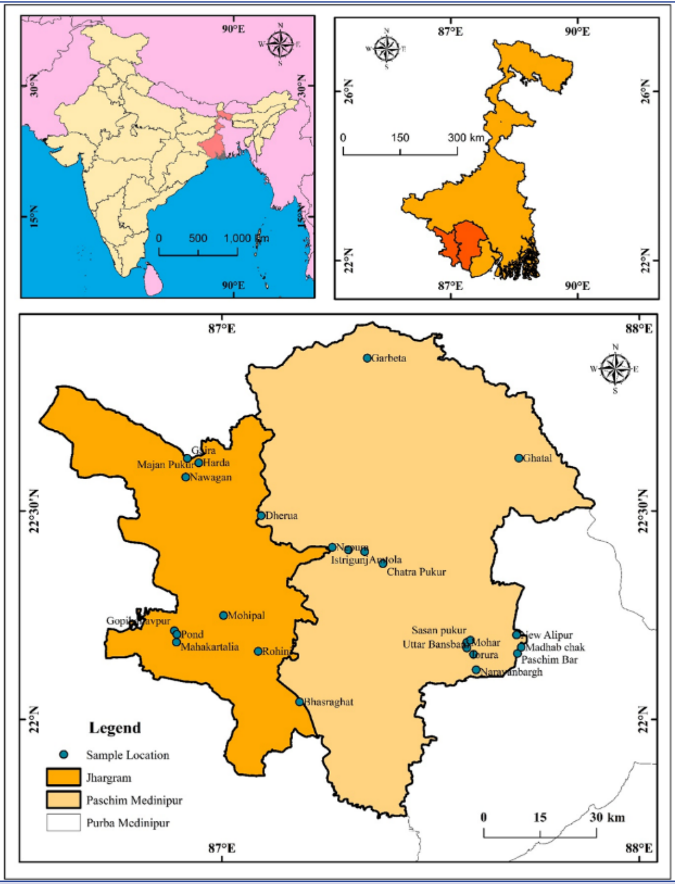

Figure 1. Specimens collection Sites.

MATERIALS AND METHODS

Collection of fish specimens: Specimens were collected every fifteen days from lentic (selected Ponds) and lotic (selected River sites) ecosystems/habitat of Paschim Medinipur and Jhargram districts, West Bengal, India, during the Pre-monsoon/Summer (March-June), monsoon (July-Oct), and Post-monsoon/Winter (Nov-Feb) seasons since March 2020 to February 2022 (Figure 1).

Measured length and weight: Seasonally and ecosystem/habitat-wise, the total weight and total length of each specimen were measured by a digital weighing machine with 0.01 gm accuracy and a digital slide caliper instrument with 0.01 mm accuracy, respectively.

Dissection and Internal organ measured: All internal organs were collected by dissection with the help of scissors, forceps, needles, and a brush. The liver and digestive tract were dissected out and kept in a vial with a labeled 10% formalin solution. Digital slide calipers were used to measure the length of the digestive tract. After that, the stomach was separated from the digestive system. An electronic balance was used to weigh the liver and stomach.

Observed stomach fullness: Stomach distention per species, as determined by season, has been observed. According to Nagar and Sharma (2016), the stomach's distension was graded as 'full', '3/4 full', '1/2 full', '1/4 full', and 'empty' by eye assessment.

Gastrosomatic index (GaSI): The following formula (Desai, 1970) was used to figure out the Gastrosomatic Index (GaSI), or the amount of food eaten each month:

$$\text{GaSI} = \frac{\textit{Weight of the stomach}}{\textit{Weight of fish}} \times 100$$

Relative gut length (RGL): The following formula was used to compute the Relative Gut Length (RGL) (Al-Hussain, 1949).

$$\boldsymbol{RLG} = \frac{\textit{Length of gut}}{\textit{Total body length}}$$

Hepatosomatic index (HSI): HSI was determined by Rajaguru's 1992 formula.

$$\boldsymbol{HSI} = \frac{\textit{Weight of liver}}{\textit{Weight of fish}} \times 100$$

Food content analysis: To identify the various foods that the fish swallowed, the stomachs were dissected, and 1 mL of the food contents were taken in a glass vial and examined under a light microscope (XSP L101). Hynes's (1950) frequency of occurrence method was used to look at the foods, and the following equation was used:

$$\text{Percentage of occurrence of a food type} = \frac{\textit{Number of guts where the food occurred}}{\textit{Total number of guts analyzed}} \times 100$$

Data analysis

Finally, data were analyzed (Descriptive statistics, MANOVA, Pearson's Correlation, Post Hoc test,) with the help of Microsoft Excel (2019), SPSS (2021), and Origin Pro (2023) software systems.

RESULTS AND DISCUSSION

Seasonally, habitat-wise maximum, minimum, and average values of gastrointestinal length and weight of *P. atherinoides* in both districts were represented in Table 1. GaSI values were highest during the Summer season (6.65 ± 1.11, 7.06 ± 1.81, 7.95 ± 1.90, and 7.08 ± 1.56), followed by the Winter (6.09 ± 1.05, 4.85 ± 1.37, 6.40 ± 1.01, and 6.09 ± 1.41) and the monsoon (2.93 ± 1.00, 4.70 ± 1.53, 6.16 ± 0.96, and 5.41 ± 1.42) in both habitats (pond and river) of two districts (Table 2 and Figure 2-3). Gogoi *et al.* (2020) recorded the average GaSI value of *P. atherinoides* was 2.683±0.495 gm, with the highest GaSI value (2.832±0.754) during the winter-spring season (Feb-April) and minimum (2.525±0.363 gm) during the summer-rainy (May-July) in the Subansiri river, Assam. In the present study, the value of GaSI is greater than that of Gogoi *et al.* The GaSI values change seasonally, and the highest during pre-breeding and lowest during breeding have been similar to the studies of Gupta and Banerjee (2014), Kurbah and Bhuyan (2018), Sharma *et al.* (2018) and Gogoi *et al.* (2020) but not similar to the study of Chaturvedi and Saksena (2013). GaSI values indicated maximum food intake during the pre-spawning season and minimum during the breeding season. GaSI ranges from 2.91 to 6.08, representing the voracious nature of fish (Lanthaimeilu and Bhattacharjee, 2018), so the present result indicates the species has been the same (Table 2). In the present study, the RGL values ranged from 0.52 ± 0.057 to 0.572 ± 0.059, and seasonal fluctuation was observed in the ecosystem of both districts for *P. atherinoides* (Table 2 and Figure 3). Gogoi *et al.* (2020) observed that the average RGL value was 0.486±0.046 with a minimum of 0.440±0.058 mm and a maximum of

Table 1. Gastro- intestinal length and gastro-intestinal weight of *Pachypterus atherenoides* in both ecosystem of Jhargram and Paschim Medinipur districts.

District	Habitat	Season	GiL (cm)				GiWt (gm)			
			Min.	Max.	Mean	SD	Min.	Max.	Mean	SD
JHARGRAM	POND	*Pre-monsoon*	2.20	5.80	4.1094	0.90531	0.16	0.47	0.2988	0.09967
		Monsoon	3.60	6.80	5.0188	0.95189	0.04	0.29	0.1763	0.09879
		Post-monsoon	2.20	5.10	3.8594	0.77078	0.04	0.39	0.2338	0.06757
	RIVER	*Pre-monsoon*	2.6	5.8	4.4281	0.90313	0.19	0.47	0.3175	0.08281
		Monsoon	3.80	6.90	5.2219	0.89973	0.08	0.30	0.1806	0.06345
		Post-monsoon	2.40	5.60	4.1938	0.81119	0.06	0.45	0.2603	0.09654
PASCHIM MEDINIPUR	POND	*Pre-monsoon*	2.20	5.90	4.1594	0.90371	0.09	0.45	0.2500	0.11843
		Monsoon	3.60	6.80	5.0344	0.95161	0.06	0.31	0.1522	0.07417
		Post-monsoon	2.30	5.10	3.9219	0.76189	0.04	0.33	0.1931	0.07464
	RIVER	*Pre-monsoon*	2.60	5.90	4.5000	0.92632	0.10	0.44	0.3097	0.09163
		Monsoon	3.90	6.90	5.2375	0.89542	0.04	0.38	0.1991	0.09730
		Post-monsoon	2.40	5.60	4.2063	0.81317	0.04	0.31	0.2013	0.06748

Table 2. Gastro Somatic index (GaSI) and Relative gut length (RGL) of *P. atherinoides* in both ecosystem of Jhargram and Paschim Medinipur districts.

District	Habitat	Season	GaSI				RGL			
			Min	Max.	Mean	SD	Min.	Max.	Mean	SD
JHARGRAM	POND	*Pre-monsoon*	4.167	8.861	6.65298	1.116203	0.400	0.659	0.52981	0.057801
		Monsoon	0.727	4.578	2.93009	1.001402	0.474	0.63	0.5432	0.049304
		Post-monsoon	3.417	7.947	6.09778	1.053266	0.395	0.622	0.53590	0.058751
	RIVER	*Pre-monsoon*	5.324	14.331	7.95290	1.906884	0.464	0.949	0.57953	0.091541
		Monsoon	3.095	7.500	6.16186	.967922	0.451	0.633	0.55654	0.048127
		Post-monsoon	4.310	9.845	6.40334	1.012078	0.421	0.691	0.57232	0.059477
PASCHIM MEDINIPUR	POND	*Pre-monsoon*	3.217	12.925	7.06904	1.812687	0.393	0.678	0.53297	0.057550
		Monsoon	2.727	8.989	4.70767	1.539878	0.468	0.630	0.54480	0.047737
		Post-monsoon	2.639	6.860	4.85507	1.370543	0.411	0.614	0.54326	0.053157
	RIVER	*Pre-monsoon*	3.689	10.553	7.08806	1.563371	0.441	0.702	0.57125	0.058865
		Monsoon	2.597	8.491	5.41102	1.425112	0.446	0.641	0.55706	0.049073
		Post-monsoon	3.003	8.616	6.09162	1.412353	0.421	0.691	0.56461	0.060830

N=128 Min=Minimum; Max=Maximum; SD=Standard Deviation

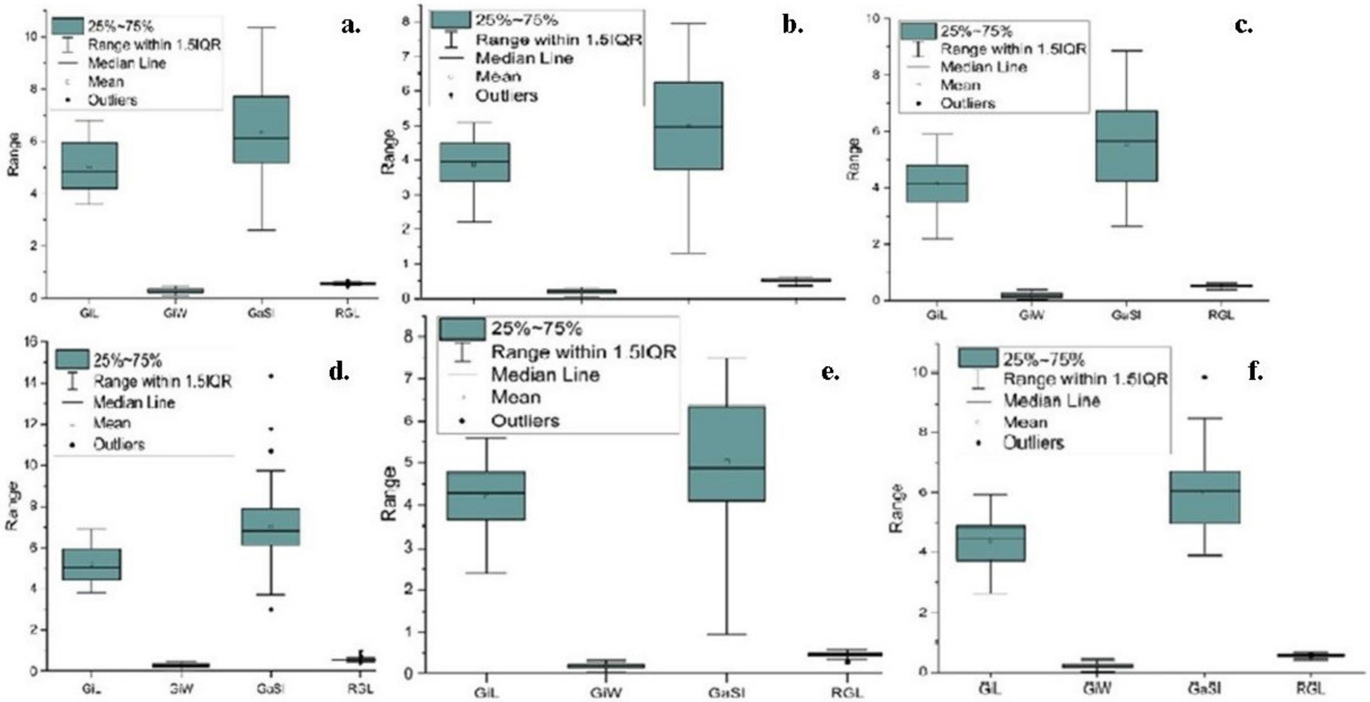

Figure 2. Seasonally GiL, GiWt, GaSI and RGL in both habitat in Jhargram (a,b &c) and Paschim Medinipur (d,e &f) district; a & d-Summer; b & e-Monsoon; c & f-Winter.

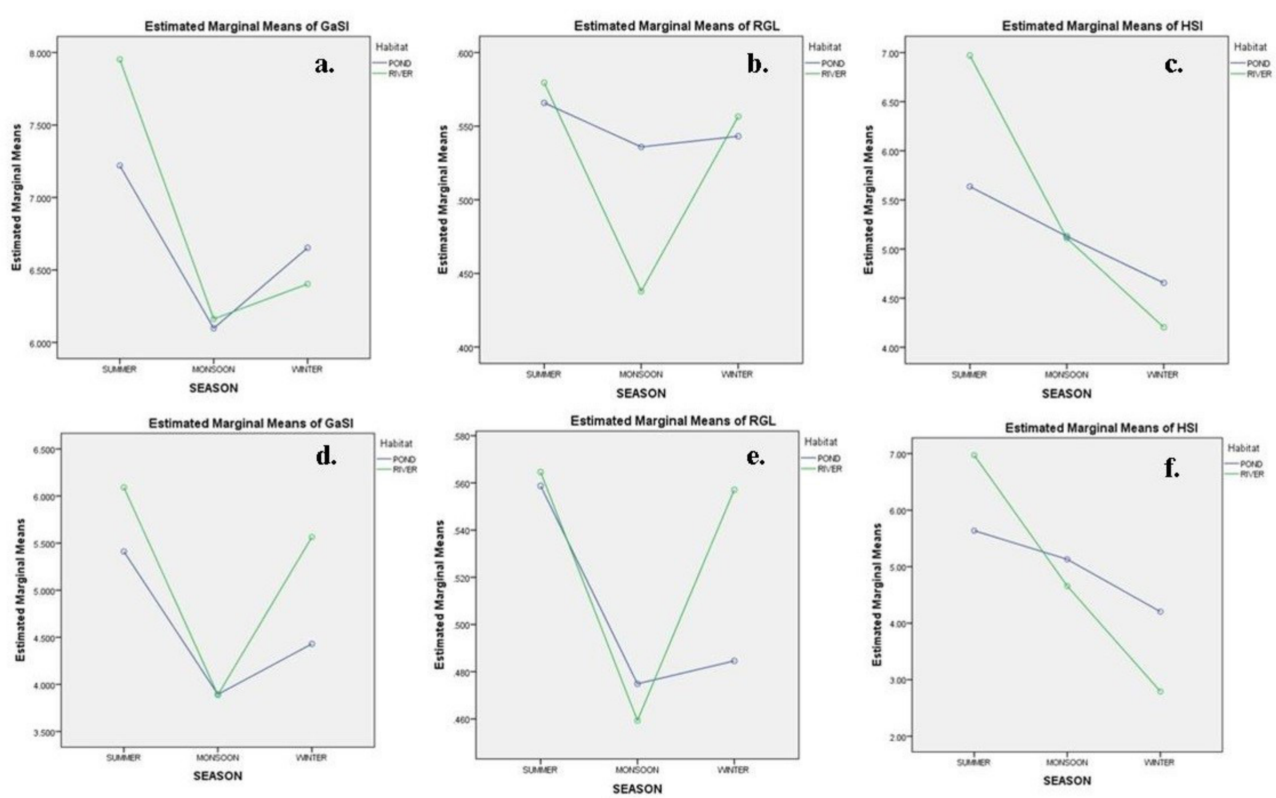

Figure 3. Seasonal variation of GaSI, RGL, HSI in both habitat in *Jhargram* (a,b &c) and Paschim Medinipur (d,e &f) district; a & d-Summer; b & e-Monsoon; c & f-Winter.

0.511±0.029 mm for *P. atherinoides*. RGL values above 0.8 indicated herbi-omnivorous, 0.7 to 0.8 represented carni-omnivorous, below 0.7 was carnivorous fish, and above 1.6 always herbivorous fish (Koundal *et al*., 2013), RGL ranged from 0.60 to 0.87 representing omnivorous nature (Dinh *et al*., 2018), the average RGL value 1.08±0.16 indicated carni-omnivorous nature (Mojumder *et al*., 2020), RGL ranged between 0.6 to 0.67 with mean SD 0.64 ± 0.003 indicated carnivorous nature (Alam *et al*., 2020) and very low (<0.32) indicated species as highly carnivorous nature (Renjit Kumar and Roshni, 2021). The present finding agrees with those of Koundal *et al*. (2013), indicating that fish are carnivorous. However, in the current study, the gut contents of *P. atherinoides* show that it eats both plant- and animal-based feeds, including phytoplanktons, zooplanktons, crustaceans, larvae, molluscs, eggs, scales, protozoa, plant parts, and so on. This research revealed the largest proportion of zooplankton accepted as animal food (Figures 4-5). The enormous variety of feeding behaviors that fish have developed is due to evolution, which produced structural adaptations for getting food from an equally large variety of environmental situations (Gupta, 2015). HSI values of female *P. atherinoides* ranged from 4.203 ± 0.979 to 6.97 ± 3.32 with the maximum during Summer (5.63 ± 1.62 and 6.97 ± 3.325) followed by monsoon (7.38 ± 5.23 and 5.11 ± 0.933), Winter (4.65 ± 1.625 and 4.203 ± 0.979) and in male HSI values ranged from 4.10 ± 0.989 to 6.486 ± 1.618 with maximum during Summer (5.51 ± 1.612 and 6.486 ± 1.618) followed by monsoon (5.12 ± 1.093 and 5.00 ± 0.91), Winter (4.567 ± 1.634 and 4.163 ± 0.966) in both pond and river (Table 3 and Figure 3). Cek *et al*. (2001) and Mitu (2017) reported maximum HSI during the fish breeding season. Jan and Jan (2017), Mojumder *et al*. (2020), Gosavi *et al*. (2020) and Paul *et al*. (2021) observed the minimum HSI during the breeding season. The HSI value in the present study has been supported by the previous work of Jan and Jan (2017), Mojumder *et al*. (2020), Gosavi *et al*. (2020), and Paul *et al*. (2021). The gut of *P. atherinoides* was a maximum of 100 % full from March to May, ¾ full from February to April, ½ full from November to January, and ¼ full and empty from July to October in both habitats in the study area (Figures 6-7). The feeding intensity may be highest before breeding season and lowest during breeding season (Mojumder *et al*., 2020). The present feeding intensity result is supported by research done by Gupta (2015). Begum *et al*. (2008) stated that fish started to feed heavily after spawning in July, with more than 60% of *M. gulio* having full stomachs; the current data contradicts this. Pearson correlations represent GiL's high positive significant correlation (> 0.01) with GiWt, GaSI with very low positive significant correlation with Giwt, Gil and RGL, HSI with low positive significant correlation (> 0.01) with GiL, GIWt, GaSI, RGL and Liv Wt in both aquatic ecosystems (Tables 4-5 and Figures 8-9). There is a significant difference between the groups in the feeding parameters related to the seasonal and ecosystem (lentic and lotic), according to the multivariate test of *P. atherinoides* in both districts, according to Wilk's lambda (Tables 6 and 9). When studied individually for the six variables, except RGL in Jhargram district, there are no significant differences between the other five parameters towards the lentic and lotic ecosystems in both districts; RGL varied due to food availability in the aquat-

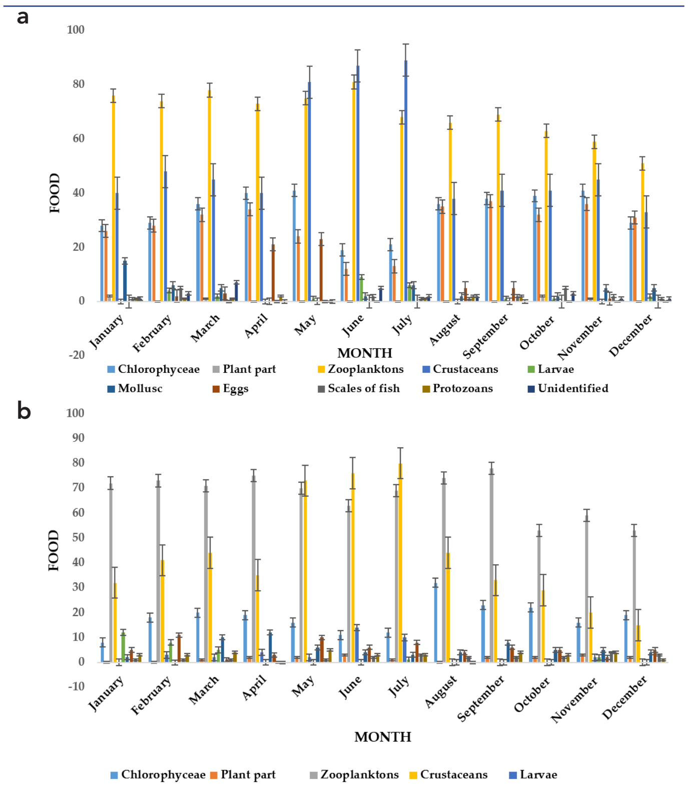

Figure 4. Monthly food item found in gut content of *P. atherinoides* in Jharghram district. a. pond; b. river.

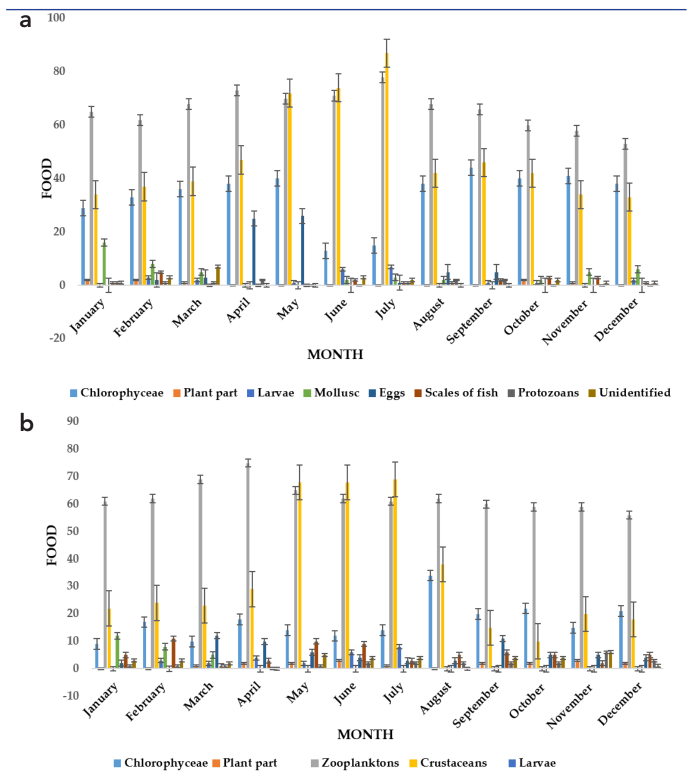

Figure 5. Monthly food item found in gut content of *P. atherinoides* in Paschim Medinipur. a. pond; b. river.

Table 3. Seasonally liver weight and Hepatosomatic index (HSI) of *P. atherinoides* in both ecosystem.

Habitat	Season	Sex	LvWt (g)				HSI			
			Min.	Max.	Mean	SD	Min.	Max.	Mean	SD
POND	PREMONSOON	*Female*	0.02	0.35	0.1859	0.08904	1.90	8.44	5.6362	1.62325
		Male	0.03	0.26	0.1169	0.06104	1.89	8.34	5.5162	1.61245
	MONSOON	*Female*	0.12	0.41	0.2531	0.09413	2.34	7.38	5.2297	1.09303
		Male	0.07	0.41	0.2097	0.11338	2.34	7.28	5.1297	1.08304
	POSTMONSOON	*Female*	0.02	0.24	0.1281	0.06114	1.33	9.61	4.6555	1.62502
		Male	0.02	0.29	0.1513	0.07052	1.33	9.91	4.5675	1.63401
RIVER	PREMONSOON	*Female*	0.02	0.31	0.1575	0.08673	4.08	12.92	6.9707	3.32530
		Male	0.04	0.39	0.2172	0.09085	4.08	12.42	6.4868	1.61879
	MONSOON	*Female*	0.14	0.41	0.2653	0.08048	2.62	6.27	5.1103	0.93395
		Male	0.08	0.43	0.2241	0.03422	2.39	6.17	5.0021	0.91013
	POSTMONSOON	*Female*	0.04	0.24	0.1225	0.05691	2.31	6.22	4.2036	0.97960
		Male	0.02	0.27	0.1591	0.05943	2.21	6.02	4.1063	0.96600

N=128 Min=Minimum; Max=Maximum; SD=Standard Deviation

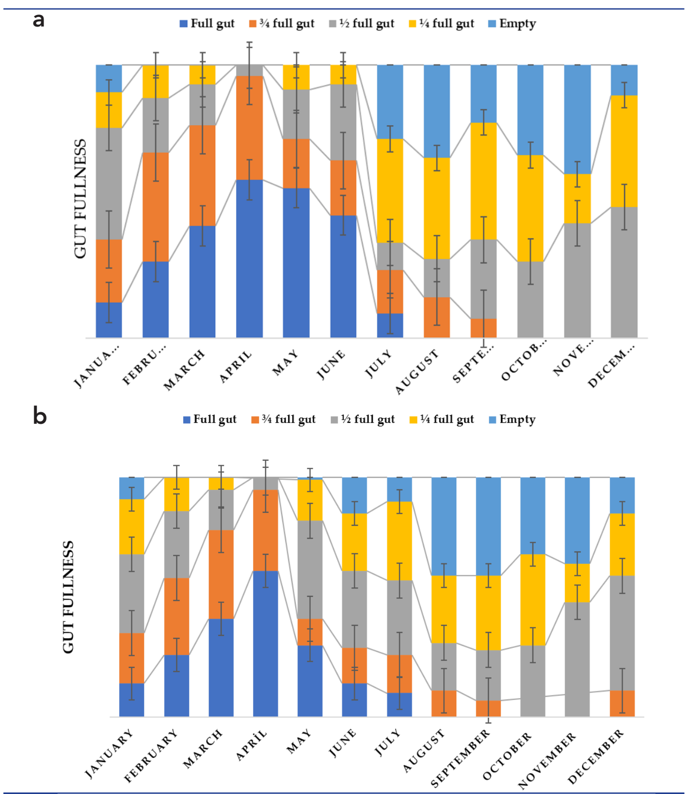

Figure 6. Monthly gut fullness of *P. atherinoides* in Jharghram district. a. pond; b. river.

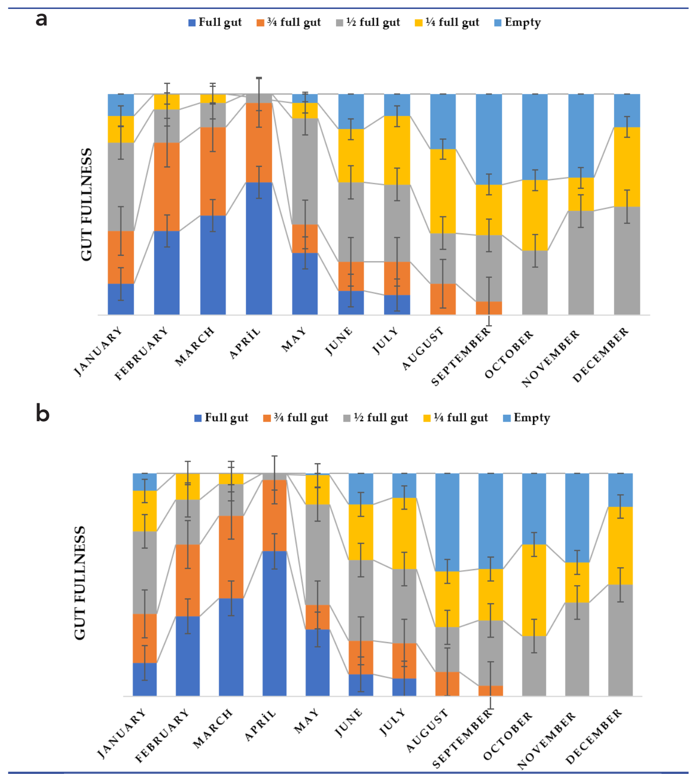

Figure 7. Monthly gut fullness of *P. atherinoides* in Paschim Medinipur district. a. pond; b. river.

ic ecosystem (Tables 7 and 10). Gogoi et al. (2020) stated that Season-wise, GaSI, and RGL were not significant statistically (p>0.05) of *P. atherinoides* in floodplain wetlands of Northeast India; this is not related to the present study. But the seasonal variation of GaSI, and RGL is supported by the study of Kurbah and Bhuyan (2018), Dinh *et al.* (2018), Gosavi *et al.*, (2020), and Mojumder *et al.* (2020).

CONCLUSION

The results of the current study make it clear that zooplankton is a vital source of natural food for *P. atherinoides*, although these fish also favored other foods with a plant origin. This finding raises questions about the conventional wisdom that the catfish species only display carnivorous feeding behaviors. On the other hand, it shows a distinct preference for carnivory over herbivory. The availability of such a diverse and partial preference for Phy-

Table 4. Pearson's correlation among feeding biological parameters in Riverine ecosystem for both district.

	GIL	GiWT	LivWt	GaSI	RGL	HSI
GIL	1	.918**	.112	.227**	.436**	.317**
GiWT	.918**	1	.080	.316**	.433**	.351**
LivWt	.112	.080	1	-.050	-.111	.165*
GaSI	.227**	.316**	-.050	1	.330**	.562**
RGL	.436**	.433**	-.111	.330**	1	.437**
HSI	.317**	.351**	.165*	.562**	.437**	1

*: 0.05 level of significance (2-tailed). **: 0.01 level of significance (2-tailed).

Table 5. Pearson's correlation among feeding biological parameters in Pond ecosystem for both district.

	GIL	GiWT	LivWt	GaSI	RGL	HSI
GIL	1	.909**	.037	.244**	.415**	.348**
GiWT	.909**	1	.105	.303**	.457**	.346**
LivWt	.037	.105	1	.115	.154*	.466**
GaSI	.244**	.303**	.115	1	.483**	.412**
RGL	.415**	.457**	.154*	.483**	1	.315**
HSI	.348**	.346**	.466**	.412**	.315**	1

*: 0.05 level of significance (2-tailed). **: 0.01 level of significance (2-tailed).

to-planktivorous resources suggests that the species' eating behaviors are dynamic. This alternate choice of feeding may result from transient adaptation or a phenomenon related to increased resource accessibility. Therefore, this finding represents that the species culture in any aquatic system like a pond, aquarium, or any aquatic body, does not depend on a definite ecosystem for their good growth and development, and it does not require pricey animal protein in its feed, its diverse diet suggests that it may be a suitable species for aquaculture. Additionally, the fact that these little fish species feed could be a crucial evolutionary factor. The study's findings would be valuable tools for developing management and protection strategies for conservation and

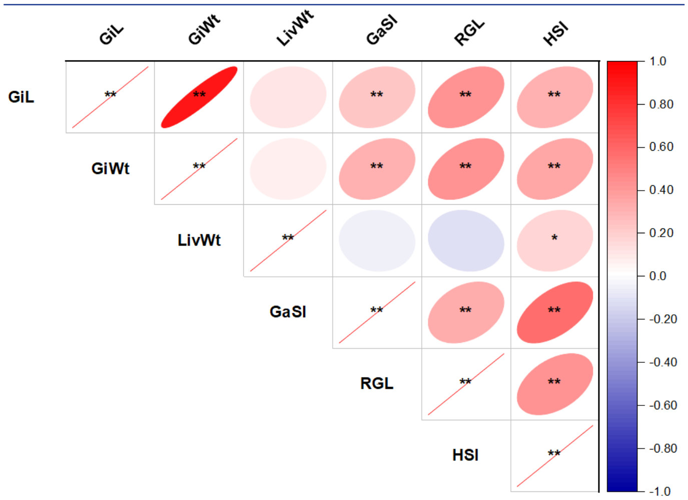

Figure 8. Pearson's correlation of feeding parameters in rivers of both district: *0.05 level of significance, ** 0.01 level of significance.

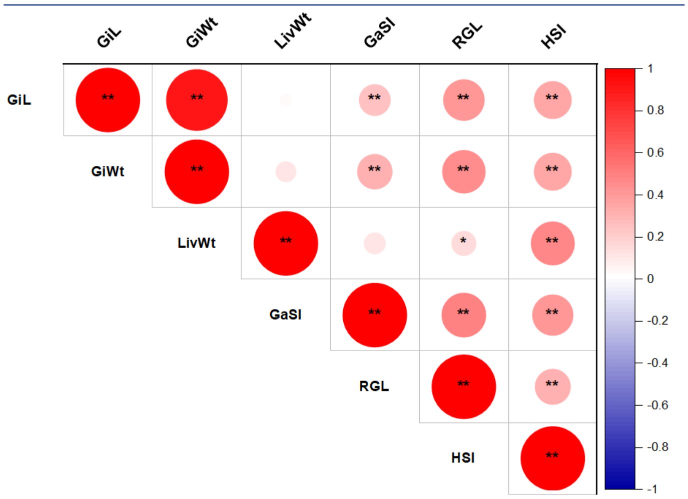

Figure 9. Pearson's correlation of feeding parameters in ponds of both district: *0.05 level of significance, ** 0.01 level of significance.

Table 6. Multivariate Tests among feeding biological parameters in Jhargram district.

Effect		Value	F	Hypothesis df	Error df	Sig.
Intercept	Pillai's Trace	.999	16493.140[b]	13.000	174.000	.000
	Wilks' Lambda	.001	16493.140[b]	13.000	174.000	.000
	Hotelling's Trace	1232.246	16493.140[b]	13.000	174.000	.000
	Roy's Largest Root	1232.246	16493.140[b]	13.000	174.000	.000
HABITAT	Pillai's Trace	.241	4.247[b]	13.000	174.000	.000
	Wilks' Lambda	**.759**	**4.247[b]**	**13.000**	**174.000**	**.001**
	Hotelling's Trace	.317	4.247[b]	13.000	174.000	.000
	Roy's Largest Root	.317	4.247[b]	13.000	174.000	.000
SEASON	Pillai's Trace	1.599	53.753	26.000	350.000	.000
	Wilks' Lambda	**.033**	**59.787[b]**	**26.000**	**348.000**	**.001**
	Hotelling's Trace	9.971	66.347	26.000	346.000	.000
	Roy's Largest Root	7.423	99.924[c]	13.000	175.000	.000

b. Exact statistic; c. The statistic is an upper bound on F that yields a lower bound on the significance level.

Table 7. Tests of Between-Subjects Effects of *P. atherinodes* in Jhargram district.

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.
HABITAT	GaSI	1.594	1	1.594	.903	.343
	RGL	.027	1	.027	6.947	.001
	HSI	3.974	1	3.974	1.232	.269
	GiL	3.910	1	3.910	5.097	.025
	GiWt	.013	1	.013	1.777	.184
	LvWt	.008	1	.008	1.189	.277
SEASON	GaSI	72.574	2	36.287	20.543	.001
	RGL	.253	2	.126	32.690	.001
	HSI	114.963	2	57.482	17.815	.001
	GiL	42.242	2	21.121	27.532	.001
	GiWt	.539	2	.269	36.355	.001
	LvWt	.577	2	.289	45.002	.001

N=256

Table 8. Post Hoc Tests seasonally of *P. atherinodes* in Jhargram district.

Dependent Variable	(I) SEASON	(J) SEASON	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
GaSI	SUMMER	MONSOON	1.45692*	.234945	.001	.90183	2.01201
		WINTER	1.05858*	.234945	.001	.50350	1.61367
	MONSOON	SUMMER	-1.45692*	.234945	.001	-2.01201	-.90183
		WINTER	-.39833	.234945	.210	-.95342	.15675
	WINTER	SUMMER	-1.05858*	.234945	.001	-1.61367	-.50350
		MONSOON	.39833	.234945	.210	-.15675	.95342
RGL	SUMMER	MONSOON	.08580*	.010992	.001	.05983	.11177
		WINTER	.02284	.010992	.097	-.00313	.04881
	MONSOON	SUMMER	-.08580*	.010992	.001	-.11177	-.05983
		WINTER	-.06297*	.010992	.001	-.08894	-.03700
	WINTER	SUMMER	-.02284	.010992	.097	-.04881	.00313
		MONSOON	.06297*	.010992	.001	.03700	.08894
HSI	SUMMER	MONSOON	1.1834*	.31754	.001	.4332	1.9337
		WINTER	1.8739*	.31754	.001	1.1237	2.6242
	MONSOON	SUMMER	-1.1834*	.31754	.001	-1.9337	-.4332
		WINTER	.6905	.31754	.078	-.0598	1.4407
	WINTER	SUMMER	-1.8739*	.31754	.001	-2.6242	-1.1237
		MONSOON	-.6905	.31754	.078	-1.4407	.0598
GiL	SUMMER	MONSOON	1.0938*	.15483	.001	.7279	1.4596
		WINTER	.8516*	.15483	.001	.4857	1.2174
	MONSOON	SUMMER	-1.0938*	.15483	.001	-1.4596	-.7279
		WINTER	-.2422	.15483	.264	-.6080	.1236
	WINTER	SUMMER	-.8516*	.15483	.001	-1.2174	-.4857
		MONSOON	.2422	.15483	.264	-.1236	.6080
GiWt	SUMMER	MONSOON	.1297*	.01522	.001	.0937	.1656
		WINTER	.0611*	.01522	.001	.0251	.0970
	MONSOON	SUMMER	-.1297*	.01522	.001	-.1656	-.0937
		WINTER	-.0686*	.01522	.001	-.1045	-.0326
	WINTER	SUMMER	-.0611*	.01522	.001	-.0970	-.0251
		MONSOON	.0686*	.01522	.001	.0326	.1045
LvWt	SUMMER	MONSOON	-.0577*	.01416	.001	-.0911	-.0242
		WINTER	.0763*	.01416	.001	.0428	.1097
	MONSOON	SUMMER	.0577*	.01416	.001	.0242	.0911
		WINTER	.1339*	.01416	.001	.1005	.1674
	WINTER	SUMMER	-.0763*	.01416	.001	-.1097	-.0428
		MONSOON	-.1339*	.01416	.001	-.1674	-.1005

N=256; *. The mean difference is significant at 0.05 level.

Table 9. Multivariate tests of *P. atherinodes* in Paschim Medinipur district.

Effect		Value	F	Hypothesis df	Error df	Sig.
Intercept	Pillai's Trace	.999	20952.388[b]	13.000	174.000	.000
	Wilks' Lambda	.001	20952.388[b]	13.000	174.000	.000
	Hotelling's Trace	1565.408	20952.388[b]	13.000	174.000	.000
	Roy's Largest Root	1565.408	20952.388[b]	13.000	174.000	.000
HABITAT	Pillai's Trace	.272	4.994[b]	13.000	174.000	.000
	Wilks' Lambda	**.728**	**4.994[b]**	**13.000**	**174.000**	**.001**
	Hotelling's Trace	.373	4.994[b]	13.000	174.000	.000
	Roy's Largest Root	.373	4.994[b]	13.000	174.000	.000
SEASON	Pillai's Trace	1.585	51.491	26.000	350.000	.000
	Wilks' Lambda	**.039**	**54.783[b]**	**26.000**	**348.000**	**.001**
	Hotelling's Trace	8.751	58.230	26.000	346.000	.000
	Roy's Largest Root	6.096	82.063[c]	13.000	175.000	.000
	Roy's Largest Root	.314	4.221[c]	13.000	175.000	.000

b. Exact statistic; c. The statistic is an upper bound on F that yields a lower bound on the significance level.

Table 10. Tests of Between-Subjects Effects of *P. atherinodes* in Paschim Medinipur district.

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.
HABITAT	GaSI	17.461	1	17.461	10.818	.347
	RGL	.021	1	.021	9.701	.001
	HSI	11.295	1	11.295	3.598	.059
	GiL	3.658	1	3.658	4.746	.031
	GiWt	.070	1	.070	8.858	.178
	LvWt	6.024	1	6.024	1.223	.270
SEASON	GaSI	112.068	2	56.034	34.716	**.001**
	RGL	.288	2	.144	66.387	**.001**
	HSI	196.681	2	98.340	31.325	**.001**
	GiL	39.883	2	19.941	25.877	**.001**
	GiWt	.387	2	.194	24.459	**.001**
	LvWt	13.907	2	6.953	1.411	.246

N=256

Table 11. Post Hoc Test seasonally of *P. atherinodes* in Paschim Medinipur district.

Dependent Variable	(I) SEASON	(J) SEASON	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
GaSI	SUMMER	MONSOON	1.86032*	.224588	**.001**	1.32970	2.39094
		WINTER	.75404*	.224588	**.003**	.22343	1.28466
	MONSOON	SUMMER	-1.86032*	.224588	**.001**	-2.39094	-1.32970
		WINTER	-1.10627*	.224588	**.001**	-1.63689	-.57566
	WINTER	SUMMER	-.75404*	.224588	**.003**	-1.28466	-.22343
		MONSOON	1.10627*	.224588	**.001**	.57566	1.63689
RGL	SUMMER	MONSOON	.09457*	.008233	**.001**	.07512	.11402
		WINTER	.04085*	.008233	**.001**	.02140	.06030
	MONSOON	SUMMER	-.09457*	.008233	**.001**	-.11402	-.07512
		WINTER	-.05372*	.008233	**.001**	-.07317	-.03427
	WINTER	SUMMER	-.04085*	.008233	**.001**	-.06030	-.02140
		MONSOON	.05372*	.008233	**.001**	.03427	.07317

Table 11. Continue.

Dependent Variable	(I) SEASON	(J) SEASON	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
HSI	SUMMER	MONSOON	2.3427*	.31321	**.001**	1.6027	3.0827
		WINTER	1.8739*	.31321	**.001**	1.1339	2.6139
	MONSOON	SUMMER	-2.3427*	.31321	**.001**	-3.0827	-1.6027
		WINTER	-.4687	.31321	.295	-1.2088	.2713
	WINTER	SUMMER	-1.8739*	.31321	**.001**	-2.6139	-1.1339
		MONSOON	.4687	.31321	.295	-.2713	1.2088
GiL	SUMMER	MONSOON	1.0719*	.15518	**001**	.7052	1.4385
		WINTER	.8063*	.15518	**001**	.4396	1.1729
	MONSOON	SUMMER	-1.0719*	.15518	**001**	-1.4385	-.7052
		WINTER	-.2656	.15518	.204	-.6323	.1010
	WINTER	SUMMER	-.8063*	.15518	**001**	-1.1729	-.4396
		MONSOON	.2656	.15518	.204	-.1010	.6323
GiWt	SUMMER	MONSOON	.0827*	.01573	**001**	.0455	.1198
		WINTER	.1042*	.01573	**001**	.0671	.1414
	MONSOON	SUMMER	-.0827*	.01573	**001**	-.1198	-.0455
		WINTER	.0216	.01573	.358	-.0156	.0587
	WINTER	SUMMER	-.1042*	.01573	**001**	-.1414	-.0671
		MONSOON	-.0216	.01573	.358	-.0587	.0156
LvWt	SUMMER	MONSOON	-.5797	.39240	.304	-1.5068	.3474
		WINTER	-.0180	.39240	.999	-.9451	.9091
	MONSOON	SUMMER	.5797	.39240	.304	-.3474	1.5068
		WINTER	.5617	.39240	.327	-.3654	1.4888
	WINTER	SUMMER	.0180	.39240	.999	-.9091	.9451
		MONSOON	-.5617	.39240	.327	-1.4888	.3654

N=256; *. The mean difference is significant at 0.05 level.

captive propagation. The knowledge from the current study may be applied to better manage *P. atherinoides* in India and to future conservation strategies and adoption of these species as possible candidates for commercial aquaculture.

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REFERENCES

Alam, A., Gopinath, V., Jha, D. N., Joshi, K. D., Kumar, J., Das, S. C. S. & Das, B. K. (2020). Food and Feeding Biology of Commercially Important Freshwater Eel, *Mastacembelus armatus* (LACEPÈDE, 1800) from the Ganga River, India. *Oceanography & Fisheries, 11*(4), 0069-0073. http://dx.doi.org/10.19080/OFOAJ.2020.11.555819

Al-Hussain, A.H. (1949). On the functional morphology of alimentary tract of some fishes in relation to differences in their feeding habits; anatomy and histology. *Qualitative Journal of Microscopic Science, 90*, 109-139.

Victor Raj, M., Sivakumar, R., & Mathialagan, R. (2014). Food and feeding habit and length-weight relationship of the Asian striped catfish *Mystus vittatus* (Bloch, 1794) (Siluriformes: Bagridae) in the Vadavar River, Lower Anicut, Tamil Nadu. *Indian Journal of Science*, *8*(20), 55-64.

Begum, M., Alam, M. J., Islam, M. A., & Pal, H. K. (2008). On the food and feeding habit of an estuarine catfish (Mystus gulio Hamilton) in the south-west coast of Bangladesh. *University journal of zoology, Rajshahi University*, *27*, 91-94.

Chanda, A. & Jana, A. (2021). A comparative review on freshwater fish fauna between West Bengal and Odisha, two middle-east Indian states. *Journal of Fisheries*, *9*(3), 93302-93302.

Chattopadhyay, S., Nandi, S., & Saikia, S. K. (2014). Mouth morphometry and architecture of freshwater cat fish *Mystus vittatus* Bloch (1974) (Siluriformes, Bagridae) in relation to its feeding habit. *Journal of Scientific Research*, *6*(1), 169-174. http://dx.doi.org/10.3329/jsr.v6i1.16369

Chaturvedi, J., & Saksena, D. N. (2013). Diet composition, feeding intensity, gastrosomatic index and hepatosomatic index of a catfish, *Mystus cavasius* from Chambal river (near, Rajghat) Morena, Madhya Pradesh. *International Journal of Recent Scientific Research*, *4*, 1350-6.

Dasgupta, M. (2004). Relative length of the gut of some freshwater fishes of West Bengal in relation to food and feeding habits. *Indian Journal of Fisheries, 51*, 381-384.

Desai, V. R. (1970). Studies on the fishery and biology of *Tor tor* (Hamilton, 1822) from river Narmada. *Journal of Inland Fishery Society in India*, *2*(5), 101-112.

Dinh, M. Q., Tran, T. L., & Nguyen, T. K. T. (2018). The relative gut length and gastro-somatic indices of the mudskipper Periophthalmodon septemradiatus (Hamilton, 1822) from the Hau River. *VNU Journal of Science: Natural Sciences and Technology*, *34*(3), 75-83. https://doi.org/10.25073/2588-1140/vnunst.4775

Gogoi, B., Das, D. N., & Saikia, S. K. (2020). Feeding Ecology of *Pachypterus atherinoides* (Actinopterygii; Siluriformes; Schilbeidae): A Small Freshwater Fish from Floodplain Wetlands of Northeast India. *Croatian Journal of Fisheries: Ribarstvo*, *78*(3), 105-120. https://doi.org/10.2478/cjf-2020-0011

Gopalan, C., Rama Sastry, B.V. & Bala Subramanian, S.C. (2004). Nutritive value of Indian foods, *National Institute of Nutrition*, ICMR, Hyderabad, 45-67.

Gosavi, S. M., Tapkir, S. D., Kumkar, P., & Kharat, S. S. (2020). The reproductive biology of *Pachypterus khavalchor* (Kulkarni, 1952) in the Panchaganga River of the Western Ghats, a biodiversity hotspot in India. *Asian Fisheries Science*, *33*, 79-90. https://doi.org/10.33997/j.afs.2020.33.2.001

Gupta, S., & Banerjee, S. (2014). Food and feeding habit of a freshwater catfish, *Mystus tengara* (Siluriformes: Bagridae). *Journal of Ichthyology*, *54*(9), 742-748. https://doi.org/10.1134/S0032945214060071

Gupta, S. (2015). An Overview on Feeding and Breeding Biology of *Mystus tengara*, A Freshwater Catfish of Indian Subcontinent. *World*, *7*(3), 195-197. https://doi.org/10.5829/idosi.wjfms.2015.7.3.94217

Hynes, H. B. N. (1950). The food of fresh-water sticklebacks (Gasterosteus aculeatus and Pygosteus pungitius), with a review of methods used in studies of the food of fishes. *The journal of animal ecology*, 19(1), F36-58. https://doi.org/10.2307/1570

Jan, M., & Jan, N. (2017). Studies on the fecundity (F), gonadosomatic index (GSI) and hepatosomatic index (HSI) of Salmo trutta fario (Brown trout) at Kokernag trout fish farm, Anantnag, Jammu and Kashmir. *International Journal of Fisheries and Aquatic Studies*, *5*(6), 170-173.

Jana, A., Sit, G., & Chanda, A. (2021). Ichthyofaunal diversity of River Kapaleswari at Paschim Medinipur district of West Bengal, India. *Flora and Fauna*, *27*(1), 113-124. https://doi.org/10.33451/florafauna.v27i1pp113-124

Jana, A., Sit, G., Das, P., Chanda, A. & Sahu, S. K. (2022A). Seasonal Length-Weight Relationships and Condition Factors of *Mystus tengara* (Hamilton, 1822) in Two Habitats. *Aquatic Sciences and Engineering*, 37(4), 205-211. https://doi.org/10.26650/ASE202221159748

Jana, A., Sit, G., Chanda, A., Nayak, S. & Sahu, S. K. (2022B). Seasonal length-weight relationships and condition factors of *Pachypterus atherinoides* (Bloch, 1794) in two habitats. *Ecology, Environment and Conservation*; 28, S515-S521. http://doi.org/10.53550/EEC.2022.v28i06s.0083

Koundal, S., Dhanze, R., Koundal, A., & Sharma, I. (2013). Relative gut length and gastro-somatic index of six hill stream fishes, Himachal Pradesh, India. *Journal of Environment and Biosciences*, *27*(1), 11-18.

Kurbah, B. M., & Bhuyan, R. N. (2018). Analysis of feeding behaviour and gastro-somatic index (GaSI) during different phases of breeding cycle of *Monopterus cuchia* (Hamilton, 1822) from Meghalaya, India. *Journal of Applied and Natural Science*, *10*(4), 1187-1191. https://doi.org/10.31018/jans.v10i4.1907

Lanthaimeilu, K., & Bhattacharjee, P. (2018). Relative gut length and gastro-somatic index of *Pethia conchonius* (Hamilton, 1822) and *Trichogaster fasciata* Bloch & Schneider 1801, Tripura. *Journal of Entomology and Zoology Studies*, *6*(2), 2403-2407.

Menon, A.G.K. (1999). Check list - fresh water fishes of India. *Record in Zoological Survey of India*, Miscellaneous Publication, Occasional Paper No. 175.

Mitu, N. R. (2017). Reproductive biology of the female Asian striped dwarf catfish *Mystus tengara* (Hamilton, 1822) (Siluriformes: Bagridae) in the Ganges River of Rajshahi, northwestern Bangladesh. *Turkish Journal of Fisheries and Aquatic Sciences*, *17*(3), 589-598. https://doi.org/10.4194/1303-2712-v17_3_15

Mojumder, N., Saha, D., Utsa, S. S., Maruf, K. K., & Paul, S. K. (2020). Biology of the endangered queen loach (*Botia dario*) collected from wild sources in Bangladesh. *Aquaculture, Aquarium, Conservation & Legislation*, *13*(5), 2599-2609.

Nagar, K. C., & Sharma, M. S. (2016). Food and feeding habit of two hill stream fishes ie *Rasbora daniconius* and *Noemachielus botia* in selected stream of Southern Rajasthan, India. *Research journal of Animal Veterinary and Fishery Science*, *4*(6), 7-14.

Rajaguru, A. (1992). Biology of two co-occurring tonguefishes, *Cynoglossus arel* and *C. lida* (Pleuronectiformes: Cynoglossidae), from Indian waters. *Fishery Bulletin*, *90*(2), 328-367.

Sahil, Mogalekar, H.S., Chandran, S., Nayak, .S.K., Kumar, S. & Singh, S.K. (2023). Length-weight relationship and condition factor of selected small Cyprinid fishes from river Burhi Gandak in North Bihar, India. *Journal of the Inland Fisheries Society of India*, *54*(1), 27-32. https://epubs.icar.org.in/index.php/JIFSI/article/view/132388

Sharma, A. K., Malik, D. S., & Bargali, H. (2018). Food and Feeding Habits of *Schizothorox Richardsonii* (Gray, 1832) Inhibiting Bhagirathi River, Tehri Garhwal, India. *International Journal of Recent Scientific Research*, *9*(4), 25562-2556. https://doi.org/10.24327/IJRSR

Sit, G., Jana, A. & Chanda, A. (2020). Diversity of small indigenous freshwater ornamental fish under genus Puntius from Purba Medinipur, Paschim Medinipur and Jhargram districts of West Bengal, India. *Advances in Zoology and Botany*, *8*(4), 334-341. https://doi.org/10.13189/azb.2020.080405

Sit, G., Jana, A., Das, P., Chanda, A. & Sahu, S. K. (2022A). Induced breeding and embryonic development of indigenous ornamental fish *Puntius terio* (Hamilton, 1822). *Indian Hydrobiology*, 21(2), 43-51.

Sit, G., Jana, A., Chanda, A. & Sahu, S. K. (2022B). Record of zipper loach *Paracanthocobitis botia* (Hamilton 1822), an ornamental fish from Paschim Medinipur, West Bengal, India. *Journal of Fisheries*, *10*(3), 103401-103401. https://doi.org/10.17017/j.fish.355

Sit, G., Jana, A., Chanda, A. & Sahu, S. K. (2023A). Dose Selection for Induced Breeding and Larval Development of Indigenous Ornamental Fish *Puntius chola* (Hamilton, 1822). *Aquatic Sciences and Engineering*, 38(1), 62-67. https://doi.org/10.26650/ASE20221177106

Sit, G., Jana, A., Chanda, A. & Sahu, S. K. (2023B). Record of zipper loach *Paracanthocobitis mackenziei* (Chaudhuri, 1910), an indigenous ornamental fish from West Bengal, India. *Journal of Fisheries*, *11*(2), 112402-112402. https://doi.org/10.17017/j.fish.477

Srivastava, S. C., Verma, P., Verma, A. K., & Singh, A. K. (2014). Assessment for possible metal contamination and human health risk of *Pangasianodon hypophthalmus* (Sauvage, 1878) farming, India. *International Journal of Fisheries and Aquatic Studies*, *1*, 176-181.