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Fisheries and Aquaculture Journal

Research Article

Study of Food Preferences and Feeding Behavior of *Aspidoparia morar* from the River Yamuna Allahabad, India

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ABSTRACT

The present study was done at Central Inland Freshwater Research Institute, Allahabad, India, to know the type and amount of food taken by *Aspidoparia morar* in the river Yamuna. To study the food and feeding habits, a total of 299 fish samples of *A. morar* were collected monthly for twelve months covering the length range 4.5cm-15.8 cm from the river Yamuna at Allahabad. Studies have shown that this fish having plant food material 85.5% and animal food material 4.7% is strongly herbivores. The analysis of food intake of *A. morar* indicated that it feeds mainly on phytoplankton which is dominated by Diatom (40.2%) followed by GA (24.8%), BGA (14.6%) and Desmids (7.8%). The contribution of miscellaneous and Protozoa was merely 7.9%and 4.0%, respectively, hence the fish can be further classified asphytoplankton feeder. The analysis of season-wise data did not reflect much variation in proportion of plant and animal matter in food items. Higher length groups (>10 cm) showed low intake of animal food as compared to smaller ones (<10 cm). In fishes of more than 10 cm in length, Diatoms were the most preferred food (52.4%).The intensity of feeding Gastro-Somatic Index (GaSI) was found to be maximum during December and lowest in monsoon (June to September). High feeding activity during October to December might be due to intensive feeding by spent fishes as well as those in early stage of maturity. Present studies revealed that it breeds mainly in monsoon period, the period of minimum feeding intensity, this indicated that feeding intensity of fish is related to its breeding. The present findings will help in filling the gap in knowledge about the feeding habit of *A. morar* which will help in formulating strategies for proper development of their fishery.

Keywords: *Aspidoparia morar*; Small Indigenous fish Species (SIS); Yamuna river; Feeding habit; Gastro-Somatic Index (GaSI)

INTRODUCTION

Small Indigenous fish Species (SIS) inhabit in rivers and tributaries, floodplains, ponds and tanks, lakes, beels, streams, lowland areas, wetlands and paddy fields. Many SIS have become threatened and endangered due to pollution, over exploitation coupled with habitat destruction, water abstraction, siltation, channel fragmentation, diseases. In order to achieve sustainable utilization, appropriate planning for conservation and management strategies are of utmost importance. The growth and survival of any fish species depends on the quality, quantity and availability of natural food in the surrounding environment. Studies on food and feeding habit could provide useful information in formulating management strategy options in multi species fishery. No published report was found on the gut contents of *A. morar* in lower stretch of river Yamuna, India. Thus, the present investigation was carried out to find out the food and feeding habits of *A. morar* from the river Yamuna at Allahabad, which might be useful to the fish culturists and fish farm mangers to maintain a needful food composition in the respective water body for a better fish growth to enhance the yield and economy of the country.

SIS has been the focus of much attention to date because these species have high nutritive value [1-4]. The majority of SIS are eaten by the rural poor people. These fishes provide food, nutrition, subsistence and supplementary income to lower income group. Among SIS *Aspidoparia morar* is a major source of animal protein and micronutrients [3,4]. No studies have been reported on food and feeding of *Aspidoparia morar* in India. However the feeding patterns of this species have been studied on a small scale in Bangladesh [5-7]. Since no report was available regarding food and feeding habits of *A. morar* in India therefore, the aim of this

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Received: 30-Sep-2023, Manuscript No. FAJ-23-27268; **Editor assigned:** 02-Oct-2023, Pre QC No. FAJ-23-27268 (PQ); **Reviewed:** 16-Oct-2023, QC No. FAJ-23-27268; **Revised:** 23-Oct-2023, Manuscript No. FAJ-23-27268 (R); **Published:** 31-Oct-2023, DOI: 10.35248/2150-3508.23.14.346.

Citation: Masud S, Singh KP (2023) Study of Food Preferences and Feeding Behavior of *Aspidoparia morar* from the River Yamuna Allahabad, India. Fish Aqua J. 14:346.

work was to determine the feeding pattern of *A. morar* at various developmental stages, identify variability in the quality-quantity of composition of food and feeding intensity on monthly cycles.

MATERIALS AND METHODS

Fish samples for food studies were procured from river Yamuna from Sadiapur fish landing center just on the left bank of the river and Gaughat and Karela Bagh retail fish markets depending on their availability. The samples were collected throughout the year to cover all the season. For the purpose of collection of samples, a stratified sampling design was adopted [8]. A month was divided in four strata of seven or eight consecutive days, depending upon the month. From each stratum samples were collected for two randomly selected days. All the three markets were covered on the sampling days (Figure 1).

Figure 1: Map showing sampling sites and fishing villages feeding fish markets.

Total 299 samples of *A. morar* were studied for food composition covering the entire length range (4.5 cm-15.8 cm). Samples were dissected out, weighed and preserved in 5% formalin. The gut contents were analyzed through quantitative and qualitative methods [9,10]. The various food items were examined under the binocular microscope (OLYMPUS-CX31 RTSF) following Pillay, et al. [11]. The relative abundance of each food item was expressed as percentage of total number of food items in the sample and identified up to generic level as far as possible with the help of Needham, et al., Ward et al. Apha, et al. [12-14]. Gastro Somatic Index (GaSI) was determined for each fish to study the seasonal variations in food by the formula [15].

"GaSI"="Weight of the gut content" /"Weight of fish" ×100

The data was analysed to correlate various observations like feeding intensity with different months of the year, feed with season and size or stages of life.

RESULTS AND DISCUSSION

The various food items observed in the guts content of *A. morar* were categorized in nine groups. Phytoplankton as Green Algae (*GA-Chlorophyceae*), Blue Green Algae (*BGA-Cynophyceae*), Diatom (*Bacillariophyceae*) and Desmids; zooplankton as crustacean, protozoan, rotifers and insects; and helminths, nematode, water spider and unidentified items were put under miscellaneous (Table 1).

The monthly occurrence of various food items observed in the gut contents are presented in Table 2. It was seen that there were considerable variations in the percentage of different food items during different months of the year. From the Table 2 it is evident that the fish mainly feed on diatom.

Table 1: Fish food organisms in gut content of *Aspidoparia morar*.

Organism	Group	Organism	Group	Organism	Group
Ankistrodesmus	ga	*Rivularia*	bga	*Staurastrum*	des
Botryococcus	ga	*Tetrapedia*	bga	*Actinophrys*	pro
Characium	ga	*Amphora*	dia	*Eudorina*	pro
Chlorella	ga	*Asterionella*	dia	*Mayorella*	pro
Coelastrum	ga	*Campylodiscus*	dia	*Pandorina*	pro
Crucigenia	ga	*Cocconeis*	dia	*Pleodorina*	pro
Dictyosphaerium	ga	*Cyclotella*	dia	*Spirostomum*	pro
Gonium	ga	*Cymbella*	dia	*Synura*	pro
Hydrodictyon	ga	*Diatoma*	dia	*Uroglena*	pro
Kirchneriella	ga	*Epithemia*	dia	*Volvox*	pro
Microspora	ga	*Gomphonema*	dia	Crustacean parts	cru
Pediastrum	ga	*Gyrosigma*	dia	*Daphnia*	cru
Protococcus	ga	*Melosira*	dia	*Mysis*	cru
Scenedesmus	ga	*Meridion*	dia	Shrimp	cru
Selenastrum	ga	*Navicula*	dia	*Simocephalus*	cru
Spirogyra	ga	*Nitzschia*	dia	*Brachionus*	rot
Tribonema	ga	*Stephanodiscus*	dia	*Dicranophorus*	rot
Ulothrix	ga	*Synedra*	dia	*Notholca*	rot
Anabaena	bga	*Tabellaria*	dia	*Antocha*	ins
Merismopedia	bga	*Closterium*	des	*Cordulia*	ins

Nostoc	bga	*Cosmarium*	des	Insect parts	ins
Oscillatoria	bga	*Gonatozygon*	des	*Gemmules*	mis
Phormidium	bga	*Mesotaenium*	des	*Sponge*	mis
Polycystis	bga	*Netrium*	des	Unidentified	mis

Note: ga: green algae; bga: blue green algae; dia: diatoms; des: desmids; pro: protozoa; cru: crustacean; rot: rotifer; ins: insect; mis: miscellaneous.

Table 2: Monthly contribution (%) of food items in gut content of *A. morar.*

Group	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
Green algae	12.4	18.4	30.3	29.3	39.7	38.9	34.6	33.6	30.5	25.6	31	6.4	24.5
Blue-green algae	8.3	8.8	5.2	14.4	15.4	20.5	25.1	42.1	18.8	17.5	15.7	28.4	14.6
Diatom	65.2	53	45.7	25.3	24.4	12.1	10.6	3.4	27.9	29.3	32.2	54.9	40.2
Desmids	4.4	6.9	4.8	9.8	6.5	17.6	17.3	11.3	8.8	12	9.9	3.6	7.8
Protozoa	1.4	4.1	5	9.6	6.9	1.8	1.9	1.4	5.4	7.2	2.2	1	4
Crustacea	0	0.2	0.2	0	0	0.5	0.1	0	0	0.2	0.3	0	0.1
Rotifer	0	0	0	0.7	0.1	0	0	0	0	0	0	0.1	0.1
Insect	0.4	0.9	0.5	0.8	0	0.6	0	0	0	0.7	0.1	0	0.4
Miscellaneous	7.9	7.7	8.3	10	7	8.1	10.3	8.2	8.5	7.6	8.2	5.4	7.9

The contribution of various groups was as follows:

Green algae

Green algae contributing 24.8% in total (Figure 2) was represented by 18 genera (Table 1). It encountered more abundantly during March-November (30.3%-31.4%) and the contribution was of low order in December to February (6.5%-18.4%) (Table 2). Hossain, et al. Studied food and feeding habit of A. *morar*, also reported more or less similar finding, Chlorophyceae was found maximum during summer and minimum during winter [16]. Among green algae Protococcus (41.5%), *Scenedesmus* (27.7%) and *Coelastrum* (17.8%) stated in their order of preference were dominating food items of the fish and was encountered abundantly in all the months (Table 3). *Scenedesmus* was absent in August. *Coelastrum* occurred in moderate quantity throughout the year. Rest of the genera was present in insignificant quantity or totally absent in most of the months.

Blue-green algae

This group formed about 14.6% of the total food (Figure 2) and represented by eight genera (Table 1) blue-green algae was found maximum in August (42.1%) and minimum in March (5.2%). This group was dominated by *Merismopedia*, *Phormedium*, and *Oscillatoria* forming 35.3%, 34.9% and 18.9% of the group (Table 3). However, *Merismopedia* contribution was of very low order during peak monsoon season. Rest of the genera was very poor in occurrence.

Diatom

Diatom contributed 40.2% of the total food item (Figure 2). This group was represented by 17 genera (Table 1) and occurred throughout the year. They were found maximum in January (65.2%) and minimum in the month of August (3.4%). Their contribution was low during monsoon months (3.4%-12.1%). Hossain, et al. reported maximum no of *Bacillariophyceae* in July and December and lowest in May [16]. The 17 genera, *Navicula*, *Amphora*, *Cyclotella* and *Synedra* constituted 30.9%, 12.0%, 12.0% and 11.5% respectively of the diatoms (Table 3). *Navicula* occurred most abundantly in the months of August (60.0%) and October (59.3%). *Amphora* was recorded maximum in December (26.8%). *Cyclotella* contribution ranged from 3.7% to 22.4% of the total diatom group.

Desmids

Desmids formed 7.8% of the total food (Figure 2) and represented by six genera (Table 1). *Cosmerium*, *Mesotaenium* and *Gonatozygon* occurred throughout the year, contributing 40.5, 32.4 and 25.7%, respectively of the total desmids (Table 3). Contribution of *Closterium* (0.3%), *Netrium* (0.1%) and *Staurastrum* (1.0%) were almost negligible and might have been consumed accidentally.

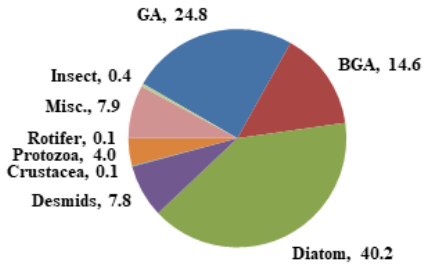

Figure 2: Percent contribution of food items in gut content of *A. morar.*

Table 3: Contribution (%) of food items contributing more than 5% within group for *A. morar.*

	A. *morar*	
Group	**Organism**	%
Green algae	*Coelastrum*	17.8
	Protococcus	41.52
	Scenedesmus	27.66
	Others	13.02

Blue-green algae	*Merismopedia*	35.3
	Oscillatoria	18.93
	Phormidium	34.88
	Polycystis	5.13
	Others	5.76
Diatom	*Amphora*	12.01
	Cyclotella	11.96
	Cymbella	6.52
	Diatoma	8.55
	Gyrosigma	6.73
	Navicula	30.92
	Synedra	11.48
	Others	11.83
Desmid	*Cosmarium*	40.48
	Gonatozygon	25.71
	Mesotaenium	32.37
	Others	1.44
Protozoa	*Eudorina*	17.65
	Pandorina	21.95
	Pleodorina	10.22
	Synura	19.86
	Uroglena	27.18
	Others	3.14
	Crustacean parts	7.69
Crustacean	*Daphnia*	26.92
	Mysis	19.23
	Shrimp	7.69
	Simocephalus	38.46
	Others	0.01
Rotifer	*Brachionus*	10.53
	Dicranophorus	57.89
	Notholca	31.58
Insect	*Antocha*	85.87
	Insect parts	10.87
	Others	3.26
Miscellaneous	Unidentified	98.63
	Others	1.37

Protozoa

Protozoa formed 4.0% of the total food (Figure 2) and represented by nine genera (Table 1). *Uroglena* (27.2%), *Pandorina* (22.0%), *Synura* (19.9%), *Eudorina* (17.6%) and *Pleodorina* (10.2%) were the major genera (Table 3) and representation of rest of the genera was insignificant. The protozoan contribution was of higher order in April, May and October, with maximum in April, forming 9.6% of the total food consumed. Percent contribution of various food items in gut content has been depicted in Figure 2 and Table 3.

Crustacean, rotifers, and insects

The occurrence of rotifers (0.1%), insects (0.4%) and crustacean (0.1%) were small and irregular in the gut contents (Table 2). They were represented by only 3, 2 and 4 genera, respectively (Table 1), and together their contribution was merely 0.5% of the total food. During monsoon months their contribution was almost negligible.

This group with a contribution of 7.9% (Table 2) mainly consisted of gemules, sponge, and unidentified matter in decayed condition. The group was dominated by unidentified items (98.6%) (Table 3). Sponge content was observed only during January and February, whereas gemules were totally absent during July to December. On the basis of proportion of different food items as described by Das, et al. *A. morar* was put under the herbivores (plant matter-87.5%; animal matter-4.7%) [17]. The analysis of food intake of *A. morar* indicated that it feeds mainly on Diatom (40.2%), GA (24.8%), BGA (14.6%), Desmids (7.8%). The contribution of miscellaneous and Protozoa was merely 7.9% and 4.0%, respectively (Figure 2). Hossain, et al. Reported that *A. morar* is an omnivore fish with a higher feeding preference for phytoplankton 80.71% and 19.29% zooplankton in the river Padma, Bangladesh [16]. Shafiqur (2003) studied the seasonal variations of food and feeding pattern of chela (*Chela cachius*) in Bangladesh and reported that among phytoplankton, Chlorophyceae was the dominant group followed by *Bacillariophyceae*.

Variation occurs in the food of fishes throughout the year. Monthly changes in temperature not only influenced food composition and the rate of digestion but also the quantity and quality of various foods. During summer and monsoon seasons the proportion of animal food showed some increase as compared to winter, the main increase was in Protozans. However, the most preferred food of the fish in all the seasons was green algae (15.1-34.0%) and Diatoms (21.0-54.8%), with slight changes in pattern with seasons (Table 4).

Table 4: Contribution (%) of various food groups for all samples, length group–wise and season-wise in A.*morar*.

Group	Total samples	L.gr. I	L.gr. II	L.gr. III	Winter	Summer	Monsoon
ga	24.8	35.4	32.4	17.7	15.1	34	29.7
bga	14.6	17.3	16.3	13.1	14.4	12.6	22.6
dia	40.2	25.4	26.5	52.4	54.8	29.8	21
des	7.8	7.5	10.3	6	5.6	8.7	13
pro	4	6.3	5.5	2.7	2.2	5.8	4.8
cru	0.1	0.1	0.2	0.1	0.1	0.1	0.1
rot	0.1	0	0.2	0.1	0	0.2	0
ins	0.4	0	0.4	0.5	0.4	0.5	0.3
mis	7.9	8	8.3	7.5	7.3	8.3	8.6
P	87.5	85.7	85.5	89.2	89.9	85.1	86.2

A	4.7	6.4	6.2	3.4	2.8	6.6	5.2
M	7.9	8	8.3	7.5	7.3	10.6	8.6

Note: ga: green algae; bga: blue green algae; dia: diatoms; des: desmids; pro: protozoa; cru: crustacean; rot: rotifer; ins: insect; mis: miscellaneous; Length groups: L.gr.I: <=7 cm; L.gr.II: >7 and <=10cm; L.Gr.III:>10cm
P: Plant matter; A: Animal matter: M: Miscellaneous items.

The analysis of season-wise data did not reflect much variation in proportion of plant and animal matter in food items of *A. morar.*

Higher length groups (>10 cm) showed low intake of animal food as compared to smaller ones (<10 cm). In fishes of more than 10 cm in length, Diatoms were the most preferred food (52.4%) (Table 4). Protozoa also showed a declining trend as fish grow (6.3 to 2.75%). These findings are more or less similar to those of Hossain, et al., Keast, et al. Who reported that many fishes changed diet as they grow [15,16]. As in case of *G.manmina* (Masud and Singh 2018) *A. morar* also showed an inverse relationship between Diatoms and green algae contribution, same, pattern was also reported by Hossain, et al. [16]. (Table 4).

Bhuiyan, et al. studied the food and feeding habits of *A. morar* from the river Padma, and on the basis of its gut content put it under herbivore [5]. Rasool, et al. Found only plant matter from the gut of *A. morar* from Pakistan; their finding was in agreement with Ali, et al. [6,7]. Kesteven, et al. Stated that although fishes can be classified into herbivorous, carnivorous and polyphagous, it is further necessary that within these three major groups the fishes should be classified according to the major taxonomic groups upon which they feed or according to the ecological conditions under which they feed [18]. Thus, the major taxonomic food groups under which the fishes can be classified are Diatom feeders, algae feeders, Crustacean feeders, molluscan feeders, vegetable feeders, Insect feeders, fish feeders, worm feeders etc. The present investigation indicated that *A. morar* was Diatom feeder fish.

Nilsson, et al. Observed that the feeding habits of fish depends on the availability of food item at certain time [19,20]. He further showed (1955, 1957) in white fishes and salmonids the preference on certain food items when these reach some state that makes them easily available than any other food occurring in the fauna at that time. This he termed as 'changeable food specialization'. This pattern of food preference was also observed in present study. The presence of a particular food item in marked abundance indicating that it was carefully selected and preferred by the fish to other items present in lesser quantities. Ivlev, et al. Suggested that the tendency of a particular animal to consume certain food items selectively in comparison to other is determined by its inherent properties [21].

In the present study, the inferior and slightly protractible mouth of *A. morar* are well adapted for browsing of food buried in mud or sheltered under crevices of the river fringes which are fully suited for their herbivorous feeding habits. Similar structural modifications are also reported in some *Cyprinids* [22-24].

In *A. morar* a well-developed stomach is totally absent which is a character common to a larger number of herbivorous species [22-23]. However, the swelled portion of the proximal part of intestine, the intestinal bulb, may be analogous with the stomach of teleost [25]. The gut of these species is long, coiled and may provide longer surface area for absorption of the decayed plant and phytoplankton matter.

Gastro-Somatic Index (GaSI)

The observation on feeding intensity was based on Gastrosomatic Index (GaSI) taken on monthly basis and the results have been summarized in Figure 3.

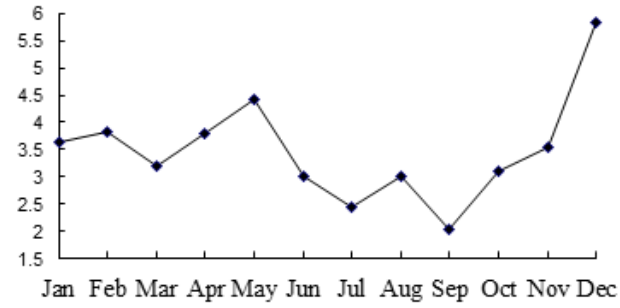

Figure 3: Monthly fluctuations in feeding index of *A. morar.*

The GaSI value of *A. morar*, was maximum in December (5.84) and onwards till April registered a decline. After an upsurge in May (4.41), again followed a declining trend, reaching its minimum (2.03) in September. *A. morar* showed regular rise and fall in the feeding intensity in various months. These variations may be related to the maturation of the gonads as fully developed gonads limit the space for stomach and spawning [24]. High feeding activity during October to December might be due to intensive feeding by spent fishes as well as those in early stage of maturity. Keshava, et al. Reported that *Etroplus suratensis* during spawning season reduces the feeding rate [26]. As Hossain, et al. reported that small fishes breed in rainy season and some species breed throughout the year [27]. However, in case of *A. morar*, they have reported that it breeds during winter and prefers low temperature and clear water. According to Hossain, et al. It breeds during winter and monsoon [28]. Present studies revealed that it breeds mainly in monsoon period, the period of minimum feeding intensity. The fluctuations in GaSI values may be ascribed to low availability of food during monsoon season and excess food requirement during pre and post breeding periods [29-33].

CONCLUSION

Based on the present observations on the food and feeding habits of *A. morar* it can be concluded that this fish is herbivorous in nature feed mainly on phytoplankton with a higher feeding preference for Diatom followed by GA and BGA. The zoo plankton and animal matter identified from the gut contents could not be treated as food of these fishes as is evident from their sporadic and sparse representation and probably, they might have entered accidentally while engulfing the phytoplankton. *A. morar* was found to change its feeding activity at different life stages. It revealed that in higher

length groups (>10 cm) most dominant food item was Diatoms while smaller group (<10 cm) preferred animal food. Protozoa also showed a declining trend as fish grow. Monthly variation of GaSI in *A. morar* revealed that the fish showed two feeding peaks; one in December and the another one in May, minimum feeding was noticed in September. It was found seasonal study did not show much variation. This information will provide an important baseline for future studies within the Yamuna River in particular and of similar nature other water bodies in general that will be useful for its future fishery management.

ACKNOWLEDGEMENT

The authors wish to express their sincere thanks to Dr. KD Joshi, former Head Riverine Division of CIFRI, Allahabad and Dr. RK Tyagi former Pri. Scientist, CIFRI, for providing necessary support to carry out the present research work. And all the fishermen who helped me during my survey work.

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