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Food and feeding habits of catfish, *Sperata aor* (Hamilton, 1822) from Bhadra reservoir, Karnataka

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Abstract
The present study deals with the food and feeding habits of catfish *Sperata aor* collected from Bhadra reservoir of Karnataka, India. Food of the fish consisted chiefly of weed fishes followed by insects, prawns and molluscs. Juveniles of carps were rarely recorded in the gut and probably the fish is not inimical to carp fishing. Higher feeding activity in *S. aor* was observed during June to August. Fishes with empty stomachs were found in all months. The stomachs of fishes collected for the study of food and feeding habits were classified depending on their relative fullness into gorged, full, $^{3}/_{4}$ full, $^{1}/_{2}$ full, ¼ full, little and empty. Fishes with stomachs classified as gorged, full, $^{3}/_{4}$ full, $^{1}/_{2}$ full were considered to have actively fed, whereas those with ¼ full and little as poorly fed.

Keywords: food and feeding, *sperata aor*, cat fish, bhadra reservoir, karnataka

Introduction
The study of food and feeding intensity is one of the most important aspects of fish food relationship. According to Nikolsky (1963) [7], the food supply is governed by the condition for obtaining and utilizing the food and is also dependent on abiotic conditions during the feeding period. Having regard to the object of the investigation, the material collected by the fish was examined to get a general view of the qualitative and quantitative composition of the food of the fish *S.aor* and their results were presented in this study.
Catfishes are considered as one of the most important orders of vertebrates, not only because of more than one-tenth of living fishes are siluriforms, but also because of their relationship with humans covers many aspects of life and culture. Several hundred species are now used as food, and other species will be looked upon as a source of protein in the future. Some species are greatly appreciated as game and commercial fishes and reach high market prices. In addition, most catfishes can be used as aquarium fishes, a business that not only worth millions of dollars, but gives urban populations the opportunity to get in touch with a significant part of nature.
Various fishes devour various sorts of food things. In this way, the food and taking care of propensities for fish have tremendous biological worth. By examining the food and taking care of propensities, the example of between explicit Competition of fishes can be evaluated (Sakhare and Jetithor, 2016) [11]. Food plays a vital role in life history of fishes (Nikolsky, 1963) [7]. The study of food and feeding habits of fishes help in understanding various aspects of biology like migration, growth, maturation, spawning and seasonal variations in biochemical composition (Sukumaran, 2004) [14]. Much of our current understanding of the autecology, production and ecological role of fish population is derived from studies of the diet based analysis of stomach contents. Hence, it is desirable to study the food and feeding habits as a part of fish biology.

Materials and Methods
Study area
Bhadra reservoir is located near Lakkavalli village of Tarikere taluk in Chikmagalur district (Figure 1).This reservoir has been constructed at an elevation of 601 m above MSL The dam is located at latitude 13°42'00" N and longitude 75°38'20"E. The Bhadra basin gets the rainfall ranging from 117 to 573 cm and the temperature varied from 30.1 to 18.8^{0}C. The reservoir is having 186 ft in depth. This is a multipurpose project for irrigation, drinking, fishery and hydroelectric power.

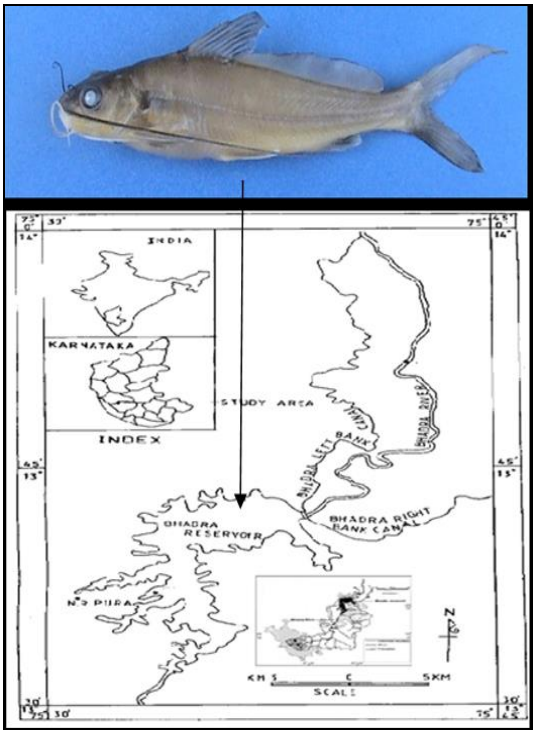

Fig 1: Location of the study area for *Sperata aor* sampling

Craft and Gear

The only craft used in the reservoir by the fisherman is the coracle. The main types of gear used are gill nets, long lines, cast nets and dragnets are used as a small scale. Surface gill nets, bottom set gill nets, large shore seine, small shore drag net, cast nets, and hook and line are the commonly used fishing tackle. The gill nets of various sizes are used to catch all varieties of fishes from big to small catfishes and carp fishes. Small fishes are usually processed for drying.

Landing centers

The fish landing centers includes, Dam top, Aadrikatte, Umblebyle camp and N.R. Pura camp. There is direct sale by the fishermen at the landing centers such as at Dam top and N.R. Pura camp. The catches are also taken by merchants for marketing. The catches from the different landing centers are taken to the Bhadravathi city, where there is a good demand for the fresh fish. When catches are good, after meeting local demand the catch is transported to neighboring towns for sale.

Fish analysis

Both qualitative and quantitative analyses were carried out to study the gut contents of *Sperata aor*. Each fish gut was observed under a binocular microscope. For qualitative analysis, the identification of crustaceans, arthropods and teleosts was restricted upto generic level. If the food items were in advanced state of digestion, they were classified as semi-digested matter. The presence of sand grains, mud, fragments of algae were considered as accidental inclusions and were excluded while grading the various food items.

Quantitative analysis was carried out by using methods (Hynes, 1950; Pillay, 1952) [4, 8]. In this method, occurrence of each food item was expressed as percentage of occurrence of individual item of food in the stomach contents during different months. The percentage occurrence of individual item was calculated from the summed up total number of occurrences of all the items in the gut.

Feeding intensity

Feeding intensity during various season was studied by the degree of fullness of the stomach. Fish with stomachs 'gorged' (the cardiac stomach swollen with food): 'full', 3/4 full and1/2 full were considered to denote poor feeding activity. The monthly percentage occurrence of stomach in active and poor feeding conditions was utilized to determine the seasonal fluctuations in feeding intensity. The percentage occurrence of stomach in different conditions of feeding during the period of study was also calculated.

Results and Discussion

The details of qualitative and quantitative composition various food items found in the gut off. S. *aor* in all the months was presented in Table 1 and 2; Fig.2 and 3.

Analysis of the gut contents indicated that teleosts, insects, prawns and molluscs formed the main food of the *S. aor*. Sand grains, semi digested matter and miscellaneous items were also presented. Some percentages of fishes with empty stomachs were also found during the study period.

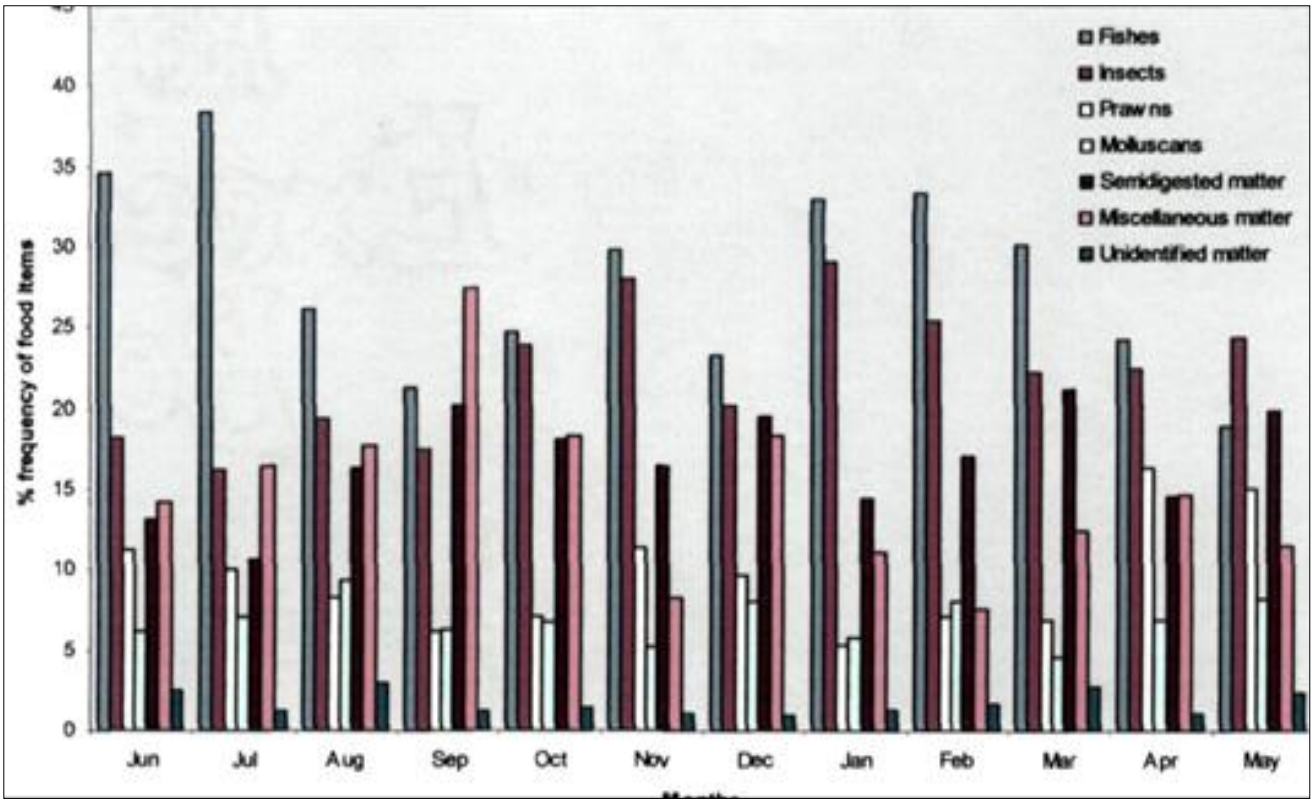

Fig 2: Percentage frequency occurrence of different food items of *S. aor* in different months

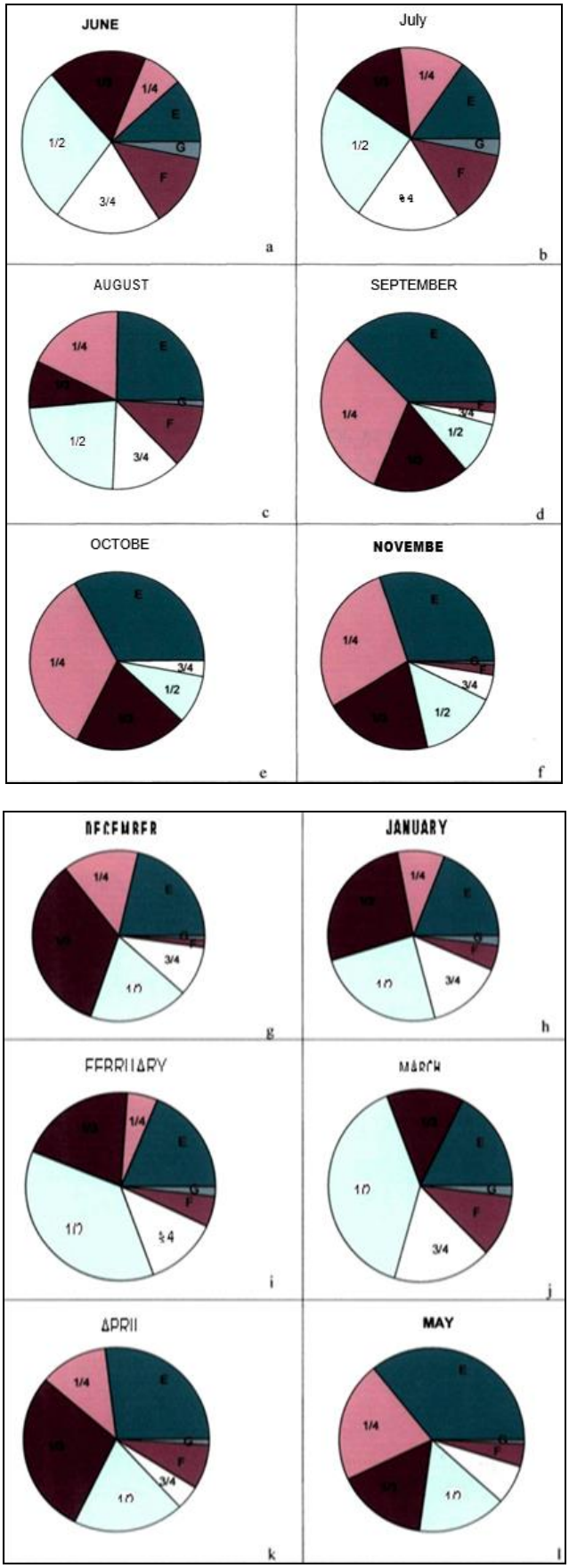

Fig 3: Seasonal percentage variation in various degrees of fullness of stomach of *S. aor* (A to l).

Composition of the Diet

Table 1 shows food items found in the stomachs of *S. aor* in different months. The relative contribution of the different items of food to the total is expressed as percentage frequency of occurrence (Fig. 2). Teleosts were recorded in all the months with peak in July 38.43% and June 34.66%, followed by February 33.29% and March 23.21%. The lowest quantity was found during May 18.89% followed by December 23.21%. In other months also fish and its remains was found in fairly good quantities. Among the teleosts the species encountered in the gut of *S. aor us* food items were *Salmostoma untrahi*, *Glossgobius giuris giuris*, *Osteobrama cotio cunma*, *Cyprinus carpio*, *Puntius species* and *Gonoproktopterus kolus*. A case of cannibalism was recorded during the months of January of 2003 and March of 2005, It is interesting to note that fish and fish larvae of Indian major carps which are formed a very low percentage in gut contents. Among fishes highest contribution was that of fish *Salmostoma untrahi* followed by *Puntius* species while, Indian major carps contributed the least. Insects formed the important item of the diet during January (29.11%) and November (28.01%) months. This group comprising mostly bottom dwelling forms and their larvae, was represented by the orders Trichoptera, mostly caddis worms; Diptera, mostly chironomus larvae; Ephemeroptera, only nymphs; Odonta, only dragon fly nymphs; Hemiptera, adult water bugs and water boatmen and Coleoptera, both adults and larvae. The frequency occurrence of prawns in the guts was high in April (16.33%) and May (14.98%) months. The lowest quantity was found during June (5.34%) followed by September (6.13%). They were represented by *Macrobrachium lamerrei.* Molluscs did not form an important food item for this fish. During the month of August (9.34%) and May (8.18%) their percentage was little higher compared to rest of the months. These were mainly represented by gastropods. Usually small gastropods of the genus Melanoides and Vivipara occurred. These gastropods were taken along with the shell, the flesh gets digested and the empty shells were excreted very often. Molluscan component was prevalent during March to April and September to October, low in monsoon months. Copepods and Rotifers along with Cladocerans were observed from August to November. *Cyclops* and *Moina* sp. were dominant in the diet of juveniles. Miscellaneous food items were recorded in all the months with peak abundance in September (27.40%). The lowest quantity was recorded during February (7.61%). Miscellaneous food items include fish scale, fish egg, spines and bones, crab remains, diatoms and unidentified matter. Semidigested matter formed a chief constituent of stomach contents throughout the year. This constituted about 10.65 to 20.19% during the period of study. Maximum quantities were found during September (20.19%) & minimum during July (10.65%). Other items like detritus, crab remains occurred rarely and did not contribute significantly to food. Sand, small pebbles which entered the stomachs incidentally were not considered to be the part of the food, since these were found always in association with other food items.

Feeding intensity

The stomach of fishes collected for the study of food and feeding habits were classified depending on their quantity of the food in the gut of the fish and their relative fullness into gorged, full, 3/4 full, 1/2 full, 1/3 full, 1/4 full, and empty. Fishes with stomachs of gorged, full, 3/4 full, 1/2 full were considered to be actively fed, where as those with 1/3 full, 1/4 full were considered as poorly fed. Data on the

percentage occurrence of these categories are presented in Table 2 and Fig. 3.

The proportion of fishes which had actively fed was highest in June (88.52%) to August (78.16%) and again during January (80.74%) to March (82.86%). Poor feeding was noticed in September (62.58%). The percentage of empty stomachs was highest in September (37.42%) and May (35.78%). The lowest was in June (I 1.48%) and July (14.96%).

Table 1: Percentage frequency occurrence of different food items off. *S aor* in different months

Food Items	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Fishes	34.66	38.43	26.14	21.24	24.63	29.71	23.21	32.9	33.29	30.14	24.16	18.9
Insects	18.16	I 6.21	19.39	17.48	23.81	28.01	20.17	29.11	25.34	22.16	22.44	24.28
Prawns	11.24	10.09	8.21	6.13	7.14	11.33	9.66	5.34	7.08	6.81	16.33	14.98
Molluscans	6.09	7.12	9.34	6.26	6.69	5.19	8.08	5.80	7.98	4.64	6.88	8.18
Semidigested matter	13.12	10.65	16.28	20.19	18.10	16.42	19.53	14.39	17	21.12	14.55	19.86
Miscellaneous matter	14.21	16.36	17.68	27.46	18.25	8.25	18.36	11.12	7.61	12.39	14.63	11.43
Unidentified matter	2.52	1.14	2.96	1.24	1.38	1.09	0.99	1.34	1.7	2.74	1.01	2.37

Table 2: Seasonal percentage variation in various degrees of fullness of stomach *of S. aor*

Condition of Stomach												
	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Gorged	3.12	2.94	1.08	0.00	0.00	0.62	0.81	1.91	1.76	2.08	1.14	0.79
Full	12.86	13.08	11.79	1.92	0.00	1.98	1.36	4.73	5.11	10.21	7.63	4.06
3/4 Full	19.21	18.91	12.72	2.36	2.84	4.72	9.43	14.19	12.59	17.16	4.39	6.91
1/2 Full	28.26	24.39	22.98	9.23	8.91	14.15	18.59	24.47	36.64	39.81	19.09	15.34
1/3 Full	17.98	13.76	8.69	17.93	20.64	20.12	34.16	26.52	20.09	13.60	28.73	15.92
1/4 Full	7.09	11.96	17.90	31.14	34.43	28.12	14.29	8.92	5.33	0.00	12.11	21.20
Empty	11.48	14.96	24.84	37.42	33.18	30.29	21.36	19.26	18.48	17.14	26.91	35.78

Seasonal changes in Feeding Intensity

The number of fish with food in the stomach to total number examined suggests that majority of the specimens were found feeding during the period of study (Table 2 and Fig. 3). The intensity of feeding as recorded from the quantity of food in the stomach showed seasonal change. Highest feeding intensity was recorded during June, July and August. Relatively low occurrence of feeding intensity of large number of individuals was recorded from September to November. Studies on the food of the fishes in reservoir ecosystem are essential to understand the food preference of various fishes as well as to estimate the extent of utilization of various food resources. Such studies would help in detecting the uncovered niches which help in turn to formulate stocking policy of the reservoir. There was considerable variation in the food and feeding habits of the same species in different ecosystems (Nikolsky, 1963) [7]. In the same ecosystem they are known to vary in time and space. Usually feeding habits of fishes may vary in accordance with locality, season, age and sex. Considerable work has been carried out on the food of catfishes *viz*., *Mystus bleeker* by Mirza and Ahamad (1981); *Mystus nemurus* by Khan *et al* (1988) [5]; *Mystus Keletius, Mystus gulio* and *Mystus cavasius* by Rao *et al*. (1997) [9]; *Glyptothorax madraspatnum* by Dobriyal and Negi (1998) [2]; *Pseudecheneis sulcatus* by Anju Thapliyal *et al*. (2004) [1]; *Wallgo attu* by Shilpa and Devendra (2006) [13].

A critical examination of the data on the food and feeding habits clearly showed that the Principle food of *S. aor* in Bhadra reservoir consist of trash fishes which was abundant in the reservoir. Juveniles of commercial carps were very negligible in the guts. Cannibalism seems to occur in *S. aor* though occasionally and such observations were also made in Ganga system by Saigal (1964) [12]. The fish seems to depend on insects next to trash fish. However molluscs form an important food only during in certain periods. The molluscs were simply swallowed with the shells by this fish and the flesh gets digested and the empty shells are Excreted. Nikolsky (1963) [7] stated that the species feeding on a variety of food are called euryphagic, those feeding on a few selected types of food are stenophagic and those which feed on single type of food are called monophagic. It was quite evident from the present study of food and feeding habits of *S. aor* is an euryphagic one. The feeding habits of *S. aor* from natural habitats like Ganga system and in impoundment like Bhadra reservoir are much similar with predominance of trash fishes. The species seems to be Probe the bottom and feed on species living at the bottom as evidenced in the predominant occur of *Salmostoma untrahi, Glossgobius giuris giuris, Osteobrama cotio cunma, dipteran larvae* and odonate nymphs. The negligible contents of carp juveniles in the stomach probably suggests that the species is non inimical to carp fishery and well suited for propagation in reservoirs. The feeding habits of the fish has a very close correction with the mouth and jaws. The size of the mouth limits the food and form of jaws controls the feeding habit to a certain extent. The fish in the present study has a mouth with wide opening. The wide mouth helps in engulfing the prey easily. In these Fishes jaws are of unequal lengths. It is well known fact that the shape and nature of the teeth could be correlated with the type of diet. These fishes have teeth which are arranged in a continuous semi lunar band across the plate which thus prevent escape of prey from the mouth. The barbels are important in detecting the food. It has been considered that animals with long intestine are herbivorous in their feeding habits and those with short intestine are generally carnivorous. However a vast majority of the fishes are omnivorous in their feeding habits. S. aor is carnivorous in its feeding habits having a short intestine with greater complexity of mucosal Foldings, which may compensate for this shortness of the intestine. The stomach is well developed in these fishes. The cardiac region of the stomach along with pyloric region forms 'J' shape in these fishes.

Predacious fishes usually have larger and conspicuous stomach. This type of stomach has thick walls. The wall of the stomach becomes stretched to a thinner degree when large quantity of the food present in the stomach during the period of intensive feeding. The alimentary system of fishes is constructed in accordance with their phylogeny on one hand and much depending on the food and feeding habits on the other. Thus the relationship between the digestive system and feeding habits exists in so far as the phylogeny of its possessor allows its modification and differentiation for the adoption of the feeding. The fishes in the present study are carnivorous in their feeding habits and the digestive system has been suitably constructed for their mode of living. Yousuf *et al*. (2003) [15] while studied the food habits of carnivorous fish, *Glyptosternon reticulatum*, found that the fish mainly feeds on benthic insects with Ephemeroptera forming 48.09% of the diet, followed by Trichoptera and Diptera contributing 35% and 16.86% respectively. A comparative study on the food habits of four species of *Mystus viz*., *Mystus keletius*, *Mystus gulio*, *Mystus cavasius* and *Mystus vittus* by Rao *et al*. (1997) [9] observed that *M. keletius*, M. cavasius and M. vittus feed mainly organisms like chironomid larvae and crustacean larvae, whereas, *M. gulio* feed mostly on small shrimps. Shilpa and Devendra (2006) [13] while working on food of *Wallago atto* and *Heteropneustes fossilis f*ound that they were completely carnivorous fed on crustaceans, rotifers, insects and their larvae, fiy and fingerlings, molluscs and shrimps.

Ramesh and Kiran (2016) [10] studied the food and feeding habits of cat fish, *Clarias batrachus*. They reported that gut content of *Clarias batrachus* consisted of zooplankton, insect larvae, fish larvae, small shrimps and organic debris. In all the months, insect larvae was dominated. The feeding intensity was poorer from pre-spawning and spawning Period but re

Conclusion

The stomach content analysis and relative length of alimentary canal is short and the studied species is carnivorous one. Variation in food items and percentage composition of different food items in the *S.aor* stomach related to fish feeding habit. Fishes with empty stomach was observed in all the months of the year. Therefore, Bhadra reservoir provides abundance food items that was consumed by the catfish and it is one of the significant areas of natural habitat for fresh water fishes.

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