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THE DIET OF CLOWN KNIFE FISH *CHITALA CHITALA* (HAMILTON – BUCHANAN) AN ENDANGERED NOTOPTERID FROM DIFFERENT WILD POPULATION (INDIA)

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Abstract: A stomach content analysis of an endangered clownknife fish *Chitala chitala* (Hamilton - Buchanan) from different wild population indicated that this species was primarily a predatory and carnivorous in nature, indicating differences in the diet in different wild populations. An increase in feeding activity was observed from February to May (premonsoon) which was reduced during June to September (monsoon) coinciding with the spawning season of this species in most of the sites . The study confirmed relatively unspecialized diet composition of *C. chitala* with ability to withstand in respect to availability of food items in different aquatic habitat. The paper provides basic information on feeding index, index of preponderance, trophic ecology, and feeding strategies which could be useful for stock enhancement and aquaculture of this new potential candidate species.

Key Words: feeding behaviour; diet, *Chitala chitala*; wild population; aquaculture; India
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Introduction

The clown knife fish *C. chitala* (Hamilton – Buchanan) known locally as “moye” or “fulli” is one of the most important notopteroid in India, commands high market demand and has been prioritized as a new candidate species (Ponniah & Sarkar 2000; Ayyappan *et al*., 2001) for aquaculture. However, over exploitation, habitat degradation, pollution and related anthropogenic pressure on their natural habitats, have considerably reduced the population of this species by 50-60% during the last decades and has been listed as “endangered” (CAMP 1998). The distribution of *C. chitala* is currently restricted to river Ganga basin, Yamuna, Brahamputra, Mahanadi, Kalindi and east and west river coast of India,. The species is highly priced, cultivable and due to its high demand and popularity it has been declared as a “State Fish” of Uttar Pradesh, India. The successful captive breeding and larval rearing of this fish have been reported by Sarkar et al. (2006).

The success of effort to introduce and cultivate any new species, however, will depend on quantitative information about the food and feeding habit, nutritional requirements and trophic ecology of this species. Therefore, a study of food and feeding habits of fishes is very important in any fisheries management programme. Review of literature indicates absence of information on the diet of this fish. Though studies on the some biological aspect of other commercial freshwater fishes had started much earlier in India (Mookherjee & Mazumdar 1950; Chacko & Kuriyan 1949; Alikunhi 1957; Natrajan & Jhingran 1963 and Kamal 1964), but recent studies on the life history traits of species with high conservation significance from different natural stocks are very scanty(Sreeraj et al 2006; Sarkar et al 2008). The objective of this were to describe

the feeding habit, feeding intensity, diet preference, food requirement from different populations, evaluating possible effect of season, area of capture on stomach content.

Material and Methods

The study was conducted in different riverine populations and details of the location of fish collection sites of *C. chitala* is shown in figure 1.and table 1. The specimens of *C. chitala* were sampled using various fishing methods, drag nets, cast nets, gill nets of different mesh size and the collections were made during 2000 to 2005.Because of "endangered" status of *C. chitala*, collection of fish was restricted to specimen caught by local fishermen and available at landing centers and markets located along the banks of the river. Fish were collected fresh, preserved in ice and transported to laboratory. The total length (*TL*) measured to the nearest 0.1mm by digital caliper and weights were taken by electronic balance. Altogether 250 specimens ranging from 50 cm to 90 cm in length were collected and studied.

The fish were dissected and stomach of each weighted to the nearest 1 g. Those stomachs containing intact and whole prey matters were opened immediately and the prey identified, measured and the individual masses of each recorded. The weighed stomachs were then preserved in 10% formalin until a more detailed study was undertaken. The gut content was examined under a steriozoom microscope (x10) and all the food items were identified. The percentage volume of major gut items were counted weighted and measured. The percentage volume of major gut items was estimated by using the point method of Pillay (1953), whereby contents of each stomach samples were as unity and the items were expressed as percentage volume by visual inspection. The percentage occurrence of food item was analyzed by the method of Hynes (1950). To estimate the dominant food items, results of the percentage occurrence and point method were combined to yield the index of preponderance *(I)* proposed by Natrajan & Jhingran (1963): $I = V_1O_1/ (\sum V_1O_1)$, where V_1 = volume of the particular food items, O_1 = occurrence of the particular food items, I = relative abundance of food items (mean %). The feeding activity was expressed as feeding index ascertained in the percentage of fullness of stomach.

Feeding Index = $P \times 100/ X \times N$, where P= total point of the gut that were examined, N= No. of guts examined, X= total points allotted to the full gut. The food items collected from full guts of live fishes were used for counting food components.

The gastrosomatic index (GI) was determined as the ratio of the gut weight to the body weight.

$GI = GW \times 100/ BW$, where GW= gut weight in gram, BW= body weight in gram. Seasonal sampling were carried out and samples were collected accordingly during premonsoon (February- May), Monsoon (June – September) and post monsoon (October - January) for measuring GI of fish.

Results

The alimentary canal of *C. chitala* is short, muscular, bag shaped and somewhat less coiled.. As shown in figures 2 & 3 the preferred diets were crustaceans, insects, mollusks, minnows and fishes. Although there were some differences in the diet composition of *C. chitala* among length groups studied, some level of variations between different populations of the different food items were also observed. The presence of detritus and molluscans remains in the gut also indicated a possible benthic feeding activity of *C. chitala*. Mud and sand particles were encountered sporadically in the gut contents. Overall, the diet preferences of *C. chitala* from different population were similar to those of air breathing fishes.

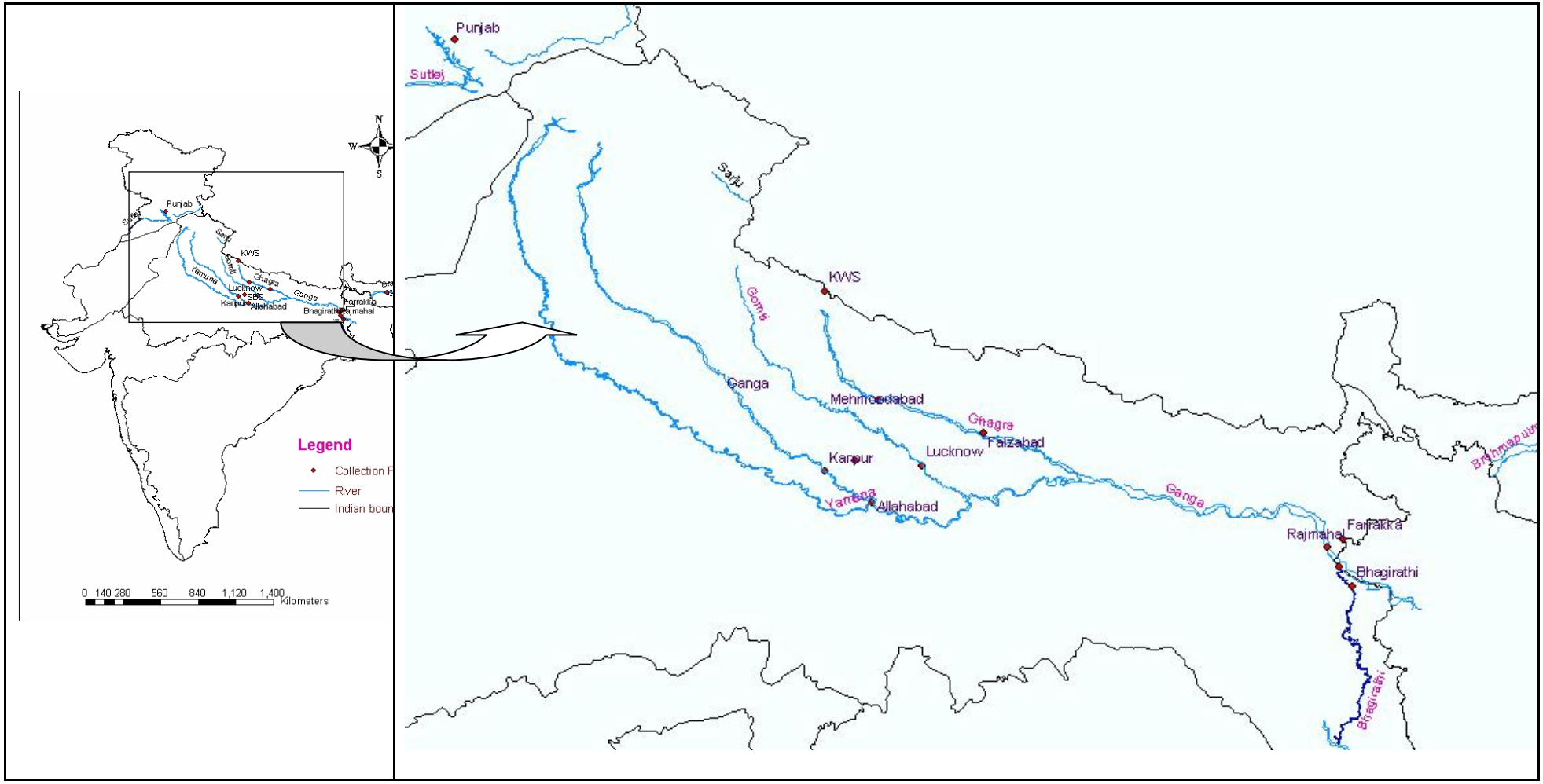

Figure- 1: Fish sample collection sites from different geographical locations of India.

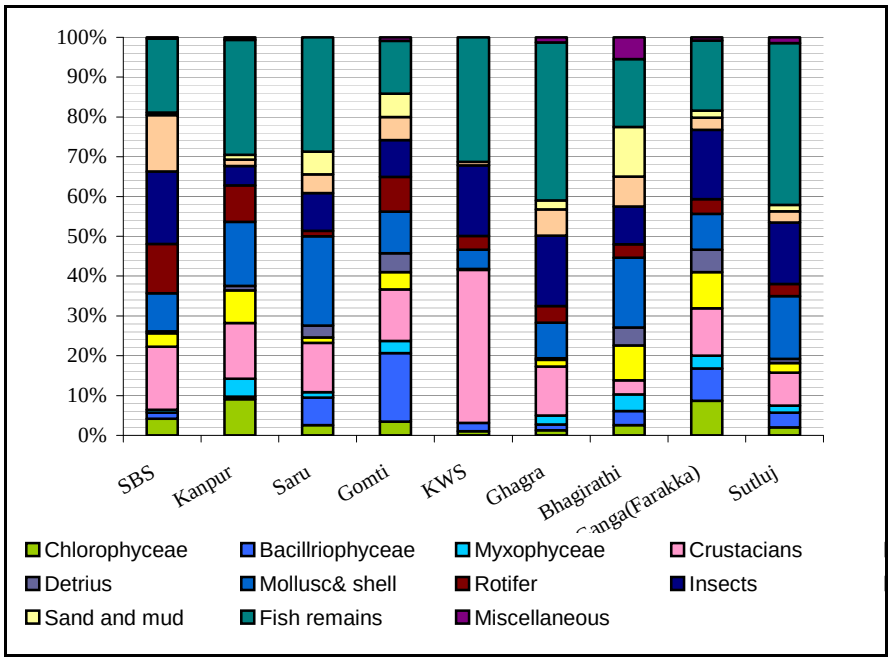

Figure 2. Index of preponderance of *C. chitala* from different locations. SBS: Samaspur bird sanctuary; KWS: Katerniaghat wildlife sanctuary.

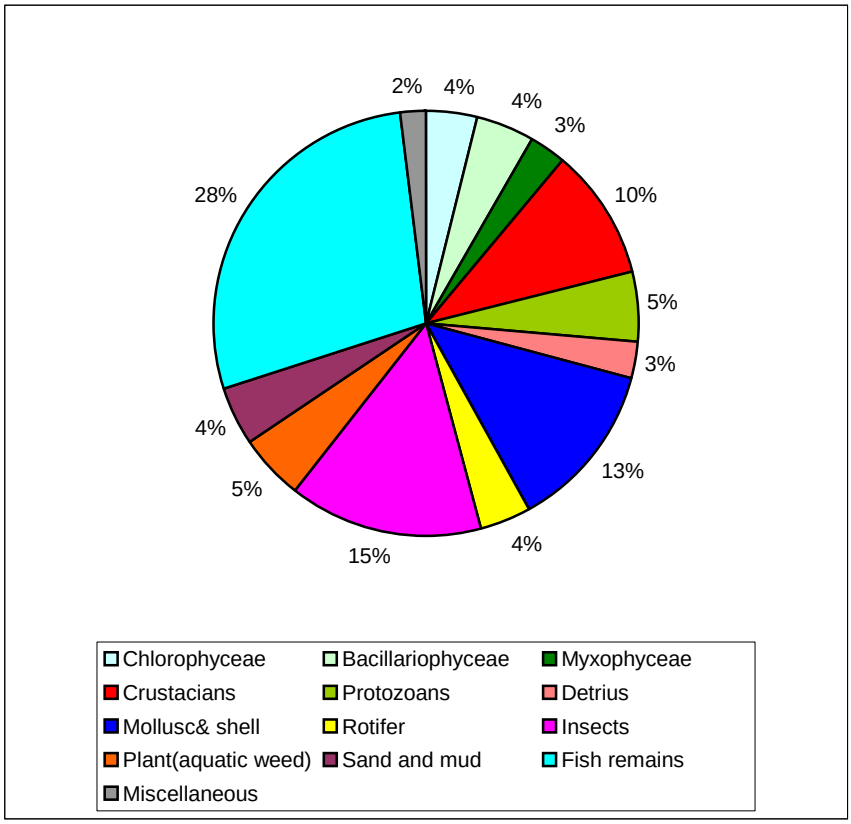

Figure 3. Percentage of food component of *C. chitala.* SBS: Samaspur bird sanctuary; KWS: Katerniaghat wildlife sanctuary.

Table 1. Latitudes and longitudes of different geographical locations of the sampling sites obtained by Global Positioning System

Sl no.	Riverine /Locations	State	Latitude	Longitude
1	Ganga (Farakka)	West Bengal	24. 53^0N	88.10^0E
2	Bhagirathi	West Bengal	24.05^0 N	88.06^0E
3	Ganga	Uttar Pradesh	25.82^0N	81. 26^0E
4	Ghagra	Uttar Pradesh	26.75^ON	81.99 ^{0}E
5	Gomti	Uttar Pradesh	25. 90 ^{0}N	82.56 ^{0}E
6	Samaspur Bird Sanctuary (SBS)	Uttar Pradesh	25. 97^0N	81.67^0E
7	Gerua (Katerniaght Wildlife Sanctuary)	Uttar Pradesh	28.21^0N	81.25^0E
8	Saryu	Uttar Pradesh	26.33^0N	832.37^0E
9	Sutluj	Punjab	31.09^0N	74.56^0E

The fish and prawn was most preferred food items from all the locations except river Bhagirathi where the fish preferred mostly molluscs and shell than the fish remains. Small fishes (2-3 mm) were present in semi-digested and completely digested state and in some stomach samples only vertebral column was encountered in the gut, however, occurrence of fish in the gut was not seasonal. The presence of maximum percentage of fish in stomach was noticed from river Satluj(40.65%) followed by river Ghagra (39.67%), river Gerua (31.20%), river Ganga (20.05%). Crustaceans are the second most preferred food items and among them, Copepods and Cladocerons were common in almost all the populations. The maximum percentage of crustaceans were recorded from river Gerua (38.39%) followed by SBS (15.86%), river Ganga at Kanpur (14.14%), Ganga at Faraka (12.98%), river Gomti (12.92%) and least 3.5% from river Bhagirathi. Insect was the third main dominant group of food items represented by Notonecta (back swimmer), and dragon fly nymph, *Sigara atropodonta* in all the locations. Notonecta were present throughout the year where as dragon fly nymph occurred during the monsoon. *Sigara atropodonta* and *beetals* occur only during summer season. The maximum (18.25%) insects were recorded in the samples collected from SBS, followed by river Ganga (19.12%) at Farakka, river Ghagra (17.71%), river Gerua (17.17%), river Satluj (15.38%), while minimum (4.95%) was recorded from river Ganga at Kanpur. Molluscs were the fourth most preferred food items and gut analysis showed that the amount of molluscan shell were present in all the locations as shown in figure 2. Maximum per-

centage of protozoans were recorded in the samples of river Ganga at Farakka (10.00%) followed by Ganga at Kanpur (8.20%), river Bhagirathi (8.8%), and minimum at river Gerua (0.23%). The dominantspecies of the protozoans were *Chaenia, Spirostomum, Gonium, Acanthocystic* and *Tokophyra*. Maximum percentage of detritus were recorded in the samples of river Ganga at Farakka (6.14%) followed by river Gomti (4.77%), river Bhagirathi (4.5%). It was observed that Rotifers were the preferred food component among the juvenile as well as in adult. Maximum percentage of rotifers were recorded from SBS (12.32%) followed by river Ganga(9.17%), at Kanpur, river Gomti (8.79%) and river Ghagra (4.17%). The representative group of rotifers was *Brachionus, Lecane, Monostyla, Keretella, Notholca.*

Among plant matters, mainly aquatic weeds represented the diet only during post spawning season. Maximum(14.16%) percentage were recorded from the samples of SBS, followed by river Bhagirathi (7.5%), river Ghagra (6.57%),river Gomti (5.80%) and river Saryu (4.77%). Aquatic weed like *Hydrilla, Chara, Najas* and portion of unidentified leaves and roots were also observed.

The represented genera of Chlorophyceae recorded from the gut analysis of *C. chitala* were *Ulothrix, Spirogyra, Zygnema, Mogeotia, Protoccocus, Ankistrodesmus, Microspora, Pediastrum* etc. This was the least preferred food items except stomach samples of river Ganga at Farakka (9.47%).The Bacillaryophycean was recorded from the gut contents of fishes collected from all the locations throughout the year. The representative genera mainly were *Synedra, diatoma, Navicula, Cymbella, Frustulia, Fragillaria, Gomphonema, Nitzschia,* etc. Blue green algae was a least preferred food items and *Anabaena, Oscillatoria, Rivularia, Microcystis, Lyngbaea, Spirulina,* and *Cymbella* were some of the common genera. Sand and mud were observed only during monsoon/breeding season with less percentage and maximum percentage was found in river Bhagirathi (12.5%) followed by river Gomti (5.92%). Among miscellaneous items, fish scale, rice husk, unidentified zooplankton and phytoplankton, cyst shells, fish eggs etc. These items were present in a very small quantity of the gut content through out year from all the locations.

Gut fullness, Feeding index and Gastrosomatic Index

The percentage of full gut, half full gut, empty guts and feeding index are presented in figure 4, respectively. In the present study maximum percentage of full guts was found in the samples of river Saryu with feeding index 83.3 while minimum from the samples of river Gerua (feeding index 40.3). The high feeding index (85.71) of *C. chitala* was found from river Gomti where as low feeding index (40.3) from river Gerua. An increase in feeding activity was observed in *C. chitala* from February to May (premonsoon) 1.6 with a reduced during June to September (monsoon) which coincides with the spawning season of this species in all the locations. Greater the fullness of stomach, higher the feeding index. In this study a maximum value for the fullness of gut was recorded from the stomach samples of river Saryu (75%). However, in case of stomachs of *C. chitala* from river Bhagirathi showed 57.5% full guts with feeding index 71.05. In river Ghagra samples fullness of gut was 65% and feeding index ratio was 75. The minimum fullness of gut was observed from river Gerua where fullness of gut was only 40% with feeding index 40.3.

The analysis of gastrosomatic indices (GI) indicated variation over the sites and seasons. The maximum *GI* was recorded from river Ganga at Kanpur (3.3 ± 0.70) followed by river Bhagirathi (3.21 ±1.11), river Ganga at Farakka (3.05 ± 0.95), river Saryu (2.9 ± 0.20), river Gomti (2.6 ± 1.44), river Gerua(2.13 ± 0.76), SBS (1.94±0.39) and river Ghagra (1.6 ± 0.80). The minimum *GI* was recorded from river Satluj (1.3 ±0.37). It was observed that GI was maximum during premonsoon (1.66) followed by postmonsoon (0.83) and mon soon (0.45) indicating high feeding activity during premonsoon months.

Table 2. Gastrosomatic Index (% of body wieght) of *C. chitala* from different location. SBS; Samaspur bird sanctuary; KWS: Katerniaghat wldlife sanctuary.

Rivers/Locations	Premonsoon	Monsoon	Postmonsoon
SBS	0.97±0.1	0.45±0.05	0.52±0.08
Gerua(KWS)	1.10±0.8	0.35±0.08	0.68±0.07
Bhagirathi	1.30±0.09	0.71±0.08	1.20±0.8
Satluj	0.68±0.1	0.23±0.07	0.40±0.1
Gomti	1.40±0.08	0.37±0.04	0.83±0.4
Saryu	1.48±0.1	0.50±0.04	0.93±0.4
Ghagra	0.70±0.08	0.40±0.02	0.50±0.6
Ganga (Kanpur)	1.50±0.7	0.48±0.08	1.32±0.5
Ganga (Farakka)	1.33±0.3	0.62±0.04	1.10±0.5

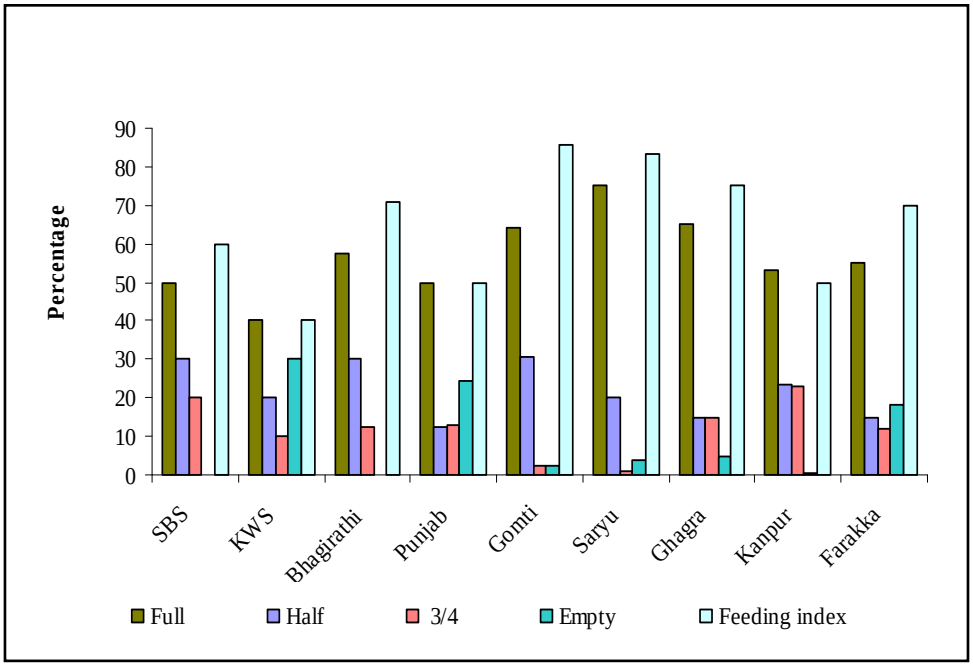

Figure 4. Feeding index of *C. chitala* from different locations. SBS: Samaspur bird sanctuary; KWS: Katerniaghat wildlife sanctuary.

Discussion

Though few preliminary reports are available on the morphology of alimentary and feeding behavior of *C. chitala* (Alikunhi 1957, Sharma & Chandi 1961, Das & Moitra 1963, Agarwal & Tyagi 1969) from India, this is the first report on the spectrum of diets and feeding habit from different populations. After gross analysis it was found that in a broad sense, the species is omnivorous, however the gut content analysis shows that the species is more carnivores. Analysis of stomach indicated that the fish is basically a predatory, carnivores and relatively unspecialized with flexible food habitat. In many of the cases, the gut contents could not be identified to species due to partial digestionThe high incidences of crustaceans and fishes in the stomach content of *C. chitala* may be related to the differential digestion of specific food particles. Crustaceans and fish remains, particularly bones and scales resist digestion and tend to be over represented in gut content analysis. The incidence of crustaceans, molluscs and fish parts in the guts of *C. chitala* in present study may be a reflection of variation in digestion rates of food particles. Crustaceans with chitinous exoskeletons are reported to be identifiable in fish guts over a longer period compared to many other food items (Wootton, 1990). Choudhary & Singh (2005) reported adult crustaceans, insects and a number of small fishes in the stomach of catfish *Wallago attu*. They also observed dominancy of crustaceans, insects, fry and fingerlings, mollusks and shrimps in the diet of *Heteropneustes fossilis* and *Channa punctatus*. Sreeraj et al. (2006) in another endangered cat fish *H. brachiosoma* reported high incidence of crustaceans in the diet analysis.

The results of the present study suggest that *C. chitala* is not so specialized in its feeding habit and capable of widening the food spectrum depending on the availability in the aquatic ecosystem. Modification in respect of alimentary canal concerning with the uptake of food, feeding digestion and absorption are fully suited for its carnivorous habit. According to Alikunhi, (1957) they changes there feeding habit completely at early stage and starts feeding voraciously on carp fry and aquatic insects. Chandy (1961) studied on the alimentary canal and feeding habit of *C. chitala* which is conformity with the present observation. Insects present in the samples of *C. chitala* from SBS may be due to lentic habitat and abundance of macro flora. This kind of feeding habit may be an optimal strategy for habitats where food sources are subject to seasonal fluctuations (Welcome 1979). The present results showed that maximum feeding intensity were during permonssoon and minimum during monsoon may be related to a decrease in food availability. In general, the diet preference of *C. chitala* as observed in this study was similar to those of catfishes (Thakur & Das 1986).

The present study indicated a tendency of fish to carnivores and omnivores(large variety of food items) and it can be defined as euryphagic fish (Nickolsky, 1963) Agrawal & Singh (1964) reported the large rectal caecum in the alimentary canal of its allied genus *N. notopterus* which is also a carnivores. Kulshrestra (1967) reported that presence of sence organ on the dorsal wall of the buccal cavity and presence of teeth on the jaw conformed that it may used for detecting presence of animal food and predatory behaviour of *C. chitala.* Occurrence of different types of food items in the gut of fish depends on their availability as mentioned by Parmeshwarn & Sinha (1966) while Das & Moitra (1963) reported plant matter up to 15 % and animal material up to 80% in the diet of *C. chitala*.

The observation made on the fullness of gut showed no full guts from any geographical locations. This might be due to competition between the other species or regurgitation during sampling. The analysis of feeding index showed maximum value in the samples of river Gomti and Saryu. The high feeding activity (85.71) of *C. chitala* was observed from river Gomti where as low feeding index (40.3) was recorded from river

Gerua which may be due to variation in habitat structure. The habitat of river Gerua is fast flowing river containing less abundance of natural food organism. The feeding intensity of fish is related to its stage of maturity, reproductive state and the availability of food items in the environment (Ricker 1956).

The ability of *C. chitala* to feed at different tropic levels, rapid growth, high conservation value, increasing consumer demand, ability to survive in confinement, makes this species a potential candidate species for freshwater aquaculture. Sarkar et al. (2006, 2007) reported good ability of early life stages of *C. chitala* to successfully weaned on to live, artificial and other non-conventional diets under experimental scale. The diversity and flexibility of food component in the diet observed in this study from different wild population indicates that the fish appears capable of widening the food spectrum in response to habitat availability. More studies are required on feeding strategies, diet preferences, and compatibility with other cultivable species during different life stages before adapting in to the culture system.

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