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Food and feeding habit of fishes in Kosi and Sharda Rivers of Uttarakhand

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Abstract
The knowledge of the food of fishes, their feeding behaviour and physiology of digestion is of great importance for planning modern fishery programmes. In view of this fact in mind, food and feeding habits of different fishes of Kosi and Sharda Rivers had been studied. According to Polling (1993), feeding habits of fish help to find out the ecological condition of fish, niche in the ecosystem and preferred food items. In the present investigation, the feeding habits of different fishes were observed and it was concluded that some fishes were herbivorous (*Glyptothorax pectinopterus*, *Garra gotyla*, *Schizothorax richardsonii*), some fishes were carnivorous (*Bagarius bagarius*, *Channa punctatus*), some were omnivorous (*Barilius barila*, *Botia almorhae*, *Puntius ticto*, *Xenentodon cancila*, *Tor putitora*, *Labeo dyocheilus*) and *Catla catla* was found to be zooplanktivorous.

Keywords: food of fishes, feeding behaviour, physiology of digestion

Introduction
The most important source of energy is food which plays an important role in determining the plenty of population, growth rate and condition of fishes. Feeding is a leading activity of many organisms through their whole life cycle and same is true with the fish also. The study of food and feeding habits of fishes have so many importances in fishery biology. Fish feed on a large range of food material and gain their nourishment from plant as well as from animals. Food and feeding habit of fish are significant biological factors for choosing a group of fish for culture in ponds to evade competition for food among themselves and live in group and to use all the existing food (Dewan and Saha, 1979) [10]. Studies on natural feeding of fish grant to identify the trophic relationships present in aquatic ecosystems, identifying composition of feeding, structure and constancy of food webs. Food and feeding habit of different fishes have been made by many researchers like Moffet and Hunt (1943) [21], Khan (1947) [19], Karim and Hossain (1972) [17], Doha (1974) [11], Dewan and Saha (1979) [10], Jhingran (1983) [16], Bhuiyan and Islam (1990) [4] and others. Food and feeding habits gives in sequence on seasonal changes of fish because the type and amount of food accessible as well as the season plays significant role in the fish (Akpan and Isangedhi, 2005) [2]. Fishes depending upon the variety of food items, which they consumed. Fishes are classified as stenophagic the fishes feeding on a few diverse types of food and euryphagic- who are feeding on a many types of food materials. Thus, generally many fishes fall under the group of euryphagic fishes. Fishes are also classified according to the feeding affinities in water bodies, where their specific food abounds.

Materials and Method
Study Area
Kosi River
The area under study is the basin of river Kosi, which pass through district Rampur, Uttar Pradesh. It is located between longitudes 78°54″ to 69°28″ E and latitude 28°25″ to 29°10″ N. It covers 2,367 Km2 areas. The people of this area work mainly in agriculture and industries in nearest places. The Kosi River water is used for agriculture, domestic use, and drinking purposes.

Sharda River
Tanakpur HEP (Hydroelectric Project) is a run of the river scheme on the Sharda River (Mahakali River in Nepal) located near the town of Tanakpur in the district of Champawat. It has a Barrage across the Sharda River for diverting river flows into a 6.2 km long power channel of 566 m³/s capacity for utilisation down stream of Banbassa Barrage. The project is designed to produce 460 million units of power on 90% availability.of 24 m head available between the Barrage at Tanakpur and the existing Sharda canal i.e. 0.6 km.

Food and feeding habit of fish species
Fish Collection
The specimens of fishes collected from both the rivers. Food and feeding habit of fishes were studied by examining the digestive tracts.

Fish Identification
Fish was identified by using keys of Talwar and Jhingran (1991) [31].

Preservation of Fishes
Fish samples preserved on buffered formalin (4%) and transported to the laboratory of department of Fisheries Resource Management for food analysis.

Dissection and Isolation of Stomach/Gut Contents
All the guts isolated from fish in the laboratory. The guts removed from the specimen and preserved in 5% formalin for further analysis. The preserved guts later uncoiled, cleaned off the attached fat.

Analysis of Stomach/Gut Contents

For estimation of gut contents the "Eye estimation method" (Pillay, 1952) [23] was followed. The food items particularly the plankton identified following the keys of Ward and Whipple (1959) [33].

Result and Discussion

Food and feeding habit of Kosi River fishes

Food and feeding habit of Kosi River fishes had been studied.

Labeo dyocheilus

In the stomach/gut content of *Labeo dyocheilus*, the total percentage of Green Algae (*Desmidium, Spirogyra, Volvox, Mougeotia sp., etc.*) and Diatoms (*Fragillaria, Navicula sp., Melosira etc.*) were observed to be 48.97% and 20.22 % respectively. The percentage of Sand and debris was found to be 26.22 % while the amount of Zooplankton (*Keratella sp. Cyclops etc.*), insect and Macrophytes were calculated as 2.60 % and 1.99 % respectively of the total food content. The primary food was 69.19 % (48.97% Green Algae and 20.22 % Diatoms) of the total food content. Secondary food (Sand and debris) was calculated as 26.22 %; while the occasional foods were Zooplankton along with insects and Macrophytes (4.59%). Thus *Labeo dyocheilus* was observed to be classified as a herbi-omnivorous fish. On the basis of straight mouth position, the fish was observed to be a column feeder. Das and Moitra (1963) [6] studied that in case of herbivorous the plant matter contains greater than 75 % of the average annual food.

Garra gotyla

Various kinds of Chlorophyceae and Bacillariophyceae were generally present throughout the study period. Chlorophyceae was found to be 36.92% in the gut contents of *Garra gotyla*. The next dominant group was Baccillariophyceae (35.15%) in the gut contents of the fish. The Cyanophyceae contributed a small part (15.53%) and sand/mud/detritus/unidentified organic matter (12.4%) was observed gut of the *Garra gotyla*. Similar observation had also been observed in the other species of *Garra by* Hora and Mukerji (1936) [15] in India. Dewan & Saha (1979) [10] reported that the low feeding activity of Tilapia in the months of February to June is related with fecundity of the water produced by heavy rain fall, whereas the immature fishes were found to vigorously feeding in all other months. Shinkafi *et al*. (2010) [29] studied on the food and feeding habits of different fishes.

Xenentodon cancila

Chlorophyceae 35.9%, Bacillariophyceae 9.3%, Cyanophyceae 11.70%, Zooplankton 26.86%, Insects part and worm 9.45% and miscellaneous items 6.79% was observed during the study period. The worms, aquatic insects, crustaceans, molluscans contributed to be in the maximum amount in the stomach/gut of fish. Thus, it may be concluded that the fish is omnivorous on the basis of above food items**.** The similar work on food and feeding habits had been described by Abbas (2010) [1], Arthi *et al*. (2011) [3]. Similar worked has been done on food and feeding habits of freshwater fish *Xenentodon cancila*, by Gupta and Banerjee (2014) [14].

Bagarius bagarius

Variations in percentage values of the stomach/gut contents of *Bagarius bagarius* is presented in Table12- and Figure-12. In the gut content of *Bagarius bagarius*, insects (15.6%), fish (39.5%), plant matter (2.3%), zooplankton (9.5%), molluscs (8.7%) and unidentified material (23.5%), were observed. In zooplankton *Brachionus sp.*, *Vorticella sp.* and *Spiristomum sp.* etc. were observed. Fish falls in carnivorous category. This result was agreed with Dewan & Saha (1979) [10] who reported that changed in food habit in *Tilapia nilotica* with changed in season. Agbabiaka (2012) studied on food and feeding habits and support the present finding.

Tor putitora

Among the phytoplankton groups, Chlorophyceae was the most dominant food group (35.98%), next to the group's viz. Bacillareophyceae (25.55%), Cyanophyceae (20.9%), Rotifera (10.9%), Crustacea (6.6%) which occupied the successive positions. Phytoplankton was the most important food item present in maximum amount in the gut content of this fish. Crustacean and Rotifera (*Keratella sp. and Brachionus sp.*) were found in a very less amount in the gut content of this fish. Keast (1968) [18] observed that many fishes changed their diet as they grow. Dasgupta (1990) [7] stated that the feeding intensity of *Tor* species increased with the increased in size.

C. punctatus

The results revealed that *C. punctatus* falls in the carnivorous category. *C. punctatus* was observed for fish (47.86%), insects (13.94%), mucks and unidentified material (9.14%), plant matter (8.25%), zooplankton (8.76%), annelids (7.97%) and molluscs (4.08%) (Fig-12).The surface feeders feed on surface plants and animals, the mid or column feeders feed on subsurface food organisms and the bottom feeders feed on mud and decaying substances and also bottom flora and fauna (Das & Moitra 1955) [5]. From the present study it can be inferred that from November to April the feeding habit of fish changed, the findings are similar with a change in seasons *C. punctatus* changes its food habit (Saxena and Saxena 1982) [28]. Dutta (1994) [12] analyzed the dominant food item of *C. punctatus* as fish and insects. Saikia (2012) [26] reported the similar observation in *Channa punctatus*.

Puntius ticto

On the basis of percentage numerical count it was observed that in the stomach content of *Puntius ticto*, phytoplankton was the first preference of the fish contributes 64.2% to the total food items. The percent composition of other groups included zooplankton (9.7%) and miscellaneous items (24.4%). The mean numerical percentage count of different groups were Chlorophyceae 19.4%, Bacillariophyceae 35.5%, Cyanophyceae 9.3%, Protozoa 2.1%, Rotifera 4.7%, Copepoda 2.9%, Crustaceans 0.2%, Molluscan 1.5%, and Miscellaneous items 24.4%. In *Puntius* percentage of phytoplankton was maximum and large animals like fishes and aquatic insect were not present in the stomach of fish so this fish was categorised as eury-omnivorous fish. Thomas (1969) [32] observed that low feeding activity may not be due to scarcity of food items but due to the fish spawning

season. Nandi and Saikia (2015) [22] worked on food and feeding habit of small freshwater fish species and supported the similar present findings.

Food and feeding habit of Sharda River fishes

Schizothorax richardsonii

The mean percentage composition reported were 67.29 % of Bacillariophyceae, 12.58% of Chlorophyceae, 11.73% of Cyanophyceae, 5.53% of detritus and 2.87% of sand. Due to its exclusive preference for phytoplankton, the fish in rivers were categorized as herbivorous which feed by scrapping the food from the gravel. Many earlier findings herbivorous feeding habit of *Schizothorax spp*. is in conformity (Mir, 1986) [20]. Similar worked supported by several workers, such as Gupta (2004) [13] observed food and feeding habit of freshwater fishes.

Garra gotyla

Various kinds of Chlorophyceae and Bacillariophyceae were generally present throughout the study period. Quantitatively Baccilariophyceae were found to be maximum (61.10%) in the gut contents. The next dominant group was Chlorophyceae (28.42%) in the gut contents of the fish. The Cyanophyceae contributed a small part (6.02%) and sand/mud/detritus/unidentified organic matter (4.46%) was observed in a good quantity in the gut of the fish.

Catla catla

The zooplankton (*Keratella sp., Brachionus sp. Cyclops, Diaptomus* etc.), formed the main items in the gut contents of the fish. Rotifers formed the main item of gut contents forming 25.7%. Copepods were next in the order of dominance forming 21.5% per cent in the gut content of *Catla-catla*. Bacillarophyceae (*Navicula sp., Synedra, Melosira, Nitzchia, Closterium sp*.) formed 13.5% of the gut contents. Chlorophyceae (*Pediastrum, Spirogyra, Scenedesmus*) formed 18.2% of the gut contents of *Catla-catla*. Aquatic insects formed 7.5% and miscellaneous items 4.8 %. Dewan *et al*. (1983) [9] reported maximum feeding activity of *Catla-catla* in middle size group and minimum feeding activity in small size group.

Barilius barila

On the basis of percentage count it was observed that in the stomach content, phytoplankton was the first preference of the fish contributes 64.4% to the total food items. The percent composition of other groups included zooplankton (20.6%), and miscellaneous items (15%). The percentage count of different groups was Chlorophyceae 21.4%, Bacillariophyceae 30.5%, Cyanophyceae 12.5%, Protozoa 8.5%, Rotifera 7.6%, Copepoda 4.5% and Miscellaneous items 15%. In *Barilius* percentage of phytoplankton was maximum and large animals like fishes and aquatic insect were not present in the stomach of fish so this fish categorised as omnivorous fish. Similarly, observation was reported by Sladeckova (1962) [30] in fish *Barilius bendelisis.* Zooplankton was scarcely seen in the gut of *Barilius bendelisis*.

Labeo dyocheilus

Labeo dyocheilus gut content showed a total percentage of Green Algae (*Pediastrum, Spirogyra, Scenedesmus, Volvox*) and Diatoms (*Fragillaria, Gomphonema, Navicula sp., Synedra*) were 45.5 % and 25 % respectively. The percentage of Sand and debris were found to be 23.5 % while the amount of Zooplankton (*Cyclops* and *Diaptomus),* insect and Macrophytes were recorded as 5.5 % and 1.5 % respectively of the total food content. Green Algae and Diatoms acted as the chief food for *Labeo dyocheilus* because their percentage contribution was highest. The monthly variation of Green Algae and Diatoms (primary food) showed that in gut it is highest in winter months. The primary food is 71% (45.5% Green Algae and 25% Diatoms) of the total food content. Secondary food (Sand and debris) was calculated as 22.5%. The fish was observed to be as a column feeder on the basis of straight mouth position. Desai (1970) [8] from Narbada River have shown that the species is herbi-omnivorous, feeding mainly on higher aquatic plants and filamentous algae and also subsists on molluscs and insects.

Tor putitora

During the study period, in *T. putitora,* algae (33.78%) and vegetable matter (29.65%) were considered as the basic food. Insects, unidentified animal matter, Crustacea and Gastropoda which altogether formed 28.37% of the gut content was the secondary food. Sand particles (8.20%) were regarded as an incidental item. Hora and Mukherji (1936) stated that Tor mahseer feeds preferably on water plants and algae.

Puntius ticto

In the stomach content of *Puntius ticto,* phytoplankton was the first preference of the fish contributes 55.9% to the total food items. The percent composition of other groups included zooplankton (15.6%) and miscellaneous items (28.5%). The mean numerical percentage count of different groups was Chlorophyceae 17.5%, Bacillariophyceae 29.5%, Cyanophyceae 8.9%, Protozoa 3.5%, Rotifera 8.7%, Copepoda 3.4% and Miscellaneous items 24.4%. In *Puntius ticto* percentage of phytoplankton was maximum and large animals like fishes and aquatic insect were not present in the stomach of fish so this fish was categorised as eury-omnivorous fish.

Botia almorhae

The percent composition of other groups included zooplankton (26.5 %), and miscellaneous items (13%).The mean numerical percentage count of different groups was Chlorophyceae 20.5%, Bacillariophyceae 28.5%, Cyanophyceae 11.5%, Zooplankton 26.5% and Miscellaneous items 13%. In *Puntius ticto,* percentage of phytoplankton was maximum and large animals like fishes and aquatic insect were not present in the stomach of fish so this fish was categorised as omnivorous fish.

Glytothorax pectinopterus

Glytothorax pectinopterus, gut content showed a total percentage of phytoplankton and zooplankton 51.5 % and 25 % respectively. The percentage of Insect was found to be 2.5 % and Sand and debris were found to be 19.5%. Phytoplankton acted as the chief food for *Glyptothorax pectinopterus* because their percentage contribution was highest. Thus the fish fell in hervivorus category.

Channa punctatus

Variations in percentage values of the stomach/gut content

of *Channa punctatus.* In the gut content of *C. punctatus,* insects (13%), fish (46.5%), unidentified material (23.5%), plant matter (7.5%), zooplankton (7%) and molluscs (3.5%) were observed**.** In zooplankton (*Brachionus sp.*, *Vorticella sp*., *Cyclop*, *Diaptomus*). Fish fell in carnivorous category. Plant matter formed the main item of gut contents forming maximum occurrence followed by aquatic insects. The dominant food item of *C. punctatus* was fish fingerlings and insects (Reddy & Rao 1993) [25]. Saxena (2001a) [27] worked on food spectrum during maturation of *Channa punctatus*.

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