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Determination of Physico-chemical water quality parameters along with food preferences in selected Fish Species collected from River Ravi, Punjab

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Abstract
The objectives behind the study was to understand the food preferences of the selected adult fish and the young ones, thereby providing information for culturing the preferred feeds under laboratory conditions for future studies and requirements. The various fish species samples were dissected and analyzed for collection of microorganisms. The quality as well as quantity of microorganism species were analyzed with the help of Sedgwick-Rafter counting Chamber. It was observed that the microorganisms were lower in number in the gut contents of fish samples collected from River Ravi due to higher levels of contamination of water at the particular site. It was reasoned on the basis of all analytical results that *Cirrhinus mrigala* was found herbivorous while *Channa punctatus* was mainly found carnivorous; however, *Oreochromis niloticus* and *Labeo boga* both were found to be omnivorous. The present study revealed that the water quality of River Ravi possesses pollutants to varying extents which poses a dangerous threat to both human and aquatic lives.

Keywords: feeding habits, fish species, microorganisms, river Ravi

1. Introduction
Food is any substance consumed to provide nutritional support for an organism. It is usually of plant or animal origin and contains essential nutrients [1-3]. The food is ingested by an organism and assimilated by the organism's cells to provide energy to maintain life or stimulate growth [4]. Fish are cold blooded gill-breathing, aquatic vertebrates with limbs represented by fins. These feed on a wide range of food material and obtain their nourishment from plants as well as animals [5]. The food and feeding habitats are related with the digestive system of the fishes. Mainly alimentary canal structure varies in different species of fishes and is generally adapted in relation to the food and feeding habits [6].

The diet of fish is classified on the basis of their feeding habits. The dietary habits of fish differ from one species to another and it is very difficult to come up with the detailed list of aquatic plants and animals on which they feed [7]. While some fish species are specifically herbivorous or carnivorous in nature feeding on either aquatic plants or animals, others are omnivorous in nature feeding on both. The first category of study examines the diet of a fish population with a view to assessing the species nutritional standing in the context of the fish community. Such a study may consider seasonal variation in the diet or dietary comparison either between different sub-groups of the same species or different species living in the same or comparable habitats. In both instances the aim may be to discern whether there is competition for food or not [8]. This category also includes studies which monitor the feeding intensity of a fish population throughout the day to discern the dial rhythm or feeding periodicity [9]. The second category is concerned with studies which attempt to estimate the total amount of food consumed by a fish population [10].

A study of the food and feeding habits of fish is very important in any fisheries research programme since food is prerequisite for all forms of life. The objective behind this study was to understand the food preferences of the selected fish, there by culturing the preferred food under laboratory conditions for future research programmes [11]. In this research, food preferences of the selected Fish Fauna of River Ravi was examined and gut contents of these species were analyzed and compared.

2. Materials and Methods

2.1 Sampling Station

Four fish species namely *Labeo boga*, *Cirrhinus mrigala*, *Channa punctate* and *Oreochromis niloticus* were selected for this study. The selected fish species in triplicates were collected from Head Balloki site, River Ravi (Fig 1) with the help of fisherman from Fisheries Department using Cast nets during the months of May and June, 2018. Fish specimens were preserved in crushed ice in the iceboxes immediately after these were caught. These were transported to the Fisheries Research and Training Institute, Complex Manawan, Lahore and were preserved immediately in deep freezer having a temperature below -20 ℃ to prevent any digestion due to enzymatic activity in digestive system.

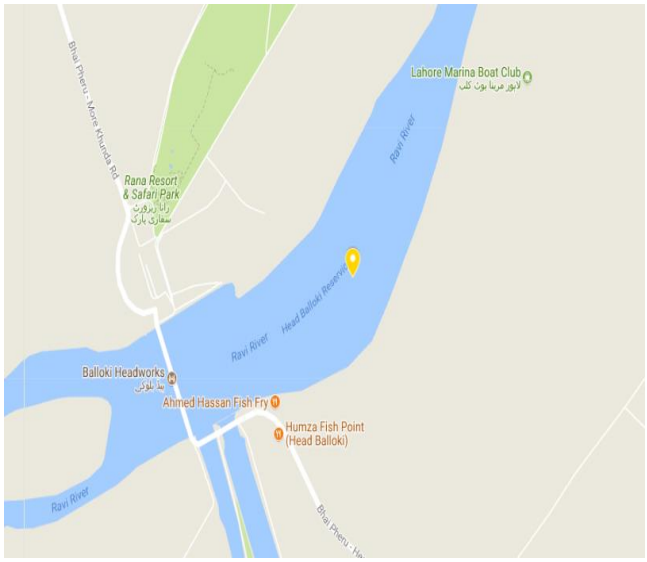


Fig 1: GPS Map of Head Balloki, River Ravi

2.2 Gut Procedure

Each fish was dissected, gut contents were removed and preserved in 4% formalin for future analysis following Prescott, 1978 [12].

2.3 Planktons Count Analysis

The suspension sample was stirred gently and one ml sample was set on the Sedgwick-Rafter for counting organisms. The planktons were counted and were identified by keys given by Ward & Whipple (1959) [13] and Atlas of Fresh Water Biota in China: Fang (1995) [14]. The planktons were calculated by the following formula [15].

Number of plankton per ml = Number of organisms counted/Number of replicates taken.

2.4 Selected Fish Species

The taxonomic position, etymology, environment / climate / range, distribution, maximum length and biology of the selected fish species have been described as follows:

2.4.1: *Labeo boga* [16]

Taxonomic position: Actinopterygii (ray-finned fishes) > Cypriniformes (Carps) > Cyprinidae (Minnows or Carps) > Labeoninae

Etymology: Labeo: Latin, labeo=one who has large lips.

Environment/Climate/Range: Fresh water, benthopelagic, potamodromous.

Distribution: Asia: Pakistan, India, Bangladesh, Nepal and Myanmar.

Max length: 30.0 cm.

Biology: Inhabits large rivers and their tributaries, above tidal influence. Spawns in flooded rivers.

2.4.2: *Cirrhinus mrigala* [17, 18]

Taxonomic position: Actinopterygii (ray-finned fishes) > Cypriniformes (Carps) > Cyprinidae (Minnows or Carps) > Labeoninae

Etymology: Cirrhinus: Latin, cirrus=Curl fringe.

Environment/Climate/Range: Fresh water, Demersal, Tropical.

Distribution: Asia: Pakistan, India, Nepal and Bangladesh. Introduced into Peninsular India.

Max length: 99.0 cm

2.4.3: *Channa punctate* [19, 20]

Taxonomic position: Actinopterygii (ray-finned fishes) > Perciformes (Perch-likes) > Channidae (snakeheads).

Etymology: Channa; Greek, channe-es=an anchovy.

Environment/Climate/Range: Fresh water; brackish; benthopelagic; potamodromous. Tropical; 22 °C – 28 °C

Distribution: Asia: Afghanistan, Pakistan, India, Sri lanka, Nepal, Bangladesh, Myanmer and Yunnan in China.

Max length: 31.0 cm

Biology: Found in ponds, swamps, brackish water, ditches and beels. Feed on worms, insects and small fish. Accept chopped fish and shrimp in the aquarium. Breed throughout the year.

2.4.4: *Oreochromis niloticus* [21-25]

Taxonomic position: Actinopterygii (ray-finned fishes) > Perciformes (perch-likes) > Cichlidae (Cichlids) > Pseudocrenilaabrinae.

Etymology: Oreochromis; Latin,aurum=gold+Greek, chromis=a fish,perhaps a perch; niloticus "Filhoa"=the Amharic word for "hot spring".

Environment/Climate/Range Freshwater, brackish, benhopelagic, potamodromous, depth range 0-20m; Tropical 14°C – 33°C; 32°N – 5°S, 17°W – 38°E

3. Distribution

Africa: naturally occurring in coastal rivers of Israel, Nile basin (including Lake Albert, Edward and Tana), Jebel Marra,

Lake Kivu, Lake Tanganyika, Awash River, various Ethiopian lakes, Omo River system, Lake Turkana, Suguta River and Lake Baringo. In West Africa natural distribution covers the basins of the Senegal, Gambia, Volta, Niger, Benue and Chad, with introduced specimens reported from various coastal basins. Widely introduced for aquaculture, with many existing strains. Several countries report adverse ecological impact after introduction.

Max length: 60.0 cm.
Biology: Occur in a wide variety of freshwater habitats like rivers, lakes, sewage canals and irrigation channels. Does not do well in pure salt water, but is able to survive in brackish water. Mainly diurnal. Feeds mainly on phytoplankton or benthic algae. Additionally, insect larvae are of some importance, as are aufwuchs and detritus; juveniles tend to be more omnivorous than adults. Oviparous. Ovophilic, maternal mouth brooder. Extended temperature ranges 8-42 °C, natural temperature range 13.5-33 °C.

4. Results and Discussion

4.1 Details of Selected Fish spp.

The common and scientific names of selected fish samples along with their body & gut weight and body & gut length measurements are provided in Table 1.

Table 1: Weight and Length Measurements of selected Fish Samples

Sr. No.	Common Name of Fishes	Scientific names of Fishes	Length of Fishes	Weight of Fishes	Length of gut	Weight of gut	Ratio of intestine to total length of fish	Fish girth
			cm±SD	g± SD	cm± SD	g± SD		cm± SD
1	Bhangan	*Labeo boga*	28.0±1.40	210.9±10.54	297.0±13.72	11.20±0.56	10.60±0.53	14.0±0.80
2	Mori	*Cirrhinus mrigala*	29.0±1.51	299.7±14.98	413.0±20.70	8.62±0.43	14.20±0.71	13.0±0.65
3	Daula	*Channa punctata*	24.3±1.21	155.8±7.81	17.0±0.85	6.45±0.32	0.69±0.03	14.0±0.70
4	Chirra	*Oreochromis niloticus*	19.0±0.95	149.5±7.47	93.0±4.65	5.90±0.29	4.90±0.24	17.0±0.91

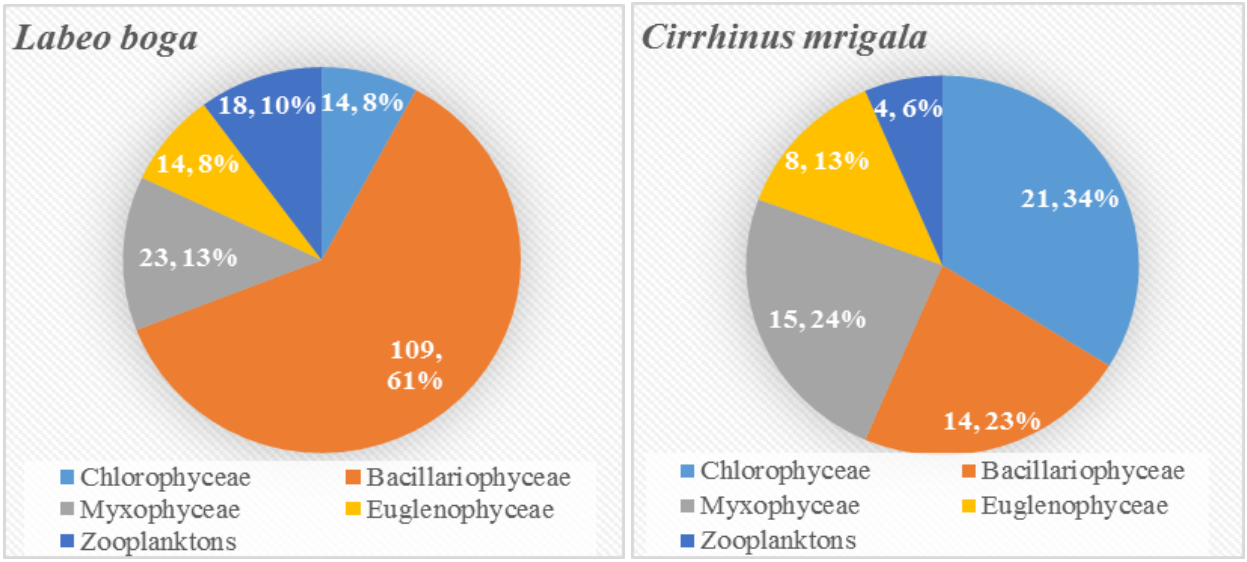
1.2 Types of Planktonic Life

The total quantity and types of planktonic life observed have been recorded in Table 2 while Fig 1 gives the comparative detail of planktonic life found in each fish species. Fig 2-5 presents the type and number of food items observed in gut contents of *Labeo boga*, *Channa punctate*, *Cirrhinus mrigala* and *Oreochromis niloticus* collected from river Ravi. Fig 6 provides a comparative account of planktonic life found in each planktonic family with respect to each fish species while Fig 7 provides a comparative account of planktonic life vice versa.

Table 2: Total Number of Planktonic Life found in selected Fish Samples

Sr. No.	Type of Families observed (Phytoplankton & Zooplanktons)	Total No. of organisms observed± SD			
		Labeo boga	***Cirrhinus mrigala***	***Channa punctata***	***Oreochromis niloticus***
1.	Chlorophyceae	14±0.84	21±1.26	5±0.30	24±1.44
2.	Bacillariophyceae	109±6.54	14±0.88	28±1.68	15±0.87
3.	Myxophyceae	23±1.38	15±0.90	5±0.41	43±2.58
4.	Euglenophyceae	14±0.99	8±0.48	0±0.0	3±0.18
5.	Zooplanktons	18±1.08	4±0.24	51±3.06	4±0.16

The present studies showed that *Labeo boga* was observed to be an herbivore with bacillariophyceae found in abundance. Zooplanktons were also found in stomach of *L. boga*. *Channa punctatus* was found to be a carnivore throughout. Aquatic insects, Crustaceans and Mollusks were found in abundance. Different types of algae have also been observed with Bacillariophyceae found in abundance. Joadder (2014) [26] reported that *Labeo boga* is an herbivore fish and feeds mainly on algae (22.32%), higher plant parts (31.26%), protozoans (7.42%), crustaceans (15.33%), insects (3.56%), mud, sand, debris and detritus (16.32%) and unidentified food materials (3.99%).



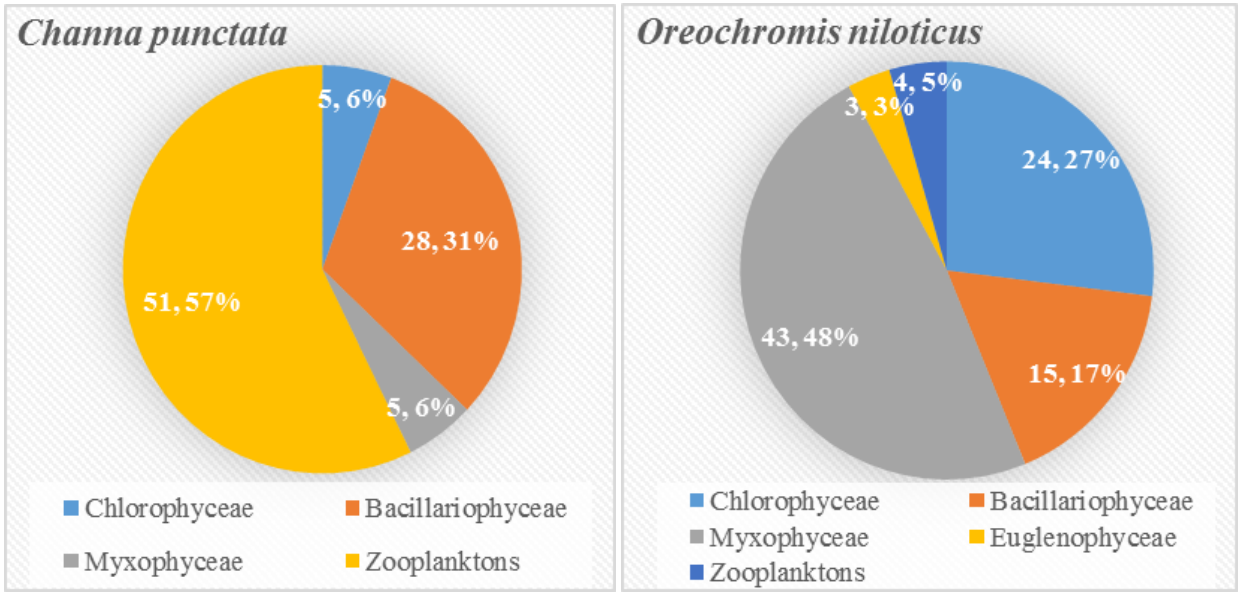


Fig 1: Types & Total No. of comparative Planktonic life present in each fish spp.

In this study, *Cirrhinus mrigala* was found to be omnivorous in lower size groups, but as size of fish increases it becomes herbivorous. Presence of zooplanktons in the stomach of *C. mrigala* indicates that fish can take zooplanktons, depending upon the type and amount of food available in aquatic ecosystem. Das and Moitra (1955) [27] reported the presence of sand and mud into the stomach along with detritus in *Cirrhinus mrigala*, *C. reba*, and *Labeo calbasu*. The present observations are slightly different and show that algae occurred in abundance along with minor quantities of zooplanktons (Rotifers and Cladocera). The occurrence of *Euglena* spp. and *Phacus* spp. has also been noticed.

Singh *et al.*, 2013 [28] described that *Channa punctatus* feeds upon crustaceans, insects, mollusks, small fishes and semi-digested material. Their study revealed that seasonal variability of natural food items in different habitats and their biological diversity put impacts on the biological needs in terms of food and feeding pattern of the same fish species. The present investigations verify the work of Singh *et al.*, 2013 [28]. It has been noticed that *Channa punctatus* feeds upon aquatic insects, crustaceans and mollusks. The presence of sand particles and algae has also been noticed.

Our present study showed that *Oreochromis niloticus* was found throughout an omnivorous specie. *O. niloticus* follows different behavioral patterns depending upon the type of environment it is inhabiting. Present investigations revealed that Myxophyceae is the most dominant algae among all the other types in *O. niloticus.* Shalloof and Khalifa (2009) [29] reported that *Oreochromis niloticus* was omnivorous feeding mostly on algal matter and diatoms. Further, the analysis of stomach contents showed the presence of more than 68% food of plant origin and about 40.5% of animal origin. Weliange *et al*. 2006 [30] reported *Oreochromis niloticus* as herbivorous or detritivorous in feeding habit. The present investigations are slightly different from Shalloof and Khalifa (2009) [29] and shows that Myxophyceae, Chlorophyceae and Bacillariophyceae are the major food items. This may, however, be due to the fact that the fish followed different behavioral patterns depending on the amount of food organisms available and the number and type of species using these organisms.

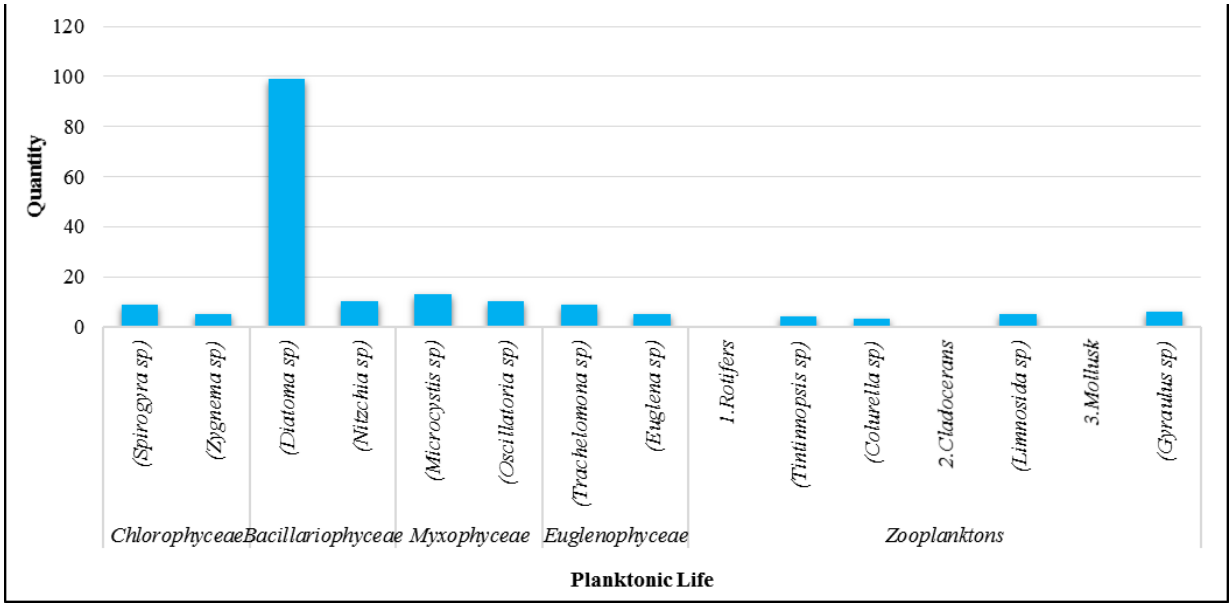


Fig 2: Type & No. of Food items observed in Gut contents of *Labeo boga*

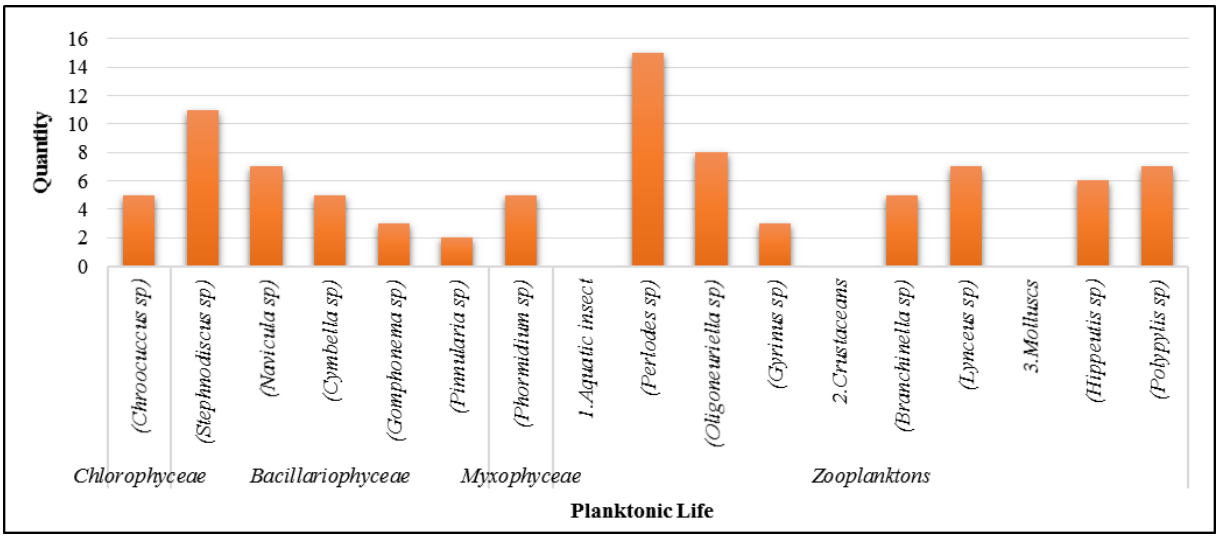


Fig 3: Type & No. of Food items observed in Gut contents of *Channa punctata*

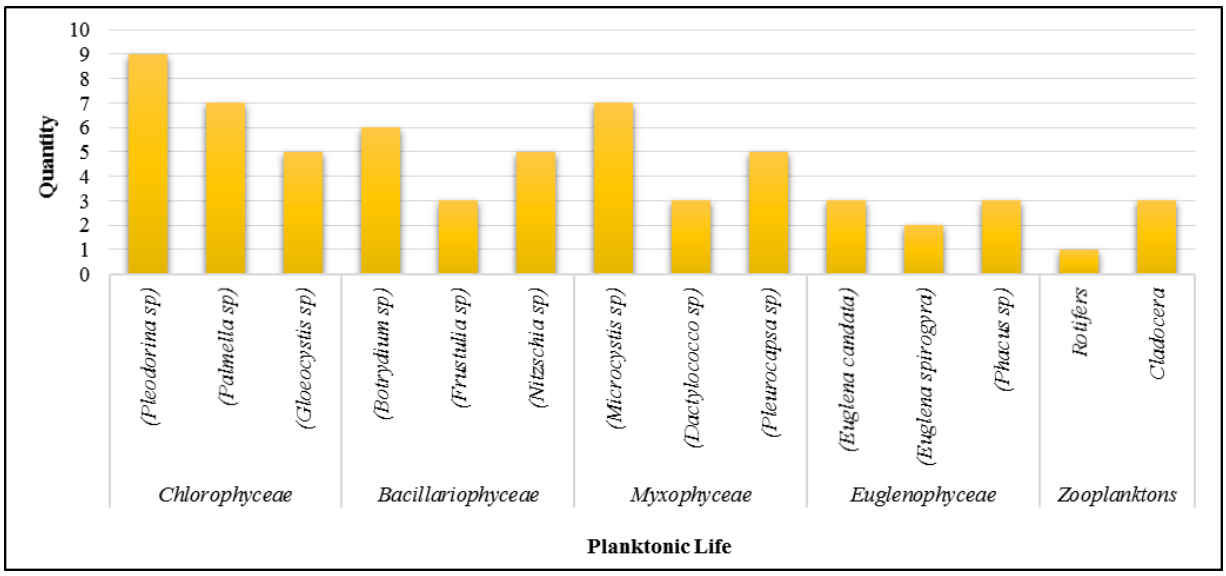


Fig 4: Type & No. of Food items observed in Gut contents of *Cirrhinus mrigala*

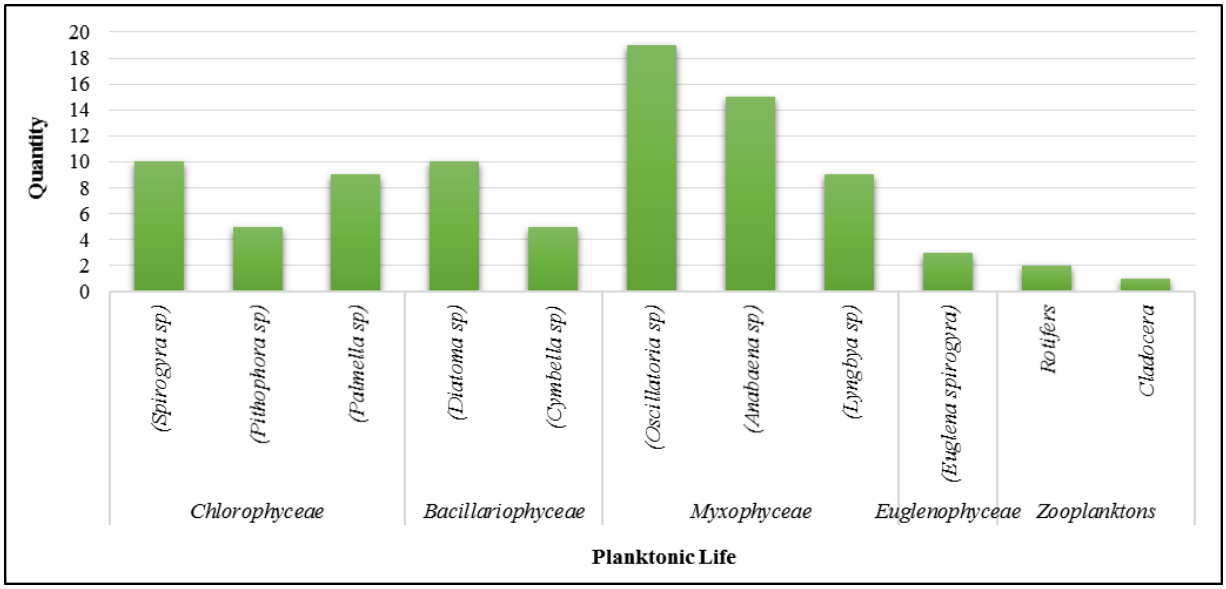


Fig 5: Type & No. of Food items observed in Gut contents of *Oreochromis niloticus*

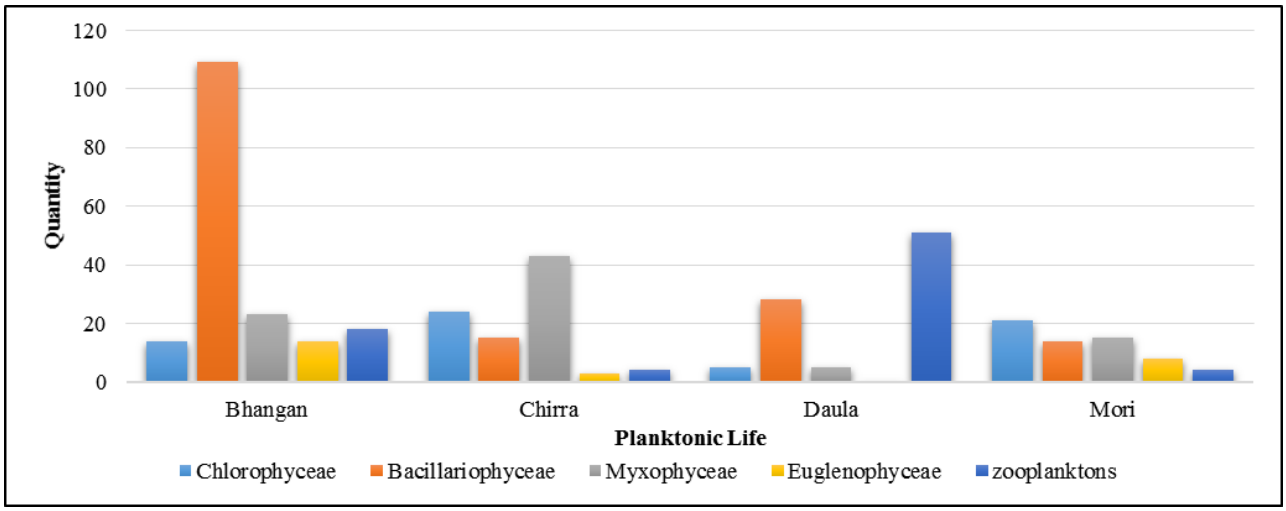


Fig 6: Selected Fish spp. comparison for Planktonic Life present

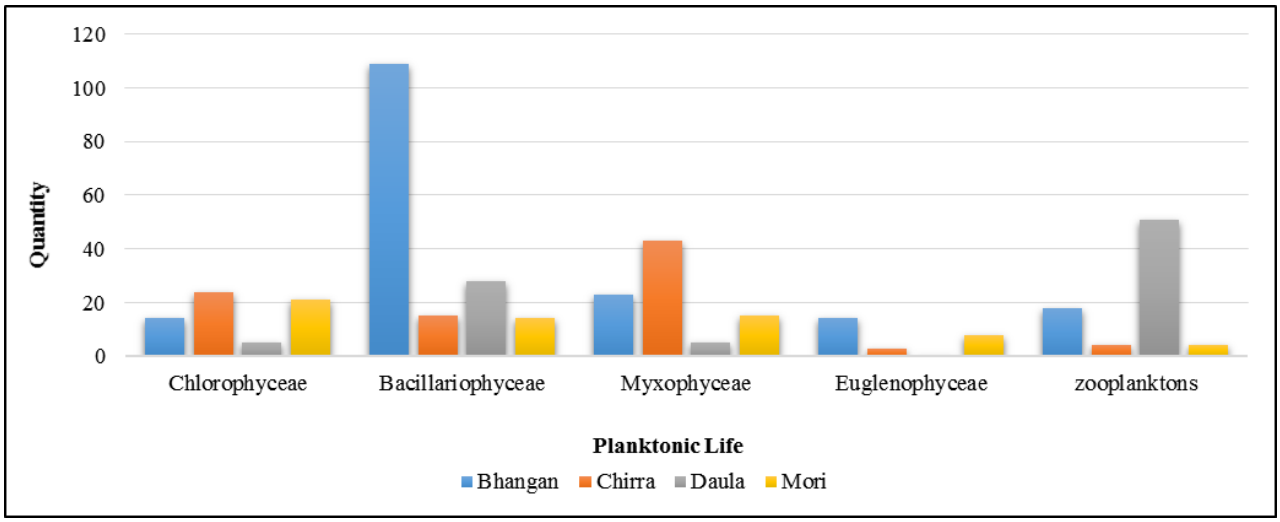


Fig 7: Planktonic Families Comparison

1.2 Physico-Chemical Water Quality Parameters:

The physico-chemical water quality parameters analyzed during this study have been shown in Table 3. The pH was almost neutral with carbon dioxide observed to be present. The water parameters indicated that water was not fertile enough as regards to planktonic life which can also be confirmed from the aforementioned figures which indicate the presence of less number of plankton which could otherwise be expected higher in number from a large water body like a river.

Table 3: Physico- Chemical Water Quality Parameters

Sr. No.	Physico- Chemical parameters	Average values ± SD
1	pH	6.96±0.35
2	Temperature	29.4±1.47 °C
3	Free Carbon dioxide	12.00±0.60 mgL^{-1}
4	Total Alkalinity	160.00±8.00 mgL^{-1}
5	Total Hardness	124.00±6.20 mgL^{-1}
6	Calcium Hardness	80.00±4.00 mgL^{-1}
7	Magnesium Hardness	44.00±2.20 mgL^{-1}
8	Chlorides	88.00±4.40 mgL^{-1}
9	Electrical conductivity	314.00±15.70 μscm^{-1}
10	Total Dissolved solids	266.90±13.35 mgL^{-1}

The present investigations are in conformity with the earlier workers. Bigliardi and Galati, 2013 [31] stated the critical examination of food and its contexts with sciences and other fields and tried to illuminate food as it relates to a vast number of academic fields. Hyslop, 1980 [32] proposed a method to measure the amount and bulk of a food category and described a method of linking measurements of dietary importance to stomach capacity and effects of differential digestion upon interpretation of stomach contents. On the same lines as our research work, Williams *et al.*, 2017 [11] also conducted a research to understand the food preference of the adult and the young fish. The main aim behind the study was that the live feed culture will open up a new way for aquaculture promotion. Moriniere *et al.*, 2003 [33] described that stomach contents and stable isotopes have shown that juveniles and adults of the fish species were separated ecologically and spatially for a specific time period. Their work was also in agreement to our research work. They also stated that herbivorous fishes do not change their trophic status whereas carnivorous fishes feed on increasingly higher trophic levels prior to their migration. Jacob and Nair, 1981 [34] conducted research on qualitative assessment of the fish diet. They revealed that quantitative and qualitative analyses of the diet indicate that feeding habit does not alter with size or seasonal changes. They also explained that seasonal fluctuations are more qualitative and depend on the food organisms, however, their work was contrary to our research work. Saikia, 2015 [35] explained the importance of food and feeding habits of fishes and stated them as center of research in different fields of Biology and put emphasis on the

affordable methodical design for research in feeding ecology. In agreement to our research, the various scientists [36, 37] also conducted research on effect of two benthivorous fish spp. on different factors i.e. water quality, fish diet and growth of rohu and the results revealed that rohu shifted towards herbivorous diet in calbasu tank while common carp showed great potential to increase yields for rohu polyculture farmers.

5. Conclusion

The goals of current study were to identify the natural food of fish samples collected from River Ravi of Punjab (Head Balloki) and to analyze the food preferences among different fish species collected from the chosen sampling station. Most of the microorganisms observed in the gut contents of fish species were of the families Chlorophyceae, Bacillariophyceae, Euglenophyceae. Zooplanktons found in the stomachs of these fish species. Among all the microorganisms; most of them were common in all the fish species collected with slight differences in the total number found in each species. Total gut lengths were variable; smaller in carnivorous species while longer in herbivorous fish varieties. It was further observed that water quality of river has shown strong impact on survival of microorganisms and these were lower in number in River Ravi with priority order of Bacillariophyceae > Myxophyceae > Zooplanktons > Chlorophyceae > Euglenophyceae being attributed to the high levels of contamination of river water.

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