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Original Article

Ichthyofaunal Biodiversity of Tunga Reservoir (Gajanoor Dam), Karnataka (India)

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ABSTRACT
The aim of the study was to investigate on the ichthyofaunal biodiversity of the Tunga reservoir of Shivamogga district, (Karnataka) India. Monthly sampling was done in three fish landing centers *viz,* Gajanoor, Sakrebylu and Mandagadde. Total 43 species belonging to 13 families and 6 orders were recorded. The order Cypriniformes found to be dominant with 27 fish species followed by Siluriformes 10 species and Perciformes 3 species. Although, 43 species were recorded, the Cyprinidae was observed as the dominated family with 23 fish species (53.48%) followed by Bagridae & Channidae with 3 fish species (6.97%) each. The Simpson's index of diversity (1- Lambda') was highest in Sakrebylu (0.907) followed by Mandagadde (0.883) and Gajanoor (0.882). This indicated the greater fish biodiversity in Sakrebylu when compared to other two centers. The biomass of fish species was more in Gajanoor (S= 43, N=157.52) followed by Mandagadde (S =43, N= 124.44), and Sakrebylu (S =43, N= 117.01). Further, the other indices such as Pielou's evenness (J'), Shannon H'(loge) and Simpson 1-Lambda' were also used to assess the richness of biodiversity of all the three fish landing centers. The paper attempts to evaluate ichthyofaunal diversity in the region and suggests mitigating measures.
Key words: Ichthyofaunal biodiversity, Tunga Reservoir, Karnataka

INTRODUCTION

Ichthyofaunal biodiversity refers to variety of fish species depending on context and scale; it could refer to alleles or genotypes within of life forms within a fish community and to species or life forms across aqua regimes [1]. Biodiversity is essential for stabilization of ecosystem protection and overall environmental quality for understanding intrinsic worth of all species on the earth. Fish constitutes half of the total number of vertebrates in the world. They live in almost all conceivable aquatic habitats. As on today, 21,723 living species of fish have been recorded all over the world. Out of these 8,411 are freshwater species and 11,650 are marine which are commercially important. India is one of the 17 mega biodiversity countries of the world. With only 2.5% of the land area, India accounts for 7.8% of the recorded species of the world [2]. In India there are 2,500 species of fishes of which 930 live in freshwater and 1,570 are marine [3]. Studies of spatial and temporal patterns of diversity, distribution and species composition of freshwater fishes are useful to examine factors influencing the structure of the fish community [4].
The distribution and composition of the fish species in each habitat were closely associated with various factors such as the availability of food, breeding sites, water current, depth, topography and physic-chemical properties of water [5]. The aquatic biodiversity of the world is changing and getting depleted alarmingly fast as a result of extinctions caused by habitat loss, pollution, introduction of exotic species, over exploitation and other anthropogenic activities. The loss of aquatic biodiversity is severe in fresh water ecosystem, which represents a meager 0.1 percent of earth water wealth, yet they harbour 40 percent of the fish species so far recorded [6].
The River Tunga originates in the Western Ghats on a hill known as Varaha Parvata at a place called Samse. The river is famous for the sweetness of its water. There is a belief that "Thunga pana Ganga snana" which means we should drink the water of river Tunga and take

bath in river Ganga. Tunga reservoir is a medium reservoir formed due to the construction of dam across the river Tunga near Gajanoor village of Shivamogga district. This reservoir was initially made to provide water for drinking and irrigation and subsequently the height of the dam was raised to make it multipurpose project. The formation of reservoir provides a very good habitat for birds and also for variety fish fauna. Its beautiful landscape and the surrounding natural environment provide a pleasant recreational retreat for general public. More than 900 fishermen families derive their livelihood by fishing in this reservoir.

Several studies on ichthyofaunal diversity from different fresh water bodies of India have been carried out during the last few decades [7; 8; 9; 10; 11]. No information is available on the ichthyofaunal biodiversity of Tunga reservoir. Hence, this study has taken up.

MATERIALS AND METHODS

Study Area and Sampling Sites

The Tunga reservoir is a medium reservoir created due to the construction of dam across the river Tunga which is a major tributary of Tungabhadra River in Shivamogga district of Karnataka. This reservoir is situated at 75°40'20"E longitude and 14°0'24"N latitudes and the total water spread area of the reservoir is about 1600 ha. Fish were sampled monthly at three fish landing centers of the reservoir namely Gajanoor, Sakrebylu and Mandagadde. Gajanoor is located near dam site, Sakrebylu is located at the middle part of the reservoir and Mandagadde is a point where river Tunga joins the reservoir.

Fish samples were collected for two year from July, 2010 to June, 2012. Majority of the fish were caught by the gill nets (mesh size measuring 30, 40, 50 and 60 mm) at all the three stations. The gill nets were set at dusk and hauled the next morning by the licensed fishermen (the fishing right of the reservoir is given to the fishermen through licenses by the Department of Fisheries, Govt. of Karnataka State). Figure: 1 shows the location of Tunga reservoir.

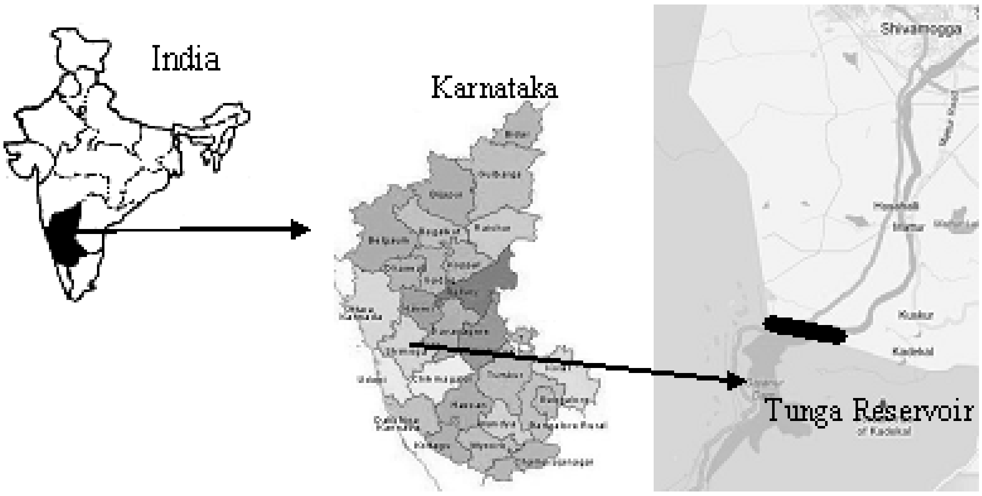

Figure 1.Location of Tunga reservoir

Identification of Fish Species

The identification of fishes was based on fresh or preserved specimens. Fishes were identified by using standard taxonomic keys viz. Fishes of India, FAO identification sheets, ITIS (Integrated Taxonomic Information System) standard report (http://www.itis.gov), Fish Base (http://fishbase.org) and other reference books. The collected fish were identified up to species level.

Diversity Indices

The diversity of fishes was calculated by Shannon- Weiner and Pielou's evenness indices. Since individual size of fish species differed greatly, the indices are expressed in terms of biomass and not in terms of number of individuals. Hill's abundance was used to examine the variation in the number of dominant species. Species richness was calculated by Margalef's index. The similarity in species composition was studied by calculating the Bray-Curtis Coefficient. However, all the diversity indices were done by using the PRIMER V.6 analytical package developed by Plymouth Marine Laboratory, U.K. [12].

RESULTS AND DISCUSSION

The result of the present study revealed the occurrence of forty three fresh water fish species belonging to six orders. The order Cypriniformes was dominant with 27 fish species followed by order Siluriformes 10, and Perciformes 3. The order Osteoglossiformes, Symbranciformes, and Beloniformes each with one species have been recorded from the three sampling centres in the Tunga reservoir. The list of fish species recorded in the fish landing centers are given in Table 1. The family Cyprinidae dominated with (260415 kg) followed by Cichlidae (69469 kg), Claridae (40434 kg), Channidae (6868 kg), Siluridae (4554 kg). The other families (Schilbidae, Bagridae, Mastacembalidae, Heteropneustidae, Notopteridae and Belonidae) contributing less than one percent to the total catches.

Among Cypriniformes, the Cyprinidae contribute (53.48%) represented with *Barilius bola, Catla catla, Cirrhinus cirrhosa, C. mrigal, Ctenopharyngodon idella, Cyprinus carpio communis, C. carpio nudus, C. carpio specularis, Garra gotyla, Hypophthalmichthys molitrix, Labeo bata, L. calbasu, L. fimbriatus, L. gonius, L. kontius, L. rohita, Puntius carnaticus, P. dobsoni, P. filamentosus, P. kolus, P. sarana, P. ticto, Tor* spp. The Genus *Labeo* and *Puntius* represented by 6 species in each followed by Genus *Cyprinus*. The other families like Cichlidae, Balitoridae, Rasboridae contributing 2.32% each to the total fish species.

The order Siluriformes contributed 10 fish species, among them the family Bagridae & Claridae contributing 6.97% each to the total fish species followed by Siluridae (4.65%), Cichlidae (4.65%), Heteropneustidae (2.32%), and Schilbeidae (2.32%) (Figure 2). Bagridae & Claridae represented 3 species each followed by Siluridae (2), Cichlidae (1), and Heteropneustidae (1). Among Perciformes, family Channidae contributing 3 species (6.97 %) to the total fish species (Figure 2). The order Osteoglassiformes, Synbranchiformes, and Beloniformes contribute with one fish species. Among them the family Notopteridae (*Notopterus notopterus*), Mastacembelidae (*Mastacembalus armatus*), and Belonidae (*Xenentodon cancila)* contribute 2.32% with each one to the total fish species respectively.

Table: 1. Fish catch data (in Kg) of Tunga Reservoir, (Gajanoor Dam), Shivamogga

		Fish landing centers		
Sl. No.	**Order/ Family/ Fish species**	**Mandagadde**	**Sakrebylu**	**Gajanoor**
	Cypriniformes			
	Cyprinidae			
1	*Barilius bola* (Hamilton 1822)	43	61	41
2	*Catla catla* (Hamilton,1822)	27861	19871	35278
3	*Cirrhinus cirrhosa* (Hamilton,1822)	671	891	786
4	*Cirrhinus mrigal* (Hamilton,1822)	9801	6781	20181
5	*Ctenopharyngodon idella* (Valenciennes,1844)	716	891	451
6	*Cyprinus carpio communis* (Linnaeus, 1758)	5461	7910	9102
7	*Cyprinus carpio nudus* (Linnaeus, 1758)	4516	8719	7711
8	*Cyprinus carpio specularis* (Linnaeus, 1758)	7861	8712	8719
9	*Garra gotyla* (Gray, 1830)	89	112	97
10	*Hypophthalmichthys molitrix* (Valenciennes,1844)	542	234	135
11	*Labeo bata* (Hamilton,1822)	78	218	187
12	*Labeo calbasu* (Hamilton,1822)	1627	3412	4231
13	*Labeo fimbriatus* (Hamilton,1822)	2213	2351	3246
14	*Labeo gonius* (Hamilton,1822)	213	221	251
15	*Labeo kontius* (Hamilton,1822)	76	98	102
16	*Labeo rohita* (Hamilton,1822)	14526	7819	24256
17	*Puntius carnaticus* (Hamilton,1822)	52	12	39

18	*Puntius dobsoni* (Hamilton,1822)	57	42	35
19	*Puntius filamentosus* (Hamilton,1822)	86	121	93
20	*Puntius kolus* (Hamilton,1822)	11	37	28
21	*Puntius sarana* (Hamilton,1822)	34	67	52
22	*Puntius ticto* (Hamilton,1822)	14	26	17
23	*Tor* spp. (Juveniles)	84	68	71
	Balitoridae			
24	*Noemaceilus rupelli* (Sykes 1839)	18	13	17
	Rasboridae			
25	*Rasbora danioconius* (Hamilton,1822)	19	73	27
	Cichlidae			
26	*Oreochromis mossambicus* (Peters, 1852)	17289	10291	16517
27	*Oreochromis niloticus* (Linnaeus, 1758)	9820	6829	8719
	Siluriformes			
	Bagridae			
28	*Rita pavimentata* (Valenciennes, 1840)	49	65	98
29	*Spearota aor* (Hamilton-Buchanan,1822)	234	256	312
30	*Spearota seengala* (Sykes,1839)	167	918	372
	Siluridae			
31	*Ompok bimaculatus* (Bloach,1794)	378	567	871
32	*Ompok pabda* (Hamilton,1822)	489	978	1271
	Schilbeidae			
33	*Silonia silondia* (Hamilton,1822)	126	59	87
	Claridae			
34	*Clarias batrachus* (Linnaeus,1758)	1987	7181	2918
35	*Clarias garipinus* (Burchell, 1822)	6782	17861	7891
36	*Wallago attu* (Bloach & Schneider,1801)	781	859	956
	Heteropneustidae			
37	*Heteropneustes fossilis* (Bloch,1794)	78	19	72
	Perciformes			
	Channidae			
38	*Channa marulius* (Hamilton,1822)	562	971	568
39	*Channa punctatus* (Bloch,1793)	982	611	871
40	*Channa striatus* (Bloch,1793)	745	739	819
	Osteoglossiformes			
	Notopteridae			
41	*Notopterus notopterus* (Pallas,1769)	19	54	36
	Synbranchiformes			
	Mastacembelidae			
42	*Mastacembalus armatus* (Lacepede,1800)	89	63	72
	Beloniformes			
	Belonidae			
43	*Xenentodon cancila* (Hamilton,1822)	25	31	18
	Total catch (Kg):	**1,17,271**	**1,17,112**	**1,57,621**

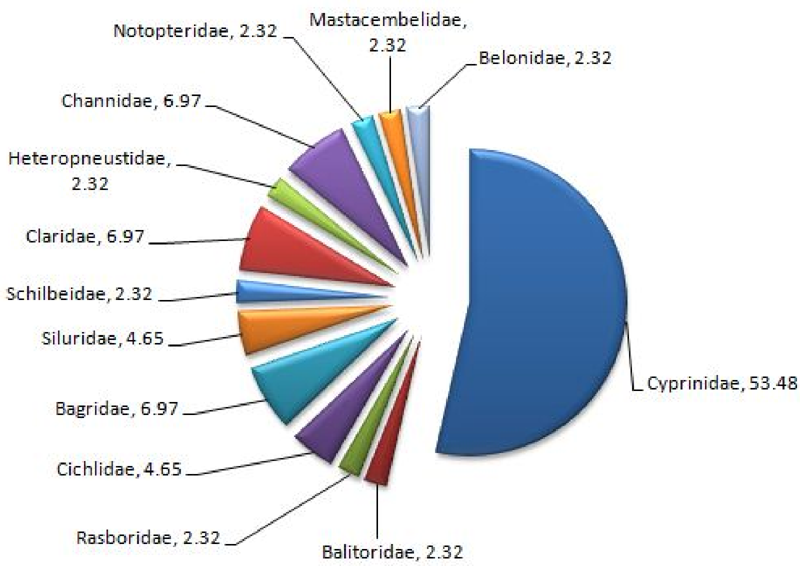

Figure 2: Diagrammatic representations of the % number Contribution of each family

The results are in accordance with Bhat [13]; Schleiger [14]. The distribution of fish species is quite variable because of geographical and geological conditions. Among the recorded fish species the highest abundance (catch) of *Catla catla, Labeo rohita, Oreochromis mossambicus, Cirrhinus mrigala, Cyprinus carpio, Clarias garipinus* and *Oreochromis niloticus* were recorded in all the sites and the lowest fish species such as *Noemaceilus rupelli, Puntius ticto, Xenentodon cancila, Puntius kolus, and Notopterus notopterus* were found in lesser quantities.

The species richness, abundance and biodiversity indices in all the three sites are shown in Table 2. In line with the higher number of species and their abundance, Shannon diversity H' (log_e) was more in Sakrebylu (2.66) than in other two centres (2.47). The Pielou's evenness (J') of the species was also more in Sakrebylu (0.70). However, Margalef's species richness (d) showed clear differences between the centres. Further the number of dominant species (N_2) was more in Sakrebylu.

The similarity in species composition and abundance among centres was in the range of 72.77 - 79.33 (Table 3). Overall the quantity of fish landings was more in Gajanoor (N= 157.52) followed by Mandagadde (N= 124.44), and Sakrebylu (N= 117.01) and the species richness (d) was more in Sakrebylu 3.59 (Table 2). This indicated the greater fish biodiversity in Sakrebylu when compared to other two fish landing centers.

Table: 2. The centre wise diversity indices of finfish in Tunga reservoir

Fish Landing Centres	Species S	Quantity N	Species Richness D	Pielou's evenness J'	Shannon H' (loge)	Simpson 1-Lambda'	Hills abundance N_1	N2
Mandagadde	43	124.44	3.58	0.65	2.47	0.883	11.86	8.59
Sakrebylu	43	117.01	3.59	0.7	2.66	0.907	14.32	10.85
Gajanoor	43	157.52	3.50	0.65	2.47	0.882	11.84	8.51

Table: 3 - Bray - Curtis similarities for Fish catch data of Tunga reservoir

Centres	Mandagadde	Sakrebylu	Gajanoor
Mandagadde	-	-	-
Sakrebylu	79.355	-	-
Gajanoor	81.695	72.776	-

Considerable quantity of exotic fishes such as *Oreochromis mossambicus, Oreochromis niloticus* and *Clarias garipinus* were recorded in all the three landing centres. The prolific breeder tilapia had an immense impact on the indigenous species competing for space and food resulting in decline of indigenous fishes. The highly carnivorous African cat fish which is illegally introduced to the aquatic system of India caused severe damage to fish fauna. The union agriculture ministry has ordered killing of these fishes *en masse* and preventing further culture of these fishes Biju Kumar [15] but this order did not have any impact as it lacked any specific guidelines to destroy this fish. The intensive stocking of advanced fingerlings under National Fisheries Development Board and the Department of fisheries Karnataka helped in improvement of Indian major carp landings.

The present study largely focuses on species richness and diversity of Tunga reservoir. It is apparent that maintaining fish biodiversity is a major issue facing the region and it is in direct conflict with the rapid development activities taking place in the watersheds, including those related to aquaculture. There is a need to formulate sustainable strategies to save fish community of this reservoir system as a whole. Being important reservoir of Western Ghats, Tunga reservoir supports variety of fish fauna. Each species often consists of several indigenous groups with a distinct genetic makeup [16]. There could be uncertainties with all scientific endeavors to monitor abundance and productivity of stocks and the underlying causes. Further, there are uncertainties with regard to climate change, aquatic ecosystem productivity, predation and fishing pressure.

CONCLUSIONS

Habitat loss and environmental degradation has seriously affected the fish fauna. Conservation of fish diversity assumes top most priority under changing circumstances of habitat. Knowledge of available resources and the biological characters of species serve the baseline information for further studies on resource conservation and maintenance. The post scenario of induction of NFDB fish stocking schemes and its consequences on the fish fauna of the Tunga reservoir should be studied for further management and development of fisheries in this particular reservoir. The study will provide future strategies for development and fish conservation.

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