Freshwater fishes distribution and diversity status of Mullameri River, a minor tributary of Bheema River of Gulbarga District, Karnataka

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ABSTRACT- Freshwater fishes distribution and diversity status of Mullameri river, a minor tributary of Bheema River of Gulbarga district, Karnataka was studied from April 2006 to March 2008. During the study period fourteen freshwater fish species have been recorded. Monthly sampling was carried out in three sites. The result of the study reveals the occurrence of fourteen fish species belonging to five orders. The order Cypriniformes was dominant with seven fish species followed by order Siluriformes with four species, and the order Channiformes, Mastacembeliformes and Osteoglossiformes each with one species. The percent representation of different families of fishes is depicted in pia chart. Fish diversity was assessed by calculating the various diversity indices such as Shannon – Weiner biodiversity index (H), Simpson's Dominance Index (D), Simpson's index of diversity (1-D), Pielous Evenness and Margalef index of species richness.
Key words: Fish fauna, Biodiversity indices, Mullameri River, Gulbarga District, Karnataka

INTRODUCTION

Freshwater biodiversity has declined faster than either terrestrial or marine biodiversity over the past 30 years [17]. In pacts of earth, declining river flow rates (discharge) have been a major cause of species loss [28] and are likely to be further reduced by warming temperatures, reduced precipitation and increased water withdrawal for agriculture and other human uses [50,1]. Future declines can therefore negatively affect freshwater biodiversity. Inland waters and freshwater biodiversity constitute a valuable natural resource, in economic, cultural, aesthetic, scientific and educational terms. Their conservation and management are critical to the interests of all human, nations and governments. The streams and rivers are facing number of environmental problems through out the world largely associated with anthropogenic activities in their catchment areas [52]. The adverse effects of human activities have resulted in degradation of stream and reverine ecosystem [32] which ultimately alter the structure and function of stream biota [44]. This is more critical in developing countries [5]. Here we focused the freshwater fish biodiversity in Mullameri river a minor tributary of Bheema River. Fish have been regarded as an effective biological indicator of environmental quality and anthropogenic stress in aquatic ecosystems [11, 40] not only because of its iconic value, but also because of sensitivity to subtle environmental changes [20] and represents a wide range of tolerance at community level [27]. Fish is sensitive to changes in water chemistry due to different anthropogenic activities from their catchment. Fish responses to environmental disturbances, including hydro-morphological factors are different in time and space in comparison to simpler organisms, as they tend to be integrated over larger intervals. Fish has been identified as suitable for biological assessment due to its easy identification and economic value [39, 42, 38].

Fish assemblages have widely been used as ecological indicators to assess and evaluate the level of degradation and health of rivers and streams at various spatial scales [53]. Plafkin et al. [27] observed that there are many advantages of using fish assemblage as biological indicator. Most of the streams exhibit variations in different sections especially from upstream to downstream and these variations become more remarkable in streams facing problem of habitat degradation particularly from direct discharge from untreated industrial and municipal effluents [29]. Upstream sections are generally less degraded with relatively less changed physical, chemical and biological conditions of habitats [9]. Sites located in upstream sections have generally been considered as reference sites and can be compared with rest of sites for assessment of stream health [19]. Fish assemblages may differ on longitudinal gradient in streams according to various biological aspects such as species diversity, stress tolerance, habitat preferences, feeding behaviours and origin of species [12]. These variations depict the level and severity of degradation in stream health. In the Indian subcontinent, there are 2,500 species of freshwater fishes, that have been recorded; of which 930 are categorized as freshwater species [16] and remaining 1570 are marine. Many fish species have become highly endangered, particularly in rivers where heavy demand is placed on freshwater. However, the impact of the anthropogenic activities, habitat degradation, exotic species introduction, water diversions, pollution and global climate change are the main causative agents for the aquatic species rapid decline.

Some early contributions were those of Hamilton-Buchanan in 'The Fishes of the Ganges' [13] and by others [22, 45, 18]. Some of the most important contributions to such studies were made by Francis Day in his Fishes of India [6]. Substantial literature is now available on the identification and systematics

of freshwater fishes in India, the most recent texts are [46, 16].

Though most of these contributions have been taxonomic in nature, there exist some works on the biogeographic distributions of fishes in the region as well [14]. Many species belonging to the peninsular part of India (particularly in Western Ghats) were found to be the same, or congeneric to, species found in the North East of India and to some species even in South East Asia. The levels of endemicity were found to be very high over all the vertebrate taxa in the Hyderabad-Karnataka region. Fishes in this region are also found to have high endemicity. Some studies on the hill stream fishes have been conducted in the recent years. Notable earlier works are [37] on the fishes of the Anamalai and the Nellimapathi Hill ranges of the Southern Western Ghats [30] on the ecology of the fishes of the rivers Moyar and Pykara. Fish diversity and distribution in the Kerala Part of the Western Ghats has been studied extensively [34, 35, 10]. Kerala has about 44 rivers and as many as 200 freshwater fishes, of which 25 have been reported as endemic. In addition to studying the systematic of the fishes of this region, their ranges and status have also been evaluated. But since large parts of the Hyderabad-Karnataka region are as yet unexplored, the distribution status of many of these species remains uncertain. Recently, studies have been conducted in some parts of Bellary and other places in Karnataka with respect to fish assemblage structure and the association of microhabitat variables to species diversity [2]; these studies seem to indicate that high habitat diversity is associated with high species diversity and abundance. Fish fauna of Bhadra and Tunga reservoirs [48, 49] have been reported; Diversity and composition of freshwater fishes in river systems of Central Western Ghats, India [4]; Fish diversity in relation to landscape and vegetation in Central Western Ghats, India [43]; Recently focused on fish fauna of Chalakudy River, part of Western Ghats biodiversity hotspot, Kerala, India: patterns of distribution , threats and conservation needs [31]; Fish diversity with relation to water quality of Bhadra River of Western Ghats, India [33].

Taxonomic collections apart, not much work has been done on the study of freshwater fishes in the northern parts of Karnataka. Given the high levels of faunal diversity and endemic observed so far, there is an urgent need to understand the fish diversity and distribution of this region. The need is, in fact, made all the more urgent by the recent spurt of human activities in this region in exploiting its water resources for hydroelectric purposes. Not only are the rivers directly affected by the developmental activities, but they are also affected by other threats like introduction of exotic species, over fishing and disposal of industrial and domestic wastes from new industries and settlements. Before the rich species diversity of this region of the subcontinent is lost forever, the documentation of the species found here as well as their distribution of the species found here is crucial; this together with the identification of the threats will help in formulating the needed conservation measures. In the present study an attempt has been made to highlight the ichthyofaunal diversity of Mullameri River. The work will provide future strategies for development and fish conservation and it is the first effort in this direction.

MATERIALS AND METHODS

Study Area

The Mullameri River is a minor tributary of river Bheema in Gulbarga district of Karnataka. The district is situated in the northern part of Karnataka state (76^{o} – 04' to 77^{o} – 42' longitude and 16^{o} – 12' to 17^{o} – 46' latitudes) located 454 meter above M. S. L. Gulbarga presents typical climate of peninsular south India with semi arid conditions, the maximum temperature in summer is around 42-46^{o}C during March – May. The river Mullamari rises near the village of Matala in Humnabad taluk of Bidar district. After flowing in a south-eastern direction for about thirty miles (48 km), it enters the Gulbarga district near the village of Kinni, forming the boundary between Gulbarga and Bidar districts up to Gobarwadi village. After running for about eight miles in Gulbarga district it again forms the boundary of the above two districts up to Kotgi village and continue to run completely in Gulbarga district in the same direction up to Chincholi town. The total length of the river from where it enters Gulbarga district up to Chincholi town is about 40 miles (64 km). From Chincholi onwards it runs south and flows for about 15 miles (24 km) before joining the Kagina river on the right flank near the village of Jattur. Chincholi, the headquarters of Chincholi taluk, is situated on the left bank of Mullamari river. The river brings a lot of water during the monsoon. The lands along the river mainly consist of black cotton soil. Many streams like Sarnalla and Karinalla join this river at various places during its course in this district. The location map of study area is shown in Fig. 1. The monthly mean gauge reading, water level and discharge is given in Table 1 and the environmental factors such as monthly mean total rainfall, air temperature, water temperature and average relative humidity is shown in Table 2.

Sampling

The present work is an attempt to study fish fauna of Mullameri River. Fishes were collected from different selected localities during the study period of April 2006 to March 2008 with the help of local fishermen using different types of nets namely gill nets, cast nets and dragnets. Immediately photographs were taken prior to preservation since formalin decolorizes the fish colour on long preservation. Formalin solution was prepared by diluting one part of concentrated formalin or commercial

formaldehyde with nine parts of water *i.e.,* 10% formalin [13, 23, 24]. Fishes brought to the laboratory were fixed in this solution in separate jars according to the size of species. Smaller fishes were directly placed in the formalin solution while larger fishes were given an incision on the abdomen before they were fixed. The fishes collected and fixed were labeled giving serial numbers, exact locality from where collected, date of the collection, the common local name of fish used in this region was labeled on each jar. Identifications done were based on keys for fishes of the Indian subcontinent [8, 15, 16, 46]. Classification was carried out on lines of Day [7]. Nelson [25] and Jayaram [15], the identification of the species was done mainly on the basis of the colour pattern, specific spots or marks on the surface of the body, shape of the body, structure of various fins *etc.* and also with the help of taxonomic expertise from the Regional Station of the Zoological Survey of India at Hyderabad.

Data analysis

Fish species diversity was subjected to diversity analysis using different indices like Shannon – Weiner index (H) [36]; Simpson Dominance index (D); Simpson index of diversity (1-D) [41]; Pielous Evenness [26]; Margalef's index [21].

1) Shannon – Weiner index

$H = - \Sigma P_i \log_2 P_i$

Where, H = Shannon – Weiner index

$$Pi = \frac{ni}{N}$$

Σ = Sum

Species diversity was calculated following Shannon – Weiner index (H) which depends on both the number of species present and the abundance of each species.

ni = Number of individuals of each species in the sample.

N = Total number of individuals of all species in the sample.

Abundance of fish population was calculated by the sum of all available species in different sites.

Species richness was simply estimated by the variety of fish species in three different sites. Data regarding threats faced by the fish fauna were obtained from both primary (direct observations and interaction with local stakeholders and fishermen) and secondary sources.

2) Simpson's diversity indices

Simpson's diversity index is a measure of diversity. In ecology, it is often used to quantify the biodiversity of a habitat. It takes into account the number of species present, as well as the abundance of each species.

(a) Simpson's index of dominance

$$D = \Sigma \frac{ni\,(ni - 1)}{N\,(N - 1)}$$

Where, ni = the total number of individuals of a particular species.

N = The total number of individuals of all species.

(b) Simpson's index of diversity 1 – D

3) Piclou's Evenness or Equitability

$J = H / \log_2 S$

Where,

'H' is the Shannon Weiner index and

'S' is the number of species

Evenness is a measure of the relative abundance of the different species making up the richness of an area.

4) Margalef index

Ma = S – 1 / Ln N

Where,

'S' is the number of species

'N' is the number of individuals in the sample.

The number of species per sample is a measure of richness. The more species present in a sample, the 'richer' the sample.

Species richness as a measure on its own takes no account of the number of individuals of each species present. It gives as much weight to those species which have very few individuals as to those which have many individuals.

RESULTS AND DISCUSSION

The result of present study revealed the occurrence of fourteen fresh water fish species belonging to five orders. The order Cypriniformes was dominant with seven fish species followed by order Siluriformes with four species, the order Channiformes, Mastacembeliformes and Osteoglossiformes each with one species have been recorded from the three sampling sties in the Mullameri river. The list of fish species order, family, genus and species is shown in Table 3. The Cyprinidae family was found to be the most dominant group among all the other families. The results are in accordance with [51, 4, 33].

The distribution of fish species is quite variable because of geographical and geological conditions. The fish species density, abundance and distribution are shown in Table 4. Among all the recorded fish species, the high abundance of fish species with maximum availability of the major carp the *Catla catla*, Murrel the *Channa striatus* and the razor fish *Notopterus notopterus*. The highest abundance of fish *Catla catla, Channa striatus, Notopterus notopterus* and *Labeo boggut* were recorded in all the sites and the lowest fish species such as *Labeo rohita, Salmostoma bacaila, Puntius chilinoides, Mystus bleekeri, Ompok pabda, Ompok bimaculatus* were found to be the least one. The fish species richness, abundance and biodiversity indices in all the three sites are shown in table 5. The highest abundance and richness is recorded in site – 1 (lower Mullameri) followed by site – 2 (upper Mullameri) and site – 3 (Chincholli village). Different diversity indices were calculated as per standard methods. The Shannon-Weiner fish diversity index of different sites of river

Mullameri shows high diversity index in site – 1 (lower Mullameri) 2.9 followed by site – 2 (upper Mullameri) 2.8 and lowest in site – 3 (Chincholli village) 2.5. The Simpson's dominance index values shows high at site – 2 and site – 3 i.e., (0.1) and low at site – 1 (0.09). With this index, 0 represents infinite diversity and 1, no diversity. That is, the bigger the value of D, the lower the diversity. This means site – 1 (0.09) shows high diversity compared to site – 2 and site – 3 that is (0.1). This is neither intuitive nor logical, so to get over this problem, D is often subtracted from 1 to give Simpson's index of Diversity (1-D). The value of this index also ranges between 0 and 1, but now, the greater the value, the greater the sample diversity. This makes more sense. In our study the Simpson's index of Diversity (1-D) values are same in all the three sites i.e., (0.9). The Pielous evenness values were recorded similar in site – 1 and site – 2 (0.7) and 0.8 in site – 3. The Margalef index of species richness values revealed high at site – 1 (2.3), moderate at site (2) (2.1) and low at site – 3 (1.5).

The percent representation of different families of fishes recorded in Mullameri river is depicted in pia chart Fig. 2. As per this the dominant species belongs to the family Cyprinidae followed by the family Channidae, Notopteridae, Mastacembelidae, Bagridae and Siluridae. This indicates good correlation with overall species richness across the sites and could be utilized by the biodiversity conservation managers for prioritization of sites of conservation and habitat restoration [3]. The present study largely focuses on fish species richness and diversity of Mullameri River. We need to formulate sustainable strategies to save fish community of this river system as a whole. Due to multiple uses of fisheries resources, fishing has become a major industry and a large number of these aquatic communities are under a big threat of extinction. A typical fishery in tropical waters may lead to harvest of rich diversity of ichthyospecies. Each species often consists of several local groups with a distinct genetic make up. It could be little difficult for detailed study of each group. 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. Fishermen and ichthyologists have a critical role to play in understanding and protecting diverse fish resources. Habitat loss and environmental degradation has seriously affected the fish fauna. Conservation of fish diversity assumes top most priority under changing circumstances of gradual habitat degradation. Knowledge of available resources and the biological characters of species serve the baseline information for further studies on resource conservation and maintenance. Further, there is a need for survey of diversity of fish fauna in different types of habitats all over the country. Industrial effluents and man made pollutants also contribute towards the disruption in the balance on aquatic ecosystem, which should be checked by taking necessary steps. The work will provide future strategies for development and fish conservation.

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Table 1- Monthly mean of Gauge reading, water level and total discharge of Mullameri river

Month/year	Monthly mean Gauge reading (M)	Monthly mean water level (mts)	Monthly mean total discharge (N^3/sec)
April 2006	0.5	441.40	16.022
May 2006	0.54	441.44	20.138
June 2006	0.59	441.49	24.490
July 2006	0.57	441.47	21.983
Aug 2006	0.61	441.51	26.648
Sep. 2006	0.73	441.63	38.841
Oct. 2006	0.68	441.58	50.482
Nov. 2006	0.56	441.46	23.617
Dec. 2006	0.57	441.47	25.027
Jan. 2007	0.63	441.53	26.148
Feb. 2007	0.63	441.53	23.102
March 2007	0.57	441.47	20.705
April 2007	0.46	441.36	13.163
May 2007	0.45	441.35	18.856
June 2007	0.74	441.64	159.424
July 2007	0.64	441.54	44.349
Aug. 2007	0.68	441.58	112.865
Sept. 2007	1.45	442.35	1137.076
Oct. 2007	0.79	441.69	119.974
Nov. 2007	0.68	441.58	55.462
Dec. 2007	0.83	441.73	72.615
Jan. 2008	0.8	441.70	118.994
Feb. 2008	0.75	441.65	74.372
March 2008	0.93	441.83	210.399

Zero guage is 440.90

Table 2- Environmental factors of Mullameri river

Month/year	Total rainfall (mm)	Average relative humidity (%)	Max. air temp. ^{o}C	Min. air temp. ^{o}C	Water temp. ^{o}C
April 2006	40.0	36.98	35.16	20.10	27.63
May 2006	72.6	42.85	37.0	22.90	29.95
June 2006	119.1	62.67	31.43	21.73	26.58
July 2006	62.9	67.62	31.04	21.90	26.47
Aug 2006	122.8	72.17	27.20	21.43	24.32
Sep. 2006	171.6	69.88	29.36	21.20	25.28
Oct. 2006	39.0	62.19	29.83	18.67	24.25
Nov. 2006	1.9	52.20	27.58	15.87	21.72
Dec. 2006	0.0	39.29	28.19	10.70	19.45
Jan. 2007	0.0	38.67	29.29	11.45	20.37
Feb. 2007	0.0	37.53	30.33	13.50	21.91
March 2007	0.0	35.53	34.51	18.34	26.53
April 2007	29.2	35.40	37.9	21.30	29.60
May 2007	72.1	38.14	40.06	23.09	31.58
June 2007	314.3	60.26	33.13	22.63	27.88
July 2007	114.0	70.45	30.16	23.00	26.58
Aug. 2007	232.5	74.38	30.03	22.45	26.24
Sept. 2007	302.3	74.30	30.0	20.0	25.35
Oct. 2007	8.80	59.83	32.0	16.0	25.53
Nov. 2007	18.6	47.71	32.0	14.0	22.85
Dec. 2007	Nil	47.85	33.0	10.5	22.42
Jan. 2008	Nil	49.53	32.0	10	21.45
Feb. 2008	0.7	54.77	35.0	10	22.91
March 2008	136.1	61.96	37.0	15	26.95

Table 3- Number of fish species recorded in the Mullameri river

Sr. No.	Species
	Family Cyprinidae
	Genus: Catla
1.	*Catla catla*
	Genus: Labeo
2.	*Labeo boggut*
3.	*Labeo rohita*
	Genus: Salmostoma
4.	*Salmostoma bacaila*
	Genus: Osteobrama
5.	*Osteobrama cotio cotio*
	Genus: Mystus
6.	*Mystus seenghala*
	Genus: Puntius
7.	*Puntius chilinoides*
	Family : Bagridae
	Genus: Rita
8.	*Rita buchanani*
	Genus: Mystus
9.	*Mystus bleekeri*
	Family: Siluridae
	Genus: Ompok
10.	*Ompok pabda*
11.	*Ompok bimaculatus*
	Family : Channidae
	Genus: Channa
12.	*Channa striatus*
	Family : Mastacembelidae
	Genus: Mastacembelus
13.	*Mastacembelus armatus*
	Family: Notopteridae
	Genus: Notopterus
14.	*Notopterus notopterus*

Table 5- Fish species richness, abundance and biodiversity indices of Mullameri river

	Study sites		
	Site -1 (Lower Mullameri)	**Site -2 (Upper Mullameri)**	**Site – 3 (Chincholli village)**
Species Richness	12	10	7
Species abundance (N)	103	66	50
Shannon – Weiner Index (H)	2.9	2.8	2.5
Simpson's Dominance Index (D)	0.09	0.1	0.1
Simpson's Index of Diversity (1-D)	0.91	0.9	0.9
Pielou evenness	0.7	0.7	0.8
Margalef index of species richness	2.3	2.1	1.5

Table 4-Fish species density, abundance, relative abundance, richness and distribution in Mullameri river

Sr. No.	Species	Study sites			Richness	Abundance	Relative abundance (%)
		Site -1 (Lower Mullameri)	Site -2 (Upper Mullameri)	Site – 3 (Chincholli village)			
	Family Cyprinidae						
	Genus: Catla						
1.	*Catla catla*	18	14	15	3	47	21.4
	Genus: Labeo						
2.	*Labeo boggut*	8	7	7	3	22	10.0
3.	*Labeo rohita*	6	-	-	1	6	2.7
	Genus: Salmostoma						
4.	*Salmostoma bacaila*	-	6	-	1	6	2.7
	Genus: Osteobrama						
5.	*Osteobrama cotio cotio*	6	2	-	2	8	3.6
	Genus: Mystus						
6.	*Mystus seenghala*	5	6	-	2	11	5
	Genus: Puntius						
7.	*Puntius chilinoides*	-	3	3	2	6	2.7
	Family : Bagridae						
	Genus: Rita						
8.	*Rita buchanani*	5	2	5	3	12	5.4
	Genus: Mystus						
9.	*Mystus bleekeri*	4	-	-	1	4	1.8
	Family: Siluridae						
	Genus: Ompok						
10.	*Ompok pabda*	6	-	-	1	6	2.7
11.	*Ompok bimaculatus*	6	-	-	1	6	2.7
	Family : Channidae						
	Genus: Channa						
12.	*Channa striatus*	18	12	11	3	41	18.7
	Family : Mastacembelidae						
	Genus: Mastacembelus						
13.	*Mastacembelus armatus*	11	4	4	3	19	8.6
	Family: Notopteridae						
	Genus: Notopterus						
14.	*Notopterus notopterus*	10	10	5	3	25	11.4

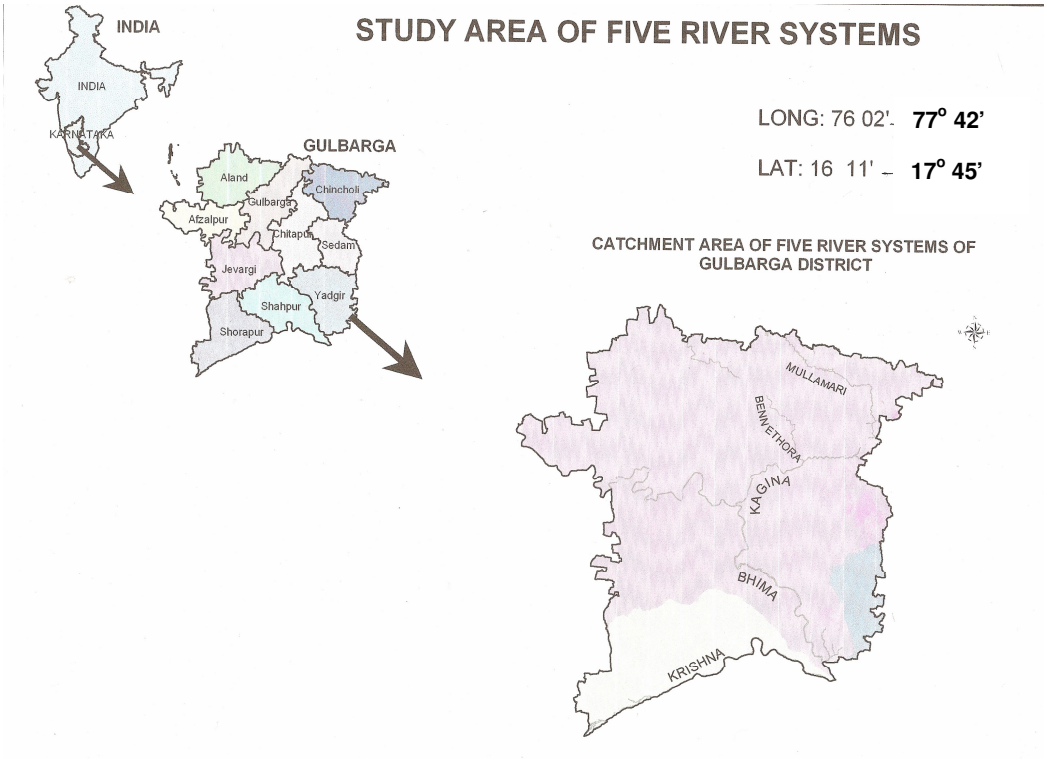

Fig. 1: Location Map Of Study Area

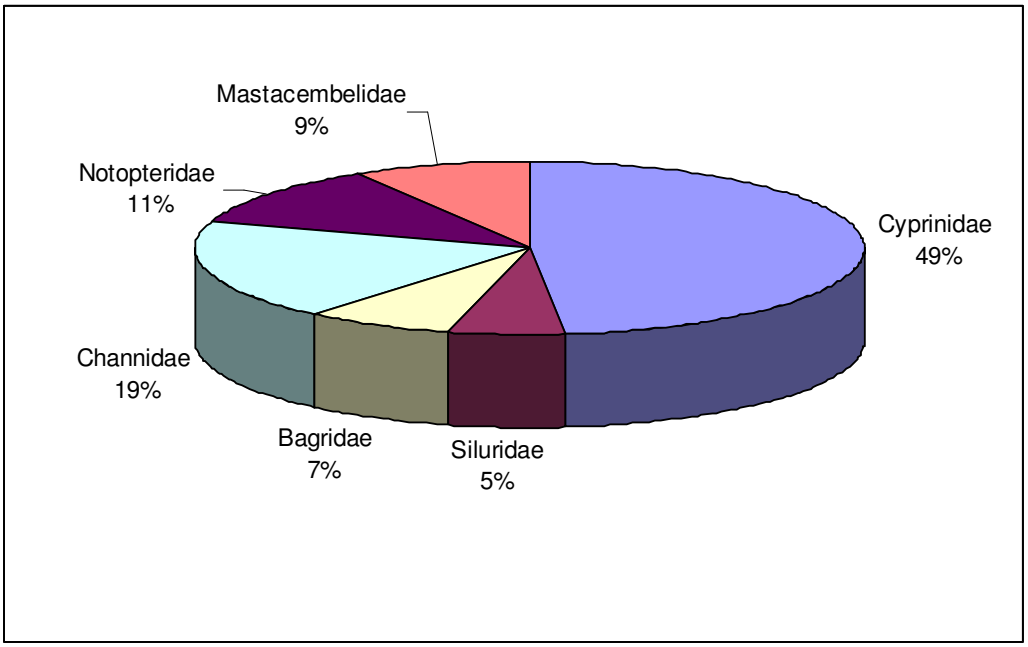

Fig. 2- Percent representation of different families of fishes in Mullameri river