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RESEARCH ARTICLE

Biodiversity of Ornamental Fishes in the Hirakud Reservoir and their Socio-Economic Benefits to Fishers' Communities of the Region

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ABSTRACT

With the objective of analyzing the fish fauna and gathering vital information on the ornamental fish diversity and species richness of the Hirakud Reservoir, a study was conducted during January to June, 2013. The study envisaged linking of the potential ornamental fish availability to the socio-economics of the fishers' community of this region. The collected data reveals the occurrence of 54 species belonging to 35 genera, 19 families and 7 orders. Among the 54 species, 20 species are classified as indigenous ornamental fishes and 6 species are ornamental as well as food fish. The present socio-economic status of the fishers of Hirakud region is poor. The study concludes that ornamental fish can be one of the alternatives for the fishers of Hirakud region for livelihood enhancement. The fisherwomen can be very well avocationed for collection, rearing and further marketing.

Keywords: Species diversity, The Mahanadi river, Hirakud Reservoir, Evenness, Inclusive growth

INTRODUCTION

India is the second largest producer of fish in the world and contributes 5.43% of global fish production. India is also the second largest producer of fish through aquaculture next to China. Fisheries sector occupies a very important place while we consider socio-economic development in the country [1]. In this scenario, ornamental fish is one of the items among the various types of commercially important fishes marketed nationally and internationally [2].The aesthetic value like multicolour, peculiar body shape and swimming behaviour of ornamental fishes and

mythological believe, attracts hobbyist and in turn become a trade practice globally due to the low operating cost and easy management system. The ornamental aquatic industry is a worldwide business with a trade of approximately US$ 15 billion retail value [3]. Developing nations contributed two third of the total export value [4]. The entire industry, including accessories and fish feed, is estimated to be worth around US$ 18-20 billion. More than 2,500 species are traded internationally. The market is dominated by nearly 30-35 species of freshwater fish. Out of this, more than 90% are developed through captive breeding. On the other hand, only 25 out of nearly 8,000 marine ornamental fish species are bred in captivity [5-6]. The trade of ornamental fish is growing with an annual growth rate of 8%and offers a lot of scope for development of the sector [7].

Review of Literature

India is one of the mega-diversity countries in the world and also considered as one of the gold mines for indigenous ornamental fishes. The two mega hubs for freshwater fish diversity in India are the North Eastern region and Western Ghats. Besides, quite a good number of indigenous ornamental fish species are also found in West Bengal [8]. Nearly 806 fish species inhabit in the freshwaters of India [9]. About 52 indigenous species of ornamental fishes are found in North East region of India [10]. Kurup and Radhakrishnan (2006) have reported 79 potential ornamental fishes in Western Ghats with special reference to Kerala [11]. Singh *et al.,* (2013) while reviewing the fish fauna of the Mahanadi Riverine system, has revealed that in the Mahanadi, 38 species are exclusively considered as ornamental and 13 species are recognized for use as ornamental and food both [6].

Hirakud Reservoir, which stands largest man made reservoir in Asia with the longest dam in the world, a major irrigation reservoir, was commissioned in the year 1957 and is situated in Sambalpur, Jharsuguda and Bargarh districts of Odisha with location of 210 30' N Latitude and 800 E Longitude and in the confluence of Mahanadi and the Ib. The reservoir has a water spread area of 463 km2. The catchment area of the reservoir is 83,395 km2 with shore line of 643.6 km [6]. According to Sugunan (1995), the commercial fishery of Hirakud Reservoir comprises nearly 40 species. Hirakud despite being the longest man made earthen dam in the world, remains one of the least researched in terms of its fishery potential [12] The fiah production form this large water body is also on eof the lowest.Having its existence for over 60 years, and having passed through the initial phases of trophic burst and trophic depression, however,the Reservior provides bread and butter to more than 4000 fishermen families directly or indirectly dwelling in its periphery[13].

In view of the potential and possibilities of agribusiness through ornamental fishes in the Mahanadi River, the present study has been undertaken to correlate the availability of potential ornamental fish species in the Hirakud Reservoir with the socio-economics of the fishermen community inhibiting this region.

MATERIALS AND METHODS

Fish species were collected from different landing centres and fish markets of Hirakud region. For taxonomic study, fish samples were preserved in 5% formaldehyde solution. The taxonomic study was done by referring Day (1878), Talwar and Jhingran (1991) and Jayaram (1981). Further, the names of the identified fishes were checked up with the website of fish base [9, 14, 15, 16]. Identifications were further confirmed with the help of Zoological Survey of India, Kolkata. Endemic status of the available ornamental fishes were determined according to the Threatened freshwater fishes of India, National Bureau of Fish Genetic Resources, 2010 and IUCN Red list of Threatened Species, 2012.2 version [17].

For determination of the diversity index for the surveyed and collected samples, Shannon and Wiener (1963) formula was followed, which is:

$$H = -\sum_{i=1}^{S} P_i \ln (P_i)$$

where; H= Shannon-Wiener index of diversity, S= total number of species, P*i*= (N*i*/N) proportion of total sample represented by species *i,* N= total number of individual of all species, N*i*= total number of specimens of each species. Evenness of the diversity index was calculated by using the formula[18]:

$$E = H/H_{max}, \text{where } H_{max} = \ln(S)$$

For analysis of important hydrological parameters, water samples were collected from certain identified landing centres with the help of Directorate of Fisheries, Government of Odisha. Water temperature, dissolved oxygen and pH were measured *in situ* with the help of digital sensors, while free CO_2, total alkalinity, hardness, inorganic nutrients, viz., ammonia, nitrite, nitrate and phosphate were measured using standard methods by following APHA (1998) [19].

Information on the habitat and economic aspect of fishes was also collected from fishermen and local fish retailers. To study socioeconomics of the fishermen communities, interviews were conducted with the fishermen families from different regions as well as the fish retailers in the market of the Hirakud region including Sambalpur town. The minimum sought information especially on the fishing gear used by them, mechanism of operation and types of fish caught, marketing of the catch fish and income earned therefrom, etc .[13, 20].

RESULTS AND DISCUSSION

Species diversity and percentage of ornamental fishes

The entire collected specimen were identified and arranged according to their taxonomic order, family, genus and species. Besides, the economic importance and their conservation status were taken into consideration. The survey recorded 54 species belonging to 35 genera, 19 families and7 orders (Table-1). It was observed that Cyprinidae is the most abundant family contributing 37% of the total species of the different families found in this region (Fig. 1).Among the orders, Perciformes topped the list followed by Siluriformes with less abundance (Fig.2). As regards diversity indices, the Shannon–Weiner diversity index ranged between 3.23 and 3.92 which showed a strong relationship with overall species richness. The result indicated that the species variation among the different selected sites is very less. The evenness varies between 0.84 and 0.91.

Presently, native fish species are in demand as ornamental fishes for trade in national and international markets. These species are *Chanda nama*(Ham.)*, Mystus vitatus*(Bloch)*, Notopterus notopterus*(Pallas)*, Colisa fasciatus*(Bloch &Schn.)*, Colisa laila* (Ham.),*Mastacembeluspuncalus* (Ham.)*, Brachydanio rerio*(Ham.)and *Botia lohachata* (Chaudhuri.)**,** etc. [21] (Ghosh *et al.,* 2003).Among the 19 families of the collected fishes, all other families, except 4 families, namely: Channidae, Cichlidae, Clupeidae and Synbranchidae have ornamental fish representatives. Out of the reported 54 fish species, 20 species are considered as only ornamental fishes, 28 species as only food fishes and 6 species as both ornamental and food fish (Fig.4). Ornamental fish species like *Parambassis lala* (Ham.), *Chanda nama* (Ham.),*Chanda ranga* (Ham.),*Amblypharyngodon mola* (Ham.), *Danio devario* (Ham-Buch.), *Osteobrama cotio* (Ham.), *Puntius sophore* (Ham.),*Puntius ticto* (Ham.),*Rasbora daniconius* (Ham.),*Glossogobius giuris* (Ham.) and *Notopterus notopterus*(Pallas) etc. documented good abundance in this region. In addition, some larger food fishes like *Labeo gonius*(Ham.)*, Channa marulius*(Ham.) and *Rita rita*(Ham.) can also be treated as ornamental fishes during their juvenile stages and are non-classified ornamental fishes [2] (Mandal *et al.,*2007).

Water Quality Parameters

The values of water quality parameters of the Hirakud Reservoir showed that the productivity level falls in the range between the medium and high productive Reservoirs described by Yadava and Sugunan (2009) (Table-2) [22]. However, despite having a huge potential in terms of production, the actual production of Hirakud Reservoir is only 5-6 kg per hectare. The total catch composition revealed that the percentage of small catfishes, major carps and big cat

fishes is nearly the same (Fig.5) as reported by Directorate of Fisheries, Government of Odisha, for the Hirakud Reservoir.

Socio-economics of the fisher community of Hirakud region

The study was undertaken covering100 families with population of 647 persons. The population studied was categorized in three age groups viz., 0 – 15 years, 16 – 45 years and 46 – 60 years. It was observed that fishers in the age group of 16 – 35 years were more in number with more active role in fishing activities. The fishers in the age group of 46 – 60 years are although not directly engaged in fishing, most of them are involved in ancillary activities including making and repairing of craft and gear. Individuals below 15 years of age are occasionally working in the fishing activities along with their elders. Besides fishing, the fishers are also engaged in agricultural activities. In the sample survey, the average sex ratio of the fisher family members is 83 females per 100 males. In the social structure of local fishers, it was found that most of them belong to Kewat caste and follow Hindu religion. The socio-economic survey indicated that the fisher population is educationally backward. Women form the most illiterate group among the fisher population. The age group under 15 years has the highest number of literates forming a little more than 50% of the group while the least literate fishers belonged to the age group of 46-60 years with less than 5%. The average income of a fisher family is in the range between Rs.100-120 per day which is quite low. There are 32 major fish landing centres around the Hirakud Reservoir.

For a judicious fisheries management and security of the Dam, the Hirakud Reservoir has been demarcated into 6 different sectors. Out of these, 5 sectors (I, II, IV,V& VI) have been allotted to five Primary Fishermen Co-operative Societies (PFCS) for commercial fishery on annual lease basis. The Sector–III is retained under Fisheries Department for experimental fishing [13]. It is observed during the study that, out of all the above PFCS, Thebra PFCS (now in Jharsuguda Disttict) is the bease managed one followed by Tamdei. But the other three PFCS are not properly managed due to internal politics and vested interest.

CONCLUDING REMARKS

Inland fishers are more vulnerable in comparison to their counterparts in marine sector or aquaculture farmers [22, 23, 24]. Considering fishery as an industry, the fishermen are the primary stakeholder group. Their capacity to toil and labour provide the platform for the prospective growth of the fishery sector substantially. Without inclusive growth and improvement of their socio-economic condition, the growth of the fishery sector shall not be at the desired level. Poor condition of living standard, unequal access to monetary income, lack of basic amenities and most importantly the education may lead to terrible consequences for the sector. Hence, there is a greater need to enhance the socio-economic conditions of the fishermen so that the fishery sector can augment productivity and enhance income status of fishers [23, 24, 25, 26].

Systematic collection and marketing of native ornamental fishes from the wild alongwith captive breeding and rearing of exotic ornamental fish species can render enormous agribusiness opportunities to the poor fishermen as native ornamental fishes are being recognized and demanded in domestic as well as in international markets [2,21,27]. Hence, this is a realistic approach to suggest that the indigenous ornamental fish species identified in this study have the potential for being a main component of the said agribusiness focusing on the economic potential of the indigenous ornamental fishes and their market value suggested by earlier authors viz. Mandal *et al.*(2007) [2, 27].

Government of India, as per its current policy, allows import of 92 varieties of ornamental fishes in accordance with Guidelines for import of ornamental fishes into India [28]. However, FAO and OIE deliberate that there is always a risk of trans-boundary disease associated with import of an exotic aquatic animal into a country. Such risk can be minimized by facilitating the trade of indigenous ornamental fishes as a result of which import of exotic species will be reduced. However, collection of wild indigenous fishes may also pose risk in terms of stock depletion due to over exploitation of the natural stock. Thus, the best possible design would be the agribusiness of both indigenous and exotic fishes which can be taken up by developing rearing centres for trading and marketing by the local fishers. This

will help in steady supply of ornamental fishes in the market and regular income for the fishers. In turn, this will reduce the fishing pressure on the wild stock and would, therefore complement the conservation efforts of native ornamental fishes.

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Table-1. Different Fish Species Found at Hirakud Region

Order	Family	Species	Food/ Orn.Fish	IUCN Status
1. Perciformes	1. Ambassidae	*Parambassis lala* (Ham.)	Orn.[1]	LRnt[2]
	2. Anabantidae	*Anabas testudineus* (Bloch)	Orn.	VU[3]
		Colisa fasciatus (Bloch&Schn.)	Orn.	LRnt
	3.Centropomidae	*Chanda nama* (Ham.)	Orn.	LRlc[4]
		Chanda ranga (Ham.)	Orn.	LRlc
	4. Channidae	*Channa gachua* (Ham.)	Food	VU
		Channa marulius (Ham.)	Food	LRnt
		Channa punctatus (Bloch)	Food	LRnt
		Channa striatus (Bloch)	Food	LRlc
	5. Cichlidae	*Oreochromismossambicus* (Peters)	Food	Intrd.[5]
	6. Gobiidae	*Glossogobius giuris* (Ham.)	Orn.	LRlc
	7. Nandidae	*Nandus nandus* (Ham.)	Orn.	LRnt
2.Beloniformes	8.Belonidae	*Xenentodoncancila* (Ham.)	Orn.	LRlc
3.Clupeiformes	9.Clupeidae	*Gudusiachapra* (Ham.)	Food	LRlc
4. Cypriniformes	10.Cobitidae	*Lepidocephalichthysguntea* (Ham.)	Orn.	LRlc
	11. Cyprinidae	*Amblypharyngodon mola* (Ham.)	Orn.	LRlc
		Catla catla (Ham.)	Food	VU
		Cirrhinus mrigala (Ham.)	Food	LRlc
		Cirrhinus reba (Ham.)	Food	VU
		Ctenophryngodonidella (Val.)	Food	Intrd
		Cyprinuscarpio (Linn.)	Food	Intrd.
		Danio devario (Ham-Buch.)	Orn.	LRlc
		Danio (Brachydenio) rerio(Ham.)	Orn.	LRlc
		Hypophthalmichthysmolitrix(Val.)	Food	Intrd.

		Labeo bata (Ham.)	Food	LRlc
		Labeo calbasu (Ham.)	Food	NT[6]
		Labeo fimbriatus (Bloch)	Food	LRlc
		Labeo gonius (Ham.)	Food	LRlc
		Labeo rohita (Ham.)	Food	LRlc
		Osteobrama cotio (Ham.)	Orn.	VU
		Puntius sarana (Ham- Buch.)	Food	VU
		Puntius sophore (Ham.)	Orn.	LRlc
		Puntius ticto (Ham.)	Orn.	LRlc
		Rasbora daniconius (Ham.)	Orn.	LRnt
		Salmostomabacaila (Ham.)	Food	LRlc
5. Siluriformes	12. Bagridae	*Mystus (Aorichthys) aor* (Ham.)	Food	DD[7]
		Mystus (Aorichthys) seenghala (Sykes)	Food	LRlc
		Mystus tengara (Ham.)	Orn.	LRlc
		Mystus vitatus (Bloch)	Orn.	LRlc
	13. Siluridae	*Ompok bimaculatus* (Bloch)	Orn./Food	VU
		Ompok pabda (Ham.)	Food	VU
		Ompok pabo (Ham.)	Food	LRnt
		Wallago attu (Bl. &Schn.)	Food	LRnt
	14.Saccobranchide	*Heteropneustes fossilis* (Bloch)	Orn./Food	VU
	15. Claridae	*Clarias batrachus* (Linn.)	Orn./Food	VU
	16.Schilbeidae	*Ailiacoila* (Ham.)	Food	NT
		Clupisomagarua (Ham.)	Food	VU
		Eutropiichthysvacha (Ham.)	Food	LRlc
6.Osteoglossiforms	17.Notopteridae	*Chitala chitala* (Ham.)	Orn.	LRnt
		Notopterus notopterus(Pallas)	Orn.	LRnt
7.Synbranchiforms	18.Mastacembeliae	*Macrognathusaral*(Bloch &Schn.)	Orn./Food	LRlc
		Mastacembelusarmatus(Laceped)	Orn./Food	LRlc
		Mastacembeluspuncalus (Ham.)	Orn./Food	LRlc
	19. Synbranchidae	*Monopteruscuchia*(Ham.)	Food	VU

[1.]Ornamental, [2.]Low Risk near threatened,[3.]Vulnerable, [4.] Low Risk least concern, [5.] Introduced, [6.] Near Threatened,[7.]DD-Data Deficient

Table-2. Water Quality Parameters of Hirakud Reservoir

Sl.No.	Water Parameters	Minimum	Maximum	Mean
1.	Temperature ^{0}C	19	39.6	32.2
2.	pH	7.8	8.2	8.1
3.	Dissolved Oxygen (mg/l)	6.2	9.2	7.9
4.	Total Alkanity (ppm)	39.6	82.2	60.2
5.	Total Hardness (ppm)	41.2	72.3	54.75
6.	Carbon Dioxide(ppm)	4.2	5.6	4.8
7.	Nitrate –N(mg/l)	0.05	2.05	0.56
8.	Nitrite-N (mg/l)	0.001	0.42	0.11
9.	Phosphate (mg/l)	0.025	0.04	0.032

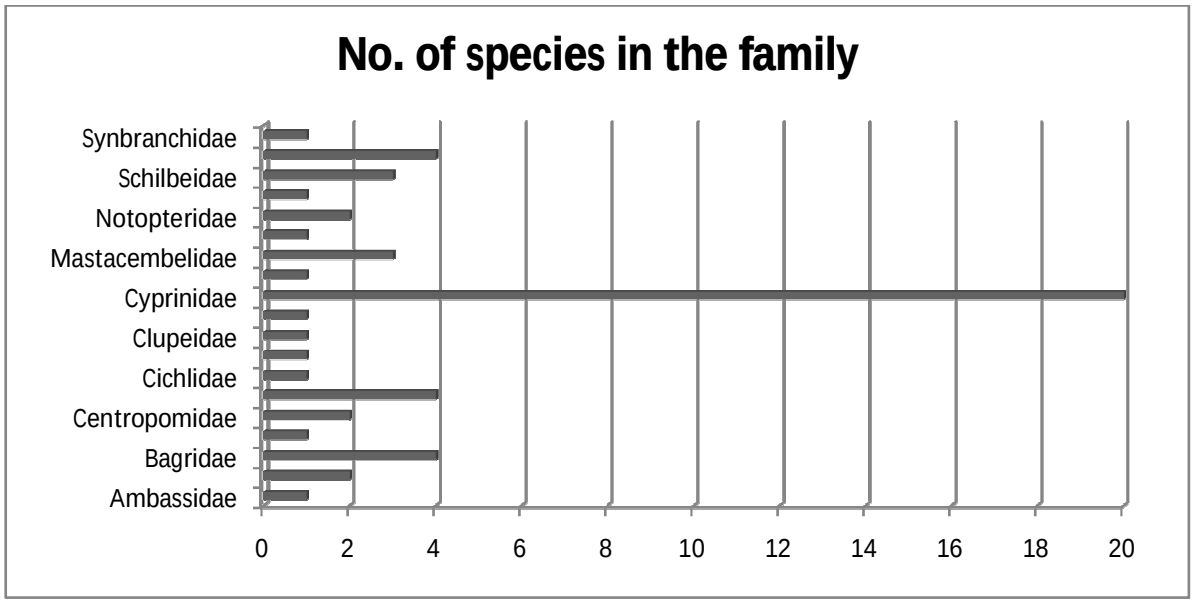

Fig. 1 .Distribution of fish species within different families in the Hirakud Reservoir

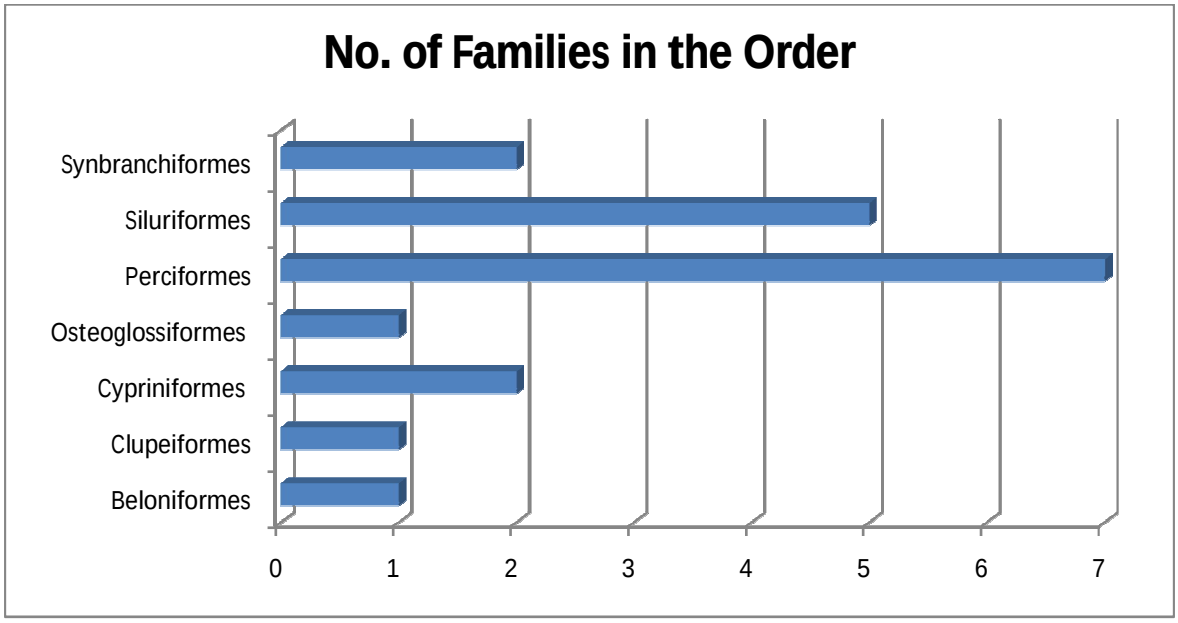

Fig.2.Distribution of fish families within different orders in the Hirakud Reservoir

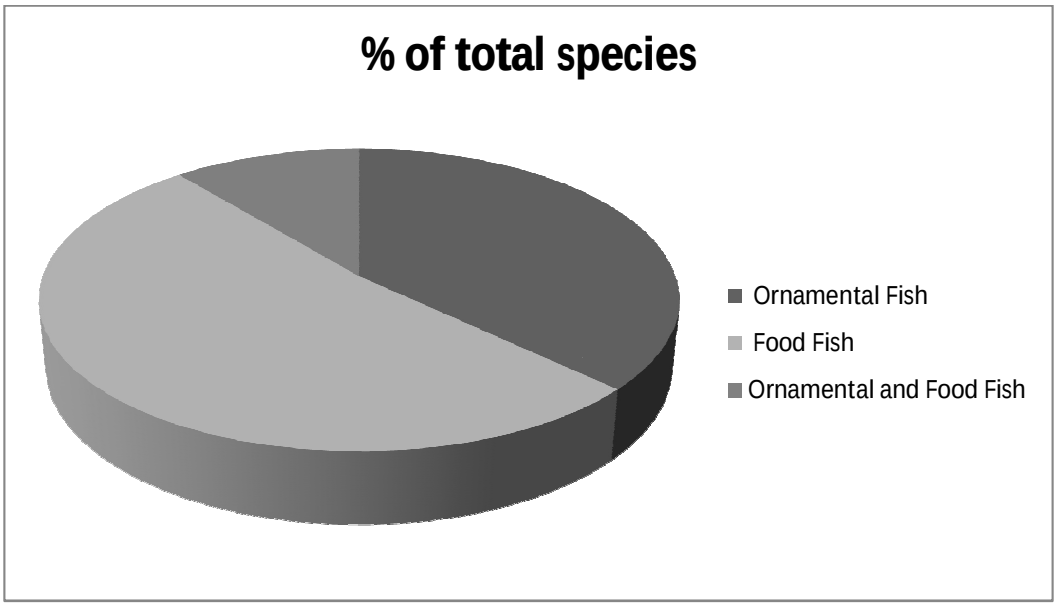

Fig. 3. Percentage of Ornamental fish species to the total fish varieties of Hirakud Reservoir

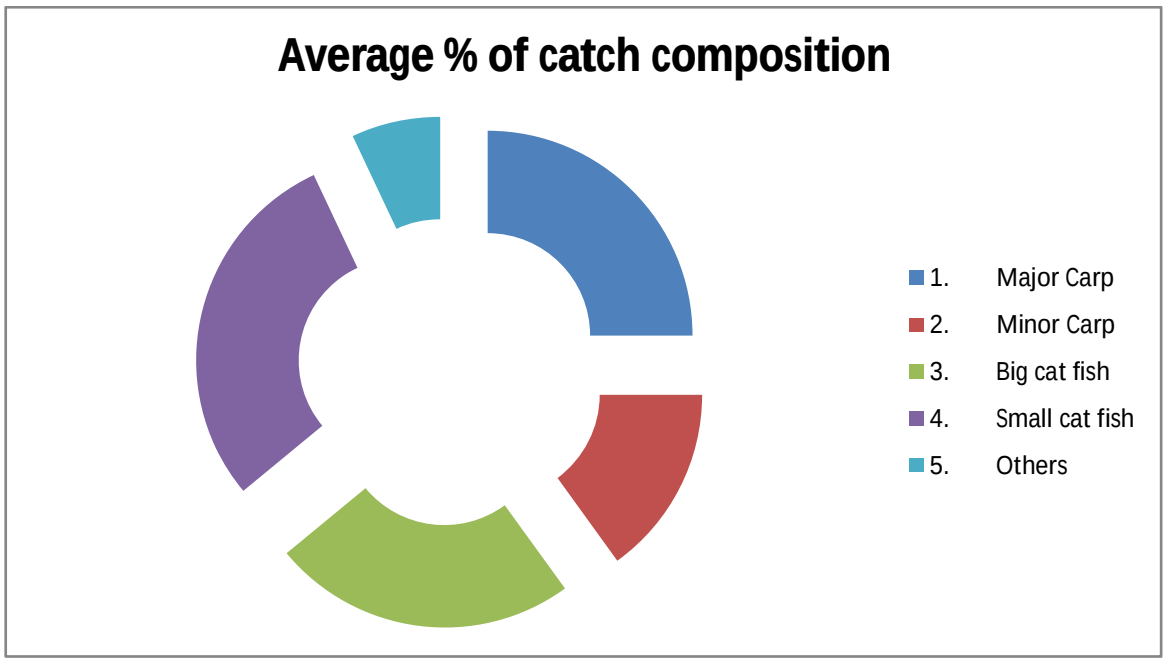

Fig. 4. Catch composition of Hirakud Reservoir