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Study of ornamental fish diversity and water quality of Adda Hole stream, Kabbinale forest range, Western Ghats

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ABSTRACT

Addahole stream belongs to Kabbinale forest of Gundia region. The water quality and ornamental fish diversity were examined. The stream water is fast and slow flowing with clear water and rocky, sandy, leafy substrate. This stream is about 14 kms long, perennial and has different habitats with diverse ornamental fish population. Results revealed the mean values of water quality of all samples collected from different sampling sites were pH 5.50, Water temperature 27.5°C, dissolved oxygen 6.32 mg/l and total dissolved solids 53.06 mg/l. The mean air temperature was 30.3°C. Fish diversity showed presence of twelve different species, belonging to six different families, of which the family Cyprinidae was dominant with Rasboradaniconius and Puntiussps being the most abundant in all seasons. Fish diversity is correlated with physicochemical parameters. The total number of taxa and individuals showed positive correlation with water and air temperature. But it showed negative correlation with dissolved oxygen and positive correlation with total dissolved solids. Shannon-Weaver diversity indices showed positive correlation with air temperature.

Key words: Western Ghats, diversity, Adda hole, Cyprinidae, Ornamental fish diversity.

INTRODUCTION

The Western Ghats (WG) is a mountain range along the western side of India. It runs north to south along the western edge of the Deccan Plateau and separates the plateau from a narrow coastal plain along the Arabian Sea. These hills cover 60,000 km² and form the catchments area for a complex of river systems that drain almost 40% of India (Bhat 2003). The WG constitute one of the 18"**?** Biodiversity hotspots" (Mittermier *et al*.2000). It is also a home to lot of perennial rivers and one can find innumerable streams and waterfalls with different ornamental fishes. The quality of water is described by its physical, chemical and microbial characteristics.

But if some correlations were possible among these parameters, then significant ones would be useful to indicate water quality (Dhembare *et al*.1997)The water quality parameters like temperature, hardness, pH, dissolved gases (oxygen and Carbon-dioxide), salinity etc. must be watched regularly, individually or synergistically to keep the aquatic habitat favorable for existence of fish.

The endemic fishes from various streams and rivers in the WG mountain ranges have been compiled by Ponnaiah and Gopalakrishnan(2000). Studies have been reported on fish diversity in selected streams of northern Karnataka and Central WG by Arunachalam *et al*. (1997), Arunachalam(2000, 2007) and Bhat (2003). Shahnawaz *et al*. (2009) reported relationship between fish diversity and various water quality parameters of Bhadra River of the WG. They found that with increase in pollution, diversity of fish is less. Currently, more than 300 species of freshwater fishes belonging to 11 orders, 33 families and 106 genera are recognized from the WG. Of the 300 species of fishes

inhabiting the different river systems of the WG, 155 are considered as potential ornamental fishes. Of this, 120 species are endemic to the WG region. In spite of the abundance of ornamental fishes, only few have received attention from fish traders in the global market. A few fish species belonging to barbs, loaches, danios are exported from India are collected illegally and directly sent to aquarium trade, as a result of which, many endemic species have now become endangered (Anna *et al.*2009). For instance the Denison's Barb (*Puntiusdenisonii*) is an endemic ornamental fish of WG which has been assessed as endangered. The population has declined by more than 50% in the recent past due to indiscriminate exploitation for the international aquarium pet trade. According to IUCN (2011) the species also has a restricted range with an area of occupancy of less than 300 km² with continuing decline in quality of key habitats. This could be the fate of any other endemic ornamental fish in the WG.

The study area is close to the proposed Gundia Hydel Power Project which has been analyzed as a threat to the flora and fauna (Center for Ecological Science, IISc 2010). Many areas in the place are still unexplored and free from pollution. The aim of the present study was to understand the distribution, diversity and assess any threat existing to the ornamental fishes of this region. The deterioration of water quality, loss of biodiversity and fast depletion of water resources are the main challenges, which need urgent attention. Since the place has not been completely explored, the findings will benefit the planning and management of sustainable fisheries and conservation of natural resources at national level.

MATERIALS AND METHODS

Description of the Study Area

Adda Hole is a perennial stream which is a part of Kabbinale forest range in Hassan district, Karnataka. It is located 2 km from the Gundia Check post(NH 48). The area of the forest is 6072.9 ha. There are a number of small streams in the forest joining one main stream called "Adda Hole". The stream is about 14 kms long and is blessed with rich riparian (70%) cover on both sides. Water at most places is clear with sandy and rocky bottom. Leaf litter is found at few places. Adda hole is a small tributary of Kempu hole river which joins Netravathi river. The annual rainfall is 3000mm and temperature ranges from 22°C and 30°C. The topography of this region is undulating.

Satellite view of the Addahole, Kabbinale forest range

Present study was carried out from May 2011 to May 2012 covering different seasons. Sampling sites were randomly chosen based on accessibility and similarity in physical habitat. Approximately 10 study sites were selected along the stretch of the Addahole stream. Of the 10 sites, Site1 to 4 were located in downstream, Site 5 to 7 located mid-stream, Site 8 to 10 located in the upstream. At every sampling site a water sample was collected to

study physico-chemical parameters. Fish sampling was conducted at each of the sampling site to record fish diversity. Water temperature was measured using hand held glass thermometer at each study site. Similarly, pH, Dissolved Oxygen and Total dissolved solids (TDS) were analyzed using standard methods (APHA, AWWA and WFF 1992, 1995).Substrate materials of each sampling site were determined by visual inspection. For instance, substrates at different study sites were classified using a numeric code '0' for silt and clay, '1' for sand, '2' for leaf litter, '3' for pebble, as followed by Bain (1999) and Sarkar & Bain (2007).Fish habitat was measured based on methods described by Pusey *et al.* (1993).Different habitats have been mentioned in Table1. Fish sampling was done by using different types of fishing gear including cast nets (9', 1"; 9', 1/2") and drag nets (with varying mesh sizes) were used to collect the fishes.10 to 15 sweeps were done using the different nets at each site to catch fish. Similar effort was kept constant at other sampling sites. The fish caught were examined, photographed and released to the system. Fishes were identified at species level following the standard books, (Jayaram 1999, 2010 and Talwar & Jhingran 1991).

Fish species diversity was subjected to diversity analysis using indices like species richness (S = number of species); Shannon – Weaver Information Index (1949); Simpson Dominance Index (Simpson 1949); Species Dominance Index (Berger and Parker 1970); Peilous Evenness (Pielou 1966)

Shannon-Weaver index

$$H=S/1 = 1\ [\Sigma\ (Pi)\ (Log2Pi)]$$

Where,
H = Shannon-Weaver index
Σ represents a capital epsilon
S= number of species, pi= proportion of individuals of the total sample belonging to thei species calculated as ni/N for each i^{th} species with ni being the number in species I and N, the number of individuals in the sample.

Simpson Diversity Indices

$$D2= \sum_{J=I}^{Sn} (nj/n)\ (n - nj/n - I)$$

Where, nj = number of individuals of the j^{th} species in the sample
n= Σ nj = total number of individuals
$_j$Sn = number of species in the sample

Evenness

$$V' = \Delta/\Delta max$$

Where V'=Pielou evenness
Δ= observed value of parameter
Δ Max = value parameter would assume if all S species were equally abundant

RESULTS AND DISCUSSION

Totally 12 species of fishes belonging to 6 different families were recorded (Table 2). Of these, family Cyprinidae was the most dominant (70%). As these fishes have evolved a variety of mechanisms to adapt to living in swift flowing water bodies, these are in accordance with the results of previous studies (Atkore 2011; Abraham *et al*. 2010; Johnson *et al*. 2009; Wakid and Biswas.2005; Jhingran 1991; Jayaram1999,2010 and Bhat2003) which also say that Cyprinidae family is the most dominant in many water bodies of WG.

There were 4 endemic ornamental fishes in our study area namely *Puntiusnarayani, Carinotetradon imitator, Bhavaniaaustralis, Schistuaranagodiensis*. They contribute to 30% of the total fishes, thus showing high endemicity. As far as the diversity indices (Table- 4) are concerned the Shannon- Weaver diversity indices of the fishes were found to be highest at Site-1(2.022) and lowest at the Site-2(1.252). This could be due to different habitats. The Simpson indices were high at Site-1(0.8609) and low at Site-2(0.6009), but the species dominance

index was high at Site-2(0.3992) and low at Site-1 (0.1391). The evenness values were recorded high at Site-5(0.9772) and low at site-2(0.5829). Similar results were also found in Bhadra River by Shahnawaz*et al*. (2009).

Table 1:Table showing the habitat type and substrates at different sampling

Parameter	Site1	Site2	Site3	Site4	Site5	Site6	Site7	Site8	Site9	Site10
Substrate	0	2	1	3	3	2	0	3	1	2
Habitat	SW	ShW	ShW	FW	FW	SW	ShW	R	SW	R
Riparian cover	Y	Y	Y	N	N	Y	Y	N	Y	Y

0= Silt and clay *Y= Present*
1=Sand *N= Absent*
2=Leaf litter *R=Riffle*
3= pebble *F=Fastwater*
ShW= Shallow Water

Table 2: Showing family wise representation of Fish species ('X'= Presence,'0' =Absence)

Sl no	Species		Study sites									
	Scientific name and Family	**Common name**	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10
	Family: Cyprinidae											
1	*Rasboradaniconius*	Striped rasbora	X	0	X	X	X	X	X	X	X	X
2	*Danioaequipinnatus*	Giant danio	X	X	0	0	X	X	X	X	0	0
3	*Garramullya*	Kallukorava	0	X	0	0	X	X	0	0	0	X
4	*Puntius sophore*	One spotted barb	0	X	0	0	X	0	0	X	X	0
5	*Puntiusfilamentosus*	Filament barb	X	0	0	X	0	X	X	X	X	X
6	*Puntiusfasciatusfasciatus*	Melon barb	X	0	X	X	0	X	0	X	X	X
7	*Puntiusnarayani*	Narayan barb	X	0	0	0	X	0	X	0	X	X
	Family: Aplocheilidae											
8	*Aplocheiluslineatus*	Killi fish	X	0	X	X	0	0	0	X	0	0
	Family: Tetraodontidae											
9	*Carinotetraodon imitator*	Dwarf Puffer	X	X	X	X	0	0	X	X	X	0
	Family: Nemacheilidae											
10	*Schisturanagodiensis*	Hill stream loach	0	X	0	0	0	X	X	0	0	X
	Family: Channidae											
11	*Channagachua*	Snake head fishes	0	X	0	X	0	0	X	X	0	X
	Family: Balitoridae											
12	*Bhavaniaaustralis*	Western ghats loach	X	0	X	0	0	X	0	0	0	0

Table 3: Showing the fish diversity indices of Adda Hole Stream

	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10
Taxa_S	8	6	4	6	5	7	7	8	6	7
Individuals	26	27	18	46	30	52	42	49	54	50
Dominance_D	0.1391	0.3992	0.3272	0.2221	0.2111	0.2078	0.1519	0.1853	0.1941	0.2008
Shannon_H	2.022	1.252	1.211	1.619	1.581	1.736	1.914	1.859	1.706	1.739
Simpson_1-D	0.8609	0.6008	0.6728	0.7779	0.7889	0.7922	0.8481	0.8147	0.8059	0.7992
Evenness_e^H/S	0.9442	0.5829	0.8392	0.8412	0.9722	0.811	0.9689	0.8022	0.9177	0.8132

Table 4: Mean values of physicochemical parameters of different sampling sites of Adda Hole Stream

Water Quality	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10
Air temperature, °C	30	29	28	31	28	29	32	33	32	31
Water temperature, °C	28	26	26	28	25	27	29	29	29	28
Ph	5.02	4.5	6.2	5.2	5.5	5.7	5.8	5.6	5.1	6.19
Dissolved oxygen (mg /l)	6.56	6.62	6.75	6.25	6.5	6.15	5.85	6.26	6.1	6.25
Total dissolved solids (ppm)	52.61	51.45	50.85	51.14	51.87	52.56	54.37	53.87	56.87	55.01

The similarity in species composition was analysed by using the jaccard index (JI) for calculating the extent of similarity between pairs of data sets (Magurran 2004). The JI value of sites 6, 7 and 10 was highest in comparison to site-2 and 5. This could be due to presence of riparian cover in these habitats. The similarity in species composition across sites is shown as a dendogram (Fig 1) obtained from the JI co-efficient of similarity using the average linkage method. Sites 2 and 3 were found to be least similar while sites 1, 8 and 4 show great similarity in species composition.

Fig 1: Dendogram showing similarity in species composition across 10 sampling sites based on Jaccard Index

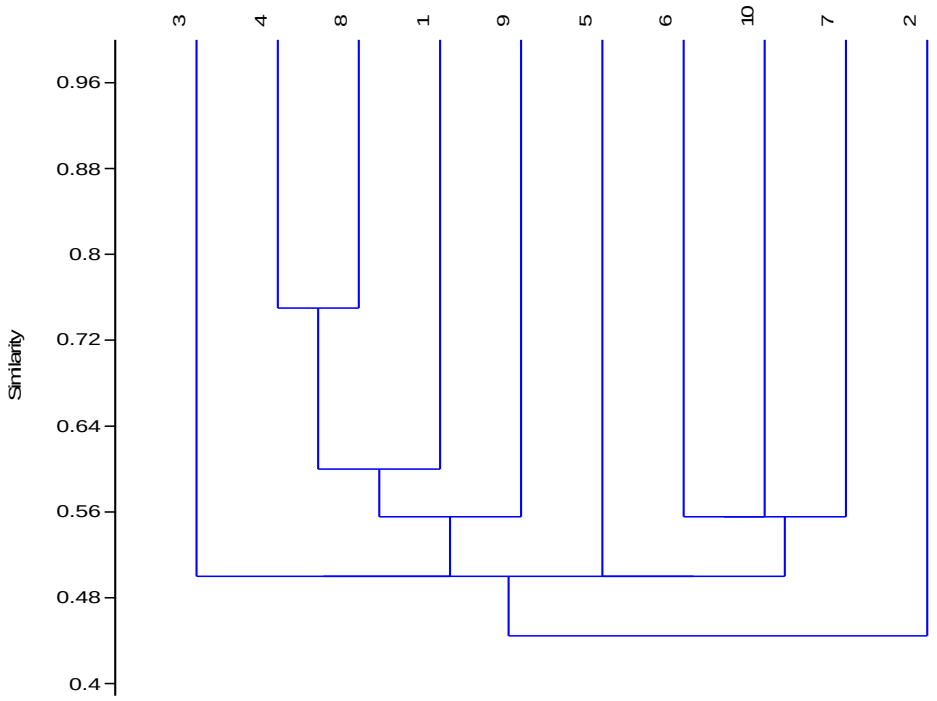

Table 5: Pearson - correlation between diversity indices and physico-chemical parameters
(indicates Positive correlation)*

	Air temperature, °C	Water temperature, °C	pH	Dissolved oxygen (mg /l)	Total dissolved solids (ppm)
Taxa_S	0.636*	0.674*	-0.147	-0.457	0.413
Individuals	0.689*	0.659*	0.122	-0.821**	0.679*
Dominance_D	-0.54	-0.626	-0.246	0.619	-0.526
Shannon_H	0.623	0.704*	0.063	-0.616	0.532
Simpson_1-D	0.54	0.626	0.246	-0.619	0.526
Evenness_e^H/S	0.147	0.245	0.338	-0.346	0.302

The mean values of Physico-chemical parameters of 10 sampling sites across all seasons were summarized in Table3. pH was highest (6.20 mg 1/l) at site-3 when compared with other sites. Mean water temperature was observed to be lower than air temperature due to less heating of the water body. Dissolved oxygen was highest at site-3(6.85mg/l) and lowest at site-7 (5.85 mg/l) showing good aeration of the stream. High value of total dissolved solids was found at site-9(56.87 ppm) and least at site-3(50.85 ppm).

Correlation among taxa and diversity with phyisco-chemical parameters are summarized in Table5.The total number of taxa showed positive correlation with water (0.63*) and air temperature (0.67*). It was the same with respect to total number of individuals (Water 0.68*, Air 0.65*), but it showed negative correlation with dissolved oxygen (-0.821**) and positive correlation total dissolved solids (0.679*). Shannon-Weaver diversity indices showed positive correlation with air temperature (0.704*). Simpson diversity indices and Evenness didn't show any significant correlation with phyisco-chemical parameters. Similar results were also recorded on ichthyofaunal diversity status of Bhadra River(Shivashankar *et al*. 2012).The habitat types have shown considerable variation in substrate types and riparian cover. The riparian cover is one of the important attributes for fish population to survive. It is having the

direct influence on fish habitat as it works as a food source, as some species feed on insects which fall from trees (Shahnawaz*et al*. 2009). The variation in species diversity at different sampling sites is less perhaps due to the similarity in habitats. Possible threat is the construction of Mini Hydel Power Project at Gundia which could have a direct impact on the fish habitat and diversity of Adda hole(CES,IISc2010).The use of illegal methods to catch fish should be banned in the area to prevent further depletion of ornamental fish.

CONCLUSION

Care needs to be taken towards conservation of their natural habitat.In conclusion, our study reveals that Adda Hole is an important stream for ornamental fish diversity of Western Ghats. Findingsof this study may be beneficial for the government to take necessary steps to conserve similar areas. Further study could lead to discovery of some less known or new ornamental fish species of the Western Ghats.

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