

Patterns of fish assemblage in Keecheri river system of Southern Western Ghats, India

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Abstract— Ornamental fish industry is a booming trade event with species crossing national and international boundaries throughout the year. Rivers are treasure houses of rich Ichthyofaunal diversity whose sustainable exploration would boost the ornamental fish industry. The distribution pattern of fish through seasons and places identify the sites and availability of various fish species.

In the present work the spatial and temporal distribution of fishes of Keecheri river was studied to aid the process of collections for ornamental fish industry. Species dominance, diversity, richness, and evenness were estimated. The fish distribution studies revealed that the river followed a strong longitudinal pattern of distribution. Seasonal distribution of fish indicates that premonsoon and post monsoon season were rich in diversity and richness. Still the appropriate time to collect the fish is during the pre-monsoon season when the river starts to dry up. High diversity was observed in the downstream.

Index Terms— Distribution, Fish diversity, Keecheri river, Western ghats

I. INTRODUCTION

According to Kottelat & Whitten, (1996) the diversity of Indian fish fauna is underestimated and the freshwater fish represent a threatened set of vertebrates (Leveque, 1997). Of the 34 hot spots of biodiversity identified in the world, Western Ghats is one with rich endemism (Bhat and Jayaram, 2004). Still, the ecosystem bears imprints of human interventions (Chandran, 1997) and a great number of endemic fishes are threatened (Dahanukar *et al.*, 2011; Raghavan *et al.*, 2012).

The majority of aquaria fish traded internationally are freshwater species (Whittington *et al.*, 2000). Although the majority of freshwater fish involved in the trade

are from captive-bred sources, significant numbers are still removed from the wild (Andrews, 2006), most being caught primarily from rivers and streams. Fish can be sustainably harvested, as long as the capture is optimum. Aquarium fish collectors are highly selective and often capture large quantities of species of high value.

Conserving biodiversity in recent years has become a concern of the global elite because of the commercial potential of the emerging biotechnologies. But much of this biodiversity resides in the third world tropics which are currently being drained of their biological and mineral wealth (Gadgil, 1993). Many of the laws of biodiversity promote conservation of biodiversity but not its sustainable utilization.

Thomas (2004) accounted for threatened fishes of India and Biju (2005) annotated conservation status of fishes of rivers of Kerala. At the juncture when local fishery is taking a face change to become international with wider prospects and lump sum returns it is decidedly essential to describe the fish assemblage pattern of rivers for the optimum utilization. Dominance, species richness, diversity and evenness are the vital alpha diversity measures. Species richness measures the total number of species in a community, species diversity their relative abundance and species evenness the equitability.

The distribution of the ichthyofauna dynamically varies within and between the rivers (Biju *et al.*, 2000; Kurup *et al.*, 2004; Bhat, 2004; Vyas, 2012). Scientific work related to pattern of fish distribution in Indian rivers is insufficient and no data exist on temporal and spatial patterns of ichthyofaunal distribution in Keecheri river system. The indigenous ornamental fish industry needs to be constructed on sufficiently strong props of resource availability. Therefore, the study of

distribution of fishes in Keecheri river system was evaluated for, the information on distribution of fish over time and space provides basic idea to assess a fishery resource.

II. MATERIALS AND METHOD

Five equidistantly placed stations were selected for the river. The sites chosen for Keecheri river were Ke1 Machad, Ke 2 Mangad, Ke 3 Chiranellore, Ke 4 Madukara, Ke 5 Idianchira. Extensive collections of live fishes were made during January 2010 to December 2012 using gillnets, cast nets, traps and scoop nets.

The collected fishes were sorted out, they were washed and dried and dropped into 7% formalin for preservation. They were brought to the laboratory and fixed in freshly prepared formalin. Collected Fishes were subjected to diversity analysis. Species composition and quantitative characteristics have been assessed in the present study by the following measures.

Species Dominance was calculated according to Simpson index of Dominance (1949), Species diversity was calculated by Shannon -Weiner index of diversity, species richness was calculated by using the method 'Margalef's index of richness' (Magurran and Magurran, 1988) and species evenness by Buzas and Gibson's Index. Jaccard's coefficient was also evaluated by the formula $C_j = j/(a+b-j)$ Where, j is the number of species recorded in both sites, a is the number of species recorded in Site A and b is the number of species recorded in Site B. The similarity in species composition across the different sites is expressed as a dendrogram created by hierarchical cluster analysis. The diversity indices of different sites were subjected to statistical analysis by two-way ANOVA and tukey's pair wise test.

III RESULT AND DISCUSSION

In total 2313 number of fishes were obtained from Keecheri river with 1208 captured during post monsoon, 591 in monsoon and 514 in pre monsoon. Five species contributed fifty percentage of the total catch for Keecheri river (Fig. 1.) Table 1 shows the dominance index of Keecheri river. The dominance index varied from 0.061 at Ke 4 during the pre-

monsoon to 0.423 at Ke 2 in post monsoon. Mean Dominance index was consistent and did not change much during monsoon, post monsoon and pre monsoon in the river with 0.208, 0.220, 0.200. It was slightly high in the upstream of the rivers with the highest at Ke 2. Figure 2 shows the seasonal dominance index in the various sites in Keecheri river. Two-way ANOVA between the different site and between seasons in Keecheri river (Table 2) indicated that F-value for comparing between seasons (0.068) and between sites (1.831) was found to be non-significant at 0.05 level indicating that there is no significant difference in the dominance index between sites and between seasons.

Table 3 and Figure 3 shows the seasonal diversity index in the various sites in Keecheri river. The diversity index increased from 1.123 at Ke 2 during the post monsoon to 3.126 at Ke 5 in pre monsoon. Mean diversity index as a general trend increased from upstream to downstream and showed a highest during the premonsoon with the average value 2.186.

Two-way ANOVA was carried out for comparing the Shannon – Weiner species diversity index between the different site and between seasons in Keecheri river (Table 4). F-value for comparing between seasons (0.650) and between sites (2.705) was found to be non-significant at 0.05 level indicating that there is no significant difference in the diversities between sites and between seasons.

Table 5 shows the richness index in the various sites in Keecheri river. Highest species richness was observed at Ke 5 6.72 in premonsoon. It was the lowest in Ke1 in premonsoon with 1.031 in Keecheri river. Mean species richness was lowest in monsoon while it increased from upstream to downstream. Figure 4 shows the seasonal variation in margalef's species richness at the various sites in Keecheri. Two-way ANOVA was carried out for comparing the Margalef's Species richness index between the different site and between seasons in Keecheri river (Table 6). F-value for comparing between seasons (2.712) and between sites (3.803) was found to be non-significant at 0.05 level indicating that there is no significant difference in the species richness index between sites and between seasons.

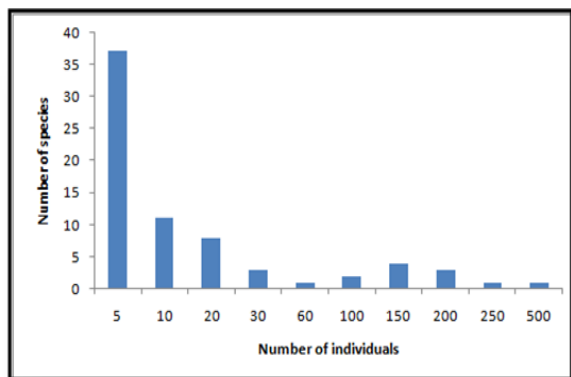


Fig. 1 Distribution of collection representing number of individuals per species for Keecheri river

Table 1 Species dominance index at the different sampling sites in Keecheri river

Seasons	Sites					Avg.
	Ke1	Ke 2	Ke 3	Ke 4	Ke 5	
Monsoon	0.188	0.190	0.274	0.177	0.214	0.208
Post monsoon	0.212	0.423	0.211	0.182	0.072	0.220
Pre monsoon	0.329	0.233	0.233	0.145	0.061	0.200
Average	0.243	0.282	0.239	0.168	0.116	0.210

Table 2: Two-way ANOVA of simpson’s dominance index at the different sampling sites in Keecheri river

Source	Df	Sum of squares	Mean square	F-value	p-value
Between seasons	2	0.001	0.0005	0.068 ^{ns}	0.935
Between sites	4	0.053	0.013	1.831 ^{ns}	0.216
Error	8	0.058	0.007		
Total	14	0.113			

ns non significant at 0.05 level

Table 3 Shannon – weiner species diversity index at the different sampling sites in Keecheri river

Seasons	Sites					Avg.
	Ke1	Ke 2	Ke 3	Ke 4	Ke 5	
Monsoon	1.955	1.873	1.519	2.031	1.844	1.844
Post monsoon	1.91	1.123	1.979	2.316	2.883	2.042
Pre monsoon	1.363	1.919	1.93	2.431	3.126	2.153
Average	1.742	1.638	1.809	2.259	2.617	2.013

Table 4: Two-way ANOVA of Shannon – Weiner species diversity index at the different sampling sites in Keecheri river

Source	Df	Sum of squares	Mean square	F-value	p-value
Between seasons	2	0.246	0.123	0.650 ^{ns}	0.548
Between sites	4	2.044	0.511	2.705 ^{ns}	0.108
Error	8	1.511	0.189		
Total	14	3.800			

ns non-significant at 0.05 level

Table 5: Margalef’s Species richness index at the different sampling sites in Keecheri river

Seasons	Sites					Avg.
	Ke1	Ke 2	Ke 3	Ke 4	Ke 5	
Monsoon	2.399	2.172	1.272	2.687	2.775	2.261
Post monsoon	2.606	1.162	2.998	4.718	5.177	3.332
Pre monsoon	1.031	3.322	3.307	5.341	6.72	3.944
Average	2.012	2.218	2.525	4.248	4.890	3.179

Table 7 and Figure 5 shows the seasonal variation in evenness index in Keecheri river. Lowest species evenness was observed at Ke 3 premonsoon with value of 0.3446 and highest value of 0.7444 at Ke 5 post monsoon in Keecheri river. Evenness was high in the monsoon season.

Two-way ANOVA was carried out for comparing the Buza’s and Gibson’s species evenness index between the different site and between seasons in Keecheri river (Table 8). F-value for comparing between seasons (0.862) and between sites (0.248) was found to be non-significant at 0.05 level indicating that there is no significant difference in the evenness indices between sites and between seasons.

Similarity between sites in Keecheri is represented as dendrogram in Fig. 6. In Keecheri river highest similarity was observed between site Ke 2 and Ke 3 with a value of 0.516 and between Ke 3 and Ke 4 with a value of .5 and the lowest between Ke 1 and Ke 5 with a value of 0.088. The figures created with jaccard’s similarity index show that upstream, midstream and downstream stations are presented as separate clusters.

Fish assemblage varies in different flow regimes of the river due to the variation in geography, habitat, irregular depth, submerged vegetation, geology and physico chemical characteristics (Vijalaxmi et al., 2010; Lakra et al., 2010b).

Table 6: Two way ANOVA of Margalef’s Species richness index at the different sampling sites in Keecheri river

Source	Df	Sum of squares	Mean square	F-value	p-value
Between seasons	2	7.259	3.629	2.712 ^{ns}	0.126
Between sites	4	20.355	5.089	3.803 ^{ns}	0.051
Error	8	10.704	1.338		
Total	14	38.318			

ns non significant at 0.05 level

Table 7: Buza’s and Gibson’s species evenness index at the different sampling sites in Keecheri river

Seasons	Sites					Avg.
	Ke1	Ke 2	Ke 3	Ke 4	Ke 5	
Monsoon	0.588	0.651	0.761	0.634	0.371	0.601
Post monsoon	0.519	0.512	0.452	0.440	0.744	0.533
Pre monsoon	0.558	0.378	0.344	0.366	0.690	0.467
Average	0.555	0.514	0.519	0.480	0.602	0.534

Table 8: Two-way ANOVA of Buza’s and Gibson’s species evenness index at the different sampling sites in Keecheri river

Source	df	Sum of squares	Mean square	F-value	p-value
Between seasons	2	0.045	0.022	0.862 ^{ns}	0.458
Between sites	4	0.026	0.006	0.248 ^{ns}	0.903
Error	8	0.208	0.026		
Total	14	0.278			

ns non significant at 0.05 level

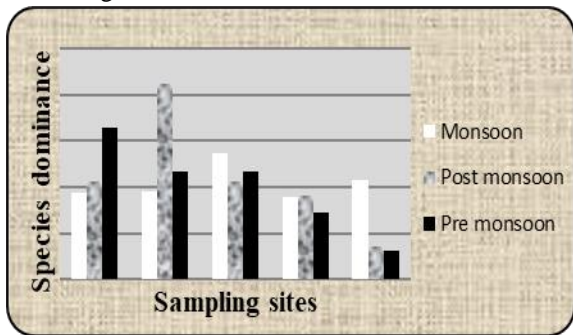


Fig. 2: Seasonal species dominance at the sampling sites of Keecheri river

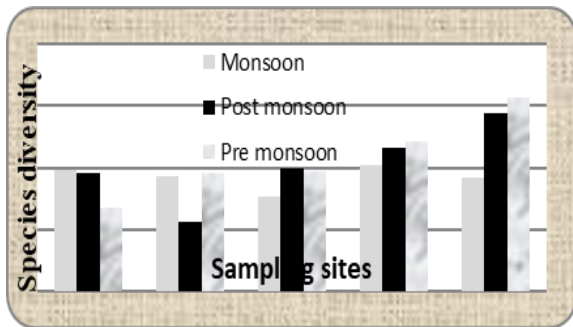


Fig. 3: Seasonal species diversity at the sampling sites of Keecheri river

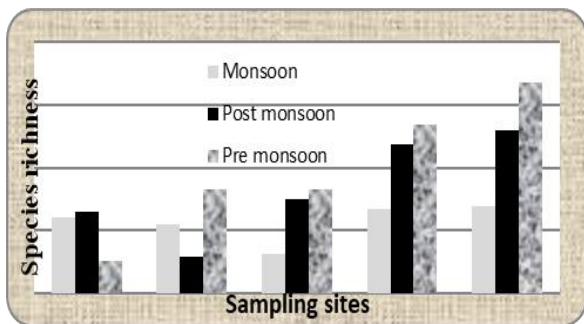


Fig. 4: Seasonal species richness at the sampling sites of Keecheri river

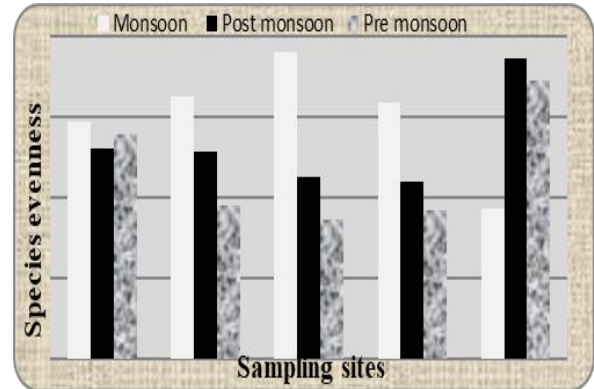


Fig. 5: Seasonal species evenness at the sampling sites of Keecheri river

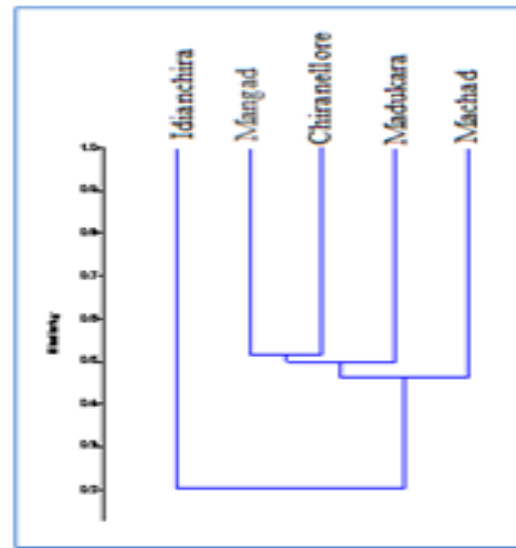


Fig. 6. Dendrogram showing similarity in species composition across different sites of Keecheri river. In the Keecheri river system the fish distribution and abundance varied markedly along the longitudinal upstream-downstream gradient and seasonal temporal gradient. Maximum fish species richness was found in the downstream it had a direct relationship with increasing stream order and smaller sized fishes upper stream. Down reaches of the rivers had freshwater and secondary fresh water fishes that were migrating from estuaries. The present studies indicate that the abundance distribution is indicative of a typical left skew showing that most of the fish species are relatively rare and a few species alone dominate. The abundance of species across the Ramganga river in the Shiwaliks rivers showed a left skew. About 25 species were rare, represented by less than 15 individuals out

of a total 12,330 (Atkore, *et al.*, 2011). Eight species of total 54 species composed almost 90% of the captured individuals (Buisson, *et al.*, 2008). Lakra *et al.*, (2010b) in his studies on distribution of fishes in river also observed that 10% of the fishes were common to all sites.

In the present study strong variation in fish assemblage was identified from upstream to downstream. Highest Simpson's dominance index value was (0.178) in Pallickal river (Jayalekshmy and Sanalkumar, 2012). In the present study it was 0.423 in the Mangad site in Keecheri river. The Shannon weiner index in the present study ranged from 1.123 to 3.126. Species richness was high at Madukara and Idianchira in Keecheri river. It has been observed that there is an increasing species richness along the stream gradient. The variation in species richness was negligible in sites in upper reaches of the Keecheri river they were equally rich in species and this may be due to the positive influence of the reservoir in the river that provides abundant water. Moreover, the sites had a pool habitat, which are preferred niche of the fish (Lakra *et al.* 2010b). Kruk (2007) was also of the opinion that dam and check dams alter habitat while the riverine ichthyofauna change gradually along longitudinal profiles of rivers. In the present study the difference in evenness index was insignificant in the different sites and seasons.

The longitudinal patterns of fish assemblages partitioning the river into clear biogeographic areas is not uncommon (Santoul *et al.*, 2005). The species richness, diversity, and abundance gradually increased from upstream to downstream. Species additions and replacements at the lower reaches created detectable changes. Falke and Gido (2006) also observed that there is occurrence of higher species richness at the confluence of tributary streams with the main river than in the tributary streams.

The studies by Sheeba (1999) reveal that abundance and diversity was maximum in dry season and Renjithkumar *et al.* (2011) observed that highest landings were reported during premonsoon season in Pampa river and the lowest in monsoon season. In the present study also the species diversity and richness in the river was high in the post monsoon and premonsoon months and lowest in monsoon months. However no significance, was observed in the dominance and evenness index in the various sites.

IV CONCLUSION

Therefore the data of seasonal variations and temporal distribution in fish communities of Keecheri river system could be judiciously used for future comparisons of the fish communities of the river systems. There is immense necessity for management of the natural resources for developing ornamental fishery for national development the data provides useful insight on the assemblage and distribution patterns of the fish in the river.

V ACKNOWLEDGEMENTS

The author is thankful to Dr. N.D Inasu former pro-vice chancellor CUSAT for the guidance and support during entire work. This work was supported by the grant from the UGC.

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