ICHTHYOFAUNAL DIVERSITY OF KALLADA RIVER IN RELATION TO THE PHYSICO-CHEMICAL PARAMETERS AND HABITAT COMPLEXITY

[1]Sawmiya Udayan, [2] Sreeja. J
[1]Research Scholar, [2]Associate professor,
[1] Department of Zoology,
[1]S.N College, Kollam, Kerala, India,

Abstract: Kallada River is one of the major rivers in Kerala, which is home to some endemic fishes of Western Ghats. The present study investigated the ichthyofaunal composition, diversity, and distribution in different regions of Kallada River. Sampling was carried out monthly from Jan 2013 to Dec 2013. Six sites were sampled covering downstream, midstream and upstream regions. Specimens were collected using cast net and scoop net. Fishes collected were identified using relevant taxonomic guides. Physico-chemical characteristics of the sites and biodiversity in different stretches of the river were assessed. The PCA analysis showed the two downstream regions are homogenous in terms of the physico-chemical parameters while midstream and upstream regions are more similar. The annual fish composition comprised of 31 species, from 17 genera and 12 families. Species from Cyprinidae family dominated in all communities of Kallada River ecosystem except downstream. *Dawkinsia filamentosa* was the common species found in all parts of the river regardless of the physico-chemical differences while *Dawkinsia exclamatio* was rare found only in the upstream regions in a short range. six stations studied the highest value of species richness and diversity was observed in Enathu (mid-stream), Thenmala and Kulathupuzha (upstream region) during all three seasons. This region showed greater heterogeneity in physical habitat when compared to other sites. The downstream region showed low diversity as, continuous sand mining activities and indiscriminate fishing activities over past few decades have resulted in a homogenous habitat and loss of fish diversity. Conservation and management strategies are required for protection of fish species inhabiting this water body.

***Index Terms* - Western Ghats, fish community, diversity, idiosyncratic.**

I. INTRODUCTION

Western Ghats are one of the hotspots of biodiversity. The streams and rivers flowing through these regions are known to harbor diverse biota including many endemic and rare species. Kallada River is one of the major perennial rivers of Kerala which originates in the high lands of Western Ghats. Most of its upstream regions are now part of wild life sanctuary or protected reserve areas. Kallada River forms an indispensable source of fish resources, water and power production. But at the same time any use of natural resources warrants sustainability. Resource management and conservation of biodiversity are our major concerns, and these require a better understanding of the structure and function of biotic communities, their habitat requirements and factors influencing them (Johnson and Arunachalam, 2010). The ichthyofaunal diversity seen in the rivers is related to the variability and complexity of the physical habitat, while it is adversely affected by anthropogenic pressures and environmental factors like flood and drought (Paller et al., 2013). A poor correlation between species richness and habitat complexity is observed when the variability in population is more may be due to extinction and recolonization (Anglermere and Schosser, 1989). The abundance of the species in an area is also correlated to their environmental preferences and the ecological ranges, with specialist species out numbering generalist species in each habitat (Tylor et al., 1993).

The ichthyofaunal diversity and high degree of endemism has been reported in rivers of Kerala. Kallada River supports a large amount of fish diversity, which includes many endemic species. The increasing water usage and river flow alteration due to climatic changes can affect fresh water biodiversity and species richness. The differences in activity patterns and habitat preferences of the fish species in a community could be related to feeding and predator avoidance (Bhat, 2003). The fish species composition of the Kallada River has been documented along with other major rivers of Kerala and their endangerment due to habitat alteration has been pointed out as a matter of concern (Kurup et al., 2004). Iwasaki et al., (2012) studied the impacts of flow characteristics on fish species richness and found that specific low and high flow characteristics of rivers are important in explaining variations in basin scale fish species richness. Although works have been carried out to determine species composition of Kallada River, studies on the species diversity in relation to the habitat preferences and physico-chemical parameters of the fish communities are sporadic. Our objective in this study was to provide an account on the fish diversity and species composition of the various communities in habiting in different stream stretches and their habitat preferences on a seasonal basis.

II. MATERIALS AND METHODS

2.1 Study site and Sampling

The study was carried out in Kallada River during the pre-monsoon, monsoon and the post monsoon seasons. Kallada River is a perennial river with a length of 121 km and a catchment area of 1699 km2. It is a fifth order stream with a gradient of 12.6 m/km. Six sampling sites were selected along the stretch of the river two sites representing each up stream, midstream and downstream regions. The location of the six sampling sites are shown in the map **Fig.1**. the details and the sampling sites with the GPS coordinates are given the table.1. Each sampling site covered 50m of sampling station. Sampling was done monthly from Jan 2013 to Dec 2013 and the data collected was pooled in to three seasons the pre-monsoon (January -April), monsoon (May- august) and post monsoon (September -December). Sampling was carried out during the day time with each sampling run lasting for 1 hour. Water was collected from each site for physico- chemical analysis. Fish samples were collected using cast nets, fish traps and scoop nets. The fishes were counted and subjected to preliminary identification specimen were brought back to the laboratory and preserved in 10% buffered formaldehyde for further detailed identification.

Table 1. Six sampling sites selected for the study in Kallada river.

SITE I	West Kallada (Munro island)	9.0009861, 76.6111341
SITE II	Kadapuzha	9.0219491, 76.6452998
SITE III	Enathu	9.0887620, 76.7547004
SITE IV	Punalur	9.0405756, 76.9191577
SITE V	Thenmala	8.9554190, 77.0681634
SITE VI	Kulathupuzha	8.8509646, 77.0469864

2.2 Habitat heterogenicity

The habitat heterogeneity was carried out on a qualitative basis depending on the presence of different depths (Depth I - shallow <1m, Depth II – medium 1m -1.5m and Depth III - deep >1.5m -1.5m), different flow (Flow I- slow (0.16 - 0.3m/sec), Flow II - moderate (0.31 - 0.60 m/sec), Flow III - fast (>0.6m/sec)), Fish cover (FCO I - submerged logs, bed rock undercuts, under bodlers, over hanging vegetation, submerged macrophytes, FCO II - Fish cover- over hanging vegetation, submerged macrophytes) and Substrate types (Substrate I- Bed rocks, bolder, cobble and gravel, Substrate II– Bolder, cobble gravel and sand, Substrate- III cooble, gravel and sand). Fishes were identified and grouped in to their respective families according to Jayram (1999), Pethiyagoda and Kottelat (2005), Pethiyagoda,et al.,(2012), Plamootil and Abraham, (2013) and Plamootil, (2014).

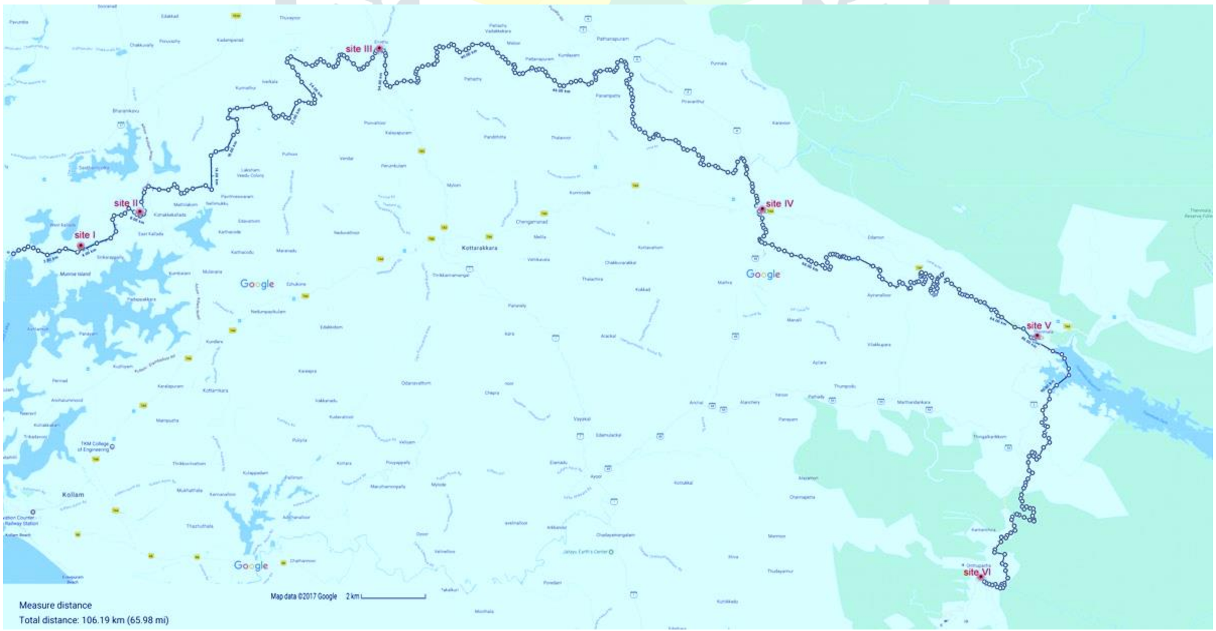

Figure .1 Map of Kallada river showing sampling sites.

2.3 Physico-chemical parameters and Biodiversity

Temperature, pH, dissolved O_2, dissolved CO_2, salinity, hardness, nitrite, nitrate and phosphate were analyzed according to the meathods described in APHA, 2005. The correlation between the physicochemical and the habitat heterogenicity at different sites was analyzed with PCA using PAST 3.0 software. Biodiversity at different sites were assessed during the pre-monsoon, monsoon and post monsoon season using (Dominance (D), Simpson(1-D), Shannon (H), Evenness (e^H/S), Brillouin, Menhinick and Margalef, Equitability (J), Fisher alpha, Berger-Parker) in PAST 3.0 software.

III. RESULTS AND DISCUSSION

3.1 Results of Habitat Heterogenicity

The percentage of habitat heterogenicity of the six sites considered for study were scored on the basis of the presence of different depths, the variety of the substrate types of the different velocities of water current observed, and the types of the fish cover present at the station under study. The downstream stations were less complex in terms of physical habitat than the midstream and upstream regions. The downstream sites showed poor values of habitat complexity, site I showing 54 % and site II showing 45 % complexity. The midstream station site III Enathu had highest 100% complexity as it had all types of depth categories, flow types, fish covers and substrate type while Site IV the habitat complexity was 63.6%. The upstream stations Site V and Site VI had more or less similar physical habitat both having 90.9% habitat complexity. The habitat complexities calculated for different station are given in table 2.

Table 2. Habitat heterogenicity calculated for the six different stations in Kallada River considered for study

	Score	STI	STII	STIII	STIV	STV	STVI
Depth I	1	0	0	1	0	1	1
DepthII	1	1	1	1	1	1	1
DepthIII	1	1	1	1	1	0	0
SubstratI	1	0	0	1	0	1	1
Substrate II	1	1	0	1	1	1	1
SubstrateIII	1	1	1	1	1	1	1
Flow I	1	0	0	1	0	1	1
FlowII	1	1	1	1	1	1	1
FlowIII	1	1	1	1	1	1	1
Fish CO I	1	0	0	1	0	1	1
Fish CO II	1	0	0	1	1	1	1
	11	6	5	11	7	10	10
HC	1	0.545455	0.454545	1	0.636364	0.909091	0.909091

3.2 PCA Results

The correlation between the annual physico-chemical parameters and the habitat heterogeneity were analyzed using PCA. The first two axis were found to be significant. The component one showed positive values for salinity, dissolved CO2, nitrite, nitrate and hardness, while component two showed positive values for pH, dissolved O2, nitrite and nitrate the values are shown in Table 3. Scatter plot given in Fig.2 showed positive correlation between temperature, nitrite, nitrate, dissolved CO2, salinity and hardness. On the other hand, the phosphate dissolved oxygen and pH showed negative correlation. Site I and II which are close to the river mouth and lie just upstream to Ashtamudy estuary show similar trends for salinity, dissolved CO2, nitrite, nitrate and hardness. On the other hand, the midstream sites were similar in terms of pH and dissolved O2. The midstream and downstream sites were similar in terms of the habitat heterogeneity and phosphate concentration.

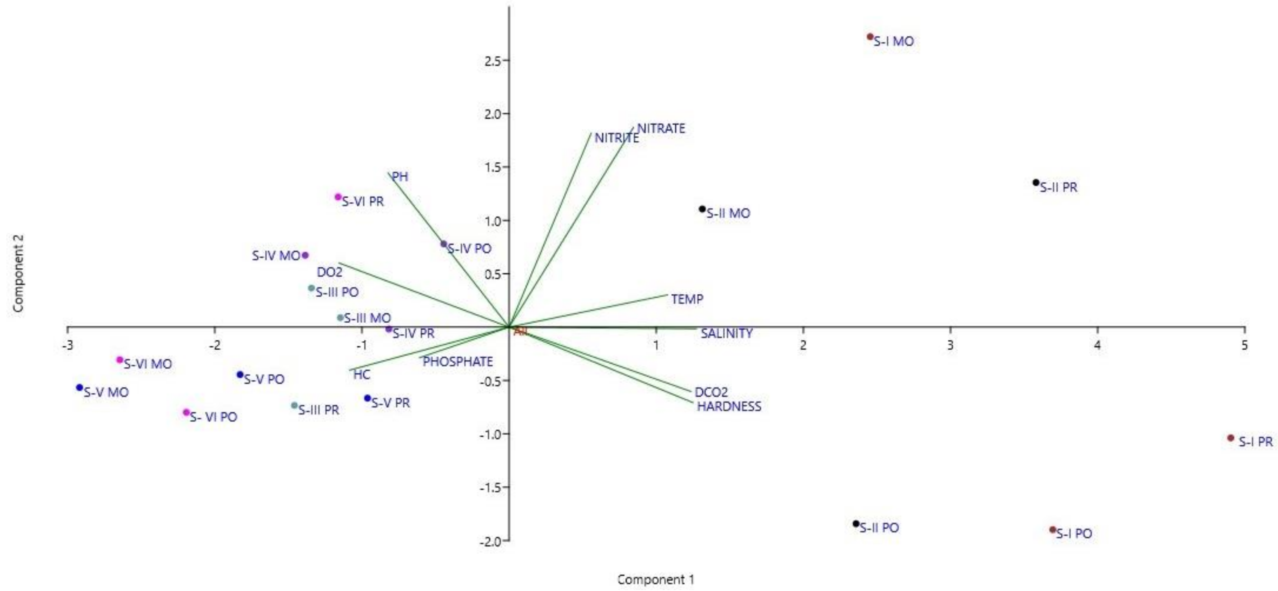

Figure 2. Scatter plot showing the correlation among different physicochemical features and habitat heterogenicity.

There is variation between the downstream, midstream and upstream region, but the downstream regions: site I and site II, midstream: site III and site IV and upstream regions - site V and site VI clustered in pairs indicating that these sites have similar in physico-chemical parameters. Thus, the sites within the upstream regions, midstream and downstream region are similar but there is difference in physicochemical parameters between the upstream midstream and downstream sites. The physicochemical parameters showed no significant correlation to the habitat heterogenicity.

Table 3. Loading scores of the different physico-chemical parameters

	PC 1	PC 2
Temperature	0.33288	0.093252
PH	-0.25456	0.44678
DO2	-0.35732	0.18573
DCO2	0.38214	-0.18659
Salinity	0.39384	-0.0048633
Nitrate	0.26151	0.579
Nitrite	0.17249	0.56189
Phosphate	-0.18866	-0.088969
Hardness	0.38662	-0.21892
Habitat Complexity	-0.3352	-0.1247

3.3 Ichthyofaunal diversity

3.3.1 Species diversity

Species diversity and richness were higher in the midstream and upstream regions during pre-monsoon, monsoon and post monsoon seasons, while downstream sites and site VI located in the Punalur region had lower biodiversity values during all the three seasons Fig.3. In the pre-monsoon season, diversity was higher in site - III, site - V and site – VI. The diversity measures Simpsons, Shannon and Brillouin index considered in the study showed higher values for these sites, all showing highest diversity for midstream site III located in the Enathu region. The lowest diversity was observed for midstream site IV located in the Punalur region. The diversity indices calculated for the six sites during the pre-monsoon season are given in the table 4. Dominance values were higher in sites with lower diversity highest dominance was recoded for site VI while the lowest value was recorded for site III. Equitability J values indicated that site II and site VI are similar in terms of evenness while highest value of evenness was observed at site V.

In the monsoon season highest diversity and evenness values were recorded in site V, while site IV had lowest values of diversity for all three diversity indices. Highest value of dominance was observed for site VI indicated by Dominance D, Fishers alpha and Berger-Parker indices. Higher evenness values observed for sites III, V and VI. The values for different diversity indices in the monsoon season are given in table 5. In the post monsoon season all three diversity measures, Simpsons, Shannon and Brillouin index showed similar results. The lowest diversity was observed in site II while the highest diversity was observed in site V followed by site III. Menhinick and Margelef 's index both richness measures showed similar trends for all the six sites under study. Species richness was highest in site I followed by site III, all other sites had similar evenness values. In Sites IV, V and VI the communities showed higher evenness values. Dominance_D, indices had higher value for site II. The values of different diversity indices in the post monsoon season for the six sites studied are given in table. 6.

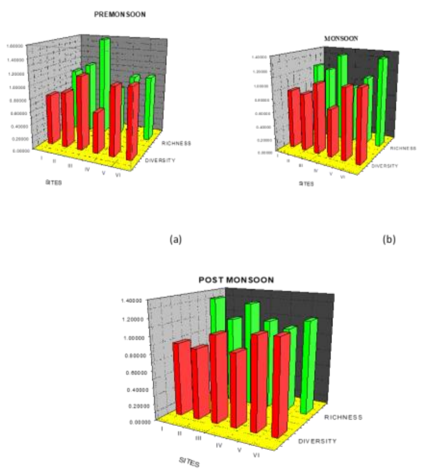

Figure 3 The species diversity and species richness of six sites during the premonsoon (2a), monsoon (2b) and post monsoon (2c)

Table 4 Diversity of Kallada River during the Pre-monsoon seasons during the year 2013

	Site I	Site II	Site III	Site IV	SiteV	Site VI
TAXA-S	8	9	18	5	13	14
Individuals	61	61	127	40	160	180
Dominance_D	0.183	0.1594	0.08525	0.2588	0.09391	0.1103
Simpson_1-D	0.817	0.8406	0.9147	0.7412	0.9061	0.8897
Shannon_H	1.845	2.016	2.661	1.477	2.465	2.374
Evenness_e^H/S	0.7912	0.8342	0.795	0.8759	0.9045	0.7675
Brillouin	1.655	1.798	2.432	1.308	2.313	2.234
Menhinick	1.024	1.152	1.597	0.7906	1.028	1.043
Margalef	1.703	1.946	3.509	1.084	2.364	2.503
Equitability_J	0.8874	0.9175	0.9206	0.9176	0.9608	0.8997
Fisher_alpha	2.462	2.915	5.727	1.508	3.343	3.548
Berger-Parker	0.2459	0.2951	0.1575	0.4	0.1563	0.1833

Table 5 Diversity of Kallada River during the monsoon seasons during the year 2013

	Site I	Site II	Site III	Site IV	Site V	Site VI
Taxa_S	9	8	14	6	12	14
Individuals	62	53	109	49	135	109
Dominance_D	0.1504	0.1506	0.1087	0.2278	0.09619	0.09637
Simpson_1-D	0.8496	0.8494	0.8913	0.7722	0.9038	0.9036
Shannon_H	2.028	1.969	2.382	1.624	2.411	2.459
Evenness_e^H/S	0.8442	0.8954	0.7733	0.8453	0.9284	0.8353
Brillouin	1.813	1.749	2.179	1.45	2.249	2.25
Menhinick	1.143	1.099	1.341	0.8571	1.033	1.341
Margalef	1.938	1.763	2.771	1.285	2.242	2.771
Equitability_J	0.9229	0.9469	0.9026	0.9062	0.9701	0.9318
Fisher_alpha	2.894	2.618	4.271	1.795	3.182	4.271
Berger-Parker	0.2419	0.2075	0.1743	0.3673	0.1556	0.1468

Table 6 Diversity of Kallada River during the Post-monsoon seasons during the year 2013

	Site I	Site II	Site III	Site IV	Site V	Site VI
Taxa_S	10	8	14	8	13	14
Individuals	49	56	105	54	162	151
Dominance_D	0.1379	0.1563	0.1006	0.142	0.08543	0.08539
Simpson_1-D	0.8621	0.8438	0.8994	0.858	0.9146	0.9146
Shannon_H	2.124	1.958	2.439	2.009	2.509	2.542
Evenness_e^H/S	0.8365	0.8853	0.819	0.932	0.9457	0.9078
Brillouin	1.847	1.747	2.226	1.789	2.357	2.374
Menhinick	1.429	1.069	1.366	1.089	1.021	1.139
Margalef	2.313	1.739	2.793	1.755	2.359	2.591
Equitability_J	0.9225	0.9414	0.9243	0.9661	0.9782	0.9634
Fisher_alpha	3.8	2.554	4.338	2.596	3.329	3.768
Berger-Parker	0.2245	0.2321	0.1619	0.2037	0.1296	0.1523

3.3.2 Relative Abundance

The ichthyofaunal composition of Kallada River recorded during the study consisted of 12 families and a total of 31 species. The different fishes collected from different regions of Kallada river with their corresponding relative abundance are shown in table 7. The relative abundance of species belonging to Ariidae, Bagridae, Cichilidae and Tetraodontidae were greater in the downstream region. *Arius jella* and *Tetrodon travancoricus* was found restricted in the downstream region. The relative abundance data showed that midstream and upstream region were dominated by Cyprinid fishes. Fishes from other families like Ambassidae, Gobidae, Bagridae and Cichilidae were also abundant in the midstream region. The upstream region was dominated by cyprinid fishes, with one endemic fish species, *Dawkinsia exclamatio. D. exclamatio* was found in a short range in the upstream region of Kallada river, showing high relative abundance in this region. These species are found to be localized and habitat specific, their highest relative abundance recoded was 0.105421 during the post monsoon season. *D. exclamatio* has already been listed as an endangered species. Channa species were also restricted to the upstream region throughout the study except *Channa micropeltes* which was observed in the midstream region during monsoon. The upstream station near the reservoir were dominated by *Puntius* s.l. species: *D. exclamatio, D. filamentosa, D. assimilus, P. ticto*. In site VI -Kulathupuzha located in the upstream higher values of relative abundance were recoded for *H. fasciata, P. ticto* and *Barilius bakeri*.

Table.7 Relative abundance of the fish fauna from Kallada River during the year 2013. US=Upstream, MS= Midstream, DS= Downstream

FISH SPECIES	PRE MONSOON			MONSOON			POST MONSOON		
	US	MS	DS	US	MS	DS	US	MS	DS
AMBASSIDAE									
Parambasis dayi	0	0.02994	0	0	0.120253	0	0	0.101911	0
ARIIDAE									
Aruus jella	0	0	0.04098	0	0	0.086957	0	0	0.048544
BAGRIDAE									
Mystus occulatus	0	0.011976	0.02459	0	0	0.06087	0	0.031847	0
CHANNIDAE									
Channa marulius	0.032353	0	0	0.102459	0	0	0.031949	0	0
Channa micropeltes	0.020588	0	0	0.040984	0.031646	0	0.051118	0	0
Channa orientalis	0.038235	0	0	0.053279	0	0	0.057508	0	0
Channa striatus	0.029412	0	0	0.065574	0	0	0.057508	0	0
CICHILIDAE									
Etroplus maculates	0.032353	0.071856	0.180328	0	0.113924	0.226087	0	0.101911	0.15534
Etroplus suratensis	0	0	0.131148	0	0.025316	0.13913	0	0.025478	0.106796
CYPRINIDAE									
Berilius bakeri	0.102941	0.0359	0	0.110656	0.113924	0	0.073482	0.101911	0
Danio equpinatus	0.170588	0.023952	0	0.118852	0	0	0.083067	0	0
Garra mullia	0.088235	0.083832	0.032787	0.102459	0.018987	0	0.070288	0.019108	0
Gonoprpktopterus curmura	0.055882	0.083832	0	0.045082	0.025316	0	0.063898	0.057325	0
Osteobrama bakeri	0	0.107784	0	0	0.094937	0	0	0.10828	0
Puntius amphibius	0.023529	0.041916	0	0.020492	0.012658	0	0	0.0138217	0
Dawkinsia assimilus	0.094118	0.041916	0	0.122951	0.056962	0	0.095847	0.082803	0
Puntius chola	0	0.023952	0	0	0.025316	0	0	0.01273	0
Dawkinsia exclaimatio	0.079412	0	0	0.045082	0	0	0.105431	0	0
Haludaria fasciatus	0.020588	0	0	0.045082	0	0	0.025559	0	0
Dawkinsia filamentosa	0.058824	0.215569	0.270492	0.098361	0.21519	0.182609	0.086262	0.146497	0.23301
Puntius sophore	0	0.02994	0	0	0.075949	0	0	0	0
Pethia ticto	0.088235	0.065868	0	0.020492	0	0	0.121406	0	0
Puntius viridis	0	0.01197	0	0	0.044304	0	0	0	0
Rasbora daniconius	0	0.0359	0	0.008197	0.018987	0	0.076677	0.101911	0
Systomus chrysopoma	0	0.02994	0	0	0.012658	0	0	0.019108	0
GOBIIDAE									
Glossohgobius giuris	0	0.047904	0.090164	0	0	0.095652	0	0	0.067961
HEMIRAMBIDAE									
Hemirambus spp.	0	0	0.10655	0	0	0.078261	0	0	0.029126
LEIOGNATHIDAE									
Equulites elongatus	0	0	0	0	0	0	0	0	0.14563
LUTGANIDAE									
Lutjanus argentimaculatus	0	0	0	0	0	0.043478	0	0	0.029126
MUGILIDAE									
Mugil cepalus	0	0	0.098361	0	0	0.06087	0	0.019108	0.116505

TETRAODONTIDAE									
Tetrodon travancoricus	0	0	0	0	0	0.017391	0	0	0
Total no of species from each site	15	18	10	15	16	10	14	16	10

The abiotic and biotic factors influence the structure and the composition fish communities in a riverine ecosystem (Tonn, 1990). The abiotic and the biotic factors of Kallada river ecosystem were analyzed to assess their role in the distribution, habitat preferences and the ecomorphology of *Puntius* s.l. species. The physico chemical parameters in the midstream and upstream regions are different from those in the downstream region. The downstream region was characterized by saline, higher temperature, carbon dioxide and hardness while lower dissolved oxygen was observed in these regions with slightly alkaline pH. These regions are close to the river mouth and thus have a brackish water environment. The downstream regions are known to have alkaline pH because of the leaching of the organic matter from the upstream region and lower dissolved O2 because of the increased temperature (Togue, Kuate, and Oben, 2017). The habitat in the downstream region were more homogenous when compared to the midstream and upstream sites. The PCA shows that midstream and upstream regions had similar physico chemical conditions. and habitats features. These regions are fresh water ecosystems having similar physicochemical parameters with the temperature increasing toward the upstream regions and have higher dissolved oxygen and are characterized by more heterogenous environment.

The upstream sites in the Kallada river showed high ichthyofaunal diversity and species richness during the period of study. The upstream portions of Kallada river are parts of Western Ghats rich in Biodiversity. Earlier works carried out in Kallada river has reported rich biodiversity from this river (Abraham, Kelker, and Kumar, 2011; Kurup, Radhakrishnan, and Manojkumar, 2004). Rivers are known to have simple structure and low species richness in head water communities but as the distance from the source of the river increases, the species richness also increases (Oberdorff, Guilbert, and Lucchetta, 1993). This increase is due to the greater availability of ecological niches (Bistoni and Hued, 2002).

The sites in the downstream region (West Kallada and Kadapuzha) are closer to the Ashtamudy estuary and have a brackish water environment. *Arius spp*. and *Tetrodon spp*. are found in brackish water. This region is brackish in nature which is a natural ecotone region which supports more species than any other regions of the ecosystem. But opposed to that, in the present study low species diversity and richness was observed here in comparison to midstream and upstream regions. This is indicative of the habitat destruction and the human interferences in this region. The downstream regions are inhabited by human population who are engaged in unscientific fishing and sand dredging (Sahib, 2011). This has made the habitat more homogenous and destroyed the bottom strata significantly. The physical habitat in this region is less complex when compared to the midstream and upstream regions, with 45 – 55% habitat complexity. Ward and Tockner, (2001) suggested that ecotones are transient zones between two adjacent patches and the connectivity between these patches are very critical for maintaining the spatio-temporal dynamics of riverine ecosystem. They also pointed out that river management schemes can disrupt the interaction of species between patches and this results in loss of biodiversity. The environmental parameters of the habitat have a direct impact on the fish assemblages. The ichthyofaunal composition of a community is adversely affected by the anthropogenically induced habitat alterations (Paller, et al., 2013).

The midstream and the upstream regions are more complexity in terms of habitat composition. Enathu had a more complex habitat with 100 % complexity, as the sampling site was a biotic mosaic which comprised of different patches of environment differing in depth, water flow and the bottom substratum. Thenmala and Kulathupuzha are not far behind with 90.9% complexity. In the midstream region out of the two sites surveyed third site - Enathu had a more heterogeneous environment with less human intervention while the fourth site - Punalur had a more homogenous environment with sandy bottom and greater depth owing to the excessive sand dredging. The species diversity and species richness of the third site Enathu was highest in all three seasons while that of Punalur was lowest in comparison to all the sites surveyed. The sites are similar in terms of physico-chemical features in the mid-stream region but Enathu had more heterogeneous habitat features which led to higher diversity and richness than Punalur. Enathu region also showed less human intervention while the fourth site, Punalur had a more homogenous environment with sandy bottom and greater depth owing to the excessive sand dredging. The upstream regions passing through wild life sanctuary and protected reserve forest was surrounded by thick forest. These regions show higher values of species richness and diversity during all three seasons. Punalur is the only site which had low species diversity and species richness this is because this region is thickly populated and water here is used for many purposes. There is a paper mill operating upstream to this site. This region is also subjected to extensive sand dredging. The habitat destruction due to human activities is the major reason for low species diversity and richness in this region. The fish assemblages and the relative abundance of the species is more in the regions were physical habitat are more diverse and complex in terms of depth, current and substrate (Johnson and Arunachalam, 2010).

To conclude, Kallada River has greater diversity towards its midstream and upstream region. The greater habitat complexity and less anthropogenic stresses are the reason for the increased species richness, diversity and relative abundance of fishes. The downstream regions showed lower diversity and richness, as these regions were under anthropogenic influence. Most of these regions were subjected to extensive fishing, sand dredging and domestic runoffs, which have negatively affected the fish assemblage structure in this area. This study may be taken as a base line study to assess the present status of the fish communities in different stretches of Kallada River.

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