CLUSTER ANALYSIS OF SEASONAL FISH FAUNAL DIVERSITY AND WATER PHYSICO-CHEMICAL ATTRIBUTES AT PALLATHURUTHY, KERALA SOUTH INDIA.

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Abstract- Pallathuruthy is a meeting point between Pamba River and Vembanad Lake of Kerala, South India. So it is an estuarine habitat. The present study analyses the seasonal variation in fish faunal diversity and its relation with existing water quality parameters through cluster analysis. The study showed that there was significant variation in diversity and fish catch strength between three seasons like pre monsoon, monsoon and post monsoon. High species diversity was observed during monsoon season, while good catch strength was obtained during post monsoon. Results of water quality analysis have showed that TDS, Copper, chromium, cadmium and lead content in water were beyond the limit set by IS (2012). Also regarding the sediment quality the cadmium content was above the threshold effect level prescribed by Canadian Sediment Quality Guidelines for the Protection of Aquatic Life (2001). So, urgent measures were inevitable to sustain the existing fish wealth of this estuarine area.

Index Terms– Pallathuruthy, season, cluster analysis, water quality, pollution.

I. INTRODUCTION

Estuaries provide a unique habitat for a wide variety of biodiversity. It is a suitable breeding and feeding ground for many fish species, due to the convergence of fresh water with brackish water, which can cater the nutritional requirements of fish species. This speciality of estuary demands special attention for the conservation of its biodiversity. Since estuary is an area of fluctuating habitat conditions, it is a challenge for its inhabitants to accustom with these variations.In a surface view, the biodiversity of estuaries were declining for the last few years. Major reasons that propped up for these declines were unscientific fishing practices, water poisoning for fish capture, habitat destruction and pollution (Kurup, 1993; Ujjania and Monika, 2015). The pollution happen to estuary through various sources gives way to changes in water conditions, to which the aquatic fauna is closely linked. High pollution driven fall in oxygen level of water can impose severe stress on fish population especially to migratory fishes like eel and salmon (Etcheber, et al., 2011).

Rich biodiversity and socio economic importance are the hall mark of Vembanad Lake, which is an ecotone between land and sea. The lake which was proclaimed as a Ramsarsite, was enriched by ten rivers, which had its origin from the Western Ghat, a hot spot and finally empties into the Arabian Sea. The mangrove trees in the form of small islands in the Vembanad Lake provide shelter for diverse fauna. This Lake is also a hot bed for tourism related activities like house boat services and boat races (Nehru Tophy boat race), due to its picturesque nature. From this Lake 150 fish species were documented by Kurup and Samuel, (1985). The intensified interventions to raise paddy cultivation in Kuttanad, had plunged the Vembanad Lake to a gravy of fertilizers and pesticides. Since Kuttanad is a low lying area, to prevent inundation during monsoon, an artificial spillway called Thottappally was constructed in 1955 (Gopalan et al., 1983). But due to the improper construction, it cannot elude the flood completely. Another problem faced by the paddy cultivation of Kuttanad was the salt water intrusion, which was managed to a certain level by the construction of Thaneermukkom bund, which had turned as a boomerang to the plight of Vembanad Lake by turning it to a pool of pesticides and fertilizers that cannot flow down (Thampatti, and Padmakumar, 1999).The repercussions of these interventions were many like a decline in primary productivity, water quality degradation, proliferation of macrophytes and a severe decline in fish wealth. Even massive fish death was also reported from

various areas of Vembanad Lake (Azis and Nair, 1981; Priyadarsanan, 2011).The present study envisages the impact of water quality on the fish fauna of Pallathuruthy, an estuarine area as well as a meeting point between Pamba and Vembanad Lake through Bray-Curtis similarity index (Cluster analysis).

II. STUDY AREA

The area selected for the present study was Pallathuruthy (9.4599° N, 76.3695° E), where Pamba meets with the Vembanad Lake. Busy plying of house boats and other motor boats were a usual sight at this area. Majority of residents on its bank depend this water for their various domestic needs. Microplastic junk was another matter to concern from this area. Map of the study area was given in Figure 1.

III. MATERIALS AND METHODS

Water and fish sample was collected in each month from Pallathuruthy for a period of 12 months, covering three seasons like pre – monsoon (Feb to May), monsoon (June to Sept) and post monsoon(Oct to Jan) from September 2012 to August 2013. Water sample was collected in glass bottles kept in ice box and bought to the laboratory on the same day for analysis. Certain water quality parameters like temperature, PH and DO were checked at the site itself. All parameters were analyzed as per the standard methods of APHA (2012). Instruments and methods adopted for the present study where given in Table 1.

Fish samples were collected once in every month from all the four sites for a period of 12 months from September 2012 to August 2013 to study the difference in diversity during pre-monsoon, monsoon and post monsoon season. Fish samples were collected with the help of local fishermen using different types of nets like gillnetscast nets and dragnets. Immediately after collecting the fish, it is preserved in 10% formalin and brought to the laboratory. In the case of bigger fishes an incision was made in the abdomen before preservation. In the laboratory each sample was identified up to its species level by analyzing meristic and morphometric characters with the reference of Day (1967), Jayram (1999) and Talwar and Jhingran (1991).

Fig 1 Location of Study area

Table 1 Instruments and methods used for water and sediment quality analysis

Sl No:	Physico- chemical Parameters	Method/Instrument
1	PH	Eutech (Model- S- 660)
2	DO	Eutech (Model- S- 660)
3	Temperature	Digital Thermometer
4	Conductivity	Eutech (Model- S- 660)

5	TDS	Eutech (Model- S- 660)
6	Salinity	Eutech (Model- S- 660)
7	Nitrate	IS 3025 (part 34)
8	Nitrite	IS 3025 (part 34)
9	Sulphates	IS 3025 (part 24)
10	Phosphates	APHA 22nd Edition 4500 P
11	Copper (water)	IS 3025 (part 42)
12	Zinc (water)	IS 3025 (part 49)
13	Lead (water)	IS 3025 (part 47)
14	Cadmium (water)	IS 3025 (part 41)
15	Chromium (water)	Annex j of IS 13428: 2005
16	Copper (soil)	AAS
17	Zinc (soil)	AAS
18	Lead (soil)	AAS
19	Cadmium (soil)	AAS
20	Chromium (soil)	AAS

IV. RESULTS AND DISCUSSION

Result of water quality analysis with respect to 20 parameters like PH, DO (mg/l), Temperature(^{0} C), TDS (ppm), Conductivity(µs), Salinity (ppm), Nitrates (mg/l), Nitrites (mg/l), Sulphates (mg/l), Phosphates (mg/l), Cu(S) (mg/kg), Cu (W) (mg/l), Zn (S) (mg/kg), Zn (W)(mg/l), Cr (S) (mg/kg), Cr(W) (mg/l), Pb(S) (mg/kg), Pb(W) (mg/l), Cd(S)(mg/kg) and Cd(W) (mg/l) were given in Table 2. When comparing with the accepted limits set by IS (2012) the level of TDS, Copper, chromium, cadmium and lead content in water were beyond the limit. When considering the sediment quality, cadmium level was above the threshold effect level prescribed by Canadian Sediment Quality Guidelines for the Protection of Aquatic Life (2001). High value for TDS was recorded during pre-monsoon season. High TDs was an indication of pollution through external sources (Pankajetal, 2015).The closure of Thanneermukkam bund also was a reason for this shoot up (Priyadarsanan, 2011).High copper and chromium level in water was recorded during pre-monsoon, while that of lead and cadmium in monsoon season. Heavy load of copper and chromium in pre monsoon may come from domestic sewage, intrusion from pesticides, from the oil exhaust of tourist boats and other mechanized boats, dumping of plastic wastes and high precipitation. Raised level of cadmium in sediment was the result of dumping of plastic waste results from unplanned tourism related regulations, fertilizer intrusion and washing of vehicles.

Regarding to the fish faunal diversity, 33 fish species were collected from Pallathuruthy during the three seasons, which belongs to 7 orders and 22 families(Table 3). Among the 7 orders, Perciforms dominated over other orders, while among the families, Cyprinidae was the dominant one. More fish catch was obtained in post monsoon and least in monsoon. Regarding the species diversity monsoon season showed high diversity with 29 species, followed by post monsoon with 23 species and pre monsoon with 21 species. The dominance of Cyprinidae family can connect to the eutrophic condition of Pallathuruthy, because cyprinidae increase in an area where zooplanktons are rich, which in turn was linked with the algal blooms (Krishna Kumar and Priyadarsanan, 2008).*Pseudetroplusmaculatus, Mystusoculatus, Ambassisgymnocephalus, Labeodussumieri and*

Dawkinsiafilamentosa were the abundant fish species collected during the study period. Being an estuarine area, Pallathuruthy was not reaching the expected level of species richness. The main challenges faced by the fish fauna of here were water poisoning (Priyadarsanan, 2011),usage of prohibited mesh sizes (Priyadarsanan, 2011), indiscriminate use of pesticides and fertilizers in the nearby cultivation areas (Renjithkumar et al, 2011), and overwhelmed service of tourist house boats. During the study 2 exotic fish species like *Labe rohita*and*Catlacatla* (Priyadarsanan, 2011),also could record from Pallathuruthy, but the catch strength of these species were poor.

Table 2 Result of water quality analysis for three seasons

Sl No	Parameters	Pre monsoon	Monsoon	Post monsoon	IS (2012) Acceptable limit	Canadian Sediment Quality Guidelines for the Protection of Aquatic Life. (2001) Threshold effect level
1	PH	8.5975	7.7775	7.58	6.5-8.5	-
2	DO (mg/l)	1.5225	5.87	2.21	-	-
3	Temperature(^{0} C)	31.05	29.5	30.95	-	-
4	TDS (ppm)	4654.85	57.685	576.2075	500	-
5	Conductivity(µs)	3055.37	88.76	42004.25	-	-
6	Salinity (ppm)	1931.125	53.3625	496.3225	-	-
7	Nitrates (mg/l)	1.9	1.925	2.175	45	-
8	Nitrites (mg/l)	0	0	0	-	-
9	Sulphates (mg/l)	27.875	14.275	16.625	200	-
10	Phosphates (mg/l)	3.125	2.15	2.1	-	-
111	Cu(S) (mg/kg)	8.775	9.975	7.275	-	18.7
12	Cu (W) (mg/l)	0.09	0.03	0.0775	0.05	
13	Zn (S) (mg/kg)	17.85	19.575	11.275	-	124
14	Zn (W)(mg/l)	0.2575	0.125	0.03	5	
15	Cr (S) (mg/kg)	8.175	13.425	6.715	-	52.3
16	Cr(W) (mg/l)	1.16	0.01	0.02	0.05	
17	Pb(S) (mg/kg)	9.35	9.75	5.7625	-	30.2
18	Pb(W) (mg/l)	0.06	0.32	0.06	0.01	
19	Cd(S)(mg/kg)	0.65	3.325	0.35	-	0.7
20	Cd(W) (mg/l)	0.01	0.05	0.00	0.003	

Table 3 Catch strength of fish species from Pallathuruthy during three seasons

Sl No	Name of fish	Order	Family	Pre monsoon	Monsoon	Post monsoon
1	*Ambassisgymnocephalus*	Perciformes	Ambassidae	500	3400	4200
2	*Anabas testudineus*	Perciformes	Anabantidae	3900	0	60
3	*Carangoidesmalabaricus*	Perciformes	Carangidae	0	12	0
4	*Catlacatla*	Cypriniformes	Cyprinidae	4	0	0
5	*Channastriata*	Perciformes	Channidae	0	15	60
6	*Cynoglossusmacrostomus*	Pleuronectiforms	Cyngolossidae	60	30	20
7	*Eubleekeriasplendens*	Perciformes	Leiognathidae	4150	1110	15
8	*Pseudetroplusmaculatus*	Perciformes	Cichlidae	4100	3500	8000
9	*Etroplussuratensis*	Perciformes	Cichlidae	2920	50	700
10	*Gerressetifer*	Perciformes	Gerreidae	50	220	0
11	*Gerresfilamentoses*	Perciformes	Gerreidae	260	50	30
12	*Gerrusoblongus*	Perciformes	Mojarra	0	20	0
13	*Glossogobiusgiuris*	Perciformes	Gobiidae	150	520	0
14	*Heteropneustesfossilis*	Siluriforms	Claridae	0	280	0
15	*Horabagrusbrachysoma*	Siluriforms	Bagridae	150	300	400
16	*Mystusgulio*	Siluriforms	Bagridae	0	0	200
17	*Labeodussumieri*	Cypriniformes	Cyprinidae	1100	3100	3800
18	*Labeorohita*	Cypriniformes	Cyprinidae	0	6	0
19	*Mastacembelusarmatus*	Synbranchiforms	Mastacembelidae	25	500	50
20	*Megalopscyprinoides*	Elopiformes	Megalopidae	0	295	150
21	*Mugilcephalus*	Mugiliformes	Mugilidae	8	0	0

22	*Mystusoculatus*	Siluriforms	Bagridae	6900	1200	5500
23	*Nandusnandus*	Perciformes	Nandidae	12	106	0
24	*Ombokmalabaricus*	Siluriforms	Siluridae	0	30	0
25	*Parambassisdayi*	Perciformes	Ambassidae	0	525	800
26	*Pristolepisrubripinnis*	Perciformes	Pristolepidae	70	20	20
27	*Dawkinsiafilamentosa*	Cypriniformes	Cyprinidae	600	2000	4000
28	*Puntiusmahecola*	Cypriniformes	Cyprinidae	0	3000	1500
29	*Systomussarana*	Cypriniformes	Cyprinidae	400	730	2200
30	*Scatophagusargus*	Perciformes	Scatophagidae	0	2	70
31	*Silage sihama*	Perciformes	Sillaginidae	82	30	20
32	*Brachirusorientalis*	Pleuronectiforms	Soleidae	450	250	1200
33	*Wallagoattu*	Siluriforms	Siluridae	0	17	500
Total				25891	21318	33495

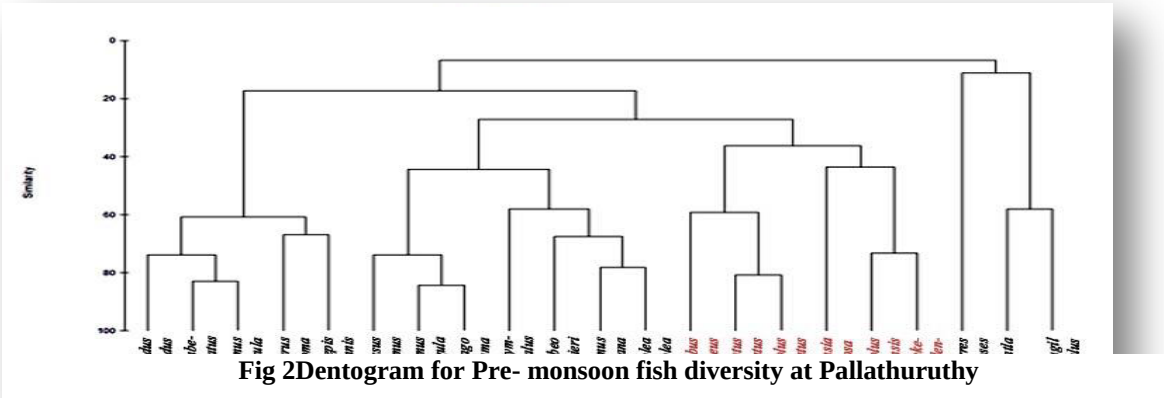

Fig 2Dentogram for Pre- monsoon fish diversity at Pallathuruthy

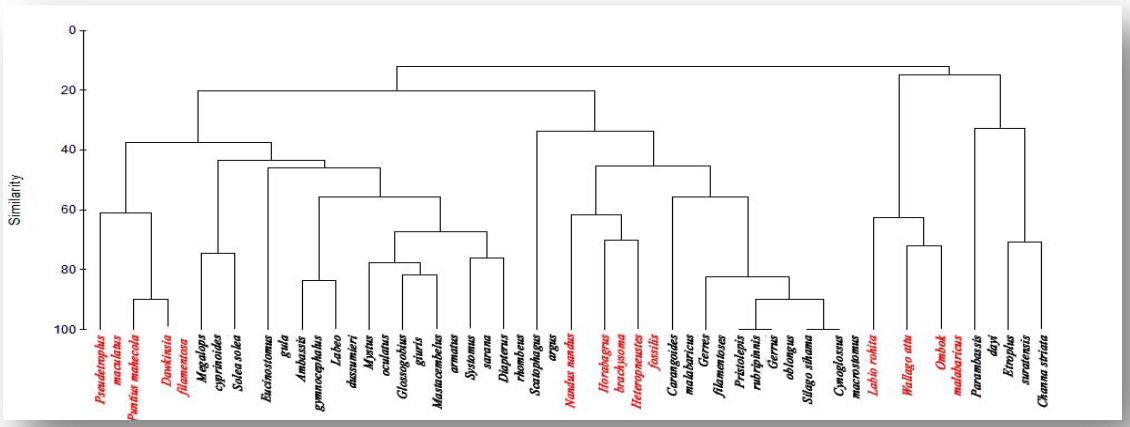

Figure 3 Dentogram for Monsoon fish diversity at Pallathuruthy

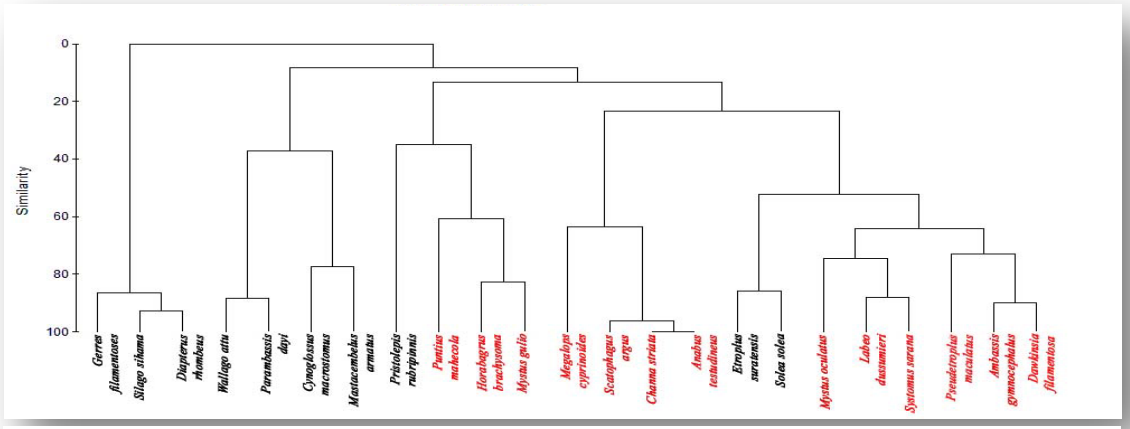

Figure 4 Dentogram for Post- monsoon fish diversity at Pallathuruthy

Bray-Curtis analysis to determine the fish composition and abundance in three seasons at Pallathuruthy, based on the clusters formed with at least 50-80 % similarity in the hierarchical cluster analysis showed that two major clusters at 50% variance were formed during pre-monsoon (Figure 2). Cluster 1 with 3 species like *Anabustestudineus, Mystusoculatus*and*Pseudetroplusmaculatus*while cluster 2 with 3 species which were *Dawkinsiafilamentosa , Etroplussuratensis*and *Eubleekeriasplendens.* In monsoon season 3 major clusters were formed at 61 % variation (Figure 3). Cluster 1consists of 3 species; they were *Pseudetroplusmaculatus, Puntiusmahecola*and*Dawkinsiafilamentosa* .While*Nandusnandus, Horabagrusbrachysoma*and*Heteropneustesfossilis*formed Cluster 2. The three species included in cluster 3 were *Labiorohita, Wallagoatu*and *Ompokmalabaricus.* Inpost monsoon also4 major clusters were formed at 63 % variation (Figure 4). The cluster 1 consists of 3 species like *Puntiusmahecola, Horabagrusbrachysoma*and *Mystusgulio.* Cluster 2 with 4 species like*Megalopscyprinoides, Scatophagusargus, Channastriata*and*Anabustestudineus.*Cluster 3 consists of 3 species, which were *Mystusoculatus, Labeodussumieri*and*Systomussarana.*And finallyCluster 4 formed of 3species like*Pseudetroplusmaculatus, Ambassisgymnocephalus*and*Dawkinsiafilamentosa.* The cluster analysis showed that all the clusters formed for Pallathuruthy in three seasons were individual with respect to its entire species composition. This indicates that changes were happening to the habitat condition in three seasons. At the same time the cluster 4 formed in post monsoon was 67 % similar to cluster 1 formed during monsoon season.Thisshows that the habitat condition during monsoon and after monsoon had some similarities. *Anabustestudineus*present in cluster 1 during pre-monsoon was also found in cluster 2 during post monsoon. This was because of the favorability of certain habitat parameters especially Total dissolved Solids, sulfates, zinc content in sediment and water and copper content in water which were comparatively high in pre monsoon during which this fish showed relative abundance. *Pseudetroplusmaculatus*present in cluster 1 during pre-monsoon was found in cluster 1 of monsoon and cluster 4 of post monsoon. This showed its even distribution at Pallathuruthy due to favorable habitat factors. But high catch

strength was obtained during post monsoon during which certain habitat factors especially zinc content in sediment and water and copper content in water were relatively low.*Dawkinsiafilamentosa* was also found in clusters formed in three seasons. But high catch strength was obtained during post monsoon. Here it was seemed that temperature during post monsoon was the most favorable factor for the distribution of this fish. Similarly *Puntiusmahecola*found in cluster 1 of monsoon season was also found in cluster 1 of post monsoon season. Regarding the relative abundance it was found that more catch was obtained during monsoon. This relative abundance may be substantiated by certain habitat conditions of monsoon especially a relatively high level of lead and cadmiumin water. The reason behind how cadmium become favorable for this fish lies in the fact that in nature cadmium is usually found together with zinc in fewer concentrations ("Water quality and fish health", 2014). Since zinc is a component of some food wastes, it can attract fish to there.*Horabagrusbrachysoma*found in cluster 2 in monsoon was also found in cluster 1 formed in post monsoon. The relative abundance of this fish was more during post monsoon may be because of the habitat favorability in post monsoon.

V. CONCLUSION

The study showed that the habitat condition of Pallathuruthy was different in three seasons. But monsoon and post monsoon habitat have some similarities with respect to habitat condition for survival of fish species. Regarding the species diversity monsoon season showed high species diversity while pre monsoon with low diversity. But considering the fish catch strength post monsoon toped the other two seasons. Pertaining to the water quality of Pallathuruthy, it was not in a safe side for the sustenance of existing fish diversity. During pre-monsoon and post monsoon, majority of water quality parameters crossed the standard limits, which can pose a serious threat to the existing fish wealth of this estuarine area.

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