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Studies on ichthyofaunal diversity in relation with physico-chemical variable of north-eastern coastal region of Tamil Nadu

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Abstract
Marine fishes are the largest living group of vertebrate. The present study was carried out to observe the abundance and seasonal distribution of the marine fish assemblage near Kalpakkam, Tamil Nadu. Fish diversity was evaluated from the by-catch landings from 30 km from north (Lat $12^0$35.566' N, $80^0$15.138' E) and south (Lat $12^0$31.514' N, $80^0$02.263' E) of the Kalpakkam coast, Tamil Nadu, India. During the study period, 43 finfish species were recorded under 35 genera, 26 families and 7 orders. The families Leiognathidae and Sciaenidae were dominant with 4 species each followed by families Mullidae, Clupeidae and Synodontidae with 3 species each. The species, richness (d) ranged from 10.63 to 11.39, with lowest value in at Premonsoon N30 (PrM_N30) and highest in Summer S 15 (SuM_S15). Evenness (J') ranged from 0.9424 to 0.9875. The very even diversity was found at Premonsoon N 30 (PrM_N30) and very less even diversity recorded at summer S 15 (SuM_S15). The diversity Shanon-Weiner (H') ranged from 3.545 to 3.695. The maximum diversity was seen during at station S 15 (PrM_S15) Premonsoon and lowest diversity was also found at station S15 in summer season (SuM_S15). During post-monsoon station N 5 and N 15 recorded with similar diversity. The pH that indicated positive correlation with abundance of fish fauna but it was a weak correlation. If pH increase by 1% than fish abundance increases by 0.26%. Abundance was negatively correlated with temperature; by 1ºC increase in temperature a decrease of 0.42% abundance was seen. Salinity was negatively correlated with all parameter except temperature. The pH showed weak positive correlation with NH_4^{-N}. Temperature showed weak positive correlation with NH_4^{-N} and NH_3^{-N}. The NH_4^{-N} showed very weak positive correlation with pH and temperature. The NH_3^{-N} showed very weak positive correlation with NH_4^{-N}.

Keywords: Fish diversity, indices, Kalpakkam, India

Introduction
Biodiversity is the variation in the life forms of populations, species, communities and ecosystems level. Biodiversity affects the capacity of living systems in response to changes in the environment, and is essential for providing goods and services from ecosystems (e. g., nutrient cycling, clean water) (Costanza *et al*., 1997 and Hooper *et al*., 2005) [5, 12]. It has intrinsic value, aesthetic value i.e. ornamental fishes on coral reefs and in other coastal habitats. Some benefits of biodiversity are not apparent today but may be unlocked in the future (known as the option value): compounds derived from marine animals and plants may serve as medicine to prevent and cure more of our ills in the future. Biodiversity is also important for maintenance of ecosystems, protection of overall environmental quality, for understanding intrinsic worth of all species on the earth (Ehrlich & Wilson, 1991) [8]. Additionally, biodiversity is essential for the future sustainability of marine natural properties that contain commercial fisheries. Fisheries that exploit a range of species may have more stable catches than fisheries that exploit a single species (Hilborn *et al*., 2003) [11]. The species diversity of an ecosystem is frequently correlated to the amount of living and nonliving organic matter present in it. Further, species diversity is a property at the population level while the functional diversity concept is more strongly related to ecosystem stability and stresses while physical and chemical factors for determining population dynamics in the lentic ecosystem. Also, the various organisms including the planktonic community play a significant role in the dynamics of the ecosystem (Kar & Barbhuiya, 2004) [16].
The inshore waters are harbour commercially important fishes and these fishes received extensive consideration in recent years due to greater demand for meat.

Fish constitutes half of the total number of vertebrates in the world. They live in almost all conceivable aquatic habitats; 33900 living species of fish have been recorded from the World (Fishbase, 2019) [10]. India is one of the mega biodiversity countries in the world (Mittermeier and Mitemeir, 1997) [22] and possess more than 2,500 species of fishes of which 930 live in freshwater and 1,570 are marine (Kar *et al*., 2003) [17]. Positive correlations between biomass production and species abundance have been recorded in various studies (Nikolsky, 1978) [21]. The distribution of fish species is effected by both biotic and abiotic factors (Kadye *et al.*, 2008) [15]. Biological production in any aquatic body gives direct correlation with its physico-chemical status which can be used as trophic status and fisheries resource potential (Jingran *et al*., 1969) [14]. Some physicochemical parameter such as temperature of water and oxygen are significant parameter that restrict survival, growth and distribution of fish (Akbulut, 2009) [2]. High temperature distribution may generate high physiological demands apart from reducing the dissolved oxygen level in a water body. This phenomenon indicates the importance of oxygen and its relationship with water temperature (Jackson *et al*., 2001) [13]. The physico-chemical characterizes of a water body is of great value in the determination of productivity, usefulness and other characteristics (Adebisi, 1981) [1]. Finally diversity of fish mainly depends upon the biotic factors and types of ecosystem (Nanda and Tiwari, 2001) [19].

Tamil Nadu has a long costal line of 1000 km. with about 1,97,120 sq. km. of exclusive economic zone (EEZ) (Prabhahar *et al*., 2011) [23]. Fishing is only avenue of employment to 8,65,033 fisher-folk populations (Department of Government of Tamil Nadu-2002) [6].

In this scenario present study was undertaken with the objective of determining the impact of physic-chemical parameter on fish biodiversity near Kalpakkam and determine the correlation between the fish diversity and physico-chemical parameter.

Material and method

The samples were collected from the fixed sampling stations (Table 1) covering 30km from north (Lat $12^{0}35.566$' N, $80^{0}15.138$' E) and south (Lat $12^{0}31.514$' N, $80^{0}02.263$' E) of the Kalpakkam coast. Seasonal sampling [Premonsoon (PrM), Postmonsoon (PoM) and summer (SuM)] was done at selected sampling sites in 2015-2016. The collected fishes were preserved in 10% formalin in separate specimen jar according to the size of species. Small species directly preserved in 10% formalin solution. The specimens were identified following for identification key of fish species [Fischer and Whitelead (1974) [9], Nelson (1994) [20] and CMFRI (1969)] [4]. The waters samples were collected and analyzed for different physical and chemical parameters, (Tem, pH, salinity, NH_4^{-N} and NH_3^{-N}) following standard procedure (APHA 1998) [3]. For statistical analysis Software Primer V6 was used.

Result

During the study 43 species of recorded under 35 genera 26 families and 7 orders (Table 2). The species was recorded under familes; Carangidae -3, Leiognathdae -4, Lutjanidae -1, Pricanthidae -, Scombridae -1, Trichiuridae -1, Mullidae -3, Mugilidae -1, Menidae -1, Polynemidae -1, Sphyraenidae -1, Sillaginidae -1, Nemipteridae -2, Sciaenidae -4, Terapontidae -1, Gerridae -1, Scatophagidae -1, Soleidae -1, Cynoglossidae -1, Paralichthydae -1, Dussumieridae -1, Clupeidae -3, Synodontidae -3, Ariidae -1, Engraulidae -2 and Dasyatidae -2. The families Leiognathidae and Sciaenidae were more abundant with 4 species each followed by families Mullidae, Clupeidae and Synodontidae with 3 species each.

The diversity indices were calculated with mean value of fish weight for every season for all station (table -3). The species richness (d) was in ranged from 10.63 to 11.39, the lowest was recorded at in N 30 (PrM_N30) premonsoon and highest value at in (SuM_S15) Summer S 15. Evenness (J') ranged from 0.9424 to 0.9875, the very even diversity was found at in (PrM_N30) Premonsoon N 30 and very less even diversity recorded at (SuM_S15) summer S 15. The diversity (H') ranged from 3.545 to 3.695. The most divers season was at in (PrM_S15) Premonsoon S 15 and very less diversity also found at station S 15 in summer season (SuM_S15). The K dominance plot (Fig 1) showed summer is having some different diversity than the other seasons. In figure 2 in MDS plot clearly showed that season summer was having different diversity than the Premonsoon and Postmonsson. The cluster similarity graph (Fig 3) showed Postmonsoon N 5 and N 15 recorded with similar diversity and almost all summer station found less similar diversity than other stations and seasons.

During the study, salinity for every season at all stations, ranged between 31.33 ppt and 35.66 ppt. The lowest value of was detected in Postmonsoon season at N 5 station (PoM_N5) and the highest value recorded in Summer on S 15 station (SuM_S15). The pH ranged from 7.33 to 8.26. The lowest value was calculated in summer at station N 5 (SuM_N5) and the highest value was found in Postmonsoon at N 10 and S 10 station (PoM_N10 and PoM_S10). In present study, the water temperature ranged from 21.6 ºC to 33.33 ºC. The lowest value was found in Postmonsson at N 5 station (PoM_N5) and highest value was recorded at N 15 station in summer season (SuM_N15). The NH_4^{-N} ranged from 0.50 to 0.85. The lowest range recorded at N 30 station in summer (SuM_N30) and highest range was also found in summer at station N15. The NH_3^{-N} was ranged from 0.97 to 1.01. The lowest value recorded at station Postmonsoon N 10 (PoM_N10) and Summer N 30 (SuM_N30). The line graph (Fig 4) showed that salinty was high during the summer at all station and low in post monsoon. The temperature was very high during the summer at all station and low in post monsoon. The PCA plot showed during summer season same kind of physico-chemical parameters than the Premonsson and Postmonsson (Fig 5). There was not much diffrenciation in pH values, NH_4^{-N} and NH_3^{-N} values.

The correlation was calculated in excel with correlation matrix in table (4). The total abundance of fish fauna indicated positive weak correlations pH, which showed if pH increase by 1% than fish abundance increases by 0.26%. Abundance was very negatively correlated with temperature, by 1ºC increase in temperature a decrease of 0.42% abundance was seen. The Salinity was negatively correlated with all parameter except temperature. The pH showed weak positive correlation with NH_4^{-N}. Temperature showed weak positive correlation with NH_4^{-N} and NH_3^{-N}. The NH_4^{-N} showed very weak positive correlation with pH and temperature. The NH_3^{-N} showed very weak positive correlation with NH_4^{-N}.

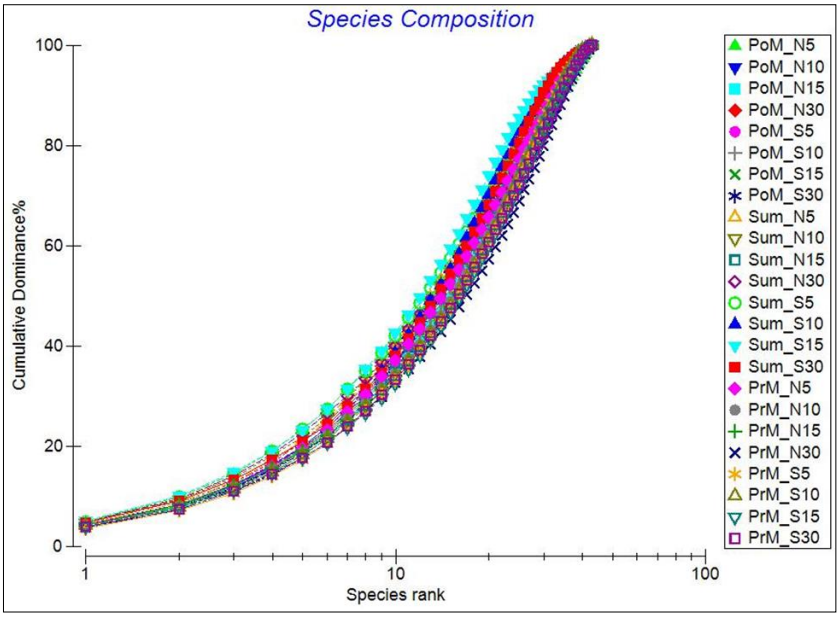

Fig 1: Showing species diversity in K dominance plot.

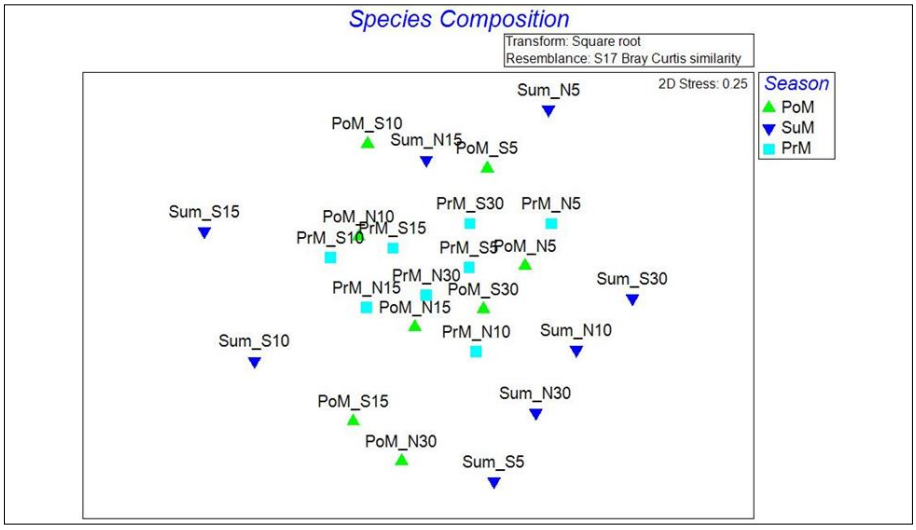

Fig 2: Showing species diversity with seasons in MDS plot.

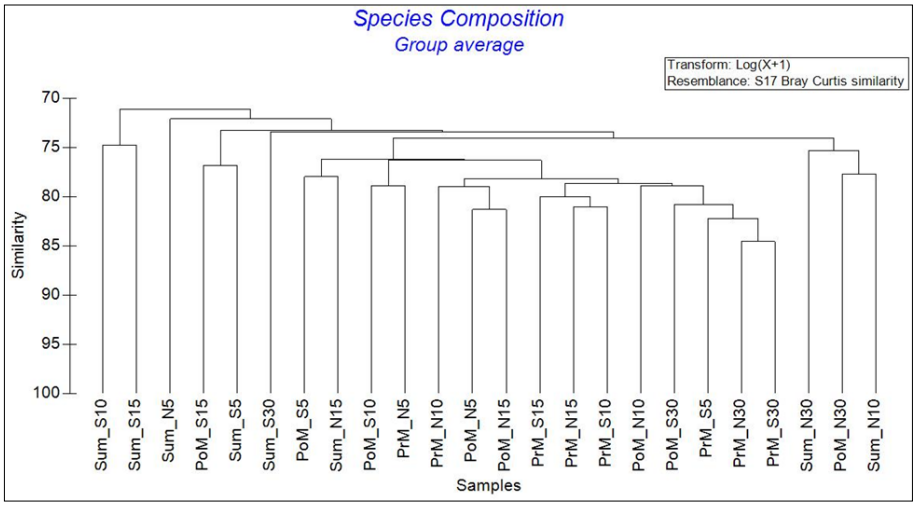

Fig 3: Cluster is showing similarity in seasonal diversity.

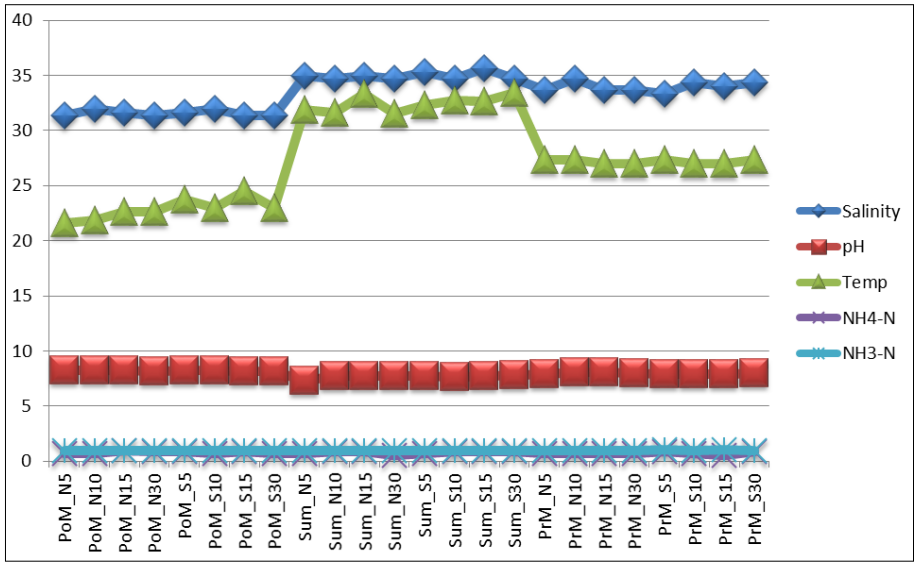

Fig 4: Showing all seasonal data of sea water analysis.

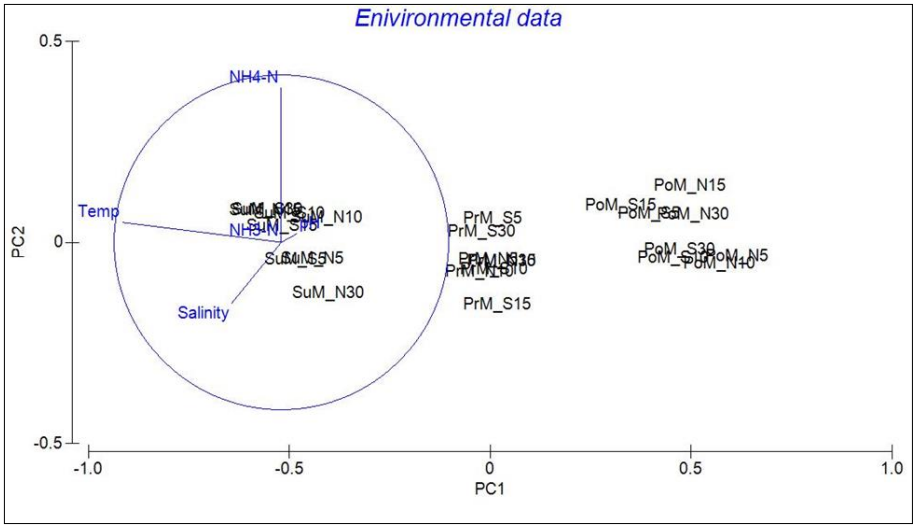

Fig 5: Showing PCA plot for environment data

Discussion

Segum and Anifowosh (2018) [25] recorded 3333 number of fish 8 families and 17 species from Apoclu reservoir, Malete, Nigeria where physico-chemical parameters of the water body such as temperature (24.1ºC–29.8ºC), dissolved oxygen (4.4mg / L – 6 mg/L), conductivity transparency (125.7cm-191.3 cm), and total dissolved solid (42ppm-69.7ppm) were also recorded all values of present finding were within the limits of fish tolerance, survival and production. Yagci *et al*. (2016) [28] conducted study on relationship between fish species and physico-chemical parameter of Egirdir Lake, Turkey and identified 15 fish species, belonging to eight families. They opined result showed that water temperature, dissolved oxygen and saturation of dissolved oxygen most important physico-chemical parameter affecting fish distribution. Other physicochemical parameters did not showed any significant statistical differences in determining fish distribution. Silambarasan *et al*. (2014) [26] recoded 07 orders of 10 families and 14 genera and 18 species of fishes from the Kolavoi Lake Chengalpet Tamil Nadu. They argued that various physico-chemical parameter such as water Temperature, Dissolved oxygen, pH and Alkanity were at the range of 26.2 to 31.5ºC, 7.2 mg/L to 10.5 mg/L, 6.52 to 8.32 and 47.82 to 65.84 respectively, which were suitable for growth of flora and stocking of fish diversity. Maigani *et al*. (2018) [27] suggested the importance of physico-chemical parameter on fish diversity in Cubi Reservoir, Bouch state Nigeria. The study conducted by Kar *et al*. (2006) [18] at Sone lake, Assam, India, revealed the occurrence of 69 species of fishes in Lake belonging to 49 genera, 24 families and 11 orders. Of these fishes 84.2% belonged to the primary freshwater of lake zoogeographically and emphasise the value of conserving biodiversity. The study revealed a significant correlation between fish and soil organic carbon, soil potassium, water pH, total alkalinity and conductivity, and aquatic macrophytic biomass. In the present study total abundance (mean value of fish weight) showed negative correlations with all physic-chemical parameter except pH, which showed positive correlation with abundance of fish fauna but it was a weak correlation and showed increase of fish abundance of 1% with increase of pH by 0.26%. The Salinity was positively correlated temperature. The pH showed weak positive correlation with NH_4^{-N}. Temperature showed weak positive correlation with NH_4^{-N} and NH_3^{-N}. The NH_4^{-N} showed very weak positive correlation with pH and temperature. The NH_3^{-N} showed very weak positive correlation with NH_4^{-N}. The study concluded that all physico-chemical parameters may not be directly correlated or impact

in abundance of fish species.

Table 1: showing the sampling details Latitude and Longitude of fixed points.

Sl. No	Symbol	Sample location	Latitude	Longitude
1	N 5	Kokilamadu kuppam	$12^0$35.566' N	$80^0$11.352' E
2	N 10	Mahabalipuram	$12^0$37.177' N	$80^0$11.930' E
3	N 15	Pattipulam	$12^0$41.152' N	$80^0$13.169' E
4	N 30	Kovalam	$12^0$47.247' N	$80^0$15.138' E
5	S 5	Meyyur	$12^0$31.514' N	$80^0$09.957' E
6	S 10	Oyyali kuppam	$12^0$29.241' N	$80^0$09.484' E
7	S 15	Kadalur	$12^0$26.917' N	$80^0$08.668' E
8	S 30	Thazhuthalikuppam	$12^0$18.548' N	$80^0$02.263' E

Table 2: List of predominant families with total no. of genera and species recorded

Sl. No.	Species	Family	Order
1	*Megalaspis cordyla*	Carangidae	Perciformes
2	*Decapterus russelli*	Carangidae	Perciformes
3	*Alectis ciliaris*	Carangidae	Perciformes
4	*Photopectoralis bindus*	Leiognathidae	Perciformes
5	*Leiognathus equulus*	Leiognathidae	Perciformes
6	*Leiognathus daura*	Leiognathidae	Perciformes
7	*Leiognathus dussumieri*	Leiognathidae	Perciformes
8	*Lutjanus bohar*	Lutjanidai	Perciformes
9	*Priacanthus hamrur*	Priacanthidae	Perciformes
10	*Rastrelliger kanagurta*	Scombridae	Perciformes
11	*Trichiurus lepturus*	Trichiuridae	Perciformes
12	*Upeneus moluccensis*	Mullidae	Perciformes
13	*Upeneus vittatus*	Mullidae	Perciformes
14	*Upeneus sulphureus*	Mullidae	Perciformes
15	*Liza parsia*	Mugilidae	Perciformes
16	*Mene maculata*	Menidae	Perciformes
17	*Polydactylus plebeius*	Polynemidae	Perciformes
18	*Sphyraena obtusata*	Sphyraenidae	Perciformes
19	*Sillago sihama*	Sillaginidae	Perciformes
20	*Nemipterus japonicus*	Nemipteridae	Perciformes
21	*Nemipterus randalli*	Nemipteridae	Perciformes
22	*Johnius borneensis*	Sciaenidae	Perciformes
23	*Nibea maculata*	Sciaenidae	Perciformes
24	*Otolithes ruber*	Sciaenidae	Perciformes
25	*Johnius amblycephalus*	Sciaenidae	Perciformes
26	*Terapon jarbua*	Terapontidae	Perciformes
27	*Gerres filamentosus*	Gerridae	Perciformes
28	*Scatophagus argus*	Scatophagidae	Perciformes
29	*Synaptura commersonnii*	Soleidae	Pleuronectiformes
30	*Cynoglossus arel*	Cynoglossidae	Pleuronectiformes
31	*Pseudorhombus arsius*	Paralichthyidae	Pleuronectiformes
32	*Dussumieria acuta*	Dussumieridae	Clupeiformes
33	*Anodontostoma selangkat*	Clupeidae	Clupeiformes
34	*Tenualosa ilisha*	Clupeidae	Clupeiformes
35	*Sardinella longiceps*	Clupeidae	Clupeiformes
36	*Saurida tumbil*	Synodontidae	Aulopiformes
37	*Saurida sp.*	Synodontidae	Aulopiformes
38	*Saurida undosquamis*	Synodontidae	Aulopiformes
39	*Arius maculatus*	Ariidae	Siluriforms
40	*Thryssa vitrirostris*	Engraulidae	Clupeiformes
41	*Stolephorus indicus*	Engraulidae	Clupeiformes
42	*Pateobatis jenkinsii*	Dasyatidae	Myliobatiformes
43	*Brevitrygon imbricata*	Dasyatidae	Myliobatiformes

Table 3: Showing diversity indices for mean value of fish abundance

Sl. No.	Sample	Species richness (d)	Species evenness index (J')	Shannon-Winer index H'(loge)
1	PoM_N5	10.68	0.9801	3.686
2	PoM_N10	10.69	0.9804	3.687
3	PoM_N15	10.8	0.9769	3.674
4	PoM_N30	11.04	0.956	3.596
5	PoM_S5	11.02	0.9621	3.619

6	PoM_S10	10.77	0.9702	3.649
7	PoM_S15	10.89	0.9652	3.63
8	PoM_S30	10.76	0.9784	3.68
9	Sum_N5	11.11	0.9558	3.595
10	Sum_N10	11.17	0.9627	3.621
11	Sum_N15	11.03	0.9708	3.651
12	Sum_N30	11.17	0.9637	3.625
13	Sum_S5	11.37	0.961	3.614
14	Sum_S10	11.08	0.9519	3.58
15	Sum_S15	11.39	0.9424	3.545
16	Sum_S30	11.21	0.956	3.596
17	PrM_N5	10.93	0.97	3.649
18	PrM_N10	10.69	0.9754	3.669
19	PrM_N15	10.85	0.9794	3.684
20	PrM_N30	10.63	0.9875	3.714
21	PrM_S5	10.74	0.9774	3.676
22	PrM_S10	10.85	0.9752	3.668
23	PrM_S15	10.83	0.9824	3.695
24	PrM_S30	10.64	0.982	3.693

Table 4: Correlation matrix (Pearson) of the fish abundance and various physico-chemical parameter of the coastal waters of Kalpakkam.

	Abundance Total	**Salinity**	**pH**	**Temperature**	**NH_4-N**	**NH_3-N**
Abundance Total	1					
Salinity	-0.19307602	1				
pH	0.263014139	-0.848002878	1			
Temperature	-0.424895282	0.916517117	-0.899297965	1		
NH4-N	-0.213279401	-0.139472006	0.091516505	0.029579118	1	
NH3-N	-0.108409611	-0.002908597	-0.105779165	0.08244493	0.018246888	1

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