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Ichthyofaunal Diversity and Physico-chemical Analysis of Water in the Middle Stretch of Vembanad Lake, Kerala, India

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The status of finfish and shellfish diversity and monthly variation in their distribution and abundance were investigated in the middle stretch of Vembanad Lake at 4 selected sites in Kerala. The study was carried out for a period of 7 months from December 2022 to June 2023. In total 31 species of finfishes and shellfishes belongs to 8 orders, 23 families and 29 genera were recorded from the study areas. Calculated values of Biodiversity indices were Shannon Weiner diversity index highest at Vaikom (3.4022), Simpson diversity index highest at Manakunnam (0.9538), Margalef's richness index highest at Manakunnam (4.346) and Pielou's evenness index was highest at Thaneermukkom (0.8573). *Etroplus suratensis* and *Villorita cyprinoides* were the most abundant species from all four study sites. Three species are under the category of threatened they are *Oreochromis mossambicus, Horobagrus brachysoma* and *Hyporhampus xanthopterus.* The result of the present study indicates that the Northern part of Thaneermukkom barrage is endowed with rich edible fish

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fauna. The physicochemical parameters of water were analyzed during the pre-monsoon and monsoon periods. Salinity was higher on the Northern side of the barrage. During the pre-monsoon period temperature, EC, TDS, alkalinity and salinity were high and during the monsoon period hardness, DO, BOD, Phosphate and Nitrate were high when compared with pre-monsoon but all are within the recommended limit.

Keywords: Vembanad lake; finfish; shellfish; biodiversity indices; physicochemical analysis.

1. INTRODUCTION

Vembanad Lake is one of the transitional ecotone which is lying parallel to the Arabian Sea and comprises mangroves, mudflats, swamps and marshes [1]. As these ecosystems provide a harsh environment, many species of fish may have found them to be an ideal place for spawning, development and growth during their life [1]. Fishery resources of the Vembanad wetlands have immense potential because they are one of the readily accessible human food source and it is considered as the basis for the development of an innumerable variety of fishes [2]. The rich biodiversity and ecological value of this wetland made Vembanad Lake to be known as a Ramsar site in November 2002.

The fisheries are classified into four main sections ([3]: Ravlinsone et al*.,*1995) subsistence, artisanal, commercial and recreation. The fin fishes and shellfish are living components of water bodies and are important food resources and bioindicators of the environmental health and wealth of the waters in which they inhabit. Globally aquatic ecosystems and fish diversity are adversely affected due to an increase in unwise anthropogenic activities [4]. Therefore knowledge of the status and trends of backwater fisheries is the key to sound policy development, better decision making and responsible fisheries management [1].

Water quality analysis is one of the essential things for using it for any purpose [5]. Water quality can be defined as the chemical, physical and biological characteristics of water, usually concerning its suitability for a designated use. Different physicochemical parameters of water such as colour, temperature, acidity, hardness, pH, sulphate, chloride, DO, BOD, COD, and alkalinity used for testing water quality and it is necessary to have detailed information on it [6]. Increasing surface water pollution causes not only the deterioration of water quality but also threatens human health, the balance of the aquatic ecosystem, economic development and social prosperity [7]. The present study was carried out to study the diversity of fishes and physicochemical analysis of water in the selected sites of the middle stretch of Vembanad Lake.

2. MATERIALS AND METHODS

In the present study selected sites from the middle stretch of Vembanad lake is chosen for ichthyofaunal diversity. The selected sites for diversity study and physico- chemical water quality parameters include Kumarakom, Thanneermukkom, Vaikom, and Manakunnam.

Fish samples were located from different selected sites of the middle stretch of Vembanad during the study period of December (2022) – June (2023). It is done with the help of local fishermen using different types of fishing gear ie., gillnets, cast nets and dragnets. At the time of collection, photographs were taken before preservation since formalin decolorizes the fish colour on long preservation and the collected samples were preserved in 10 % formalin. The fishes were identified by following Talwar and Jhingran [8] and Jyaram [9].

The water samples were collected in both pre-monsoon and monsoon seasons to find out the temporal variation. Water quality was checked across parameters like colour, odour, temperature, electrical conductivity, TDS, PH, hardness, salinity, alkalinity, dissolved oxygen, BOD, phosphates and nitrates. For BOD determination water samples were collected in BOD bottles. For further analysis samples were transported to the laboratory and analyzed other parameters using standard procedures [10].

3. RESULTS AND DISCUSSION

In the present ichthyofaunal study total of 31 species were obtained. Among them, 26 finfishes and 5 shellfishes were reported from the four selected sites of the middle stretch of Vembanad Lake (Fig.1 to Fig. 31). 26 species of finfish belong to 24 genera and are included under 19 families and 5 species of shellfish belong to 5

different genera and are included under 4 families. The order of Perciformes were dominated in the present study. From the study of Narayanan et al*.,* [11] a similar report was recorded that order perciformes dominated the study. The systematic positioning of all the fish collected were listed in Table 1.

The abundance of species in percentage was studied from the four sites. The most abundant species from all four sites were observed as *Etroplus suratensis*. The most abundant species of site 1 Kumarakom was *Etroplus suratensis* (8.9%) and the least abundant species is *Macrobranchium rosenbergii* (0.7%). The most abundant species of site 2 Thanneermukkom were observed as *Etroplus suratensis* (9%) and the least abundant one is *Macrobrachium rosenbergii* (0.6%). Some of the species were absent in both sites 1 and 2 like *Leiognathus equulus*, *Nematalosa nausus*, *Scylla serrata,* and *Penaeus monodon.* The most abundant species of site 3 Vaikom was observed as *Etroplus suratensis*(8.7%) and the least abundant species was *Scylla serrata* and finally the most abundant species of site 4 Manakunnam was found to be *Etroplus suratensis* (8.5%*)* and the least abundant one is *Scylla serrate* (0.1%).

The collected species were categorized according to IUCN status. 45% of species were demarcated as Not Evaluated, followed by 42% as Least Concern, 7% as Vulnerable, and 3% as Data Deficient, and 3% as Near Threatened. *Oreochromis mossambicus* belongs to order Perciformes and the family Cichlidae is under the Near Threatened category of IUCN. *Horabagrus brachysoma* of Siluriformes order and Bagridae family is under the Vulnerable status of IUCN. *Hyporhampus xanthopterus* of order Beloniformes and family Hemiramphidae family is also under the category of Vulnerable that is in short three species were identified as threatened. It is clear that three of the species of fishes reported in the present study is threatened and it was shown in the checklist of Bijikumar et al*.,* [12]. A similar report was given by Ansar et al*.,* [13] showing the list of threatened species of fishes in Vembanad Lake.

The statistical analysis of the collected data was done and various diversity indices were used (Table 2). The Shannon- Weiner diversity index of species collected from four different sites was found in the present study. Here site 3 Vaikom has the highest Shannon diversity index ie., 3.4022 and the low Shannon diversity index in Kumarakom ie., 3.131 but they are within the range of 1.5 to 3.5. The next index used in the study is Simpson's Diversity Index of four sites in which Manakunnam site 4 is with high value that is 0.9538 followed by Vaikom site 3 (0.09535), Thanneermukkom site 2 (0.9514) and Kumarakom site 1 (0.9508). To measure species richness Margalef's Diversity Index is used in the present study. The range of Margalef's diversity index varies from 0 to 8 and here Site 4 Manakunnam has high species richness among the four sites selected with a value of 4.346, followed by Site 3 Vaikom (4.292), Site 1 Kumarakom(3.816) and Site 2 Thanneermukkom (3.777). To measure the evenness of species from the four sites Pielou's evenness index was used and usually Pielou's Index ranges from 0 to 1. In the present study, Thanneermukkom site 2 is with high value of evenness that is 0.8573 followed by Kumarakom site 1 (0.8522), Manakunnam site 4 (0.8051), and Vaikom site 1 (0.8031).

With the construction of Thaneermukkom bund, the salinity barrage divided the lake into two distinct ecosystems, freshwater on the south and brackishwater on the north and there were some changes in the physicochemical condition of water and species diversity. The southern part of the bund ie., Kumarakom (Site1) and Thaneermukkom South (Site 2) has less number of species when compared to the Northern part ie.,Vaikom (Site3) and Manakunnam (Site4). The most abundant species are *Etroplus suratensis* and *Villorita cyprinoides* from all study sites. Two species of shellfish *Scylla serrata* and *Penaeus monodon* were completely absent on the Southern side of Thaneermukkon bund.

The physicochemical analysis of water from selected sites was done using standard procedures (APHA 2005) and depicted in Fig. 32 to Fig.42. Water quality analysis was done during both Pre-monsoon and Monsoon seasons. The correlation between water quality parameters is done using Pearson's Correlation Coefficient. Correlations were cross-checked with species abundance and water quality parameters. It is clear that mean species abundance is positively correlated with some of the water quality parameters like Temperature (r = 0.75422), EC (r = 0.85703), Alkalinity (r = 0.96895), Hardness (r = 0.74110), Salinity (r = 0.97750) and BOD (r = 0.25275) and negatively correlated with TDS (r = -0.97528), PH (r = -0.42240), DO (r = -0.98974), Phosphate (r = -0.23601) and Nitrate (r = -0.83535).

Table 1. List of fin fishes and shell fishes collected from the study area

Order	Family	Study Site	Scientific Name	Common Name	Local Name	Commercial status
Perciformes	Ambassidae	KMR TMK VKM MKM	*Parambassist homassi*	Western ghats glassy perchlet	Arinjil	Ornamental /food fish
Perciformes	Anabantidae	KMR TMK VKM MKM	*Anabas testudineus*	Climbing perch	Andikalli	Ornamental /food fish
Perciformes	Cichlidae	KMR TMK VKM MKM	*Etroplus surantensis*	Banded pearl spot	Karimeen	Ornamental /food fish
Perciformes	Cichlidae	KMR TMK VKM MKM	*Pseudetroplus maculatus*	Orange chromide	Pallathi	Ornamental /food fish
Perciformes	Cichlidae	KMR TMK VKM MKM	*Oreochromis mossambicus*	Tilapia	Silopia	Food fish
Perciformes	Centropomid ae	KMR TMK VKM MKM	*Lates calcarifer*	Barramundi	Narimeen	Food fish
Perciformes	Gobidae	KMR TMK VKM MKM	*Stenogobius gymnopomus*	Malabar goby	Poolan	Ornamental/fo od fish
Perciformes	Leignathidae	VKM MKM	*Leiognathus equulus*	Common pony fish	kurichil	Ornamental/fo od fish
Perciformes	Lutjanidae	KMR TMK VKM MKM	*Lutjanus argentimacula tus*	Mangrove red snapper	Chemballi	Ornamental/fo od fish
Perciformes	Scatophagida e	KMR TMK VKM MKM	*Scatophagus argus*	Spotted scat	Nachara	Ornamental/ food fish
Perciformes	Sciaenidae	KMR TMK VKM MKM	*Daysciaena albida*	Bengal arvina	Pallikora	Food fish
Perciformes	Sillaginidae	KMR TMK VKM MKM	*Sillago sihamo*	Silver sillago	Kathiran	Food fish
Perciformes	Sphyraenidae	KMR TMK VKM MKM	*Sphyraena jello*	Banded barracuda	Seelavu	Food fish
Cypriniform es	Cyprinidae	KMR TMK VKM MKM	*Amblypharyn godon melettinus*	Mola carplet	Vayambu	Ornamental/ food fish
Cypriniform es	Cyprinidae	KMR TMK VKM MKM	*Labeo dussumieri*	Malabar labeo	pullan	Food fish
Cypriniform es	Cyprinidae	KMR TMK VKM MKM	*Systomus serana*	Olive barb	Paral	Ornamental/ food fish
Siluriformes	Ariidae	KMR TMK VKM MKM	*Arius subrostratus*	Shovel nose sea catfish	Vazha koori	Ornamental/ food fish
Siluriformes	Bagridae	KMR TMK VKM	*Mystus oculatus*	Malabar mystus	Chilan koori	Ornamental/ food fish

Order	Family	Study Site	Scientific Name	Common Name	Local Name	Commercial status
		MKM				
Siluriformes	Bagridae	KMR TMK VKM MKM	*Horabagrus bracysoma*	Gunter's cat fish	Manjakoor i	Ornamental/ food fish
Clupeiforme s	Clupeidae	VKM MKM	*Nematalosa nausa*	Bloch's gizzard shad	Manga meen	Food fish
Clupeiforme s	Engraulidae	KMR TMK VKM MKM	*Stolephorus commersonnii*	Commerso n's anchovy	Netholi	Ornamental/ food fish
Clupeiforme s	Engraulidae	KMR TMK VKM MKM	*Stolephorus indicus*	Indian anchovy	Kozhuva	Food fish
Beloniforme s	Hemiramphi dae	KMR TMK VKM MKM	*Hyporamphus xanthopterus*	Vembanad half beak	Kola	Ornamental/ food fish
Beloniforme s	Hemiramphi dae	KMR TMK VKM MKM	*Hyporamphus limbatus*	Half beak	Kola	Ornamental/ food fish
Pleuronectif ormes	Soleidae	KMR TMK VKM MKM	*Brachirus orientalis*	Oriental sole	Nanku	Ornamental/ food fish
Pleuronectif ormes	Cynoglossida e	KMR TMK VKM MKM	*Cynoglossus cynoglossus*	Bengal tongue sole	Manthal	Ornamental/ food fish
Venerida	Cyrenidae	KMR TMK VKM MKM	*Villorita cyprinoides*	Black clam	Kakka	Food
Decapoda	Portunidae	VKM MKM	*Scylla serrata*	Mangrove crab	Njand	Food
Decapoda	Penaeidae	VKM MKM	*Penaeus monodon*	Giant tiger prawn	Kara	Food
Decapoda	Palaemonida e	KMR TMK VKM MKM	*Macrobrachiu m resenbergii*	Giant freshwater prawn	Aattu Konch	Food
Decapoda	Penaeidae	KMRTMKVKM MKM	*Metapenaeus dobsoni*	Kadal shrimp	Thelly	Food

KMR : Kumarakom; TMK : Thanneermukkom; VKM : Vaikom; MKM : Manakunnam

Table 2. Diversity indices of four sites studied

Sl.No	Sites	Shannon diversity Index	Simpson's diversity index	Margalef's diversity Index	Pielou's evenness Index
1	Kumarakom	3.131	0.9508	3.816	0.8522
2	Thanneer- mukkom	3.2195	0.9514	3.777	0.8573
3	Vaikom	3.4022	0.9535	4.292	0.8031
4	Manakunnam	3.19321	0.9538	4.346	0.8051

Table 3. Physico-chemical parameters of water

Parameters	Site 1 (K)		Site 2(T)		Site 3(V)		Site 4(M)	
	PM	M	PM	M	PM	M	PM	M
Temp.	30.8^{0}C	26.8^{0}C	30^{0}C	27^{0}C	31^{0}C	27^{0}C	31^{0}C	27^{0}C
EC	0.058mS/cm	0	0.058mS/cm	0	0.4mS/cm	0.188mS/cm	0.412mS/cm	0.195mS/cm
TDS	0.142g/l	0.002 g/l	0.138 g/l	0	0.069 g/l	0.003 g/l	0.071 g/l	0.003 g/l
PH	6.6	6.9	6.5	6.8	6.5	6.7	6.6	6.8
Alkalinity	75 mg/l	45 mg/l	77 mg/l	50 mg/l	125 mg/l	50 mg/l	120 mg/l	55 mg/l
Hardness	40 mg/l	68mg/l	41 mg/l	65 mg/l	48 mg/l	78 mg/l	45 mg/l	70 mg/l
Salinity	0.033 ppt	0.002 ppt	0.033 ppt	0.002 ppt	0.193 ppt	0.092 ppt	0.199 ppt	0.095 ppt
DO	7.2 mg/l	9 mg/l	7 mg/l	9 mg/l	6.9 mg/l	7.5 mg/l	6.5 mg/l	7 mg/l
BOD	2mg/l	3 mg/l	2 mg/l	2.2 mg/l	2.5 mg/l	3 mg/l	2 mg/l	2.6 mg/l
Phosphate	0.0086mg/l	0.012 mg/l	0.007 mg/l	0.01 mg/l	0.0079mg/l	0.0108 mg/l	0.0078mg/l	0.0107 mg/l
Nitrate	0.0049mg/l	0.016 mg/l	0.0047 mg/l	0.014 mg/l	0.005mg/l	0.013 mg/l	0.006mg/l	0.012 mg/l

3.1 Observed Ichthyofauna during the Study Period

3.1.1 Fin fishes of Vembanad lake

Fig. 1. *Parambassis thomassi*

Fig. 2. *Anabas testudineus*

Fig. 3. *Etroplus suratensis*

Fig. 4. *Pseudetroplus maculatus*

Fig. 5. *Oreochromis mossambicus*

Fig. 6. *Lates calcarifer*

Fig. 7. *Stenogobius gymnopomus*

Fig. 8. *Leiognathus equulus*

Fig. 9. *Lutjanus argentimaculatus*

Fig. 10. *Scatophagus argus*

Fig. 11. *Daysciaena albida*

Fig.12. *Sillago sihamo*

Fig. 13. *Sphyraena jello*

Fig. 14. *Amblypharyngodon melettinus*

Fig.1 5. *Labeo dussumieri*

Fig. 16. *Systomus serana*

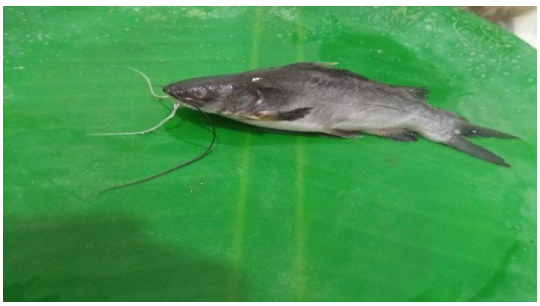

Fig. 17. *Arius subrostratus*

Fig. 18. *Mystus oculatus*

Fig. 19. *Horabagrus brachysoma*

Fig. 20. *Nematalosa nausa*

Fig. 21. *Stolephorus commersoni*

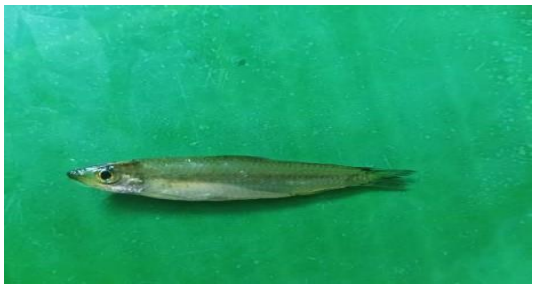

Fig. 22. *Stolephorus indica*

Fig. 23. *Hyporhamphus xanthopterus*

Fig. 24. *Hyporhamphus limbatus*

Fig.* 25. *Brachirus orientalis

Fig. 26. *Cynoglossus cynoglossus*

3.1.2 Shell fishes of Vembanad lake

Fig. 27. *Penaeus monodon*

Fig. 28. *Macrobrachium rosenbergii*

Fig. 29. *Metapenaeus dobsoni*

Fig. 30. *Scylla serrata*

Fig. 31. *Villorita cyprinoides*

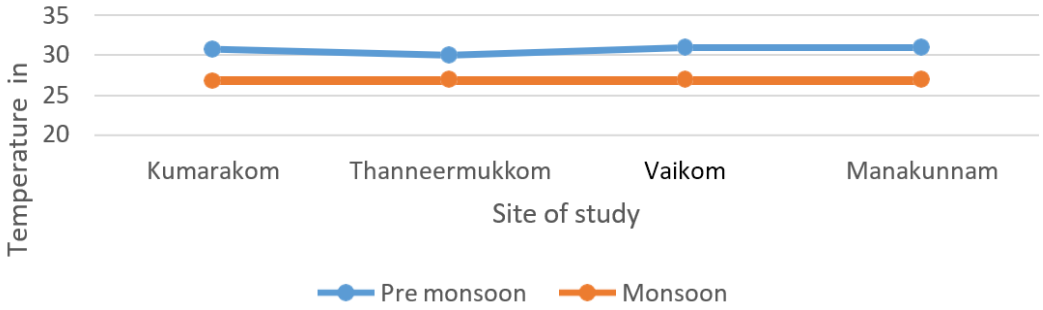

Fig. 32. The distribution plots of evaluated temperature

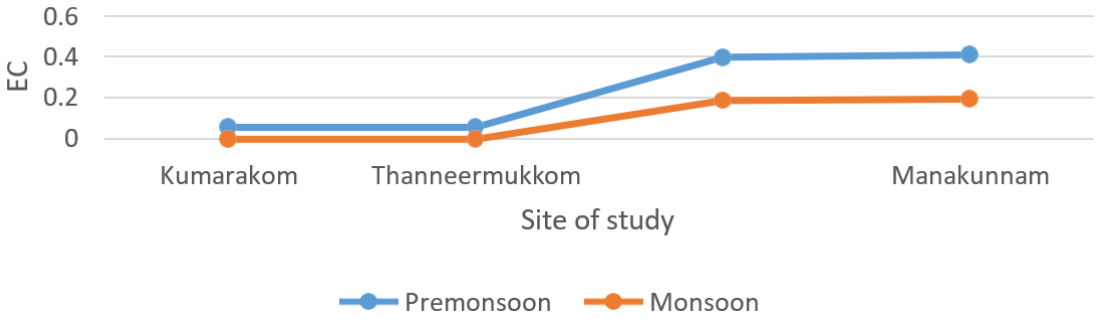

Fig. 33. The distribution plots of evaluated EC

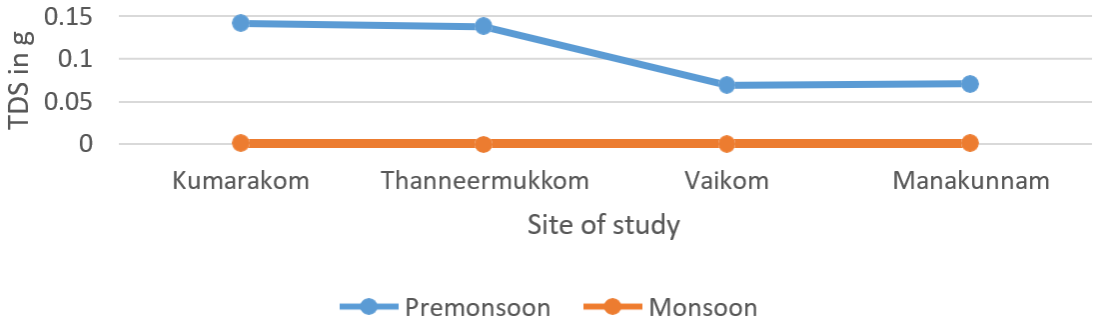

Fig. 34. The distribution plots of evaluated TDS

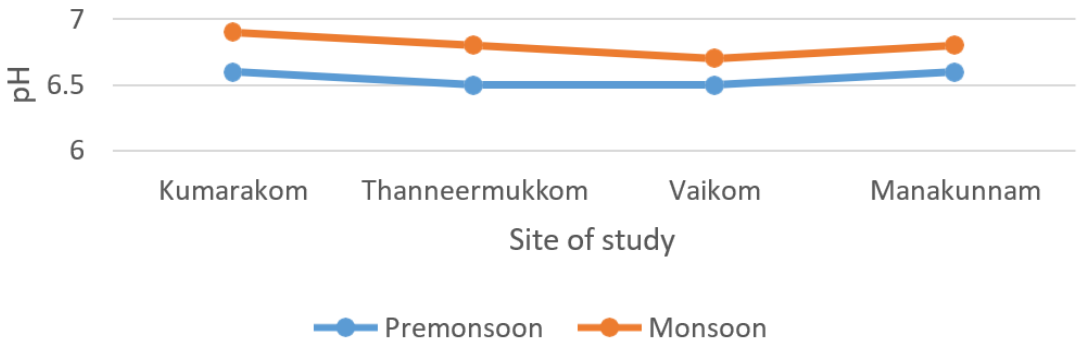

Fig. 35. The distribution plots of evaluated PH

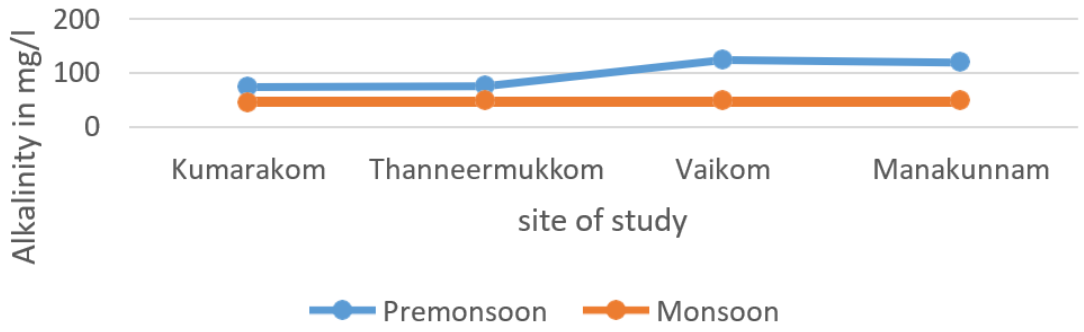

Fig. 36. The distribution plots of evaluated Alkalinity

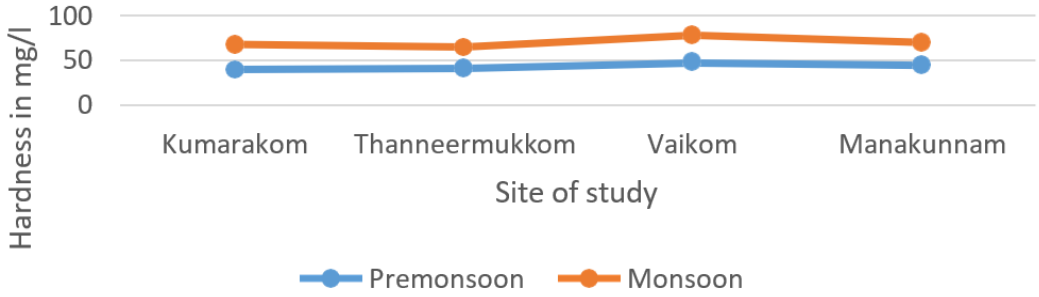

Fig. 37. The distribution plots for evaluated Hardness

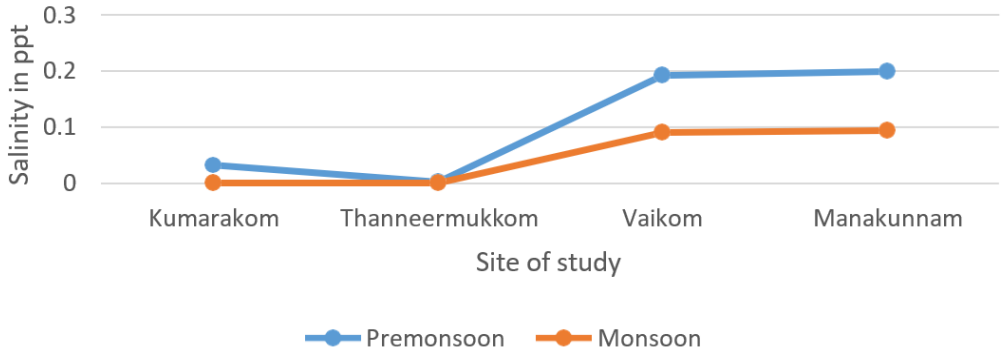

Fig. 38. The distribution plots for evaluated Salinity

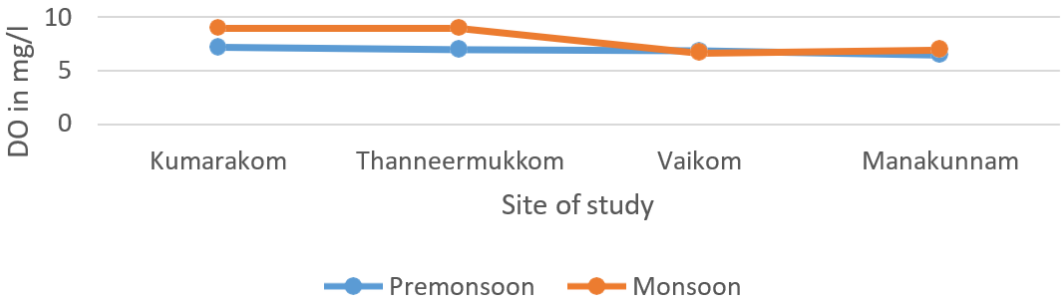

Fig. 39. The distribution plots for evaluated DO

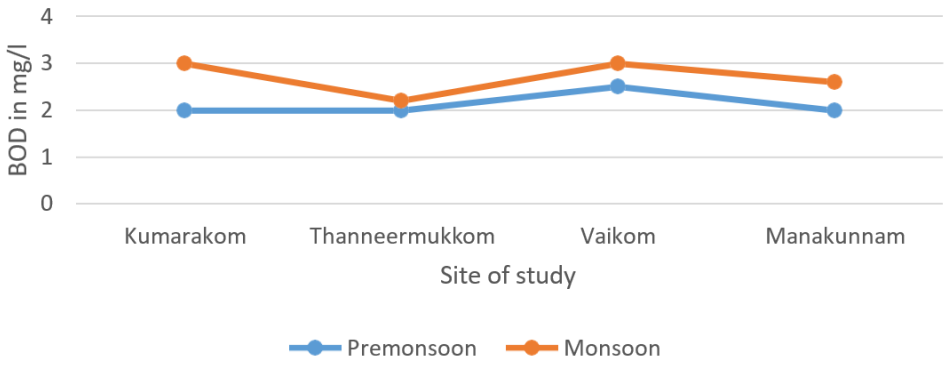

Fig. 40. The distribution plots for evaluated BOD

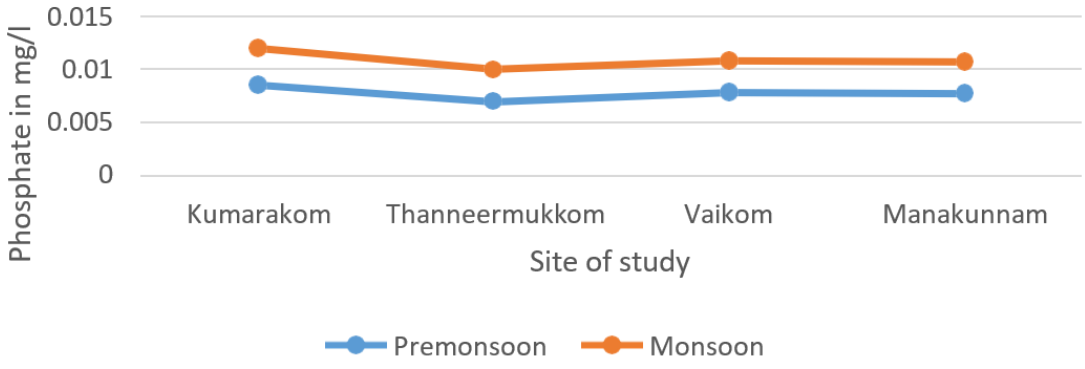

Fig. 41. The distribution plots for evaluated Phosphate

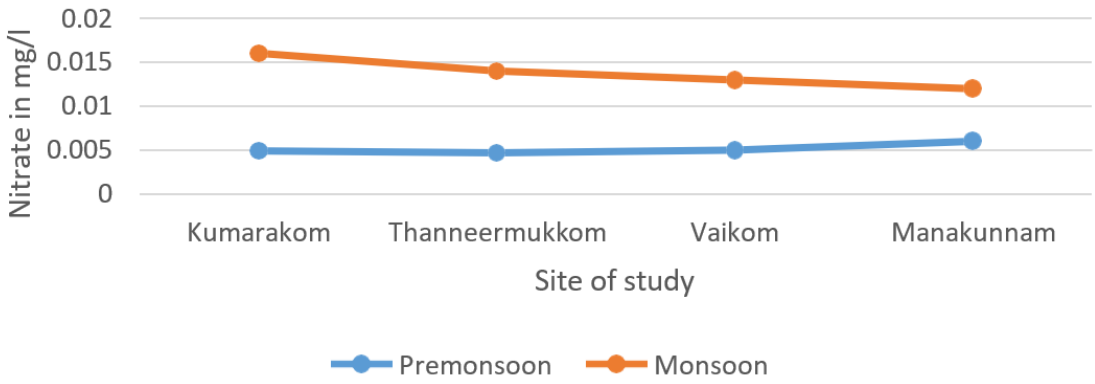

Fig. 42. The distribution plots for evaluated Nitrate

4. CONCLUSION

The study reflects on the fin fish and shellfish diversity of selected sites of Vembanad Lake along with the analysis of physico-chemical parameters of water. The most abundant species are *Etroplus suratensis* and *Villorita cyprinoides* from all study sites. Two species of shellfish *Scylla serrata* and *Penaeus monodon* were completely absent on the Southern side of Thaneermukkon bund. Under the IUCN categorization, there were two Vulnerable species and one Near Threatened species ie., *Horabagrus brachysoma and Hyporhampus xanthopterus* were considered as vulnerable and *Oreochromis mossambicus* as Near Threatened. All the physicochemical parameters are within the limited range during both pre-monsoon and monsoon periods. Salinity was higher on the Northern side of the barrage. During the Pre-monsoon period Temperature, EC, TDS, Alkalinity, and salinity are high and during Monsoon season hardness, DO, BOD, Phosphate, and Nitrate were high when compared with Pre- monsoon but all were within the limit. Water quality parameters like Temperature, EC, Alkalinity, Hardness, Salinity and BOD were positively correlated with species abundance.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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