Eco. Env. & Cons. 29 (July Issue) pp. S90-S97
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ISSN 0971–765X

Special Issue on "Int. Conf. on Impact of Clim. Change on Aq. Life and Mtgn. Measures for a Sust. Blue Economy", 23-25 Nov, 2022, PG & Res. Dept. of Zoology, FMNC, Kollam, Kerala, India.

DOI No.: http://doi.org/10.53550/EEC.2023.v29isp2.015

Ichthyofaunal Diversity of Pillai Kadavu, Northern Region of Kayamkulam Backwater, Kerala, India

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ABSTRACT

Diversity and conservation status of fishes of Pillai Kadavu, the northern region of Kayamkulam backwater were analysed from April 2019 to March 2020. A total of 30 fishes under nine orders, 14 families and 22 genera were collected from the station. Order Cypriniformes and family Cyprinidae constituted the most species-rich order and family respectively. Shannon-Wiener diversity index of 2.73 and Margalef species richness of 7.56 were calculated along with a lower Peiolou evenness of 0.22 and Simpson dominance index of 0.88. All fishes were categorised with respect to the International Union for Conservation of Nature's (IUCN) red list of threatened species and found that 22 species were categorised as Least Concern (LC), two fishes came under Vulnerable (VU), and one species was under Near Threatened (NT) category. *Hypselobarbus curmuca* was found to be Endangered (EN), one species was under Not Evaluated (NE) and three were categorised as Data Deficient (DD). The relative abundance showed that 13 fishes were abundant (A), two were included under Common (C) and 13 fishes were found to be Very Rare (VR) and two were Not Common (NC).

Key words : *Kayamkulam backwater, Pillai Kadavu, Ichthyofaunal diversity, Abundance, Diversity indices.*

Introduction

An estuarine environment is a unique and important part of the aquatic habitat and forms the transition zone between the inland world of freshwater and the seawater lying offshore (Ketchum, 1951). The flora and fauna are adapted to tolerate various natural conditions happen in the estuaries. A wide variety of fishes inhabit the estuarine environment. Estuaries form important areas for fishing, transport, and recreation. They are known to be highly productive and also contribute a lot to the productivity of the coastal environment. Moreover, they are breeding, feeding, and nursery ground for many commercially important fishes and shellfish.

India is considered as one of the mega-diversity countries supported by its vast geographical area and lodging tropical zone (Nelson *et al.*, 2016). Regular assessment of ichthyofaunal diversity from the aquatic ecosystems is a prerequisite for proper management and conservation of the respective resources. The estuaries, backwaters, coastal creeks, and large brackish water systems contribute to a significant part of fish production in India (Nair *et al.*, 1983; Tudu *et al*., 2018). The peculiarity of Indian estuaries is that they are characterised by high species diversity with low numerical abundance (Sreekanth *et al*., 2019).

Fisheries constitute an important source of a country's economy. Fishes have formed an important item of the human diet from time immemorial and are primarily caught for this purpose (Sarwade *et al*., 2010). Most marine species use backwater and estuaries as nursery grounds while some freshwater

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fishes utilize them for breeding purposes. Biodiversity is essential for the stabilization of the ecosystem (Ehrlich and Wilson, 1991). There are many indices to measure biodiversity by relating the number of species and their relative abundance. These indices treat all species as equivalent and ignore taxonomic, morphological, or any such biological differences among species of a community (Ganeshaiah *et al.,* 1997). In studies investigating diversity partitioning among sites, biodiversity indices are almost exclusively based on species composition even though the definition of biodiversity includes various facets of the diversity of life (Villeger, 2012).

Remya and Amina (2017) studied the biodiversity status of fishes in Kayamkulam backwater, Kerala during a period of one year and reported the presence of 125 fish species belonging to 13 orders, 57 families, and 87 genera. Remya and Amina (2017) conducted a study on the biodiversity status of fishes from Vettathu Kadavu, a part of Kayamkulam backwater, Kerala during a period of one year and documented 25 fishes belonging to six orders and 15 families. They also evaluated their conservation status. The status of fisheries and seasonal variations in fish biodiversity in the Kodungallur-Azhikode estuary was studied by Bijoy *et al.* (2012) and their study revealed the presence of 60 fishes. The status of fisheries and seasonal variation in fish diversity in four selected estuaries (Pozhiyoor, Adimalathura, Poonthura, and Kappil) of Trivandrum district in Kerala was studied for the first time by Nansimole *et al*. (2014) and reported the presence of 134 fishes. Thomas *et al*. (1995) reported 23 species of fishes belonging to 18 families and 5 species of prawns under 2 families from the mangroves of Quilon, Kumarakom and Veli areas. Bijukumar and Sushama (2000) gave the first report on the ichthyofauna of Ponnani estuary; it represented 112 species belonging to 14 orders, 53 families, and 80 genera. Rajukumar (2005) recorded 38 species from Anchuthengu backwaters.

Regular monitoring of fish faunal diversity is an important factor in maintaining the sustainability of water bodies. So, the present work is aimed to study the fish diversity, its diversity indices, abundance, and conservation status of Pillai Kadavu, the freshwater side of the northern part of Kayamkulam backwater, Kerala which marks the first effort in this direction.

Materials and Methods

Study area and sampling location

Pillai Kadavu, the northernmost region of Kayamkulam backwater, lies between a latitude of 9°14′51.4′′ N and a longitude of 76°25′24.1′′ E, which has freshwater influence throughout the year. This station receives run-off during the southwest monsoon and to some extent during the northeast monsoon season. The discharge of freshwater from adjacent rivers like Achancoil and Pamba, particularly during the south-west monsoon period, and the influence of movements from the Arabian sea into the backwater through the small inlet canals in the North-Southern region (Fig. 1). The study was conducted during a period of one year from April 2019 to March 2020.

Sample collection and identification

The fishes were collected with the help of local fishermen. The collected fishes were brought to the laboratory, fixed, and preserved in 10% formalin. Larger fishes were given injections with the same solution in their abdomen and other parts of the body to ensure the preservation and placed in plastic containers. Each container was labelled properly, and specimens were examined in detail and identified up to species level by using the standard keys (Day, 1878; Jayram, 1981; Talwar and Jhingaran, 1991). Voucher specimens of the fish species collected were deposited in the Museum of the Post Graduate and Research Department of Zoology, Sree Narayana College, Kollam.

The different species recorded during the study were checked with International Union for Conservation of Nature (IUCN, 2022) list to assess the conservation status of fish species. To assess the abundance status of fish landed in each station, species were categorised into Abundant, A (>1000), Common, C (500-1000), Not Common, NC (100-500), Rare, R (50-100) and Very Rare, VR (<50). Statistical analyses for diversity indices such as the Shannon-Wiener index, Margalef's species index, Simpson's diversity index, and Evenness index were carried out to count the biodiversity criteria using the PAST version 3 (Harper and Ryan, 2001).

Results

The present study conducted at Pillai Kadavu re-

Table 1. Systematic position, Common name, Abundance, Conservation status, and Occurrence of ichthyofauna of Pillai Kadavu

Sl. No.	Order, Family, and Scientific names of fishes	Common names	Abundance	IUCN status	Occurrence
A	**ORDER ANABANTIFORMES**				
A	FAMILY ANABANTIDAE				
1	*Anabas testudineus*	Climbing perch	VR	LC	FW
B	FAMILY CHANNIDAE				
2	*Channa marulius*	Great snakehead	VR	LC	FW
3	*Channa striata*	Striped snakehead	VR	LC	FW
C	FAMILY NANDIDAE				
4	*Nandus nandus*	Gangetic leaffish	R	LC	FW
B	**ORDER CICHLIFORMES**				
D	FAMILY CICHLIDAE				
5	*Etroplus suratensis*	Pearlspot	A	LC	FW & BW
6	*Oreochromis mossambicus*	Mozambique tilapia	A	VU	FW
7	*Pseudetroplus maculatus*	Orange chromide	A	LC	FW & BW
C	**ORDER CLUPEIFORME**				
E	FAMILY ENGRAULIDAE				
8	*Stolephorus commersonnii*	Commerson's anchovy	A	LC	M & BW
D	**ORDER CYPRINIFORMES**				
F	FAMILY CYPRINIDAE				
9	*Dawkinsia filamentosa*	Blackspot barb	VR	LC	FW
10	*Hypselobarbus curmuca*	Curmuca barb	VR	EN	FW
11	*Labeo rohita*	Roho labeo	VR	LC	FW
12	*Pethia ticto*	Ticto barb	VR	LC	FW
13	*Puntius mahecola*	Mahecola barb	VR	DD	FW
14	*Puntius vittatus*	Greenstripe barb	VR	LC	FW
15	*Systomus subnasutus*	Olive barb	VR	LC	FW
E	**ORDER CYPRINODONTIFORMES**				
G	FAMILY APLOCHEILIDAE				
16	*Aplocheilus lineatus*	Striped panchax	VR	LC	FW
F	**ORDER MUGILIFORMES**				
H	FAMILY MUGILIDAE				
17	*Mugil cephalus*	Flathead greymullet	A	LC	M, BW & FW
G	**ORDER PERCIFORMES**				
I	FAMILY AMBASSIDAE				
18	*Ambassis ambassis*	Commerson's glassy	A	LC	M, BW & FW
19	*Ambassis gymnocephalus*	Bald glassy	A	LC	BW & FW
20	*Ambassis urotaenia*	Banded-tail glassy perchlet	C	LC	BW & FW
21	*Parambassis thomassi*	Western Ghat glassy perchlet	R	LC	FW
H	**ORDER PLEURONECTIFORMES**				
J	**FAMILY CYNOGLOSSIDAE**				
22	*Cynoglossus bilineatus*	Fourlined tonguesole	A	LC	M & BW
23	*Cynoglossus cynoglossus*	Bengal tonguesole	A	LC	M & BW
24	*Cynoglossus macrostomus*	Malabar tonguesole	A	NE	M & BW
25	*Cynoglossus puncticeps*	Speckled tonguesole	A	DD	M & BW
I	**ORDER SILURIFORMES**				
K	FAMILY ARIIDAE				
26	*Arius arius*	Threadfin sea catfish	A	LC	BW
27	*Arius maculatus*	Spotted catfish	A	DD	BW
L	FAMILY CLARIDAE				
28	*Clarias dussumieri*	Valenciennes clariid	VR	NT	FW
M	FAMILY HETEROPNEUSTIDAE				
29	*Heteropneustes fossilis*	Stinging catfish	VR	LC	FW

Table 1. *Continued ...*

Sl. No.	Order, Family, and Scientific names of fishes	Common names	Abundance	IUCN status	Occurrence
N	FAMILY HORABAGRIDAE				
30	*Horabagrus brachysoma*	Gunther's catfish	C	VU	FW

A-Abundant, C-Common, R-Rare, NC-Not Common, VR- Very Rare; LC-Least Concern, EN-Endangered, NT-Near Threatened, NE-Not Evaluated, DD-Data Deficient, VU-Vulnerable; M-Marine, BW-Brackish Water, FW-Freshwater

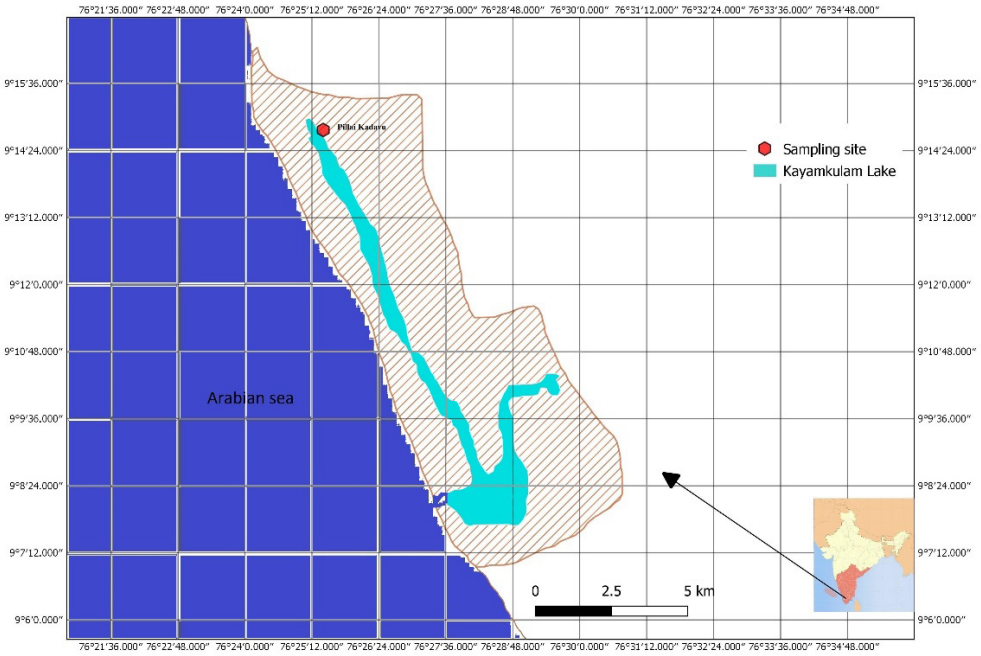

Fig. 1. Map showing Pillai Kadavu in Kayamkulam backwater.

vealed the presence of a total of 30 species of fishes belonging to nine orders, 14 families, and 22 genera which are depicted in Table 1.

Biodiversity indices

Biodiversity indices of fishes collected from the Pillai Kadavu were analysed and found out various biodiversity indices such as Shannon-Wiener diversity, Margalef species richness, Simpson dominance, and Peiolou evenness (Table 2). Shannon-Wiener diversity index of 2.73 and Margalef species richness of 7.56 indicated lower species richness and species diversity in the Pillai Kadavu when compared to that of all the stations in the Kayamkulam backwater together. The dominance of orders Cypriniformes (7 fishes) and Siluriformes (5 fishes) were responsible for lower Peiolou evenness of 0.22 in the Pillai Kadavu. The Simpson dominance index was found to be 0.88.

Table 2. Biodiversity indices of fishes collected and identified from the Pillai Kadavu

Sl. No	Diversity indices	Values
1	Shannon-Wiener diversity index	2.73
2	Margalef species richness	7.56
3	Peiolou evenness	0.22
4	Simpson's dominance index	0.88

The fishes identified from the Pillai Kadavu were categorized under different Red List categories as per the IUCN Red List of Threatened Species (IUCN, 2022). Twenty-two species fishes fell into the category of Least Concern (LC) and three were categorised as Data Deficient (DD) (Fig. 2). There were two fishes coming under the category Vulnerable (VU) which are *Oreochromis mossambicus* (Family: Cichlidae), and *Horabagrus brachysoma* (Family: Horabagridae). One species was found to be under the status of Near Threatened (NT), which was

Clarias dussumieri (Family: Clariidae). The species coming under the category of Endangered was *Hypselobarbus curmuca* (Family: Cyprinidae). The conservation status of the remaining one fish was found to be designated as Not Evaluated (NE). Observations on the order and family-wise distribution of fish fauna revealed that order Cypriniformes forms the most species-rich order with seven species during the study which is followed by Siluriformes with five species, Anabantiformes, Perciformes and Pleuronectiformes with four fishes in each order (Fig. 3). Family Cyprinidae with seven species forms the largest family followed by Ambassidae and Cynoglossidae with four species in the present study (Fig. 4).

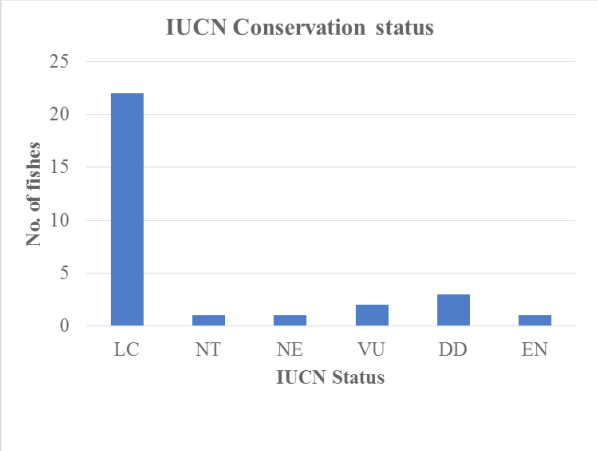

Fig. 2. IUCN Conservation status assessment of fish species Pillai Kadavu

The relative abundance of the species landed during the period of study was analysed. It showed that 43% of the fish species in the total catch were abundant throughout the year and another 43% forms the Very Rare (VR) category. Seven percentage of fish species were coming under the Common (C) and Not Common (NC) categories respectively (Fig. 5).

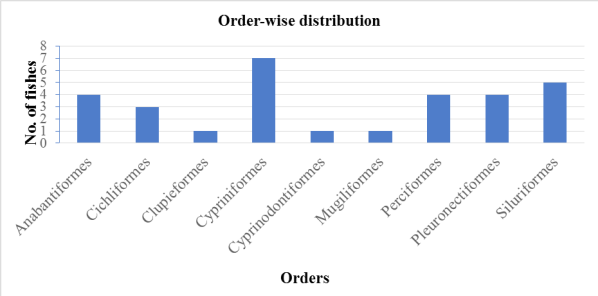

Fig. 3. Order-wise distribution of fishes collected and identified from Pillai Kadavu

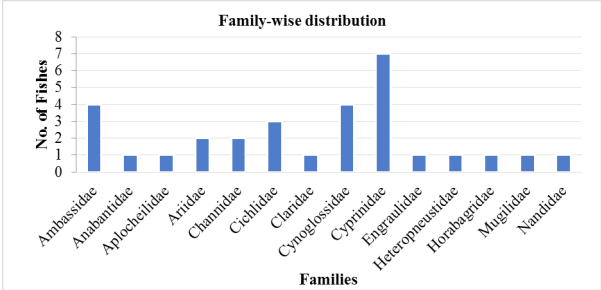

Fig. 4. Family-wise distribution of fishes collected and identified from Pillai Kadavu

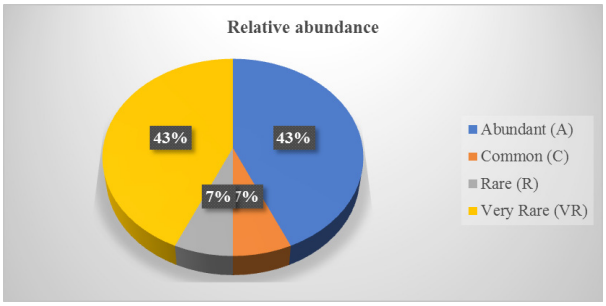

Fig. 5. Relative abundance of fishes collected and identified from the Pillai Kadavu

Since the station has a free connection with the freshwater outputs from the northern most end, the piscine fauna in this area was comprised mostly of freshwaters, brackish water forms, and some marine forms which can tolerate this environment. Among the 30 fishes collected, 17 fishes comprised of pure freshwater forms, two were brackish water forms (Fig. 6). Four of them were commonly seen in the freshwater and backwater. Five fishes were inhabitants of brackish water, and marine waters and two were seen in freshwater, brackish water, and marine.

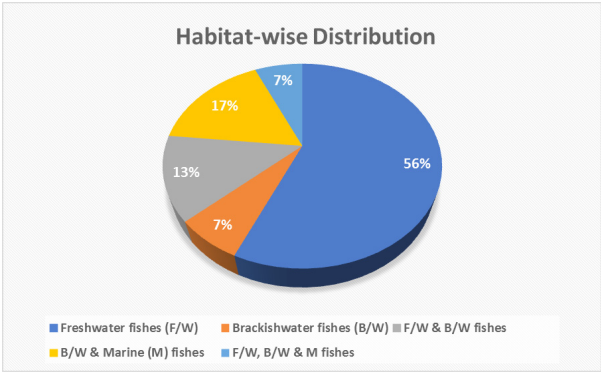

Fig. 6. Habitat-wise distribution of fishes collected and identified from Pillai Kadavu

Discussion

Fish diversity

It is a crucial element to investigate information on the diversity and distribution of species for appropriate and timely decision-making in biodiversity conservation. The freshwater fish species contribution to this particular station seems to be high during the study period and very low when compared to their marine and estuarine counterparts in the whole backwater. It may be probably due to the differences in environmental conditions, a wide salinity range, and changes in osmoregulatory ability, etc. According to Whitfield *et al.* (2015), only a few freshwater species, especially some of those belonging to the family Cichlidae, have become fully euryhaline and have successfully occupied a wide range of estuaries, sometimes even dominating in the hypersaline system where salinity ranges more than 40ppt. An opposite trend was seen in our study in which the family Cichlidae with three fishes is abundantly seen in the catch throughout the year. Cyprinidae forms the species-rich family with seven fishes, but all are freshwater inhabitants and come under the category Very Rare (VR).

A previous study was conducted by Remya and Amina (2017) on the biodiversity status of fishes from Vettathu Kadavu, a part of Kayamkulam backwater, Kerala during a period of one year and documented 25 fishes belonging to six orders and 15 families. They also evaluated their conservation status. Another study conducted by Ansar *et al.* (2017) on the finfish and shellfish diversity of Kumarakom region of Vembanad lake in the Kottayam district documented fin fishes and shell fishes belonging to 13 orders and 31 families. As per their study, *Etroplus suratensis, Pseudetroplusmaculatus, Amblypharyngodon melettinus* and *Stolephorus indicus* were found to be highly abundant species in the backwater. *Amblypharyngodon melettinus* were not collected from the Pillai Kadavu during any previous studies. Jayasree (1995) reported 36 species belonging to 24 families from Veli backwater and the most abundant species *were E.suratensis, Pseudetroplus maculatus, Mugil cephalus,* and *Liza tade*. Shibu (1991) recorded *E.suratensis and E.maculatus* as the most dominant species throughout his study in the Paravur backwater.

Conservation status

While assessing the threat status of these fishes according to the IUCN red list, some species are included in the Near Threatened, Vulnerable and Endangered Categories which indicates that they face a very high risk in their existence. Hence it is essential to conserve the fish fauna of this ecosystem. The exotic fish, *Oreochromis mossambicus* being a hardy fish, can survive water with highly fluctuating parameters. Even though it is included in the Vulnerable category, it is easily available in the backwater throughout the year. But all other rare fishes are seen only during rainy seasons.

Habitat-wise distribution

All the species were found equally distributed throughout the year in the station except all the freshwater species which enter the estuary along with the discharge of freshwater from the adjacent rivers and streams, particularly during the South-West monsoon period and their existence duly depends on the influence of tidal movements from the Arabian sea into the backwater through the small inlet canals. So, in our present study, due to this, the freshwater fishes are dominant in this particular station.

Bijukumar and Sushama (2000) studied the ichthyofauna of Ponnani estuary and classified nine typically estuarine and freshwater fishes, 41 marine estuarine forms, and 53 purely marine fishes as the estuary derived mainly from the sea. A similar trend was seen in the study conducted by Vimal *et al.* (2013) at Ashtamudi lake, which collected and categorised a total of 68 fishes into 24 pure marines, nine freshwater, and four typical brackish water forms. The rest were transient forms inhabiting estuarine-riverine (8 species), marine-estuarine (19 species), and marine-riverine-estuarine (4 species). Both these studies show the dominance of marine forms.

Biodiversity indices

The biodiversity indices for Shannon-Wiener diversity, Margalef species richness, Simpson dominance, and Peiolou evenness were measured for the piscine community in the Pillai Kadavu during the present study. Shannon-Wiener diversity recorded was 2.73 and Margalef species richness, was 7.56, indicating higher species richness and diversity in the Pillai Kadavu. Simpson's dominance was calculated as 0.88. The dominance of Cypriniformes with seven species and Siluriformes with five fish species were responsible for lower Peiolou evenness of 0.22 in the

Pillai Kadavu.

Similar work on the diversity of the finfish population in Poonthura estuary was carried out by Kiranya *et al.* (2018) who worked out various diversity indices such as Margalef's richness, Pielou's evenness, Shannon diversity, Simpson diversity, Simpson dominance, etc. The ranges of species richness, evenness, Shannon diversity, and Simpson diversity and dominance were 2.30 to 4.51, 0.79 to 0.92, 2.52 to 3.42, 0.76 to 0.91, and 0.11 to 0.23 respectively. Another work was conducted on the fish diversity of Vembanad lake in the Panangad-Kumbalam region of Kochi and used Primer K6 software to quantify the fish species diversity and species abundance data (Mogalekar, 2015). The diversity indices included Shannon–Wiener diversity (H') ranged from 2.9 to 3.4, Margalef's species richness ('d') ranged from 4.8 to 7.05, Pielou's evenness (J') ranged from 0.95 to 0.97 and they estimated indication of high fish species composition and richness from the work. Yedukrishnan *et al*., (2020) studied species diversity of selected sites in Vembanad lake and reported *Etroplus suratensis, Dawkinsia filamentosa, Barbus mahecola, Pseudetroplus maculatus* as the dominant species.

It can be concluded that Pillai Kadavu, the northern region of Kayamkulam backwater is found to be low in fish diversity. A total of 30 fishes under nine orders 14 families and 22 genera were identified from the study site. Cyprinids were the dominant families. 22 species were categorised as Least Concern, and two fishes were under the Vulnerable category. *Hypselobarbus curmuca* was the only species reported under Near Threatened category. Stringent conservative measures have to be taken to reduce the anthropogenic stress which often causes the deterioration of the fishery resources.

Acknowledgements

The authors are grateful to The Principal, Sree Narayana College, Kollam for providing the facility for carrying out the study. The authors are also acknowledging the research facility provided by DST-FIST (2018-2021) and DBT- Star College Schemes. The first author acknowledges the Government of Kerala for Welfare E-Grantz fellowship for pursuing his Ph.D. program and University of Kerala for his Ph.D. registration.

Conflicts of Interest

The authors declare that they have no conflict of interest.

Ethical Approval

This manuscript does not harm any animals or humans performed by any of the authors. We followed all applicable international, national, and or institutional guidelines for the care and use of animals, hitherto, for this study, no formal consent from any authority is required.

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