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Spatiotemporal Studies in the Fish Fauna of Kole Wetlands of Kerala

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Abstract

The Kole wetlands, part of the Vembanad–Kol wetland system in Kerala, are among the most fertile and productive ecosystems on Earth. A detailed study conducted between January 2012 to December 2013 examined the spatiotemporal distribution of fish across 12 selected sites in the Kole region. A total of 54 fish species were categorized based on their abundance: 4 species were abundant, 5 near-abundant, 15 common, 25 rare, and 5 very rare (fewer than 10 individuals recorded). Amblypharyngodon melettinus was identified as the most abundant species. The study also observed a significant increase in fish numbers during the post-monsoon period, indicating the seasonal influence on fish distribution. A two-way ANOVA analysis revealed a statistically significant difference in species abundance across the sampling sites. However, there was no significant variation in species abundance across different seasons or in total species numbers across sites. Interestingly, a significant seasonal variation was found in the total number of species. These findings underscore the need for continuous monitoring and conservation of the ichthyofaunal diversity in wetlands. Spatiotemporal studies like this are essential for understanding ecological patterns and for ensuring the protection and sustainable management of wetland ecosystems for future generations.

Keywords: fish fauna, kole wetlands, abundance, seasonal influence

Introduction

WETLANDS are home to a wide variety of life forms and represent an undiscovered treasure trove for humanity. Small and big lakes, rivers, streams, low-lying paddy fields, swamps and periodically flooded woods are all examples of wetlands. In addition to providing an invisible supply of freshwater, wetlands also maintain a diverse range of living forms, operate as a natural sponge to prevent river flooding, safeguard our coastlines, store CO2 to slow down climate change, and produce food. Following the 1971 International Convention on Wetlands in the Iranian city of Ramsar, the significance of wetlands gained international recognition. A list of wetlands of worldwide importance was released, and the wetlands of high value were listed under Ramsar Sites. The three Ramsar Sites of Kerala are Ashtamudi Backwater, Vembanad-Kol Backwater System and Sasthamkotta Lake.

One of Kerala's unique ecosystems is Kole Lands, which is a part of the Vembanad-Kol wetland ecosystem (Ramsar site No. 1214). The Kole land is a low-lying, flat, saucer-shaped region with lateritic hills on both its eastern and western borders. The low-lying Kole land tracts are situated between 0.5 and 1 m below mean sea level and run parallel to the sea. A data base on fish biodiversity is cardinal in decision

making drive for conservation and management of fish germplasm, preservation and protection of species that are endangered and alleviation of anthropogenic activities to fulfil India's obligations under Convention on Biological Diversity (Kurup *et al*., 2003). An investigation into the spatiotemporal distribution of fishes in Kole wetlands was conducted.

Objectives of the Study

Kole lands of Kerala, one of the internationally renowned wetlands of India, are a region of unique biodiversity. The objectives of the present work are the following.

- To find out the abundance and the status of fishes in the Kole lands of Kerala
- To find out the Abundance Index for fishes of the Kole wetlands of Kerala

Materials & Methods

Twelve sites were selected from the entire expanse of Kole lands of Kerala. The sites selected were Chettupuzha, Manakodi, Chaladypazhamkol, Pazhuvil, Ettumuna, Parappur, Manalurthazham, Ennamavu Bund Region, Konthipulam, Thommana, Aiynoor and Srayikadavu. Collections were made for this study during the period January 2012 to December 2013 using cast nets of mesh size 15 mm and 18 mm releasing thrice in a sampling site at a time. The collected samples were sorted, washed and dropped in freshly prepared formalin for preservation. They are then brought to the laboratory for species identification and abundance studies. They were then subjected to quantitative analytical studies for the diversity indices using following formulas.

Abundance and Status of Fishes

Abundance and the status of fishes in the Kole lands of Kerala was calculated using the number of individuals noted from the sampling sites put together based on the numbers they are categorized as

A – Abundant – > 1000 individual; **C** – Common – 100 ≤ 1000; **R** – Rare – 10 ≤ 99; **VR** – Very Rare – < 10 individuals

Abundance Index

Abundance Index was calculated according to Arun (1999) for each fish species.

AI = n (k)/ N/ Total FU x 100

Where, AI is Abundance Index, n (k) is the number of individuals of species k captured at the selected site. N is the total number of individuals of a species of fish caught at a site and FU is the fishing unit that is, unit time spent for fishing (1 Hour).

I.

Findings & Result

Abundance and Status of Fishes

Abundance categorization shows that there are 4 fish species that are abundant in the present study. They are *Amblypharyngodon melettinus, Carinotetraodon travancoricus, Dayella malabarica* and *Pethia ticto*. Another five species seems to be just near the abundance range and they are *Dawkinsia filamentosa, Devario malabaricus, Etroplus maculatus, Parluciosma daniconius* and *Xenetodon cancilla*. 15 species are Common; 25 species are Rare and 5 species are Very Rare that their number is below 10 individuals in the study. Very Rare species are *Channa punctata, Mystus armatus, Mystus cavasius, Mystus gulio* and *Ompok bimaculatus.*

Abundance Index

Total number of fishes caught during the sampling period was 20399 during the three seasons, pre monsoon, monsoon and post monsoon. 5054 fishes were obtained during the pre- monsoon season, 5888 fishes during monsoon and 9457 during post monsoon season from the 12 sampling sites altogether. The number indicates that major hike in the number of fishes were seen during post monsoon period. *Amblypharyngodon melettinus* was the most abundant single species of the catch. The other fish species contributed towards high abundance index are *Carinotetraodon travancoricus, Dawkinsia filamentosa, Dayella malabarica, Devario malabaricus, Etroplus maculatus, Parluciosma daniconius, Pethia ticto and Xenetodon cancilla.* These fish together constitute 73% of the total catch. The fishes *Amblypharyngodon melettinus, Dayella malabarica, Pethia ticto, Carinotetraodon*

travancoricus and *Devario malabaricus* made up 50% of the catch. *Amblypharyngodon melettinus* dominated the catches during pre-monsoon and post monsoon seasons but *Dayella malabarica* was seen in large numbers during monsoon season.

Abundance Index of indigenous ornamental fishes of Kole lands of Kerala at different sampling sites were studied. On studying the rank abundance site wise we could see that Site G – Manalurthazham had highest abundance index followed by Site A – Chettupuzha, Site H – Ennamavu Bund region, Site L – Srayikadavu and Site F – Parappur.

Two way ANOVA was carried out for species-wise abundance across 12 sampling sites in three different seasons of pre-monsoon, monsoon and post monsoon in the Kole lands of Kerala. P-value was less than .05, there was a statistically significant difference in the species abundance across the sampling sites. **F (53,106) = 3.455, P < .0001** (P –value is 2.87 x 10^{-8}). Descriptive statistics of two-way ANOVA for species-wise abundance across sampling sites is given in the Table.3.1.

Table 3.1. Descriptive Statistics of Two-way ANOVA for Species-Wise Abundance across Sampling Sites in the Kole Lands of Kerala

Summary	N	Mean	STD DEV	Summary	N	Mean	STD DEV
1	3	1434.33	1545.50	28	3	10	3.46
2	3	203.33	269.59	29	3	7	4.58
3	3	42.67	27.39	30	3	2	2.65
4	3	5.33	1.53	31	3	2.67	2.31
5	3	41.33	20.60	32	3	2.67	1.53
6	3	5.67	2.08	33	3	17.67	11.50
7	3	487.67	182.87	34	3	110	103.16
8	3	13.33	12.58	35	3	185	115.30
9	3	20.67	8.14	36	3	47	24.25
10	3	5.67	3.21	37	3	1	1.73
11	3	1.33	0.58	38	3	13.67	2.52
12	3	20.67	7.23	39	3	93.33	20.26
13	3	5	3.46	40	3	90.67	19.30
14	3	310.67	99.43	41	3	326.67	104.89
15	3	722	297.29	42	3	7	8.72
16	3	193.33	57.50	43	3	614.33	242.47
17	3	328.33	43.36	44	3	19.33	11.72
18	3	304.67	48.75	45	3	6	3.61
19	3	21.33	11.59	46	3	221	129.12
20	3	6	2.00	47	3	120	156.27
21	3	24	7.55	48	3	12.33	4.04
22	3	113	122.29	49	3	17.67	13.50
23	3	10	13.89	50	3	19.33	23.12
24	3	136.67	71.91	51	3	39.33	22.50
25	3	5	4.36	52	3	36.33	13.20
26	3	21	8.54	53	3	11.67	10.97
27	3	13	8.54	54	3	270	41.04

P-value was greater than .05, there was no statistically significant difference in the species abundance across different seasons. **F (2,106) = 2.017, P =.138**. Descriptive statistics of two-way ANOVA for species-

wise abundance in different seasons is given in the Table 3.1.2.

Table 3.1.2. Descriptive statistics of two-way ANOVA for species-wise abundance in different seasons in the Kole lands of Kerala

Summary	N	Mean	STD DEV
Pre Monsoon	54	109.04	10.44
Monsoon	54	93.59	9.67
Post Monsoon	54	175.13	13.23

Two way ANOVA was carried out for total species for 12 sampling sites in three different seasons of pre-monsoon, monsoon and post monsoon in the Kole lands of Kerala. P-value was greater than .05, there was no statistically significant difference in the total species across the sampling sites. **F (11, 22) = 1.097, P = .412**. Descriptive statistics of two-way ANOVA for total species across sampling sites is given in the Table.3.1.3.

Table 3.1.3. Descriptive statistics of two-way ANOVA for total species across sampling sites in the Kole lands of Kerala

Summary	N	Mean	STD Deviation
1	3	751.67	81.082
2	3	576.00	175.428
3	3	323.00	140.467
4	3	538.67	430.317
5	3	572.67	550.714
6	3	698.67	378.820
7	3	834.33	601.851
8	3	739.33	619.017
9	3	576.33	249.079
10	3	228.67	81.002
11	3	230.67	37.820
12	3	729.67	485.989

P-value was less than .05, there was a statistically significant difference in the total species across different seasons. **F (2, 22) = 3.902, P =.0354**. Descriptive statistics of two-way ANOVA for species-wise abundance in different seasons is given in the Table.3.1.4.

Table 3.1.4. Descriptive statistics of two-way ANOVA for total species across seasons in the Kole lands of Kerala

Summary	N	Mean	STD Deviation
s1	12	490.67	335.020
s2	12	421.17	222.469
s3	12	788.08	446.421

Interpretations & Discussion

Studies on the temporal and spatial distribution of fishes reveal that fish composition varies significantly over time and across locations (Turner et al., 1994). Proportional abundance indices are considered effective in measuring fish diversity (Jayson, 2002a). Jayson (2018) identified *Amblypharyngodon melettinus* and *Systomus sarana subnasutus* as dominant species in the Kole wetlands of Kerala. Francis (2015) also reported seven abundant fish species, including *Amblypharyngodon melettinus*, *Carinotetraodon travancoricus*, and *Anabas testudineus*. In the present study, *Amblypharyngodon melettinus*, *Carinotetraodon travancoricus*, *Dayella malabarica*, and *Pethia ticto* were found to be abundant, with five other species noted as near abundant. Interestingly, *Carinotetraodon travancoricus*, listed as Vulnerable by IUCN, was widely distributed. The study highlights that species abundance in diverse habitats indicates environmental tolerance (Johnson & Arunachalam, 2009). Supporting earlier findings (Lakra et al., 2010), the present study confirms the dominance of small indigenous species, with 25 species categorized as Rare and five as Very Rare, constituting over 50% of the total catch.

Abundance index studies indicated seasonal variations in fish species, with *Amblypharyngodon melettinus* emerging as the most abundant. Species with an abundance index above 4.0 were considered abundant; nine species met this criterion. *Channa punctata* and *Mystus armatus* had the lowest index (0.02), marking them as least available. Dominic (2014) reported high abundance of small indigenous ornamental fishes in Thrissur rivers, a finding echoed in this study across Kole lands. While abundance varied significantly across sampling sites, seasonal

differences were minimal. Manalurthazham recorded the highest index (12.27), followed by Chettupuzha, confirming the Kole wetlands' rich fish faunal diversity.

Fish abundance exhibited noticeable variation across seasons and years. Jayson (2018) observed annual fluctuations in fish landings during his study, noting peak abundance in the monsoon and the lowest during pre-monsoon in the Kole wetlands. Contrarily, Deepa (2014) found higher species diversity during the prawn cultivation period in Pokkali fields, coinciding with the pre-monsoon season, although actual abundance dropped in the post-monsoon cultivation season. This reduction was attributed to dense vegetation and weed growth that hindered fish development. In contrast, Francis (2015) recorded high fish abundance during the cultivation season in the Kole lands, aligning with the post-monsoon period. Similarly, the current study found the highest abundance index in the post-monsoon season, followed by pre-monsoon and monsoon. This increase is linked to the breeding patterns of tropical lake fishes, which spawn during the monsoon, with juveniles enriching the post-monsoon fishery. Additionally, dewatering of fields in the post-monsoon allows for easier fish capture. Traditional rice-fish integrated farming also enhances productivity. Statistical analysis confirmed significant seasonal variation in total species abundance.

Conclusion

Spatio-temporal analysis of indigenous ornamental fish diversity in the Kole lands was carried out across 12 sampling sites during pre-monsoon, monsoon, and post-monsoon seasons. This study on fish abundance and status was the first of its kind in the region and identified four species with populations exceeding 1000 individuals, while five others were just below that mark. Based on individual counts, species were categorized as abundant, common, rare, or very rare. Abundance index results showed that nine species had values above 4.0, qualifying them as abundant, with *Amblypharyngodon melettinus* being the most dominant. These nine species accounted for 73% of the total catch. Abundance was also assessed by site. Statistical analysis revealed significant variation in species-wise abundance index across the sampling sites and also indicated a significant difference in site-wise abundance between different seasons.

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