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Macroinvertebrate diversity of Veli and Kadinamkulam lakes, South Kerala, India

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Abstract: *The diversity and distribution pattern of benthic macroinvertebrates in two backwaters viz., Veli and Kadinamkulam of Kerala were assessed using diversity indices. The samples were collected once in three months for a period of two years from six sampling sites (K1, K2, K3, V1, V2 and V3) and community variations were analyzed. Overall, 24 families were identified represented by mollusca, annelida and arthropoda (crustaceans and insects). Among this, dominant taxon was Mytilidae of molluscan family and site-wise dominance was maximum in sites V1 and V2. Richness and abundance were highest in site V2 and lowest in site K2. Diversity index ranged from 0.27 (K2) to 2.33 (V1). The diversity and distribution patterns of certain species were clearly related to water quality as evident from the present study.*

Key words: *Benthic macroinvertebrates, Diversity, Species richness*
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Introduction

Benthic macroinvertebrates have been attractive targets of biological monitoring efforts because they are a diverse group of long-lived, sedentary species that react strongly and often, predictably to human influence on aquatic ecosystems (Rosenberg and Resh, 1993). Macroinvertebrates and water quality are interrelated to each other, as macroinvertebrates are a potential indicator of water quality (Sharma and Rawat, 2009). They are most frequently used in biomonitoring studies because the responses of macroinvertebrates to organic and inorganic pollution have been extensively documented (Thorne and Williams, 1997; Kazanci and Dugal, 2000).They have sensitive life stages that respond to stress and integrate effects of both short-term and long-term environmental stressors (EPA, 1998) and that they are important areas for maintaining biodiversity (Meyer *et al*., 2007; Richardson and Danehy, 2007).

An outstanding feature of the coastal zone of Kerala extending north-south is the presence of a discontinuous chain of perennial /temporary water bodies and estuaries, popularly known as backwaters with an area of 2,42,000 ha (Soman, 1997). Pollution is an important hazard, which threatens the biology and productivity of this unique ecosystem. A thorough knowledge on the components of the biotic communities of an aquatic environment is of paramount importance for understanding the productivity of such water resources. The benthic macroinvertebrate population may vary in time and space and their diversity within a certain area are clearly related to fertility and productivity of overlying water.

This study was done to find out the spatial and temporal variation in diversity and distribution patterns of benthic invertebrates in Veli and Kadinamkulam estuary, so as to establish the role of these macroinvertebrates as bioindicators of pollution.

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Materials and Methods

Study area: The Kadinamkulam estuary, N. Lat. 8°35' to 8°38' and E. Long. 76°52 is the largest among the estuaries in Thiruvananthapuram. Here the typical coconut husk retting pits are situated all along the bank of the estuary and the exchange of water is very poor, so the area is heavily polluted. This estuary is also prone to activities like fishing, aquaculture, tourism, transportation, sand mining, dumping of waste, estuarine reclamation. The Veli lake is a smallest brackish water lake situated 5 Km North-West of Thiruvananthapuram city between Lat 08° 31' and 08° 31' N and Long. 76° 52' 30" to 76° 53' 30" E on the southern part of Kerala. The English Indian Clay Factory on the southern bank of the lake and the Travancore Titanium products, pour waste materials and sewage are discharged into the lake. The lake is an excellent inland water navigational tract and the Kerala Tourism Development Corporation has developed the Veli boat club situated on its banks as a major tourist attraction in the region. The Kadinamkulam estuary is connected with the Veli lake by the Parvathyputhanar canal in the south and with the Anchuthengu Kayal in the north through the lower reaches of the Vamanapuram river.

Sample collection: Benthic macroinvertebrates were collected from six sampling sites representative of the major habitats established in Veli (V1,V2 and V3) and Kadinamkulam (K1, K2 and K3) estuaries (Fig. 1) during April 2004, July 2004, October 2004, January, 2005, April 2005, July 2005, October 2005 and January 2006 (totally 8 samplings taken once in three months). The organisms were collected using a D-frame net (0.5 mm mesh) and preserved on site in 70% ethyl alcohol (Winterbourn *et al*., 2000). Mud samples of one liter were collected from the bottom using an Ekman's grab

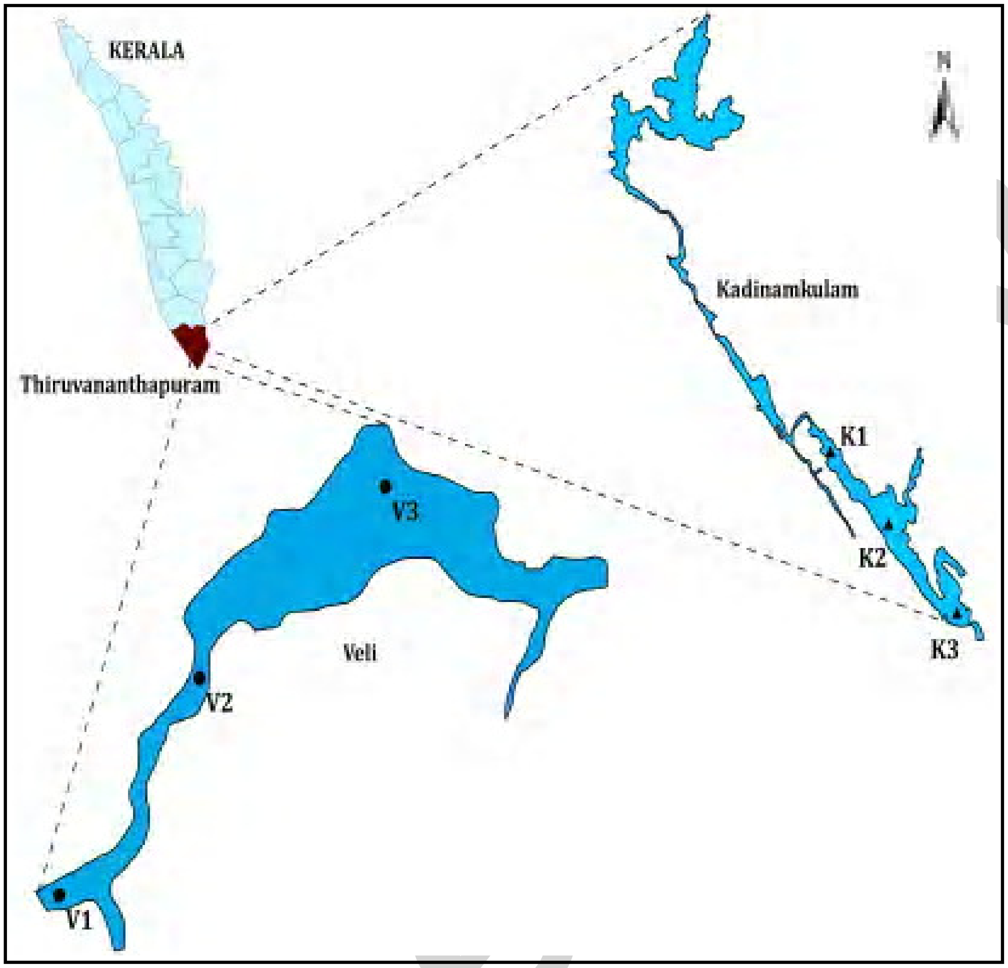

Fig. 1: Map showing different sampling sites of the study area (Kadinamkulam and Veli lakes)

and the samples were preserved in 9% formaldehyde. The macroinvertebrates were sorted and were identified using standard keys (Edmondson, 1993; Pennak, 1989). To evaluate the distribution and diversity between sampling sites, community indices such as species richness, species abundant and Shannon diversity index were used. Kruskal-Wallis (1952) and Mann-Whitney (1947) tests were conducted to evaluate significant differences of species abundance between sites and between seasons.

Results and Discussion

A total of 14,660 individuals representing 24 taxa were collected from all the sampling sites as shown in the table 1. Of these, 11829 were Mollusca representing 2 classes (Bivalvea and Gastropoda) and 10 families, 2746 individuals belonged to Arthropoda, encompassing 2 classes (Insecta and Malacostraca) representing 12 families and 85 individuals belonged to Annelida representing 2 families of class Polychaeta (Table 1). The dominant order was Mesogastropoda (5 families and 6960 individuals) of class Gastropoda. Diptera (3 families and 1034 individuals) was the dominant order of the class insecta. Similar report of relatively high species richness of Diptera (with high Chironomidae richness) was noted in an intermittent river of North Africa by Arab *et al*. (2004), which was attributed to presence of a pollution gradient.

The macroinvertebrates showed fluctuations among the different sampling stations of Kadinamkulam and Veli. The dominant taxa were Mytilidae, Culicidae, Chironomidae and Buliminidae at K1, K2, K3, V2 respectively and Thiaridae at V1 and V3 (Fig. 2). Mytilidae habitats the estuaries, where as Diptera larvae (Culicidae and Chironomidae) occur in a wide variety of aquatic habitats, including marine, saline and estuarine waters. Chironomidae is an ecologically important group of aquatic insect often occurring in high densities and diversity. The relatively short life cycles and the large total biomass of the numerous larvae confer ecological energetic significance on the taxon and the partitioning of ecological resources by a large number of species enhances the biotic stability of the ecosystem (Edmondson, 1993).

Species abundance was the highest at V2 (4225) followed by K1 (3531). K2 showed the lowest value (935) as shown in the Fig. 2. Abundance class distribution revealed that 50% of the samples showed abundance of less than 200. Only 6% of samples showed abundance of more than 1000 individuals. Most of the species displayed low abundance. Less than 500 individuals represented 71% of the species. 8% of the species showed abundance from 500 to 1000 and another 8 from 1000 to 1500. Abundance group of 2000 to 2500, 2500 to 3000 and > 3000 were each represented

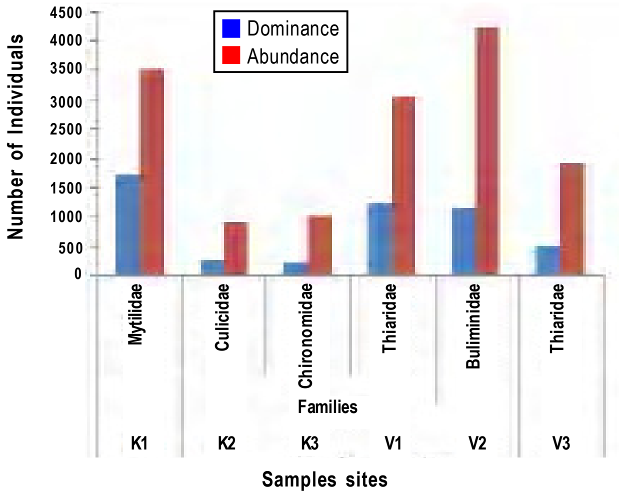

Fig. 2: Abundance of macro invertebrates and dominant taxa of Kadinamkulam (K1, K2 and K3) and Veli (V1, V2 and V3)

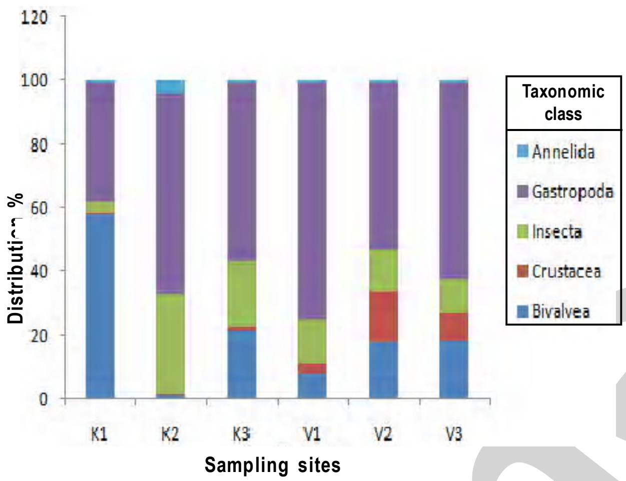

Fig. 3: Percentage distribution of various taxonomic classes of Kadinamkulam (K1, K2 and K3) and Veli (V1, V2 and V3)

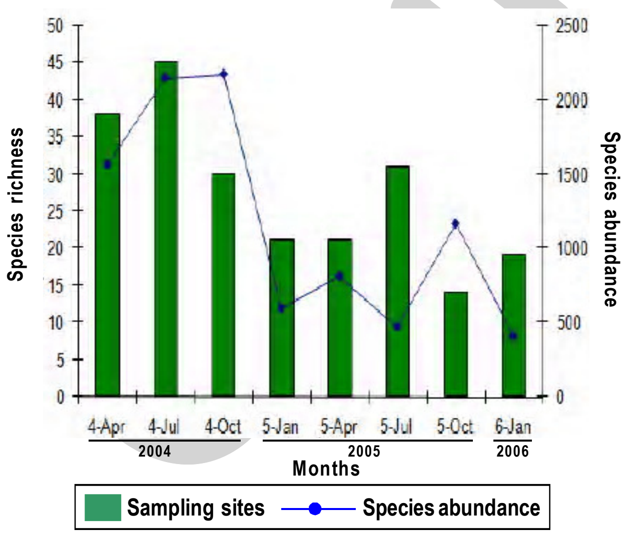

Fig. 4: Temporal changes in species richness and abundance of macroinvertebrates at Kadinamkulam (K1, K2 and K3) and Veli (V1, V2 and V3)

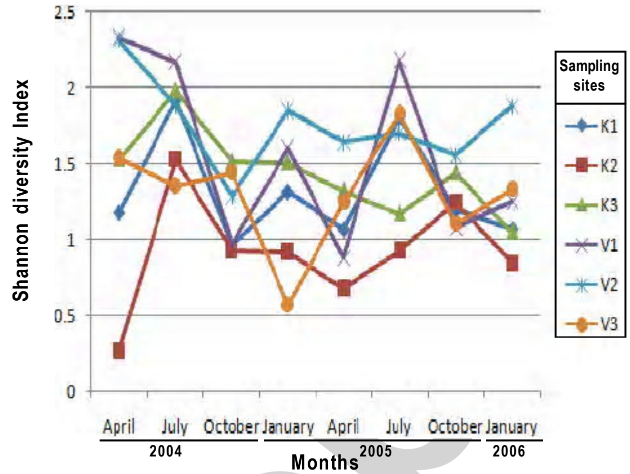

Fig. 5: Spatial and temporal changes in Shannon diversity index of macroinvertebrates at Kadinamkulam (K_1, K_2 and K_3) and Veli (V_1, V_2 and V_3)

by 4% of species. This site (K2) was heavily polluted due to retting activity. Species richness was also found to be lowest in this site. Studies conducted by Nandan (2003) in the same study area reported that diversity of benthic fauna in retting zones was quantitatively and qualitatively depleted. Pratt and Hall (1981) opined that when conditions change, such as when a stream receives significant nonpoint source runoff, the abundance and distribution of animals in the affected site change as well.

The distribution of species among samples showed that 23% of the samples had species richness less than 5 and 65% of the samples had species richness less than 10. Only 2% of the sample showed species richness ranging from 16 to 20. Species richness is influenced by environmental conditions (Legendre and Legendre, 1998; Benbow *et al.*, 2003; Marchese *et al.*, 2008). A stable environment contains more species and more niches, because a more stable environment involves a higher degree of organization and complexity of the food web (Margalef, 1958). Compared to Kadinamkulam, sampling stations at Veli showed higher species richness with average values of 7.6, 5.0, 6.0, 10.6, 10.9 and 7.1 at K1, K2, K3, V1, V2 and V3 respectively. The number of absent taxa (of totally reported taxa) was more at Kadinamkulam than at Veli. At K1 and K3, 11 out of 24 reported taxa were absent and at K2, 13 taxa were absent. In case of Veli at V1 and V2, 2 taxa were absent and at V3, 7 of the reported taxa were absent. This clearly indicates the disturbances caused at Kadinamkulam due to human activities. The deterioration in water quality suffered by the backwater consequent to the retting activity can be attributed to be the main reason for the depletion and absence of several important faunal groups in these productive zones (Nandan, 2003).

In all the stations of Ka dinamkulam and Veli, the dominant class was Gastropoda with an exemption of Bivalvea at K1. The least contribution was by Annelida in all stations of Kadinamkulam and Veli except at K2 were it was Crustacea. Gastropoda and

Table - 1: Systematic list of benthic macroinvertebrates from Kadinamkulam and Veli

Phylum	Class	Genus / species	No. of individuals
Mollusca	Bivalvea	*Pholas orientalis*	1080
		Modiolus metcalfei	2279
		Meretrix meretric	295
	Gastropoda	*Robertsiella sp.*	87
		Bithynia sp.	376
		Iravadia sp.	318
		Thiara sp.	2620
		Bulimus tentaculata	3559
		Lymnaea megasoma	19
		Gyralus hirsutus	1196
Arthropoda	Insecta	*Culex sp.& Anaphels sp.*	394
		Chironomous sp.	563
		Stratiomys sp.	77
		Gigantimetra gigas	427
		Ranatra filiformis	22
		Diplonychus indicus	177
		Corduligaster sp.	1
		Coryphaeschna sp.	5
		Agriocnemis lacteola	101
		Elophila interruptalis	27
	Malacostraca	*Asellus aquaticus*	57
		Gammarus pulex	895
Annelida	Polychaeta	*Capitella sp.*	59
		Namalycastis indica.	26

Insecta (Chironomidae and Culicidae) showed higher incidence in the retting zones when compared to non-retting zones (Fig. 3). Total number of taxa was lowest during January 2005 (869). Considering seasonal changes, the species richness was high during July 2004 (2775) or July 2005 in all the sampling stations either individually or as a whole. Overall species richness was low during October 2005; however, at individual stations lowest species richness was recorded during January also (Fig. 4). In all the sites, the maximum species richness was observed during the second sampling *i.e.* July 2004. The minimum value of 3.0 was observed during January in three sampling sites *i.e.* K2 during January 2006, K3 during January 2006 and V3 during January 2005.

The Shannon diversity index, which takes account of species richness as well as abundance showed similar patterns (Fig. 5). V2 (1.28 to 2.31) showed maximum value of diversity index and lowest value was observed at K2 (0.27 to 1.53). This might be because of poor water exchange insufficient for self-purification. Similar observations show that diversity index for the different species was generally low in the retting zones (0.68 to 1.20) when compared to the non-retting zones (0.88 to 2.97) of Kadinamkulam backwaters (Nandan, 2003). Season-wise change showed lowest Shannon diversity index during October 2005 and maximum during July 2004. Bass and Potts (2001) reported the same decrease in diversity index during October and they attributed it to emergence of several groups of aquatic insects prior to sampling or indicate some movement into shallower parts of the lake during the hottest part of the year. Mann-Whitney test for Shannon diversity index between sampling sites were conducted. At V1, there was no significant difference (Mann-Whitney test $p>0.05$), K1 was found to be significantly different from K2 and V2; K2 was significantly different from sites K3 and V3; K3 differed significantly from V2 ($p<0.05$); V3 was significantly different from V2 ($p<0.01$). However, between seasons the differences in diversity was not statistically significant.

A study conducted by Latha and Thanga (2008) in Kallar mountain stream showed higher incidence of diversity especially EPT (Ephimeroptera, Plecoptera and Trichoptera). Arab *et al.* (2004) also reported high species richness in the upstream part of Chelif course, which decrease at the downstream site, where the water was heavily polluted. According to Duran and Suicmez (2007) the Cekerek stream of Turkey was characterized as class 1 water quality with a high species richness dominated by EPT. Clean water supports a great diversity of organisms; where as polluted water would yield just a few organisms, with one or few dominant forms (Trainor, 1984).

For a variety of reasons, invertebrates are extremely important in the functioning of wetland, and thus can be viewed as surrogates for wetland wealth. First from a logistic standpoint that they make a good study specimen, because, they are abundant, readily surveyed, and taxonomically rich (Dodson, 2001). Macroinvertebrate abundance, community structure, and ecological function have long been used to characterize water quality in freshwater ecosystems. Identifying the diversity and community composition of a sample of macroinvertebrates in a selected wetland will help to determine the overall richness and abundance of the macroinvertebrate fauna within that wetland.

While many taxa contribute to biodiversity in streams, aquatic ecosystem macroinvertebrates play a central ecological role in many stream ecosystems and are among the most ubiquitous and diverse (Strayer, 2006) organisms in fresh waters. In our study, between the two lakes, Veli Lake showed more macro invertebrate diversity than Kadinamkulam. Gastropoda was the dominant class and Annelida was the least observed class. A clear discrimination can be made between the sampling sites of Veli and Kadinamkulam based on the macroinvertebrate diversity.

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