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Original Research Paper

Diversity of Macroinvertebrates as a Tool to Assess Aquatic Pollution in Lentic Ecosystems

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ABSTRACT

In the three lakes of Mysore city recorded fourteen species of macroinvertebrates. Different diversity indices for these macroinvertebrtaes were computed, which have shown that the Kamana lake is moderately polluted and other two lakes (Mandakally lake and Devanoor lake) are heavily polluted.

INTRODUCTION

Biological diversity refers to the variety and variability among living organisms and ecological complexes in which they occur (Bazmi & Shahabuddin 2005). In pollution stressed aquatic environments, change in the community structure is reflected in the diversity patterns of the component species. These changes can be quantified numerically as diversity indices, which are useful in water quality monitoring. Various indices are now extensively used in measuring stress on plants and animals due to overexploitation and pollution (Chaurasia & Agarwal 2004, Sharma et al. 2005, Padmanabha & Belagali 2007). In the present study an attempt has been made to select appropriate diversity indices to represent aquatic pollution.

MATERIALS AND METHODS

Three lakes namely Kamana, Mandakally and Devanoor lakes were selected for this study. The soil and sediment samples were collected to sample macroinvertebrtaes. These were fixed and preserved in 4% and 5% formalin respectively, and then identified with the standard keys (Ward & Whipple 1959, Needham & Needham 1962, Tonapi 1980, Adoni 1985 and Pennak 1989).

Ecological indices: Different ecological indices were computed to derive community parameters to monitor the pollution level. Different ecological indices such as Shannon Weaver index (Shannon & Weaver 1949) for species diversity (H), Simpson index (Simpson 1949, Magurran 1988) for species dominance (λ), β- diversity or heterogeneity index (βd) (Whittaker 1975), species diversity or species richness Index (D) (Margalef 1958), Evenness index of diversity (E) (Pielou 1966), Berger-Parker index (Berger & Parker 1970) of dominance (d), Breadth of utilization (β) (Levins 1968) and Jaccard index or similarity index (Cj) (Southwood 1978) were calculated.

RESULTS AND DISCUSSION

Altogether 14 species of macroinvertebrtaes were recorded from these three lakes. Kamana lake recorded 13 species, Mandakally lake 12 species, and Devanoor lake 9 species of macroinvertebrates (Table 1).

Shannon-Weaver Index of species diversity (SWI) (H): The SWI recorded highest in Kamana lake (1.12) followed by Mandakally lake (0.94) and Devanoor lake (0.82) (Table 2). According to Odum (1971), diversity tends to be higher in communities in stable environments than disturbed conditions. As per the species diversity scale of Wilhm & Dorris (1968) ($H > 3$ = clean water, $H = 1\text{-}3$ = moderately polluted, $H < 1$ = heavily polluted) Kamana lake is moderately polluted and the other two lakes are heavily polluted.

Simpson Dominance Index (SDI) (λ): Devanoor lake recorded highest SDI (1.0) followed by Mandakally lake (0.76), and Kamana lake (0.69) (Table 2). Increase in the SDI indicates increase in pollution load (Padmanabha & Belagali 2007). Some species of macroinvertebrtaes are intolerant due to increased pollution and disappeared, but few species have increased tolerance for adverse conditions (Myslinski & Ginsberg 1977, Mohammad 1980).

β-Diversity or Species Heterogeneity Index (βd): β-diversity is highest in the Devanoor lake (1.46) followed by Mandakally (1.19) and Kamana lake (1.08) (Table 2). The

higher value of β-diversity index indicates greater perturbations due to environmental disturbances/pollution stress on these macroinvertebrates (Sharma et al. 2005, Padmanabha & Belagali 2007).

Species Richness Index (SRI)(D): Species richness index is highest in the Kamana lake (1.10) followed by Mandakally lake (0.92) and Devanoor lake (0.83) (Table 2). Higher value of SRI represents higher number of species, lower abundance and lower aquatic pollution (Padmanabha & Belagali 2007). As per the diversity index (D) scale of Staub et al. (1970) (D < 1 = heavily polluted, D = 1-2 = moderately polluted, D > 2-3 = lightly polluted, D > 3-4.5 = slightly polluted), the species richness index has been successful to explain convincingly about the pollution levels in these lakes. According to this scale, Devanoor and Mandakally lakes are heavily polluted whereas Kamana lake is moderately polluted.

Evenness Index (EI) (e): Evenness index was highest in the Kamana lake (0.92) followed by Mandakally lake (0.89) and Devanoor lake (0.84) (Table 2). Evenness index attempts to quantify the unequal representation of species against a hypothetical community in which species are equally common. This suggests that only a few species grow abundantly while majority of them are rare/absent, indicating unequal representation of most of the species. This indicates that Kamana lake was with highest equal representation of species and Devanoor lake with lowest equal representation or highest unequal representation (Padmanabha & Belagali 2006, 2007).

Berger-Parker Dominance Index (BPD) (d): BPI of dominance for was highest in the Devanoor lake (1.0) followed by Mandakally lake (0.87) and Kamana lake (0.84) (Table 2). As dominance index increases in a community, diversity index decreases. This indicates that, as aquatic pollution increases dominance index increases but diversity index decreases. In higher level of pollution, only a few species can tolerate and survive and later flourish to increase their population abundance due to better adaptation to the changed environment and reduced competition from other species. So, higher Berger-Parker dominance index signifies higher level of aquatic pollution, which leads to lesser number of species and higher population density of few species.

Breadth of Utilization (β): Breadth of utilization was highest in the Kamana lake (1.41) followed by Mandakally lake (1.32) and Devanoor lake (1.0) (Table 2). Breadth of Utilization reflects utilization of resource by macroinvertebrates. BU depends upon the water quality, competition among biotic components, availability of quantitative and qualitative food to the population growth.

Table 1: Diversity and density (No./m^3) of macroinvertebrtaes in the three lakes of Mysore city.

Phylum	Class	Genera	Kamana lake	Mandakally lake	Devanoor lake
Annelida	Oligochaeta	*Tubifex*	25	93	180
		Limnodrilus	42	86	165
		Lumbriculus	93	102	110
	Hirudena	Leech	12	18	69
Arthropoda	Coleoptera	*Psephenus*	34	45	-
		Ectopilium	80	35	-
	Ephemeroptera	*Centroptilium*	46	-	-
		Ephemerella	80	32	-
	Diptera	*Chironomus*	20	65	126
		Pentanura	22	45	97
		Psychoda	16	35	85
		Simulium	22	14	-
		Tabanus	-	-	19
Mollusca	Gastropoda	*Gyarulus*	15	42	52

Table 2: Biodiversity indices of macroinvertebrtaes in the three lakes of Mysore city.

	Kamana lake	Mandakally lake	Devanoorlake
Shannon-Weaver Index (SWI) (H)	1.12	0.94	0.82
Simpson Dominance Index (SDI)	0.69	0.76	1.00
β-Diversity Index (β-d)	1.08	1.19	1.46
Species Richness Index (D)	1.10	0.92	0.83
Evenness Index	0.92	0.89	0.84
Berger-Parker Index	0.84	0.87	1.00
Breadth of Utilization	1.41	1.32	1.00

Table 3: Matrix showing Jaccard index between different paired lakes in the Mysore city.

	Kamana lake	Mandakally lake
Kamana lake	-	-
Mandakally lake	0.48	-
Devanoor lake	036	0.38

In the higher aquatic pollution, Breadth of Utilization narrows down, so that population size reduces and decreases the equal distribution of environmental resources among different species. This indicates that the availability of environmental resources is highest in the Kamana lake due to lowest pollution but availability of resources is lowest in the Devanoor lake due to highest pollution. In the lower pollution level, macroinvertebrates could utilize the environmental resources to the maximum extent, which could not do in the higher pollution level.

Jaccard Index or Similarity Index (Cj): The result (Table 3) reveals that Kamana and Mandakally lakes pair has highest similarity index (0.48) followed by Mandakally and Devanoor lakes pair (0.38) and the Kamana and Devanoor lakes pair (0.36) (Table 3). From the results, it appears that Kamana lake and Mandakally lake pair showed highest similarity in ecological parameters and hydrographical conditions. But Kamana and Devanoor lake pair shows lowest similarity or highest dissimilarity in ecological parameters and hydrographical profile. Calculation of Jaccard index reflects the similarity of hydrographical profile and biotic components between different aquatic bodies. The higher value of Jaccard index reflects higher similarity between two water bodies (Sinha & Chatterjee 2004, Padmanabha & Belagali 2006).

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