IMPACTS OF TREATED WASTEWATER DISCHARGE ON MACRO-BENTHIC ASSEMBLAGES OF CANAL SECTIONS IN DALUGAMA

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Canal sections in Dalugama are polluted due to industrial, domestic, and urban discharges, affecting macrobenthic assemblages. Macrobenthos are ideal bioindicators to identify water quality due to their limited mobility and sensitivity to pollution. The study aims to analyze the impact of effluent water on macrobenthos assemblages to gain a comprehensive understanding of the water quality in the canal sections of Dalugama. The health of canal sections was investigated by studying the composition of its macrobenthos assemblages and calculating the ecological parameters. Macrobenthos were sampled from three sampling sites for six months. The sampling sites are the drain to which effluent is discharged, a point upstream, and a point downstream to the effluent discharge point. Eight macrobenthos taxa belonging to three phyla, Mollusca, Annelida, and Arthropoda, were identified. The recorded taxa were *Faunus ater, Melanoides Tuberculata, Lymnaea sp., Valvata piscinalis,* Chironomid larvae, *Hydnobius latifrons, Tubifex sp.* and *Chelifera sp.* larva. The most abundant taxa were *Tubifex sp*., Chironomid larvae and *Chelifera sp.* larvae. These species are indicators of organic pollution. These pollution-tolerant species dominated all three sampling sites, although their relative abundance was different. *Faunus ater, Melanoides tuberculate* and *Lymnaea sp.* recorded in all three sampling sites can also tolerate organically enriched aquatic environments. Species richness and diversity were the highest at the drain where effluent is discharged due to the availability of point and non-point sources of pollution. High pollution may provide more habitat niches for pollution-tolerant species. Evenness was highest at the upstream point. This suggests a more balanced community composition at this site and good water quality at the upstream point. Low heterogeneity in the upstream point reveals that the dominant species do not allow other species to thrive. The Bray-Curtis similarity index revealed a distinct macrobenthos assemblage at the drain where effluent is discharged compared to the upstream and downstream locations. These findings suggest that treated effluent discharge can negatively impact the macrobenthos communities in the drain and water quality of receiving water bodies. However, the similarity of the macrobenthos assemblages in the upstream and downstream points suggests that the influence of wastewater on the canal is not significant.

Keywords: bioindicators, ecological parameters, effluent, wastewater treatment, water quality

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INTRODUCTION

Macrobenthos refers to the community of organisms that live in the benthic zone of aquatic environments, such as the ocean floor or the bottom of lakes and rivers (Sajeeb, 2021). Macro benthic organisms have relatively sedentary lifestyles, which means they have long life cycles and limited mobility. The distribution patterns of benthic species are highly influenced by substrate type, sediment composition, salinity, food availability, and predation (Behera *et al*., 2023). They are important indicators of water quality because they are sensitive to changes in their environment, including pollution and habitat degradation. Macro-benthic invertebrates act as a link between the sediment and water column predators, while also contributing to nutrient release (Belal, 2019). By monitoring macrobenthos communities, researchers can assess the health and condition of waterways and identify potential problems before they become more severe.

Treated effluent from one of the sewage wastewater treatment plants was released to this canal through a drainage system. The purpose of this study was to analyze the effect of effluent water on macrobenthos assemblages to obtain a better understanding of the water quality of the canal sections.

METHODOLOGY

The study area is in Warakanatta and Nungamugoda Grama Niladhari divisions of the Kelaniya Divisional Secretariat Division. This canal acts as storm water drains and it flows adjacent to the Dalugama area and drains into the Kelani River. Many drainage systems from nearby industries, livestock farms, and residential buildings discharge into this canal causing significant pollution. Excessive growth of *Eichhornia crassipes* (water hyacinth) and *Pistia stratiotes* (Water lettuce) can be identified, and certain sections are stagnant due to the accumulation of garbage and rapid growth of water hyacinths.

Sediment samples were collected from three sampling sites for 6 months and were utilized for the analysis of benthic macroinvertebrates. Samples were collected from the drain that diverts the effluent into canal sections (site 1), upstream point (site 2), and downstream point of the drain (site 3). During the field sampling, all the collected samples were preserved in rose bengal solution containing 5% formaldehyde and stored in a cool container to ensure the retention of biological integrity and prevent degradation of the specimens. At the laboratory, the samples underwent a thorough rinsing process with water, which was carried out using a 500 µm mesh sieve. This process effectively separated the benthic macroinvertebrates from the sediment. Subsequently, the collected macroinvertebrates were identified with the naked eye and binocular stereo microscope (blakely *et al*., 2014).

The spatial variations of macrobenthos abundance between the three sites were analyzed. Then the percentage abundance, relative abundance, and species richness of macrobenthos taxa were calculated. Shannon-wiener diversity index, Pielou's J′ evenness values, and total abundance were calculated. H is the Shannon-wiener diversity index and pi is the proportion of the total sample represented by species i. j' is Pielou's evenness index, H' is the number derived from the Shannon-wiener diversity index and H_{max} is the maximum value of H'. Similarities among the macrobenthos community were assessed using the Bray-Curties similarity clustering method. In addition, principal component analysis was conducted to reduce the dimensionality of the data set and identify the site-specific variabilities. (Almaniar *et al*., 2021).

RESULTS AND DISCUSSION

The study found that 8 different taxa belong to three phyla. These phyla are Mollusca, Annelida, and Arthropoda. The recorded benthic macroinvertebrate taxa were *Faunus ater, Melanoides Tuberculata, Lymnaea* sp., *Valvata piscinalis,* Chironomid larvae, *Hydnobius latifrons, Tubifex* sp. and *Chelifera* sp. larva. Among these 8 taxa, *Tubifex sp.*, Chironomid larvae, and *Chelifera sp*. larva were the most abundant taxa in three sampling sites. Their abundance is 58.68%, 30.32% and 7.82 respectively. More than 95% of all macroinvertebrates at the three sampling sites belong to these three types. The highest species richness was recorded at site 1 and the lowest species richness was recorded at site 3. Tubifex sp exhibited the highest total abundance.

Table 1 exhibits the composition of each benthic macroinvertebrate taxa in the three sampling sites. *Tubifex* sp. dominated the site 2 and 3. Chironomid larvae. dominated in site 1. In site 1, Tubifex sp. was the second most abundant species. *Chelifera* sp. larva was the next most abundant species. Other species were found in very small percentages and *Hydnobius latifrons* had not been observed at Site 1. In site 2, *Chelifera* sp. *larvae* were the second most abundant species and 9% of *Tubifex* sp. were observed. Other species that were found in the other two sampling points were not observed in site 2. In site 3, 11% of the *Chelifera* sp. larva, 6% of the Chironomid larvae and 2% of *Melanoides tuberculata* were observed.

Chironomid larvae and *Tubifex* sp. are known as pollution-tolerant species, and they act as indicators for polluted water. These two species are dominant in all three sampling sites. Chironomid larvae can survive in high pollutant concentrations and low dissolved oxygen levels. This species is the dominant species in the site 1. Site 1 may have a high pollution level. Tubifex sp. can be found in organically loaded sediments and water with low dissolved oxygen. Tubifex sp. was recorded in sites 2 and 2. *Faunus ater, Melanoides tuberculate*, and *Lymnaea* sp. can tolerate a wide range of water quality conditions. *Faunus ater* is an indicator of slightly organically enriched aquatic environments. It was only recorded on site 1. *Melanoides tuberculata* can be observed in polluted areas due to industrial activity. This species acts as an indicator of organic pollution from industrial and domestic sewage. This species was recorded in sampling sites 1 and 3 but the abundance of this species is very low. *Valvata piscinalis* is a freshwater gastropod. It can survive under eutrophic conditions. *Hydnobius latifrons* are known as scavenger beetles can be found in clean water with enough organic matter in the sediments. The highest total abundance (N) (178), species richness (S) (7), and species heterogeneity (H') (0.97) were observed in site 1. The highest species evenness (J') was recorded in site 2 (0.61) and the lowest J' was observed in site 3(0.41). The lowest S was recorded in site 2(3). The lowest N value was observed in site 3(41). The lowest H' value is recorded in site 2 (0.67).

The Bray-Curtis similarity index is used to measure the similarity between samples based on species abundance. The Bray-Curtis similarity index is calculated by considering the presence and abundance of species in different samples. The Bray-Curtis similarity index provides insight into the community composition and structure (Somerfield, 2008). According to the Bray-Curtis similarity index, 2 main clusters can be observed (Figure 1). Site 1 was clustered separately. The benthic macroinvertebrate community at sites 2 and 3 is relatively similar. Sites 2 and 3 are sampling sites from the same stream. The dominant species in both the sites is *Tubifex* sp. Figure 1 indicates a distinct macrobenthos assemblage at Site 1 compared to Sites 2 and 3.

Table 1: Composition of macrobenthos in each site

	Species composition (%)		
Species	site 1	site 2	site 3
Tubifex sp.	32	78	80
Chironomid larvae	61	9	6
Chelifera sp. larva	3	13	11
Lymnaea sp.	1	0	1
Melanoides Tuberculata	2	0	2
Valvata piscinalis piscinalis	1	0	0
Faunus ater	1	0	0
Hydnobius latifrons	0	0	1

Table 2: Total abundance and relative abundance of the macrobenthos taxa in 3 sampling sites

Taxonomic category			Abundance			Total abundance	Relative abundance
Phylum	**Family**	**Species name**	**Site 2**	**Site 3**	**Site 4**		
Mollusca	Pachychilidae	*Faunus ater*	2	0	0	2	0.50%
	Thiaridae	*Melanoides Tuberculata*	3	0	3	6	1.47%
	Lymnaeidae	*Lymnaea sp.*	2	0	1	3	0.73%
Arthropoda	Valvatidae	*Valvata piscinalis*	1	0	0	1	0.24%
	Chironomidae	Chironomid larvae	108	8	8	124	30.32%
	Empididae	*Chelifera sp. larva*	5	12	15	32	7.82%
Annelida	Leiodidae	*Hydnobius latifrons*	0	0	1	1	0.24%
	Naididae	*Tubifex sp.*	57	71	112	240	58.68%
Total abundance (N)			178	91	40	409	100%
Species Richness (S)			7	3	6		
H' -Shannon-Weiner Diversity Index			0.97	0.67	0.73		
Species evenness (J' – Pielou’s evenness index)			0.5	0.61	0.41		

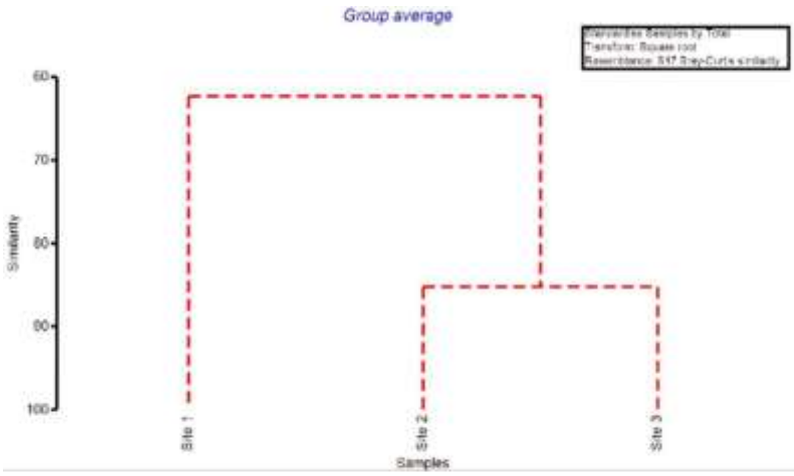

Figure 1: Dendrogram showing the clustering of macrobenthos assemblage among the three sampling sites.

CONCLUSIONS/RECOMMENDATIONS

The analysis of macrobenthos communities further supported the findings. Site 1 was dominated by pollution-tolerant species like Chironomid larvae and *tubifex* sp. Total abundance, species richness and species heterogeneity were highest in sampling site 1. *Tubifex* sp. was also dominated in the sampling sites 3 and 4 but the abundance of Chironomid larvae was low in these two sites. The presence of *Hydnobius latifrons* in site 3 suggests a slightly healthier aquatic ecosystem compared to the other locations. In the Bray-curtis similarity index, sampling site 1 was categorized separately indicating the difference in macrobenthos assemblage compared to the other two sites.

Based on the study, macrobenthos assemblages in water bodies provide valuable insight into variations in water quality. Therefore, it is crucial to conduct a long-term monitoring program with more sampling sites to investigate the relationship between macrobenthos communities and variations in water quality along the canal sections in Dalugama to establish pollution control measures.

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