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# General Effects of Urbanization on the Distribution Pattern of Zooplankton Diversity

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***ABSTRACT***
*The species diversity of urban wetlands has suffered terrible tragedies as a result of urbanisation. However, because of the complexity of the urban setting, it is unclear how urban biodiversity is distributed or what produces it. One of the biggest dangers to biodiversity is urbanisation, which is one of the environmental changes caused by humans. Urbanisation causes landscape patterns to invert, allowing anthropogenic environments to take control. This results in the loss and fragmentation of natural habitats as well as the development of powerful barrier effects that obstruct or even completely restrict organism mobility and ecological connection. Understanding the impact of urbanisation on biodiversity is one of the top priorities for preserving the functionality of natural systems and the services they provide, keeping in mind that human wellbeing also depends on these. Urban land use is predicted to increase by 1.2 million km2 during the first third of this century. In this work, we used spatial rather than temporal methodologies to highlight the urbanisation process in the urban dense River Basins. We looked at patterns and emergence of spatial differentiation in zooplankton in the context of urbanisation. The findings demonstrated that zooplankton diversity decreased with rising degrees of urbanisation and that there were substantial differences in species composition between regions with varying levels of urbanisation. The species richness of zooplankton showed a substantial positive association with the water quality of wetlands, which rose concurrently with declining levels of urbanisation. The findings highlight the need for habitat reconstruction and ecological restoration of urban wetland areas and disclose the spatial differentiation mechanism of zooplankton in the course of urbanisation.*
***Keywords-*** *Urbanization, Environmental changes, Zooplankton, Diversity etc.*

## I. INTRODUCTION

Urbanisation involves significant changes in the make-up of organism communities, with the gradual loss of specialists and the rise of generalists. Urban areas' abundance and frequent disruptions, which favour alien species' establishment in natural habitats, also enhance the likelihood of exotic species invasion in close proximity to urban areas. We research how extinctions and colonisations linked to urbanisation affect the taxonomic, functional, and phylogenetic variety of natural groups.

Urban river wetlands are a valuable natural resource that contribute significantly to the urban ecology as well as being a significant source of water for domestic use, business, and agriculture. The land use types of river wetland buffers have seen a significant change as a result of the city's growing urbanisation. By altering river courses, removing riparian vegetation, opening canopies, releasing pollutants (such as nutrients, organic matter, and heavy metals), and lowering habitat heterogeneity, these changes in land use patterns put increased stress on the natural environment and consequently create their own set of environmental problems. The loss of native species in urban areas has been reported in several studies, which has led to the generalisation that urbanisation diminishes species diversity and encourages homogenization of plant and animal assemblages.

In addition, artificial food sources, disturbances, and various forms of pollution, such as chemical, light, and sound pollution, are all on the rise. The most notable effects of these changes on natural communities are the decline in phylogenetic and functional diversity, the development of more homogeneous communities dominated by a small number of anthrpophilic species, and the spread of invasive species. Despite the seriousness of these effects, little is known about how urbanisation affects living things and environmental systems.

Urban biodiversity plays a significant role in the urban environment and acts as a resource guarantee for the long-term growth of urban ecosystems. As a key consumer in the wetlands ecosystem, zooplankton can complete energy transmission via the food web, which has an impact on the ecosystem's stability. Zooplankton is a key indicator of changes in the water environment because it is sensitive to changes in water quality. Abiotic (such as nutrition, light, temperature, transparency, pollution) and biotic (such as parasite, predator, and competition) factors both have an impact on the community structure of zooplankton. There are variances in zooplankton communities on the spatial scale due to the spatial variety of the environment and the complexity of interactions between organisms. The structure of the zooplankton community has been significantly impacted by the variety of urban pollution; for instance, organic pollutants may have an impact on zooplankton population dynamics by regulating individual survival and reproduction as well as changing the sex ratio. Additionally, predator risk may be reduced by toxic compounds by altering swimming habits and body morphology, which in turn affect population dynamics. Zooplankton plays a significant function in the food chain between phytoplankton and swimming animals as both a consumer of primary production and a secondary producer. Through the amplification effect of the food web and the diffusion process, zooplankton, as a main consumer, transmits pollutants (such as heavy metals, microplastics, and organic pollutants) to other freshwater biological populations.

The variety and composition of zooplankton are influenced by land use in watersheds, including urbanisation, through both dispersals and by altering the environment at the patch level. Changes in land use can affect the local environmental conditions of habitat patches during the urbanisation process, including variations in water quality, temperature, conductivity, and organic matter. Land use changes have also made extreme water flows more likely to occur, which could directly alter zooplankton ecosystems through scouring and diffusion.Because species that are intolerant of urban surroundings are replaced by those that are tolerant of them, the biological reactions of functional groups to urbanisation may result in a significant replacement pattern, eventually generating distinct communities over the urbanisation gradient. It is impossible to overlook how changing urban land use patterns may affect the replacement of biological functional categories. However, it is unclear how significant changes in land use in the course of urbanisation may affect the composition of the zooplankton community and functional groupings. The biological community approach should be used to establish a foundation for the timely management of urban wetlands and the protection of biodiversity. At the same time, we think that ecological theory should be linked with the application of urbanisation.

An urban ecosystem's shift in species composition is thought to be a response to human landscape alteration. Our knowledge of zooplankton as a water quality indicator is still limited, despite the important role that it plays in environmental monitoring. It is unclear how zooplankton react to the urban environment and how they might be utilised to monitor the water quality of urban wetlands given the extremely fragmented habitats of urban wetlands and the complexity of contaminants. Urbanization is a long-term, ongoing process, making it challenging to gather some crucial facts. Investigations are typically undertaken on spatial scales rather than chronological ones to save time and examine irrecoverable things. Through an extensive survey of cities and counties, we sought to assess the relationship between urbanization and zooplankton richness, diversity indexes, and community structure, investigate the significance of changes in the zooplankton community and functional groups in urban wetland environment monitoring, and provide a scientific basis for urban wetland management.

## II. OBJECTIVES OF THE STUDY

The purpose of this study was

(1) review the alterations in zooplankton species diversity, species richness, and community structure brought about by urbanisation,

(2) provide an overview of the relationship between the zooplankton community, land use types, and environmental factors,

(3) ascertain how various zooplankton functional groups react to environmental factors, and

(4) To talk about the zooplankton environmental monitoring pattern and offer a scientific foundation for monitoring the environment in urban wetlands, protecting biodiversity, and restoring their ecological integrity.

## III. MATERIAL AND METHODS

3.1. Study area

In the major river basins, we chose the region with the highest population density and the average population density. The areas that are highly urbanised, have a developed economy, and are populated densely. Pollutants were released into rivers at an increasing rate as the basin's urbanisation and industrialization processes developed, which worsened the aquatic environment. There are numerous locations throughout the world.

3.2. Sampling and analyses

In these River Basins, we examined about 200 samples from various cities and counties. We determined the sample points' shortest physical distance from the county centre or the city's district centre in order to exclude the influence of various cities on the sample points and the substantial variances in the regions of the cities and counties. The sample that was most likely to be impacted by the administrative region was determined using the sample with the lowest geographic distance. Based on a linear relationship between distance and species richness, we categorise distances into three tiers.

We chose an equidistant belt area 500 m away from the bank of the river wetland as a buffer zone to better highlight the effects of various land uses on the aquatic environment and to investigate the relationship between land use patterns and the richness of zooplankton species on a spatial scale. We categorise the riparian buffer zone into five different land use types based on those uses: factory, building, highway, agriculture, and woods. The supplemental information shows how different distance scales divide the different types of land.

3.3. Environmental factors

We collected information on land use types, habitat characteristics, water physical and chemical properties. Water samples were collected along with the zooplankton at the same sites. We measured the water temperature, pH, dissolved oxygen (DO), electrical conductivity (EC), suspended solids (SS), turbidity (NTU) and other related on-site data using a portable water quality analyzer

## IV. RESULTS

4.1. Effects of urbanization on zooplankton

Globally, urban expansion significantly degrades aquatic ecosystems, and controlling the water cycle in urban environments is a key area for future research. By 2050, it's anticipated that 66% of people on Earth would live in metropolitan regions.Urban expansion and its associated changes to hydrology, local climate, and biochemical processes will have an impact on natural ecosystems all over the world.

One management tactic to lessen the harm that urbanisation does to aquatic environments is the construction of wetlands to catch storm water. In order to lessen the impact of storm flows and the movement of nutrients, sediment, and pollutants into ecosystems downstream, constructed wetlands are built solutions. In artificial wetlands, pollutants are eliminated by a variety of physical, chemical, and biological processes. In addition, because they are made to resemble the processes that occur in natural wetlands, artificial wetlands serve as habitat for native wildlife, including aquatic invertebrates, fish, and water fowl. The percentage of a catchment that is covered by impervious surfaces, such as paved areas and roofs (total imperviousness; often referred to as imperviousness), has an impact on the volume of storm water that enters aquatic systems. An rise in imperviousness reduces the diversity and number of fish and macro invertebrates in stream systems. These consequences are caused by a combination of changed hydrology, which produces flashier flows, and elevated pollution loads. Because it can anticipate the hydraulic efficacy of the wetland and suggest the pollutant-loading rate, imperviousness is a crucial factor to take into account when building artificial wetlands. Because contaminants are predominantly derived from impervious surfaces, imperviousness is a surrogate measure that represents a simplification of underlying processes. Nevertheless, it can be used as an index to show the loading rate of contaminants into a wetland.

4.2. Effects of urbanization on zooplankton functional groups

Cladocerans, copepods, and rotifers are the three main functional groups whose spatial distribution of zooplankton populations we examined. This study discovered that, in the setting of urbanisation, many functional groupings displayed significant spatial variability. In contrast to rotifers, copepods and cladocerans showed an increase in density as the distance from the city centre rose. The distribution range of zooplankton in the major functional categories was shown by the kernel density map to be rotifers > copepods > cladocerans, demonstrating that rotifers and copepods were more tolerant of pollution and more easily adapted to urban eutrophic waters. The three groups did share one trait, though: it was simpler for them to congregate in low-pollution and less-disturbed water environments.

## V. DISCUSSION

The river wetland ecosystem's water environment has become substantially polluted as a result of the rapid urbanisation process that has significantly altered the land use pattern of the river wetland buffer zone. Instead of using a temporal scale, we employ a spatial scale to investigate how urbanisation affects zooplankton diversity. In our study, we took into consideration the regions that essentially constitute total urbanisation. We referred to these regions as highly urbanised, weakly urbanised, and non-urbanized. Urbanisation has essentially the same effects on wetland characteristics, the biological habitat matrix, and biodiversity as those found in earlier studies. According to our findings, there is an urbanization-related high negative association between distance and the zooplankton species richness and diversity index. Eutrophication of water bodies was a major factor in this study's findings that zooplankton species diversity, species richness, and community structure were inhibited. According to certain research, a eutrophic water body has a substantial organic matter deposit at the bottom, and anaerobic fermentation there will become more pronounced in anoxic circumstances. Additionally, it was discovered that sulphate reduction reactions and biogas fermentation affect the original ecological environment by causing the succession of zooplankton populations and communities. At the same time, a lot of zooplankton will perish due to algae outbreaks brought on by eutrophication. It is impossible to overlook how heavy metal contamination affects zooplankton.

In earlier investigations, several researchers found that heavy metals can slow zooplankton's growth, reproduction, and biomass, which will reduce species variety and richness and alter the community structure. when a result, the population in highly urbanised places is made up of species that are very resistant to pollution, and when urbanisation decreased, the aquatic environment substantially improved, especially in non-urbanized areas. But zooplankton must take into account how urbanisation is altering ecological resources. In heavily urbanised locations, the formation of zooplankton populations is hampered by frequent human activity, a poor water environment, and a lack of food resources. On the other hand, as urbanisation has slowed, biological resource diversity has grown and the habitat has become more stable, which has aided in the diversification of zooplankton. The zooplankton community structure also underwent significant modification at the same time. While the communities in the highly and weakly urbanised areas largely overlapped one another, the non-urbanized area was very different from the first two. Communities including Cyclops, Polyarthra, and Synchacta, which are found in oligo-polluted water, made up the majority of the non-urban region. This outcome could be explained by the fact that while the environmental elements in high and low urbanisation share some characteristics, those in non-urbanized areas differ significantly from those in the other two locations.

The complexity of urban ecosystems is determined by changes in land use, and these changes are also what fuel regional differences in urban biodiversity. In our study, as urbanisation decreased, water environmental parameters improved. Factory, roadway, and building land use categories all significantly impact environmental factors in heavily urbanised locations. Due to the discharge of wastewater containing heavy metals as Zn, Ni, Li, and Cr, factories not only exacerbate eutrophication in the production process but also the deterioration of water quality. The eutrophication of the river is a significant element impacting the aquatic environment in this area, and the majority of the structures in the riparian buffer zone are residential zones. The loss of zooplankton species diversity is directly caused by habitat degradation and eutrophication of water.

Due to the presence of numerous factories in sparsely populated areas, industries have emerged as the primary cause of water pollution, with other land uses having a substantially smaller negative impact on the aquatic environment. In weakly urbanised areas, species diversity has increased as land use frequency and size have decreased, improving water environmental parameters. In the range of non-urbanized areas, which are primarily made up of farmlands, highways, and woodlands, there aren't many different land use classifications. This region's farmlands play a significant role in the fluctuations in river water quality.

The longevity of aquatic organisms is impacted by the phosphate salts that enter the water body through soil erosion, surface runoff, and atmospheric wet and dry deposition. According to studies, excessive phosphorus in water can reduce the quality of algae and harm the digestive systems of herbivorous zooplankton. The growth and reproduction of zooplankton can be impacted by phosphate intake. Heavy metals have a substantially greater impact on zooplankton abundance in non-urbanized locations. The majority of the heavy metals present here do not, however, surpass the usual limit, indicating that they originate primarily from the environment. In conclusion, the riparian buffer zone's altered land use pattern has a significant role in the regional disparities in water quality that result from urbanisation. The complexity of the impact on organisms depends on how varied the urban environment is. We must look into the factors affecting the shifts in zooplankton species diversity.

First, zooplankton's spatial distribution pattern in the urban environment is influenced by nutrients. The level of land usage in the riparian buffer zone in particular has a detrimental effect on the diversity of species. Second, nutrients rather than heavy metals have a greater effect on species richness in heavily urbanised environments. However, the effect of heavy metals on species richness becomes more pronounced as urbanisation levels and land use patterns decline.

The replacement of zooplankton species and environmental adaptation of zooplankton caused a change in the functional group structure of zooplankton. In our study, the densities of cladocerans, copepods, and rotifers in response to urbanisation were spatially distributed in considerably diverse ways. Rotifers showed higher strain tolerance under urbanisation than cladocerans and copepods, and this finding is mostly in line with those of earlier studies. The unusual buildup of nutrients in rivers close to populated areas causes a lot of bacterial and algal development, which produces enough food for rotifers. Natural predators of rotifers are weakened by urbanisation, urban rivers' water temperatures are raised, and rotifers reproduce more quickly due to an abundance of food sources.

As a potential indicator of how the water environment has changed as a result of urbanisation, zooplankton may be useful. Zooplankton may react swiftly to environmental changes and can pick up on even minute alterations in water quality. It is impossible to ignore zooplankton's role as an indicator in wetlands along urban rivers. We think that the three following factors primarily reflect the zooplankton monitoring pattern:
1. the alteration of species richness and diversity; 2. the alteration of functional group structure; and 3. the presence of a single species.

In addition to providing information on changes in aquatic parameters (nutrient levels, heavy metal pollution, etc.) in the water environment, zooplankton diversity and species richness in urban ecosystems can also serve as a proxy for the degree of urbanisation in a given area. Low species variety and species richness point to a significantly polluted urban water environment, as well as the possibility of eutrophication and heavy metal pollution. Since a long time ago, zooplankton variety and abundance have been used to monitor the environment, but we still don't have a reliable way to determine how polluted a particular body of water is. Since environmental adaptation leads to structural changes in zooplankton functional groups, we think that biological monitoring should also take into account changes in the relative abundance of zooplankton functional groups.

## VI. CONCLUSION

The results of the study's research showed that nutrients and heavy metals had a negative association between their levels and the density of functional groups, with nutrients having the greatest estimate. This finding indicates that the functional groups of the zooplankton community in the wetland environment can vary in composition and structure as a result of an increase in nutrients. Studies have shown that the characteristics or ratios of nitrogen and phosphorus have an impact on the functional group organisation of zooplankton. Because of their distinct feeding habits and nutrient modes, rotifers have a low utilisation rate of nitrogen and phosphorus compared to cladocerans and copepods, which allows them to maintain high tolerance levels in the presence of eutrophic environments. At the same time, we discovered that Cr's impact on the density of various functional groups was crucial. Through amplification of the food web, Cr can be easily enriched in organisms, the human body, or huge animals, producing a potent poisonous effect. Additionally, Cr is highly harmful to zooplankton, causing it to grow slowly, develop slowly, move slowly, have lower reproductive capacities, and die more frequently.

Urbanisation is posing a grave threat to the ecological community and is becoming the leading cause of extinction of species. We discover that the loss of urban species diversity is mostly caused by a sharp change in land use patterns. Large-scale demolition and reconstruction have been done, but the outcomes are not satisfactory. In the last few decades, landscape reconstruction looks to be an essential method of urban ecological restoration. We think that in order to restore urban ecosystems effectively, community ecological theories, the sensible application of biological environmental indicator functions, and timely actions should be integrated with the ecological restoration of urban wetlands and the protection of biodiversity. Controlling the intake of nutrients will become a crucial strategy for enhancing wetland ecology as a result of our discovery that nutrients are a major role in reducing both zooplankton diversity and other aquatic species. To start, it should be strictly forbidden to discharge sewage at will in order to lessen the amount of nutrients and other dangerous compounds that are introduced into the environment. In order to lessen the intake of contaminants from surface runoff or the atmosphere, a buffer zone close to the river bank should be developed. This zone should be dominated by vegetation. Third, to minimise human involvement with wetlands, appropriate land planning and utilisation practises should be adopted. The extensive alteration of urban river courses and the improper exploitation of riverbank buffer zones have a negative impact on a habitat's connectivity and variety. In order to alter the habitat characteristics that effect diffusion and restore the original vitality of urban wetlands, we need focus more on the creation of biological habitats.

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