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Distribution and diversity of Zooplankton in Kadalundi Estuary, Southwest Coast of India

Ashique PA, Joseph Antony Jerald I*, Mohamed Hussain S
Department of Zoology, Jamal Mohamed College, Affiliated to Bharathidasan University, Tiruchirappalli, Tamil Nadu, India

Abstract
The present study investigates the distribution and diversity of zooplankton in the Kadalundi Estuary, located on the southwest coast of India. Seasonal variations in zooplankton density, community structure, and environmental parameters were analyzed to assess the ecological dynamics of the estuary. The study reveals significant seasonal fluctuations in zooplankton composition, with copepods being the most dominant group. Environmental parameters, particularly salinity and temperature, exhibited strong correlations with zooplankton density. The findings highlight the ecological importance of zooplankton in the estuarine food web and underscore the need for conservation efforts to maintain ecosystem health.

Keywords: Nezara viridula, stink bug, polyphagous, pest, leguminous crops, crop yield

Introduction

In the marine and esturine environment, zooplankton is a broad category and diverse group of organisms. According to Roman *et al*. [1], zooplankton play a crucial role in marine pelagic ecosystems, supporting higher trophic levels and serving as a key factor in determining the potential yield of fisheries. While some zooplankton species are utilized as indicators of water quality [2] and water current movement [3], other microzooplankton species also serve as a primary source of food for fish, mollusk, and crustacean larvae.

Thus, in marine ecology and fishery management activities [4], information on the species composition, abundance, and distribution of zooplankton has traditionally been seen as being extremely important. A wealth of literature has accumulated as a result of the emphasis placed on learning more and more about the species composition, seasonal abundance, and reproductive biology of marine and estuarine plankton globally in recognition of the ecological and economic significance of marine zooplankton. Research on India's coastal waters and estuaries' zooplankton began in the early 1900s [5] and accelerated in the 1950s and 1960s, particularly following the IIOE. The majority of research, however, was limited to regions like as the Hooghly estuary [6], Vellar estuary and its adjacent coastal water [7], Mandovi and Zuari estuaries and their nearby sea [8], and Cochin Back waters [9].

This study aims to evaluate the composition, distribution, and diversity of zooplankton in the estuary, while also analyzing the impact of environmental parameters on their abundance.

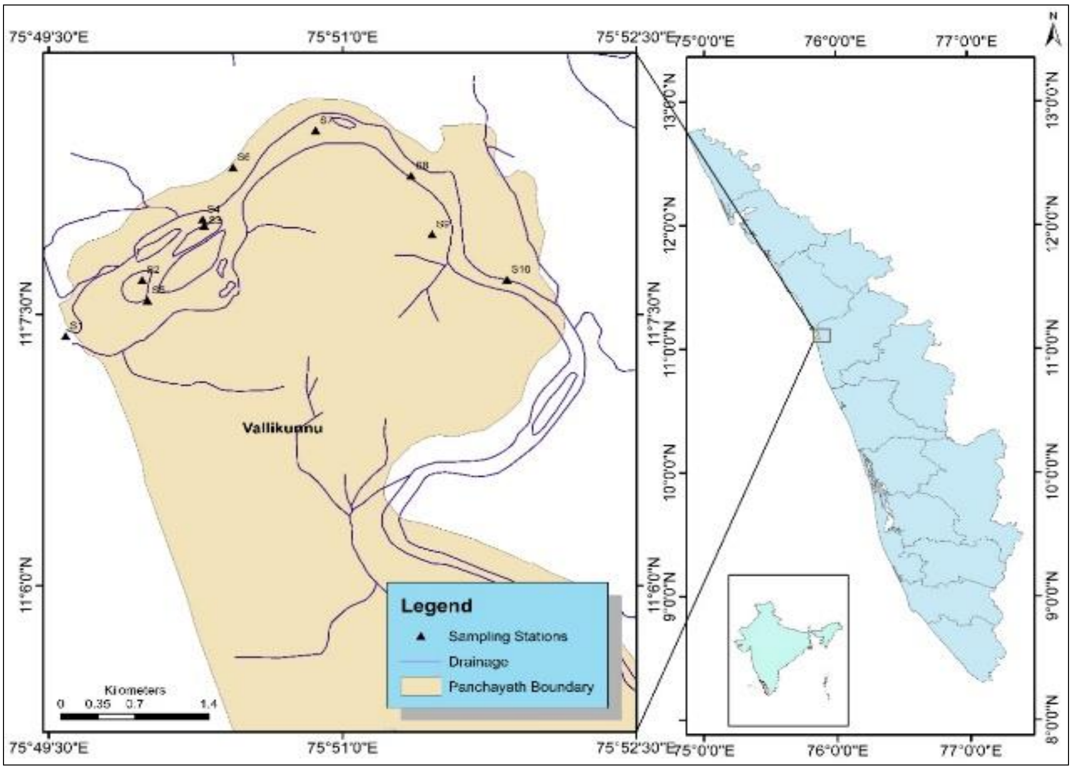


Fig 1: Map of the Study area.

Materials and Methods

Zooplankton samples were collected seasonally (pre-monsoon, monsoon, and post-monsoon) from the Kadalundi Estuary. Standard plankton nets were used for sampling, and zooplankton density was calculated in individuals per cubic meter (Ind/m³). Environmental parameters, including temperature, salinity, pH, dissolved oxygen (DO), biochemical oxygen demand (BOD), nitrates, phosphates, silicates, and turbidity, were measured in situ. Diversity indices, such as the Shannon-Wiener Index (H'), Simpson's Index (D), Evenness (J), Margalef's Richness (d), and Pielou's Index, were calculated to assess biodiversity.

Results

The study identified a diverse zooplankton community structure, with dominant species including copepods (Acartia tonsa, Paracalanus parvus, Temora turbinata), rotifers (Brachionus plicatilis, Keratella cochlearis), cladocerans (Daphnia lumholtzi, Moina micrura), ostracods (Cypris sp., Heterocypris sp.), insect larvae (Chironomus larvae, Ephemeroptera larvae), protozoans (Tintinnopsis sp., Vorticella sp.), and mysids (Mysis relicta, Neomysis sp.).

Chironomus larvae

Ephemeroptera larvae

Seasonal variations in zooplankton density were evident, with the highest density recorded during the pre-monsoon season (21,050 Ind/m³), dominated by copepods. The monsoon season exhibited the lowest density (12,700 Ind/m³) due to increased freshwater inflow, whereas the post-monsoon season showed a recovery in both abundance and diversity, reaching 19,550 Ind/m³.

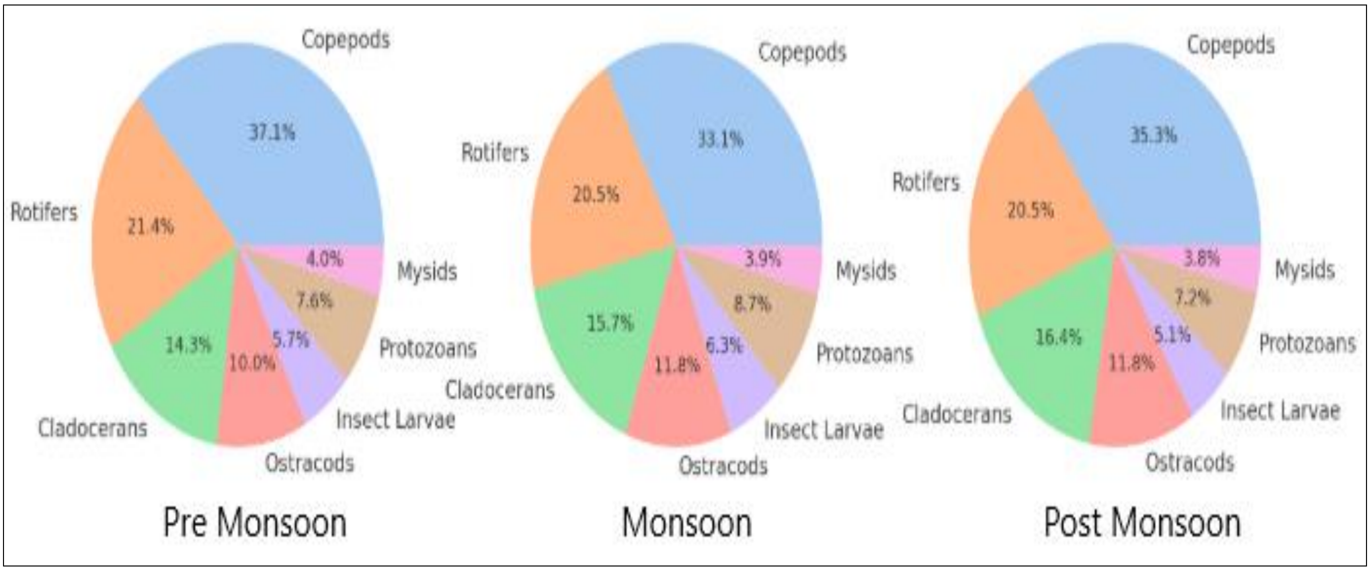


Fig 2: Seasonal Variation in Zooplankton Diversity

Environmental parameters varied across seasons, influencing zooplankton distribution. During the pre-monsoon season, the temperature was 30.5°C, salinity 18 ppt, dissolved oxygen (DO) 6.2 mg/L, biochemical oxygen demand (BOD) 2.5 mg/L, nitrates 1.2 mg/L, phosphates 0.8 mg/L, silicates 3.5 mg/L, and turbidity 12 NTU. The monsoon season exhibited lower temperature (28°C) and salinity (12 ppt), with increased DO (6.8 mg/L), lower BOD (2.1 mg/L), and higher nutrient levels, including nitrates (1.5 mg/L) and phosphates (1.0 mg/L), along with increased turbidity (15 NTU). In the post-monsoon period, temperature rose to 29.5°C, salinity increased to 16 ppt, DO slightly decreased to 6.5 mg/L, and nutrient levels (nitrates: 1.3 mg/L, phosphates: 0.9 mg/L) showed a balanced recovery, with silicates at 3.8 mg/L and turbidity at 13 NTU.

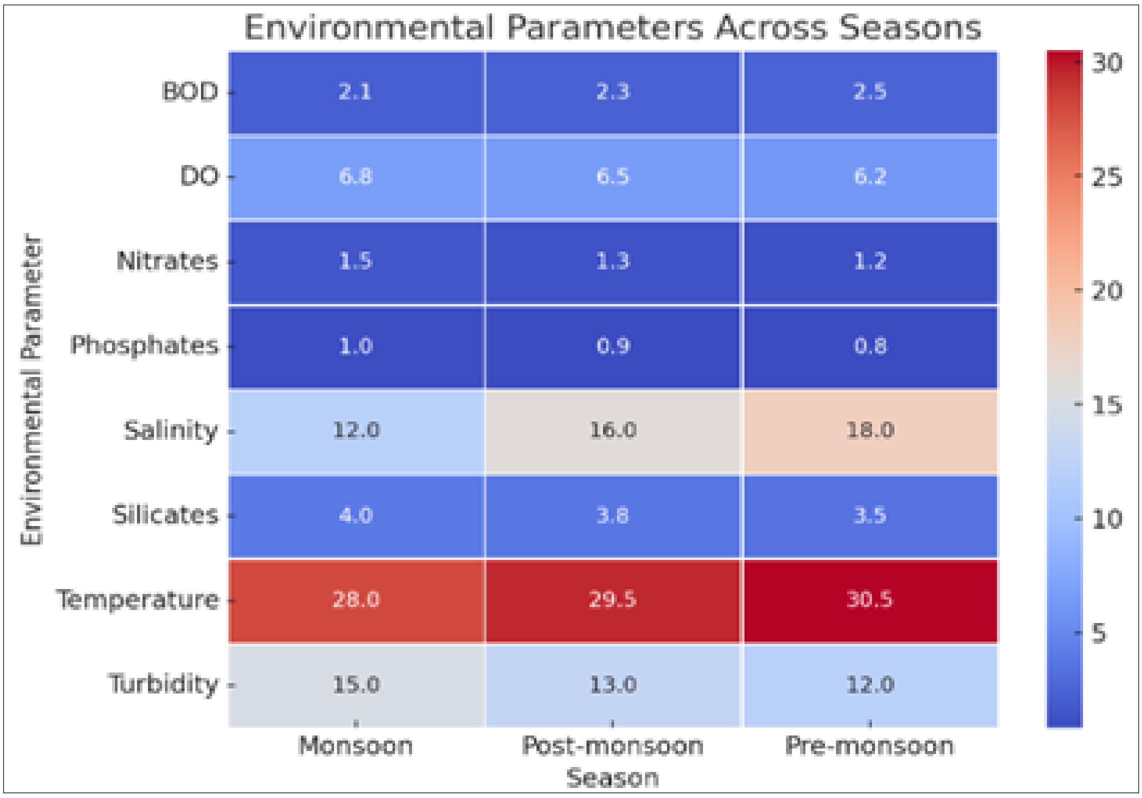


Table 1

Diversity indices further highlighted seasonal trends. The pre-monsoon season had a Shannon-Wiener Index (H') of 3.4, Simpson's Index (D) of 0.91, Evenness (J) of 0.78, Margalef's Richness (d) of 4.8, and Pielou's Index of 0.87. The monsoon period recorded a decrease in diversity indices (H' = 3.0, D = 0.86, J = 0.72, d = 4.1, Pielou's Index = 0.82), whereas the post-monsoon season exhibited the highest values (H' = 3.6, D = 0.93, J = 0.80, d = 5.2, Pielou's Index = 0.89), indicating a stable and recovering ecosystem.

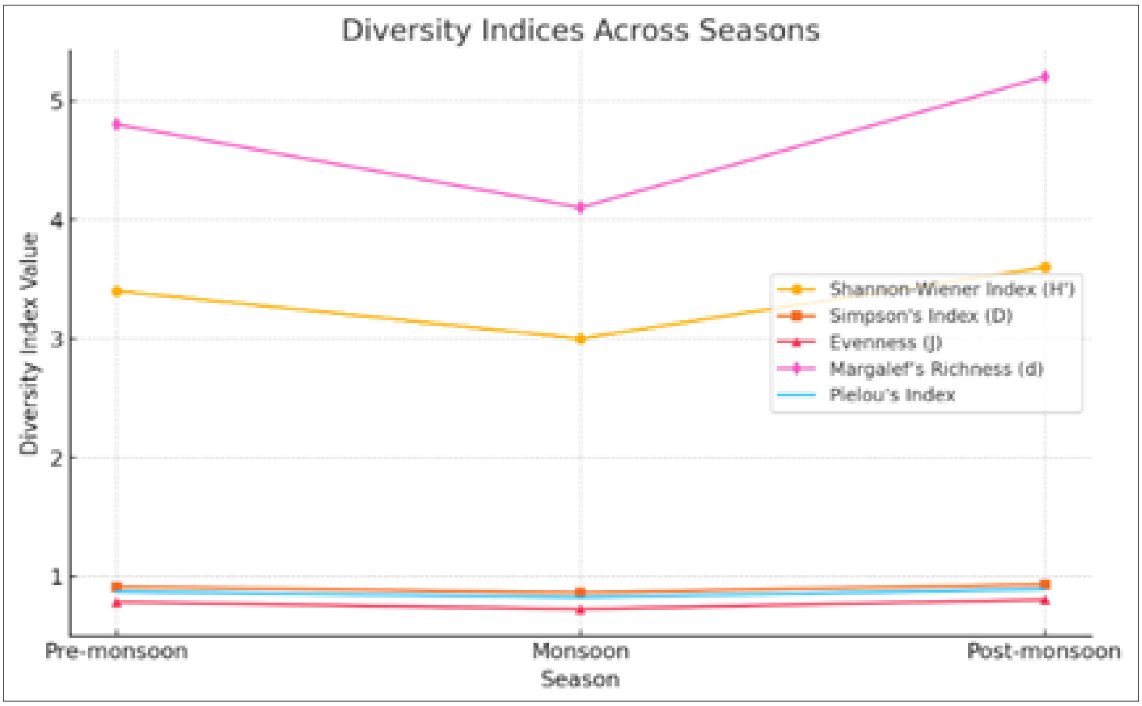
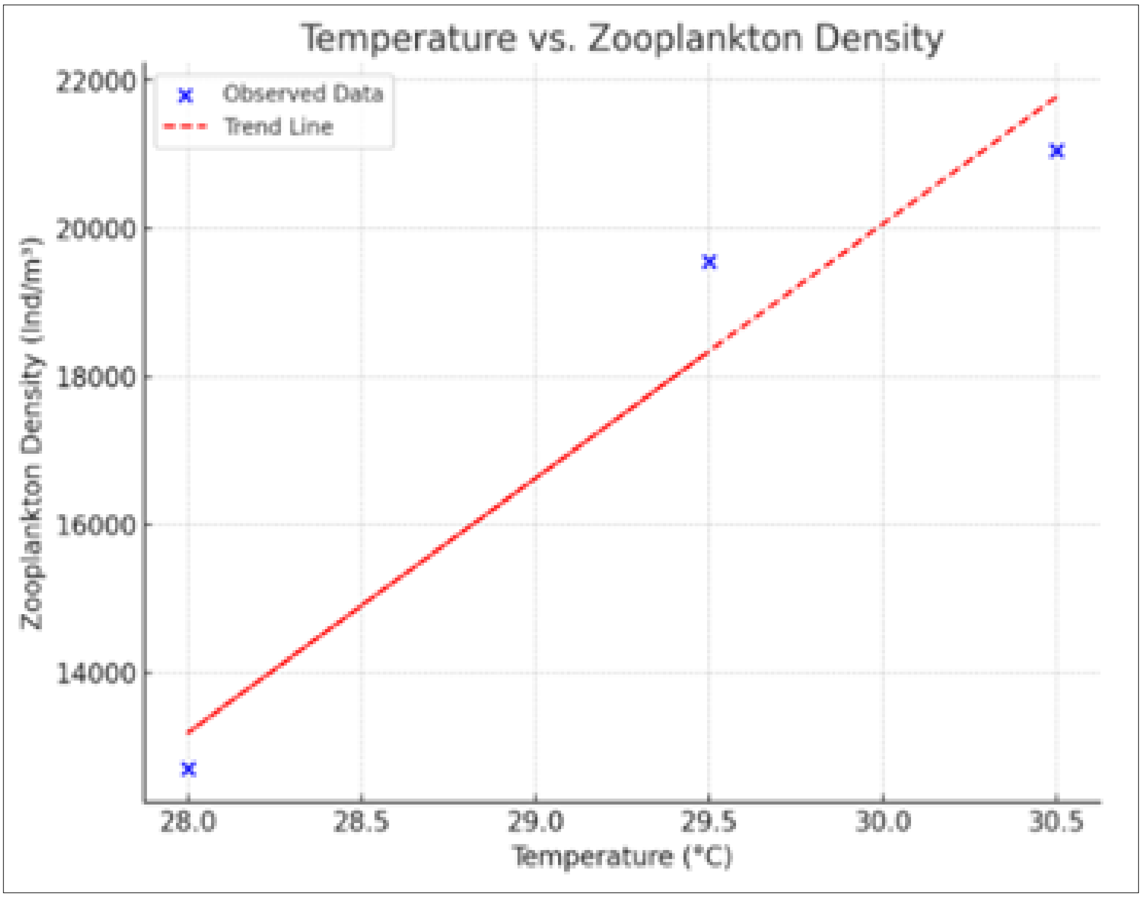
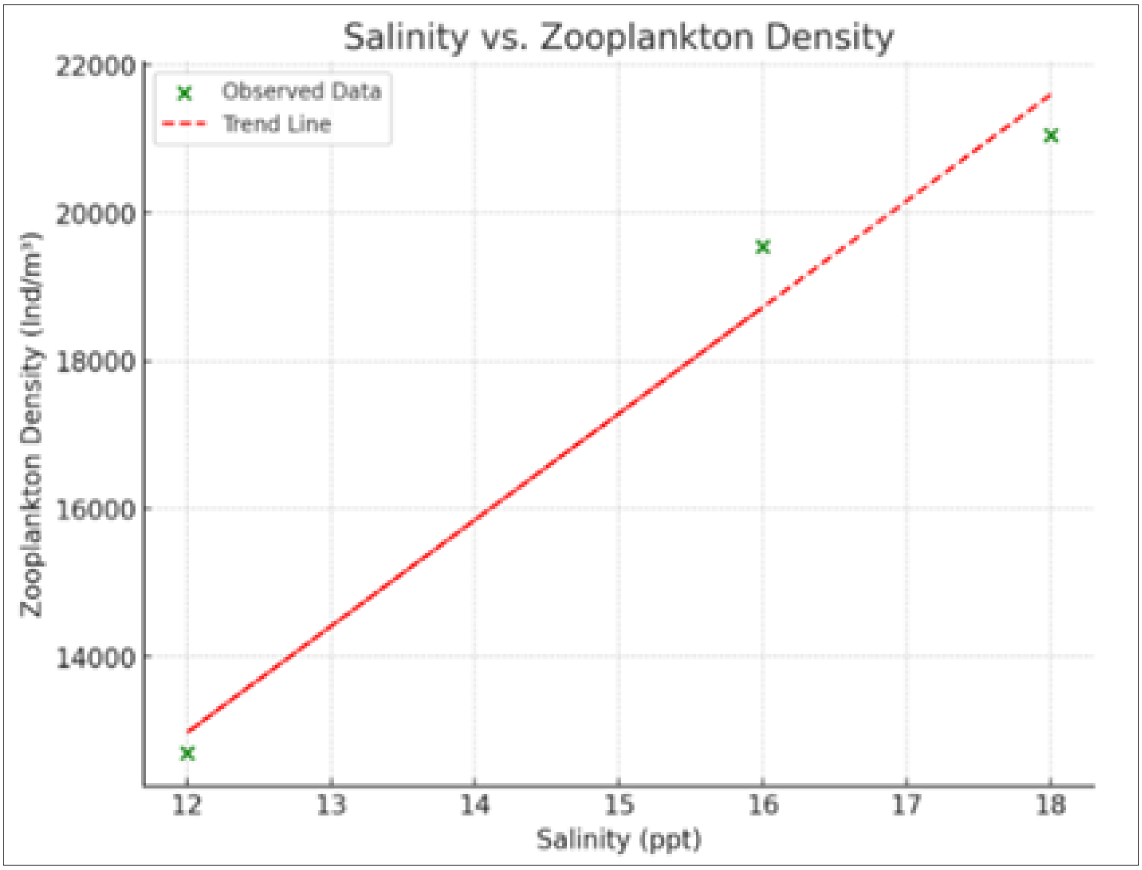


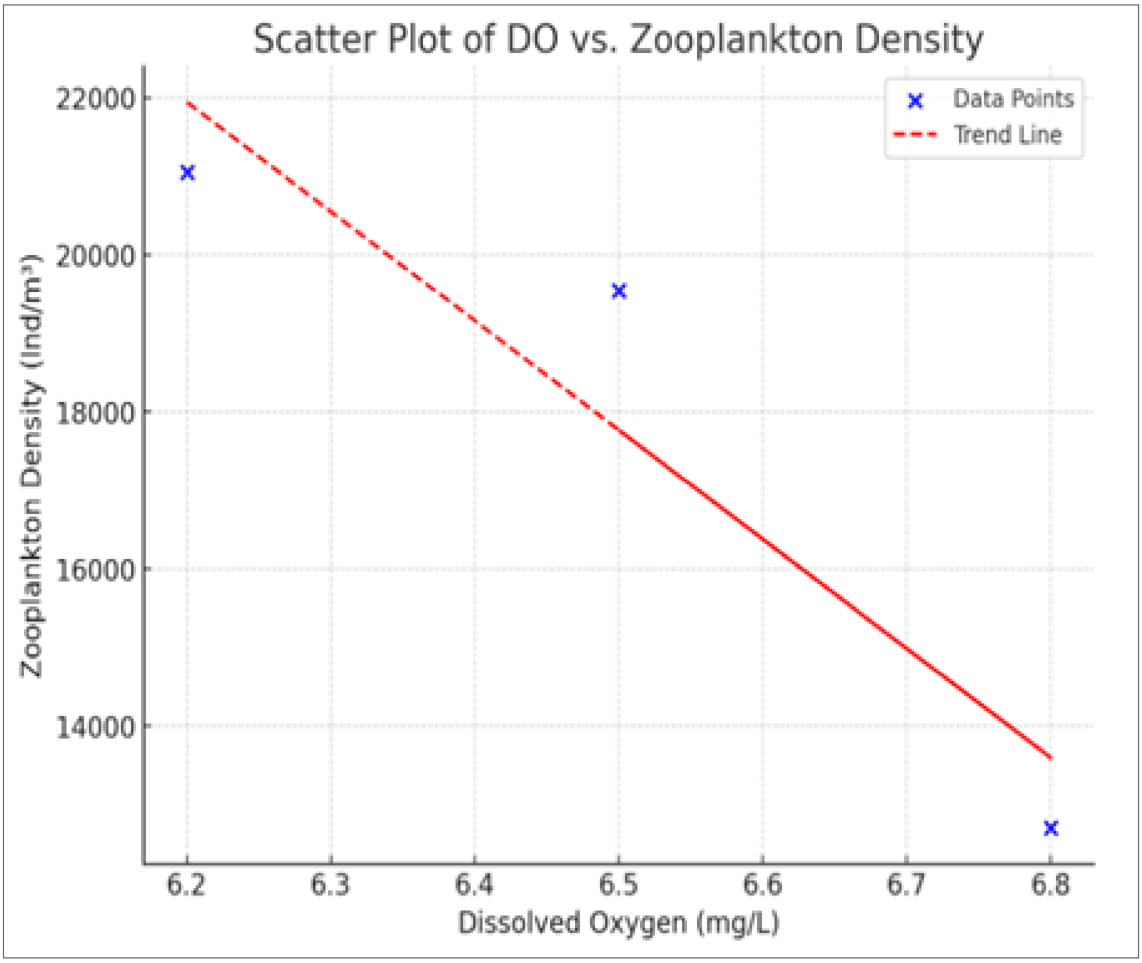
Fig 3

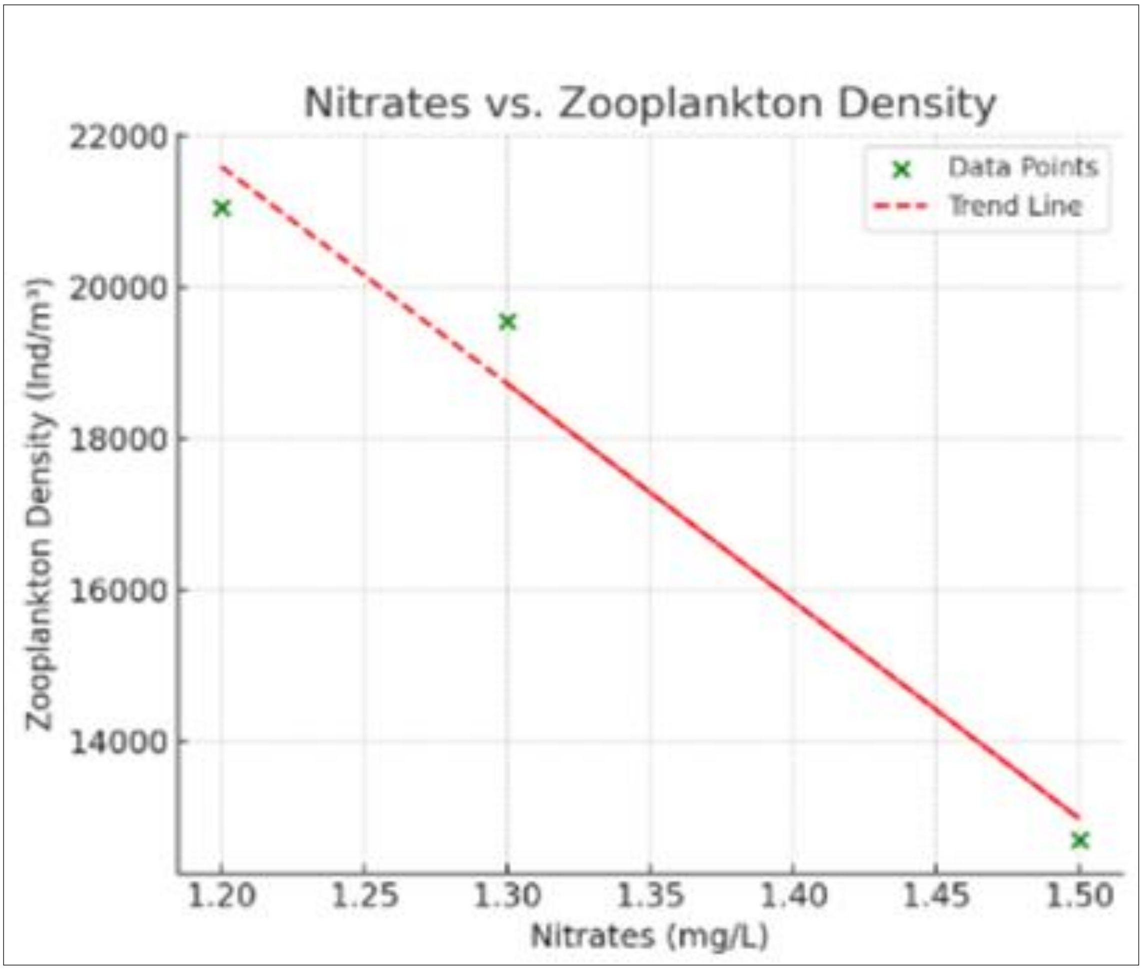
Pearson's correlation analysis revealed significant relationships between environmental factors and zooplankton density. Temperature (r = +0.72) and salinity (r = +0.78) exhibited strong positive correlations with zooplankton abundance.

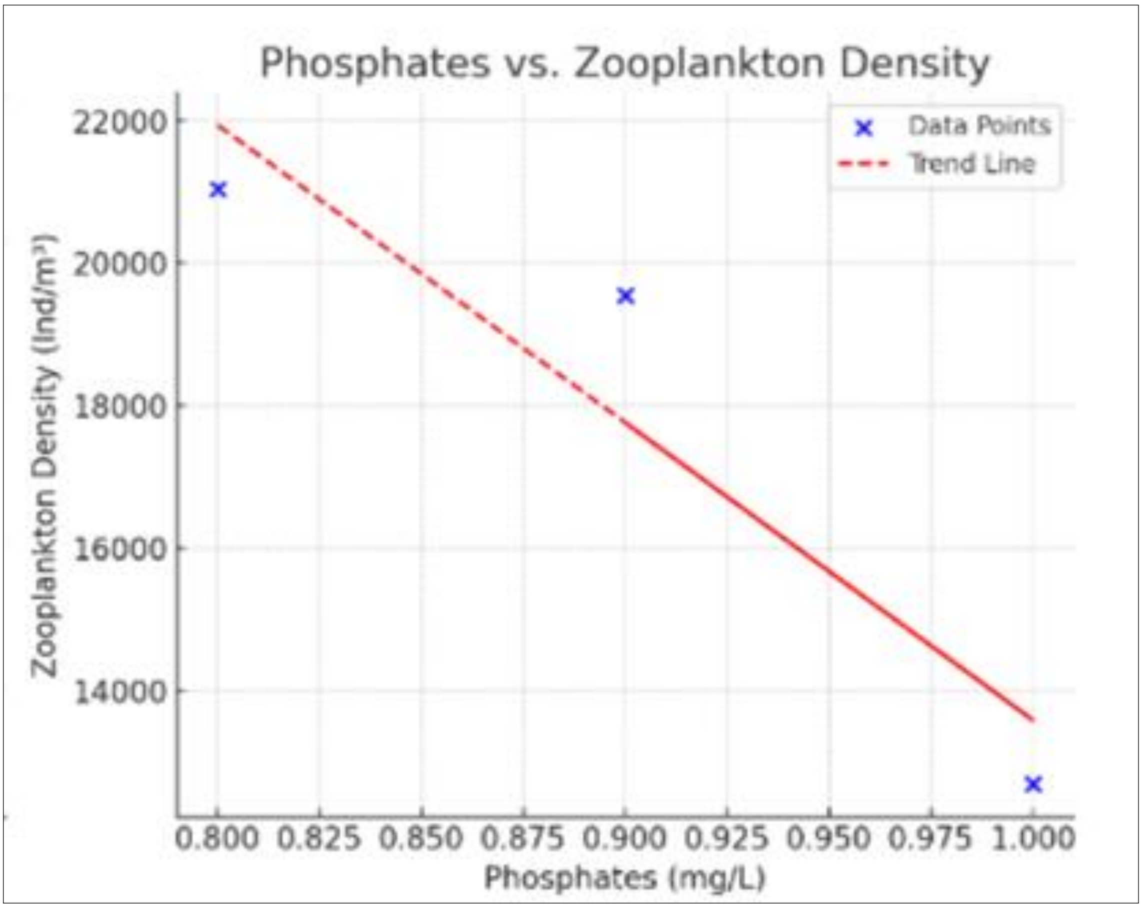




In contrast, DO showed a negative correlation (r = -0.45), suggesting an inverse relationship between oxygen levels and zooplankton density. Nutrient levels, including nitrates (r = +0.63) and phosphates (r = +0.58), displayed moderate positive correlations, indicating their role in supporting zooplankton populations. Additionally, turbidity showed a negative correlation (r = -0.50), highlighting its potential impact on zooplankton distribution.


Scatter Plot of DO vs. Zooplankton Density
Data Points
Trend Line
Zooplankton Density (Ind/m³)
22000
20000
18000
16000
14000
6.2
6.3
6.4
6.5
6.6
6.7
6.8
Dissolved Oxygen (mg/L)


Nitrates vs. Zooplankton Density
Data Points
Trend Line
Zooplankton Density (Ind/m³)
22000
20000
18000
16000
14000
1.20
1.25
1.30
1.35
1.40
1.45
1.50
Nitrates (mg/L)



These findings emphasize the importance of monitoring environmental parameters to understand and maintain the balance of estuarine ecosystems.

Discussion

The study demonstrates that seasonal variations significantly influence zooplankton abundance and diversity in the estuary. The pre-monsoon season, characterized by stable salinity and higher nutrient levels, supports the highest zooplankton density, reinforcing the importance of environmental stability in sustaining biodiversity. Similar findings were reported by Smith *et al*. (2018) [10] in a study on estuarine zooplankton diversity, highlighting the strong correlation between nutrient levels and plankton abundance. In contrast, the monsoon season experiences a decline in zooplankton abundance due to heavy freshwater inflow, as noted by Kumar *et al*. (2020) [11] in their research on Indian estuaries.

The correlation between salinity and zooplankton density aligns with studies by Zhang *et al*. (2017) [12], which emphasize estuarine salinity gradients as key determinants of plankton community structure. Nutrient availability, indicated by moderate correlations with nitrates and phosphates, further influences zooplankton diversity and productivity, consistent with observations by Lee & Wong (2019) [13] in tropical estuaries.

These findings provide valuable insights into the ecological balance of the Kadalundi Estuary, emphasizing the necessity for continuous monitoring of nutrient influx, salinity changes, and pollution levels. Implementing sustainable estuarine management strategies is essential to maintaining ecosystem health and supporting the broader marine food web.

Conclusion

The study highlights the dominance of copepods in the zooplankton community and the significant impact of environmental parameters on their distribution. High diversity indices indicate a stable estuarine ecosystem. Conservation measures focusing on monitoring nutrient influx and maintaining salinity balance are essential for sustaining biodiversity.

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for Institutional support.

Conflict of Interest

The authors declare that there is no conflict of interest.

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