

Spatio-temporal variation in the distribution and community structure of mesozooplankton in Mandovi-Zuari estuarine complex

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Mesozooplankton are tiny but mighty members of the marine ecosystems, playing a crucial role in food webs, and serve as sensitive indicators of environmental change. The present study delved into how these communities shift across space and time within the Mandovi-Zuari estuary in Goa, India, a vibrant tropical system significantly influenced by the southwest monsoon. Our observations revealed clear monthly variations and distinct differences in mesozooplankton communities between the Mandovi and Zuari estuaries. During pre-monsoon, mesozooplankton abundance was higher at the mouth of the Mandovi estuary, while in the Zuari, their abundance was higher in the interior stations. Whereas during the post-monsoon, higher mesozooplankton abundance was observed in the Mandovi estuarine mouth region. During the monsoon, mesozooplankton abundance was lowest and was similar in both the Mandovi and Zuari estuarine regions. The copepods were the most dominant group, followed by decapod and cirripede larvae. We also found a higher abundance of gastropod and bivalve larvae, especially in the Zuari estuary. The higher abundance of mollusc larvae in the upper estuarine regions suggests these areas are important spawning grounds for the molluscan community. The physico-chemical parameters of the water significantly affected mesozooplankton community composition, e.g., a higher abundance of cladocerans in low-salinity regions during the monsoon season. By grouping stations by mesozooplankton community, we identified ecological similarities among them, largely determined by their location within the estuarine complex. This highlights how different parts of the estuary support unique communities. The present study offers valuable insights into the intricate dynamics of mesozooplankton in a tropical estuarine environment, emphasising their sensitivity to seasonal changes and their vital role as indicators of estuarine health.

Keywords: Abundance, community structure, Mandovi-Zuari estuary, mesozooplankton, spatio-temporal.

ZOOPLANKTON are the key components of the aquatic food web and they serve as a link between the primary producers and the higher trophic level. They play a crucial role in the functioning of the marine ecosystem by maintaining a balance between organic and inorganic components. The primary food for the zooplankton is bacteria and microalgae, and they are a key food source for many invertebrates, fish, and birds¹. To evade predators, zooplankton show a phenomenon of diurnal vertical migration (DVM) by descending into deeper waters during the day and rising to the surface of the aquatic environment at night. They help in recycling of the nutrients and energy through their metabolism, which is transferred to higher trophic levels².

Zooplankton serve as food for fish, which is essential for their survival, making them foundational to aquatic food webs and chains³. Omnivorous and planktivorous fish rely on zooplankton as their primary food source and are hence important for the cultivation of fish larvae⁴. Qualitative and quantitative information of zooplankton vary within an ecosystem depending on the ecological conditions⁵. They respond to environmental changes such as nutrient loading, sediment input, and acidification, thus making them bio-indicators of water quality⁶. Zooplankton play a critical role in the efficiency of the biological carbon pump (BCP)^{7,8}. Zooplankton are classified based on size into micro-zooplankton (20–200 µm), mesozooplankton (200–2000 µm), and macro-zooplankton (> 2000 µm). Mesozooplankton, which largely include the copepods, cladocerans, and larval stages of larger organisms, are particularly abundant in estuarine and coastal environments^{9,10}. The abundance and diversity of zooplankton in the estuarine ecosystem are influenced by factors such as salinity, temperature, dissolved oxygen levels, availability of food, and nutrient availability, and this can lead to a highly dynamic community structure^{11,12}. Mesozooplankton play a crucial role in the estuarine food web, linking primary producers and higher trophic levels, and their abundance is often higher in estuaries compared to open oceans due to nutrient-rich environments^{13–15}.

Estuaries serve as critical transitional ecosystems that play a vital role in shaping the community composition and abundance of zooplankton^{16,17}. The dynamic salinity gradients and varying temperature conditions within estuaries promote a diverse array of zooplankton taxa, which adapt

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