

**BIOAVAILABILITY OF MICROPLASTICS AND
INGESTION IN ZOOPLANKTON IN
SEPANGGAR BAY, SABAH**



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UMS
UNIVERSITI MALAYSIA SABAH

**BORNEO MARINE RESEARCH INSTITUTE
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ABSTRACT

Microplastics (MP) is an emerging global environmental concern due to their widespread abundance in the marine environment and increasing documentation of ingestion by marine organisms, including small lower trophic zooplankton. This study examined the spatiotemporal variation of MP in the water column and ingestion by marine zooplankton relative to monsoon seasons in Sepanggar Bay, Sabah, Malaysia. MP and zooplankton samples were collected in vertical tows using 20 μm and 300 μm plankton nets, respectively, from October 2021 to August 2022, covering the Northeast monsoon (NEM), Southwest monsoon (SWM) and inter-monsoon periods (INTER). Preliminary investigation showed that MP were vertically distributed in the water column, with a significantly higher MP concentration in the water column (82.7 ± 10.8 particles/ m^3) than in the surface water (34.8 ± 5.7 particles/ m^3). MP concentration decreased from SWM (106.6 ± 23.0 particles/ m^3) to NEM (63.0 ± 8.0 particles/ m^3) and INTER (31.2 ± 6.7 particles/ m^3), with a significant seasonal difference between SWM and INTER. MP were observed in all eight zooplankton taxonomic groups examined (Appendicularia, Chaetognatha, Cladocera, Copepoda, Decapoda, Hydrozoa, Ostracoda and Salpidae). The average MP ingestion varied from 0.001 ± 0.001 (Ostracoda and Appendicularia) to 0.045 ± 0.028 particles/ind. (Salpidae) and increased along the planktonic food chain. MP ingestion decreased significantly from carnivorous to omnivorous and herbivorous zooplankton, suggesting the influence of zooplankton feeding behaviour on MP ingestion. The composition of MP in the water column and zooplankton was homogeneous, dominated by fibrous and translucent MP. Nine of the twelve polymers identified were high-density polymers, with polyethylene terephthalate being the most prevalent in the water column (55.6%) and zooplankton (23.1%) samples. The presence of low- and high-density polymers in zooplankton highlights their susceptibility to ingesting MP due to their vertical migration behaviour. MP composition in the water column formed distinct groups relative to monsoon seasons and associated with temperature, rainfall and wind speed, suggesting that MP composition in the water column tracked monsoonal changes of environmental conditions. In addition, all environmental variables were found to have a significant influence on MP concentration in the water column in the order of salinity > rainfall > wind speed > temperature. Increased rainfall during SWM may have increased the concentration of MP from land-based sources (river discharge and runoffs). The low MP concentration coincided with high wind speed during monsoon transition periods could be due to the high dispersion towards the open sea caused by heavy winds. The interactions of salinity, rainfall and temperature are important in regulating seawater density and the vertical distribution of MP in the water column. The present work provides new insight into the interactions between MP and zooplankton in the water column in the tropical marine ecosystem. This information is of great importance to bridging field observations and laboratory studies to improve impact assessment of marine MP pollution, which contributes to the United Nations Sustainable Development Goal 14 - conserve and sustainably use the oceans, seas and marine resources for sustainable development.

ABSTRAK

KEHADIRAN MIKROPLASTIK DALAM LAPISAN AIR DAN SISTEM PENCERNAAN ZOOPLANKTON DI TELUK SEPANGGAR, SABAH

Kelimpahan mikroplastik (MP) meluas dalam persekitaran marin merupakan isu alam sekitar yang mendapat perhatian umum. Justeru itu, kehadiran MP dalam sistem pencernaan organisma marin, termasuk zooplankton di peringkat trofik rendah turut didokumentasikan sejak kebelakangan ini. Terdapat dua objektif kajian iaitu memeriksa variasi mikroplastik dalam lapisan air dan kehadiran MP dalam sistem pencernaan oleh zooplankton marin mengikut monsun di Teluk Sepanggar, Sabah, Malaysia. Sampel mikroplastik dan zooplankton telah dikutip dengan menggunakan jaring plankton bersaiz 20 μm and 300 μm yang diambil secara menegak dari kedalaman 10-30 meter. Tempoh sampling bermula dari bulan Oktober 2021 hingga Ogos 2022 yang dikutip sebulan sekali di mana meliputi monsoon Timur Laut (NEM), monsoon Barat Daya (SWM) dan peralihan monsoon (INTER). Keputusan awal menunjukkan bahawa taburan MP terserak dalam pola menegak dalam lapisan air dengan purata kelimpahan MP secara total (pada kedalaman 10 -30 meter) yang lebih tinggi secara signifikan dengan nilai (82.7 ± 10.8 partikel/ m^3) berbanding MP di permukaan air (34.8 ± 5.7 partikel/ m^3). Bagi variasi monsun, kelimpahan MP adalah tinggi pada SWM (106.6 ± 23.0 partikel/ m^3) dan menyusut pada NEM (63.0 ± 8.0 partikel/ m^3) dan INTER (31.2 ± 6.7 partikel/ m^3) dengan perbezaan yang signifikan antara SWM dan INTER. Kelimpahan MP dalam sistem pencernaan kesemua lapan kumpulan zooplankton (Appendicularia, Chaetognatha, Cladocera, Copepoda, Decapoda, Hydrozoa, Ostracoda dan Salpidae) turut diperiksa. Purata kelimpahan MP adalah berbeza dari 0.001 ± 0.001 (Ostracoda dan Appendicularia), dan 0.045 ± 0.028 partikel/ind. (Salpidae) dan meningkat sepanjang rantai makanan planktonik. Penurunan kelimpahan MP dalam sistem pencernaan zooplankton adalah signifikan dari zooplankton karnivor ke omnivor dan herbivor. Ini menunjukkan pengaruh tingkah laku pemakanan zooplankton terhadap kehadiran MP dalam rantai makanan. Komposisi MP dalam lapisan air dan dalam sistem pencernaan zooplankton adalah konsisten dan didominasi MP berjenis fiber lutsinar. Sembilan daripada 12 polimer yang dikenalpasti adalah polimer berketumpatan tinggi, di mana ia didominasi oleh MP berjenis polyethylene terephthalate (PET) dengan kelimpahan PET sebanyak 55.6% (dalam lapisan air) dan 23.1% (dalam sistem pencernaan zooplankton). Kehadiran polimer yang berbeza ketumpatan dalam zooplankton menunjukkan kecenderungan kehadiran MP dalam sistem pencernaan zooplankton disebabkan oleh tingkah laku migrasi vertikal. Komposisi MP yang berbeza mengikut monsoon turut dikaitkan dengan variasi suhu, hujan dan kelajuan angin sejajar dengan perubahan keadaan persekitaran semasa monsoon. Selain itu, semua parameter persekitaran menunjukkan kesan yang significant terhadap kepekatan MP dalam lapisan air (kemasinan > hujan > kelajuan angin > suhu). Didapati taburan hujan pada SWM telah meningkatkan kelimpahan MP daripada daratan (sungai dan air larian). Berdasarkan kajian lain, halaju angin yang tinggi secara relatif pada peralihan monsoon menyebabkan serakan kelimpahan MP kurang tertumpu di kawasan teluk. Namun demikian, interaksi antara kemasinan, hujan, halaju angin dan suhu air laut adalah penting dalam mengawal ketumpatan air laut dan taburan menegak MP dalam lapisan air. Kesimpulannya, kajian ini memberikan perspektif