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Seasonal variation of microplastics ingested by copepods in Jiaozhou Bay, the Yellow Sea

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Microplastic (MP) contamination is a growing threat to marine biota and ecosystems. As the dominant functional group of zooplankton, copepods are at an increased risk of MP ingestion. The seasonal change in MPs in copepods and the key environmental factors influencing the retention of MPs in copepods are largely unknown. For the first time, the characteristics of MPs in copepods across four seasons were studied in Jiaozhou Bay. The abundance, shape, size, and chemical composition of MPs in copepods were investigated, and the relationships between MP/copepod and key environmental factors were analyzed. The results reveal a significant seasonal difference in the MP/copepod in Jiaozhou Bay. The MP/copepod was 0.26, 0.23, 0.14 and 0.16 in February, May, August and November, respectively. The MP/copepod was significantly higher in winter and spring than in summer, which was possibly correlated with the lower temperature in winter and spring seasons. Seawater temperature was negatively correlated with the MP/copepod value. The MP/copepod in the area near the estuary was significantly higher than inside the bay. No significant seasonal differences were detected in the characteristics of MPs in copepods in Jiaozhou Bay. The size of MPs in copepods ranged from 90 to 2485 μm , with an average of $454 \pm 376 \mu\text{m}$. Fibers are the most risky MPs in copepods, accounting for 92% of the total. In terms of the chemical composition, a total of 20 polymers were detected from copepods in Jiaozhou Bay in four seasons. The main components were polyester and cellophane. The percentages of polyester were 29.4%, 45.5%, 41.2%, and 57.1%, and those of cellophane were 52.9%, 18.2%, 11.8%, and 28.6% in February, May, August and November, respectively. By revealing the seasonal characteristics of copepods in Jiaozhou Bay, this study provided key parameters of MPs in copepods in Jiaozhou Bay and formed an important basis for further ecological risk assessment of MPs. The chronic effects of low MP retention on copepods, the impact of fibers on copepods, and the risk assessments of MPs under different environmental conditions were recommended as the research topic for the next step to achieve an environmentally relevant risk assessment.