

Occurrence of zooplankton entangled in microplastic: in situ and laboratory studies

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Despite numerous studies on the deleterious effects of microplastics on zooplankton, little is known about entanglement of zooplankton with fiber microplastics in the marine environment. Probability in entanglement of zooplankton with microfiber was investigated in samples of zooplankton from the Korean waters and demonstrated in laboratory. Zooplankton samples were collected with a standard type net (200 μm mesh) in the Yellow Sea and a Manta-trawl with 330 μm mesh in the Jinhae bay in 2013. Averaged abundances of zooplankton and fiber microplastic ranged from 315 to 1,162 inds. m^{-3} and 2.55-4.91 particles m^{-3} in the Yellow Sea, from 102 to 281 inds. m^{-3} and 0.15-0.25 particles m^{-3} in the Jinhae bay, respectively. The average ratio of microplastic to zooplankton, indicating encounter rate, was 0.03(Yellow Sea) and 0.01(Jinhae bay) in 2013. The incidence of entangled zooplankton with microfiber was 17% in the Yellow Sea and 20% in the Jinhae bay. The entangled zooplankton were copepods (*Acartia omorii*, *Calanus sinicus*, *Centropages abdominalis*), chaetognaths (*Sagitta* sp.), cladocerans (*Penilia avirostris*) and barnacle nauplii. Fiber microplastic polymers were polyester, emery cloth, Kayocel, and cotton. Laboratory studies reproduced that the entanglement was first observed after 24 hour exposure under environmentally realistic concentration. And the entanglement clearly increased to maximum 11 individuals under the condition of 500 particles of fiber with average length of 0.86 mm and 20 individuals of *Tigriopus japonicus* for 240 hours. The impact of entanglement on zooplankton remains uncertain, but may negatively affect feeding activity, mechanical perception and avoidance behavior of zooplankton leading to survival reduction.

Keywords: entanglement, fiber microplastic, zooplankton, Yellow Sea, Jinhae bay

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