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Characterizing the plastic-associated biofilms by a multi-isotope approach: Insight from visible plastics in two contrasting coastal areas of Japan

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Plastic debris in the aquatic environment receives special attention from scientific communities, whereas the radioactivity of environmental plastic and the dynamics of plastic-associated biofilm remain largely unknown. In this study, we addressed plastic-associated biofilms and bottom sediments from two contrasting coastal areas of Japan to elucidate their characteristics and interaction with radionuclides especially radiocesium (^{137}Cs) in the environment. We also explored stable isotope (^{13}C and ^{15}N) signatures of the biofilm and sediment samples based on seasonal variations. Firstly, biofilms from field-collected plastics were extracted using an ultrasound-assisted extraction method with additional simple treatment. Obtained biofilm samples were ranging from 20.4 to 97.2 mg due to the variety in composition and collected amount of visible plastics from the research sites. A trace of ^{137}Cs was observed in biofilm with an activity concentration of 292 ± 19.4 Bq·kg^{-1} biofilm (dw) which correspond to 1.15 ± 0.08 Bq·kg^{-1} plastic (dw). The results revealed the potential interaction between plastics and ^{137}Cs within 120 km distance from the Fukushima Daiichi Nuclear Power Plant (FDNPP). Statistically significant differences in δ^{13}C and δ^{15}N signatures of biofilms among sampling seasons and locations emphasized the microbial responses against different nutrient conditions and environmental changes in the coastal ecosystem. Our results suggest the potential alteration of nutrient cycling by plastic-associated biofilms. Further evaluation considering the microbial communities in the Plastisphere is needed to demonstrate the biofilm-associated ecological processes on plastics which would advance our understanding of plastic-altered biogeochemical cycling in the aquatic environment.