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Study on Behavior and Environmental Risk of Microplastics Drifting in Coastal Waters and Open Oceans

Atsuhiko ISOBE
Kyushu University
6-1 Kasuga-koen, Kasuga, Fukuoka 816-8580, JAPAN
E-mail: aisobe@riam.kyushu-u.ac.jp

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Marine pollution due to plastic debris (including microplastics) has become a serious concern in recent years worldwide, as stated in the leaders' declaration of the G7 Elmau Summit, followed by those of the G7 Toyama and Bologna Environment Ministers' Meetings. On the basis of standardized and harmonized protocols, field surveys were conducted in the present study to quantify microplastic abundance on beaches (Kataoka et al., 2015; Hinata & Kataoka, 2016; Hinata et al., 2017), and to quantify the abundance of marine plastic debris, including microplastics, in coastal waters (Isobe, 2016; Tanaka & Takada, 2016), in marginal seas around Japan (Fig.1; Isobe et al., 2015; Uchida et al., 2016), and along a meridional transect from the Southern Ocean to Japan (Fig. 2; Isobe et al., 2017). In addition, persistent organic pollutants (POPs) included in pelagic microplastics in the ocean and microplastics littered on beaches were also investigated (Yamashita et al., 2018). Significant concentrations of microplastics found in the Southern Ocean would suggest that marine plastic pollution has spread throughout the world's oceans. The present findings raise concern about the widespread nature of marine plastic pollution, indicating that plastic-free ocean environments are increasingly rare. We attempted to reproduce the observed microplastic distribution using a numerical transport model, and to predict future microplastic abundance. Laboratory-based studies to date have suggested that marine organisms can be harmed by ingesting microplastics. However, unless the current and future microplastic abundance in ocean environments is quantified, these experimental studies may be criticized for using unrealistic densities or sparsities of microplastics. Secular variations in pelagic microplastic abundance in the Pacific Ocean from 1957 to 2066 were provided, based on a combination of numerical modeling and transoceanic surveys conducted meridionally from the Southern Ocean to Japan. Marine plastic pollution is an ongoing concern especially in the North Pacific. If there is no reduction in the amount of plastic waste, microplastic abundance in the East Asian seas and central North Pacific in the 2060s will exceed levels at which feeding has been shown to be impeded in zooplankton in laboratory experimentation. These years, it is also expected that POPs associated with microplastics will be carried into marine organisms by ingestion, and that the quantities of these POPs will exceed those associated with ingestion of oceanic plankton by the same marine organisms.

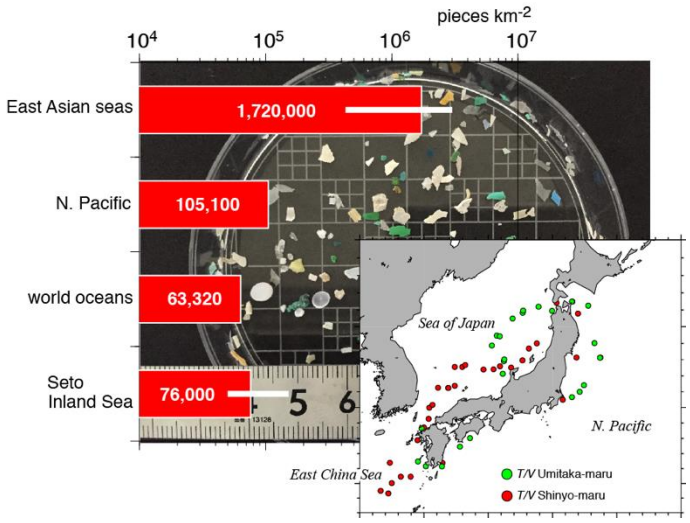

Fig. 1 Comparison of particle counts per area, computed in four regions. Particle counts are shown numerically as well as by bar heights. Locations of stations in the East Asian seas are shown in the inset map. Superimposed on the bars of the East Asian seas and Seto Inland Sea is the margin of error evaluated by a *t*-test with a 95% confidence interval.

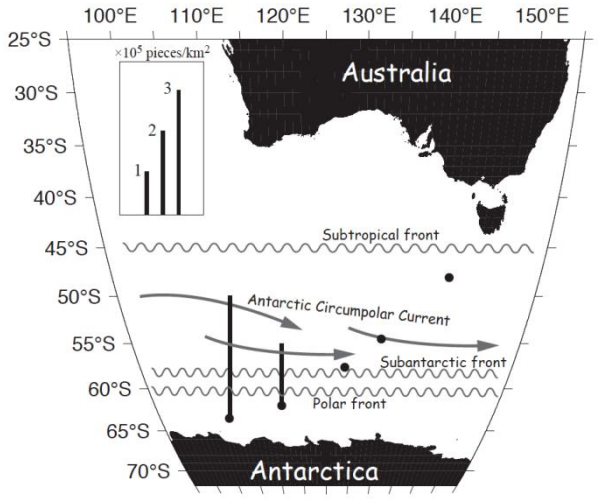

Fig. 2 Observed particle counts per area, and schematic view of oceanic conditions in the Southern Ocean. The positions of three oceanic fronts are shown by the wavy lines, and the arrows represent the Antarctic Circumpolar Current.

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