Buried Debris Inhibits the Expansion of *Zostera marina* Meadows

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ABSTRACT

Marine debris pollution is a growing environmental challenge, with substantial accumulation occurring in coastal zones that are closely associated with human activity. Previous studies have reported that epibenthic or surface-dwelling debris negatively affects seagrasses, which serve as critical foundation species in coastal ecosystems, through physical disturbance and shading that inhibits growth. However, while these impacts of visible surface debris are well-documented, the vast majority of these studies completely overlook the debris buried within the sediment, which accumulates underground where essential seagrass life-history processes occur. Many seagrasses reproduce sexually and asexually through expanding underground rhizome systems. However, buried debris may interfere with rhizome elongation and prevent asexual reproduction that also contributed to seagrass growth and meadow expansion. Therefore, evaluating the abundance of buried debris in seagrass meadows and its impacts on seagrass beds is essential. We hypothesized that the amount of buried debris increases in proportion to seagrass biomass, and that this buried debris inhibits rhizome elongation. To test this hypothesis, we conducted two field experiments in a *Zostera marina* (eelgrass) meadow located in Arikawa Bay, Nakadori Island, Nagasaki, Japan (32°98'44.42" N, 129°12'15.44" E). In experiment 1, 25 sampling plots were established at regular intervals within the meadow. We recovered all buried debris from each plot (25 cm × 25 cm area; 20 cm depth). Debris were classified into six categories; fishing gear, plastic, glass, metal, rubber, and cloth and quantified by count and dry weight. The above- and below-ground biomass of eelgrass within the excavated plots were also recorded. Buried debris was recovered from all plots (fishing gear: 121 items & 260.97 g; plastic: 298 items & 90.32 g; metal: 2 items & 4.00 g; rubber: 1 items & 0.32 g; cloth: 7 items & 1.22 g). A significant positive correlation was observed between the abundance of these fishing gears and plastic with seagrass biomass. We suggest that the *Z. marina* meadow facilitates the trapping and eventual burial of debris. In experiment 2, a section of the *Z. marina* canopy was cleared to install artificially buried debris (fishing nets and plastic sheets). Over the course of one year, we followed the changes in *Z. marina* shoot density relative to the presence or absence of each debris type every three months. Shoot density was lower in net and plastic-sheet treatments than in controls (Maximum density difference and one standard difference: Control vs. Net: 23.2 ± 27.6 ind. m^{-2}; Control vs. Vinyl 19.2 ± 36.4 ind. m^{-2}) and demonstrates that buried debris limits the expansion of seagrass shoots and reduces the potential for asexual reproduction.

Keywords: Marine debris/ Macro plastics/ Buried debris/ Seagrass ecosystem/ Environmental pollution