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A stable isotope assay for determining microbial degradation rates of plastics in the marine environment

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The popularity of plastic as a cheap and easy to use, moldable material has been growing exponentially, leading to a likewise increase in plastic waste. As a result, plastic pollution has been surging in the marine realm, and the effects and fates of these modern, man-made compounds in our oceans are unresolved. Pathways of plastic degradation (physicochemical and biological) in the marine environment are not well constrained; yet, microbial plastic degradation is a potential plastic sink in the ocean. However, there is a lack of methods to determine this process, particular if the overall turnover is in the sub-percent range. We developed a novel method based on incubations with isotopically labelled polymers for investigating microbial plastic degradation in marine environments. We tested our method with a *Rhodococcus Ruber* strain (C-208), a known plastic degrader, as a model organism. In our experiments we used granular polyethylene (PE) that was almost completely labelled with the stable isotope ^{13}C (99%) as a sole carbon source. We monitored CO_2 concentration and stable carbon isotope ratios over time in the headspace during 35-day incubations at atmospheric oxygen concentrations and found an excess production of 13C-CO_2. This result provides direct evidence for the microbially mediated mineralization of carbon that was ultimately derived from the polymer. After terminating the incubation, we measured the dissolved inorganic carbon (DIC), and pH, allowing us to determine the total excess production of 13C-CO_2 and DIC, and thus the rate of plastic degradation. Of the 2000 µg PE added, ~0.1% was degraded over a time course of 35 days at a rate of ~1.5 µg month^{-1}, providing a first characterization of the mineralization kinetics of PE by *R. Ruber*. The results show that isotopically labelled polymers can be used to determine plastic degradation rates. The method shows promise for being more accurate than the classic gravimetrical methods.