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# Modulation of Coastal $N_2O$ Dynamics via microplastics

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Coastal aquaculture systems serve as critical interfaces for microplastics (MPs), inducing important biogeochemical cycling processes, especially the modulation of nitrous oxide ($N_2O$) emission by MPs, which remains insufficiently studied. This study fills the knowledge gap by investigating the distribution of MPs and their influence on nitrogen transformation pathways across representative aquaculture sites and adjacent aquatic environments using $^{15}N$ stable isotope tracing. In comparison to adjacent waters, aquaculture ponds are typically characterized by higher polyethylene (PE) and polypropylene (PP) sources with a prevalence of fibrous particles. The adjacent sediments downstream of these aquaculture sites display a unique accumulation of polyamide (PA) and spherical pellets. Despite continuous MPs inputs, aquaculture ponds exhibit lower baseline $N_2O$ emissions than their downstream sediments. Through isotopic tracing, the fundamental $N_2O$ production pathways are primarily regulated by site-specific nutrient conditions; ammonia oxidation dominates in ponds with nitrate limitation, whereas nitrate denitrification dominates in habitats with elevated nitrate availability. Overall, the presence of MPs acts as an important factor modifying $N_2O$ dynamics, by accelerating $N_2O$ production under PA addition, and by suppressing under addition of biodegradable polybutylene succinate (PBS). As such, specific biogeochemical processes could be tied to anthropogenic particles. This work highlights the potential of utilizing biodegradable plastic as a mitigation strategy for greenhouse gas emission in managed coastal environments.