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Impacts of Biofilms on Microplastics Movement and Aggregation

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Microplastics pose significant environmental and health challenges due to their widespread presence in aquatic systems and their potential for ingestion by animals and humans. While much research has focused on the transport of microplastics, the role of biofilms in modulating microplastic transport remains underexplored. Most studies conclude that biofilms decrease microplastic transport. Here, we demonstrate that biofilms can also increase microplastic transport under certain conditions through a combination of microfluidic experiments, confocal imaging, numerical simulations, and theoretical models. We seeded a straight microfluidic channel with polystyrene microspheres and injected *Pseudomonas aeruginosa* solution into the channel. We observed that biofilms developed on the surfaces of microplastics of certain sizes under certain shear stress conditions. Furthermore, we discovered that such biofilms can reduce the critical shear stress required for beads movement by an order of magnitude. By simulating the flow field around biofilm-coated beads, we revealed that such biofilms facilitated microplastic movement by increasing both drag and lift forces. In addition to colonizing microplastic surfaces, we found that biofilms can promote the formation of aggregates by altering the trajectories of these microplastic beads, thereby increasing their encounter rate. In summary, our results demonstrate that biofilms can enhance the transport of microplastics of certain sizes as well as promote the formation of particle clusters. Our findings underscore the significant influence of biofilms on microplastic transport and aggregation and have implications for predicting and mitigating microplastic pollution.

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References

Primary author: WEI, Guanju(William) (University of Minnesota)

Co-author: YANG, Judy (University of Minnesota)

Presenter: WEI, Guanju(William) (University of Minnesota)

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