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Experimental assessment of settling velocity of pristine and biofouled microplastics

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Understanding and predicting the transport and fate of microplastics (MPs) in aquatic systems is a complex research challenge due to the simultaneous effect of different physical processes and the large variability in MPs dynamical properties. The dynamical behavior of MPs is further complicated by the development of biofilms and weathering processes. However, the effect of these processes on the dynamical properties of MPs is not fully understood. This study aims to evaluate the effect of the particle properties and biofilm on the settling velocity of microplastic sheets and fibers under laboratory conditions. The experiments focus on two types of particles (polyethylene sheets and polyester fibers), of nine sizes (between 1 and 5 mm), two degrees of biological colonization (new and aged during 3 months in the ocean) and three replicas of each type of particles. Density, size, and shape indices were first quantified. The settling velocity was then estimated by image analysis in a sedimentation column with salt- and freshwater. The dynamical behavior of the two types of particles was very different. Interestingly, the settling velocity of sheets increased with size up to a threshold in both salt- and freshwater, from which particle swinging and drag force increased, and settling velocity decreased. The effect of biofilm was also complex, increasing or decreasing the settling velocity of sheets as a result of the combined effect of the enhanced density and the biofilm distribution that influences the particle swinging. The settling velocity of fibers was independent of their length. Biofilms increased densities but their impact on settling velocity increase is less evident due to the high variability of this property for the same type of fiber. The relevance of theoretical drag models to predict the settling velocity of pristine and biofouled particles in salt- and freshwater will be also evaluated.