Observing microplastics using low-cost microscopy techniques

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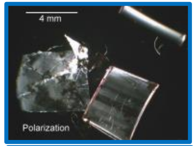
Introduction

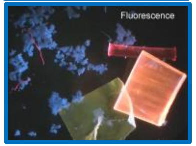
Plastic contamination at the macroscopic level is well recognized by the public (e.g. beach litter and wildlife entanglements). However, microplastics are potentially a more serious problem when they enter the food chain via filter feeders, but normally go unobserved. In a plankton monitoring program, we frequently found likely anthropogenic fragments and fibers in samples collected in the Monterey Bay. We confirmed their plastic identity using inexpensive adaptations to a basic microscope. These procedures are appropriate for teaching and outreach programs.

Collecting sample with plankton net

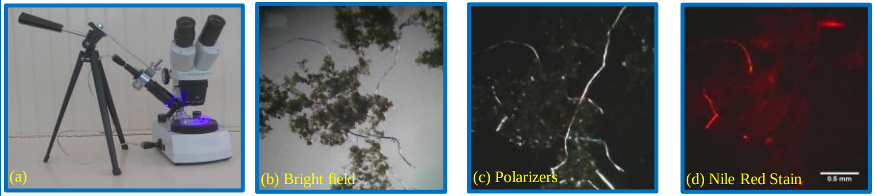
Methods

Seawater samples were examined with a microscope under bright field illumination, crossed polarizers and fluorescence excitation following Nile Red staining. These adaptations required polarizing film, a blue LED flashlight and a yellow or orange emission filter. The total cost of these add-ons is less than $100, making them accessible to schools and community scientists. Known plastic fragments (e.g. polythene, nylon and cigarette filter fibers) were tested as controls. Plastics stained with Nile Red dye emit yellow, orange or red fluorescence, depending on the hydrophobicity of the plastic. Blue arises from scattering by other detritus in the sample.





Results



(a) Microscope set-up for fluorescence detection. (b-d) Sample collected from the Santa Cruz wharf with a 20 µm mesh net. (b) Under bright field illumination, plastic fragments or fibers are sometimes distinguished from particles of natural origin by the lack of internal structure. (c) Under crossed-polarizers, plastics often stand out due to their birefringent properties. (d) Nile red staining highlights microplastic contamination by the fluorescence emission observed through an orange filter.

Conclusion

Knowing the magnitude of the environmental problem is a first step in reducing microplastic contamination. The frequency of observation in our samples suggests that the level of plastic contamination off the Santa Cruz wharf, in the size range 20 µm to 5 mm, is of the order of 100 particles per cubic meter of seawater (Labbe et al., 2020).

These methods are useful for educational activities in several different forms:

- Outreach events where the public can observe microplastics firsthand
- Schools and community scientists who have access to basic microscopes but are working with a limited budget
- Undergraduate practical classes, where the chemistry of polymer structure, birefringence and fluorescence spectroscopy can be discussed

References

- **Labbe, A. B., Bagshaw, C. R. and Uttal, L. (2020)** Inexpensive adaptations of basic microscopes for the identification of microplastic contamination using polarization and Nile Red fluorescence detection. **J. Chem. Educ. 97, 11, 4026–4032**.
- **YouTube video on Nile Red staining procedure**