Why small plastic particles may pose a big problem in the oceans

Over the past few years, scientists have begun to realize that the increasing volume of plastic materials slowly decomposing in the world's oceans may present a long-term problem for marine food chains already reeling from overfishing and other anthropogenic insults. Partly as a result of a pair of influential papers published in *ES&T*, scientists are now exploring the role that fragments of plastic trash may play in transporting marine pollutants.

The first international conference about this newly emerging "microplastics" problem was held in September and sponsored by the U.S. National Oceanic and Atmospheric Administration (NOAA). Attendees from six countries agreed to define microplastics as plastic pieces or fragments smaller than 5 millimeters. Sources of microplastics include both the small plastic particles used in products like body washes and cosmetics and the weathering of larger plastic flotsam and jetsam, says conference organizer Joel Baker of the University of Washington Tacoma, where the event was held.

Larger plastic debris tends mainly to float on the surface, but microplastics also can be found in the water column and on the seabed, says Richard Thompson, a researcher at Plymouth University (U.K.) and a coauthor of both *ES&T* papers. "This distribution, together with the smaller size, means that a wider variety of organisms could be exposed to [microplastics]," he says. Thompson has been at the forefront of developing methods to definitively identify plastic fragments as small as 20 micrometers.

As plastic items break down, any toxic additives they contain—including flame retardants, antimicrobials, and plasticizers—may be released into the ocean environment, Thompson explains. Plastics can act like sponges to collect hydrophobic persistent organic pollutants, such as PCBs, adds Holly Bamford, director of NOAA's Marine Debris Program. Microplastic particles have been shown to hold concentrations of PCBs more than 1 million times higher than those in the surrounding water, Baker says.

NOAA MARINE DEBRIS PROGRAM

Microplastic debris isn't unattractive, but research shows that it can be highly toxic.

At the recent conference, Hideshige Takada of the Tokyo University of Agriculture and Technology presented persuasive data that microplastics can impact marine food chains; the results came from a feeding experiment with streaked shearwaters, a common seabird in Japan and Australia. Takada's group, which has analyzed plastic pellets found on beaches around the world, fed chicks living in their natural environment a diet of fish laced with PCB-laden polyethylene resin pellets collected from Tokyo Bay. The pellet-consuming chicks took in up to 3 times the concentrations of lighter-weight PCB compounds, or congeners, as did chicks fed fish alone, he reported.

Takada's research buttresses laboratory data published in the *ES&T* papers. The first paper (*Environ. Sci. Technol.* **2007**, *41*, 7759−7764) used modeling experiments to show that common marine lugworms can accumulate phenanthrene, a persistent anthropogenic compound commonly found in the ocean, when microplastic particles saturated with a small amount of the contaminant are added to the sediments where the worms dwell. The second paper (*Environ. Sci. Technol.* **2008**, *42*, 5026−5031) confirmed that captive *Mytilus edulis* mussels fed microplastic fragments accumulated the plastic bits in their guts. At the September conference, Thompson and his colleagues reported that their latest work appears to confirm that contaminants can transfer from plastics to live lugworms.

Takada is currently investigating whether microplastics are exposing marine animals to phenolic compounds, including nonylphenol, octylphenol, and bisphenol A. "Ingestion of marine plastics could be a direct and important route of phenolic chemicals to higher animals such as seabirds," he says. Several studies suggest that biomagnification does not play an important role in the transfer of such endocrine-disrupting compounds to animals and birds that are higher up in the food chain, he adds.

The world now uses 230 million pounds of plastic annually, Thompson says, noting that much of this is "for one-trip packaging that is thrown out within a year of production, on average." Because the plastic that enters the ocean tends to fragment, it is likely to remain in the environment "for hundreds, if not thousands, of years," he says.

—KELLYN BETTS

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