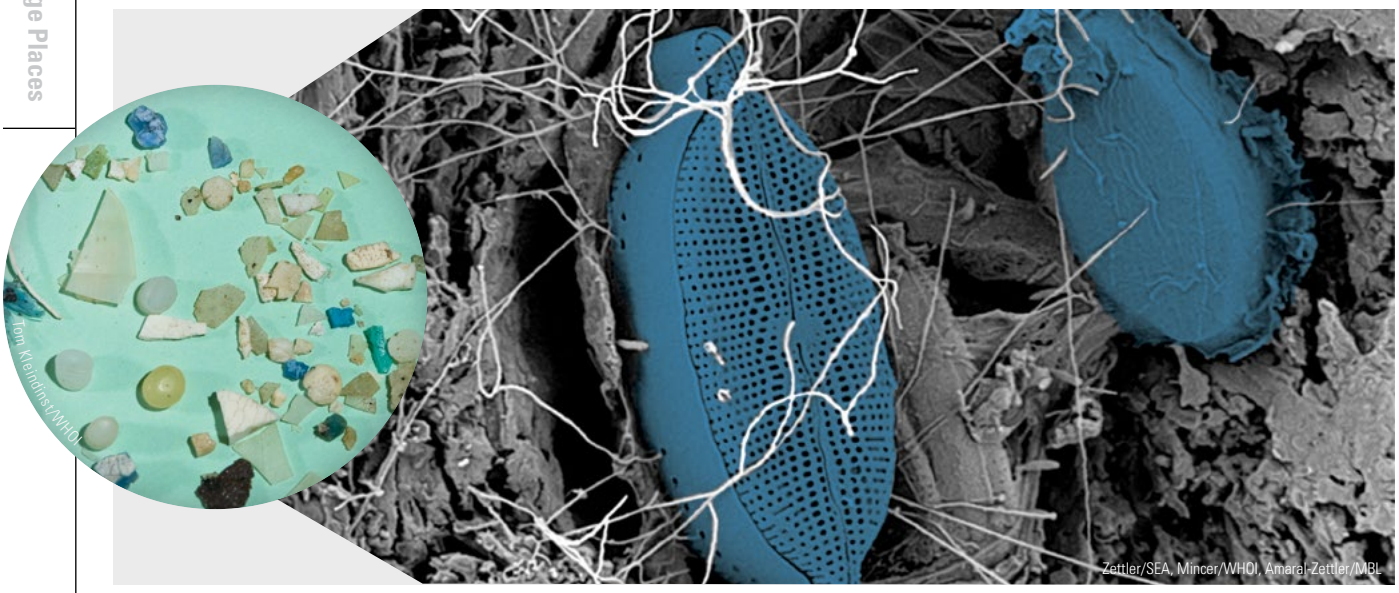
Behold the 'Plastisphere'

COLONIES OF MICROBES FLOURISH ON TINY BITS IN THE OCEAN

by Lonny Lippsett



A scanning electron microscope reveals diatoms (blue shaded) and bacteria with filamentous appendages aboard rafts of plastic flotsam.

Scientists have discovered a diverse multitude of microbes colonizing and thriving on flecks of plastic that have polluted the oceans—a vast new human-made flotilla of microbial communities that they have dubbed the "plastisphere."

In a study published July 2013 in *Environmental Science & Technology*, a team of scientists says the plastisphere represents a novel ecological habitat in the ocean and raises a host of questions: How will it change environmental conditions for marine microbes? Will it favor some over their competitors? How will it change the overall ocean ecosystem and affect larger organisms? How will it change where microbes, including pathogens, will be transported in the ocean?

The team—Erik Zettler from Sea Education Association (SEA), Tracy Mincer from Woods Hole Oceanographic Institution (WHOI), and Linda Amaral-Zettler from the Marine Biological Laboratory (MBL), all in Woods Hole, Mass.—analyzed millimeter-size fragments of plastic debris that were skimmed with fine-scale nets from the sea surface at several locations in the North Atlantic Ocean. They were collected and processed by students participating in SEA research cruises.

"We're not just interested in who's there. We're interested in their function, how they're functioning in this ecosystem, how they're altering this ecosystem, and what's the ultimate fate of these particles in the ocean," Amaral-Zettler said. "Are they sinking to the bottom of the ocean? Are they being ingested by other organisms? If they're being ingested, what impact does that have?"

Using scanning electron microscopy and gene sequencing techniques, they found at least 1,000 different types of bacterial cells on the plastic samples, including many species yet to be identified. The colonies included plants, algae, and bacteria that manufacture their own food (autotrophs), animals and bacteria that feed on them (heterotrophs), predators that feed on these, and other organisms that establish symbiotic relationships. These complex communities exist on plastic bits hardly bigger than the head of a pin, and they have arisen with the explosion of plastics in the oceans in the past 60 years.

"The organisms inhabiting the plastisphere were different from those in surrounding seawater, indicating that plastic debris acts as artificial 'microbial reefs,' " Mincer said. "They supply a place that selects for and supports distinct microbes to settle and succeed."

These communities are likely different from those that settle on naturally occurring floating material such as feathers, wood, and algae, because plastics offer different conditions, including the capacity to last much longer without degrading.

On the other hand, the scientists also found evidence that microbes may play a role in degrading plastics. They saw microscopic cracks and pits in the plastic surfaces that they suspect were made by microbes embedded in them, as well as microbes possibly capable of degrading hydrocarbons.

"When we first saw the 'pit formers' we were very excited, especially when they showed up on multiple pieces of plastic of different types of resins," said Amaral-Zettler. "Now we have to figure out what they are by genetically sequencing them and doing experiments."

The plastic debris also represents a new mode of transportation, acting as rafts that can convey harmful microbes, including disease-causing pathogens and harmful algal species. One plastic sample they analyzed was dominated by members of the genus *Vibrio*, which includes bacteria that cause cholera and gastrointestinal maladies. ▲

This project was funded by the National Science Foundation and a pilot award from the Woods Hole Center for Oceans and Human Health.