Name: _____ Class: _____

Tiny Plastic, Big Problem

Scientists find that tiny pieces of plastic travel great distances, threatening the ocean ecosystem

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2015

When plastic was invented at the turn of 20th century, it was lauded as a miraculous new material that could be used to create innumerable products. Few could have recognized the impact that plastic would have on our world – particularly in our oceans – over the course of a century. As you read, take notes on the problems that plastic has caused in the oceans and the potential solutions to them.

[1] Plastic bottles lying in the gutter. Grocery bags tangled in branches. Food wrappers scuttling across the ground on a windy day. Although such examples of litter easily come to mind, they only hint at the serious and growing problem of plastic pollution — a problem mostly hidden from view.

"Microplastics IIb - Beach Clean up - 25g plastics / 22m That's 638KG along the Oregon Coast" by Wolfram Burner is licensed under CC BY-NC 2.0.

The problem with plastics is they do not easily degrade.[1] They may break down, but only into smaller pieces. The smaller those pieces get, the more places they can go.

Many pieces wind up at sea. Tiny bits of plastic float throughout the world's oceans. They wash up on remote[2] islands. They collect in sea ice thousands of kilometers from the nearest city. They even meld with rock, creating a whole new material. Some scientists have proposed calling it plastiglomerate (pla-stih-GLOM-er-ut).[3]

Exactly how much plastic is out there remains a mystery. Scientists are hard at work trying to find out. So far, though, experts haven't found as much plastic floating in the oceans as they expected. All that missing plastic is worrisome, because the smaller a plastic bit becomes, the more likely it will make its way into a living thing, whether a tiny plankton or an enormous whale. And that may spell some real trouble.

1. **Degrade** ***(verb):*** to break down
2. **Remote** ***(adjective):*** far away from the main population; distant or isolated
3. "Plastiglomerate" is a name some scientists have proposed for a category of rock created when plastic melts and fuses with chunks of stone, shell or other materials to create a long-lasting record of human pollution.

Into the soup

[5] Plastics are used to make countless everyday products — from bottles to auto bumpers, from homework folders to flowerpots. In 2012, 288 million metric tons (317.5 million short tons) of plastic were produced worldwide. Since then, that amount has only grown.

Just how much of that plastic winds up in the oceans remains unknown: Scientists estimate about 10 percent does. And one recent study suggests as much as 8 million metric tons (8.8 million short tons) of plastic wound up in the ocean in 2010 alone. How much plastic is that? "Five plastic bags filled with plastic for every foot of coastline in the world," says Jenna Jambeck. She's the researcher from the University of Georgia, in Athens, who led the new study. It was published February 13 in *Science*.

Of those millions of tons, as much as 80 percent had been used on land. So how did it get into the water? Storms washed some plastic litter into streams and rivers. These waterways then carried much of the trash downstream to the sea.

The other 20 percent of plastic ocean trash enters the water directly. This debris includes fishing lines, nets and other items lost at sea, dumped overboard or abandoned when they become damaged or are no longer needed.

Once in the water, not all plastics behave the same way. The most common plastic — polyethylene terephthalate (PAHL-ee-ETH-ill-een TEHR-eh-THAAL-ate), or PET — is used to make water and soft-drink bottles. Unless filled with air, these bottles sink. This makes PET pollution tough to track. That's especially true if the bottles have drifted to the ocean depths. Most other types of plastic, however, bob along the surface. It's these types — used in milk jugs, detergent bottles and Styrofoam — that make up the abundance of floating plastic trash.

[10] Abundant, indeed: Evidence of plastic pollution abounds across the world's oceans. Carried by circular currents called gyres (JI-erz),[4] discarded pieces of plastic can travel thousands of kilometers. In some areas, they amass in huge quantities. Reports on the largest of these — the "Pacific Garbage Patch" — are easy to find online. Some sites report it to be twice the size of Texas. But defining the actual area is a difficult task. That's because the garbage patch is actually quite patchy. It shifts around. And most of the plastic in that area is so tiny that it's hard to see.

Millions of tons... gone missing

Recently, a group of scientists from Spain set out to tally just how much plastic floats in the oceans. To do so, the experts traveled the world's oceans for six months. At 141 locations, they dropped a net into the water, dragging it alongside their boat. The net was made of very fine mesh. The openings were only 200 micrometers (0.0079 inch) across. This allowed the team to collect very small bits of debris.[5] The trash included particles called *microplastic*.[6]

4. A ringlike system of ocean currents that rotate clockwise in the Northern Hemisphere and counterclockwise in the Southern Hemisphere. Many of the biggest gyres have become collection sites for floating long-lived trash, especially plastic.
5. **Debris** ***(noun):*** scattered pieces of waste or remains
6. A small piece of plastic, 5 millimeters or smaller in size. Microplastics may have been produced at that small size, or their size may be the result of the breakdown of water bottles, plastic bags or other things that started out larger.

The team picked out the plastic pieces and weighed the total found at each site. Then they sorted the pieces into groups based on size. They also estimated how much plastic might have moved deeper into the water — too deep for the net to reach — due to wind churning[7] up the surface.

What the scientists found came as a complete surprise. "Most of the plastic is lost," says Andrés Cózar. This oceanographer[8] at the Universidad de Cádiz in Puerto Real, Spain, led the study. The amount of plastic in the oceans should be on the order of millions of tons, he explains. However, the collected samples lead to estimates of just 7,000 to 35,000 tons of plastic floating at sea. That's just one-hundredth of what they had expected.

Most plastic that Cózar's team fished out of the seas was either polyethylene[9] or polypropylene.[10] These two types are used in grocery bags, toys and food packaging. Polyethylene is also used to make microbeads. These tiny plastic beads can be found in some toothpastes and facial scrubs. When used, they wash down the drain. Too small to be trapped in filters at wastewater treatment plants, microbeads continue to travel into rivers, lakes — and eventually down to the sea. Some of this plastic would have been too small to have been caught in Cózar's net.

[15] Most of what Cózar's group found were fragments broken from larger items. That comes as no surprise.

In the oceans, plastic breaks down when it's exposed to light and wave action. The sun's ultraviolet (UV) rays weaken the otherwise strong chemical bonds within the plastic. Now, when waves smash the chunks against each other, the plastic breaks into smaller and smaller pieces.

When the Spanish team began sorting its plastic by size, the researchers expected to find larger numbers of the very smallest pieces. That is, they figured that most of the plastic should have been tiny fragments, measuring just millimeters (tenths of an inch) in size. (The same principle applies to cookies. If you were to smash a cookie, you would wind up with many more crumbs than you would large pieces.) Instead, the scientists found fewer of these tiny bits of plastic.

What had happened to them?

Entering the food web

Cózar proposes several possible explanations. The tiniest bits might have broken down quickly into particles too small to catch in his net. Or maybe something caused them to sink. But a third explanation seems even more likely: Something ate them.

7. to break up the surface of an area or ground
8. Someone who works in the field of oceanography, or the branch of science that deals with the physical and biological properties and phenomena of the oceans.
9. A plastic made from chemicals that have been refined (produced from) crude oil and/or natural gas. The most common plastic in the world, it is flexible and tough. It also can resist radiation.
10. The second most common plastic in the world. It is tough and durable. Polypropylene is used in packaging, clothing and furniture (such as plastic chairs).

[20] Unlike the organic matter found in living things, plastics do not provide energy or nutrients[11] to growing animals. Still, critters do eat plastic. Sea turtles and toothed whales gulp down plastic bags, mistaking them for squid. Sea birds scoop up floating plastic pellets, which can resemble fish eggs. Young albatross have been found dead from starvation, their stomachs full of plastic garbage. While feeding, adult seabirds skim floating trash with their beaks. Parent birds then regurgitate[12] the plastic to feed their young. (These plastic bits eventually can kill them.)

Yet such large animals wouldn't eat pieces just millimeters in size. Zooplankton[13] might, however. They are much smaller marine[14] creatures.

"Zooplankton describe a whole range of animals, including fish, crab and shellfish larvae," explains Matthew Cole. He is a biologist at the University of Exeter in England. Cole has found that these tiny critters are just the right size to snap up the millimeter-size bits of plastic.

His research team has collected zooplankton from the English Channel. In the lab, the experts added polystyrene[15] beads to tanks of water holding the zooplankton. Polystyrene is found in Styrofoam and other brands of foam. After 24 hours, the team examined the zooplankton under a microscope. Thirteen of the 15 zooplankton species had swallowed the beads.

In a more recent study, Cole found that microplastics limit the ability of zooplankton to consume food. Zooplankton that had swallowed polystyrene beads ate smaller bits of algae. That cut their energy intake nearly in half. And they laid smaller eggs that were less likely to hatch. His team published its findings January 6 in *Environmental Science & Technology*.

[25] "Zooplankton are very low on the food chain," Cole explains. Still, he notes: "They are a really important food source for animals like whales and fish." Reducing their population could have a widespread impact on the rest of the ocean ecosystem.

And, it turns out, not just tiny zooplankton are eating the plastic bits. Larger fish, crabs, lobster and shellfish do too. Scientists have even found plastic in the guts of marine worms.

Once there, the plastic tends to stick around.

In crabs, microplastics remain in the gut six times longer than food does, says Andrew Watts. He is a marine biologist[16] at the University of Exeter. What's more, eating plastic causes some species, such as marine worms, to store less fat, protein and carbohydrate, he explains. When a predator (such as a bird) now eats those worms, it gets a less nutritious meal. It also ingests the plastic. With each meal consumed, more and more plastic makes its way into a predator's body.

11. vitamins, minerals, fats, carbohydrates and proteins that are needed by organisms to live and comes mainly from one's diet
12. to vomit or throw up
13. Small organisms that drift in the sea. Zooplankton are tiny animals that eat other plankton. They also serve as an important food source for other marine creatures.
14. having to do with the ocean or sea
15. A plastic made from chemicals that have been refined (produced from) crude oil and/or natural gas. Polystyrene is one of the most widely used plastics, and an ingredient used to make styrofoam.
16. A marine biologist is a scientist who studies creatures that live in ocean water, from bacteria and shellfish to kelp and whales.

That's cause for concern. "Plastics might pass up the food chain," says Cole, "until it gets into food that ends up on our own dinner plates."

An accumulating problem

[30] The thought of eating plastic isn't pleasant. But it isn't just the plastic that's cause for concern. Scientists also worry about a variety of chemicals found on the plastic. Some of those chemicals come from the manufacturing process, explains Kara Lavender Law. She is an oceanographer at the Sea Education Association in Woods Hole, Mass.

Plastics also attract a variety of dangerous pollutants,[17] she notes. That's because plastic is hydrophobic — just like oil, it repels water.

But plastic, oil and other hydrophobic substances are attracted to each other. So oily contaminants tend to glom onto pieces of plastic. In a way, plastic acts like a sponge, soaking up hydrophobic contaminants. The pesticide DDT[18] and polychlorinated biphenyls[19] (or PCBs) are two such toxic[20] contaminants that have been found in ocean-going plastics.

Even though both contaminants have been banned for decades, they are slow to break down. So they persist in the environment. To this day, they hitch a ride on trillions of pieces of plastic floating in the oceans.

One reason these contaminants were banned is because of the way they affect animals and people. When eaten, the chemicals work their way into an animal's tissues. And there they stay. The more of these chemicals a critter consumes, the more that gets stored in its tissues. That creates a constant exposure to the pollutants' toxic effects.

[35] And it doesn't stop there. When a second animal eats that first critter, the contaminants move into the new animal's body. With each meal, more contaminants enter its tissues. In this way, what had started as trace amounts of a contaminant will become increasingly concentrated as they move up the food chain.

17. A substance that taints something — such as the air, water, our bodies or products. Some pollutants are chemicals, such as pesticides. Others may be radiation, including excess heat or light. Even weeds and other invasive species can be considered a type of biological pollution.
18. DDT is short for dichlorodiphenyltrichloroethane. This toxic chemical was for a time widely used as an insect-killing agent. It proved so effective that Swiss chemist Paul Müller received the 1948 Nobel Prize (for physiology or medicine) just eight years after establishing the chemical's incredible effectiveness in killing bugs. But many developed countries, including the United States, eventually banned its use for its poisoning of non-targeted wildlife, such as birds.
19. A family of 209 chlorine-based compounds with a similar chemical structure. They were used for many decades as a nonflammable fluid for insulating electrical transforms. Some companies also used them in making certain hydraulic fluids, lubricants and inks. Their production has been banned in North America and many countries throughout the world since around 1980.
20. **Toxic** ***(adjective):*** containing poisonous substances

Whether contaminants hitching a ride on plastic work their way into the body tissues of marine animals in the same way remains unknown. But scientists are concerned that they might. Just how much of these chemicals in marine organisms came from eating contaminated plastic and how much from eating contaminated food is a big question, says Law. And no one yet knows whether the problem affects people.

Managing microplastics

The very nature of microplastics makes cleanup impossible. They are so tiny and so widespread that there is no way to remove them from the seas, notes Law.

The best solution is to prevent more plastic from reaching the ocean. Trash traps and litter booms can snag garbage before it enters waterways. Even better: Reduce plastic waste at its source. Be aware of packaging and buy items that use less of it, Law suggests. Skip the plastic bags, including zippered ones used for foods. Invest in reusable water bottles and lunch containers. And say no to straws.

Law also recommends asking restaurants to stop using polystyrene foam containers. These break up quickly and are not recyclable. Talk to friends and parents about the problems of plastic, and pick up litter when you see it.

[40] Law recognizes that reducing plastic use won't be an easy change. "We live in an era of convenience," she says. And people find it convenient to throw things away when they are done with them.

That's not to say that we should do away with plastic altogether. "Plastic has a lot of beneficial uses," says Law. But people need to stop looking at plastic as disposable, she argues. They need to view plastic items as durable things to hold on to and reuse.

Text-Dependent Questions

Directions: For the following questions, choose the best answer or respond in complete sentences.

1. In your own words, summarize the central ideas of this article:.

2. What is the purpose of paragraph 1?
    A. to make readers curious about the “hidden” pollution
    B. to introduce the topic of pollution on the ground and in trees
    C. to argue that pollution on land is a more serious problem than pollution in the ocean
    D. to claim that pollution is becoming harder to see because people are ignoring it

3. Based on the information in paragraph 4, what is the likely reason why experts have found less plastic floating in the ocean than they expected? Cite evidence from the text.

4. PART A: As it is used in paragraph 10, the word “abundant” most closely means:
    A. dangerous
    B. minimal
    C. challenging
    D. widespread

5. PART B: Which phrase best provides support for your answer to Part A?
    A. “plastic pollution”
    B. “across the world’s oceans”
    C. “circular currents”
    D. “difficult task”

6. What is the purpose of paragraphs 22-23?
    A. to prove that zooplankton consume as much plastic as other species of sea animal even though they are extremely small
    B. to provide support for the theory that scientists cannot find much of the missing plastic because it was likely consumed by organisms in the ocean
    C. to argue that sea animals would be less likely to consume plastic if people could prevent them from breaking down into smaller particles
    D. to show that most zooplankton will not consume plastic particles if they are exposed to them

7. Which of the following is an inference based on the information in the section “Entering the Food Web”?
    A. If humans continue to pollute the ocean with plastic, it could have serious effects on the ocean’s food chain and beyond.
    B. The plastic particles that end up in the ocean will be so degraded and small that they will not have a significant effect on the animals that might consume them.
    C. Many sea animals will likely learn to avoid consuming plastic so that it does not affect their health.
    D. Sea animals are being forced to eat more plastic particles because their natural food supply is decreasing.

8. As it is used in paragraph 32, infer the meaning of the word “glom.”

9. Based on the information in paragraphs 32-34, how did the banned substances DDT and PCBs end up in the ocean? Cite evidence in your answer.

10. Explain 2 or more ways people can help prevent further pollution of the ocean with plastic.

Discussion Questions

Directions: Brainstorm your answers to the following questions in the space provided. Be prepared to share your original ideas in a class discussion.

1. In your opinion, are many people aware of the amount of plastic in the ocean? Why or why not? What can you do to spread awareness of this issue?

2. What are some potential solutions you could foresee for solving this plastic problem? What can you do on a daily basis to reduce plastic waste?

3. In the context of this article, what are the costs and benefits of plastic and plastic-related technology? How has plastic had a positive or a negative influence on your life? Use evidence from this text, your own experience, and other news, literature, art or history in your response.