Plastic in the Ocean: A Report on What It Is and a Short Survey on Miyazaki's Seashore

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Abstract

Plastic in the ocean is an environmental issue that has been gaining attention in recent years. It not only affects marine habitats, but ingestion or entanglement can also kill marine life. The final destination of plastic waste is not yet known, but some researchers believe that such debris may be entering our food chain as plastic molecules are broken down and absorbed by marine life. In this study, we are going to discuss some of the effects that plastic in the ocean may have on marine environment and how it may be entering our food chain. Finally, we surveyed a local beach in order to verify the ratio of plastic within the litter found on the shore and found out that most of it was in fact plastic-related.

Keywords: *plastic in the environment, ocean pollution, marine debris, sea life endangerment*

Introduction

In 1997, Charles Moore discovered the Great Pacific Garbage Patch, which is composed of marine debris in the North Pacific Ocean. Marine debris is characterized as garbage found in the ocean or other large bodies of water (National Geographic 2014) that ultimately have been washed away from land and ends up in ocean gyres, which have slow-moving centers that collect plastic and other debris (Environmental Cleanup Coalition 2014). Greenpeace, in its 2006 report, and other researchers have been warning about how marine debris is hurting both humans and marine life, affecting habitats, killing animals, and as we will later discuss, possibly entering our own food chain.

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Habitat Pollution

Marine habitats today are greatly affected by human generated waste that is regularly found floating in the ocean. The most commonly found waste is plastic. It has been discovered that eighty-percent of plastic in the marine debris found in the ocean comes from land, through beaches, streets and highways (Allsopp et al. 2006). Also, according to the Environmental Health News "plastic buried deep in landfills can leach harmful chemicals that spread into ground water" (Environmental Health News 2009), that ultimately flow out to the ocean. This plastic have been corrupting the marine animals' habitats in terms of food ingestion, causing them to mistakenly ingest the non-nutrient and toxic materials floating on the ocean or use it as parts of their nests. Although the final destination of plastic debris is unknown, Song et al. (2009) pointed to the fact that the low temperatures found in the oceans will reflect in slower degradation. That idea leads us to infer that the length of time required for some plastic products, such as plastic bottles and fishing line, to be completely broken down in the ocean is longer than most human and animal life spans. What makes us think that, which such long lifespan, pieces of plastic swallowed by a marine animals can return to the ocean after the dead body of the animal has decomposed, continuing to pollute.

Habitat pollution problems do not end with direct impact to species, but also indirect. Floating plastic waste can be used by invasive species as rafts for transportation into habitats where they do not naturally exist (Mayell 2002). This causes the possibility of another species colonizing other habitats and competing for the food available in the area. It shows that plastic waste can change natural habitats of humans and animals over long periods of time.

Marine Life Mortality

Particles of plastic and plastic nets play a great role in marine animal mortality and sea turtles are an example of species that have been affected by plastic debris. In 1980 researchers have found that 30% of sea turtles had swallowed plastic debris, but in 2012 50% of turtles were found to have ingested it (Schuyler et al., 2014). This, according to the researchers, shows that the amount of the debris in the ocean has been increasing. Once turtles see the plastic bags floating in the ocean, they confuse it with food (e.g. jellyfish). Ingesting plastic may block turtles' stomachs and lead to death by starvation and malnutrition. In addition, there is already evidence that toxic chemicals that are incorporated to plastic during manufacture, like bisphenol-A (BPA) and phthalate, can be released to humans through plastic containers and toys. Both chemicals have shown to affect marine life in different ways during laboratory studies (Thompson et al. 2011).

Fig. 1 - A decaying plastic bag resembling a jellyfish - which happens to be one of sea turtles favorite food (By seegraswiese (Own work) [CC-BY-SA-3.0 (http://creativecommons.org/licenses/by-sa/3.0)], via Wikimedia Commons)

Other materials that have plastic in their composition are also harmful to sea animals. Among those, fishing nets are one of the most harmful products when thrown away in the ocean or involuntarily lost by fishermen. Large marine animals such as turtles, seals, and whales have been entangled in the nets (Laist et al. 1997). When an animal is trapped, the net limit their movements, preventing them from catching food, escaping from their predators and even resurfacing to breathe, causing death by drowning. Even if an animal succeeds in escaping from the net, it could be injured leading to infection and eventual death (Poiner et al. 1996).

Not only fish, but also predatory birds can be entangled and dragged into the ocean while they hunt for their food (Miljö, A. 2001). As oceans have currents, these discarded plastic nets travel around the world and keep trapping the animals in what is called ghost net fishing. In addition, the movement of the nets drag and tear coral reefs off from the ocean floor causing loss of habitats for smaller marine animals and plants. Plastic debris is harming animals that live both in and near the ocean.

Food Chain

It was previously believed that it took high temperatures and dozens of years for plastic to break down, but studies have shown that plastic starts decomposing even in lower temperatures within a year (Barry 2009; Andrady 1989), leaving toxic substances in the sea. The amount of time a specific piece of plastic takes to completely decompose may vary according to size and manufacture process, but it is important to notice that, as mentioned before, when plastic starts to decompose it can leave toxic chemicals behind that will affect marine life in various ways. In addition, plastic waste in the oceans absorb other chemicals from present in the ocean making plastic in the ocean an actual toxic “sponge” (Teuten et al. 2009).

Many marine animals, including seabirds, have been found to eat plastic, but now it is known that they are consuming the chemicals from the dissolved plastic as well (Tanaka et al. 2013). These chemicals are known to cause cancer in humans, which raises questions as to whether smaller animals will be more susceptible to their effects. Also, toxins such as mercury can travel up the food chain and large fatty fish like tuna can have higher concentrations of it in their body. In order to understand how plastic plays a role in the toxins moving up the food chain, one study tested a Japanese fish called medaka by adding plastic to their diet (Rochman et al. 2013). One group of fish ate normal fish food, another group's diet consisted of 10% "clean" plastic, and another group's diet was made up of 10% "dirty" plastic that had been floating in the San Diego Bay for several months. It was found that the fish that ingested plastic absorbed the toxins through their stomachs and were more likely to have tumors or liver problems.

Fig. 2 - Pollution swan. (Licensed under Public domain via Wikimedia Commons, http://commons.wikimedia.org/wiki/File:Pollution_swan.jpg)

Fig. 3 - Laysan albatross chick remains (Licensed under Public domain via Wikimedia Commons, http://commons.wikimedia.org/wiki/File%3ALaysan_albatross_chick_remains.jpg)

For some time, researchers had speculated about toxins being absorbed by fish (Derraik 2002; Katsanevakis 2010) but the medaka study confirmed what many had feared. There is now a concern about humans consuming toxic fish, as it is impossible to know how much plastic a certain fish has consumed. This is especially true in the United States where only a small portion of imported fish are tested for contaminants (GAO 2012).

Effects in our Local Area

In 1986 a Texan and former member of the Ocean Conservancy organized a beach cleanup along the Texan coast. This effort soon spread globally as Canada and Mexico held cleanups in 1989. This International Coastal Cleanup aims to centralize information about cleanups in a

global scale, asking volunteers around the world to share their data. In 2014, 92 countries were participating in the cleanup (Ocean Conservancy,2014) and their report (which contains data from the cleanup performed September 20, 2013), shows that more than 5,592,490 kilograms of garbage was collected over 20,783 kilometers of shore line. Unfortunately, due to time constraints[1], we were unable to participate more actively in the International Coastal Cleanup, but we were able to go to a local beach and collect data on the rubbish found on the shore.

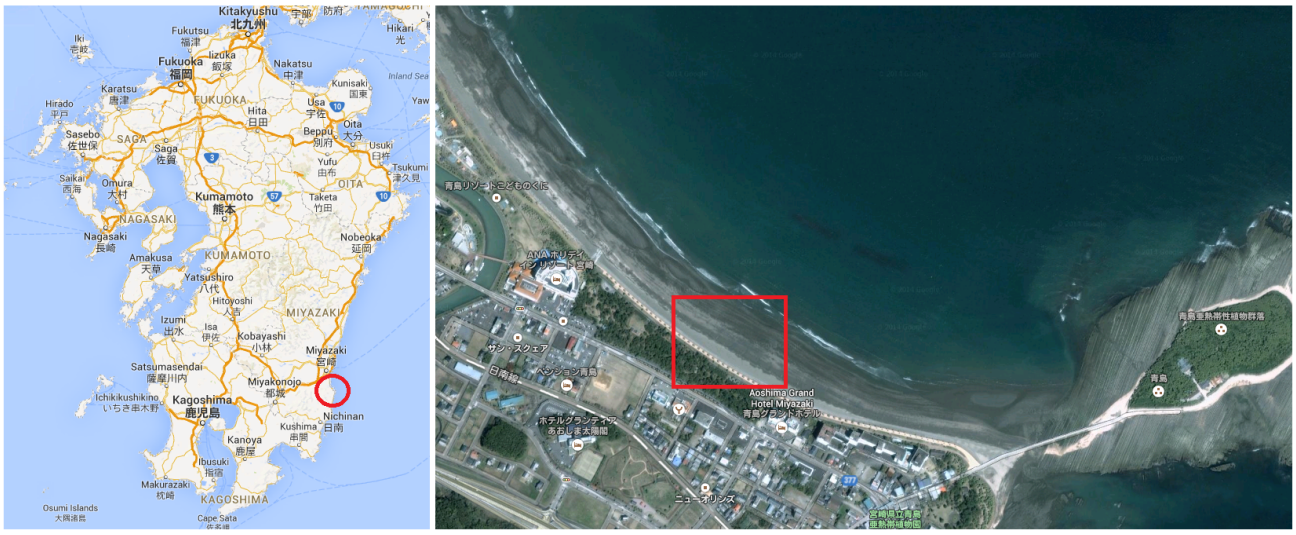

Fig. 4 - Location of Aoshima beach in Kyushu, Japan (left) and detailed view of the surveyed area (right)

[1] The International Coastal Cleanup is held every year on September 20. Our research deadline was set to July 15, 2014, what made impossible for us to organize an institution wide volunteer group.

Fig. 5 - Bottle caps and beverage bottles were the most common items in the surveyed area

Data Collection

Our group went to Aoshima beach, located in Miyazaki, Japan (31.8050° N, 131.4757° E). There, we used the same data form used by the Ocean Conservancy[2] to catalog all kinds of rubbish we could find. Also, due to the fact that our data collection group counted with only 4 people, the total area covered by our group was restricted to around 48m^2.

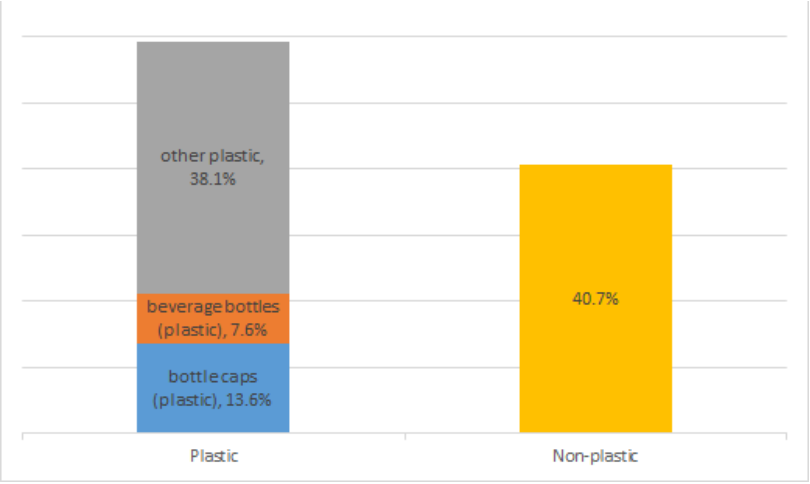

Fig. 6 – Ratio of plastic and non-plastic rubbish found during data collection

[2] http://www.oceanconservancy.org/our-work/international-coastal-cleanup/data-form.pdf, retrieved on June 13, 2014

Bottles and bottle caps comprised most of the plastic rubbish found by our group coming only after foam packaging. Most of the foam packaging found were food containers used by Japanese people to store ready-to-eat meals. Looking at the non-plastic related rubbish, we found an amazing quantity of fireworks material what lead us to think that most of the rubbish found by our group didn't come through sea currents but were probably brought and disposed of by visitors to the beach.

Finally, looking at the ratio of plastic and non-plastic litter found by our group, 59.3% of all rubbish cataloged was plastic or plastic related, which reflects Ocean Conservancy' findings. In addition, it is safe to assume that, once the littler is washed away into the ocean, the plastic will start its pollutant-cycle by killing direct or indirectly sea animals and birds.

Discussion and Future Directions

Though the immediate effects of pollution on marine life are evident, the long-term consequences of plastic pollution are still unclear. Some researchers argue that there is a risk that plastic will make a permanent imprint on our planet (Nuwer, 2014 & Corcoran et al. 2014), leaving its traces for generations to come. Whether or not this happens, humanity is responsible for taking care of the environment that it depends on. Just as it is a good practice to keep our houses clean, taking care of the environment should not be a chore.

Some possible solutions have been proposed for the plastic problem. Recycling definitely could be an effective solution because by reducing the possibility of plastics thrown away we would be reducing the amount of debris in the oceans. Also, improving recycling technology and making clear policies of how and why recycling is a vital activity to the public can also be effective measures. Offering incentives for recycling could be another method of

encouraging more people to take care of the plastic. Another solution that has been proposed is a method to clean up the plastic that is already in the ocean (The Ocean Cleanup 2014) .A collection of floating barriers would trap debris as the ocean currents push under them. The barriers are solid rather than nets, so marine life can swim around them without being caught. It is understandable that such method would take a long time to show itself effective but implementation of both would undeniably help to reduce the impact that plastic pollution in the ocean have on marine life and, probably, on human life as well.

We hope we can organize an institution-wide activity in the near future and help providing data to the Ocean Conservancy for the International Coastal Cleanup. We would also like to raise people's awareness as to how not only plastic, but garbage in general affects marine life and our lives. This would hopefully encourage people to volunteer for cleanup activities and raise awareness of plastic disposal methods in their local communities.

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