

The Life of Plastic

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Introduction

Since their invention in the 1950's plastics have been a stain on the planet, and most of the plastics that we have ever created have been discarded by either being thrown away, incinerated, or recycled. There are plenty of papers on the havoc that plastics wreak on the environment, but few rarely discuss the topic of how it ends up affecting the underwater life of oceans and tributaries, how it affects *human* health, and what happens to the plastics that are not recyclable. If you have ever looked hard enough at a piece of plastic or Styrofoam, you will see a number inside of a discontinuous triangle; this is the number associated with the type of plastic it is and how it can be recycled. However, if you have ever looked at the top of a recycling bin, you may notice that the number on that piece of plastic is not actually allowed to be recycled in that bin; most of this plastic ends up either in landfills or the ocean. This literature review will cover a few of the topics that may not be regularly brought to attention.

Life of Plastics

If someone were to be able to travel in time back to the early 1950's when plastic was invented, and ultimately began mass production, asking someone in that time period if they thought that plastics were going to wreak havoc on the ocean and the health of humans, they would probably just shrug it off. Now, there is irrefutable evidence that plastics have affected the ocean and health of humans, mainly because it affects marine life. The total amount of plastics produced since its invention is approx. 8300 million metric tons (Geyer, Jambeck, Lavender Law et al. 2017). Most of the plastics that have been produced are no longer in use and the average amount of time that any given piece of plastic is in use spans a range based on the category of plastic with the most used type of plastic being packaging, which has an average use of one to five years. The category with the longest lifespan is building and construction with an average of

thirty to forty years. After that use lifespan, plastic is disposed of in one of three methods: recycling, incineration, or just by being thrown in the garbage with other waste. Both recycling and incineration have their own downfalls, however, throwing away plastics into a waste bin to be dumped in a landfill provides time for that piece of plastic to break down and end up in rivers and oceans. After it ends up in rivers or the ocean, those microplastics can be swallowed by fish and other marine life.

It is irrefutable that seafood is part of many diets across the globe, and as such, it should be brought to attention that the consumption of microplastics by humans have a factor on their respective health. In a study done on global consumption of microplastics, it was found that on average the amount of microplastics found in seafood was 1.48 MP/gram (Cox, Covernton, Davies, Dower, Juanes, Dudas et al. 2019). The aforementioned article is a study on the human consumption of microplastics from multiple universities in British Columbia. While this may not seem very high on a global perspective, nations that are closer to ocean plastic pollution are more negatively affected, such as Japan. Seafood is a major part of Japanese diets, and on average, Japan has the highest potential consumption at 154 microplastics per day (Cox, Covernton, Davies, Dower, Juanes, Dudas et al. 2019). It is obvious that islands in the pacific, specifically near countries that pollute the most plastic into the oceans, are affected greater than other countries. This may stem from the fact that the surrounding countries do not have proper waste management policies, mainly China and India.

Even though Japan is affected by other countries' mismanagement of plastic waste, Japan has made efforts to maintain the surrounding waters and prevent plastic pollution in the ocean surrounding their country. "Japan led the way in concluding the Vision, through which G20 countries aim to reduce additional marine plastic pollution to zero by 2050." (Kojima and

Iwasaki et al. 2019). The G20 summit is a forum involving 19 countries and the EU. Japan is a part of this group of G20, along with the United States and all member countries of Europe. This was even despite the fact that Japan did not sign an agreement at the G7 summit alongside the United States, which was a discussion on similar topics as G20. Japan is negatively affected by surrounding countries, but it seems that they are willing to step up to the plate and act on the issue of ocean plastics. Other countries in the Eastern Asian Pacific area need to follow in order to prevent nations like Japan from being disproportionately affected by microplastic consumption and marine life intoxication.

Marine life is affected by different types of plastics in different ways; however, only until recently was BPA considered safe for use by humans. BPA, or Bisphenol A, is used in most of the plastics production as a hardening agent. “In 2008, the possible health risks of Bisphenol A (BPA) -- a common chemical in plastic -- made headlines. Parents were alarmed, pediatricians flooded with questions, and stores quickly sold-out of BPA-free bottles and sippy cups.” (Brennan et al. 2019). The use of BPA in plastics made general consumers slightly worried for their children, since it seems to have more of a pronounced affect on children. It is worth noting that most of the studies completed on BPA have been conducted on animals, so more studies have still yet to yield proper results on humans. BPAs are known to cause cancers, brain problems, cardiovascular problems, and all of these affects are amplified in offspring. While the effects in humans haven’t been studied thoroughly, the affects in marine life have been.

BPA and its affects can be seen in marine life, specifically in vertebrate organisms. “More recent advances were obtained in zebrafish, where it was demonstrated that the orphan nuclear estrogen-related receptor γ (ERR γ) is the mediator of BPA-induced malformation of the otoliths” (Canesi, Fabri et al. 2015). It has been determined that BPAs have caused malformation

in males, leading them to have a higher output of estrogen hormones. Experiments were done on these zebrafish with varying amounts of BPA traces up to 100 micrograms per liter of water for a total of four days. “E₂ concentrations were significantly decreased in plasma of females, while circulating testosterone levels were significantly reduced in males, consistently with a negative feedback response to an increasing estrogenic signal.” With the varying levels of BPA introduced into the water, one can imagine just how much this has an effect on actual sea life. Sea life on average contains approx. 1.48 microplastics per gram, and it can be assumed that most of the plastic that pollutes the ocean was made with BPA.

Conclusion

It is clear that laws, or the lack thereof, in countries that are polluting disproportionately must be changed. Mismanagement of waste has occurred for far too long of a timespan, and it is now time to change that. As a concerned citizen, I do not think that it is fair that only western countries and the occasional eastern country should be the only ones concerned with the pollution of plastics in the ocean and rivers. There is evidence of microplastics entering the food chain in seafood diets, and some countries are disproportionately affected by the carelessness of their surrounding countries. The underwater life of the globe's oceans matters just as much as terrestrial life and should be given equal care. If we wish to end plastic pollution, we must come together as a collection of countries and work together.

Article Review: “Human Consumption of Microplastics”

I reviewed this article for the consumption of microplastics based on seafood or marine life, as it may prove plausible to show microplastic ingestion from multiple different spectrums. The article, titled *Human Consumption of Microplastics*, is based off 27 other studies in human consumption of microplastics and food chain logistics. The article goes over the collection of data, analysis, assumptions, and results of the findings of each of the studies and comprises them into one article.

While this article goes in depth from multiple perspectives, it shows how the pollution of plastic into our rivers and oceans has true, lasting effects on our health, ecology, and economy, and this will be visible in the full literature review. The article’s research question is “What is the consumption of microplastics in humans and how does it affect human health?” There is a small weakness to this article in that it doesn’t really go in depth with the effects on human health; however, the authors do a wonderful job in showing the consumption of microplastics, and go in depth about where these microplastics come from. One such location is the ocean, from marine life.

Seafood is a major piece of many countries diets and has a large impact on the healthiness of those countries’ citizens. In Japan, citizens on average consumes approx. 105 grams per day of seafood (Cox, 2019, para. 17) and seafood is said to contain approx. 1.5x this amount in microplastics, leaving us with approx. 154 microplastics per day per citizen. Even though that number doesn’t really mean much to someone just looking for a bite to eat, that is the current level today, whereas it may have been that forty-five years ago, that number could have been 0.2x or even 0.

This article does go into the actual data collection and analysis of the research, which was done with a literature review from numerous other studies addressing airborne and foodborne microplastics in the United States and some minor other countries. Much of which is data on the rates at which microplastics are ingested through air and food. Again, I only wish to show the ingestion of microplastics from seafood and marine life, but it gives an idea of just how far this has gone, logistically. Interestingly, the ingestion of airborne microplastics was based on the respiration (breathing) rate of an individual, and was separated by gender and age category, namely the natural join of male & female, child & adult. The sizes of plastics were also collected, with seafood containing the most diverse in terms of size of plastics. Most of the plastic found in airborne and foodborne consumption is fiber-sized and is very tiny.

After data collection, the analysis and assumptions created from the data allowed the authors to show the microplastic concentrations to be separated into categories. According to the article (Cox, para. 11), the average resulting value from a variety of 60 seafood species was approx. 1.49 calories based on a 15% caloric intake, which is all that the research accounts for. This means that out of our average recommended caloric intake of 2000 calories per day, 10 calories are microplastics. After a full year, we have consumed nearly two whole days of just microplastics, which could have an effect on our health. Being mindful of the fact that this is solely from seafood, there is a possibility that this number could be far greater since the study was done with other foods and air.

Overall, I think this article would be very strong for a full literature review, simply because it meets the criteria for most of the IMRaD checklist and is from a reputable source (I had to login with my mason id). While it may not be fully about the ocean or seafood in general, it is useful for showing just how microplastics play a role in the food chain and ecology of our

world. I plan to use this article for possibly more than just this SDG paper in the future; I am a data scientist after all.

Article Review: “Sea Change: Japan Leads on marine plastic Litter”

In the wake of ocean plastic pollution, Japan has been a country that has seen fully the effects of plastics pollution in the ocean, as mentioned in my previous article review. From that review, Japan had a substantially higher amount of microplastics in their food chain since a large portion of their diet is seaborne. This article, from the East Asia Forum Quarterly, goes in depth on the reason why Japan did not join the Osaka Blue Ocean Vision, chartered by the United Nations at the G20 Summit in June 2019, according to the article (Kojima, 2019). However, even though Japan did not join the summit, they are still leading in ocean cleanup, hence the title of this magazine article.

According to this article, “Japan also developed five new recycling laws focused on packaging, home applications, food waste, construction waste and automobiles” (Kojima, 2019). Given how Japan was slated in the last article, and the positioning of their country, it comes as no surprise that they would attempt to prevent their country’s citizens from polluting the waterways even more. Asia is the top river plastic polluter in the world; however, Japan only plays a very small part in this. It is possible that the average Japanese citizen could see plastics from the shoreline that have come from other countries such as China, Vietnam and India, leaving them to clean up the mess while their fellow Asian countries pollute the waterways and ocean ever-so-rapidly.

The article also presents the idea that Japan is involving some of their resources to aid developing countries and emerging economies in the reduction of plastic waste and management

of waste. According to the article, a large point of the Japanese presidency and election was mismanagement of plastic waste, which should be true for all economies at this time, but unfortunately is not.

I plan to use this article as a way to show that even though there is a large amount of pollution and articles on pollution, there are still articles that show countries like Japan making efforts to prevent the pollution of waterways and oceans. Japan has been taking large steps in spite of their neighboring countries causing most of the havoc in the regional oceans such as the Pacific and the Indian oceans. Japan seems to have it under control, so why can't the rest of the world.

Article Review: "Production, use, and fate of all plastics ever made"

In an article written for sciencemag.org, Mr. Roland Geyer, Ms. Jenna Jamback, and Ms. Kara Lavender Law wrote a compelling piece on the lifecycle of global plastics, mentioning the production, use, and ultimate methods of disposal of plastics that were produced since the 1950s; a.k.a. the beginning of plastics production. The article contains data on the history of production of plastics, the types of plastics produced, and the methods used to dispose of plastics.

The article, written in 2017 estimates approx. 8300 metric tons of synthetics have been produced between when production began in the 1950s to the article's most recent data in 2015. Some of the introductory statements contain some preluding information to the article, stating the growth of plastics production and the disparities of production share in middle- and high-income countries. I think that the article has a small weak point here in that they did not include the plastics production of low-income countries, and that may be because of the lack of research, so I suppose it would be understandable why that was not included.

Astonishingly, nearly half of all plastic ever produced was produced between 2002 and 2015, approx. 3900 metric tons according to the article. I have discovered a partial weakness in the article; however, again this is an understandable withholding of information, where the article states that they did not include the production of biodegradable plastics since there was not a large production of said plastics. The article comprises data on the disposal of plastics based on their use, mainly: packaging, consumer & institutional products, others and textiles, electrical and electronic, transportation, industrial machinery, and building and construction. Out of all of these categories, packaging had an average lifecycle of **less than one year**, meaning that all of that plastic used in the packaging of foods that we see at the grocery store, gets immediately thrown away, and most of it ends up in landfills or the ocean.

The second shortest lifetime category is consumer and institutional products, which has an average lifecycle of approx. five years and the longest lifecycle of a category was building and construction at an average of thirty-five years. The article estimates that only approx. thirty per cent of all plastics ever produced are still in use, leaving 70% being either recycled or thrown in the trash or left somewhere to degrade and end up in the ocean. There are multiple forms of disposal for plastics, the first being recycling, disintegration through pyrolysis which turns plastics into fuels, combustion, and last and worst of all, littering. The best form of disposal, recycling, only accounts for approx. 18% of all disposal of plastics, and only 10% of that recycled plastic gets recycled a second time, and one can speculate that the recycle percentage drops drastically as a single piece of plastic is recycled more and more.

Overall, this article is very strong for a literature review on plastics. It is very useful for showing the lifecycle of plastics, as all the data is collected from global sources. There are some minor weaknesses, which I believe can be overlooked simply because there may have not been

data available. I think that this is also a very good read for anyone that is interested in the data on the lifecycle of plastics simply because it makes one realize that they should be doing more to protect the environment. I do want to find another article on the actual waste management laws because I've noticed that on my recycling bin, there are only certain types of plastics that they wish to take in, leaving all other plastics to be thrown away, which I despise greatly, but unfortunately, I do not know how else to dispose of it.

APA References

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