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The Effects of Microplastics and the Urgency of Further Scientific Research

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Abstract: **Without even consciously knowing, humans leave microplastic footprints into the world. From burning tires to plastic pellets from personal care products, there are various ways in which microplastics are formed. The world produces 300 million tons of plastics annually, and about 5 million tons of microplastics are released annually. Despite the alarming rate of microplastics, we lack the research and studies for microplastics. It was only recently that microplastics became an issue, and still, many are unaware of the term microplastics. In a 2019 survey in America, only 52 percent of adults knew about microplastics. The purpose of this paper is to bring more attention to microplastics and the potential harm it brings to us. In this paper, we go over the History of Plastics and Microplastics, Types of Microplastics, Benefits and Modern Use of Plastics, Microplastic Assessment Methods, Proven Environmental Issues, Lack and Need of Research on Biological Effects, The Future Trajectory of Microplastics (Data Analysis).**

Keywords: **microplastics, plastics, sustainability, ecology, global warming, synthetics.**

I. INTRODUCTION

The purpose of this paper is to bring more attention to microplastics and the potential harm it brings to us. In this paper, we go over the History of Plastics and Microplastics, Types of Microplastics, Benefits and Modern Use of Plastics, Microplastic Assessment Methods, Proven Environmental Issues, Lack and Need of Research on Biological Effects, The Future Trajectory of Microplastics (Data Analysis).

II. HISTORY OF PLASTICS

The very first synthetic plastic was made by John Wesley Hyatt in 1869. He used cotton fibers with camphor, found in wood, to produce plastic. 1907 was the year that fully synthetic plastics were first created by Leo Baekeland. He created Bakelite, a thermosetting plastic. Plastic was advertised to the world as a never-ending possibility, and ever since then, plastics have been used for everyday essentials such as bottles, clothing, packaging, microbeads, cosmetics, and much more. Plastic was the first material besides natural resources like wood or steel that was used for manufacturing materials. Many types of plastics were produced after Bakelite, as many chemical companies were interested in the success of Bakelite. Many of the chemical companies made laboratories and facilities for plastics. This helped the growth of plastics. “The mass markets now coming into view for plastics justified the massive investments by big chemical companies in this branch of technology”[1]. In 1912, Polychloride vinyl, or PVC was made. PVC is very versatile, and many household appliances are made by PVC, such as pipes and shoes. Soon after, cellophane was made. It was made by Edwin Brandenberger, who wanted plastic packaging for food. In 1933, Polyethylene was discovered by E.W. Fawcett and R.O. Gibson.

Originally, Polyethylene was England’s secret plastic production. They were used for Britain’s airplanes and gave them a bigger advantage over the Germans' planes. However, the production of polyethylene was not cheap. “The material’s good insulating properties were soon recognized. However, it took many years – and huge investments – before the company was able to develop safe, high-pressure equipment”[1]. Today, it is the most used plastic. Polyethylene became one of the most important plastics because plastic wraps for food were used to a great extent. After people began using plastic wrappings, there were less bacteria in foods, less physical damage, more preservability, and retaining the quality. This was revolutionary for people because it changed markets from being a service-based industry to a self-serve industry. This

helped the food industry tremendously with sales. About 12.5 million tons of plastic was used for food production worldwide in 2019. Nylon was developed in 1938 and was used for its elastic threads. "After the first nylon stockings appeared on the market in 1939, a staggering 64 million pairs were sold within the space of one year. The success of nylon was a huge boost to future industrial research" [1]

In 1944, Polystyrene was developed by Ray McIntire. Styrofoam is a form of expanded polystyrene. There are many more types of synthetic plastics being made today. Although there were many types of synthetic plastics being discovered, each one took enormous amounts of research and investments to successfully advertise the plastic.

The turning point for plastics was WWII. As the military needed more machines and other resources for war, they turned to plastics as a substitute. After all, plastic is a cheap alternative and is very flexible. "At the time, it was concentrated in the West: 8 million metric tons in the United States, 4 million in Japan and England, 1.3 million in the UK, Italy and France"[2]. The production for plastics was a 300% increase during this time. After WWII and the Great Depression, there was a sudden surge in the plastic industry as people began to spend more on products and markets. During this time, the working class began to buy more luxury items rather than spending their wages on necessities after getting increased wages. "Although the rise in prosperity did not necessarily mean that workers were ready to move into stately homes, they could start looking forward to buying small-scale imitations. Plastics manufacturers made plans for catering for this new market"[1]. Because plastic was cheap to make, many people of the middle and working class bought plastic imitations of original items. For example, plastic figurines were popular in turn to wooden figurines. Another reason for the sudden surge in plastics was the consumer revolution. The consumer revolution was a period when there were more consumptions of goods. Items such as washing machines, refrigerators, and vacuum cleaners were consumed. Along with the consumption of goods, there were new building formats. "The new trends were underpinned by new industrial materials such as reinforced concrete, aluminum, and stainless steel. Designers sought to create modern shapes using modern materials"[1]. It played an important role in modern design. Plastics could be used to paint elegant furniture and tables. Plastic also allowed for the items to be assembled in one piece. "Plastic acquired a new image alongside that of imitation and mass production: it now stood for modernity, creativity and functional convenience"[1]. Plastic was used in daily necessities, from sunscreens to radios to Tupperware. Tupperware was made in 1946, and even today, it is a staple item in the households of America. By the 1950's, the plastic market began to rise. In the 1950's, there were approximately 2 million tons of plastic being made worldwide. There were many useful products being made, such as plastic milk jugs and plastic bags. In 1965, a company called Cellopast received a patent for the creation of plastic bags. Ever since then, plastic bags are constantly used and produced. In addition to plastic bags, plastic water bottles were made in 1968. "In 1980, the world produced 60 million metric tons of plastic. By 2000, production reached 187 million metric tons, then 265 million in 2010 and 348 million in 2017"[2]. During the 1960's, thermoplastics were being used in the space industry, specifically, polysulfone used for space suits.

"By the 1960s plastics were synonymous with the space age and modern living. They were also vital in putting man on the Moon - providing lightweight materials such as Teflon that were also durable and could be used in the multiple layers that made up the fabric of the Apollo landing astronauts' space suits"[3]. In 1965, Kevlar was discovered and used for racing tires in the racing industry. The use of plastics is on an exponential rise today. In 1960, about 8 million tons of plastic were being produced worldwide. Today, about 380 million tons of plastic are being produced.

There are countless industries that involve using plastics, and unfortunately, not all plastics are used. The waste of plastics increases at an alarming rate. In the 1960's, the waste of plastics in the United States was approximately 390 thousand tons. In the 1900's, it spiked up to 17,130 thousand tons of waste, and in 2018, the plastic waste was 35,680 thousand tons of waste. There were many concerns about the waste of plastic. According to the Science Institute, "plastic also gradually became a word used to describe that which was cheap, flimsy, or fake. In The Graduate, one of the top movies of 1968, Dustin Hoffman's character was urged by an older acquaintance to make a career in plastics. Audiences cringed along with Hoffman at what they saw as misplaced enthusiasm for an industry that, rather than being full of possibilities, was a symbol of cheap conformity and superficiality." It was also brought to people's attention that plastics are full of chemicals that may harm animals or humans. Even though the reputation of plastic was degrading, plastics were still being used in all parts of the world.

III. PLASTIC POLLUTION

Every year, we produce 380 million tons of plastic, and most of the plastics end up in the ocean. The first reports of plastic litter in the ocean were reported in the 1970's. Back then, it wasn't an essential problem, and plastic litter was overlooked by many. However, approximately 245 million tons of plastics are accumulated in the ocean today. After discovering the harm that plastics bring to the environment, companies began to focus on producing plastics that were degradable. For

example, expanded polystyrene is 100 percent recyclable, and made with no toxic substances. However, it was hard to produce biodegradable plastics that can live up to people's satisfaction. Plastics were and are still being produced despite the pollution. Companies began to encourage recycling plastics. In 1981, New Jersey mandated recycling. Soon, other states followed and even companies like McDonalds stopped using Styrofoam containers. In 1988, there were about 1,000 recycling programs. Recycling rates have increased to 32 percent in 2021. However, the number of recycled plastics does not compare to the amount of plastics produced. Thus, microplastics were formed. Microplastics were also discovered in the 1970s, but it was officially termed microplastics in 2004 by Professor Richard Thompson (University of Plymouth).

(Figure #1)[8]

IV. TYPES OF MICROPLASTICS

Microplastics are small plastic particles that are about 5 millimeters in length. There are two types of microplastics. Primary microplastics are plastics that are introduced directly from manufacturing like plastic pellets or beads. There are 6 key sources of primary microplastics: plastic pellets, synthetic textiles, tires, road markings, marine coatings, and personal care products. Plastic pellets are usually unintentionally in the ocean. There are many accidents where the pellets are dropped. For example, in 2012, Hong Kong experienced Typhoon Vincente. The unexpected typhoon knocked about 150 tons of plastic pellets into the beach. The fibers of the clothes are discarded into the ocean." Significant amounts of these textile fibers have been observed in many in situ sampling studies both in open water and marine sediments" (Browne et al., 2011). Tires are also unintentionally lost. When driving, some particles of the tires rub off. Road markings with paint also get eroded. Marine coatings have many different plastics. "They include solid coatings, anticorrosive paint or antifouling paint"[4] . Personal care products include plastic microbeads that eventually go into the waste stream. Many of the personal care products come in plastic containers. Deodorant, shampoo bottles, lotion bottles, and makeup products all come wrapped in plastics. Microplastics are also found in skin care products such as toothpastes and exfoliants. Primary microplastics end up in the ocean in a couple of ways. For sources of primary microplastics like marine coating, it is bound to release into the ocean. Fishing gear is one of the most noted plastic debris items with a marine source. "Discarded or lost fishing gear, including plastic monofilament line and nylon netting, is typically neutrally buoyant and can therefore drift at variable depths within the oceans"[5] .For tires and road markings, the microplastics are carried over by wind, or end up in the sewer. The sewer transports the microplastic to the ocean. Most primary microplastics come from road runoffs. "The overwhelming majority (98%) of the losses of primary microplastics are generated during land-based activities… The main pathway is road runoff (tires, road markings and pellets incidents on land) (66%) followed by wastewater treatment systems (25%) and by wind transfer (7%). Marine activities only generate around 2% of the losses"[4]. However, not all the primary microplastics are released in the ocean. It is said that about 48 percent of the primary microplastics end up in the ocean. This accumulates to about 1.5 million tons per year.

Secondary microplastics are plastics that break down from larger pieces, such as water bottles. Secondary microplastics are especially harmful to the environment because they can take centuries to fully break down. The most abundant source of secondary microplastics are single use plastics. These include water bottles, straws, plastic wrapping, and plastic shopping bags. About 89 percent of the plastics in the ocean are single use plastics. 1.3 million plastic bottles are produced each day. About 5 trillion plastic bags are made per year. In America, 500 million straws are used per day. Most of these single use plastics end up in the ocean. These break down into microplastics. An important note about microplastics is that they usually never break up completely. Microplastics continuously break into smaller pieces, to the point where it is nearly impossible to separate microplastics from the ocean. Nanoplastics, which are extremely small plastic particles, are said to be about 1-100 nm. Larger plastic particles are called meso-plastics. Today, there are about 530 trillion pieces of microplastics in our oceans. When comparing whether more microplastics come from primary or secondary sources, it is said that "...between 15% and 31% of the microplastics could be from a primary source"[4].

V. BENEFITS AND MODERN USES OF PLASTICS

Plastics are very flexible and versatile. It can be used in many different materials, and in many ways. "...they are inexpensive, lightweight, strong, durable, corrosion-resistant, with high thermal and electrical insulation properties. The diversity of polymers and the versatility of their properties facilitate the production of a vast array of plastic products that bring technological advances, energy savings and numerous other societal benefits" (Andrady & Neal 2009). Synthetic plastics were revolutionary. To use non-natural materials to manufacture products was shocking. Ever since synthetic plastics were created, the use of plastics has been on an exponential rise. Plastics are used in many industries, including the food industry,

the textile industry, and the beauty industry. The food industry benefits greatly from plastics as food is being packaged. This promotes the increase of sanitary, quality, and physical product of the food. Plastic packaging provides safety. Before plastic wrapping was invented, many used glass containers to store their food. Unlike glass, plastic is shatterproof, and will not risk accidents when dropped. Plastic increases the shelf life of the foods and keeps the food fresh. Along with plastic packaging, plastic containers and kitchenware allow for more efficiency. One of the main benefits of plastics is that it can be produced into any shape, size, and color. There is a wide range to experiment. Plastics are also used in construction. Plastics are used in construction for its durability and cost effectiveness. Pipes, seals, and insulation are some areas of use. Many construction items with plastic take less energy to make, and transporting takes up less gas, since plastics are lightweight. The insulating foam in buildings also saves about 2,400 million tons of gas. 19 percent of plastics produced are used by the construction and building industry. Recently, lots of plastics have been used for transportation. Automotives, Aerospace, Rail, and the Marine transports all use plastics for its flexibility and cost effectiveness. Plastics help benefit cars in terms of fossil fuel. The lightweight plastic car parts save about 3 thousand liters of gas compared to when the car is made of metal. Also, plastics are extremely durable, and can withstand most weather conditions. "Plastics often have relatively simple chemical structures, but they can be extremely resistant to the process of natural decay, guaranteeing their long persistence in the environment"[6]. Plastics in electronic and electrical appliances are also extremely common. Some of the benefits of using plastics for electronics are the insulation, freedom of design, and the energy efficiency. Plastics do not absorb heat easily and do not conduct electricity, making plastics suited for electronics like kettles and hairdryers. Plastics are also easy to design. With no limit to color and design, manufacturers can design their products to increase sales or attract customers. The medical industry is also reliant on plastics. The medical industry uses single use plastics because they are cheap, durable, and efficient. The staff also utilize gloves, IV bags, and blue sheets. About 25 percent of the waste produced in hospitals are from plastics. Many daily products also involve plastics. For instance, water bottles, plastic bags, and straws are some of the most common single use plastics. Shampoo bottles are made from plastics, and so are mthompsonany toys. 90 percent of the toys produced are made from plastic, and the toy industry uses about 40 tons of plastic per 1 million dollars in revenue.

Although plastics make up a big percent of the world's waste, many companies and industries are trying to make biodegradable products. Scientists are testing biodegradable plastic mulches as an alternative to polyethylene. "Biodegradable plastic mulches are a promising alternative to the currently used polyethylene-based mulches, but rigorous testing is needed to ensure their use is environmentally safe"(Simtim). Plastics hold a big future. "Plastics are already becoming 'smart' and will likely serve numerous important roles in future living, including human tissue or even organ transplants, key materials used in ultra-low-emission lightweight cars and aircraft, superior insulation for homes that run on photovoltaic technology based on plastic collectors, reusable electronic graphic media for books or magazines, smart packaging that monitors food content continuously for signs of spoilage and high-efficiency solid-state lighting based on plastic organic diode technology"[13].

VI. MICROPLASTICS ASSESSMENT METHODS

For years, scientists have been trying to assess the amount and types of microplastics in the ocean. There are a couple of proven techniques, which include beachcombing, sediment sampling, marine trawls, and biological samplings. Beachcombing is the most common method for finding plastic debris. "This technique is particularly useful for determining the presence of macroplastics and plastic resin pellets, termed 'Mermaid's Tears' by beachcombers, but microplastics, especially those too small to be observed by the naked eye, are likely to go unnoticed using such a technique"[5]. Sediment sampling is another method to find microplastics along beaches. "To separate any plastics from the benthic material, saline water or mineral salts can be added to the sediment samples to increase water density, permitting lower density microplastics to be separated via flotation. Visible, denser plastic fragments can be removed by hand under a microscope" (Andrady, 2011; Thompson et al., 2004).

Marine trawls can also be used with a mesh to examine the plastics. However, depending on the mesh used, the samples of plastic vary. "Typically, 330 lm aperture meshes have been used for many of the microplastic trawls documented in this review, but it is important to note that using meshes with different apertures can produce large variations in the quantity of microplastics collected: by utilising 80 lm meshes, KIMO Sweden found microplastics at 100,000 times higher concentrations than when using 450 lm meshes" (Lozano and Mouat, 2009). If finer mesh nets are used, then smaller pieces of microplastics are found, and if larger mesh nets are used, larger sizes of plastics are found. The plastics are then observed with microscopes. Biological samplings involve using marine animals. "By dissecting beached marine animals, or by

instigating regurgitation in some seabirds, their gut contents can be analysed for the presence of plastics, which can then be identified and quantified" (van Franeker, 2010). There are other methods, such as marine observational surveys, but these surveys do not detect microplastics. The divers will not be able to observe microplastics with their naked eye. There are also multiple field surveys made for collecting microplastics. "Microplastics were collected on bridges over the rivers according to a survey of water quality (Fig. S1). Although the collection of microplastics has previously been conducted using ships in rivers and oceans, bridge surveys are advantageous because the microplastics can be safely collected regardless of the flow conditions" [12].

VII. PROVEN ENVIRONMENTAL ISSUES

There are concerns regarding microplastics within the environment. If microplastics do exist within the environment, the amount of harm it could give to organisms is indescribable. Microplastics such as fibers and fragments are "a small proportion of the detected microplastic types"[7]. Within the number of organisms and environments tested, only the similar microplastics were found, which emphasizes there are a lot more microplastics that haven't been found yet. The detected microplastics are "reported to affect endpoints such as biochemistry, feeding, reproduction, growth, tissue inflammation, and mortality in organisms"[7]. Throughout the ecosystem chain, microplastics are found in every organism and within the environment. The environment that the organisms share overflows with microplastics; organisms that devour one another also consume the microplastics within one's system. The number of concentrations of these microplastics is unimaginable if only certain microplastics can be detected. Although it is difficult to exactly estimate the amount of microplastics found within the environment, it can be easily found by starting with the primary microplastics: within the 5mm size range such as cosmetic beads found in shampoos and scrubs. The sale and usage volumes of plastics multiplied by microplastic content can give a "rough emission estimation for down the drain microplastics which then enter the environment through wastewater treatment plants" (Song 63). The microplastics found within the drainage system can equate to the amount found within the environment because it is difficult to filter out these microplastics. From the drainage system to the ocean, these microplastics travel from an area populated with people to a new environment where there are organisms that depend on the state of the environment. The organisms that eat other living organisms within the waters consume the microplastics that were consumed by the previous prey, thus cycling within the ecosystem. There are other sources of microplastic such as "primary and secondary microplastic emissions from tire dust"[7]. With the increase of human population, there is also an increase in transportation usage, elucidating more microplastics released within the environment.

"Over the past decade there has been increasing scientific, public, and regulatory interest in the occurrence and impacts of microplastic in the environment, defined as plastic particles smaller than 5mm in size" [7]. The term microplastics refer to the plastics that are small to be seen with bare eyes, referring that the other plastics such as tire fragments and plastic bottles aren't considered. Over the course of years, there have been regulatory interests regarding the ban of usage of plastics to reduce the amount of microplastics, evidently pointing out the increasing levels of microplastics within the environment. The microplastics found within the environment are "adversely affecting marine life and that may pose a risk to human health" [7]. There is a chance that marine animals digest the plastics, and this may potentially harm the animals. "Microplastics may present a mechanical hazard to small animals once ingested, like the effects observed for macroplastics and larger animals (Barnes et al., 2009; Fendall and Sewell,2009): plastic fragments might block feeding appendages or hinder the passage of food through the intestinal tract (Tourinho et al.,2010) or cause pseudo-satiation resulting in reduced food intake (Derraik, 2002; Thompson, 2006). Other studies show some effects of microplastics in fish. "Indeed, histological examinations of different tissues in exposed fish showed a strong inflammatory response induced by microplastics" (Lei et al., 2018; Lu et al., 2016; Peda et al., 2016). The plastics may also contain toxic chemicals that are absorbed in the animal's systems. Not only are animals and other live organisms being affected by these microplastics but also humans are consuming the animals.

There is also evidence of microplastics found in human blood. According to the Guardian, "The scientists analyzed blood samples from 22 anonymous donors, all healthy adults and found plastic particles in 17." The impact of microplastics on human health is unknown. However, there are many studies being done to determine the effects of microplastics inside human blood. "A recent study found that microplastics can latch on to the outer membranes of red blood cells and may limit their ability to transport oxygen. The particles have also been found in the placentas of pregnant women, and in pregnant rats they pass rapidly through the lungs into the hearts, brains, and other organs of the fetuses" (The Guardian).

VIII. THE LACK OF RESEARCH

The main issue regarding microplastics is the lack of resources and statistical data regarding it. Knowledge about global microplastic releases is quite unknown as it has never been assessed yearly. "Consequently, the relative importance of primary versus secondary sources of microplastics is still unknown, and the plastic debate generally does not look outside of the waste management arena"[4]. There is a lack of research regarding the global amount of microplastics; rather there is research done on a small sample, mainly within the waste management arena. This implies that there are a lot of unknown areas where microplastics have yet to be measured to exactly know the amount of microplastics found globally. Not only that but the microplastics that are researched are the ones that fit within the range of less than or equal to 5mm in size, meaning other microplastics that are bigger in range aren't considered in the research. Sources "generate unintentional losses through abrasion, weathering or unintentional spills during production, transport, use, maintenance or recycling of products containing plastic"[4]. Field studies that are done on microplastics consider many factors such as when it is being built to typically estimate the amount of microplastics, but the amount released into the environment remains unknown. For instance, when "tires get eroded, the microplastic particles are formed from the outer parts of the tire and consist of a matrix of synthetic polymers"[4]. In situations such as these, losses regarding the synthetic rubber being created are considered but losses of natural rubber aren't included within research. "There is no reliable information on the transfer of microplastics from tires to the world's oceans, but a large fraction seems to originate from car tires". The surface level to estimate the amount of microplastics found within the environment is perplexing and thus only a handful of research are done which then estimate using statistical data. Factors such as the tire abrasion are impossible to calculate. "Sources are grouped together because their individual contribution is small. However, together they account for a considerable number of losses in country studies"[4].

IX. THE FUTURE TRAJECTORY OF MICROPLASTICS (DATA ANALYSIS)

The biggest source of plastics comes from packaging. We use plastics for packaging food, clothes and other items, and often, the plastic packaging is only used once then thrown away. 40 percent of plastic produced is used for plastic packaging. The world produces 380 million tons of plastic packaging every year. When looking by region, China produces the most plastic every year. As of 2020, China made up for 32 percent of the plastic production, which is 78 million tons of plastic being produced per year. The United States produces 35.7 million tons of plastic, which makes up for 12 percent of the plastic production worldwide. Considering that the United States takes up 4 percent of the population but makes up for 12 percent of the plastic production worldwide, the United States consumes much more plastic per person. When looking at the plastic waste, the United States came first with 105kg of plastic waste[11]. The United Kingdom came second, with 98.66kg of plastic waste. South Korea came third with 88.09kg of plastic waste. "Though programs exist to deter consumers from buying or using one-time use plastics, it is almost impossible to avoid using plastics of some kind in day-to-day life, simply due to the sheer volume and depth of integration plastics have made into the world's systems"[9]. Although many point to the solution of recycling, recycling isn't very useful. Single use plastics are a hassle to recycle. Only 9 percent of plastics are recycled[10]. The process is difficult, and the plastic doesn't get used much after it was already used. It costs more to reuse plastic than making plastic. Thus, many companies are not willing to recycle plastics. For big plastic consuming countries like the United States and the UK, plastic wastes take up too much space. Therefore, they export their plastic wastes into other counties. Up till 2018, China bought the plastic wastes from the United States. However, China stopped taking plastic waste in 2018, and other countries like India or Thailand also stopped buying the plastic wastes. It is said that places like Bangladesh and Laos are taking US plastic. Indonesia and India ranked the highest for the biggest amount of plastic waste ending up in the ocean. By 2040, the plastic waste is said to triple the amount, accumulating to 29 million tons of plastic waste in the ocean.

X. CONCLUSION

The effects microplastics leave on the environment is inevitable, as there are countless sources of microplastics that are created and released into the environment. The amount of microplastics found within the environment correlates to the usage of plastics. The issue regarding microplastics is exponentially increasing, bringing alert to people about the overall dangers it brings. Not only does microplastics harm the environment but the people as well. Living organisms that ingest plastic found within their environment are eaten by other larger organisms that are then eaten by humans. Organisms that devour plastics have microplastics within their system which are then passed down to humans that consume these organisms. This causes a cycle where microplastic is passed down from one organism to another. Microplastics are difficult to see with

the naked eye but are still within the environment. Although microplastics are quite small, they pose a huge threat to the environment. Since plastic isn't biodegradable, it has a high sustainability, constituting a major issue towards the environment. Unlike other materials, plastic is non-biodegradable where microorganisms don't have the proper enzymes to break down microplastic. Thus, after the usage of plastics, it gets thrown into the environment from various ways such as sewage, litter, etc. The plastics then accumulate as it isn't biodegradable and disrupts the environment; this also causes living organisms to spark interest, assuming that the unknown plastic item is food, and consume the plastic. Although it is well known that microplastic poses a threat to our environment, there isn't enough research to prove the accumulated amount of plastic nor the high-risk dangers it brings. There are several studies that do correlate to the topic of the dangers microplastic brings. However, this research isn't enough to pinpoint the risk plastics bring to the environment, only a mere statistical data showing the massive accumulation of plastics throughout the years. This research shines a light as to the number of plastics used by humans throughout the years but despite the number increasing, there isn't a standard way to measure the amount of microplastics. Despite the lack of research regarding microplastics, microplastics are still evident within the environment and living organisms and are accumulating exponentially.

REFERENCES

[1] Lintsen, H. (n.d.). The Plastics Revolution How the Netherlands Became a Global Player in Plastics (5th ed.). Foundation for the History of Technology, https://www.polymers.nl/_asset/_public/News/First-instalment-The-Plastics-Revolution.pdf

[2] Chalmin, Philippe. "The history of plastics: from the Capitol to the Tarpeian Rock", Field Actions Science Reports [Online], Special Issue 19 | 2019, Online since 01 March 2019, connection on 13 July 2022, http://journals.openedition.org/factsreports/5071

[3] Mossman, Susan. "Early Plastics : Perspectives 1850–1950." Early Plastics : Perspectives 1850–1950, 27 Dec. 2021, https://web.archive.org/web/20211227090318id_/https://www.e-periodica.ch/cntmng?pid=fer-002:2017:89::158

[4] Boucher, J. and Friot D. (2017). Primary Microplastics in the Oceans: A Global Evaluation of Sources. Gland, Switzerland: IUCN. 43pp.

[5] Cole, M., Lindeque, P., Halsband, C., & Galloway, T. S. (2011, October 14). Microplastics as contaminants in the marine environment: A Review. Marine Pollution Bulletin. Retrieved July 15, 2022, from https://www.sciencedirect.com/science/article/pii/S0025326X11005133#aep-acknowledgment-id10

[6] Tolinski, M., & Carlin, C. P. (2021). Plastics and Sustainability Grey is the new green: Exploring the nuances and complexities of modern plastics. Wiley.

[7] Microplastics in the aquatic environment: Evidence for or ... - SETAC. (n.d.). Retrieved July 15, 2022, from https://setac.onlinelibrary.wiley.com/doi/10.1002/etc.4268

[8] Statista. "Volume of U.S. Plastic Municipal Solid Waste Generated 1960–2018." Statista, 21 June 2022, www.statista.com/statistics/1097290/us-plastic-waste-generation.

[9] Dodd, Carly. "10 Countries Producing The Most Plastic Waste." WorldAtlas, 29 Sept. 2021, www.worldatlas.com/geography/10-countries-producing-the-most-plastic-waste.html.

[10] Tiseo, I. (2021, April 13). Plastic waste generation worldwide by country. Statista. Retrieved July 15, 2022, from https://www.statista.com/statistics/1166177/plastic-waste-generation-of-select-countries/

[11] Tiseo, I. (2022, June 21). U.S. plastic waste generation 1960-2018. Statista. Retrieved July 15, 2022, from https://www.statista.com/statistics/1097290/us-plastic-waste-generation/

[12] Kataoka, T., Nihei, Y., Kudou, K., & Hinata, H. (2018, October 29). Assessment of the sources and inflow processes of microplastics in the river environments of Japan. Environmental Pollution. Retrieved September 6, 2022, from https://www.sciencedirect.com/science/article/pii/S0269749118338028

[13] Andrady, A. L. (2011, July 13). Microplastics in the marine environment. Marine Pollution Bulletin. Retrieved September 6, 2022, from https://www.sciencedirect.com/science/article/pii/S0025326X11003055