DETECTION AND IDENTIFICATION OF MICROPLASTICS IN SEDIMENTS ALONG THE COASTAL AREA OF BORONGAN CITY

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Abstract: Sedimentary particles or sand were collected from the areas of Baybay Boulevard and Hilangagan Beach Resort for qualitatively analyzing the presence of microplastics. Density separation was done using 20% NaCl solution and microscopic identification was done under wet conditions using a 30 micron filter at 40x magnification under a stereo microscope. Obsevations found out that microplastics are present in the sediments of Borogan City, Eastern Samar. From this, secondary microplastics were found to be prominent within the sample which indicates the degradation of these polymeric substances in the environment. Microfibers are the most common type of microplastics found in sediments. Almost all microplastics observed within the sediment samples were filamentous in shape. In terms of the coloration, blue was the most prominent color in most microplastics observed; this is seconded by the color red. A total of 30 microplastics were observed from the sediments collected from Baybay Boulevard and Hilangagan beach resort. Baybay Boulevard averages at 10.1 MP/Kg, while the average microplastic contamination in Hilangagan beach resort was calculated at 1.88 MP/Kg. this sums up to an average of 5.84 MP/Kg for both sampling sites in Borongan City.

Keywords: sediments, Borongan City, microplastics, density separation, microscopic examination, microcontaminants.

1 Background of the Study

For decades, scientists around the world have been studying the origin of manmade pollution and its effects. One of the most pervasive pollution problems our environment is facing is marine debris. Let us introduce you to marine debris, define what it is, and explore the impacts it has on the environment. You can then take the knowledge you gain and apply it as a citizen scientist to your local waterways or coastline, and along with it, plastics.

Plastics are polymers which are a chain of molecules that are derived from small molecules of monomers that are extracted from oil or gas.[1,2,3]

Major negative effects can be outlined by the contamination of marine environments with microplastics. The National Oceanography and Atmospheric Administration (NOAA) stipulated that marine debris such as plastics can cause losses in aesthetic values of tourist attraction which in turn can result in substantial economic loss[4]. There is also the consumption of plastics and microplastics by marine animals can lead to false satiation, starvation and death.[1,5]

Microplastics are plastic pieces smaller than 5 millimeters, which is about the width of a pencil eraser. They come in different forms, including microbeads, microfilms, microfibers, and microfragments. Many microplastics start out as larger plastic products (plastic water bottles, beach toys, or large fishing nets) that get broken up over time. Some begin as intentionally small plastics for cosmetic purposes (beads in face exfoliants, toothpaste).[6]

Microplastics have been found all over the ocean—from the surface water to deep-sea benthic zones (lowest level of the ocean). There are even reports of microplastics being found frozen in Arctic ice! These small plastic pieces are often mistaken as food and can be ingested by small organisms like plankton to larger organisms like whale sharks. Not only are plastics indigestible, but they may also be toxic to the animals that consume them.[6]

Plastic is absorbent, like a sponge, so it absorbs hydrophobic chemicals from the water it floats in. There are all kinds of chemicals in seawater—from pesticides to steroids to BPA—that can be very harmful to humans and wildlife. Plastic can absorb these chemicals.[6]

Primary microplastics are tiny particles designed for commercial use, such as cosmetics, as well as microfibers shed from clothing and other textiles, such as fishing nets. Secondary microplastics are particles that result from the breakdown of larger plastic items, such as water bottles. This breakdown is caused by exposure to environmental factors, mainly the sun's radiation and ocean waves.[7]

The main route of microplastics to the marine environment is the effluent from sewage and storm water generated in areas contains a significant amount of plastic. This pose some difficulties for treatment because many sewage treatment plants are not able to capture and treat plastic materials that are less than .5mm in diameter.[1,2,3] These plastics and micro plastics become an even greater threat to the marine environment.

In the context of the locality in Eastern Samar alone there is prevailing problem with the numerous numbers of plastics contaminants that are harbored after a rough season, increase in the use of plastic materials for various human use as well as the poor management of garbage and non-biodegradable wastes, hence, this research will be conducted to detect and approximately identify the presence of microplastics in the Coastal Area of Borongan City.

2 Objectives of the Study

This study aims to detect the presence of microplastics in the sediments along the coastal area of Borongan City. More specifically, this study aims to:

1. Classify the present microplastics as:
   a. Primary microplastics
   b. Secondary microplastics
2. Identify the types of microplastics as:
   a. Microbeads
   b. Microfilms
   c. Microfibers
   d. Microfragments
3. Determine the physical structure of microplastics as:
   a. Round
   b. Angular
   c. Filament
   d. Other shape
4. Determine the color of the microplastics as:
   a. Blue
   b. Red
   c. Transparent/white
   d. Black
   e. Green
   f. Other colors
5. Compute the total number of microplastics found in sediment samples.

2 Methodology

2.1 Research Design

This descriptive study used qualitative analysis in detecting and estimating the present microplastics in sediments along the coastal area of Borongan City with the use of density separation, filtration and sieving as well as Microscopic Technique.

2.2 Locale of the Study

This study will be conducted at the Chemistry Laboratory of the Biology Department of the College of Nursing and Allied Sciences. Sediment samples will be collected from the tourism areas of Borongan City such as the area of Baybay Boulevard. The Baybay Boulevard coastal area of the city along with its identified tourism areas with sedimentary particulates will be divided containing 2 sampling sites which will be established. The boulevard and all other identified sites is considered for its strategic location in the city and the flourish of food economy in the area where plastics of various kinds are frequently used as food packaging.

2.3 Data Gathering Procedures

The following step-by-step processes was used in the study to detect the presence of microplastics in the sands along the tourism sites of Borongan City, Eastern Samar. All procedures will follow the Mississippi State University Microplastic Sampling and Processing Guidebook.[6]

2.3.1 Sediment Sampling

Sampling followed the standard procedures published by the Mississippi State University[6] on sediment sampling.

Sediment sampling was done at the high, high tide line (wrack line). The wrack line is the accumulation of debris (sticks, seaweed, etc.) that marks the maximum extent of water height during high tide. The deposit of debris here is where microplastics (if there are any) are most dense, without much wave action to carry them away. For accurate data collection, collect at least three sediment samples.

2.3.2 Processing the Sediments

The process of separating the microplastics from the sediment sample was done by density separation. In density separation, salt water and air bubbles were pumped through the sediment sample, fluidizing it; because microplastics are less dense than the salt water and sediments, they float to the top where they can be counted.

2.3.3 Density Separation of Microplastics

Microplastics tend to float on the water surface due to their lower density than water. The target component and impurities can be separated by density flotation according to their density differences. To be specific, for density separation, the flotation solution was added to the sample, and then MPs were collected through a series of processes such as stirring, mixing, standing, and settling, and finally, the supernatant was separated. The density of most MPs is in the range of 0.80–1.40 g/cm^3.[8] Generally speaking, MPs with a density of 1.40 g/cm3 can be obtained using a flotation solution.

The solution of NaCl is used extensively for the separation of MPs because it is cheap, readily available, green, and non-toxic.[9] Other flotation solutions are more efficient but limited to their expensive (SPT, NaI, etc.) or may pose a threat to the environment (ZnCl2, etc.).[8]

2.3.4 Filtration and Sieving

Filtering or sieving is the most commonly used approach for separating the supernatant containing MPs from sediment samples and MPs from density separation of samples. However, there exist some differences. For example, for filtration, the MPs onto filter membrane are obtained using a vacuum pump and sieving is performed directly onto screens with different pore sizes through gravity (Baldwin et al., 2016). The particle size of MPs collected depends on the size of the sieve and filter apertures. Generally speaking, the pore size (0.45–2 μm) of the filter membrane is smaller than that of the screen.[10,11,12]

2.3.5 Microscopic Identification of Microplastics

With the use of a Stereomicroscope at 40x magnification, tweezers, forceps and needles, a Microplastic identification reference materials, and disposable gloves and lab coat (as required for safety), the following procedures were followed to identify microplastics:

Prepare a clean and dedicated workspace in the laboratory or controlled environment to avoid contamination during the analysis. Wear disposable gloves and a lab coat to maintain a sterile working environment and prevent contamination. Water samples were from the sediments and collected. The water samples with filtered using a 30 micron filter mesh. The filter was allowed to stand and placed unto a Petri Dish. The Petri dish was then examined under a stereomicroscope at 40x magnification. The dish was scanned from side to side, moving across the sample area to search for particles that match the characteristics of microplastics, such as shape, color, and texture. Use the microscope's focus and illumination controls to obtain a clear view of the particles. Take note of any particles that appear consistent with microplastics based on their size, shape (e.g., fragments, fibers), and visual appearance. Optionally, compare the observed particles with microplastic identification reference materials or images to assist with accurate identification. If needed, capture images of potential microplastics using a digital camera or microscope camera attachment for further analysis or documentation.

Repeat the process with multiple other filters and Pteri dishes to different representative water samples for thorough examination. Record and document the characteristics and quantities of identified microplastics, including their size, shape, color, and any additional relevant observations. Clean the filter paper for further use using distilled water and properly dispose any debris left from the previously observed filter mesh with adherence to laboratory's waste management protocols. Analyze and interpret the collected data to assess the presence, abundance, and characteristics of microplastics in the water sample. This was done under wet analysis for a thorough identification.

3 Results and Discussion

After sediments were sieved and possible microplastics (MP) were obtained via floatation, and density separation, microscopic analysis was done to the filtrate. The following data were obtained:

3.1 Microplastics Classification

One of the most important aspects of microplastics identification is for it to classify so as to have pre-determined knowledge on the source of the contamination. The sediments collected from the sampling sites were observed for the presence of primary or secondary microplastics.

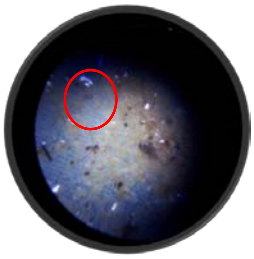

Figure 1. Microplastics Observed

As observed from the sediments collected via microscopic identification, it was found out that Baybay Boulevard has the highest observed number of microplastics suspended within the sediments with a total number of 25, while in Hilangagan, a total of 5 microplastics were observed. Of this enumerated contaminants, all were considered secondary microplastics, and that, none of the observed microplastics were considered primary microplastics.

Secondary MPs are more prominent in the environment as secondary microplastics form from the breakdown of larger plastics; this happen when larger plastics undergo weathering, through exposure to, for example, wave action, wind and sand abrasion, as well as ultraviolet radiation from sunlight. Moreover, these results make sense because primary microplastics are tiny particles designed for commercial use, such as cosmetics, as well as microfibers shed from clothing and other textiles, such as fishing nets. Secondary microplastics are particles that result from the breakdown of larger plastic items, such as water bottles.[7]

3.2 Types of Microplastics

Identifying the type of microplastics is crucial so as to further elucidate the physical properties of the the contaminants present in the environment. The observed microplastics in sediments along the whack line of the sampling sites were identified in terms of their types either as microbeads, microfibers, microfilms and microfragments.

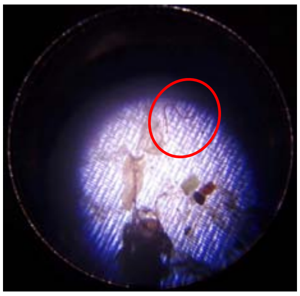

Figure 2. Microplastics under 40x magnification

It was found out that the most common form of microplastics present in the sediments from the two (2) sampling sites were mostly microfibers, a total of 23 microfibers were observed in Baybay boulevard while, out of the 5 MPs observed in Hilangagan, 4 were considered to be microfibers. Moreover, the other remaining 3 observed microplastics were observed to be microfragments. However, no microbeads and microfilms were observed from all the sediment samples from all the sampling sites.

The presence of plastic microfibers can be attributed to some of the most common environmental pollution such littering, but much is the result of storms, water runoff, and winds that carry plastic—both intact objects and microplastics—into our oceans. Moreover, secondary microplastics result from the fragmentation of larger plastic products. Beach litter contributes to microplastic production as larger plastic pieces break down in the sun and waves.[7]

3.3 Physical Structure of Microplastics

Physical structure of microplastics present refers to the physical observation under the microscope at 40x magnification either as angular, filament, round and other shapes.

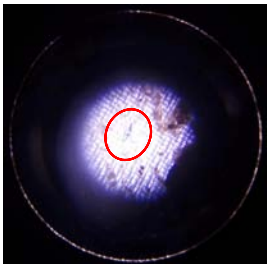

Figure 3. Filamentous Microplastic Sample Observed

In terms of the microplastics observed, it was found out that the most common structure of microplastics found in the sediments from the sampling sites were mostly filamentous, that is, they are somewhat long thread-like microplastics, which is in consonance to the results of the microplastics being microfibers.

Filaments are the most common physical structure because filament-type microplastics usually came from broken plastic bags. Moreover, water flowing towards the sea also carries out filament-type microplastics.[13]

3.4 Microplastics Color

Microplastics color is one of the most important indicators in determining its presence in water and sediments. The following data shows the most common color of microplastics obtained from the sediments of Baybay Boulevard and Hilangagan beach resort:

It was observed that the most common color of the microplastics was blue, it was found to be abundant in the areas of baybay and hilangagan, and this was seconded by the color red. However, 2 transparent/white colored microplastics were found in hilangagan beach resort.

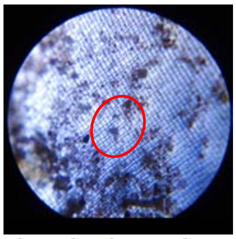

Figure 4. Blue-colored Microplastic Observed

Color distribution for microplastic particles are usually found to be black, blue and red representing the predominant colors of these water and sediment contaminants.[14] Blue plastics cannot effectively absorb UV light, they age faster in the sun and a higher proportion of bluish microplastics is often found in the environment, especially toward the smallest sizes.[15]

3.5 Total Microplastics

Overall, a total of 25 microplastics were found and observed to be present in the sediments of Baybay Boulevard from a total of 2480 g sediments collected. This constitutes to an average of 10.1 MP/Kg in the area of Baybay boulevard. In hilangagan beach resort, a total of 5 microplastics were found and observed under the microscope, from a 2661 g sediment samples collected. This numbers constitute a average of 1.88 MP/Kg which is significantly lower than the average MP from Baybay Boulevard.

In general, a total of 30 microplastics were recorded from both sampling sites, wherein Baybay Boulevard was found to be significantly higher than the MPs present in Hilangagan, this result establishes an average of 5.84 microplastics (MP) found per kilogram (Kg) of sediments in the coastal sedimentary areas of Borongan City.

4 Conclusions

Based on the results of the laboratory analysis of the sediments collected from the two (2) sampling sites, the following conclusions are herein drawn by the researchers:

1. Microplastics were observed to be present in the sediments of Borogan City, Eastern Samar. From this, secondary microplastics were found to be prominent within the samples which indicate the degradation of these polymeric substances in the environment.
2. Microfibers are the most common type of microplastics found in sediments.
3. Almost all microplastics observed within the sediment samples were filamentous in shape.
4. In terms of the coloration, blue was the most prominent color in most microplastics observed; this is seconded by the color red.
5. A total of 30 microplastics were observed from the sediments collected from Baybay Boulevard and Hilangagan beach resort. Baybay Boulevard averages at 10.1 MP/Kg, while the average microplastic contamination in Hilangagan beach resort was calculated at 1.88 MP/Kg. this sums up to an average of 5.84 MP/Kg for both sampling sites in Borongan City.

4 Conclusions

Based on all results generated and the conclusions herein listed, the researchers recommend the following:

1. Conduct FT-IR spectroscopic analysis to further identify the molecular compositions of the present microplastics.
2. Conduct similar analysis on the presence of microplastics in mangrove areas and other marine areas in Borongan City or even in Eastern Samar.
3. Conduct similar study involving presence of microplastics in freshwater estuaries or areas in Borongan City.
4. Conduct similar study to further affirm or oppose the results of this study.
5. If possible, limit the use of plastics and observe proper disposal of plastic utensils and products to further limit microplastics contamination into the sediments in Borongan City.

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