

Microplastics Detection and Identification in the Waters along Coastal Areas of Borongan City

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Abstract

This study detects the presence of microplastics in the coastal areas of Borongan City, Eastern Samar, this specifically implies the microplastics present in the waters along coastal areas of Borongan City. Two (2) sampling areas were identified and selected for the presence of these microcontaminants using density separation, filtration and microscopic identification. Results reveal a total of 35 microplastics observed from the water samples collected, with this the microplastics from Baybay boulevard with an average of 0.79 microplastics per Liter, while the average microplastic contamination in Hilangagan beach resort was calculated at 0.43 microplastics per Liter. This sums up to an average of 0.49 microplastics per Liter for both sampling sites in Borongan City.

Keywords

Microplastics, Microcontaminants, Borongan City, Density Separation, Microscopic Identification, Nonbiodegradable Contaminants

1. Introduction

Plastics have become a valuable commodity and an important part of everyday life, more so that global plastic production has increased from 5 million tons in the 1950's to over 250 million tons in 2006 [1]. But the high volume and the quality which makes this material so useful, is also harmful for the environment, especially our marine environment [2].

Plastics are polymers which are a chain of molecules that are derived from small molecules of monomers that are extracted from oil or gas [3]-[5].

Major negative effects can be outlined by the contamination of marine en-

vironments with microplastics. The National Oceanography and Atmospheric Administration [6] 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. There were also statements that the consumption of plastics and microplastics by marine animals can lead to false satiation, starvation and death [7].

Recently, a news agency reported the detection of microplastics in Laguna Lake by researchers from Mindanao State University. In all specifications. The pollution of aquatic systems by microplastics is a well-known environmental problem. They determined for the first time the amount of microplastics in the Philippines' largest freshwater lake, the Laguna de Bay. Ten (10) sampling stations on the lake's surface water. A total of 100 microplastics were identified from 10 sites with a mean density of 14.29 items/m³. The majority of microplastics were fibers (57%), while blue-colored microplastics predominated in the sampling areas (53%). There were 11 microplastic polymers identified predominantly polypropylene (PP), ethylene vinyl acetate copolymer (EVA), and polyethylene terephthalate (PET), which together account for 65% of the total microplastics in the areas. The results show that there is a higher microplastic density in areas with high relative population density which necessitates the implementation of proper plastic waste management measures in the communities operating on the lake and in its vicinity to protect the lake's ecosystem services [8].

Moreover, Plastics and microplastics are composed of harmful substances such as antimicrobials, hydrocarbons and flame retardants which can cause significant changes in marine and biodiversity health [9].

Microplastics are typically defined as plastic particles measuring less than 5 mm in size, plastic materials smaller than this measure are considered nanoplastics. There are various types of plastics. They can be either a primary or secondary microplastics. A primary microplastic is an intentionally manufactured small plastic particle with sizes ranging from a few micrometers to 5 millimeters. They are directly produced for specific purposes and applications. Examples of primary microplastics include microbeads and microfibers. On the other hand, secondary microplastics are formed as a result of the degradation and fragmentation of larger plastic items. Secondary microplastics can originate from various sources, including plastic bottles, bags, packaging materials, fishing gear, and other plastic debris. Over time, exposure to environmental factors like sunlight, wave action, and mechanical forces can break down larger plastics into smaller particles. Secondary microplastics can vary in size, ranging from millimeters to nanometers.

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 5 mm in diameter [10]. 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 was 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 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. Microbead
 - b. Microfibers
 - c. Microfilms
 - d. Microfragments
- 3) Determine the physical structure of the microplastics as:
 - a. Angular
 - b. Filament
 - c. Round
 - d. Other shape
- 4) Determine the color of the microplastics as:
 - a. Black
 - b. Blue
 - c. Green
 - d. Red
 - e. Transparent/white
 - f. Other colors
- 5) Compute the total number of microplastics found in water samples.

3. Methodology

3.1. Research Design

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

3.2. Locale of the Study

This study was conducted at the Chemistry Laboratory of the Biology Department of the College of Nursing and Allied Sciences. Water samples were collected from the tourism areas Borongan City namely; Baybay Boulevard and Hilangagan Beach Resort. The Baybay Boulevard coastal area of the city and Hilangagan Beach Resort areas was divided into 2 sampling sites. These areas are 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.

3.3. Data Gathering Procedures

The following step-by-step processes were used in the study to detect the presence of microplastics in the waters of tourism areas in Borongan City, Eastern Samar.

3.3.1. Gathering of Water Samples

Water samples were gathered from identified sampling sites to be established at various identified tourism areas. A total of 1 to 20 Liters of water per site was collected during high tides regardless of time and weather. These samples were kept in a clean high density plastic container to minimize contamination and preserve the integrity of the sample. The samples were labeled and were brought into the laboratory for density separation, filtration and sieve analysis, and microscopic analysis. Representative sample from each site was gathered using at 5 meters from the shoreline with a depth of around 0.5 to 1 meters.

3.3.2. 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/cm³ [10]. 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. Other flotation solutions are more efficient but limited to their expensive (SPT, NaI, etc.) or may pose a threat to the environment (ZnCl₂, etc.) [11].

3.3.3. 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 water 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. The particle size of microplastics (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 [12]-[14].

3.3.4. Microscopic Identification of Microplastics

Stereomicroscope at 40× magnification
Tweezers, forceps and needles
Microplastic identification reference materials

Disposable gloves and lab coat (as required for safety)

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. Collected water samples were filtered using a 30 micron filter mesh. The filter was allowed to stand and placed into a Petri Dish. The Petri dish was then examined under a stereomicroscope at 40× 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 Petri 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.

4. Results and Discussion

Based upon microscopic analysis of water samples from Baybay area and Hilangangan Beach resort, the following data were gathered:

4.1. Classified Microplastics

Based upon ocular inspection and contrasting of the microplastics found in water samples, all were found to be secondary microplastics. Almost all microplastics were found to be secondary microplastics, with just 1 primary from Hilangangan Beach Resort. As per definition from the Mississippi State University Extension Service [15], Secondary microplastics are the result of the breakdown of larger plastic pieces. The environment cannot naturally break down plastic materials. Chemical and physical processes like wave action, heat, UV radiation, and animal grazing cause plastics to break up into smaller and smaller pieces.

However, Baybay Boulevard has higher average microplastics (MP) per Liter of water samples. From a total of 11.356 L collected from Baybay boulevard a total of 9 microplastics were observed having an average of 0.79 MP/L, in Hilangangan beach resort, a total of 26 MPs were observed from a 60 L water sample, averaging 0.43 MP/L (**Figure 1**). Secondary microplastics are particles that result from the

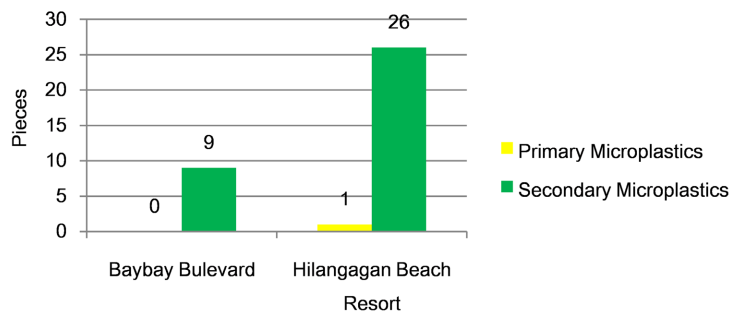


Figure 1. Microplastics present in terms of their classification.

breakdown of larger plastic items, such as water bottles. According to the National Geographic, this breakdown is caused by exposure to environmental factors, mainly the sun’s radiation and ocean waves. Secondary microplastics come from larger pieces of plastics, such as beverage bottles, bags, and toys. Sun, heat, wind, and waves can cause these plastics to become brittle and break into smaller and smaller pieces that may never fully go away. Microplastics are also created when pieces of plastic break off during use. For example, particles of synthetic tires can break off during regular use and through wear and tear [16].

Similarly, clothing, furniture, and fishing nets and lines may produce plastic microfibers, another type of secondary microplastics. These fibers are extremely common on shorelines across the United States, and are made of synthetic materials, such as polyester or nylon. Through general wear or washing and drying, these tiny fibers break off and shed from larger items [16].

4.2. Types of Microplastics

Microplastics are classified either as microbeads, microfibers, microfilms or microfragments. The following data on microplastics typing found in the water samples were gathered:

It was found out that the most common type of microplastics was Microfibers. Moreover, only 1 microfragment was observed, and that, all microplastics found in Baybay boulevard were microfibers (Figure 2). This result indicates that microplastic fibers, also known as microfibers, are the most abundant microplastic

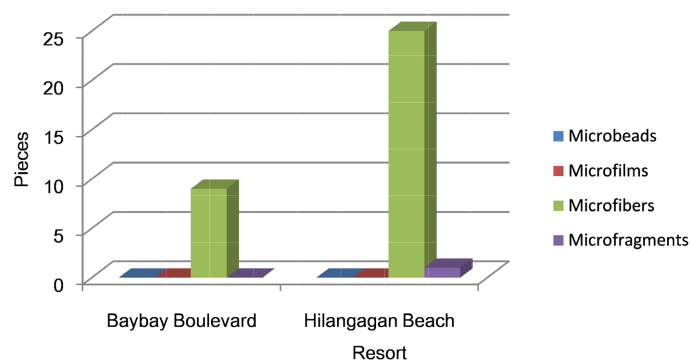


Figure 2. Types of microplastics present in the study sites.

forms found in the environment. Microfibers are released in massive numbers from textile garments during home laundering via sewage effluents and/or sludge [17].

4.3. Physical Structure of Microplastics

The physical attributes of the microplastics found were also observed, the result are as follows:

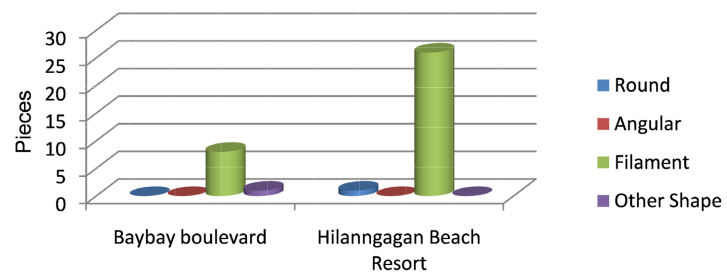


Figure 3. Microplastics present in terms of their physical structure.

Almost all microplastics observed were filamentous in shape, only 1 was found to be irregularly shaped, while another 1 was found to be rounded fragmentous (Figure 3). This result is predictable as observed since microplastic released by the form as fabric woven with filament polyester are six times more likely to be released into the environment than other forms of microplastics [18].

4.4. Microplastics Colors

Colors form part of the important aspect of microplastic identification, henceforth colors were recorded on microplastics observed from water samples, the results are as follows:

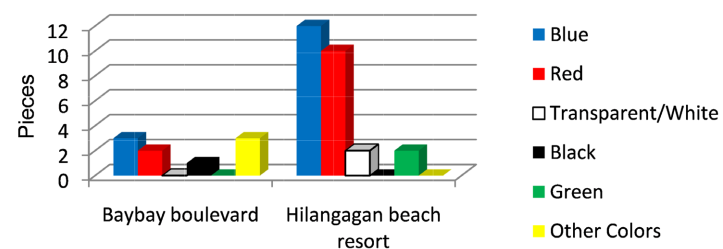


Figure 4. Colors of microplastics present in the study site.

As seen from the figure above, the highest number of microplastics are the those that are colored blue, this color is followed by the color red in all the water samples that were taken from both Baybay boulevard and in Hilanngagan Beach Resort in Brgy. Punta Maria, both locales are from the City of Borongan, Eastern Samar (Figure 4).

According to the Mississippi State University Extension Service, microplastics are usually brightly colored, frequently blue or reddish which further supports the

results of this study, in terms of microplastic coloration [17].

4.5. Total Microplastics Observed

A total of 35 microplastics were observed on all water samples coming from both areas of Baybay boulevard and Hilangagan beach resort (Figure 1). From there, 11.356 L of water were sampled from Baybay Boulevard, while 60 L were sampled from Hilangagan beach resort. With this, a total of 9 microplastics were observed from Baybay boulevard with an average of 0.79 microplastics observed per Liter of water. In Hilangagan beach resort, from the 60 L of sampled water, 26 were observed microplastic contaminants averaging 0.43 microplastics observed per Liter of water. This result averages to an overall of 0.49 microplastics per Liter of water.

These results followed the data sheet constructed by the Marine and Environmental Research Institute and the Microplastics Sampling and Processing Guidebook of the Mississippi State University Extension with the association of the Dauphin Island Sea Lab, Alabama, and the National Oceanic and Atmospheric Administration. Data gathered in this study will be submitted to further add data on microplastics at Mississippi State University Extension Publication.

5. Conclusions

Based on the results of the laboratory analysis, the following conclusions are herein drawn by the researchers:

- 1) Microplastics were observed to be present in waters of Borongan City, Eastern Samar. From this, most of the microplastics observed were secondary microplastics, indicating the degradation of these polymeric substances in the environment.
- 2) The most common type of microplastics was Microfibers.
- 3) In terms of its physical structure, it was found out that almost all microplastics observed were filamentous in shape, only a number of microplastics observed were irregularly shaped and rounded fragments.
- 4) In terms of the color, it was observed that blue was the most prominent color in most microplastics observed; this is seconded by the color red.
- 5) A total of 35 microplastics were observed from the water samples collected, with this the microplastics from Baybay boulevard averages at 0.79 MP/L, while the average microplastic contamination in Hilangagan beach resort was calculated at 0.43 MP/L. this sums up to an average of 0.49 MP/L for both sampling sites in Borongan City.

6. Recommendations

Based on all results generated and the conclusions herein listed, the researchers further enlist the following recommendations:

- 1) Conducting similar analysis on the presence of microplastics in mangrove areas in Borongan City.
- 2) Conducting FT-IR spectroscopic analysis to further identify and disclose the

molecular compositions of the present microplastics.

3) Conducting similar study to further affirm or oppose the results of this study.

4) Conducting similar study involving presence of microplastics in freshwater estuaries or areas in Borongan City.

5) If possible, limit the use of plastics and stop the use of water bodies like “trash cans” to further limit microplastics contamination into the water systems in the province.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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