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Microscopic detection and characterization of microplastics along Rivermouths in Borongan city, Eastern Samar, Philippines

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Abstract: The purpose of this study was to ascertain whether microplastics were present in the waters near rivermouths in the Eastern Samar, Philippines, area around Borongan City. Two filtration system meshes were used to filter 20 to 30 liters of sample per area: a 30 micron nylon mesh to separate the microplastics from the filtrate and a filter sieve to remove suspended particles. A 40x magnification stereomicroscope was used to view the residue. The water samples include microplastics, according to the results. Furthermore, the majority of the microplastics that were seen were primary microplastics, which are filamentous in size and shape and primarily microfibers. Subsequent investigation showed that blue and transparent/white were the most prevalent colors. There were 104 microplastics in all, or an average of 0.74 microplastics per liter of water sample. This study suggests the use of microplastics as indicator of aquatic environmental contamination or pollution, as well as degradation.
Keywords: *30 micron filter, Borongan City, Contamination, Microcontaminants, Microplastics.*

1. Background of the Study

Rivers have become the central aspect of life in every civilization; rivers give food, and shelter materials. With the increase in population, there is also an increase in the land use of its inhabitants, and with an increase in population, there is also an increase in the use of various materials and instruments that are needed by the people for its everyday commodity. One of these is the polymeric material known as plastic.

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 250million tons in 2006 [1]. According to Cole [2], Andrady [3] and Moore [4] plastics are polymers which are a chain of molecules that are derived from small molecules of monomers that are extracted from oil or gas

Plastics have become a part of every people's lives. It can be everywhere, from hard polystyric-type, to the soft fibrous and filamented polypropylenes. These non-biodegradable instruments can almost be of any shape and sizes. But with this high volume and the quality which makes this material so useful the UNEP [5] also stated its harmful effect to the environment, especially to marine environment.

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. Valentine [6] and Cole [2] also stated that the consumption of plastics and microplastics by marine animals can lead to false satiation, starvation and death.

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Arcadio, et al. [7] stated that 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. Moreover, there have been an outlined data by the researchers on the presence of microplastics in the waters and sediments of Borongan City.

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 .5mm in diameter [3, 4]. These plastics and micro plastics become an even greater threat to the marine environment.

In Eastern Samar, upland barangays along rivers also use large volume of plastic which are used by the people living in it. With its poor waste management, a certain amount of these wastes can be brought into the river system and can travel into its mouth during lowtides. This alone is a 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 characterize the presence of microplastics along rivermouths in the rivers of Borongan City.

2. Objectives of the Study

This study aims to detect the presence of microplastics along rivermouths in 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

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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 rivermouths of Borongan City with the use of filtration and Microscopic Technique.

3.2. Locale of the Study

This study was conducted at the Chemistry Laboratory of the Biology Department of the College of Science. Water samples were collected from the rivermouth areas in all the rivers in the vicinity of Borongan City. These areas are considered for its strategic location because of the presence of upland barangays which uses different kinds of plastics for various uses.

Borongan City has more than 60 barangays in its locality with around 30 barangays present upland residing near rivers that flows into the open sea in the area of Borongan City. The territorial barangay north of the city is barangay Bugas, while in the south area, its territorial boundary is barangay Camada.

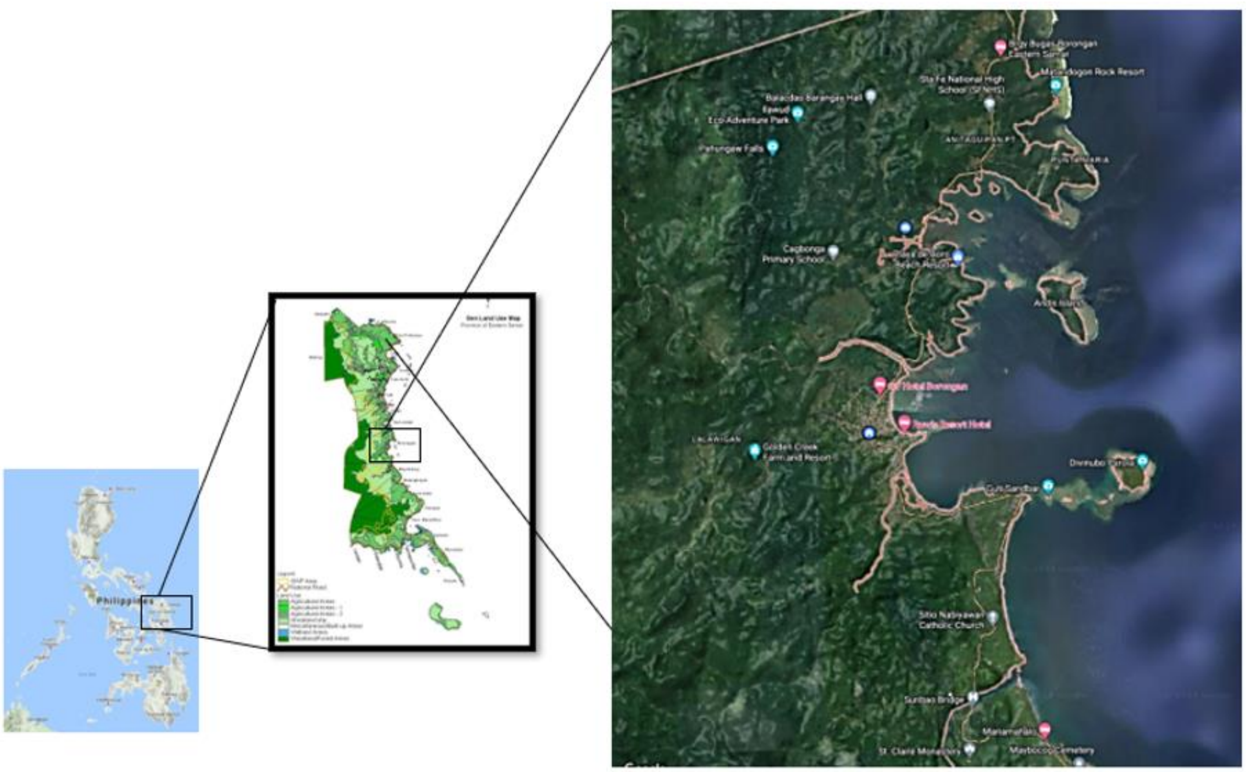

Figure 1:
Location Map of Rivers found in the vicinity of Borongan City (maps.google.com)

DOI: 10.55214/25768484.v8i6.3927

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 along rivermouths of Borongan City, Eastern Samar.

3.4. Gathering of Water Samples

Water samples were gathered from identified sampling sites established at rivermouths. A total of 20 to 30 Liters of water per site was collected during low tides or when the river water is flowing towards the sea 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 then labeled and was brought into the laboratory for filtration and microscopic analysis. Representative sample from each site was gathered using at the rivermouth area, approximately 100 to 150 m from the river area sides.

3.5. Filtration and Sieving

Filtering or sieving is the most commonly used approach for separating the supernatant containing MPs from water samples. However, there exist some differences. 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 [8-10]. In this study, 30 micron nylon filtration mesh was used for filtering MPs in the samples.

3.6. Microscopic Identification of 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. Collected water samples were filtered using a 30 micron filter mesh. The filter was allowed to stand and placed unto a Petri Dish. The Petri dish containing the filter 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 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.

3.7. Quality Control

Quality control of this study was done following the methods by with some modifications as stipulated by Arcadio, et al. [7]. During microscopy, all the wet samples to be analyzed were kept covered in glass Petri dishes. Background contamination from laboratory sources via the air and laboratory tools and equipment were tested using procedure blanks made from a filter blank which is contained in the Petri dishes. The contents of control Petri dishes were processed and screened for microplastic contamination. The procedural blanks should contain no microplastic as per stereoscopic analysis.

4. Results and Discussion

After thorough analysis and examination of observed microplastics, the following data are herein elucidated:

4.1. Microplastics Classification

Microplastics (MPs) are classified either as primary or secondary data, the following results were obtained after microscopic analysis:

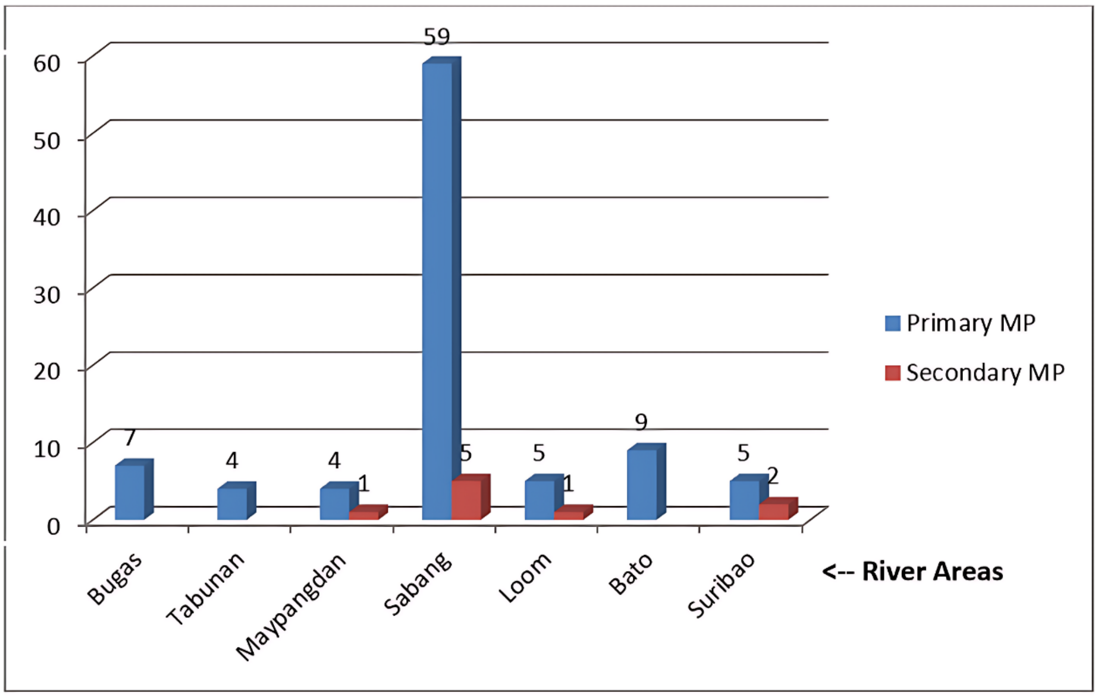

Figure 2:
Classification of Microplastics.

Based on the figure above, it can be seen that the water samples from sabang contain the highest microplastics observed (59). With these, most of the MPs observed were primary microplastics. Only a small number of MPs observed were secondary MPs. According to the Microplastics [11] the most common form of microplastics are primary microplastics, which are tiny particulates that are designed for commercial use, as well as microfibers that are shed from clothing and other textiles such as fishing nets.

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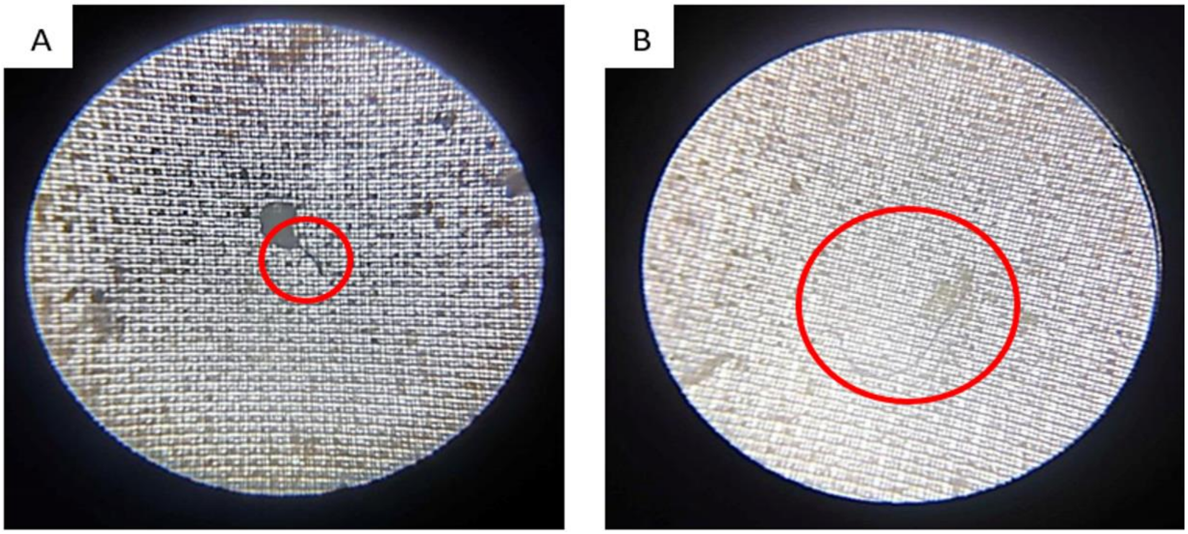

Figure 3:
A & 1B. Microfibers.

4.2. Microplastics Identification

Microplastics are identified either as microbeads, microfragments, microfibers or microfilms. The results are herein elaborated:

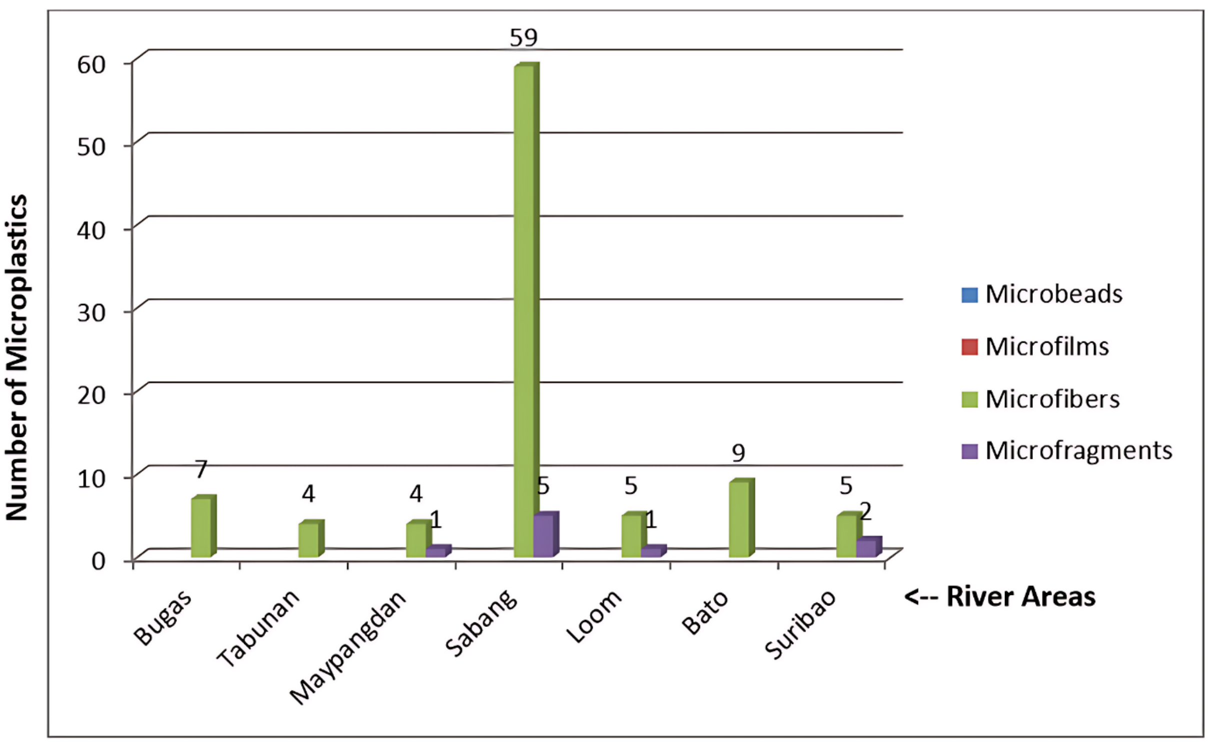

Figure 4:
Identification of Microplastics.

The figure above shows that the most common microplastics are microfibers. Also, small numbers of MPs observed were microfragments. However, no microbeads or microfilms were observed under the microscope. This result indicates consonance to the previous result that the MPs observed were primary microplastics which are mostly microfibers.

This result is supported by the statement of Weis [12] wherein the most common microplastics in the environment are microfibers , these are plastic fragments shaped like tiny threads or filaments which has many sources, including cigarette butts, fishing nets and ropes.

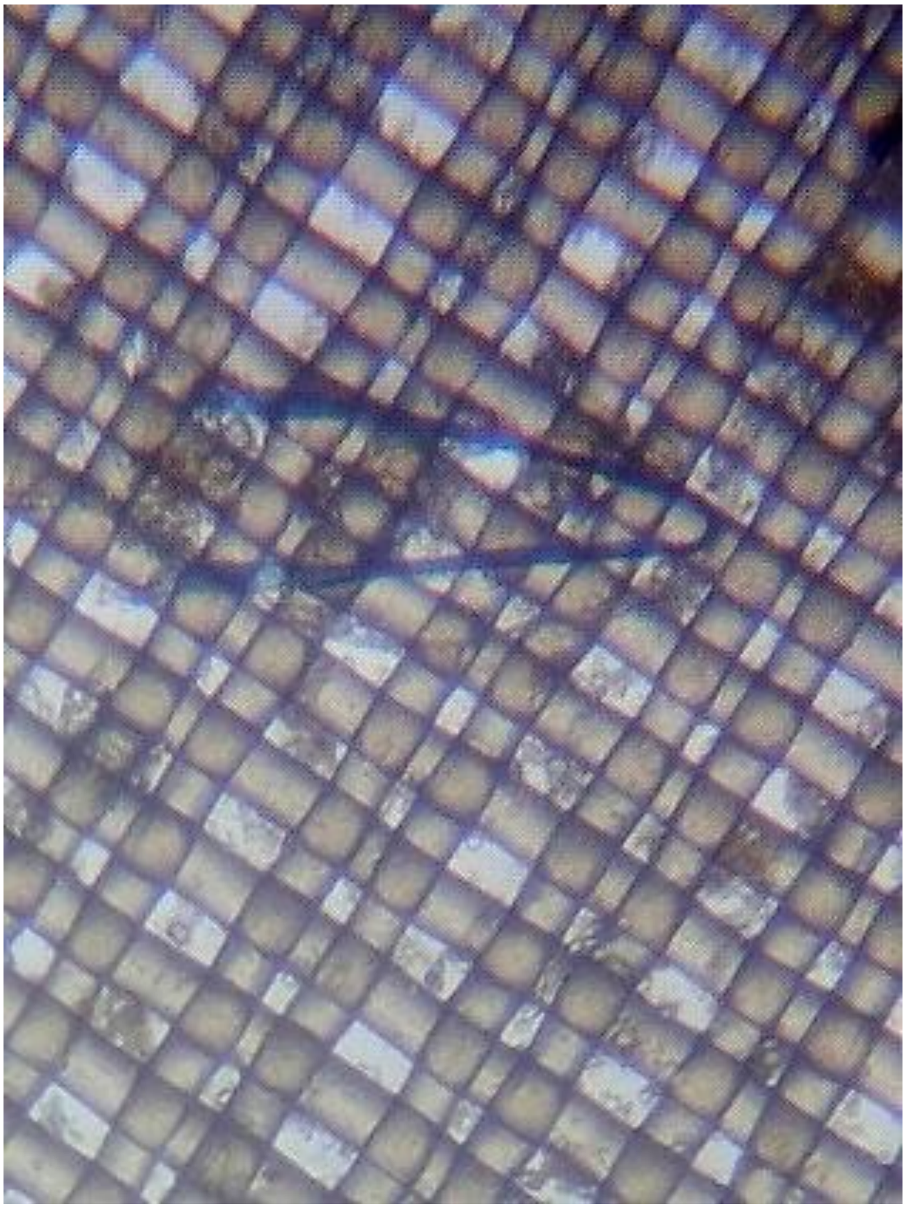

Figure 5:
Photo of a blue microplastic fiber at 40x magnification.

4.3. Physical Structures of Microplastics

Physical structure means the overall physical shape and size of the microplastics, it is round or spherical, angular, filamentous or other shaped MPs which means it goes out the usual shape of most microplastics . Results on the physical structure of the MPs observed can be seen on the figure below:

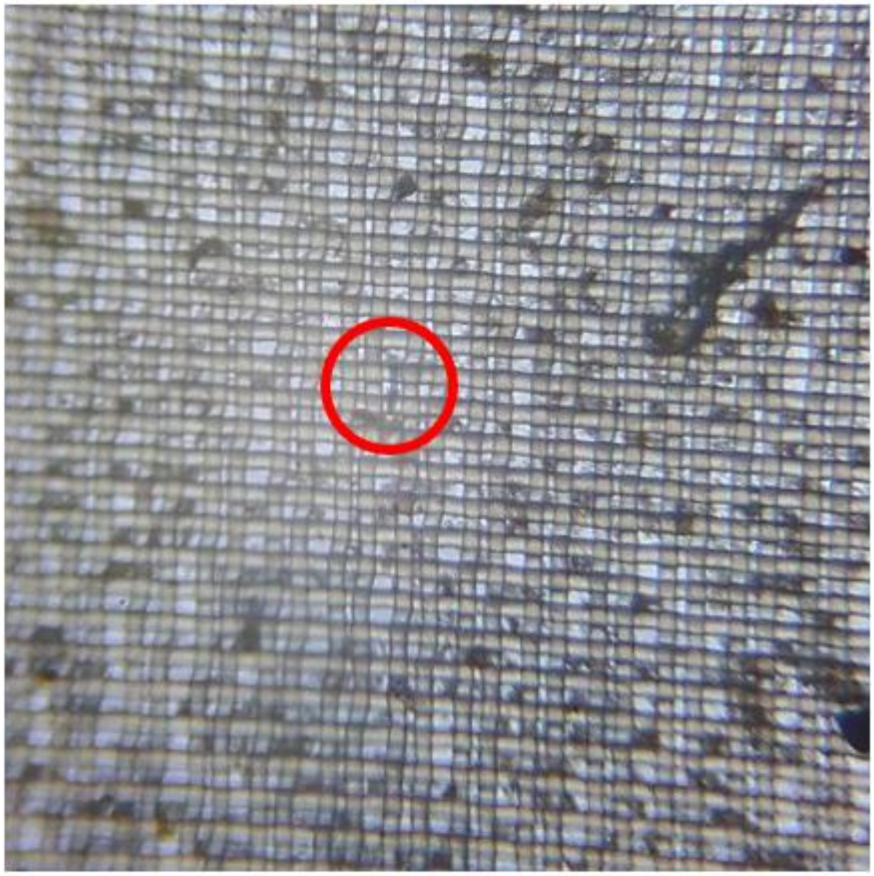

Figure 6:
Photo of a blue microfragment at 40x magnification.

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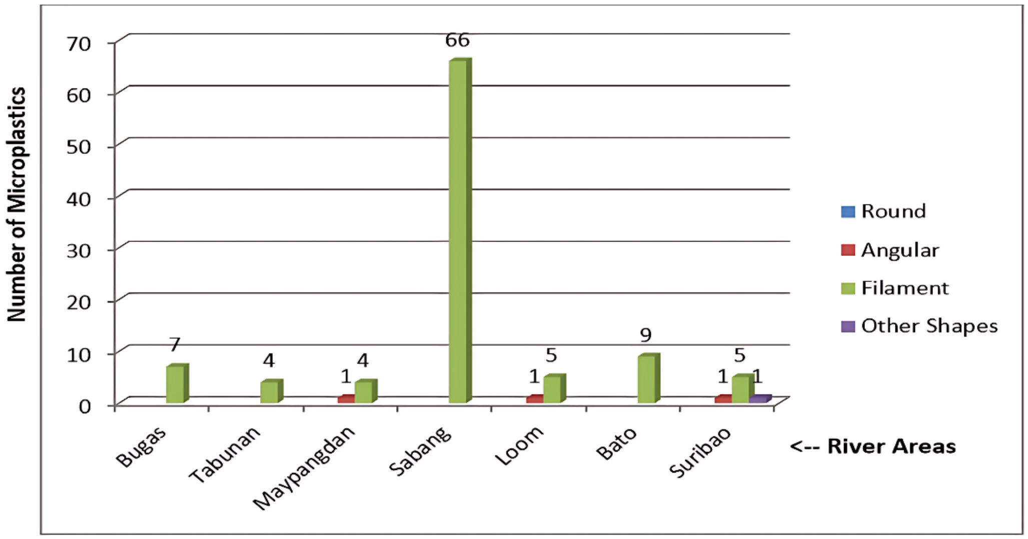

Figure 7:
Physical structure of observed microplastics.

The figure above shows that the most common MPs observed were filaments in terms of their physical structure. One distinguishing observable part of the result is that all 66 observed MPs from Sabang water samples were filaments which indicates contamination of longitudal MPs. On the other hand, only a small amount of MPs were observed as other shapes or angular. No rounded MPs were observed all throughout the conduct of the research.

This result is interestingly related to ropes and woven fabrics and other woven plastic items which are commonly being utilized in the area due to it being a "parking lot" for most water vehicles of varying proportions.

4.4. Colors of Microplastics

The following are the colors observed in the microplastics that were identified:

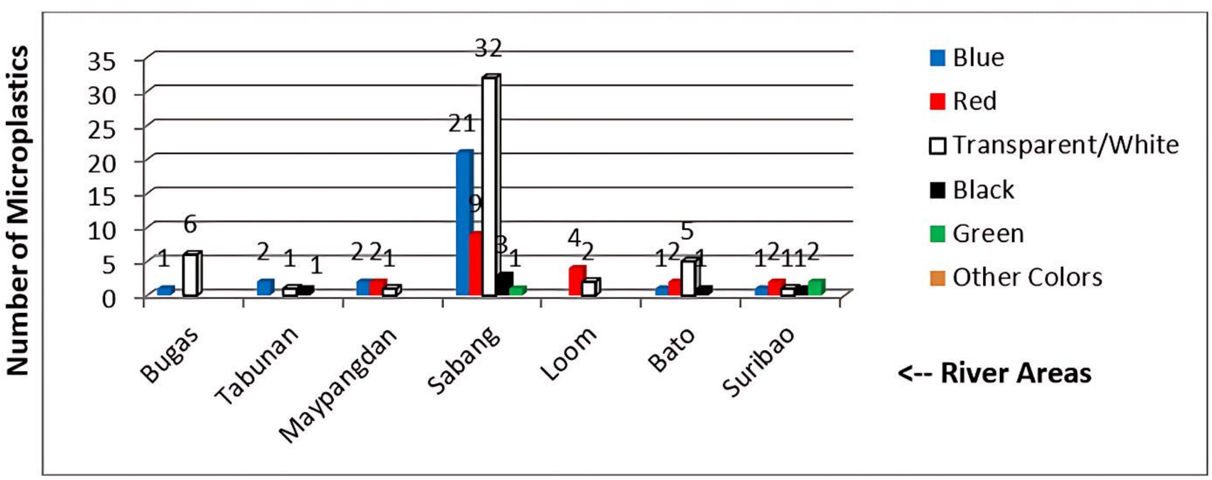

Figure 8:
Microplastic colors.

ISSN: 2576-8484
Vol. 9, No. 1: 146-158, 2025
DOI: 10.55214/25768484.v8i6.3927

It was found out that the most common color of microplastics was transparent or white. This result was recorded as most MPs observed under the microscope were filaments that are somewhat resembles nylon strands. Moreover, this results also support data from literatures that clear/white particles are the most common, but deviations such as identifying black/yellow or green/blue are also present, which is why the other common colors were blue and red.

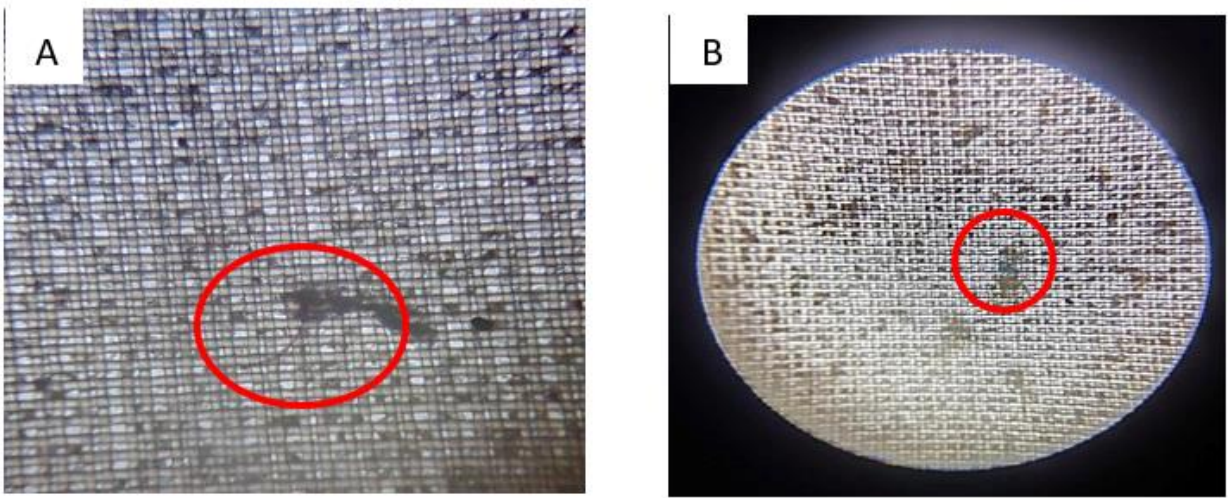

Figure 9:
A red microfilament (A); blue microfragment (B) at 40x magnification.

This result is supported by the statement from which states that the most abundant color is white or transparent. Moreover, Key, et al. [13] argues that plastics with bright colors such as red, blue and green degrade and form microplastics quicker than those with plainer colors.

4.5. Total and Average Microplastics

The total and average microplastics per sampling site is further itemized in the figure below:

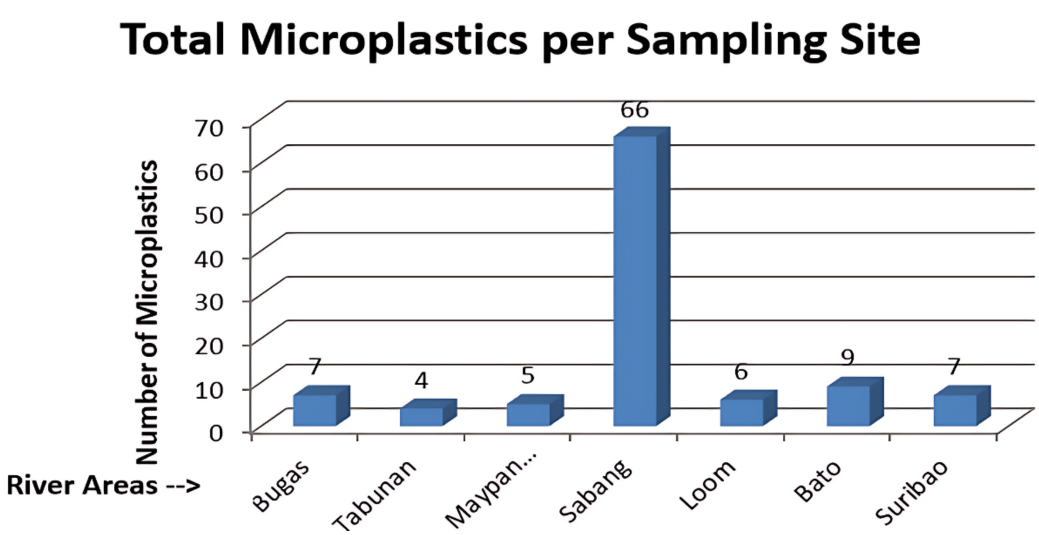

Figure 10:
Total MPs per river sites.

ISSN: 2576-8484
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Based on the overall results of the study, it was observed that a total of 104 microplastics were recorded from overall water samples of 160 Liters, coming from all the rivermouths in Borongan City. Furthermore, it was calculated that 0.65 MPs/L is the average microplastics that contaminates these rivermouths which is low.

The high number of MPs observed in the River of Borongan in Sabang can be attributed to its location. First off, the area is considered as parking spot for most motorboats and other fishing vessels that are typically used by fishermen, since the area is also a landing spot for catchment. Secondly, around the river there are multiple houses and settlers which may unintentionally dispose contaminants into the river system. Third, the Borongan river in Sabang area stretches into the Borongan city dam and from then, there are small sitios and barangays that are within the river system. Hence, the high number of microplastics observed can be attributed to river contamination due to poor waste management.

Table 1:
Average microplastics per sampling site.

River area	Amount of water sample (L)	Total MPs identified	Average (MPs/L)
Sabang	30	66	2.2
Bato	20	9	0.45
Bugas	20	7	0.35
Suribao	30	7	0.23
Loom	20	6	0.3
Maypangdan	20	5	0.25
Tabunan	20	4	0.2
Total	160	104	0.65

However, there has been no regulatory exposure limits for microplastics henceforth, this data can be used to bear support that microplastics and nanoplastics are common contaminants throughout our environment, and that, it may be deemed impossible for humans and animals, especially aquatic organisms to avoid contact with these particulates. Lastly, microplastics are deemed to be as a rising factor in terms of contamination and pollution of our natural environment which can be used as an indicator for environmental degradation measure.

Microplastics are microcontaminants that are slowly degrading our ecosystem. According Pradeau [14] plastic is ubiquitous in all compartments of the environment especially due to the fact that the food packaging found on the market for food products such as dairy products, meat, fish or drinks, including mineral water, are made in large part from plastic. Contact between food and plastic packaging is almost always the cause of mutual transfers between container and contents. The quality of food products is influenced by the contamination resulting from the interaction with the substances in the composition of the packaging, sometimes the alteration of the nutritional qualities being doubled and affecting the safety of consumption. Finally, the wide range of microplastic concentrations in effluents can be attributed to various factors, including influent from different sources such as household discharges and human activities [15].

Plastic materials represent between 60% and 80% of the waste present in the marine environment and 90% of the waste floating on the seas and oceans [16]. Plastic waste present in the marine environment is a threat to both the environment and marine fauna due to the risk of being swallowed by marine life. Statistics show that at least 267 species worldwide are affected by this problem, including 44% of birds, 43% of mammals, 86% of turtles and various fish species [17]. Plastic waste has a negative impact on the health of marine ecosystems as evidenced by the increasing number of marine species affected. These fragments of plastic material, decomposed into microparticles in suspension in the water column, or deposited in sediments, slow down or prevent the vertical transfer of oxygen [18].

In order to encourage the population to take part in a project to reduce plastic pollution, the Plastic Bank proposes for the inhabitants of Haiti, Brazil and the Philippines to bring plastic waste to areas set up for their collection; the Bank then rewards residents with digital tokens that can be exchanged for goods such as water, food or phone minutes [19].

For this result, it is strictly recommended that a more extensive implementation of the solid waste management be conducted in the contaminated areas, and in all of Borongan City. Since these contaminants and pollutants are non-biodegradable, it may affect the lives of everyone in the long run when all of the environmental aspects of the city are already contaminated or polluted with microplastics.

It is hereby theorized that the presence of these microplastics is mostly due to anthropogenic activities, effect of weather conditions to plastic polymers and plastic degradation.

5. Conclusions

The researchers hereby conclude that according to their categorization, primary microplastics are the most often seen microplastics. According to their identification, microfibers were the most prevalent type of microplastic seen. Microfibers and microfragments were the two (2) microplastics (MP) kinds that were found. The majority of MPs that were seen are filaments or filamentous physical structures. Additionally, angular forms were seen. The MPs that were seen were primarily translucent or white in appearance. Additionally, red and blue hues were seen. One hundred four (104) microplastics were found in 140 liters of water samples collected from all of Borongan City's rivermouths. Additionally, it was determined that the samples' average microplastic content was 0.74 MPs/L.

6. Recommendations

Consequently, the researchers also recommend the following based on all gathered results and conclusions: first, the researchers recommend to conduct quantitative analysis on the present microplastics such estimated length of the microfibers. Also, conducting FTIR spectroscopic analysis of MPs is strongly acclaimed to further confirm its presence and determine what type of plastics are contaminating these organisms. Consecutively, the researchers would find it helpful if there will be a conduct, or a similar study on the sediments in the area to further relate the results of this study. Moreover, conduct a similar study to further affirm or oppose the results of the current study, as well as conducting a similar study utilizing more quantity of samples to further affirm the presence of microplastics in the environment. Finally, it is recommended to the local government, the intensification of the waste management in the area so as to avoid plastic wastes and other non-biodegradable materials into open waters which can lead to microplastic contamination, which can further contaminate the ecosystem in the city.

Transparency:

The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

Copyright:

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