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Detection and Identification of Microplastics from Locally Sold Fishes in Borongan City, Samar Island, Philippines

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Abstract

Microplastics, a prevailing modern contaminant, were detected on fish caught in Brgy. Mayangdan and Brgy. Tabunan, Borongan City, Eastern Samar. Fish samples were collected from markets and barangays, with 1 representative species per species, irrespective of location. The digestive channel, including the gills, was utilized as an anatomy of concern in fishes as the digestive systems are used in the feeding process while gills are primarily exposed to the water around them. Results found a few microplastics, mostly micro fragments that are irregularly shaped and colored either red or transparent/white. This concludes the presence of microplastics in the area of the two barangays in Borongan City. Therefore, it is highly recommended that the presence of microplastics in the water and mangrove areas of the said barangay be assessed to lessen the contamination of water systems with different plastic garbage.

Keywords

Microplastics, Fish, Aquatic System, Microfragments, Borongan City, Microcontaminants

1. Introduction

Plastics are polymers, which are chains of molecules that are derived from small molecules of monomers that are extracted from oil or gas [1]-[3]. 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 1950s to over 250 million tons in 2006 [4]. However, the high volume and the quality that makes this material so useful are also harmful to the environment, especially our marine environment [5].

Plastics have penetrated everyday life. Cheap, durable, lightweight, and easy-to-carry plastic results in greater losses. Plastic waste that starts to enter rivers and exits has a bad effect on marine ecosystems [6]. The issue of marine pollution by microplastic particles has opened the eyes of many people about the potential dangers targeting marine life and humans due to the careless disposal of plastic waste into the sea [7]. Without realizing it, the use of plastic packaging and other materials containing plastic has triggered the accumulation of plastic waste in the ocean due to the absence of good waste management [8].

A study conducted in Indonesia claimed that fish can be contaminated with microplastics. The microplastic forms identified were fragments and lines. The colors of the microplastics identified were purple, black, blue, red, and brown. The microplastic assizes identified were <1 mm and 1.00 - 4.75 mm [9].

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 attractions, which in turn can result in substantial economic loss [10]. Moreover, the consumption of plastics and microplastics by marine animals can lead to false satiation, starvation and death [11].

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/m^3. 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 [12].

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 poses some difficulties for treatment because many sewage treatment plants are not able to capture and treat plastic materials that are less than 0.5 mm in diameter. These plastics and micro plastics become an even greater threat to the marine environment.

Eastern Samar, more specifically in the areas of Borongan City alone, has a prevailing problem with the numerous numbers of plastic contaminants that are harbored after a rough season, an 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 locally caught fishes in the locality of Borongan City.

2. Methodology

2.1. Research Design

This descriptive study used qualitative analysis in detecting and estimating the present microplastics in the fish sold at Borongan City with the use of Microscopic Technique. Also, fish samples were identified and classified either as offshore or onshore dwellers.

2.2. Locale of the Study

This study was conducted at the Chemistry Laboratory of the Biology Department of the College of Nursing and Allied Sciences. Fish samples were gathered from identified rural and urban barangays of Borongan City (see **Figure 1** below). Two (2) representative barangays were selected for their strategic location and for their capacity to sell fish; they were the barangays of Tabunan and Maypangdan, wherein onshore as well as offshore fish were sampled.

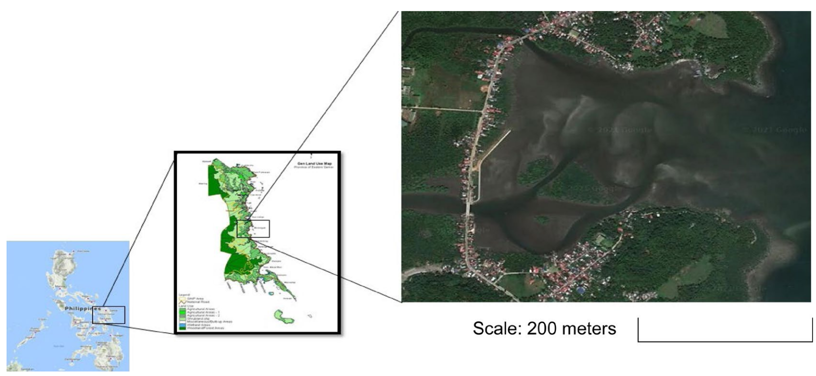

Figure 1. Location map of Brgy; Tabunan and Brgy; Maypangdan in Borongan City.

2.3. Data Gathering Procedures

The following step-by-step processes were used in the study to detect the presence of microplastics in the fish samples from Borongan City, Eastern Samar.

2.3.1. Gathering of Fish Samples

Fish samples were gathered from the local wet market of identified barangays. These samples were kept in a sterilized and disinfected hard plastic to minimize contamination. Sample preservation was done to maximize the integrity of the sample using ice and freezers. The samples were labeled and brought into the laboratory for digestion and microscopic analysis. Representative sample from each kind of locally caught fish was done. Picture Fish application, Fish Base website and the Bureau of Fisheries and Aquatic Resources (BFAR) Regional Consolidated Price Monitoring Report were used to deter mine, as accurately as possible, the scientific names of sampled fishes.

2.3.2. Sample Preparation

Fish samples were taken to the laboratory for dissection and identified sample preparation will follow the procedure by Bahri, *et al.* with minor modifications. All equipment was sterilized with distilled water. The fish was dissected, and their digestive tract was taken to extract the microplastics. The digestive tract is inserted into the sample bottle and given a 30% NaOH solution mixed with distilled water up to 3 times the volume of the tissue. The sample is left to stand for 14 days or until the digestive tract of the fish has disintegrated. Then the sample is filtered using filter paper with the help of a vacuum pump followed by a 30 micron nylon mesh. The filtrate was collected and observed using a stereo microscope.

2.3.3. Microscopic Identification of Microplastics

Wet Sampling and Microscopy were done on all fish collected and prepared.

Materials:

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. Dissolved fish samples were filtered using a 30 micron filter mesh. The filter was allowed to stand and placed on 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 matched 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 digested fish 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 of 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.

2.3.4. Quality Control

Quality control of this study was done following Egessa's methods, with some modifications as stipulated by Arcadio. During microscopy, all the wet samples 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 glass filters contained in the Petri dishes and distilled water. At each stage of sample collection and analysis, the Petri dishes were left open to the air. The contents of control Petri dishes were processed and screened for microplastic contamination. The procedural blanks contained no microplastic [13].

3. Results and Discussion

The following are the results of data gathering and analysis.

3.1. Fish Identification

The following name list of fish is commonly sold around Brgy. Tabunan and Brgy, Maypangdan.

Of all 31 fishes (**Table 1**) that were sampled in this study, 9 of those were taken off shore, meaning they are being caught out in the deep waters off Eastern Samar area. The other remaining fish are caught within the barangay areas or near the vicinity of the barangays.

Some of these fish samples are common food commodities by the majority of people such as *Thunnus tonggol*, *Trachurus mediterraneus* and *Thunnus albacares.* But most of the fish samples are commonly used as food by the local people of Brgy. Tabunan and Brgy. Maypangdan.

3.2. Microplastic Classification

Microplastics observed and confirmed were identified as primary or secondary microplastics. Only a total of 5 microplastics were observed in the overall

Table 1. List of fish species locally sold in the Barangays of Tabunan and Maypangdan.

No.	Scientific Name	Common/Local Name	Classification
1	*Abudefduf vaigiensis*	Sahoy	On shore
2	*Apogon fraenatus*	Mo-ong	On shore
3	*Caesio erythrochilurus*	Dalagambukid	On shore
4	*Chanos chanos*	Bangus	Off shore
5	*Coryphaena hippurus*	Dorado	Off shore
6	*Ctenochaetus striatus*	Oring	On shore
7	*Dascyllus trimaculatus*	Palang	On shore
8	*Decapterus macrosoma*	Malimno	Off shore
9	*Halichoeres scapularis*	Mandalunot	On shore
10	*Katsuwonu pelamis*	Budlis/Turingan	Off shore
11	*Leiognathus spilotus*	Sapsap	On shore
12	*Lutjanus decussatus*	Bangaraw	On shore
13	*Lutjanus fulviflamma*	Tulbok	On shore
14	*Myripristis murdjan*	Bukaw	On shore
15	*Naso unicornis*	Surahan	On shore
16	*Neoglyphidodon nigroris*	Palang	On shore
17	*Novaculoides macrolepidotus*	Mandalunot	On shore
18	*Paracirrhites forsteri*	Isda bato	On shore
19	*Priacanthus hamrur*	Toras	On shore
20	*Rastrelliger kanagurta*	Buraw	Off shore
21	*Saurida tumbil*	Talho	On shore
22	*Scarus ghobban*	Parrotfish	On shore
23	*Scolopsis lineata*	Silay	On shore
24	*Scomber scombrus*	Hasa-hasa	Off shore
25	*Siganus guttatus*	Kitong	On shore
26	*Siganus sp.*	Manlalara	On shore
27	*Sphyraena barracuda*	Bulos	On shore
28	*Thunnus albacares*	Baliling	Off shore
29	*Thunnus tonggol*	Pak-an/Yellowfin	Off shore
30	*Trachurus mediterraneus*	Galonggong	Off shore
31	*Upeneus moluccensis*	Tiaw	On shore

sample of fishes collected from both Maypangdan and Tabunan. Of the 5 microplastics, all of those were classified as secondary microplastics because of their irregular shape and structure. The microplastics observed were very small, just enough for the 30 micron filter mesh to capture the said contaminant. The image below (**Figure 2**) shows a microplastic trapped in the filter mesh.

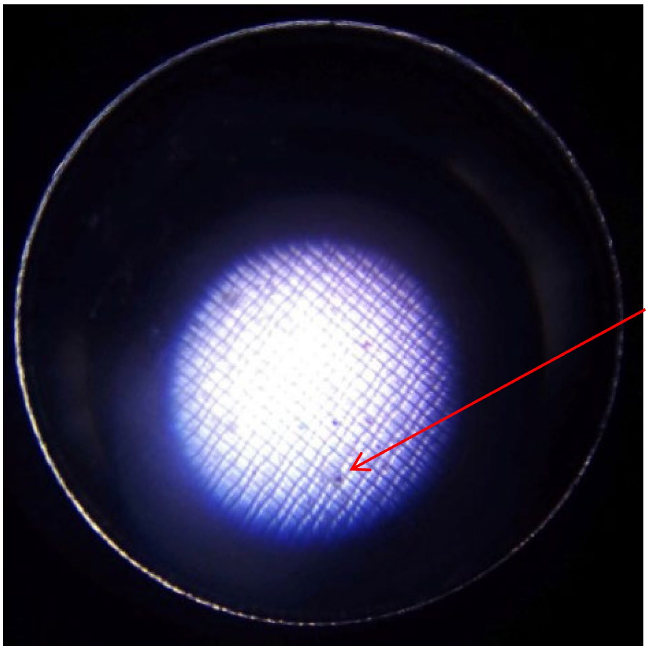

Figure 2. A red colored microplastic specimen from one of the fish samples.

Secondary microplastics are particles that result from the 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 plastic, 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.

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.

3.3. Types of Microplastics

Most of the microplastics observed were micro fragments, but microfibers (**Figure 3**) were also observed.

One observable feature of microplastics contamination in aquatic biota is that these microplastics tend to be most prominent in smaller fishes. Of the total 5 microplastics observed, 4 of those were coming from onshore fish samples while the other one was found to be present on Katsuwonu Pelamis, locally known as Budlis.

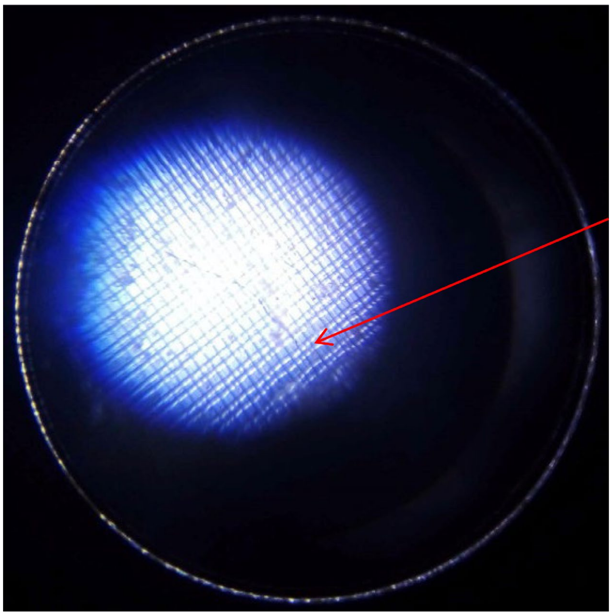

Figure 3. Microfiber from fish samples.

While larger fish contained a higher number of microplastics, smaller fish contained more microplastics per gram of tissue. These results highlight the uniqueness of microplastics as a contaminant, because they are physical particles rather than dissolved organic chemicals; they may behave differently than chemical contaminants [14].

3.4. Microplastics Structure

Three (3) out of five (5) microplastics observed were of other shapes, since they do not conform to common shapes. The other two (2) were found to be filaments, long structures of polymer plastics. One example of a microplastics contaminant can be seen in the picture below (**Figure 4**).

This result is predictable as observed since microplastics 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.

3.5. Color of Microplastics Observed

Based on the results, of the five (5) microplastics, 2 were observed to be red, 2 were transparent/white and 1 was a filamentous blue color. Coloration of microplastics is common since most plastics used in the market are colored ones. Also, according to the Microplastics Sampling and Processing Guidebook of 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 [15].

3.6. Total Microplastics

A total of 5 microplastics were observed from all the fish samples. Interestingly,

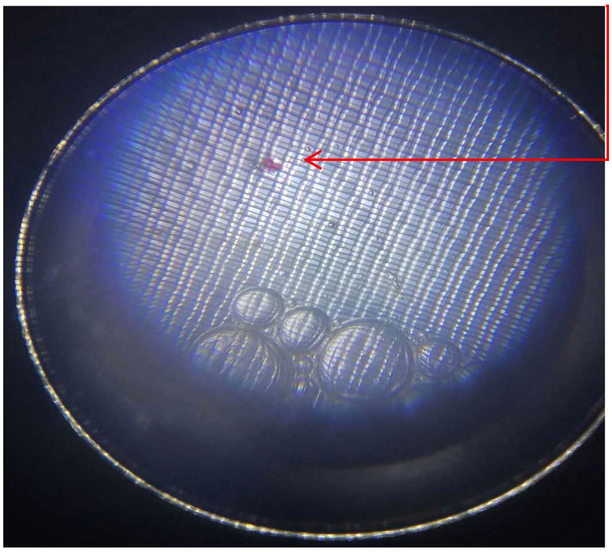

Figure 4. Microplastic specimen observed and recorded as "Other Shape".

all the five (5) MPs were also observed from 5 different samples, with it, 4 of those were coming from onshore fish samples or those that were caught on the shoreline or within the aquatic areas of Brgy Maypangdan and Brgy. Tabunan. While the other 1 was found to be present on Katsuwonu Pelamis, locally known as Budlis, an offshore species of fish.

Overall, that constitutes around 0.16 MPs/species of fish, a very small number, yet this means there are contaminations of microplastics in Borongan City, more so to its food source.

3.7. Summary

The table below (Table 2) summarizes the results obtained in this study; it shows the species where the microplastics were observed and its classification, structure as well as color are also reflected.

Table 2. Summary table of microplastics observation in fish samples.

Fish Species Collected	Mcroplastics (MP) Observed			
Scientific Name	Classification	MP Type	MP Structure	MP Color
Abudefduf vaigiensis	Secondary	Microfragment	Other Shape	Red
Dascyllus trimaculatus	Secondary	Microfragment	Other Shape	Red
Katsuwonu Pelamis	Secondary	Microfragment	Other Shape	Transparent/ white
Neoglyphidodon nigroris	Secondary	Microfiber	Filament	Blue
Paracirrhites forsteri	Secondary	Microfragment	Other Shape	Transpar-ent/white

A total of 5 microplastics which were classified as secondary MPs were observed from 5 different species of fish that are being sold in the markets of Brgy Tabunan and Brgy Maypangdan. Of the 5 MPs found, 4 of those were microfragments, which were observed to be Other Shape in terms of their structure. The colors were red and transparent/white. Generally, that constitutes around 0.16 MPs/species of fish, a very small number, yet this means there are contaminations of microplastics in Borongan City, more so to its food source.

Toxic elements and compounds have been found to be adsorbed on MNPs owing to the unique high functionalized surface area characteristic of the particles [16]. Plastics' persistence in the environment as a result of insufficient activity of catabolic enzymes continues to imperil aquatic and terrestrial ecosystems [17] [18].

The increasing presence of microplastics and nanoplastics (MNPs) in aquatic habitats poses a threat to marine life, and it is predicted that nanoplastics will be just as ubiquitous as macro- and micro-plastics, but far more destructive to living organisms due to their ability to infiltrate cells. Recent research has shown that marine and freshwater biota become entangled with plastic litter, which disrupts the ecosystem. Aquatic creatures are known to absorb and deposit these new pollutants in their digestive systems [19].

In a study conducted on various marine samples, it was observed that fishes have the highest microplastics abundance (75% ± 12.0%), followed by mollusks (90% ± 3.5%) and crustaceans (20% ± 7.0%). Filter feeders like mussels and oysters might possibly ingest microplastics [20].

Microplastics present a multifaceted challenge when it comes to waste management and remediation. Their diminutive size makes them exceptionally challenging to capture and remove from aquatic environments, rendering mitigation efforts quite demanding. To effectively tackle the microplastics issue, a comprehensive approach is necessary [21].

4. Conclusion

Microplastics contamination has found its way into the food source of Borongan City in the areas of Brgy. Maypangdan and Brgy. In Tabunan, where fish constitute a large portion of the diet of its people, microplastics were found to be present. A total of 5 microplastics were observed on a total of 31 species of fish. Of the 31, 9 were considered to be caught offshore, 22 other species were said to be caught within the vicinity of the barangays. All microplastics observed were secondary microplastics, 4 of those were coming from onshore fish samples while the other one was found to be present on the budlis fish. 3 out of 5 MPs found were considered irregularly shaped and the other remaining 2 were filaments. They were mostly micro fragments with red, transparent/white, and blue colors. The results of the study infer that an in-depth analysis and study on the presence of microplastics in rural areas, especially in third-world countries such as the Philippines, where the use of single-use plastics is prevalent and common, should be conducted. Lastly, microcontamination is a prevailing environmental problem in marine ecosystems today. Henceforth, it is crucial to create studies that will address these microcontaminants and present valid data such as this one to concerned offices that cater to combatting plastic waste and the degradation of the environment.

5. Recommendation

It is hereby recommended that more intensive microplastic research be done in the area of the barangays; also, it may be possible to conduct microplastics analysis to its mangrove areas or sea areas where these fishes are commonly caught, so as to derive a path of microplastic contamination in the area. Lastly, it is recommended that a total halt of throwing any plastic materials into aquatic environments to lessen the effect of these contaminants.

Conflicts of Interest

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

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