Microplastic Contamination Analysis in Blood Cockles (*Anadara* sp.) from Cowrie Island, Puerto Princesa City, Palawan

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ABSTRACT

Microplastics pose escalating threats to marine ecosystems and public health worldwide. Cowrie Island, despite its rich marine biodiversity, faces chronic anthropogenic pressures that degrade coastal ecology. Blood cockles (*Anadara* sp.), among the most frequently harvested shellfish in the area, are particularly vulnerable to microplastic contamination. This study aimed to detect and characterize microplastics in *Anadara* sp. from Cowrie Island. Thirty samples were collected and microplastics were characterized by particle type, shape, and color using standard methods. A total of 45 microplastic particles were found, with fibers comprising 40% of the total. Particle concentration ranged from 0.14/g to 0.24/g. Black microplastics were predominantly observed, with most particles exhibiting elongated shapes. These findings raise significant public health concerns regarding consumption of *Anadara* sp. from Cowrie Island and emphasize the need for regular water quality monitoring and expanded research employing advanced detection methods.

Keywords: bioaccumulations, bivalves, coastal contamination, plastic pollution

INTRODUCTION

Microplastics (or MPs; <5 mm) pollution remains largely unstudied in the Philippines. Understanding the characteristics, abundance, and environmental fate of plastic debris across size classes, including MPs that are difficult to detect, is important for environmental sustainability (Espiritu et al. 2019). Microplastics contaminate water, land, air, and groundwater, with ecological impacts on plants, animals, and humans. Microplastics act as vectors of toxins, absorbing pollutants and promoting bioaccumulation in marine ecosystems, organisms, and food webs (Amelia et al. 2021). Human exposure to microplastics necessitates evaluation of exposure pathways and toxicological effects on human health. Microplastics may contain and transfer harmful chemicals to plants and animals, potentially increasing bioaccumulation in food chains (Sana et al. 2020).

Recreational waters are marine environments, particularly coastal areas, that support diverse aquatic organisms and accommodate recreational activities such as tourism and fishing (Cayabo et al. 2021; World Health Organization 2021). However, increasing recreational activities in these waters raise public health concerns due to potential environmental contamination. Microplastic pollution on recreational beaches has been documented, with intermediate contamination levels observed compared to previous studies (Wu et al. 2020). Resort beaches showed elevated microplastic concentrations, indicating a positive correlation between microplastic pollution and tourism intensity. Microplastics are consumed by marine organisms, creating potential health risks through food chain bioaccumulation (Miller et al. 2020). The Philippines relies heavily on marine resources for food security, making microplastic contamination a public health concern.

Blood cockles (*Anadara* sp.) are bivalve mollusks enclosed between two shells joined by an elastic hinge ligament. They typically inhabit tidal mudflat areas with low oxygen content and possess hemoglobin that enables high oxygen retention. As filter–feeding organisms, blood cockles are economically and ecologically important and can serve as indicators of ecosystem water quality. Consequently, they are exposed to and at high risk of contamination by microorganisms and inorganic materials, including bacteria, viruses, toxin–producing dinoflagellates, and phytoplankton (Jantan et al. 2018). Moreover, microplastics are also shown to be consumed by blood cockles (Ta et al. 2022) in Thailand. The presence of microplastics in *Anadara* sp. poses potential health hazards to the community.

Cowrie Island (9°50'21.51" N 118°46'10.22" E), a popular recreational area in Honda Bay, supports active fisheries and tourism industries due to its rich marine ecosystem (Gonzales 2004). However, increasing anthropogenic pressures from recreational activities threaten water quality, marine ecosystem integrity, and public health. This study addresses these concerns by quantifying microplastic contamination in *Anadar*a sp., providing relevant data for community, fisheries, medical, and academic stakeholders. This study aimed to (1) detect microplastic contamination in *Anadara* sp. from Cowrie Island and (2) characterize microplastic types.

Microplastic contamination data in these economically and ecologically important bivalves provide baseline information on potential public health risks and environmental contamination in marine resources from Cowrie Island, Puerto Princesa City, Palawan.

METHODS

Locale of the Study

The samples of *Anadara* sp. were collected from Cowrie Island, Puerto Princesa City, Palawan (**Figure 1**). Located at Honda Bay with the coordinates 9°50’21.51” N 118°46’10.22” E, the pristine beach of the island boosts the city’s tourism as it draws volumes of tourists, foreign and locals, and the rich mangrove area of the island is home to various marine organisms.

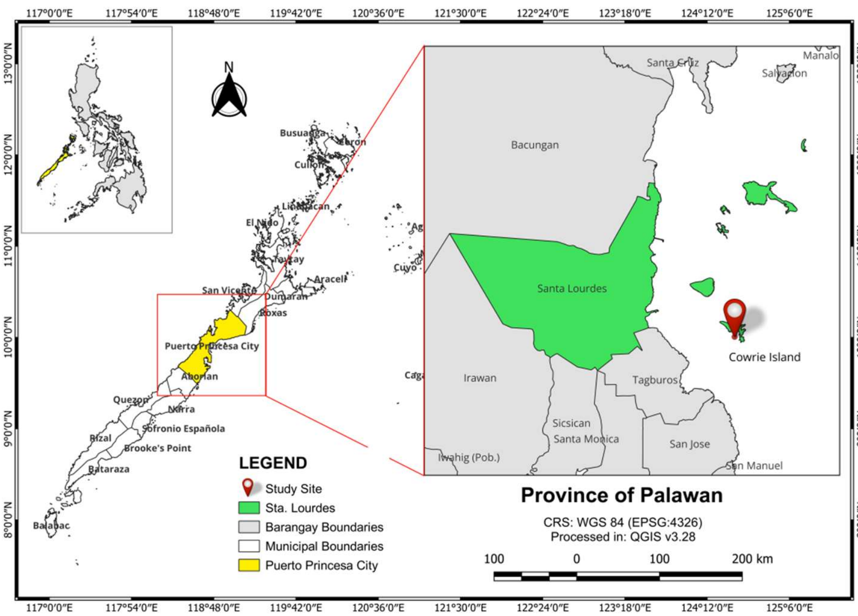

Figure 1. Map of the study site in Cowrie Island, Puerto Princesa City, Palawan.

Sample Collection and Preparation of Materials

Sampling for microplastic analysis was conducted on January 7, 2026. Thirty blood cockle samples were collected from different locations in the mangrove area of Cowrie Island and transported in glass containers within a cooler box to the Microbiological Laboratory of Western Philippines University–Puerto Princesa Campus. Glassware and equipment were cleaned thoroughly with detergent, rinsed with running water followed by filtered distilled water, and then air–dried before use. All materials used were subsequently rinsed with filtered distilled water to prevent microplastic contamination.

Preparation of Samples for Microplastic Contamination

Shells were rinsed with filtered distilled water to remove excess debris. Meat was aseptically removed using a knife and scalpel, divided into three groups by weight (Sample 1, Sample 2, Sample 3), and each group was prepared in triplicate by weight. Meat samples were cut into pieces using scissors to facilitate digestion. Samples were placed into pre–labeled Erlenmeyer flasks and covered with aluminum foil. Plastic materials such as gloves were avoided throughout the procedure.

Digestion of Organic Matter

The meat samples were soaked in 10% KOH solution where required volume was calculated using a 1:4 ratio (sample by weight solution). Samples were oven–dried for 24–48 hours at 60°C. Following digestion, samples were examined for residual organic matter. The supernatant (10% KOH and organic residue) was removed, and 100 mL of filtered distilled water was added. The replicates were rinsed with filtered distilled water by vigorous shaking to ensure complete contact with flask walls; the rinse water was retained. The 10% KOH solution was prepared by dissolving 11.8 g of 85% KOH in 100 mL of filtered distilled water (Thiele et al. 2019).

Flotation Method

Following organic matter digestion, each replicate was subjected to density separation using a concentrated saltwater solution. The volume of saltwater solution added was calculated using a 1:4 ratio (sample by volume solution). The concentrated saltwater solution was prepared by dissolving 358.9 g of laboratory–grade NaCl in 1000 mL of filtered distilled water. Laboratory–grade NaCl was added gradually to filtered distilled water while stirring. Each replicate was mixed with the concentrated saltwater solution and allowed to settle for 12–24 hours, during which organic matter residue sank and microplastics floated to the surface (Sajorne et al. 2022).

Filtration of Microplastic Samples

Filtration was performed using a filtration set, vacuum pump, clean forceps, and Whatman filter papers. Before filtration, a blank control (filtered distilled water only) was processed to assess laboratory microplastic contamination. Each replicate was carefully decanted and filtered to prevent organic residue from entering the flask opening. Filtration continued until approximately 50 mL remained in each replicate and no organic residue entered the flask opening. Each replicate required two filter papers. After filtration, filter papers were rinsed with filtered distilled water to remove salt crystallization and transferred to pre–labeled petri dishes. Samples were oven–dried for 24 hours at 37°C (Sajorne et al. 2022).

Detection and Confirmation of Microplastics

Each filter paper was examined under a stereo microscope for the presence of microplastics. Suspected microplastics were confirmed using the Hot Needle test, where a heated needle rod (heated with an alcohol lamp) contacts the particle; polymeric microplastics melt, crumple, or bend upon contact, confirming their identity.

Characterization of Microplastics

Confirmed microplastics from each replicate were pooled with their respective sample group. All microplastics were counted and characterized by shape, color, and particle type. Particle types were classified according to Frias et al. (2018) and Gündoğdu and Çevik (2017) (**Figure 2**, **Figure 3**). Microplastics were photographed using a microscope–mounted digital camera.

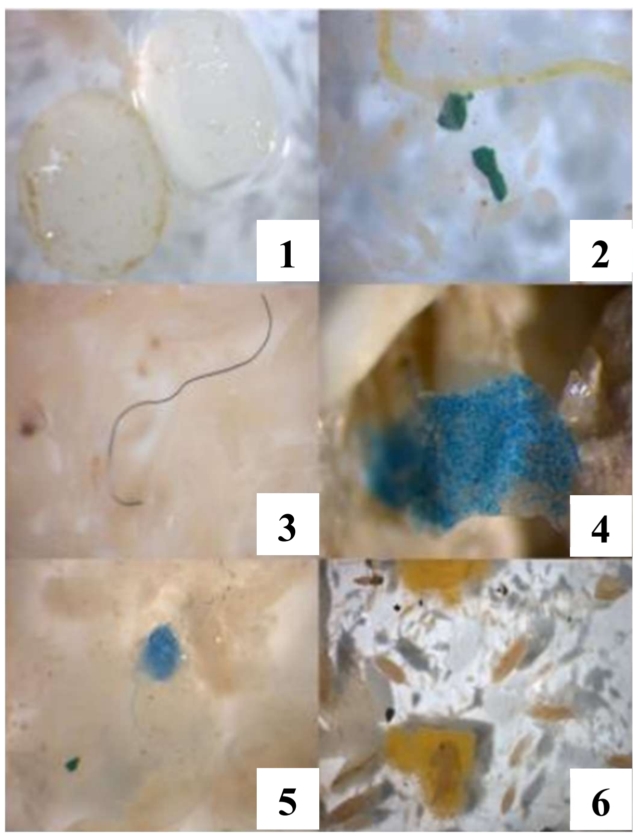

Figure 2. Examples of Microplastic Types with corresponding numbers to categories – 1) spherules/pellets, 2) fragments, 3) fibre, 4) film, 5) rope and filament, 6) sponge/foam.

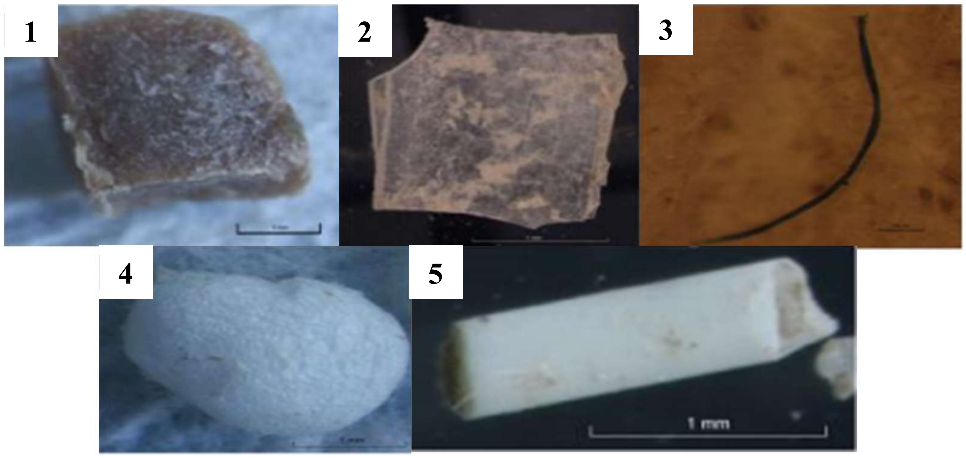

Figure 3. Shapes of Microplastics with corresponding numbers to categories – 1) irregular, 2) flat, 3) elongated, 4) spherical, and 5) cylindrical.

Data Analysis

Microplastic data were organized by sample group and replicates. Particle count, type, color, and shape were recorded for each replicate. Microplastic abundance was calculated as particles per gram of sample material (particles/g) by dividing total particle count by sample dry weight. Particle type distribution was expressed as percentage of total microplastics recovered. Color and shape frequencies were tabulated and presented as counts and percentages. Descriptive statistics including ranges and means were calculated for microplastic abundance across samples.

RESULTS

Microplastic contamination was detected in blood cockles (*Anadara* sp.) samples. Five particle types were identified: fibers, films, fragments, rope/filaments, and sponge/foam (**Figure 4**, **Table 1**). The blank control tested positive for microplastic contamination, indicating background laboratory contamination. The number was deducted from the observed MPs in samples. A total of 45 microplastics were recovered from the three samples. Fibers were the dominant particle type, comprising 40% of total microplastics, followed by fragments (33%) and films (20%). Rope/filaments and sponge/foam accounted for the remaining 7% (**Figure 5**).

Microplastic abundance per sample ranged from 0.14 to 0.24 particles/g (**Table 2**). Color distribution exhibited considerable variation: black was most prevalent at 23.1%, followed by red (19.2%), transparent (15.4%), and orange (15.4%). Brown, green, blue, and purple comprised the remaining 11% (**Figure 5**).

Four microplastic shapes were identified. Elongated particles were most abundant (n = 7), followed by irregular (n = 6), flat (n = 5), and cylindrical (n = 1) shapes (**Table 3**, **Figure 6**).

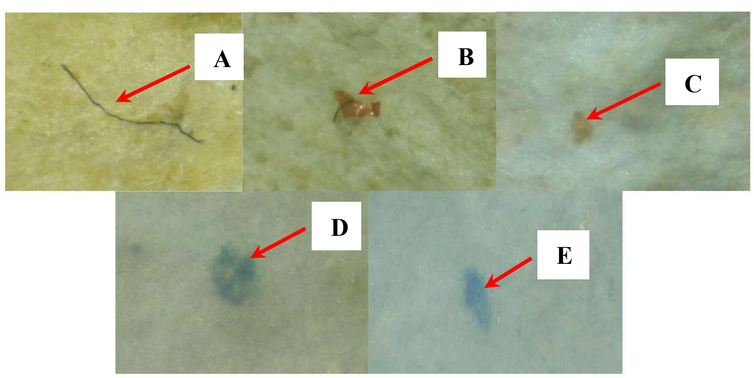

Figure 4. Examples of the microplastic particle types determined from the samples – A) fibre, B) film, C) fragments, D) rope and filament, and E) sponge/foam.

Table 1. Microplastic type, number of particles per type, and total number of microplastic particles per replicate.

Total Microplastic Particles	Microplastic Type and Total Quantity of Microplastics				
	Fibre	Fragments	Film	Rope and Filament	Sponge/Foam
Replicate 1					
S1R1	**3**	**2**			
S1R2	**2**	**1**	**1**		
S123			**1**		
Total Particles	**5**	**3**	**2**		
Replicate 2					
S2R1	**1**	**3**	**5**		
S2R2	**1**	**1**	**1**		
S2R3	**6**				
Total Particles	**8**	**4**	**6**		
Replicate 3					
S3R1	**1**	**2**			
S3R2		**4**		**1**	**2**
S3R3	**4**	**2**	**1**		
Total Particles	**5**	**8**	**1**	**1**	**2**

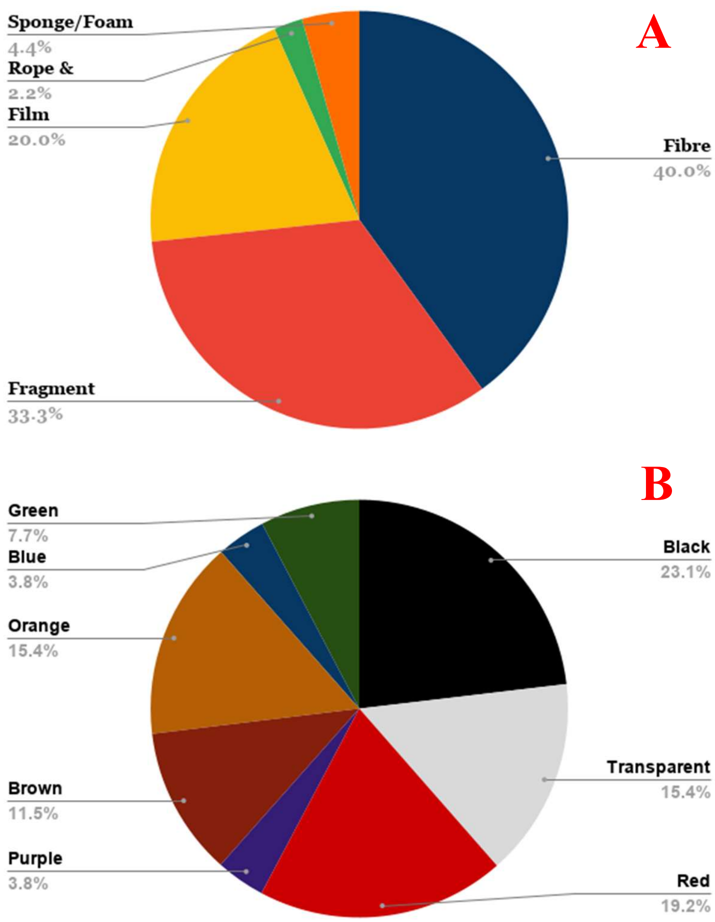

Figure 5. Characterization of Microplastics in terms of Particle Type and Color – A and B.

Table 2. Wet Weight in Grams per Sample, Quantity of Microplastic Particles and their Particles per Gram

Samples	Wet Weight in Grams	Quantity of Microplastic Particles	Particles Per Gram	Percentage of Number of Particles
Sample 1	74.325	10	0.14	22%
Sample 2	74.716	18	0.24	40%

Sample 3	71.909	17	0.24	38%
Total	220.95	45	0.62	100%

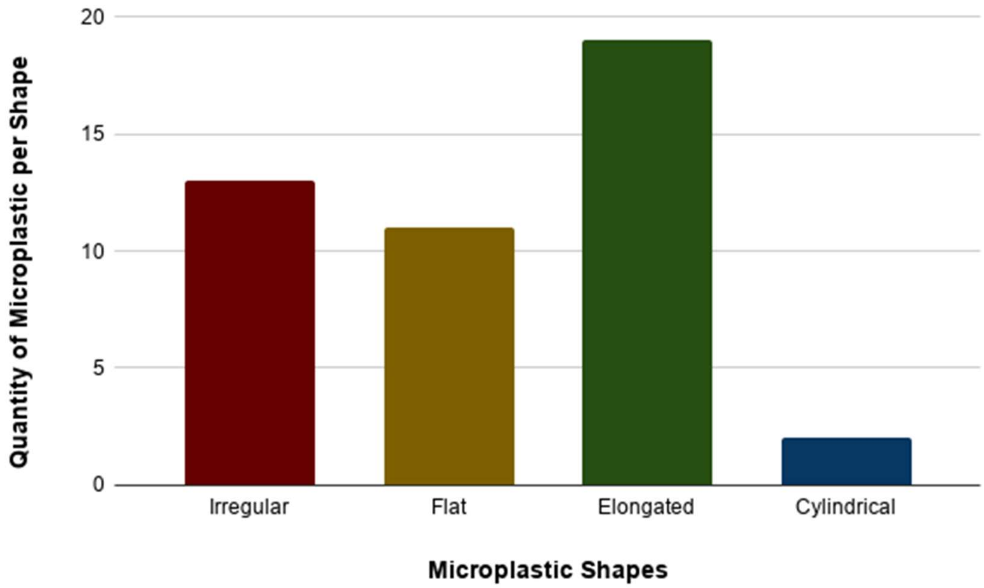

Figure 6. Quantity of Microplastic Shapes – Irregular, Flat, Elongated, and Cylindrical

Table 3. Shapes of Microplastic Particles Determined per Replicate (Indicated by ✓)

Replicates	Shapes of Microplastic Particles			
	Irregular	Flat	Elongated	Cylindrical
Sample 1				
S1R1		✓	✓	
S1R2	✓	✓	✓	
S1R3	✓			
Sample 2				
S2R1	✓	✓	✓	✓
S2R2	✓		✓	
S2R3			✓	
Sample 3				
S3R1	✓	✓	✓	
S3R2	✓	✓		
S3R3		✓	✓	

DISCUSSION

Microplastic contamination was confirmed in blood cockles collected from Cowrie Island, Puerto Princesa City, Palawan. Five distinct particle types were identified: fibers, films, fragments, rope/filaments, and sponge/foam. Overall microplastic burden and particle type composition indicated a total of 45 microplastic particles recovered across the three samples. Fibers were the dominant particle type, comprising 40% of total microplastics, a finding consistent with other bivalve microplastic studies. Multiple investigations have identified transparent fibers as the primary microplastic composition in fresh or frozen bivalve mollusks, with lesser quantities of fragments and granules (Capuozzo et al. 2025).

Fiber dominance in coastal bivalves is attributed to multiple anthropogenic sources. Fiber sources likely include fishing nets, ropes, and synthetic textile fragments released during laundering and coastal activities, which undergo fragmentation through mechanical weathering and ultraviolet degradation (Andrady 2011). This fiber dominance aligns with findings from similar coastal environments where recreational and fishing activities are prevalent (Ruairuen and Ruangpanupan 2022). The predominance of secondary microplastics (fibers and fragments) in *Anadara* sp. suggests environmental breakdown of larger plastic debris in the surrounding marine ecosystem of Cowrie Island.

Microplastic abundance per sample ranged from 0.14 to 0.24 particles/g, demonstrating variable contamination across samples. This range is lower than commercially important bivalve species but indicates consistent microplastic exposure in these filter–feeding organisms. For context, average microplastic loads of 0.36–0.47 particles per gram have been detected in commercially important bivalve species such as mussels (*Mytilus edulis*) and oysters (*Crassostrea gigas*) (Van Cauwenberghe et al. 2015). The variation in abundance across samples may reflect differences in sample composition, individual feeding rates, or temporal exposure variation.

Color distribution exhibited considerable variation, with black being most prevalent (23.1%), followed by red (19.2%), transparent (15.4%), and orange (15.4%). Brown, green, blue, and purple comprised the remaining 11%. The diversity in microplastic colors reflects the heterogeneous nature of plastic waste in the marine environment, originating from diverse consumer products and industrial sources. Black coloration may indicate aged or degraded plastics, while vibrant colors (red, orange) may represent more recently fragmented materials. This color diversity in blood cockles mirrors findings in environmental water and sediment samples, suggesting that bivalves accumulate particles reflective of their surrounding marine ecosystem (Zhu and Wang 2020).

Four microplastic shapes were identified: elongated (n = 7), irregular (n = 6), flat (n = 5), and cylindrical (n = 1). Elongated particles were most abundant, consistent with fiber morphology dominance noted in particle type composition. Irregular shaped microplastics typically originate from mechanical fragmentation of larger debris, while elongated and cylindrical shapes are characteristic of fibers derived from textile and fishing sources (Andrady 2011). The predominance of elongated particles aligns with the fiber–dominant composition of the assemblage and supports the inference that coastal fishing and textile release are primary contamination vectors at this site.

Public health implications of microplastic contamination in *Anadara* sp. are significant given the role of bivalves in local food security and consumption patterns. Bivalves are at high risk of microplastic contamination due to their filter–feeding mechanism and pose a risk to consumers as they are ingested whole (Capuozzo et al. 2025). Microplastic contamination in seafood has emerged as a significant concern for public health and food safety, as bivalve molluscs are especially vulnerable due to their filter–feeding behavior, leading to accumulation of contaminants including microplastics (Capuozzo et al. 2025). Consumption of contaminated bivalves is a main pathway of exposure to microplastics by humans, which raises potential human health concerns (Van Cauwenberghe et al. 2015).

Annual dietary exposure for shellfish consumers can amount to thousands of microplastics per year, depending on consumption patterns and contamination levels (Van Cauwenberghe et al. 2015). Beyond the physical presence of microplastics, these particles serve as vectors for persistent organic pollutants and heavy metals that accumulate on their surface (Andrady 2011). Microplastic contamination in bivalves may pose health risks to humans via seafood consumption, based on polymer hazard index assessments indicating risk levels II–III (Zhu and Wang 2020).

This study provides important baseline microplastic contamination data for *Anadara* sp. from Cowrie Island, Puerto Princesa City, emphasizing the importance of monitoring microplastic levels in locally harvested shellfish and considering food safety implications for communities dependent on marine resources. Future research should employ additional detection methods (e.g., Raman spectroscopy, FTIR) to characterize polymer types and assess associated chemical contaminants. Comparative studies across multiple harvest sites and seasons would provide greater insight into spatial and temporal microplastic contamination patterns in Palawan's coastal ecosystems.

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GENERATIVE AI STATEMENT

There were no AI tools used in the making of this manuscript.

ETHICAL CONSIDERATIONS

A Gratuitous Permit was granted by the Palawan Council for Sustainable Development for the usage of blood cockles (*Anadara* sp.) for this study.

DECLARATION OF COMPETING INTEREST

The authors would like to express that there are no competing interests to any authors.

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