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Types and Abundance of Microplastics in *Meretrix meretrix* Clams and Sediments in the Sri Tanjung Coastal Area, Rupat Sub-District, Bengkalis

Jenis dan Kelimpahan Mikroplastik pada Kerang dan Sedimen Meretrix meretrix di Wilayah Pesisir Sri Tanjung, Kecamatan Rupat, Bengkalis

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Abstract

This study was conducted in August 2024 in the coastal area of Sri Tanjung Village, Rupat Sub-district, Bengkalis Regency. The objectives of this research were to identify the types and abundance of microplastics, examine the differences in microplastic abundance across sizes, analyze the relationship between microplastic abundance and size (shell length and total weight), and explore the relationship between microplastic abundance in *Meretrix meretrix* clams and sediments. A survey method was used. Random sampling of *M. meretrix* was carried out using small shovels and traditional fisher tools (iron rakes) during the lowest tidal conditions. Results indicated that water quality parameters in Sri Tanjung were relatively good, with temperatures of 28–31°C, salinity ranging from 21–26%, brightness values between 19–25 cm, and pH values of 7–7.7. Types of microplastics found in *M. meretrix* and sediments in the coastal area included fragments, fibers, and films, with an average microplastic abundance of 55.16 particles/g and 1310 particles/kg, respectively. The abundance of microplastics was categorized based on the morphometric size of clams: small (61.32 particles/g), medium (45.01 particles/g), and large (59.16 particles/g). Sediments showed an average abundance of 1310 particles/kg. Fragment-type microplastics were the most dominant in both clams and sediments, with average abundances in small clams (29.22 particles/g), medium clams (21.29 particles/g), large clams (62.27 particles/g), and sediments (541.3 particles/kg). Film-type microplastics were the least abundant, with average values in small clams (14.44 particles/g), medium clams (10.80 particles/g), large clams (13.05 particles/g), and sediments (319.3 particles/kg). A one-way ANOVA test revealed significant differences ($p < 0.05$) in microplastic abundance between small and medium and medium and large clams but not between small and large clams ($p > 0.05$)

Keywords: *Meretrix meretrix*, Microplastics, Bengkalis.

Abstrak

ad Penelitian ini dilakukan pada Agustus 2024 di wilayah pesisir Desa Sri Tanjung, Kecamatan Rupat, Kabupaten Bengkalis. Tujuan penelitian ini adalah untuk mengidentifikasi jenis dan kelimpahan mikroplastik, mengkaji perbedaan kelimpahan mikroplastik lintas ukuran, menganalisis hubungan kelimpahan dan ukuran mikroplastik (panjang cangkang dan berat total), serta mengeksplorasi hubungan kelimpahan mikroplastik pada kerang *Meretrix meretrix* dan sedimen. Metode survei digunakan. Pengambilan sampel acak *M.*

meretrix dilakukan dengan menggunakan sekop kecil dan alat nelayan tradisional (garu besi) pada kondisi pasang terendah. Hasil penelitian menunjukkan bahwa parameter kualitas air di Sri Tanjung relatif baik, dengan suhu 28–31°C, salinitas berkisar antara 21–26%, nilai kecerahan antara 19–25 cm dan nilai pH 7–7,7. Jenis mikroplastik yang ditemukan pada *M. meretrix* dan sedimen di wilayah pesisir antara lain fragmen, serat, dan film, dengan kelimpahan mikroplastik rata-rata masing-masing 55,16 partikel/g dan 1310 partikel/kg. Kelimpahan mikroplastik dikategorikan berdasarkan ukuran morfometri kerang: kecil (61,32 partikel/g), sedang (45,01 partikel/g), dan besar (59,16 partikel/g). Sedimen menunjukkan kelimpahan rata-rata 1310 partikel/kg. Mikroplastik tipe fragmen adalah yang paling dominan baik pada kerang maupun sedimen, dengan kelimpahan rata-rata pada kerang kecil (29,22 partikel/g), kerang sedang (21,29 partikel/g), kerang besar (62,27 partikel/g), dan sedimen (541,3 partikel/kg). Mikroplastik tipe film adalah yang paling tidak melimpah, dengan nilai rata-rata pada kerang kecil (14,44 partikel/g), kerang sedang (10,80 partikel/g), kerang besar (13,05 partikel/g), dan sedimen (319,3 partikel/kg). Tes ANOVA satu arah mengungkapkan perbedaan yang signifikan ($p < 0{,}05$) dalam kelimpahan mikroplastik antara kerang kecil dan menengah dan sedang dan besar, tetapi tidak antara kerang kecil dan besar ($p > 0{,}05$).

Kata kunci: *Meretrix meretrix*, Mikroplastik, Bengkalis

1. Introduction

Plastic is used daily for household tools, vehicles, and various other products. However, excessive plastic consumption negatively impacts the environment. One of the main issues caused by plastics is marine pollution caused by marine debris originating from human activities. Plastic debris is the most commonly found marine debris and takes decades to centuries to decompose naturally. This debris undergoes mechanical degradation, forming small particles known as microplastics (Alpiansyah et al., 2021).

Microplastics, less than 5 mm in size, seriously threaten marine ecosystems. Through larger plastic breakdown, they derive from primary sources such as cosmetics and detergents or secondary sources. These particles enter marine waters through rivers, ocean currents, and human activities, including fishing gear and domestic waste.

Microplastics accumulate in marine organisms, particularly filter feeders like clams, disrupting food chains. Sri Tanjung Village, located in Rupat Sub-district, Bengkalis Regency, Riau Province, borders the Malacca Strait and is known for producing *M. meretrix* clams, a primary livelihood for locals. These clams naturally inhabit muddy and sandy sediments in relatively calm waters. Microplastics in sediments can affect these clams, potentially impacting human health through consumption.

Given that clams are good bioindicators of microplastic pollution in coastal areas, this study aims to analyze the types and abundance of microplastics in *M. meretrix* and sediments in Sri Tanjung's coastal area, as well as to reveal the relationship between microplastic abundance and clam size and between microplastics in clams and sediments.

2. Materials and Methods

2.1. Time and Place

This research was conducted in August 2024 in the Sri Tanjung coastal area, Rupat Sub-district, Bengkalis Regency. Sample analyses were conducted to determine microplastic abundance in *M. meretrix* in the Marine Chemistry Laboratory, Department of Marine Science, Faculty of Fisheries and Marine Sciences, Universitas Riau (Figure 1).

2.2. Procedures

2.2.1. Measurement of Water Quality

Measured parameters included temperature, pH, salinity, and current velocity during high tide at sediment sampling locations. A thermometer measured temperature, a pH meter determined pH, salinity was gauged using a hand refractometer, and current velocity was measured with a current drogue.

2.2.2. Sampling

Sediment samples were collected with small shovels at the lowest tide, at 0–10 cm depths, with 500 g per sample. Clam samples were randomly collected using traditional iron rakes, with 15 ind sampled per location, ranging in shell size from 1.5 to 4 cm.

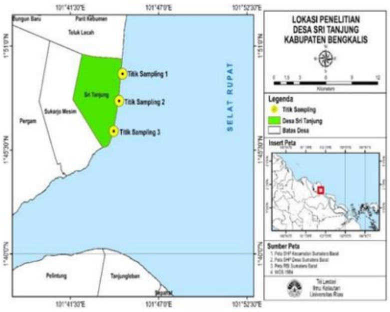


Figure 1. Research location map

2.2.3. Microplastic Abundance in Sediments and Clams

Microplastics in sediment can be calculated using the method described by Dewi et al. (2015). The calculation of microplastic abundance in sediment can be determined using the following formula:

$$\text{microplastic abundance} = \frac{\text{number of microplastic particles}}{\text{dry sediment weight (g)}}$$

Meanwhile, the calculation of microplastic abundance in clam samples refers to Digka et al. (2018) and can be performed using the following formula:

$$\text{microplastic abundance} = \frac{\text{number of microplastic particles}}{\text{Clam flesh weight (g)}}$$

The BCF categories are divided into three classifications: Accumulator if BCF > 1; Indicator if BCF = 1; Excluder if BCF < 1. According to MacFarlane et al. (2007), BCF is calculated using the following formula:

$$\text{BCF} = \frac{\text{microplastic concentration in clam}}{\text{microplastic concentration in sediment}}$$

2.3. Data Analysis

The analysis of differences in microplastic abundance among the sizes (small, medium, large) of Meretrix meretrix was conducted using a One-Way ANOVA test, followed by an LSD test. The relationship between microplastic abundance in *M. meretrix* and its size (total weight and shell length) and the relationship between microplastic abundance in *M. meretrix* and sediment was determined using simple linear regression analysis.

3. Result and Discussion

3.1. Water Quality

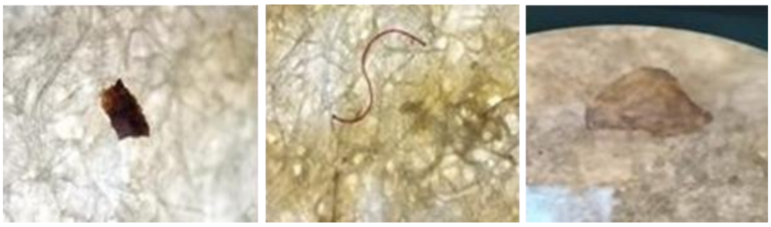
The village of Sri Tanjung has significant natural resource potential in the fisheries sector, making fishing a common occupation among its residents. The coastline of Sri Tanjung is surrounded by extensive mangrove forests that stretch along its shores. The beach features a gently sloping contour with a sand and mud substrate. The local community utilizes this beach as a site for harvesting shellfish for personal consumption and sale in local markets. Based on the results of water quality parameter measurements in the intertidal zone at various sampling points in Sri Tanjung Village (Table 1), the coastal waters of Sri Tanjung exhibit a salinity range of 22-26‰, a current velocity of 0.2-0.3 m/s, a temperature of 30-31°C and a pH level of 7.5-7.7, indicating normal conditions.

Table 1. Water quality parameters at sampling sites

Sampling Point	Temperature (°C)	Salinity (%)	Current Velocity (m/s)	pH
1	31	22	0.2	7.5
2	30	25	0.3	7.7
3	31	26	0.3	7.7
Average	30.67	24.33	0.26	7.6

3.2. Types and Abundance of Microplastics in M. meretrix

Based on observations conducted in the Marine Chemistry Laboratory, three types of microplastics were identified in the Asiatic hard clam from the coastal area of Sri Tanjung Village: fragments, films, and fibers (Figure 2). The quantity of microplastics in *M. meretrix* can be classified into three size categories: small (2.3–2.7 cm), medium (2.8–3.2 cm), and large (3.3–4 cm). The highest microplastic count was found in large clams, with an average of 109.8 particles/individual, while the lowest count was observed in small clams, with an average of 32.73 particles/individual (Table 2).



Fragment Fiber Film

Figure 1. Types of microplastics found in Asiatic hard clams (*M.meretrix*)

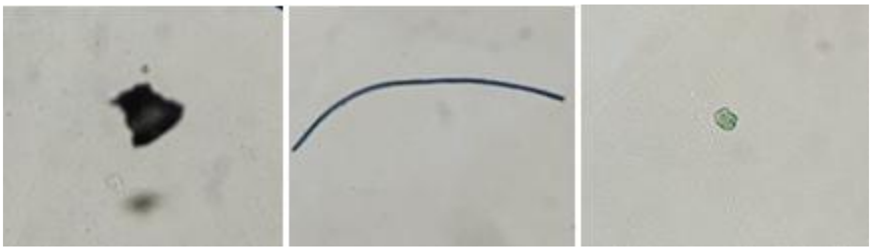
Table 2.Types and Abundance of Microplastics in M. meretrix Based on Size

Size	Shell Length (cm)	Fragment (particles/ind)	Fiber (particles/ind)	Film (particles/ind)	Total (particles/ind)
Small	2.45	15.4±2.10	9.33±2.79	8±3.46	32.73±8.35
Medium	3.03	25.47±2.70	15.73±2.76	13.07±3.03	54.27±8.49
Large	3.67	64.27±7.69	21.60±3.91	23.93±2.89	109.8±14.49
Average	3.05	34.71±4.16	15.55±3.15	15±3.12	65.6±10.44

Fragments were the most dominant type of microplastics identified in this study, with an average abundance of 28.33 particles/gram. Fragment-type microplastics originate from the breakdown of larger plastics containing synthetic polymers, such as those found in bottled beverages and food packaging. According to research by Jahan et al. (2019), fibers represent the most common and widely distributed type of microplastic in aquatic environments, eventually accumulating in various organisms, including clams. Fibers in clams likely result from their ability to accumulate in the digestive system easily. Film-type microplastics were the least abundant, as their buoyant nature causes them to float in the water column and be more readily transported by currents. Consequently, film microplastics are rarely found in benthic organisms like oysters and clams burrowing into the seabed (Kazour et al., 2019).

3.3. Types and Abundance of Microplastics in Sediments

Based on research findings and laboratory analysis, three types of microplastics were identified in the sediment from the coastal area of Sri Tanjung Village: fragments, fibers, and films (Figure 3). According to the results in Table 3, the highest abundance of fragment-type microplastics was observed at sampling point III (590 particles/kg), followed by sampling point II (546 particles/kg) and sampling point I (488 particles/kg). The lowest abundance of film-type microplastics was recorded at sampling points II (292 particles/kg) and I (320 particles/kg). Meanwhile, the lowest abundance of fiber-type microplastics was found at sampling point III (434 particles/kg).



Fragment Fiber Film

Figure 3. Types of microplastics found in sediment in the coastal area of Sri Tanjung Village

Table 3. Types and abundance of microplastics in sediments

Sampling Point	Fragment (particles/kg)	Fiber (particles/kg)	Film (particles/kg)	Total (particles/kg)
1	488±94.45	466±92.90	320±88.03	1274±275.38
2	546±168.76	448±78.55	292±40.87	1286±288.18
3	590±83.67	434±66.56	346±71.27	1370±221.50
Average	541.33±115.62	449.33±79.33	319.33±66.72	1310±261.68

Fragment and fiber microplastics were the most frequently detected types in the study area. This is likely due to the high presence of household plastic waste and marine debris. Fragment microplastics typically derive from plastic bottles and single-use food or beverage packaging, characterized by irregular shapes, various colors, and relatively thick structures. Fiber microplastics were the second most common type found, which can be attributed to the activities of the residents of Sri Tanjung Village, where fishing is a predominant occupation. Fishing activities are a primary source of fiber microplastics, originating from fishing ropes and nets that become detached or are carried away by currents and waves (Wang et al., 2019). On the other hand, film microplastics are characterized by their thin and flexible physical properties and generally originate from fragments of single-use plastic waste.

3.4. Relationship Between Microplastic Abundance and Clam Size

Based on simple linear regression tests of shell length and total body weight of clams against the abundance of microplastics in the clams, the results showed no significant relationship, with correlation values (r) = -0.1933 (Figure 4) and (r) = -0.1803 (Figure 4).

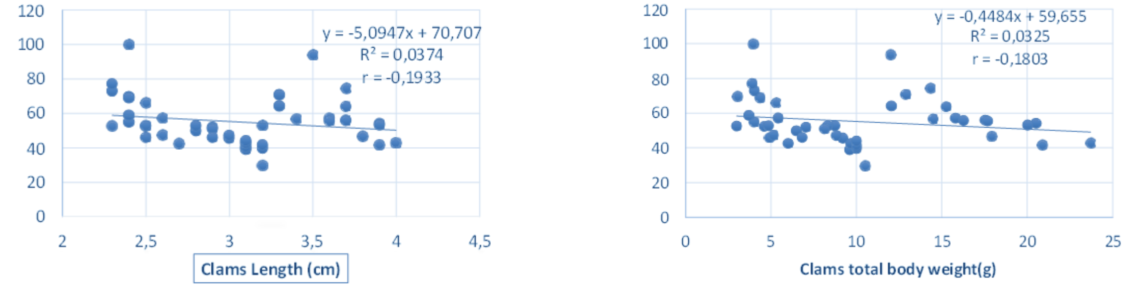


Figure 4. Relationship between microplastic abundance and clam size

The simple linear regression analysis between microplastic abundance and shell length in *M.meretrix* showed a negative relationship, with a correlation value (r) = -0.1933 and a coefficient of determination (R^2) = 0.0374, yielding the regression equation Y = 70.707 + (-5.0947)x. The simple linear regression analysis between microplastic abundance and total body weight in *M. meretrix* showed no significant relationship, with a correlation value (r) = -0.1803 and a coefficient of determination (R^2) = 0.0325, yielding the regression equation Y = 59.655 + (-0.4484)x. The absorption of microplastics in clams is suspected to be influenced by filtration rates, which can increase as the growth rate increases. However, it is suspected that filtration rates may differ between large and small-sized clams. According to Tantanasarit et al. (2013), smaller clams tend to have faster filtration rates than larger clams, likely due to smaller clams absorbing more food than larger clams.

3.5. Relationship Between Microplastic Abundance in Clams and Sediments

Based on the results of simple linear regression analysis, the concentration of microplastic abundance in *Meretrix meretrix* and sediment showed a positive relationship with a correlation value (r) = 0.11338 and a coefficient of determination (R^2) = 0.0129, yielding the regression equation Y = 43.277 + 0.0091x (Figure 5).

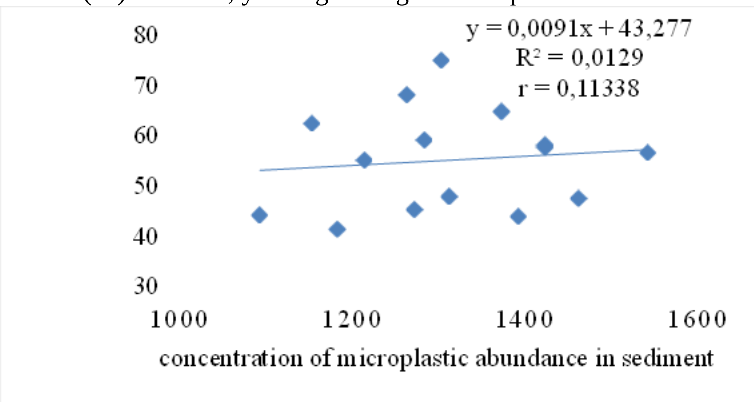


Figure 5. Relationship between microplastic abundance and clam size

Based on the observations and simple linear regression analysis between microplastic abundance in *M. meretrix* and microplastic abundance in sediment, it was found that the microplastic abundance in clams increased as the microplastic abundance in sediment increased. The analysis results suggest that the increase in microplastic abundance in clams is relatively small. This occurs because *M. meretrix* is a biota that lives within the sediment and is a filter feeder. The feeding method of clams as filter feeders can influence the accumulation of particles in their bodies (Sekarwardhani et al., 2022). As filter feeders, clams filter all food within their bodies, such as seawater and sediment. Microplastics in sediment and water are suspected to enter the clam's body due to its limited movement, causing it to ingest particles from its surroundings. Based on the BCF calculations conducted in this study, the BCF values for small clams (0.047), medium clams (0.034), and large clams (0.045) were obtained.

4. Conclusions

Based on the results of the study, the types and abundance of microplastics in *Meretrix meretrix* classified by size (small, medium, large) in the coastal area of Sri Tanjung Village included fragments, fibers, and films, with an average abundance of 55.36 particles/individual. In sediment, the microplastics identified were fragments, fibers, and films, with an average abundance of 1310 particles/kg. The abundance of microplastics among the different sizes of *M. meretrix* (small, medium, large) showed no significant differences. Additionally, the relationship between microplastic abundance in *M. meretrix* and the total weight and shell length of the clams was negative, indicating that neither total nor shell length influenced the abundance of microplastics in the clams. In contrast, there was a positive relationship between microplastic abundance in *M. meretrix* and sediment, where higher microplastic abundance in sediment corresponded to higher microplastic abundance in the clams.

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