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# Accumulation of Microplastics on Seagrass Leaves of *Enhalus acoroides* on Mare Island as a Conservation Area in North Maluku

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## ABSTRACT

Seagrass ecosystems have been indicated as the new hotspots of microplastics (MPs) in the marine environment. This work aimed at determining the potential of microplastics and epibionts accumsulation on *Enhalus acoroides* leaves at the coast of Mare Island as one of the conservation areas in North Maluku region. Samples collection was carried out in August 2021 at two research locations, namely Maregam (Station 1) and Marekofo (Station 2) villages. Seagrass leaves were collected using line transect which was stretched out to 50 m vertically seaward.Each of *E. acoroide*s leaves (18 leaves) was observed for the presence of microplastic that attached on the epibionts of seagrasses. Subsequently, the characterization of epibionts on the seagrass leave were determined according the rank of the cover percentage of epibionts. Meanwhile microplastics were identified referring to their shapes and colors under microscope observation. The results showed that three types of microplastics were embedded on the epibiont matrices *of E. acoroides* leaves namely fibers, fragments, and pellets. The average number of microplastic particles *in E. acoroides* leaves at station 1 was higher (9.1 MPs particles/leaf) than Station 2 (4.5 MPs particles/leaf). The accumulation of fiber type was higher at station 2 (76%) than station 1 (41%), conversely the accumulation of fragment type was higher at Station 1 (54%) than station 2 (19%), while pellets were found to be the least in both stations. Overall, seven colors of microplastic were found, namely blue, brown, black, red, green, orange and white, except at station 2 was absence of brown one. Station 1 was dominated by the white color (32%) while station 2 dominated by the black color (32%). According to the level of epibiont closure, it was found that the presence of microplastics was higher in the rank 1 epibiont at Station 1 where the epibiont covers less than 25%, while at station 2 was the highest one with the rank of 3 which meant that the epibiont covers was 50 – 75%. We concise that through this finding the society should be aware of microplastics extention on coastal area including seagrass leaves. Thus, the local government should pay attention of plastic debris management in the future to mitigate the impacts of these contaminants to the marine environment.

Keywords: Microplastics, *Enhalus acoroides*, Epibiont, Mare Island.

## *ABSTRAK*

Ekosistem lamun telah diindikasikan sebagai hotspot baru mikroplastik (MPs) di lingkungan laut. Penelitian ini bertujuan untuk mengetahui potensi akumulasi mikroplastik dan epibiont pada daun lamun *Enhalus acoroides* di perairan Pulau Mare yang merupakan salah satu kawasan konservasi di Maluku Utara. Pengambilan sampel daun lamun E. acoroides dilakukan pada bulan Agustus 2021 di dua lokasi penelitian yaitu Desa Maregam (Stasiun1) dan Desa Marekofo (Stasiun 2). Daun lamun diambil menggunakan Metode Transek Garis yang ditarik tegak lurus garis pantai sejauh 50 meter. Setiap daun *E.acoroides* (18 daun) diamati keberadaan mikroplastik yang menempel pada epibion lamun. Karakterisasi epibiont pada daun lamun ditentukan berdasarkan peringkat persentase penutupan epibiont. Sementara mikroplastik diidentifikasi berdasarkan bentuk dan warna melalui pengamatan dibawah mikroskop. Hasil penelitian diperoleh tiga tipe mikroplastik yang tertanam di matriks epibion daun lamun *E. acoroides* yaitu fiber, fragmen, dan pellet. Jumlah rata-rata partikel mikroplastik pada daun lamun *E.acoroides* di stasiun 1 lebih tinggi (9,1 partikel MPs/daun) daripada Stasiun 2 (4,5 partikel MPs/daun). Akumulasi mikroplastik tipe fiber

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lebih tinggi di stasiun 2 (76%) dibandingkan stasiun 1 (41%), sebaliknya akumulasi mikroplastik tipe fragmen lebih tinggi di Stasiun 1 (54%) daripada di stasiun 2 (19%), sementara pellet ditemukan paling sedikit di kedua stasiun. Secara keseluruhan ditemukan tujuh warna mikroplastik yaitu biru, coklat, hitam, merah, hijau, orange dan putih, kecuali di stasiun 2 tidak ditemukan warna coklat. Stasiun 1 lebih didominasi oleh warna putih (32%) sementara stasiun 2 lebih didominasi warna hitam (32%). Berdasarkan tingkat penutupan epibiont diperoleh hasil bahwa keterdapatan mikroplastik lebih tinggi pada epibiont peringkat 1 dimana penutupan epibiont <25% di Stasiun 1, sedangkan di stasiun 2 ditemukan paling tinggi di epibiont peringkat 3 dimana penutupan epibiont 50% - 75%. Kami menyimpulkan bahwa melalui temuan ini masyarakat harus mewaspadai meluasnya mikroplastik di wilayah pesisir termasuk di daun lamun. Oleh karena itu pemerintah daerah harus memperhatikan pengelolaan sampah plastik di masa depan untuk memitigasi dampak kontaminan tersebut terhadap lingkungan laut.

**Kata kunci:** Mikroplastik, *Enhalus acoroides*, Epibion, Pulau Mare.

## 1. Introduction

Plastic debris is currently becoming a global threat to marine ecosystems, it is estimated that around 60% - 80% of the total waste in the ocean is in the form of plastic debris (Derraik 2002). Microplastics (MPs) are particles derived from plastics measuring <5mm (Thompson et al., 2004). Sources of MPs are divided into primary and secondary. Primary MPs are pure plastic granules which when produced are already micro-sized, such as pellets and microbeads used in the cosmetic and toothpaste industries. While secondaries are MPs produced through the degradation and weathering process of large plastics. These MPs can enter the aquatic environment through wind or wave action (Andrady 2011). They are widely distributed in the marine environment, where sediments and marine organisms are recognized as carriers and final destinations of microplastics (Zhang et al., 2020). They have also been identified in several marine protected areas such as in Sri Lanka (Dharmadasa et al., 2021), Turneffe Atoll Marine Reserve in Belize (Goss et al., 2018) and Marine Conservation Zones in Cornwall and Special Conservation Areas in Wales (Unsworth et al., 2021). One of the important ecosystems in coastal areas, namely the seagrass ecosystem, has been pointed out as a new hotspot of MPs in the marine environment because of their presence has been identified in sediment, water column and seagrass plants themselves (Huang et al., 2021; Kreitsberg et al., 2021; Goss et al., 2018). According to Wu et al., (2022), MPs can act as vectors of contaminants and even pathogens that have the potential to threaten the vital ecosystem zone, one of which is the seagrass meadows.

Mare Island is a small volcanic island located on the west side of Halmahera Island, North Maluku, which is part of the Halmahera volcanic arc chain. Administratively, Mare Island is included in the Tidore Islands City area and since 2020 has been designated as a conservation area in North Maluku through the Decree of the Minister of Maritime Affairs and Fisheries of the Republic of Indonesia No. 66/Kepmen-KP/2020. Although it has been designated as a conservation area, plastic debris keep existing as a paramount problem on the coastal waters of Mare Island. It is feared that this will be a threat to one of the important habitats that can be found on the coast of Mare Island, namely seagrass beds. Several previous studies have indicated the ability of seagrasses to accumulate microplastics through biofilm layers and epibiont communities in seagrass leaves (Goss et al., 2018; Jones et al., 2020). The microplastics present in seagrass leaves have the potential to be transferred into the body of herbivore organisms that consume seagrass leaves and seagrass epiphytes, and may have a sustainable effect on both these organisms and the seagrass plant itself. However, available studies on plastics affecting seagrass as an important marine ecosystem are still relatively scarce (Bonano and Orlando-Bonaca, 2020), so this research is necessary to be carried out.

One of seagrass species found in the Mare Island Waters is *Enhalus acoroides* (L.f Royle), which is a seagrass commonly found in Indonesian waters (Hernawan et al. 2017) and in North Maluku (Ramili et al., 2018). *E. acoroides* is a climax species, large, long-lived, dioecious with the ability to reproduce both generatively through seeds and fruit and vegetatively through rhizome extension (Hemminga and Duarte 2000), and ecologically this seagrass provides shelter for juvenile fish and shrimp (Tomascik et al., 1997).

In addition, its large leaf size can provide more space for epiphytic growth (Pane et al., 2021) which is hypothesized to bind microplastics (Goss et al., 2018). Several previous studies have identified the presence of microplastics in seagrass leaves include *Thalassia testudinum* (Goss et al., 2018), *Cymodocea rotundata* (Priscilla et al., 2019), and *Zostera marina* (Jones et al., 2020). This study aimed to determine the potential for microplastic accumulation and epibiont presence on the leaves of *E. acoroides* at Mare Island Waters, North Maluku. The results of this study are expected to provide the data base on microplastics in seagrass beds, especially in seagrass leaves and provides the important information on the vulnerability of seagrass beds to microplastic pollution. Additionally, this information can be used as the baseline of coastal management toward the conservation area

## 2. Material and methods

### Time and Study Site

Leaf samples of *E. acoroides* were collected in August 2021 from Mare Island Waters, namely in Maregam (Station 1) and Marekofo Villages (Station 2) (Figure 1). This island is located just in front of Tidore Island which has high urban and transport activities. Assuming that plastics are the highest abundant of marine debris in this area without any waste water treatment plant and the society are lack of the awareness regarding plastic debris management. Thus microplastics would be extended around the area including seagrass leave. Additionally, this area has been established as one of Marine Protected Area in North Maluku Province.

### Data Collection

Seagrass samples were taken using the line transect method (English et al., 1997). where each station consisted of three lines transects with a distance between transects of 50 m. The line transect was stretched vertically seaward f of 50 meters, then seagrass leaves were taken at a distance of 0 m (the starting point was found seagrass), 25 m and 50 m on each transects. The seagrass leaves of *E. acoroides* were then put in a plastic ziplock to be analyzed for the presence of microplastics and epibionts in the laboratory. Each seagrass leave was put in the ziplock plastic assuming that the microplastics that would be observed were adhered on the epibionts of the leave. A total of 9 seagrass leaves of *E. acoroides* were taken along the seagrass beds at each station, thus the total number of leaf samples was 18 seagrass leaves which was represented of the upper, middle and lower area of the stations.

### Epibiont Coverage and Microplastics Analysis

The determination of the epibionts coverage level on *E. acoroides* leaves through the following procedure proposed by Goss et al., (2018). Seagrass leaves were given a ranking score based on the percentage of epibiont cover, i.e. leaves with <25% epibiont cover were ranked first, leaf epibiont coverage ranged from 25% – 50% were ranked second, and leaves with 50% – 75% epibiont cover were ranked third, and leaf epibiont cover >75% was ranked fourth.

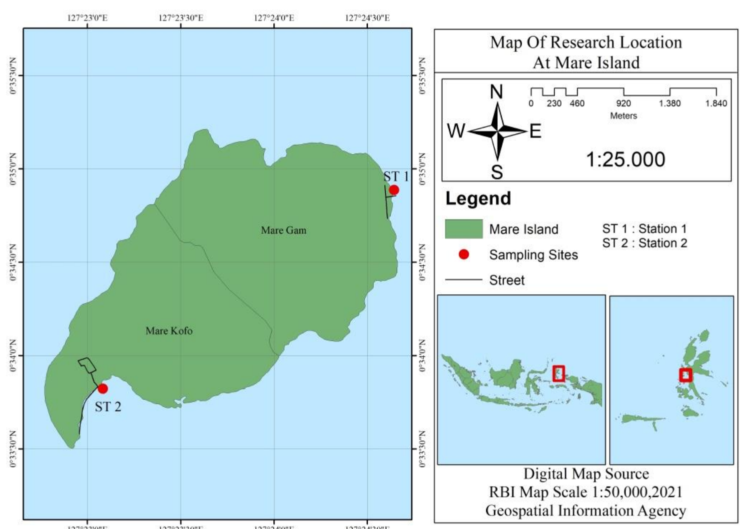


**Figure 1.** Location and sampling site at Mare Island

The observation of the microplastics presence on the *E. acoroides* leaves using a digital Musb1600X Tokmik23 microscope with 1000 x magnificient. Microplastic observations were carried out directly on seagrass leaves both on the surface and on the underside of the seagrass leaves. The results of observations that indicated that there were microplastics in seagrass leaves were then photographed for further identification. The microplastics found were recorded based on the type or shape in the form of fibers, fragments, or pellets, as well as the various colors of microplastics found based on the identification instructions by Hidalgo-Ruz et al., (2012). The results of the analysis of microplastic and epibiont data were performed in the form of tables and graphs.

## 3. Results and Discussion

### The Occurrence of Microplastic on *E. acoroides* seagrass leaves

This is the first work describing the presence of MPs on the leaves of *E. acoroides* found in one of the conservation areas in North Maluku, namely Mare Island. These MPs were found on the leaves of *E. acoroides* at both research sites, namely at St 1 (Maregam) and St 2 (Marekofo). The MPs found in the leaves of the *E. acoroides* seagrass were mostly embedded in the gelatin of epibiont matrices. Overall, three types of MPs were found, namely fiber, fragments, and pellets (Figure 2). This finding is in accordance with several previous studies by Goss et al., (2018) who found MPs on the leaves of *Thalassia testudinum*, as well as on *Cymodocea rotundata* by Priscilla et al., (2019), and *Zostera marina* (Jones et al., 2020). The results of this study indicated that MPs can be found in several species of seagrass with different leaves morphology. According to Yin et al., (2021), vascular plants, such as seagrass, can act as sinks for MPs because their surface can absorb plastics. Additionally, the presence of epibiont or epiphytic communities in seagrass leaves can trap MPs suspended material in the water column, which will then adhere to the outer layer of seagrass leaves through an adhesive biofilm (Rummel et al., 2017; Goss et al., 2018). Furthermore, Zhao et al., (2022) explained that seagrass leaves were able to encourage the formation of white floc to trap and immerse MPs and accelerate the formation of biofilms on the surface of these MPs.

The various types of microplastics found on the leaves of several other seagrass species are shown in Table 1. It can be seen that fiber and fragment type of MPs were more often found in seagrass leaves compared to others such as pellets, microbeads, films, plastic chips and flakes. This is possibly related to the source of microplastics in the local aquatic environment, where it can be directly observed a lot of plastic waste such as plastic bottles, plastic packaging and other plastics found on the coast of Mare Island. According to Kreitsberg et al., (2021), fiber type is a microplastic that is commonly found in

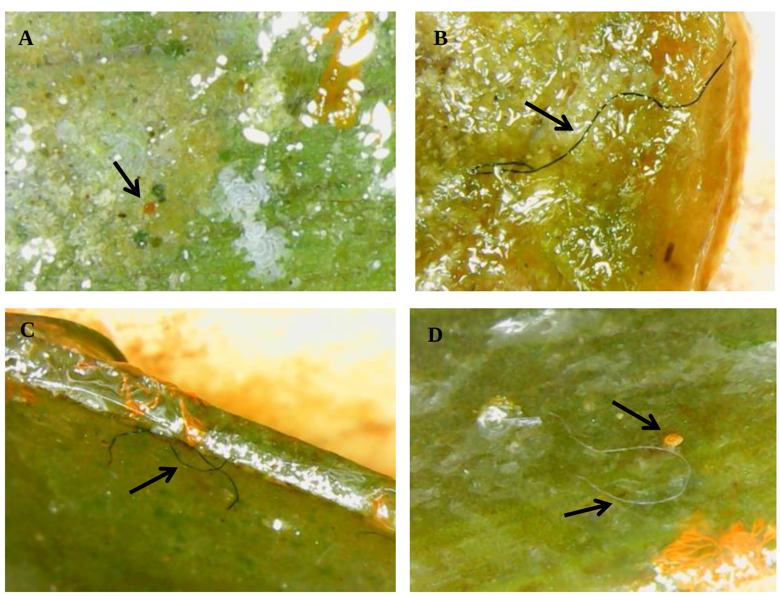


**Figure 2.** Various types of microplastics found embedded in the epibiont gelatin matrix of *E. acoroides* leaves: (A) pellet type microplastic; (B – C) black fiber type microplastic; and (D) fragment and fiber type microplastics.

**Table 1.** The various of microplastic types on several seagrass species

| Seagrass species | Sampling Area | Mikroplastic types | | | | | | | References |
|---|---|---|---|---|---|---|---|---|---|
| | | Fiber | Fragmen | Microbead | Pellet | Film | Plastic chip | Flake | |
| *Enhalus acoroides* | Mare Island, North Maluku | + | + | - | + | - | - | - | This study |
| *Cymodocea rotundata* | Seribu Island, DKI Jakarta | + | + | - | - | + | - | - | [19] Priscilla et al. 2019 |
| *Thalassia testudinum* | Turneffe Atoll, Belize | + | - | + | - | - | + | - | [6] Goss *et al.* 2018 |
| *Zostera marina* | Deerness Sound, Orkney-Scotland | + | + | - | - | - | - | + | [12] Jones et al 2020 |

Note: (+) = found
(-) = not found

the aquatic environments. Meanwhile, the weathering of plastic bottles, bags, fishing rods, and other products that are thrown into the sea causes small fragments in the form of plastic fragments (Graham and Thompson 2009). Furthermore, according to James et al., (2020), microplastic fragments measuring < 1 mm generally dominate marine sedimentary environments.

The total number of MPs particles observed on nine leaves of *E. acoroides* at St 1 was 82 particles while at St 2 there were 41 particles from nine observed leaves. The average number of microplastics found in *E. acoroides* seagrass leaves at St 1 was 9.1±10.9 MPs/leaf while at St 2 it was 4.5±4.6 MPs/leaf. These findings are higher than the average number that were found on *T. testudinum* leaves, which was 3.69±0.99SE/leaf (Goss et al., 2018) and in *Z. marina* of 4.25±0.59SE/leaf (Jones et al., 2020). The results of this study obtained three types of MPs particles attached to the leaves of the *E. acoroides*, namely fiber, fragment, and pellet. The range of the number of each MPs particle found on seagrass leaves at St 1 were fragment particles ranged from 0 to 27 particles/leaf; fiber particles with a range of 0 – 15 particle/leaf; while pellets were found ranged from 0 to 2 particles/leaf. For St 2, the fragment particles ranged from 0 to 3 particles/leaf; fiber particles ranged from 0 to 11 particles/ leaf while pellets were found between 0 and 2 particles/leaf. The average number of each types of MPs particles found on *E. acoroides* leaves is shown in Table 2. The results of other studies conducted by Goss et al., (2018) on *T. testudinum* found fiber particles ranging from 0 to 15 particles/leaf, while microbead particles were 0 to 3 particles/leaf of 16 observed leaves. This indicated that fibers are the most often found attaching to seagrass leaves. According to Jones et al., (2020), the difference in the number of MPs found on seagrass leaves is not only caused by the number and type of MPs, but also related to the ability of

**Table 2.** The various of microplastic types on several seagrass species

| Stasion | The average number of microplastics found in *E. acoroides* seagrass leaves (particle MPs/leaf) | | |
|---|---|---|---|
| | Fiber | Fragment | Pellet |
| Stasion 1 | 3.8±4.9 | 4.8±9.0 | 0.44±0.72 |
| Stasion 2 | 3.4±3.6 | 0.88±1.16 | 0.22±0.66 |

seagrass to slow down ocean currents because MPs suspended in the water column can stick to seagrass leaves. This is also supported by the physical structure of the leaves of *E. acoroides* which is the largest type of seagrass with wider morphology and longer of leaf. It supports the growth of seagrass epiphytes (Pane et al., 2021), as well as the presence of biofilm or biofouling on MPs (Hidalgo-Ruz et al., 2012) which can help their attachment to the seagrass leaves (Jones et al., 2020).

*E. acoroides* is a species of large seagrass that is commonly found in the Mare Island waters. The length of the leaf observed at St 1 ranged from 22 cm to 88.2 cm with the width ranging from 1.1 cm to 1.5 cm. While at St 2 the range length was 35 to 90 cm with the width ranging from 1.1 to 2.1 cm. The average length of *E. acoroides* at St 1 was 47.72±19.27 and the width was 1.24±0.15, while at St 2 the average length was 57.11±18.85 and the width was 1.32±0.32. The results of this study indicated that the length and the width of *E. acoroides* were higher at St 2 compared to Station 1. Unsworth et al., (2021) stated that a higher seagrass canopy height could increase the ability of seagrass to trap MPs due to the larger leaf surface area. However, in this study, it was found that the average number of MPs particles on seagrass leaves was actually higher at Station 1 than Station 2 as described above. This finding suggested presumably that station 1 is located in front of Gurabati village which has higher anthropogenic activities including plastics uses than station 2 that is situated on the southwest of the island that faces to the Moti Island. The population at Moti Island is far less than Tidore One. However, it is certainly required further investigation with a larger number of leaf samples and macro plastic debris around those islands.

**Composition of type and color of microplastics in *E. acoroides* seagrass leaves**

The MPs found on *E. acoroides* leaves at both research stations had various shapes and colors with a total of 123 MPs particles identified. A total of 7 leaves of 9 leaves (about 77.8%) at St 1 found MPs with three types, fibers, fragments and pellets, while the other two leaves (about 22.8%) were not found. At St 2, about 66.7% or 6 of the 9 leaves identified MPs embedded in the epibiont of seagrass leaves, while 33.3% (3 leaves) were not found. The results of this study found that the fibers and fragments were found to be the most common compared to the pellet ones. However, there were differences in the composition of MPs found at the two research stations. The composition of MPs found *E. acoroides* leaves at St 1 was fragments (54%), followed by fiber (41%) and then pellets (5%). Meanwhile at St 2, the most commonly found microplastic composition was fibers (76%), followed by fragments (19%) and the least one was pellets (5%) (Figure 3). This difference compositions of microplastics probably implied that the difference sources, anthropogenic activities and hydro-oceanography factors that play the important roles in terms microplastic compositions.

MPs found on *E. acoroides* leaves, namely 123 particles were also identified based on their color. Overall, seven colors of microplastic were found, namely blue, brown, black, red, green, orange and white, except at station 2, the brown

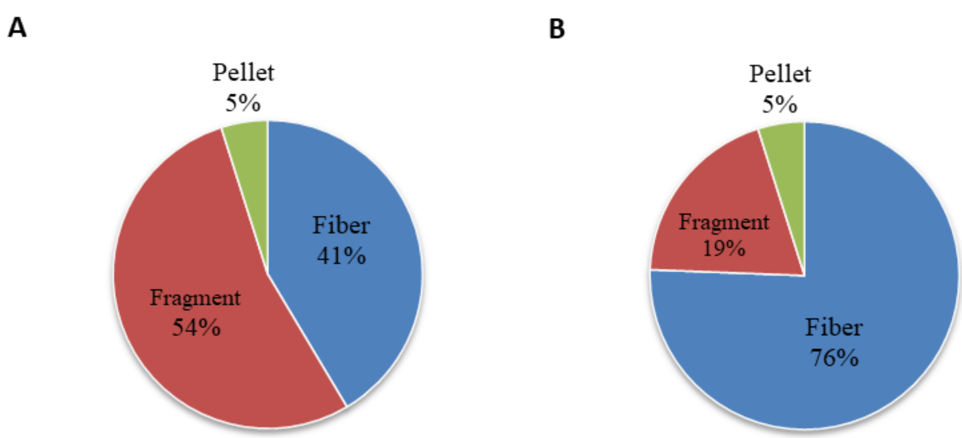


**Figure 3.** Composition of microplastic types, namely fiber, fragments, and pellets on *E. acoroides* seagrass leaves found at Station 1 (A) and Station 2 (B).

one was not found. Similar to the composition of the microplastic type, the colors composition of MPs found on *E. acoroides* leaves at these two stations also showed a different colors composition. The colors composition of MPs at Station 1 consisted of seven colors, which was dominated by white (32%) followed by black (27%), while the lowest was brown (4%). Meanwhile at St 2, the highest color composition was black (32%) followed by orange (24%), while the lowest composition was blue (2%) (Figure 4). Previous studies conducted by Goss et al., (2018), Priscilla et al., (2019), and Jones et al., (2020) did not explain the color of MPs found in the seagrass leaves. However, research conducted by Unsworth et al., (2021): Kreitsberg et al., (2021); and Huang et al., (2020) found that blue is the dominant color in the aquatic environment in seagrass beds. However, in this study, blue microplastics were found in the lowest levels in both research stations. This may indicate a different source of microplastics from other previously studied areas. Qi et al., (2020) found a high percentage of black color composition in the nearshore seawater of Haikou Bay (71.44%) and nearshore sediments of Haikou (21.56%) in Haikou Bay, another color that found, among others, red, white, green, blue and yellow. Meanwhile Zuo et al., (2020) also found a high percentage of black microplastics (28.3% - 47.6%) in mangrove sediments. The high percentage of black microplastic on *E. acoroides* leaves at the two research stations needs attention because it is able to absorb other

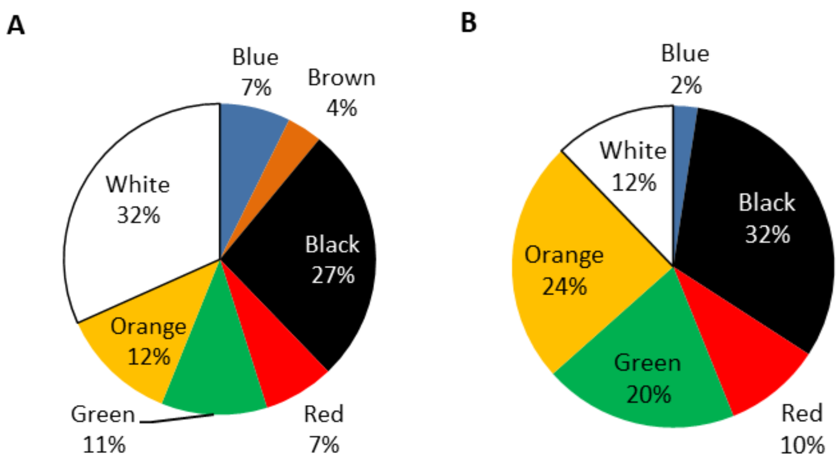


**Figure 4.** Color composition of microplastics on *E. acoroides* seagrass leaves found at Station 1 (A) and Station 2 (B).

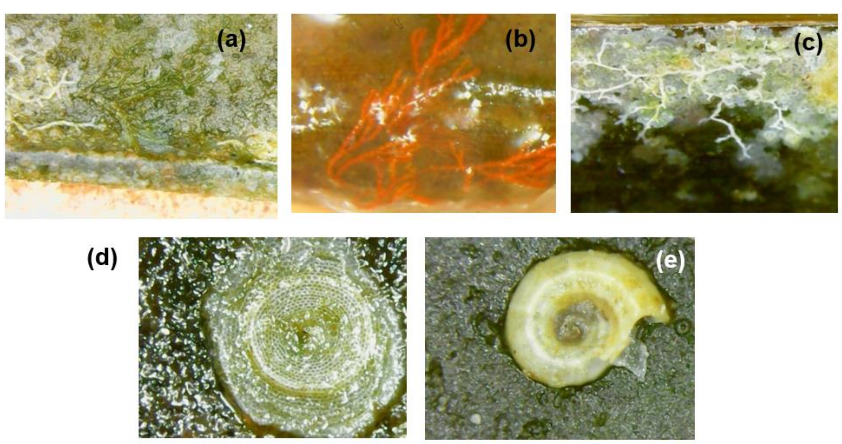


**Figure 5.** Epibiont communities including crustose corraline algae (a), (b), (c); gelatin epibionts (d); and other epibiont organisms (Spirobidae) (e) found on the leaves of the seagrass E. acoroides in the waters of Mare Island

organic micro-pollutants higher than other colors (Wang et al., 2018), which may have a negative effect on marine biota that consume seagrass leaves such as turtles and dugongs.

### Epibiont coverage and the presence of of microplastics in *E. acoroides* seagrass leaves

Epibionts are the epiphytic organisms that live attached to their host organisms, for example on the surface of seagrass leaves. The epibiont communities found attaching to the leaves of *E. acoroides*. In this study, they consists of crustose corraline algae, gelatin epibionts and other epibiont organisms as shown in Figure 5. This epibiont community is similar to that found on the leaves of the seagrass *T. testudnum* (Goss et al., 2018). Some epibionts act as scavengers that consume various host secrets and in turn are food for organisms at the higher trophic level (Irwani and Afiati, 2013). The high diversity of epiphytic communities found on seagrass leaves influences the higher herbivore in terms of food webs (Marco-Mendez et al., 2015). According to Goss et al., (2018), herbivore fish tend to eat seagrass leaves with a high epibiont density.

The epibionts coverege on *E. acoroides* leaves in this study was ranked or graded according to the percentage of epibiont closure referring to Goss et al., (2018) (Figure 6). From a total of 18 seagrass leaves of *E. acoroides* identified at the two research stations, the results obtained were eight seagrass leaves classified as rank 1, two seagrass leaves classified as rank 2, five seagrass leaves classified as rank 3, and three leaves are classified as rank 4.

Based on the level of epibiont coverage, it was found that the microplastics were higher in the rank 1 epibiont at St 1, while at St 2 was found to be the highest at the rank 3 epibiont (Figure 7). The number of microplastic fragment particles in the epibiont rank 1 ranged from 1 to 15 particles, fibers with a range of 0 to 27 particles, while pellets ranged from 0 to 2 particles found attaching to the *E. acoroides* leaves at St 1.

(a) (b) (c) (d)

**Figure 6.** Epibiont coverage on the leaves of seagrass *E. acoroides* : (a) rank 1 (epibiont coverage < 25%; (b) rank 2 (epibiont coverage 25 – 50%); (c) rank 3 (epibiont coverage 50 – 75%; and (d) rank 4 (epibiont coverage >75%)

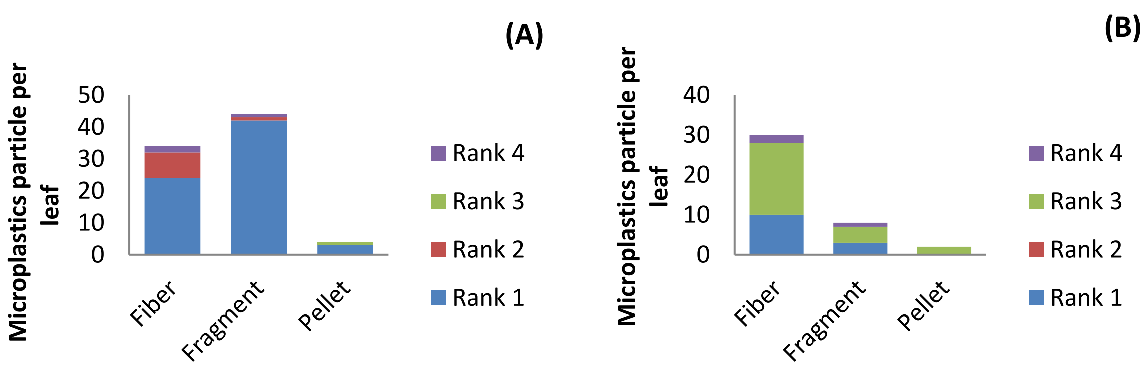


**Figure 7.** The presence of microplastics based on the level of epibiont ranking in the leaves of *E. acoroides* seagrass at Stasion 1 (A) and Stasion 2 (B)

Meanwhile at St 2, the number of MPs particles embedded in the rank 3 epibiont matrices were fragments ranging from 0 to 2 particles, fibers with a range of 3 to 11 particles, while pellets were 0 – 2 particles. According to Goss et al., (2018), there is no significant relationship between the epibiont rank and the abundance of microplastics, although there was a tendency to increase MPs at epibiont ranks 3 and 4. However this may be a consequence of the limited sampling size for the seagrass leaves observed. Therefore, it is necessary to carry out further investigations with a larger number of samples.

This research has indicated that the vulnerability of seagrass beds in accumulating microplastics, especially on Mare Island as a conservation area. This could provide a database on the presence of microplastics in seagrass beds, but further research is still required regarding the interaction effects of microplastics and seagrasses. Since when we compare to other biotas, the impact of plastics on seagrasses is still poorly studied, particularly the effect of plastic-seagrass interactions and the impact of plastics on seagrass. plastics in seagrass as part of food webs (Bonano and Orlando-Bonaca 2020). However, according to Yin et al., (2021) plastics on plant surfaces can cause various phytotoxic effects, including impacts on growth, photosynthesis, and oxidative stress. While Goss et al., (2018) hypothesized that seagrass leaves with a high abundance of epibionts are more likely to be consumed by herbivores so that microplastics can be accidentally consumed, and will enter the seagrass food web system. In addition, dead and degraded seagrass leaves with the remaining plastic can increase the accumulation of microplastics in seagrass sediments (Zhao et al., 2022; Unsworth et al., 2021). For this reason, further studies are still needed regarding the presence of microplastics in various fields. The indications of the MPs presence in the seagrass beds of Mare Island Conservation area should receive attention from various environmentalists considering the important role of seagrass beds as providers of ecological services for various associated biota, including habitat, shelter, foraging and breeding grounds (Hemminga and Duarte 2000), as well as providing environmental services such as carbon sinks and carbon storage in relation to climate change (Duarte et al. 2010), protecting the coastlines of small islands from currents and waves (Subur et al. 2011). Seagrass beds on the coast of Mare Island covering an area of 9.8 ha are certainly an important habitat for various types of pelagic fish (DKP Malut Province 2019). According to James et al., (2020) pelagic fish consume more microplastics than demersal fish. Therefore, monitoring of MPs loading in seagrass beds are ecologically critical to address the biological impact of microplastics in these ecosystems and determine the potential for trophic transfer in marine food webs (Jones et al. 2020). Additionally, there is a need for education on emergency mitigation of plastic waste to coastal communities and the development of policies and programs to prevent and reduce plastic pollution, especially on Mare Island.

## 4. Conclusions

Seagrass leaves have the capacity to accumulate MPs particles through symbiotic epibionts on the surface of seagrass leaves particularly *E acoroides*. The number of MPs particles on the leaves of *E acoroides* was higher at Maregam station compared to Marekofo station. The types of microplastics found were dominated by fibers and fragments, while the majority of MPs colors were white, black, and orange, respectively. The epibionts on *E. acoroides* leaves also plays an important role in trapping MPs. The presence of MPs on seagrass leaves needed attention because it can be a route for MPs to enter the food web systems in seagrass beds which is one of the important ecosystems in coastal areas, especially in the Mare Island as a conservation area.

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