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# Studies on microplastic contamination in seagrass beds at Spermonde Archipelago of Makassar Strait, Indonesia

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**Abstract**. There is growing awareness and concern on microplastics pollution in marine environments. Seagrasses are among the most productive shallow water ecosystems, serving a diverse assemblage of fish and invertebrates. Sediment and benthic animal samples collected from small islands at Spermonde archipelago confirmed the presence of microplastics with different levels of contamination. The occurrence of microplastics for up to 28.29% and 25% of contamination level in sediments and benthic animals, respectively, clearly indicated an alarming state of the microplastics pollution in rich and productive shallow water seagrass ecosystem of tropical seas. Moreover, all positively contaminated microplastics of benthic animals are for human consumption and therefore pose threats for microplastics transfers which may facilitate pathways for a wide spectrum of organic pollutants entering the food web and affecting human health.

## 1. Introduction

Plastic pollution is an accelerating threat to the sustainability of our planet [1]. Plastic pollution has increased over the past decades, at least in part due to mismanagement of plastic waste from landfills and find their ways to the ocean [2,3]. Plastic waste input to the world ocean from 192 coastal countries ranged from 4.9 to 12.9 million metric tons (MT) per year, and without improvements in land based management, a10 fold increase is predicted by 2025 [2]. Microplastics is a word coined to describe the vast tide of microscopic plastic debris that is now found throughout the world's oceans range in size from 1 µm to 5 mm [4]. Microplastics (further referred to as "MPs") are formed by the fragmentation of larger plastic items, ropes and synthetic fabrics through the mechanical action of wind and waves or by sunlight-induced photo-oxidation, and could also come from manufactured plastic products such as microbeads (cosmetics and personal care) [5,6] and pellets [7] originating from landfill sites. Research by Li et al. [8] revealed the accumulation of related toxic substances to MPs generating problems such as intestine injury and change in metabolic profile in fish. Additionally, ingestion by biota is considered a possible sink for microplastics [9], rendering oceans contamination by microplastics is of concern not only because of the ecological impacts but also because they may compromise food security, food safety and consequently human health.

With respect to world ocean currents, the location of Indonesia in particular with the Indonesian Through-flow II (also known as ALKI II) which transported massive water mass through Makassar strait, having consequences that accumulated plastic debris can readily be carried into the nation's seas [10]. Coupled with the fact that Indonesia is recently indicated as the second highest contributor of marine plastic pollution worldwide [2], this situation places Indonesia at high risk of environmental impacts from marine pollution, including marine plastic debris, and MPs in particular.

Seagrasses are flowering plants adapted to life in the oceans. They are the only angiosperms able to withstand a saline existence, with almost all genus capable of completing their lifecycle in a fully submerged marine environment, hence seagrass ecosystem played significant roles in water filtration, habitat provision, fish nursery grounds and biodiversity support [11]. The Spermonde Archipelago in the Makassar Strait, Indonesia, comprises many small islands with abundant multispecies-seagrass beds [12,13]. Multispecies seagrass beds with a moderate abundance of species such as *Halophila ovalis, Cymodocea rotundata, Enhalus acoroides, Thalassia hemprichii, Syringodium isoetifolium* and *Halodule uninervis*, were observed in small islands of the Spermonde archipelago [14]. This study was conducted in three small islands, namely: Kodingareng Lompo, Bone Tambung and Langkai islands at the Spermonde Archipelago with distance ranged from 12 to 28 km west of the Makassar City, on the western coast of South Sulawesi (Fig. 1).

Therefore, this research was conducted on the current state of plastic pollution and the effect it can have on ecosystem health potentially affecting human food security in Makassar City, which obviously will provide important information in efforts of mitigating future problems. This study aims to conduct an initial investigation that will determine whether MPs have been present in seagrass sediments and benthic animals from Spermonde archipelago by digestive content analysis.

## 2. Materials and Methods

Sediment and benthic animal samples were collected in July and September 2017 at Spermonde Archipelago, at different seagrass cover percentage [15], with water depth ranging from 4 to 6 m. Purposive random sampling was conducted on sediment at each seagrass percent cover with total of 81 sediment samples. Oven dried sediments (100 g) were subjected to sieve-net with gradient mesh size down from 2 mm to 0.063 mm, according to NOAA 2013 [16], with slight modification. MPs specific gravity values were characterized with ZnBr solution made to 1.5 g.cm$^{-3}$ of solution density [17]. Respective sieved sediments were added into ZnBr solution followed with centrifugation at 150 rpm for 5 min. Supernatants were carefully collected with glass pipette from the top of beaker glass and subjected to Buchi vacuum pump filtration through nitro-cellulose filter (Whatman WCN Type 7141-104), then observed with stereo microscope Euromex SB1902 with magnification 4.5 x 10.

Benthic animals were all subjected to 10% KOH 3 times of samples' volume [18] and left at 60$^{o}$ C overnight, to digest all organic materials, poured into clean petri dish, and MPs identification with stereo microscope were conducted. Samples with less than 5 individuals number were omitted from calculation (i.e. *Holothuria* sp (n=1); *Diadema setosum* (n=3), *Anadara* sp. (n=1) and *Lambis* sp. (n=1).

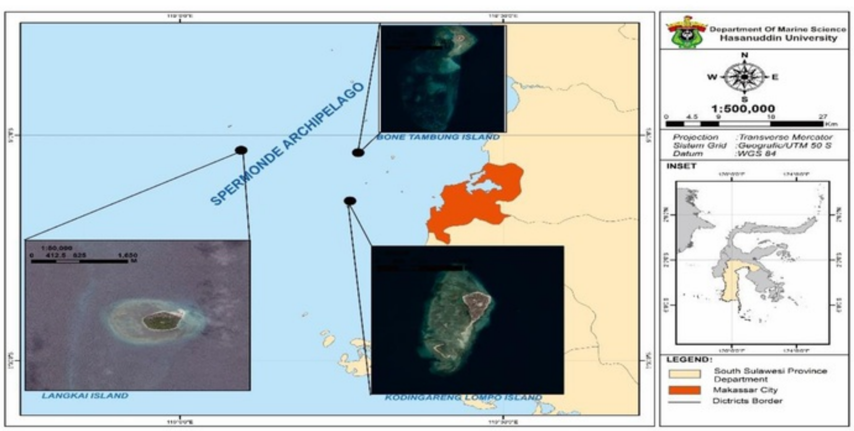


**Figure 1.** Sampling locations at Spermonde Archipelago of Makassar Strait.

## 3. Results and Discussion

From 81 sediment samples collected within different seagrass percent of coverage, there are 22 sediment samples found positively contaminated with MPs (or 27.16% of contamination, calculated by dividing positive contaminated sediment with total sediment samples). There are no consistent trend in sediment MPs numbers in all seagrass meadow percent cover observed, with 25.93% (low coverage), 22.22% (medium coverage) and 33.33% (high coverage) levels of contamination (calculated by dividing positive samples with total samples at respective percent cover, i.e. 27 samples). The numbers of sediments MPs observed from all seagrass percent cover were ranging from 1-11, with highest occurrence detected from sediments with low seagrass percent cover of the Langkai Island. Variation in sediments MPs contamination are presented in Fig. 2. Jones [19] discovered 87.5% of MPs contamination level in biota, sediment and blades of *Zoostera marina* beds at Orkney Isles of Scotland. In other studies, MPs were also present in vascular plant *Thalassia testudinum*, a species of seagrass, collected from Turneffe Atoll Marine Reserve in Belize [20], and even being ingested by seagrass associated fish [21]. In addition, from all MPs discovered from sediment samples (n=81), blue was predominating color with total percentage of 35%. While for the MPs form perspective, line (filament) was the highest form observed with 84% of dominance in sediment samples.

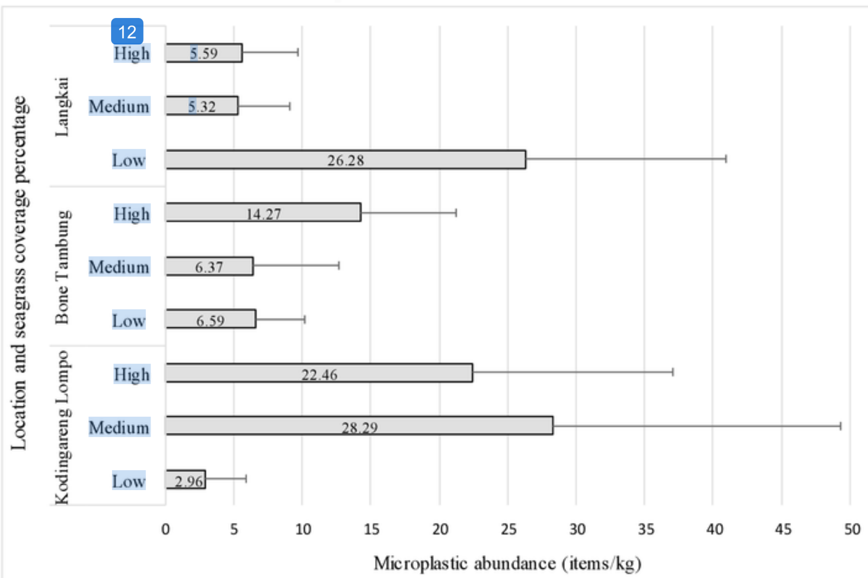


**Figure 2.** Variation of MPs abundance in sediment samples (number of MPs/kg sediment) with respective seagrass percent cover at Spermonde archipelago (average value ± S.E., n=9).

Due to inconstant number of benthic organisms dispersion and eventually found during the field samplings, all animals with total of 51 individuals, consist of 5 species of 3 classes, collected from different islands were pooled. Microscope observation on all dissected benthic animals are presented in percentage of MPs contamination in each species of different classes (Table 1). While for the MPs abundance per individual of benthic animals were calculated by dividing total MPs discovered in one species with total individual per-species (Fig. 3). In addition, from all MPs observed in benthic animals, blue and black were the most dominant colors discovered with equal prevalence of 37% with line form of MPs being the most prevailed (95%).

Seagrasses are among the most productive shallow water ecosystems on the continental shelf of all continents except Antarctica, serving a diverse assemblage of fish and invertebrates [11]. The occurrence of MPs loading in sediments and benthic animals of seagrass beds, has the potential to alter trophic interactions and the overall health of ecosystem. Ingested MPs particles are thought able to evoke a biological response through both physical and chemical mechanisms, although many of these effects have yet to be studied [22]. It is suggested that ingested MPs could provide a possible new route for POPs to enter the food chain [23].

**Table 1.** Percentage of MPs contamination in benthic animals collected from Spermonde archipelago.

| Class | Species | No. of samples | No. of individual with MPs | No of MPs | Percentage of MPs contamination |
|---|---|---|---|---|---|
| Echinoderm | *Tripneustes gratilla* | 17 | 4 | 9 | 23.53% |
| Bivalve | *Pinna* sp. | 6 | 1 | 3 | 16.67% |
| | *Pinctada* sp. | 12 | 3 | 4 | 25% |
| Gastropod | *Cypraea tigris* | 10 | 2 | 3 | 20% |
| | *Nudi Branch* | 6 | 0 | 0 | 0% |

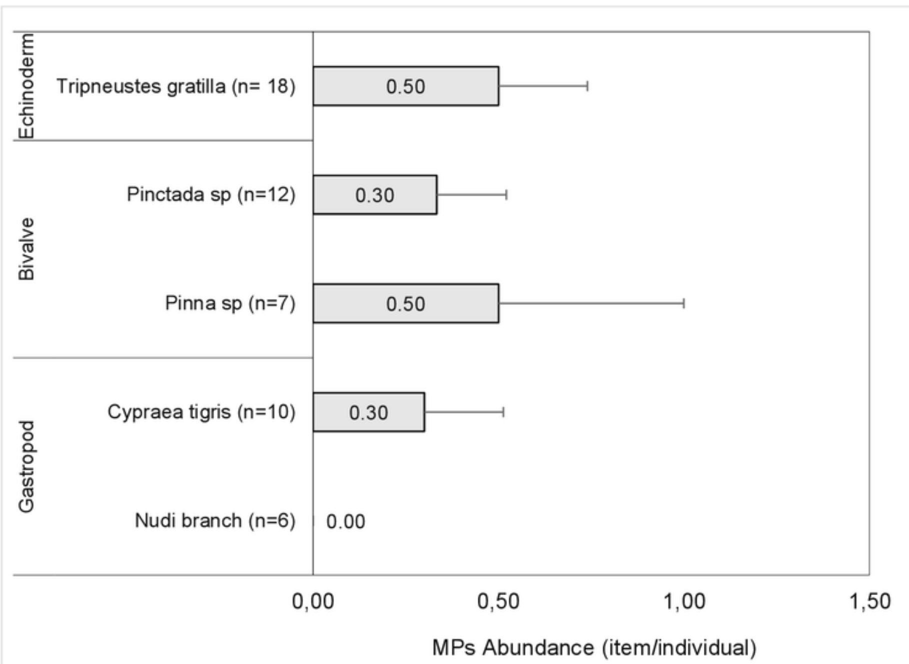


**Figure 3.** Microplastics abundance per individual of benthic animal species from Spermonde archipelago.

The effects of MPs in the natural environment and implications for the food web in the present study remain unknown, due to the size of benthic animals samples are not equally distributed in all seagrass beds percent cover, making them may not be representative. Nonetheless, with the level of MPs contamination in all species of benthic animals (but none for the *Nudi branch*) which ranging from 16.6 to 25%, there is a strong indication on the presence of negative effects in benthic food web. This is particularly true with respect to demonstrated physical impacts of MPs such as cellular necrosis, inflammation, and lacerations in gastrointestinal tracts in diverse marine animal species [24].

## 4. Conclusion

Sediments and benthic animals at small islands of the Spermonde archipelago were contaminated with microplastics pose threats to the benthic food web. Further research on surface water, water column, epibiont communities inhabit the seagrass blades, and fish related to seagrass beds are needed to have complete pictures for a comprehensive results with reliable conclusion, especially pertaining to detrimental effects on food webs, shallow water ecosystem health, enter and spread in the food chain all the way up to humans with microplastics particles as vectors.

## Acknowledgement

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