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Microplastics in scleractinian corals from the upper Gulf of Thailand

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Abstract. Microplastics are plastic fragments <5 mm in diameter that are recognized as pollution in marine ecosystems worldwide. Coastal habitats, such as sandy beaches and inshore coral communities, are particularly impacted by microplastics because they enter the marine environment through the fragmentation of larger plastic components from land-based sources. A few studies reported ingestion of microplastics by scleractinian corals, and the presence of microplastics in coral reef waters adjacent to inshore reefs. This study aimed to assess the abundance of microplastics in six scleractinian corals, i.e., *Acropora muricata*, *Galaxea fascicularis*, *Pocillopora acuta*, *Porites lutea*, *Favites abdita* and *Favia speciosa* from Mu Ko Sichang, the upper Gulf of Thailand in April 2018. The fragments of each coral species were collected and preserved in 10 % formalin in seawater before being decalcified in 3 % formic acid over a period of four days. Then the decalcified tissues were dissected using a stereo zoom microscope to separate individual polyps. The coral polyps were then sectioned longitudinally. Ingestion of microplastics was examined by the presence of microplastics in the mouth and among the mesenteries of the polyps. The highest abundance of microplastics were found in *Galaxea fascicularis*, while no microplastics were found in *Acropora muricata*. This study provides essential information concerning microplastic contamination on natural coral communities in the Gulf of Thailand.

Keywords: coral, *Galaxea fascicularis*, Gulf of Thailand, microplastics, pollution

1. Introduction

Plastics have been used in many industries and are widely found in most products for daily life. Plastic production is currently about 300 million tons per year on a global scale. It supports an increase in plastic consumption around the world. Microplastics are defined as plastic fragments <5 mm in diameter with various shapes and sizes (Betts 2008; Hidalgo-Ruz et al. 2012; Wright 2013). In general, microplastic forms mostly detected in the marine environment include spheres, pellets, irregular fragments, and fibers (Horsman 1982). Coastal and marine ecosystems, such as sandy beaches and coral reefs, are particularly affected by microplastics. These contaminants often enter the marine and coastal environment through fragmentation of larger plastic components from land-based sources, including water treatment plants effluents, fishing gears, discharge from shipping, and intentional and accidental discharge of domestic, agricultural, and industrial sewage (Horsman 1982; Galgani 2000; Thompson et al. 2004; Ng and Obbard 2006; Fendall and Sewell 2009; Andrady 2011; Browne et al. 2011). Impacts of microplastics on marine organisms have been extensively examined worldwide. They include ingestion by marine organisms such as plankton, benthic organisms, crustaceans, fish, filter feeders, sea turtles, seabirds, and marine mammals. Microplastics and their toxic chemicals could impact marine ecosystems and human health more than larger plastic debris because of bioaccumulation and biomagnification via the food web. (Wright 2013; Farrell and Nelson 2013; Ivar do Sul and Costa 2014). Several studies found microplastics in various marine organisms such as plankton (Cole et al. 2013; Setälä et al. 2014; Frias et al. 2014; Desforges et al. 2015; Sun et al., 2017), invertebrates (von Moos et al., 2012; Farrell & Nelson, 2013; van Cauwenberghe and Janssen 2014; Watts et al. 2014; Li et al. 2016), fishes (Lusher et al. 2013; Avio et al. 2015; Murphy et al. 2017; Chen et al. 2017; Murphy et al. 2017), and seabirds (Wilcox et al., 2015). However, few studies reported ingestion of microplastics by scleractinian corals and the presence of microplastics in coral reefs adjacencies. This study aimed to assess the abundance of microplastics in scleractinian corals at Mu Ko Sichang, the upper Gulf of Thailand.

2. Materials and Methods

2.1 Study sites

Mu Ko Sichang, Chonburi Province is located in the upper Gulf of Thailand (13° 09'30" N, 100° 48'41" E). This island is approximately 60 and 40 kilometers from the Chao Phraya and Bang Pakong river-mounts, respectively. This area is affected by runoff during rainy season (Figure1).

2.2 Coral collections

The fragments of each coral species, i.e., *Acropora muricata*, *Galaxea fascicularis*, *Pocillopora acuta*, *Porites lutea*, *Favites abdita* and *Favia speciosa* were collected from several sites, at an average depth of 5 m, around Mu Ko Sichang during April 2018. Those coral species were selected in different morphology and polyp size which are dominant in the study sites. The samples were collected 3 cm long for branches coral or 3 cm^2 surface area for massive corals. Coral fragments were preserved in 10% formalin with seawater and transferred to the laboratory. The samples were decalcified in 3 % formic acid over a period of four days (Hall et al. 2015). Then the decalcified tissues were dissected using a stereo zoom microscope to separate individual polyps from each other. The coral polyps were then sectioned longitudinally. Ingestion of microplastics was examined by the presence of microplastics in the mouth and among the mesenteries of the polyps. The microplastic particles were analyzed by Fourier transform infrared (FTIR) spectrometry to confirm type of the microplastics, which was then determined based on matching peak wavenumber positions.

2.3 Data analysis

The data of density of microplastics were tested for normality and transformed using the square root function. One-way ANOVA was used to test the difference between species. Where significant differences were established, the pairwise test of Tukey’s HSD was employed to detect individual differences between each species

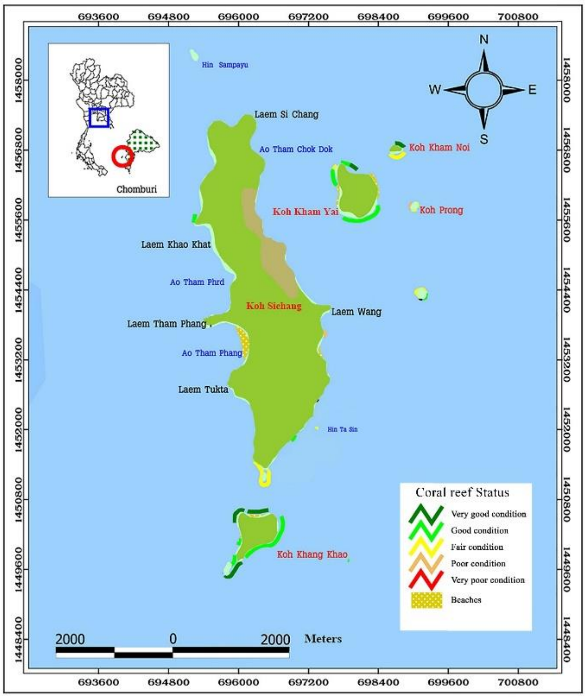

Figure 1. Map of study sites at Mu Ko Sichang

3. Results

The abundance of microplastics varied between species with a range of 0.0 – 0.8 particles/cm^2. Most of them were fragmented fibers. The most abundant microplastics were found in *Galaxea fascicularis*, 0.8 ±0.12 particles/cm^2 while no microplastic was detected in *Acropora muricata*. (Figures 2-3).

The average densities of microplastics found in all coral species were not statistically different except those detected in *Acropora muricata* and *Galaxea fascicularis* (One-way ANOVA, p<0.01) (Table 1). The FTIR microscope analysis indicated that the main component of the fibrous microplastics were polyethylene terephthalate (Figure 4)

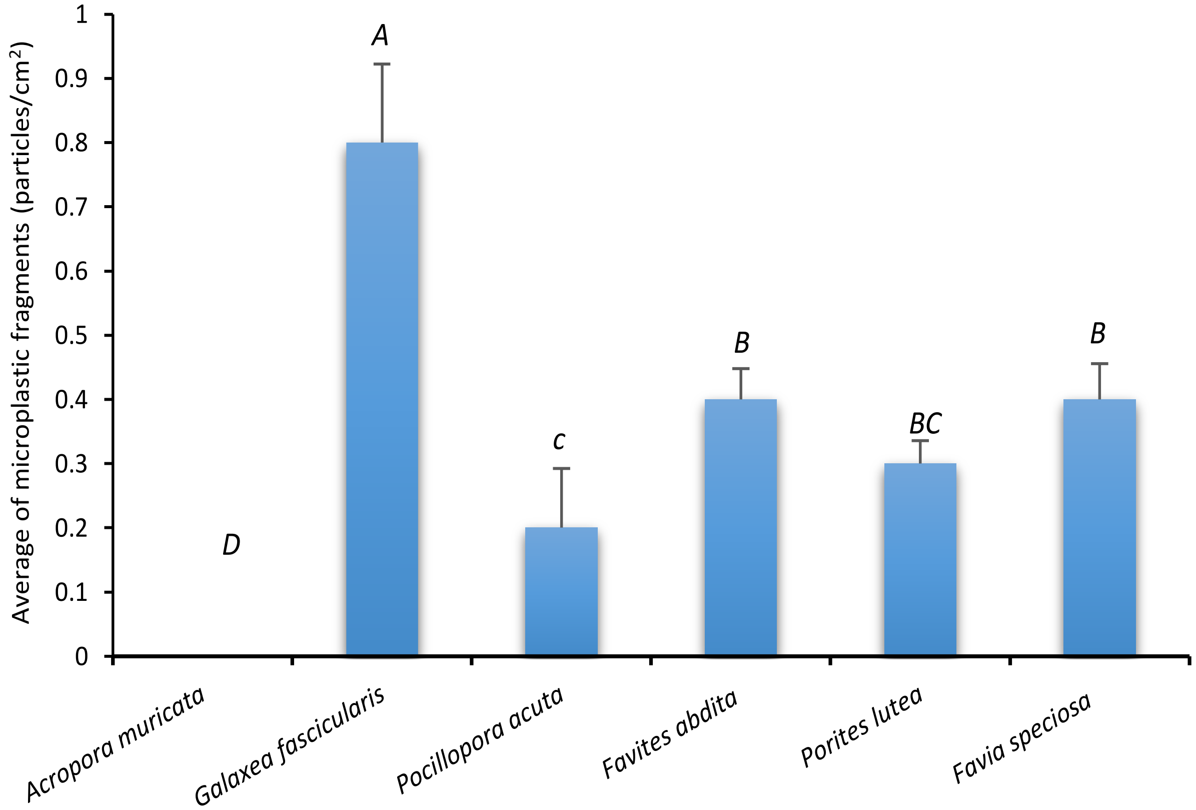

Figure 2. Abundance of microplastics in corals (Means ± SE)

Table 1. A result of one-way ANOVA testing for differences between species

Source of variation	SS	df	Mean Square	*F*	*P*
Between species	1.326	5	0.265	81.768	0.000
Within species	0.039	12	0.003		
Total	1.365	17			

*Significant difference *p*<0.001), df: degree of freedom

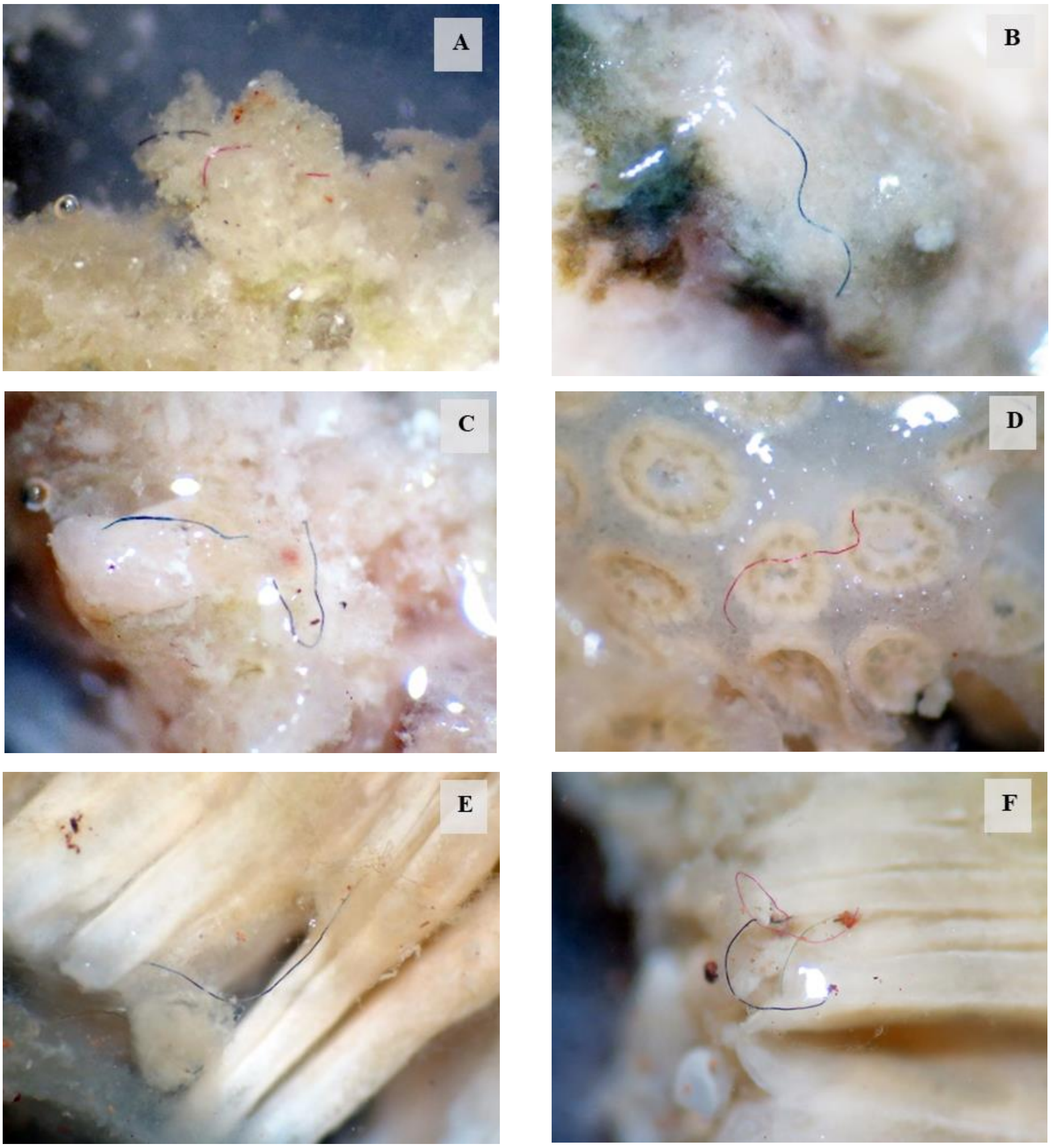

Figure 3. Microplastics present in the mouth and among the mesenteries of coral polyps: (A) *Porites lutea* (B) *Favites abdita* (C) *Favia speciosa* (D) *Pocillopora acuta* and (E-F) *Galaxea fascicularis*

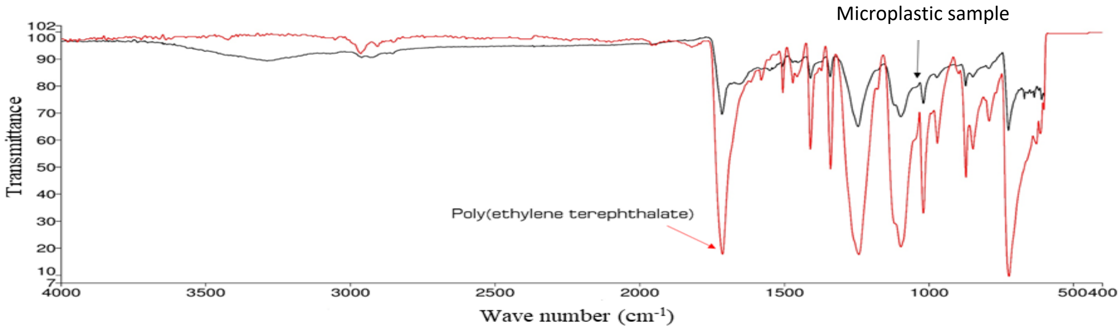

Figure 4. FT-IR microscope analysis of the fibrous microplastics

4. Discussion

This study provides the first investigation of microplastics were found in scleractinian corals from natural coral communities in the Gulf of Thailand. A previous study showed that corals could ingest and retain microplastics within their gut cavity for at least 24 hours (Hall et al., 2015). Since buoyancy and density of microplastics are variable, they have the potential to become widely distributed in marine and coastal ecosystems (Andrady 2011).

Scleractinian corals that are in symbiosis with algae, a dinoflagellate usually named zooxanthellae, receive nutrition (mostly carbohydrates) via translocation of organic matter synthetized by their zooxanthellae. However, microplastic was inside coral's gastric cavity due to the heterotrophic feeding process. Heterotrophic feeding of coral on plankton is an important feature of corals in order to balance nitrogen and phosphorous supply against the carbon reach materials gain by translocation (Palardy et al., 2006; Houlbrèque & Ferrier-Pagès, 2009; Hall et al., 2015). Our result shown microplastic in *Galaxea fascicularis* with large polyps was significantly higher than other coral species with small polyps. The microplastic density in corals might depend on the feeding rate. Feeding rate in different coral species have to consider parallelling with polyp size, the energy reserve in coral tissue such as glucose, glycerol includes energy support from endolithic algae (Houlbrèque et al., 2004; Wang et al., 2012; Schoepf et al., 2013; Sangsawang et al., 2017).

A study on plastic pollution in the South Pacific subtropical gyre revealed, from a (4489 km) 2424 nautical mile transect, that the average abundance and mass was 26,898 particles/km2 and 70.96 g/km2, respectively. About 88.8% of the plastic pollution was found in the middle third of the samples with the highest value of 396,342 particles/km^2 occurring near the center of the predicted accumulation zone (Eriksen et al. 2013). In this research, microplastics in coral are mostly fibres. These results agree with several studies that had commonly found fibres in marine organisms and seawater (Lusher et al., 2015; Murphy et al., 2017; Sun et al., 2017).

Chemoreception driving plastic consumption in a hard coral is important for coral reef studies. (Allen et al. 2017) investigated consumption of weathered, unfouled, biofouled, pre-production and microbe-free National Institute of Standards plastic by a scleractinian coral that relies on chemosensory cues for feeding. It was observed that corals ingested more plastic that was not covered in a microbial biofilm than plastics that were biofilmed. Corals also retained ~8% of ingested plastic for 24 h or more and retained particles appeared stuck in corals, generating energetics, pollutant toxicity and trophic transfer consequences. The potential for chemoreception to drive plastic consumption in marine organisms has implications for conservation of marine and coastal ecosystems.

This study suggests that investigation on the prevalence of microplastics at various reef sites should be extended, to examine marine sediments and different taxa in the future; in order to facilitate our understandings of the microplastics sources, and to identify the potentials of microplastics-associated pollutants transferred along the food chain of coral reefs and related ecosystems.

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