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Microplastics Ingestion by Fish in The Pangandaran Bay, Indonesia

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ABSTRACT

This study investigated the occurrence of microplastic particles in the digestive tracts of fishes from Pangandaran bay. The fish were collected by local fisherman. A total of 18 fish representing 2 species (*Trichiurus sp.* and *Johnius sp.*) were examined for microplastics. In total, 193 microplastic particles were found in the gastrointestinal tracts of all fishes. Microplastic particles were categorized as fragment (49.74%), fiber (22.8%) and film (27.46%), with size ranging from 0.12 to 5 mm. A statistically significant difference existed in the abundance of microplastic ingestion among the two species. The results of this study provide the first evidence of microplastic contamination in fish in Pangandaran bay.

***Keywords*:** Commercial fish, Ingestion, Microplastics, Pangandaran, *Trichiurus*, *Johnius*

1. INTRODUCTION

Global marine litter is dominated by plastic in the ocean (Jambeck et al., 2015; UNEP, 2014). Plastic production is between 4.8 to 12.7 million metric tons (MMT) of plastic waste that goes into the sea (Jambeck et al., 2015). Indonesia is 2nd in the contribution of plastic marine litter, between 0.48-1.29 MMT (Jambeck et al., 2015). Plastic litter is degraded to micro size and commonly called microplastics (MPs) (Andrady, 2011). Other studies have found MPs in intertidal zones, tidal zones and coastal areas of Indonesia (Dhamar et al., 2017; Intan, Budiarsa & Sitongga, 2015; Ismail, Lewaru & Prihadi, 2018). The existence of microplastic in the sea has a negative impact on marine wildlife (Thevenon & Carroll, 2015; Wilcox, Mallos, Leonard,

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Rodriguez, & Hardesty, 2016). The MPs particles is potential toxic to fish, i.e physical and chemical toxicity, because basically microplastic absorbs addictive substances and other monomers that are toxic (Browne, Niven, Galloway, Rowland, & Thompson, 2013; Mato, Isobe, Takada, Kanehiro, Ohtake, & Kaminuma, 2001). Beside that the presence of MPs in the body of fish can reduce fish fitness and then lead to death (Tosetto, Williamson, & Brown. 2017; Wright, Thompson, & Galloway, 2013). The MPs can be absorbed by the tissues of the body of the fish which can then be transferred to other higher trophic organisms (Farrell & Nelson, 2013). This is very dangerous if the fish is consumed by humans. The level of plastic pollution and feeding habits are important factors that influence consumption of plastic in fish (Romeo, Pietro, Pedà, Consoli, Andaloro, & Cristina, 2015; Ismail et al., 2018; Jabeen, Su, Li, Yang, Tong, Mu, & Shi, 2016). The entry of MPs into the body of the fish is caused by accident or wrong prey (Jantz, Morishige, Bruland, & Lepczyk, 2013; Setälä, Fleming-Lehtinen, & Lehtiniemi, 2014). In global studies, the highest percentage of plastic pollution has been reported in marine fish (68% of selected samples), then pelagic fish, demersal fish and freshwater fish (Abbasi, Soltani, Keshavarzi, Moore, & Hassanaghaei, 2018). Microplastics is found in the digestive tract (GIT) (Jabeen et al., 2016; Kolandhasamy, Su, Li, Qu, Jabeen, & Shi, 2018).

This paper for to evaluating the presence of microplastic in Indonesian sea, so it is necessary investigated microplastics accumalate taht in commercial fish, sediments and water columns. So that it can be seen the existence and the microplastic particle threat to marine ecosystems in Indonesia. In this study, MPs pollution was investigated on fish from Pangandaran Bay. The abundance, morphotype and size of plastic are recorded throughout GIT and in the intestines of fish. Our goal is to determine the features of plastic pollution in fish and differences in plastic accumulation between GIT.

2. MATERIAL AND METHODS

a. Sample collection

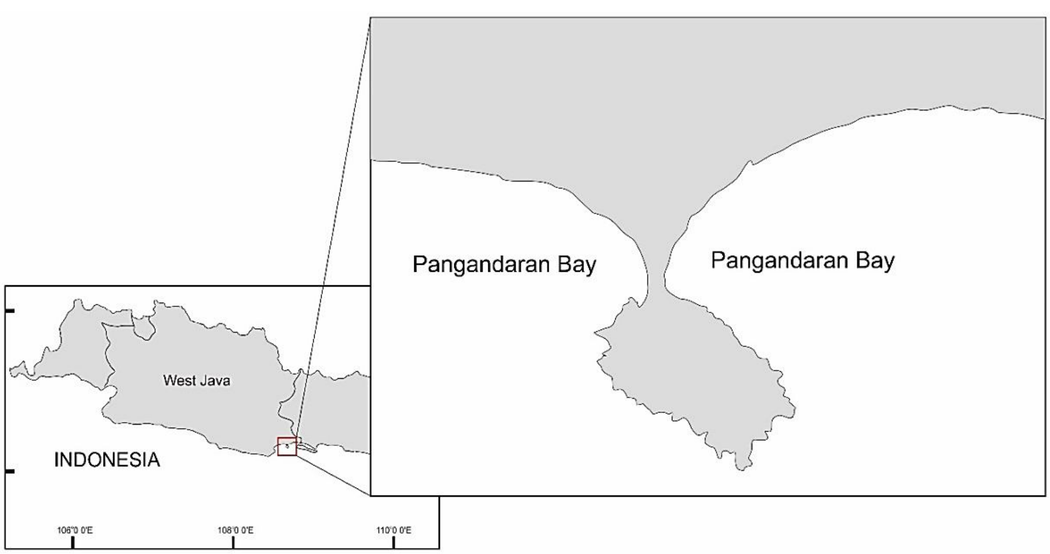


Figure 1. Sample Location

These fishes were collected from the Pangandaran Bay, in Indonesian (Supplementary Fig. 1), by local fisherman. A total 18 fishs collected on April 2018, representing 2 species among other *Trichiurus* sp. and *Johnius* sp.

The total weight and weight of the fish GIT were calculated, and the total length of each fish was recorded with accuracy of 0.1 g and 0.1 cm, respectively (Jabeen et al., 2016; Romeo et al., 2015). Microplastic accumulation calculated from the intestinal tract and fish stomach or GIT of fish. Location of sample shown in Figure 1.

b. Nitric Acid Solution, Hydogen Peroxide and Fe II (Solution)

The GIT sample was immersed in 20% alcohol, then the fish GIT was crushed with a mixture of nitric acid (65%) with a ratio of 5: 1. Soaking is carried out for 24 hours in an acidic room. Then the suspension was boiled for 10 minutes and left for 30 minutes (Witte, Devriese, Bekaert, Hoffman, Vandermeersch, Cooreman, & Robbens, 2014). The suspension is then diluted with distilled water 4 times and filtered with a 0.5 mm filter with a vacuum filtering method. The filtered particles were observed under the stereo microscope (40x magnification). Microplastics found then of counted types, measurements of length and area of the bridge and the number of particles.

Microplastic methods in these waters can be used to analyze plastic debris as suspended solids in water samples collected by plankton nett. While for processing water samples using a solution of hydrogen peroxide and Fe II. Water samples added 20 ml of a solution of 0.05 m FE (II) to a glass, then added hydrogen peroxide 30%. Then let the mixture stand and close, after being allowed to heat up to 75 ºC on the electric stove for 30 minutes. If organic matter is still visible, add 30% hydrogen peroxide until no natural organic material is seen. Then add 6 g of Nacl per 20 ml of sample to increase water density. then the last microscope test which is weighing the vial include the label and stamp, then identified from the 0.3 mm filter using a monocular microscope to see the number and type of microplastic.

c. Filtration

Saturated salt solution is used as a separation between microplastic and not microplastic by floatation on microplastic. Saturated salt solution which is prepared with a concentration of 1.2 g / mL. Approximately 800 mL of NaCl is inserted into the bottle of the GIT sample, then left for a moment.

The solution is filtered through Wattman paper no. 1 using a vacuum pump. After the filtration process, filter paper is stored in a petri dish with its lid to observe microplastic particles using a microscope. This procedure has been followed as explained Van Cauwenberghe & Janssen (2014) and Jabeen *et al.*, (2016).

d. Microplastics Visual Identification

The microplastics particles are assessed visually (Hidalgo-Ruz, Gutow, Thompson, & Thiel, 2012). Microplastics are classified according to Jabeen et al., (2016) and categorized by type into fibers (elongated), fragments (small corner pieces), pellets (round, ovoid), and films (thin, soft, transparent).

e. Statistical analysis

To verify the significant difference between the number of plastic particles and the type of fish, a statistical analysis was performed by using a one-way ANOVA test at a 0.05 level of significance (modified for variant homogenization) using excel software.

3. RESULTS AND DISCUSSION

3. 1. Size and Weight of Fish

At the time of fishing, fishermen get a variety of fish products. There are only two types of fish which, according to fishermen, are of economic value, or human consumption. This species can represent consumption fish which can be investigated for MPs presence in its GIT. The measured fish yield is presented in Table 1, the intestinal weight of Trichiurus sp is around 3.38% of total weight, while the weight of the johnius sp intestine is around 0.46% of total weight. Microplastic was found in the digestive tract of all fish with fragments (49.74%), fiber (22.8%) and films (27.46%), with sizes ranging from 0.12 to 5 mm.

Table 1. Number of species caught from fisherman (*n*) together with the average (and minimum and maximum) total lengths (cm), total weights (g), and weight of GIT (g)

n	***Trichius* sp.**	***Johnius* sp.**
	6	12
Total Lenght	$\bar{x}$: 278,8 (200,3 – 440,8)	$\bar{x}$: 175,1 (100,4 – 245,6)
Total Weight	$\bar{x}$: 50,5 (24,3 – 104,5)	$\bar{x}$: 84,4 (25,4 – 160,2)
Weight of GIT	$\bar{x}$: 1,6 (0,61 – 4,73)	$\bar{x}$: 0,4 (0,04 – 1,7)

3. 2. MPs in GIT of Fish

The MPs was found in all sample fish, accumulated in the digestive tract of fish. The total number of microplastic found was 193 particles, of which Johnius sp accumulated more microplastic compared to Trichiurus sp (Figure 2). Table 2 shows that some marine organisms are exposed to microplastic in their digestive tract. In this study, microplastic observations were visualized and differentiated based on the shape of the microplastic (Abbasi et al., 2018; Jabeen et al., 2016). Microscopic types of fragments, films and fibers found in the GIT, but only types of microplastic fragments found in all digestive tracts of fish.

Figure 3 shows the size of the MPS in the digestive tract of fish not more than 0.5 mm. The type of fiber is the longest of the other types of MPs. The MPs size that accumulates around 0.07 to 0.5 mm (Eerkes-Medrano, Thompson, & Aldridge, 2015). The microplastic color visualized in figure 3 shows red, black, green and blue.

Table 2. Abundance of microplastics in marine organism from Indonesian.

No	Spesies / organism	Feeding Habits	MPs		Location of Fishing	Reference
			Fragmen	Fiber		
1	*Scarus quoyi*	Herbivore	100%	0%	Java Sea	(Ismail et al., 2018)
2	*Chaetodon guttatissimus*	Herbivore	100%	0%	Java Sea	
3	*Priachantus tayanus*	Herbivore	100%	0%	Java Sea	
4	*Valamugil seheli*	Herbivore	95%	5%	Java Sea	
5	*lutjanus lutjanus*	Carnivore	93,29%	6,71%	Java Sea	
6	*Lethrinus atkisoni*	Carnivore	99,39%	0,61%	Java Sea	
7	*Pletorhinchus chrysotaenia*	Omnivore	94,81%	5,19%	Java Sea	
8	Macrofauna	Plankton	100%		Ambon Bay	(Uneputty, 1997)
9	*Epinephelus* sp.	Carnivore	n.a.	n.a. (dominant)	Pelabuanratu bay and ancol bay	(Hapitasari, 2016)
10	*Lutjanus* sp.	Carnivore	n.a.	n.a. (dominant)		
11	Johnius sp.	Omnivore	52,33%	25,78%	Pangandaran Bay	This Study
12	Trichiurus sp.	Carnivore	43,37%	37,66%		

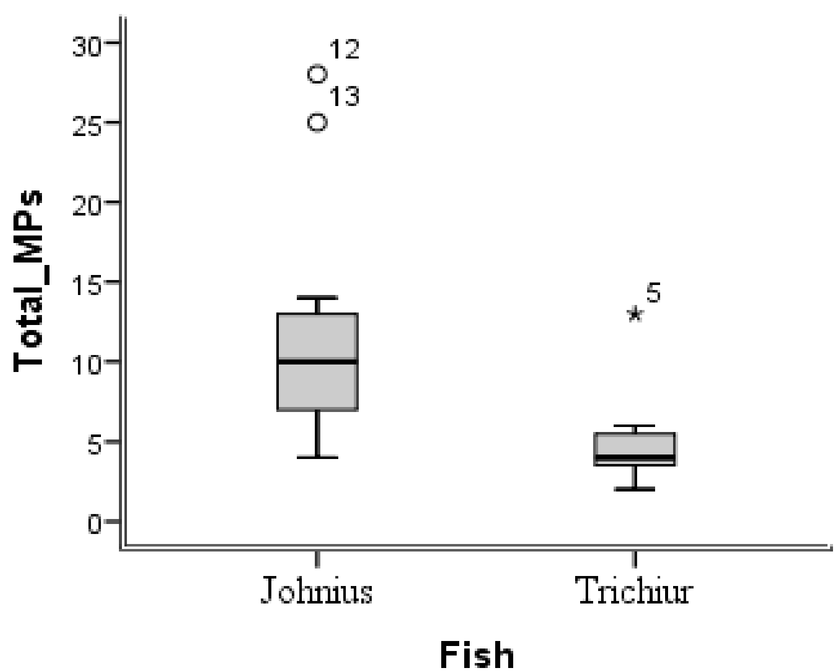
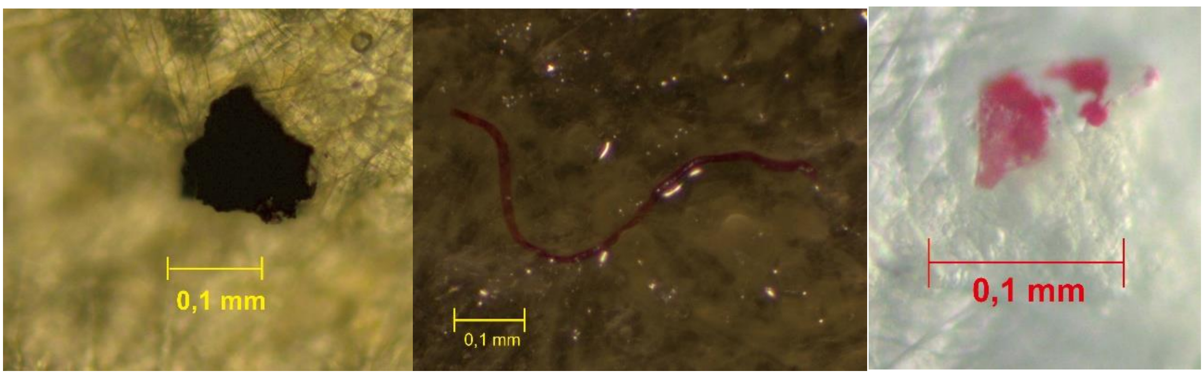


Figure 2. Boxplot Accumulated of *Johnius* sp. compared to *Trichiurus* sp.

The cause of microplastic entry into the digestive tract is due to wrong prey or accidentally consumed by fish (Boerger, Lattin, Moore, & Moore, 2010; Kolandhasamy et al., 2018; Setälä et al., 2014). The wrong of preying for these two fish may not be the right reason for microplastic presence in the digestive tract, because these fish are predatory or carnivorous fish. The prey of Johnius sp is a type of crustaceans, while Trichiurus sp is a type of small fish. A most likely there is MPs transfer from the food web (Fanini and Lowry, 2014; Setälä et al., 2014).



(a) Film (b) Fiber (c) Fragment

Figure 3. Microplastics types in GIT of Fish

Johnius sp accumulates more MPs compared to Trichiurus sp, even though the two fish are carnivorous fish. This is estimated because it is related to food habits. Food habits of John sp are crustaceans, while Trichiurus sp is small fish. Crustaceans spend more of their lives in the bottom of the waters, these waters are the site of accumulation of microplastic Graca, Szewc, Zakrzewska, Dolega, & Szczerbowska-Boruchowska, 2017; Munari, Infantini, Scoponi, Rastelli, Corinaldesi, Mistri, & Sea, 2017).

The more microplastic types of fragments are found, this is in harmony with the presence of macro-sized plastic waste around the Pangandaran. The MPs fragments come from macro-sized plastic degradation due to physical or marine chemistry (Wang, Tan, Peng, Qiu, & Li, 2016). Whereas the presence of fiber types is thought to originate from fishermen's activities, which comes from degraded fishing nets.

There were statistically significant differences in the abundance of Trichiurus sp and Johnius sp fish (0.03 <0.05), so that Jonius sp fish had a higher potential for ingestion MPs.

4. CONCLUSION

Microplastic was found in the digestive tract of all fish with fragments (49.74%), fiber (22.8%) and films (27.46%), with sizes ranging from 0.12 to 5 mm.

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