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Research Article

Identification of the Existence and Type of Microplastic in Code River Fish, Special Region of Yogyakarta

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Abstract: E Microplastics are plastic fragments with size less than 5mm in length, according to the U.S. National Oceanic and Atmospheric Administration (NOAA). Microplastics occur and spread in the environment as a result of plastic pollution. Although further assessment is needed to find the health impact of microplastic exposure to humans, several studies show that microplastic might harm the ocean and aquatic life. Code river is one of the big rivers in Yogyakarta. According to the Regional Environmental Agency of Yogyakarta, Code river was highly polluted by domestic waste and wastewater from the settlement along the river and its tributaries. Therefore, the objectives of this research are to investigate the abundance and characteristic of microplastics in fish from Code River Yogyakarta. Fish samples were collected from the fisherman in the upstream, middle, and downstream areas of Code River from February to May 2019. In the laboratory, the samples were analyzed using Wet Peroxide Oxidation (WPO) method. Fish gills and intestine were oxidized using WPO method followed by density separation for 24 hours. Nikon SMZ445 Stereoscopic Microscope with 35x magnification was used to analyze the shape, color, and total of microplastics. The highest abundance was found in fish samples collected from the upstream area (4.33 particles/gram) compare with the downstream area (3.25 particles/gram). The dominant color is blue, while the dominant type of microplastics is fiber.

Keywords: code river, fish, microplastics

Introduction

Waste pollution, especially plastic, has spread in waters throughout the world and becomes a global issue today [1]. Microplastic is a plastic particle with a diameter of approximately 5 mm. Microplastic is divided into two big size categories, including (1-5 mm) and small (<1 mm) [2]. Plastic is a synthetic ingredient from the results of polymerization (polycondensation) various kinds of monomers (styrene, vinyl chloride butadiene, and acrylonitrile) [3]. Plastic polymer is a very stable ingredient, so that it will remain undamaged as a polymer for a long period of time [4]. In other words, a plastic ingredient that enters the environment as plastic waste will not decompose anytime soon. It takes hundreds of years for the plastic to degrade into microplastics and nano plastics through physical, chemical, and biological processes [5].

The abundance composition of microplastic types that are frequently found in water bodies is the type of fiber, foam, film, and fragments [6]. Microplastics are not visible, but they have the potential to have a negative impact on both biota and water. Human health problems are suspected of coming from microplastic accumulation in the food chain and absorption of toxins into plastics when carried through ocean flows [7]. Microplastics vary greatly in terms of size, shape, color, composition, density, and other properties.

Code River is one of the rivers in the Special Region of Yogyakarta. Across three regencies, that was Sleman Regency, Yogyakarta City, and Bantul Regency, making Code River was called an urban stream, passing through residential areas and there are various activities around the Code River. Before entering the City of Yogyakarta, River Code passes through the agricultural sector and then crosses the densely populated

city center with the number of pollutant sources increasing [8]. Increased economic development activities cause the high pressure of the area around the river located on the environment, changes in land use and population growth resulting from consumptive use of plastic, toilet washing and bathing activities (MCK), and fisheries around the location [9]. Watersheds store a variety of biodiversity of public waters, such as fish and various types of fishery resources, which allows opportunities for various forms of fishery resource use and freshwater media as a forum for fisheries resource development [10].

Microplastic contamination is currently a major concern given the magnitude of the impact caused [11]. Microplastics have great potential to enter the human body and fish. According to Hirai, microplastics can facilitate toxic organic contaminants such as polychlorinated biphenyls (PCBs)[12]. Plastic particles enter the body of the fish. The resulting impact is the potential to damage the function of organs such as the digestive tract. In addition, the significant impact that will result when the fish are taken from the Code River consumed by the surrounding community. Therefore, it is necessary to do research on the identification of the presence of microplastics on fish in the waters of the Code River. This research aims to determine microplastics the exsictence and its spread on the shape, color, and abundance in the fish in Code River.

Materials and Methods

Sampling location

Sampling location is along Code River from upstream and downstream (Figure 1). Sampling points were selected base on several considerations such as : land use, increased population growth, socio-cultural potential, affordable access, and fishing spot. Four (4) sampling points were obtained, starting from upstream to downstream of Code River (Table 1). The sampling was carried out in April - May 2019. Fish samples were collected from fisherman along Code River and store in cooler box contain blue ice prior to analysis in the laboratory.

Table 1. Sampling points location and condition

Location	Coordinate	Condition
Upstream Sinduharjo Ngaglik, Sleman Regency	-7.7158078 , 110.3892463	Dominated by paddy field
Middlestream Code river , Yogyakarta Regency	-7.806090 , 110.374221	Dominated by settlement, influence by domestic waste and wastewater
Middlestream Bangunharjo Sewon, Bantul Regency	-7.860565, 110.376656	Dominated by settlement, influence by domestic waste and wastewater
Downstream Before Opak river	-7.893936, 110.3869075	Settlement and paddy field

Sampling preparation

In the laboratory, fish samples weight and length were measure and its intestines and gills were taken because plastic particles tend to accumulate in fish intestines and gills. Intestines and gills samples were dry at 90°C for 48 hours and measure the dry weight of the samples. Samples preparation and analysis were adopted from the National Oceanic and Atmosphere Administration (NOAA). The sample preparation process was as follows: Wet Peroxide Oxidation (WPO), Density Separation, and then analyzed using a microscope. Wet Peroxide Oxidation is a digesting method to destroy organic material. In this step, the solution of 0.05 M Fe (II) solution and Hydrogen Peroxide solution (30%) was added to samples and heated using magnetic stirrer at 75°C. After the sample cooled down, 12 grams of NaCl salt was added to increase the density of the test solution so that it could separate between microplastic particles and organic deposits[13]. Density Separation is a process of separating organic deposits from microplastic particles to facilitate analysis under a microscope. Glass Microfiber Filters Papers with 47 mm diameter was used to filter the samples prior to microscope analysis. Analysis of samples were conducted using Nikon SMZ445

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Stereoscopic Microscope, twin zooming objective optical system type with 35 times magnification. Microplastic abundance was quantified and calculate using equation below:

$$C = \frac{n\left(\frac{particle}{sample}\right)}{fish\ weight\ (gram)} \quad (1)$$

Description:

C = Microplastic Abundance (particle/gram)
n = Number of Microplastic Particles per Sample

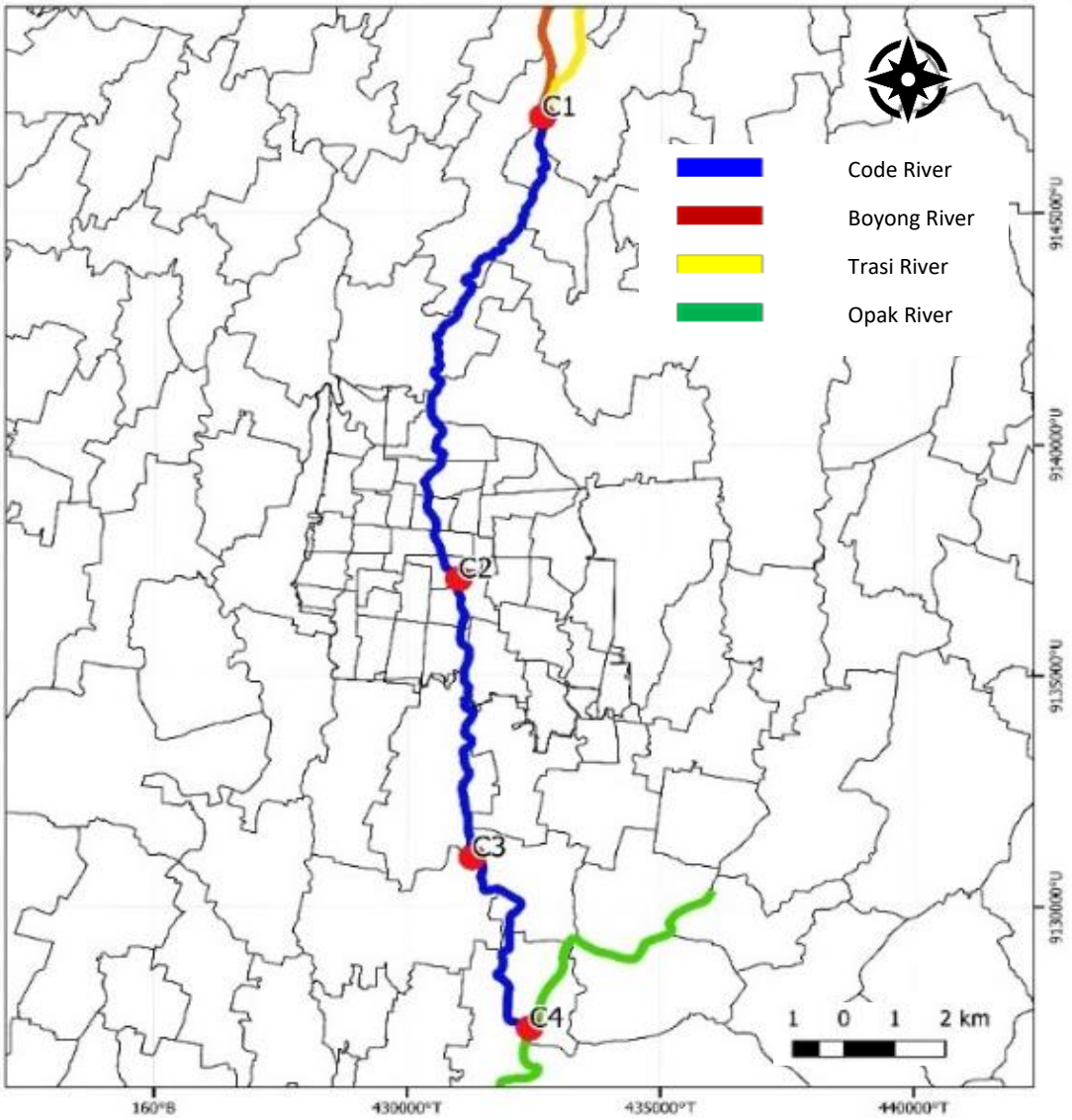

Figure 1. Sampling location

Results and Discussion

River is considered as one water source that is widely used to meet the needs of human life and other creatures. Therefore, the river can be said as the most important ecosystem for humans because it provides water for humans to support various activities such as agriculture, industry, and domestic [14]. The research location was along Code River from upstream (confluence of Trasi River and Boyong River), middle

(Yogyakarta and Sewon) to downstream (confluence of Opak River). At the upstream of Code River (Boyong), 1 sampling point was determined. For the middle part of Code River, 2 sampling points were determined. While for the downstream, 1 sampling point was determined.

Microplastic is a type of plastic waste that is smaller than 5 mm. It is classified into 2 types, including primary and secondary microplastics. Primary microplastic is the result of plastic products made in microform, such as microbeads in skincare products that enter drains. Secondary microplastics are fragments resulting from larger plastics [15]. In this research, we were explain the exsictence and its spread on the shape, color, and abundance in the fish in Code River.

From the observation results by using microscope examination, microplastics forms at the location of research data collection in the form of film, fiber, pellets, and fragments were found (Figure 1). The most dominant microplastic form at the research location was 82% fiber in the gills and 70% in the intestinal organs of fish with a total abundance of 8.685 particles/gram. While the microplastic form that is rarely found in the form of pellets with an abundance of 0.203 particles/gram. Fiber and pellets are suspected to originate from primary sources of microplastics. Basically, the primary source is the result of plastic production in microform, and disposal of household as well as industrial waste[15].

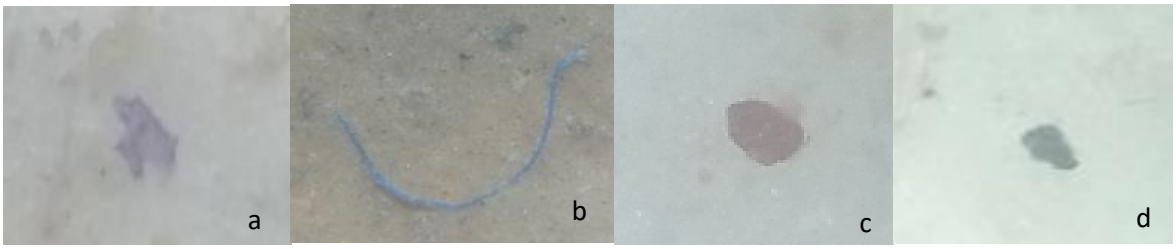

Figure 2. Pictures of microplastic; (a) film, (b) fiber, (c) pellets, and (d) fragments

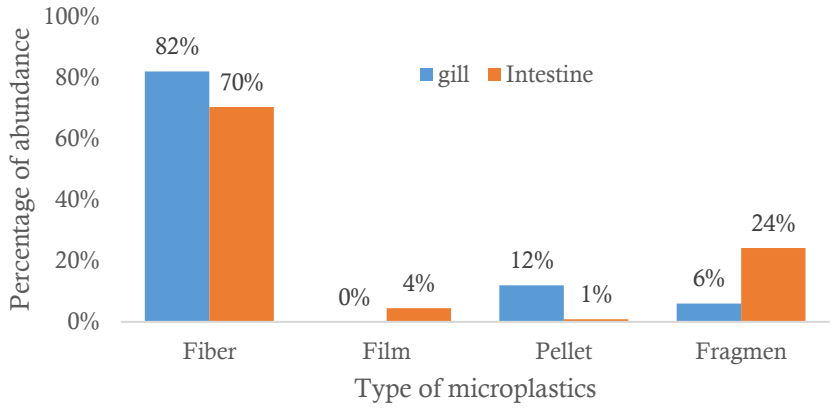

Figure 3. Microplastic Abundance in Fish at Code River based on Shape and Size

Fiber microplastics are widely used in the manufacture of clothing, rigging, and various fishing activities such as nets and plastic bags that have been degraded [16]. Whereas Pellet microplastics are primary microplastics that frequently used in making plastic raw materials that are made directly by factories and industries [17]. Microplastic distribution in the territorial waters is not yet fully known, but can be estimated by understanding the external forces that cause the movement. Microplastics are present in a variety of groups that vary significantly in terms of size, shape, color, composition, density, and other properties . Microplastic degradation can again occur to a smaller size and increase abundance at the surface of the water. In location, there were also found a number of macroplastics floating along the river body covering the surface of the water. This causes the movement of the microplastic to be slow and accumulate, so that the fragmentation process will hamper it.

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Several microplastic colors found at all points were red, blue, green, black, brown, transparent, white, and purple. The most dominant microplastic color was blue by 49% in the gills and 48% in the intestinal organs of fish. The blue one had 130 particles with an abundance of 5.78 particles/gram. This shows that the color of the microplastic is still concentrate, which means that the microplastic has not undergone significant discoloring. Other factors also trapped microplastic becomes difficult to degrade due to low temperatures and ultraviolet (UV) radiation. Solid color microplastics are used as initial identification of polyethylene (PE) polymers. PE polymer is the main ingredient in the compilation of bags and plastic containers [18]. Whereas the fewest colors found were purple with and abundance of 0.022 particles/gram. We also found microplastic with transparent colors. Transparent colored microplastics are the initial identification of this type, including polypropylene (PP) polymer. This type of polymer is one of the polymers most commonly found in waters [19].

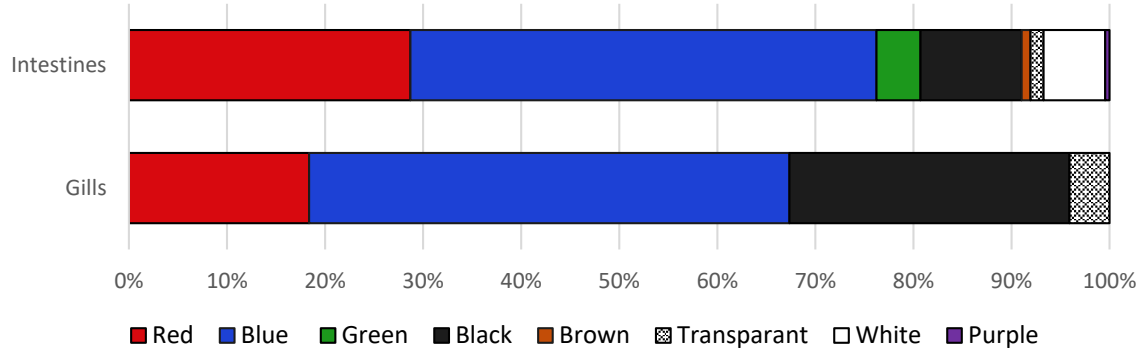

Figure 4. Percentage of Microplastic Abundance by Color in Fish Gills (left) and Intestine (right)

Classification of microplastic distribution based on river zones is divided into 3 zones, which are upstream, middle, and downstream with 4 points. Therefore, the upstream zone was represented by point 1, the middle zone was represented by points 2, and 3, while the downstream zone was represented by point 4. Based on the results of the analysis conducted, the fiber form microplastic is more dominant, and the distribution of microplastic abundance in the Code River in fish is larger happened in the upstream zone (point 1) compared to that in the downstream zone of Code River (point 4).

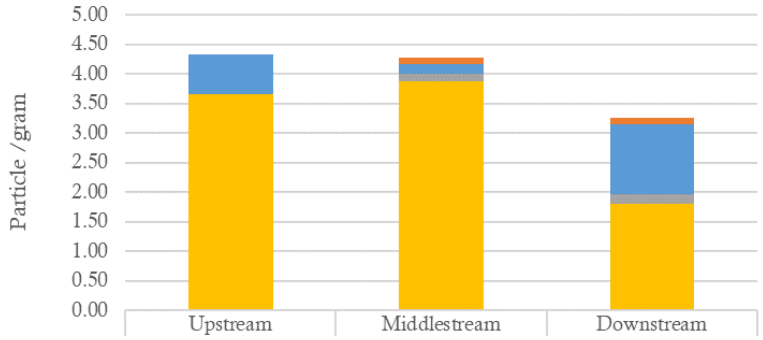

Figure 5. Distribution of Microplastic Abundance in Fish from Code River

Based on the analysis of research conducted, the microplastic distribution in the upstream of the Code River was greater with an abundance of 4.33 particles/gram compared to the downstream ones with an abundance of 2.595 particles/gram. This can be related to variations of fish in each zone with different characteristics based on physical conditions in the upstream, middle, and downstream of Code River. Microplastic distribution conditions also have not fully reached the downstream for its transformation. In addition, it can also be associated with fish with different types and sizes, which can affect the microplastic distribution itself.

According to previous research, the similarity between the size of plankton and high microplastic in waters is estimated to reach 1: 5 from the ratio between abundance of microplastic and plankton, making it difficult for fish to distinguish prey or other particles [20]. This can be indicated that the highest microplastic abundance occurs in the upstream of Code River (Sinduharjo, Sleman Regency) due to factors from the anatomical structure of the digestive tract in barbs that are classified as omnivorous.

Microplastic mechanism might end up in the fish's digestive system because the main factors supporting the bioavailability of microplastics with a small size fraction, consequently microplastic can be found by organisms up to the lower trophic level. Many organisms of this trophic level have low selectivity in capturing particles of the same size as their natural prey [21]. Therefore, if it is related to the shape, color, sampling position, and source, different microplastic in terms of color, shape and size are surely can be found. Fish of different types and sizes can also affect the existence of the microplastic itself. The difference in abundance values shown in each research can be caused by the characteristics of the different research locations.

Conclusion

The results of this study shows that microplastics were identified in fish samples collected from Code River. The dominant type of microplastics are follow: fiber, film, pellet, and fragment. Blue color was dominated compare with other colors. The quantification results of the total number of microplastics found at all points were 273 particles with a total abundance of 11.205 particles/gram. The abundance of microplastics in fish collected from the upstream (4.33 particles/gram) and middle stream (4.28 particles/gram) are almost similar while the abundance in downstream area was the lowest (3.25 particles/gram). This shows that Code River water have been contaminated by microplastics.

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