Highlighting the Importance of Studying Microplastics in Freshwater Fishes

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Plastic pollution has recently been considered one of the major pressing concerns in the world, as the demand for plastic continues to increase, especially over the last decade and during the COVID-19 pandemic. Nowadays, most of people's daily practices tend to move toward the use of more plastic materials that could not be rapidly recycled, not only for wrapping various things including food products, but also for the manufacture of plastic-wear gears such as hand gloves, face shields, and personal protective equipment (PPE) used by health workers in their work areas during this period of the pandemic, *e.g.* in hospitals, health centers, and health check-points among others. Amidst these developments, increase in production of plastic materials is not usually followed by advocacy on the adoption of plastic waste management, a phenomenon that remains a global challenge.

Plastic debris or plastic particles that enter the environment come in a wide range of sizes. Arthur *et al*. (2009) defined microplastics as any plastic particles or polymers that are smaller than 5.0 mm, originating from manufactured plastics that come in particular sizes and/or shapes with varying purposes. Microplastics could be primary or secondary microplastics, where primary microplastics come from materials specifically produced for industrial use, while secondary mircoplastics are those particles that result from the physical, biological, or chemical degradation of larger particles (Andrady, 2011) and constitute the main source of microparticles released into the environment. In general, larger plastic particles of various sizes could be detected visually, which means that their relevant physical information could be extracted using the naked eye and such inspection process is generally used in monitoring their presence in the environment. **Figure 1** shows some types of microplastics that come in various shapes.

However, some plastic microparticles, such as small microplastics (< 1.0 mm = 1000 µm) and nanoplastics (< 100 nm) can only be detected through the use of light microscopy. These particles are relatively difficult to detect, especially in terms of their chemical composition except through the use of infrared spectroscopy or any microscopic technology. This is true for food products including freshwater fishes since the small microparticles usually pass through the gut wall, as in the case of fishes.

Microplastics could be found in marine waters, riverbeds, natural fertilizers, and soils, even contaminating drinking water, and recently these particles had also been traced in the human food chain. The omnipresence of microplastics in almost all things around makes it an enormous challenge to protect the health and well-being of humans and the environment. The threat of microplastics to marine life has been extensively studied, like the ingestion of microplastics by several marine species has already been examined and analyzed, but little is known of the presence of microplastics in freshwater fishes so that information regarding the impacts of microplastics ingested by freshwater fishes are still very scarce. Considering that the uptake of microplastics by fishes is known to contaminate the human food chain, it has also become urgent to assess the presence of microplastics especially in freshwater fishes since consuming microplastic-contaminated freshwater fish could pose potential risk to humans.

Plastic pollution has recently become one of the key environmental issues of the world in general and of the ASEAN Member States (AMSs) in particular, not only coming from the plastic particles in the form of marine debris but

Figure 1. Microplastics *(top)* and their shapes *(bottom)*: A - sheet; B - film; C - line/fiber; D - fragment; E - pellet/granule; and F - foam
Source: *Wu* et al. *(2017)*

also from those particles found in freshwater environments. Against this backdrop, the SEAFDEC Inland Fishery Resources Development and Management Department (SEAFDEC/IFRDMD) based in Palembang, Indonesia has embarked on a one-year preliminary investigation of microplastics in freshwater fishes in Southeast Asia starting in 2021, with financial support from Japan-ASEAN Integration Fund (JAIF).

This study is part of the SEAFDEC project "Regional Collaborative Research and Capacity Building for Monitoring and Reduction of Marine Debris from Fisheries in Southeast Asia" which is being supported by JAIF and coordinated by the SEAFDEC Secretariat. Under this Project is a study that focuses on the impacts of microplastic contaminants in freshwater fishes which is being carried out by SEAFDEC/IFRDMD with pilot site at the Musi River, South Sumatra, Indonesia. This study is in parallel with the investigation of mircoplastics in marine fishes which has the Gulf of Thailand as its pilot site, and carried out by SEAFDEC/TD. Results of these studies could provide a clear understanding of the characteristics of microplastics in freshwater and marine fishes and the risks from consuming microplastic contaminated fish and fishery products. Generally aimed at securing food safety in the Southeast Asian region, these studies are being undertaken through monitoring surveys on the effects of microplastics in freshwater and marine fishes at the targeted pilot research sites in Indonesia and Thailand, respectively, and risk assessments of the hazards on humans and the environment caused by the microplastics as contaminants. The results would be disseminated to the AMSs to provide valuable lessons on the impacts of microplastics on the socioeconomic development of the AMSs.

Microplastic pollution in inland waters

Southeast Asia is endowed with natural inland waters that include vast river systems and lakes, floodplains, and wetlands, as well as man-made and enhanced natural waters such as reservoirs and dams (Pongsri *et al*., 2015). A rich diversity of aquatic species inhabits these inland waters, including a variety of freshwater fishes that contribute to food security, generate livelihood and recreational opportunities, and serve as sources not only of nutrients for the rural populace but also income for millions of people living along these water bodies.

Inland fishery activities give a vital component of the economy in sustaining and alleviating the economies of rural communities whose subsistence depends on inland fishery products. These inland water resources could be sustainably utilized to promote responsible inland fisheries. However, most of the region's inland water resources are being degraded, and many are almost lost, mainly due to destructive human activities that lead to pollution. It is in this regard that the awareness of residents living around the inland water bodies should be enhanced, especially on the use of plastic materials in their day-to-day activities, as well as on the proper and responsible disposal of solid wastes.

Being a natural recipient and receptacle of solid wastes, inland water resources are at risk of being polluted and contaminated by microplastics, a situation similar to the issues of plastic debris in marine environments, making the inland waters known to be important source of plastic pollution. In the study of Bessa *et al*. (2018) carried out in the Mondego Estuary, Portugal, the results indicated that ingestion of microplastics in sea bream populations, where the dominant polymers were polyester, polypropylene, and rayon (semi-synthetic fiber). The presence of these pollutants in commercial fish populations from Mondego Estuary which was reported for the first time had raised concerns on the potential negative effects of microplastics in the human food chain.

The extensive use of plastic materials has resulted in the presence of microplastics in the food chain and exposure of consumers to such contaminants. There have also been studies that confirmed the presence of microplastics in freshwater fishes. The review conducted by van Raamsdonk *et al*. (2020) which focused on recently published data on concentrations of microplastics in food, possible effects, and monitoring methods, some studies on zebrafish, a freshwater fish, indicated diverse results related to the type and extent of the effects of microplastic ingestion, although exposure of the fish to microplastics led to changes in their gut microbiota, lipid metabolism, and oxidative stress.

Preliminary assessment of microplastics in freshwater fishes in Southeast Asia: a challenge

The investigation on microplastics in freshwater fishes in Southeast Asia which is being carried out by SEAFDEC/IFRDMD, is aimed at characterizing the composition of microplastics in commercially important freshwater fishes at Musi River in South Sumatra Province, Indonesia (**Figure 2**). The study also intends to come up with a risk assessment of the microplastics present in freshwater fishes on human health and the environment.

The Musi River is a type of inland water ecosystem located on the Sumatra Island in Indonesia. The river roughly flows from Barisan Mountains in Kepahiang, Bengkulu to the Bangka Strait that drains to the South China Sea, stretching a total length of about 750 km. Also flowing through Palembang, the provincial capital of South Sumatra, Musi River has nine tributaries, namely: Batang Hari Sembilan which includes the Komering River, Ogan River, Lematang River, Batangharileko River, Rawas River, Lakitan River, Semangus River, Kelingi River, and Kikim River. The area of the Musi River Basin is around 2.5 million ha or about 20 % of the total

Figure 2. Map of Sumatra, Indonesia showing Musi River, the pilot site for the study on microplastics in freshwater fishes, with the sampling stations 1-9 identified

area of the Sumatra's rivers and swamps of 12.5 million ha (Manggabarani, 2015; Sukadi, 2005). The Musi River has a strategic role in supporting the economic development of the people in South Sumatra.

The important role of the Musi River has been recorded historically since the days of the Srivijaya Empire. At that time, the Musi River was widely used as the transportation route for ships carrying agricultural produce to trade centers both in the South Sumatra region and outside the region to all of Sumatra and the islands outside Sumatra. Until now, the Musi River is still used by various sectors such as fisheries and transportation, while its bank is used by other sectors, such as agriculture, industrial, and forestry, as well as for palm plantations, and settlements, all of which contribute one way or another, to the status of the river's aquatic ecosystem. The Musi River has high biodiversity, such as fish, crustaceans, mollusks, and reptiles that have economic value and functions to maintain environmental balance.

For this SEAFDEC/IFRDMD study, the presence of microplastics in three economically important freshwater fishes, namely: catfish (*Mystus* sp.), bagrid catfish (*Hemibagrus nemurus*), and *Pangasius* sp. (**Figure 3**) would be monitored and analyzed. The fishes would be caught using gillnet and long line from three river zones. The fishes to be monitored in the upstream zone are *Mystus* sp. and *Pangasius* sp.; in the middle zone, *Hemibagrus nemurus* and *Pangasius* sp.; and in the downstream zone, *Hemibagrus nemurus* and *Pangasius* sp.

Pangasius sp.

Hemibagrus nemurus

Mystus sp.

Figure 3. Three commercially-important freshwater fish species to be monitored in the IFRDMD study on microplastics
(**Source:** www.fishbase.org)

Way Forward

The results of the investigation by SEAFDEC/IFRDMD would be discussed during a regional workshop to be participated by representatives from the AMSs that is aimed at disseminating the results of the investigation, especially the presence of microplastic contaminants in freshwater fishes. From the recommendations of the workshop, SEAFDEC/IFRDMD would formulate the appropriate workplan for monitoring and analyzing the presence and risks of

microplastic contaminants in freshwater fishes to humans and the environment, taking into consideration the other inland waters of the AMSs. Furthermore, the said workplan would also include identification and reduction or elimination of the sources of microplastics in freshwater ecosystem. It is also envisioned that the results of this pilot study would provide the methodology and information necessary in establishing standardized sampling programs and more comprehensive understanding of the absorption of microplastics in freshwater fishes. Ultimately, the results would lead to the identification of the scientific evidence on the microplastic contaminants in the food supply chain and the risks of such contaminants to humans and the environment.

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