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# Occurrence and Visual Characteristics of Suspected Microplastics in the Gastrointestinal Tract of Wild Rabbitfish (*Siganus guttatus*) from Tamisan, Pujada Bay, Philippines

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A R T I C L E I N F O

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A B S T R A C T

Microplastic pollution threatens coastal ecosystems through ingestion by marine organisms. This study assessed the occurrence and characteristics of suspected microplastics in the gastrointestinal tract of wild rabbitfish (*Siganus guttatus*) from Tamisan, Pujada Bay. Sixty samples were collected and analyzed using KOH digestion, filtration, and stereomicroscopy. Microplastics were identified based on morphology and color over the sampling period, without FTIR confirmation due to size limitations. Results showed 26.7% occurrence (16/60), with a mean of 0.27 ± 0.45 particles per fish. Fibers dominated (87.5%), with blue as the most frequent color. These findings indicate exposure of wild rabbitfish to microplastics and highlight the need for continued monitoring and polymer confirmation.

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## INTRODUCTION

Plastic pollution has become one of the most visible and persistent problems in marine environments. As larger plastic materials are exposed to sunlight, wave action, mechanical abrasion, and other natural processes, they may break down into smaller particles known as microplastics. Microplastics are commonly defined as plastic particles smaller than 5 mm (Law & Thompson, 2014; Andrady, 2017; Auta et al., 2017). Because of their small size, these particles can be widely distributed in coastal waters, sediments, and biological organisms (Barnes et al., 2009; Gewert et al., 2015; Peng et al., 2020).

Marine organisms may ingest microplastics directly when the particles resemble food, or indirectly through contaminated prey and feeding substrates (Rochman et al., 2013; Lusher et al., 2017; Roch et al., 2020). In fish, ingestion may depend on habitat, feeding behavior, food availability, particle color, and particle shape (Santos et al., 2016; Mizraji et al., 2017; Liang et al., 2023). Microplastics may remain in the gastrointestinal tract and may cause digestive stress, reduced feeding efficiency, or exposure to chemicals associated with plastic particles (Wright et al., 2013; Hirt & Body-Malapel, 2020; Hossain & Olden, 2022).

The Philippines is highly exposed to plastic leakage into marine environments due to its long coastline, growing coastal population, and ongoing challenges in solid waste management (Jambeck et al., 2015; Galarpe et al., 2021). Local studies have reported microplastics in Philippine coastal waters, sediments, and fish, showing that the issue is not only global but also relevant to local fisheries and seafood safety (Abreo et al., 2016; Espiritu et al., 2019; Galicia et al., 2023; Go et al., 2024; Alburo et al., 2024). Since many coastal communities depend on fish for food and income, documenting microplastic occurrence in commonly consumed species is important.

Rabbitfish (*Siganus* spp.) are economically and ecologically important fishes in tropical coastal ecosystems. They are herbivorous fishes commonly associated with seagrass beds, reef flats, and coastal habitats where they graze on algae and seagrass-associated materials (Hoey et al., 2013; Fox & Bellwood, 2014; Parawansa et al., 2020; Latuconsina et al., 2021). Because seagrass and algal surfaces can trap suspended particles, rabbitfish may accidentally ingest microplastics while feeding. This makes rabbitfish a relevant species for assessing microplastic exposure in coastal habitats.

Pujada Bay in Davao Oriental is a biologically rich coastal area that supports fisheries, aquaculture, and nearby coastal communities. Tamisan is one of the areas within Pujada Bay where wild rabbitfish are collected. Despite the ecological and economic importance of rabbitfish, there is still limited information on microplastic ingestion in wild rabbitfish from this area. This study therefore, focused on the gastrointestinal tract of wild rabbitfish from Tamisan and aimed to determine the occurrence, abundance, and visual characteristics of suspected microplastics. The study was limited to visual identification because the recovered particles were too small for FTIR confirmation.

## THEORETICAL REVIEW

The study of Microplastics in marine ecosystems is supported by theoretical frameworks that explain their sources, transport, and biological uptake. Microplastics are derived from both primary sources, such as industrial microbeads, and secondary sources resulting from the fragmentation of larger plastic debris, which are then dispersed through oceanic and coastal processes (Andrady, 2017; GESAMP, 2019). Once in the marine environment, these particles are transported by currents and tend to accumulate in coastal and benthic zones, increasing their availability to marine organisms (Lebreton et al., 2019; van Sebille et al., 2015). The concept of exposure pathways explains how organisms ingest microplastics either directly from the water column or indirectly through contaminated food and sediments, with feeding behavior influencing susceptibility (Wright et al., 2020). In particular, benthic and herbivorous species are more prone to ingestion due to their interaction with sediment-associated particles. The theory of trophic transfer further suggests that microplastics can move through the food web via prey–predator interactions, potentially increasing exposure across trophic levels, although evidence for biomagnification remains inconclusive (Provencher et al., 2019; Savoca et al., 2021). Additionally, the physical characteristics of microplastics, including size, shape, and color, influence ingestion patterns, with fibers frequently reported as dominant due to their widespread origin from synthetic textiles and fishing-related activities (Barboza et al., 2018; Covernton et al., 2021). Methodologically, microplastic research follows standardized procedures involving digestion, filtration, and microscopic examination, while advanced techniques such as Fourier Transform Infrared Spectroscopy (FTIR) and Raman spectroscopy are recommended for polymer confirmation; however, limitations in detection and accessibility often result in reliance on visual identification, particularly in developing regions (Primpke et al., 2020; Cowger et al., 2021). These theoretical perspectives provide a comprehensive framework for understanding the occurrence, ingestion, and potential impacts of microplastics in marine organisms and coastal ecosystems.

## METHODOLOGY

### *Study Area*

The study was conducted in Tamisan, a coastal area within Pujada Bay, Davao Oriental, Philippines. Pujada Bay is located on the Pacific coast of the southern Philippine island of Mindanao. The bay was declared as a protected area under the National Integrated Protected Areas System (NIPAS) through Presidential Proclamation No. 431 in 1994. Pujada Bay is also considered as one of the most beautiful bays in the world (Ybañez, 2024). The bay is recognized for its productive marine ecosystems and supports local fisheries, including wild rabbitfish. Tamisan was selected as the sampling site for wild rabbitfish because it is associated with nearshore habitats, and it has a wide seagrass area where rabbitfish commonly feed and caught (Figure 1).

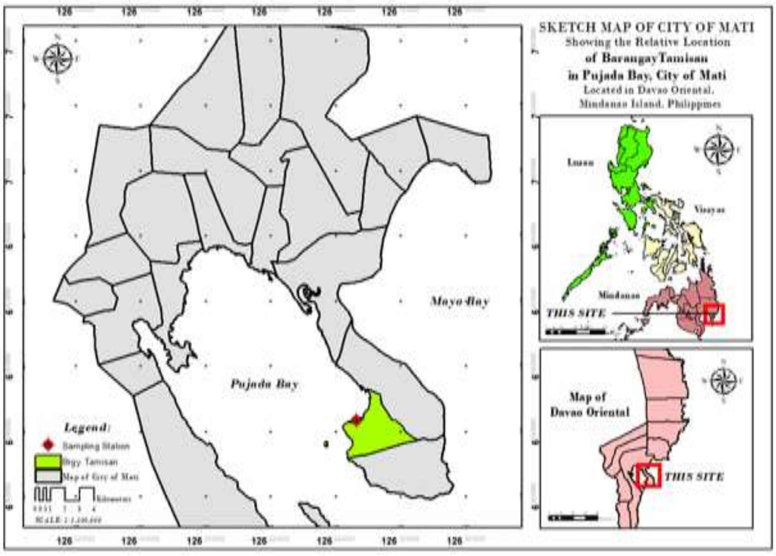


**Figure 1. Map of the study area.**

*Research Design and Sample Collection*

This study used a descriptive-quantitative design to determine the occurrence and characteristics of suspected microplastics in the GIT of wild rabbitfish. A total of 60 wild rabbitfish (*Siganus guttatus*) samples were collected from Tamisan. After collection, the fish samples were wrapped in aluminum foil to reduce contamination, placed in an ice box during transport, and stored in a freezer until laboratory processing. Only the wild rabbitfish GIT data from Tamisan were included in this article.

*Contamination Control*

To minimize possible contamination, clean laboratory materials were used and samples were handled carefully during processing. Containers and materials were covered when not in use. Filtered distilled water was used for rinsing, and the samples were handled in a way that avoided unnecessary exposure to airborne particles. Natural-fiber clothing and non-plastic handling materials were preferred during field and laboratory work whenever possible.

*Dissection, Digestion, and Extraction of Suspected Microplastics*

Each fish was dissected and the whole gastrointestinal tract was removed using clean dissection materials. The GIT was placed in a clean glass container and digested using 10% potassium hydroxide (KOH). The samples were left until the organic tissues were sufficiently digested. After digestion, the solution was filtered using a vacuum filtration set-up. The filter papers were then dried and stored in covered petri dishes until microscopic examination.

*Visual Identification and Characterization*

The dried filter papers were examined under a stereomicroscope. Suspected microplastics were recorded based on visual characteristics such as morphology and color. Morphology was categorized as fiber, fragment, film, pellet/granule, or foam when applicable. Color was recorded according to the visible color of each suspected particle. In this study, polymer confirmation through FTIR was not completed because the recovered suspected particles were too small for the available FTIR reading. For this reason, the results are reported as visually identified suspected microplastics rather than confirmed microplastics.

*Data Analysis*

The occurrence of suspected microplastics was calculated as the percentage of fish samples containing at least one visually identified suspected microplastic particle relative to the total number of fish examined. Abundance was expressed as the mean number of suspected microplastic particles per fish and presented as mean ± standard deviation. Descriptive statistical analyses were used to summarize the data.

The morphology and color of suspected microplastics were categorized and quantified using frequency counts and percentage distribution. Morphological categories included fibers, fragments, and films, while color categories included blue, red, black, and transparent particles. The frequency of each category was computed relative to the total number of suspected particles observed.

Data tabulation and descriptive statistical computations were performed using Microsoft Excel. Results were presented in tables to facilitate comparison of occurrence, abundance, morphology, and color distribution of suspected microplastics in wild rabbitfish collected from Tamisan, Pujada Bay.

**RESULTS**

*Occurrence and Abundance of Suspected Microplastics*

Out of the 60 wild rabbitfish examined from Tamisan, 16 samples contained suspected microplastics, while 44 samples had no observed suspected particles. This corresponds to an occurrence rate of 26.7%. Since each positive sample contained one visually recorded suspected particle, the total number of suspected particles was 16. The mean abundance was 0.27 ± 0.45 suspected microplastic particle per fish (Table 1).

Table 1. Occurrence and abundance of suspected microplastics in wild rabbitfish from Tamisan.

| Parameter | Value |
|---|---|
| Number of fish examined | 60 |
| Fish with suspected microplastics | 16 |
| Fish without suspected microplastics | 44 |
| Occurrence (%) | 26.7 |
| Total suspected particles recorded | 16 |
| Mean abundance (particles/fish) | 0.27 ± 0.45 |

*Morphology of Suspected Microplastics*

The suspected particles observed in the GIT of wild rabbitfish were mainly fibers. Fibers accounted for 14 out of 16 particles, or 87.5% of the total particles recorded. Only one fragment and one film were observed, each representing 6.3% of the total suspected particles (Figure 2).

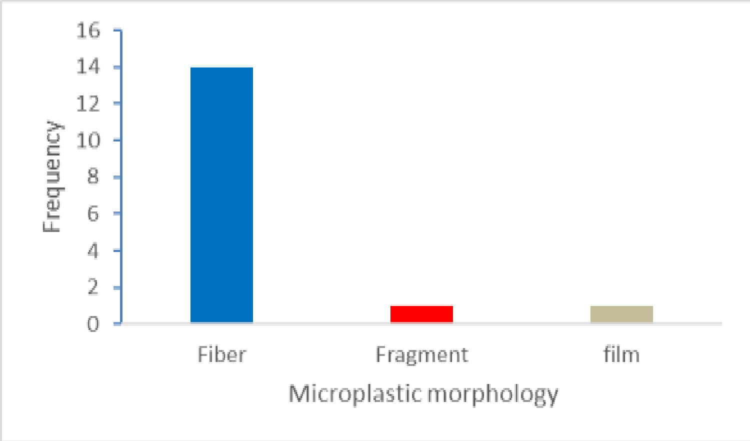


**Figure 2. Morphological characteristics of suspected microplastics**.

*Color of Suspected Microplastics*

The suspected microplastics showed four observed colors: blue, red, black, and transparent. Blue was the most common color, representing half of the total particles recorded. Red particles were the second most common, followed by black and transparent particles (Figure 3).

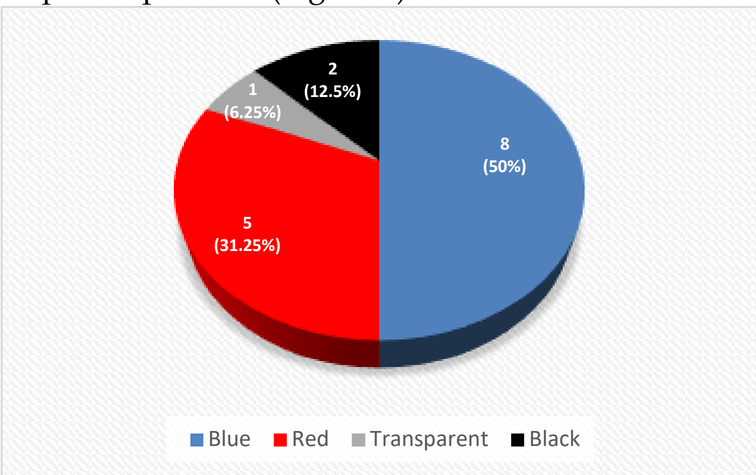


**Figure 3. Color distribution of suspected microplastics.**

*Samples with Suspected Microplastics*

Suspected microplastics were recorded in the following Tamisan fish samples no. (TF): TF3, TF4, TF11, TF12, TF13, TF15, TF16, TF17, TF18, TF22, TF32, TF37, TF41, TF44, TF55, TF60.

## DISCUSSION

The present study revealed that 26.7% of wild *Siganus guttatus* collected from Tamisan contained visually identified suspected microplastics, with a mean abundance of 0.27 ± 0.45 particles per fish. The occurrence of suspected microplastics in more than one-fourth of the examined fish indicates that microplastic contamination is already present within the coastal environment of Pujada Bay. Although the abundance observed in this study was relatively lower compared to reports from highly urbanized or industrialized marine systems, the findings remain ecologically significant because rabbitfish are widely consumed and play an important role in tropical coastal food webs. Similar ingestion frequencies ranging from 10% to 40% have been documented in marine fishes from tropical and coastal environments, where contamination levels vary depending on habitat characteristics, anthropogenic pressures, feeding ecology, and proximity to pollution sources (Lusher et al., 2017; Savoca et al., 2021; Hossain & Olden, 2022).

In the Philippine setting, the occurrence observed in this study is comparable to previous reports documenting microplastic contamination in marine organisms from coastal ecosystems. Espiritu et al. (2019) reported the presence of microplastics in selected fish species from Batangas, Philippines, although differences in abundance were influenced by species-specific feeding behavior and environmental conditions. Similarly, Go et al. (2024) documented microplastics in fish, seawater, and beach sediments from tourist coastal destinations, suggesting that microplastic contamination has become widespread even in areas that are not heavily industrialized. The relatively moderate abundance recorded in Tamisan may reflect the semi-rural condition of the area, which may experience lower plastic input compared to densely populated urban coastlines. However, continuous coastal activities such as fishing, domestic waste disposal, and shoreline human settlements may still contribute to the gradual accumulation of plastic-derived particles in the marine environment.

The ingestion of suspected microplastics by S. guttatus may be strongly associated with the species' herbivorous feeding behavior and habitat preference. Rabbitfish commonly graze on algae, seagrass surfaces, and benthic-associated materials where suspended particles may accumulate (Mizraji et al., 2017; Latuconsina et al., 2021). Seagrass ecosystems and benthic habitats are recognized as sinks for fine suspended particles because reduced water movement promotes sedimentation and particle retention (Peng et al., 2020). Consequently, rabbitfish feeding within these habitats may accidentally ingest microplastics together with algal matter, detritus, or sediment-associated food materials. This suggests that ingestion in wild rabbitfish is likely incidental rather than selective and occurs during normal feeding activities within contaminated coastal habitats.

A notable finding of this study is the dominance of fiber morphology, which accounted for 87.5% of the total suspected particles observed. The predominance of fibers is consistent with findings from numerous global and regional microplastic studies involving marine organisms (Lusher et al., 2017; Savoca et al., 2021). Fibers are commonly recognized as the most abundant microplastic type in aquatic environments because they are continuously released from synthetic textiles, domestic laundry wastewater, ropes, fishing nets, and other fishing-related materials (De Falco et al., 2020). Their elongated and lightweight structure also allows them to remain suspended in seawater for longer periods, increasing the likelihood of ingestion by marine organisms. In addition, microfiber contamination has been reported to persist even after wastewater treatment because many treatment systems are unable to completely remove very fine synthetic fibers before discharge into coastal waters (Auta et al., 2017; De Falco et al., 2020).

The dominance of fibers observed in this study may therefore reflect both land-based and marine-based sources of plastic pollution within the study area. Similar observations were reported in Philippine coastal waters, where fibers were frequently associated with household wastewater, improper solid waste disposal, fishing activities, and degradation of synthetic fishing materials (Galarpe et al., 2021; Galicia et al., 2023). Since Tamisan supports active fishing activities and nearby coastal communities, the presence of fibers in wild rabbitfish may indicate continuous exposure to locally generated plastic debris and fishing-related materials entering the marine environment.

Color distribution analysis further showed that blue particles were the most dominant, followed by red, black, and transparent particles. The predominance of blue particles may be linked to the widespread use of blue-colored fishing ropes, synthetic fishing lines, and netting materials in coastal fisheries (Santos et al., 2016; Lusher et al., 2017). Meanwhile, red and black particles may originate from degraded packaging materials, painted surfaces, domestic plastic waste, or fragments of consumer products transported into the marine environment. Previous studies have suggested that fish may unintentionally ingest colored particles because some plastics visually resemble prey organisms or suspended organic materials in the water column (Santos et al., 2016). However, the interpretation of color origin should be approached cautiously because environmental weathering processes such as ultraviolet radiation, oxidation, abrasion, and biofouling can alter the original appearance of plastic particles over time (Andrady et al., 2022).

Although the suspected microplastics detected in this study were confined to the gastrointestinal tract, their occurrence remains ecologically relevant. Microplastics may not always accumulate permanently within fish because particles can be egested after ingestion (Roch et al., 2020). Nevertheless, continuous exposure may lead to repeated ingestion and prolonged interaction with digestive tissues, potentially causing physical stress, reduced feeding efficiency, gut irritation, and exposure to toxic chemicals adsorbed onto plastic surfaces (Wright et al., 2013; Hirt & Body-Malapel, 2020). Microplastics may also act as carriers of contaminants such as heavy metals and persistent organic pollutants, which could further increase ecological risks to marine organisms (Teuten et al., 2009). From a food safety perspective, the occurrence of microplastics in edible fish species raises concerns regarding possible human exposure, particularly in coastal communities where whole fish or internal organs are occasionally consumed (Smith et al., 2018; Cox et al., 2019; Prata et al., 2020).

Compared with studies reporting substantially higher microplastic abundance in fish, the relatively lower abundance observed in this study may be attributed to differences in environmental contamination levels, species ecology, sampling strategies, and analytical methodologies. Studies utilizing more advanced analytical techniques capable of detecting smaller particles often report higher microplastic abundance because microscopic particles that are not visible under conventional stereomicroscopy may also be identified (Prata et al., 2020; Liang et al., 2023). Consequently, the actual abundance of microplastics in the examined rabbitfish may have been underestimated in the present study.

One important limitation of this study is the absence of polymer confirmation using Fourier Transform Infrared Spectroscopy (FTIR). While visual identification remains widely used in preliminary microplastic assessments, it may result in possible misidentification of non-plastic materials such as natural fibers, organic debris, or degraded biological particles (Hidalgo-Ruz et al., 2012; Lusher et al., 2017). For this reason, the particles identified in this study were cautiously classified as "suspected microplastics." Similar methodological limitations have also been recognized in previous studies involving very small particle sizes and limited analytical resources (Prata et al., 2020). Despite this limitation, visual identification still provides valuable baseline information for areas where advanced spectroscopic instruments are not readily accessible.

The findings of this study contribute baseline information on microplastic contamination in wild rabbitfish from Pujada Bay and provide additional evidence that economically important marine fish species are already exposed to plastic-derived particles in Philippine coastal ecosystems. The consistent detection of fibers and the measurable occurrence of suspected microplastics emphasize the need for continued environmental monitoring, improved coastal waste management practices, and further studies incorporating polymer confirmation techniques and environmental sampling to better understand the sources, transport pathways, and ecological implications of microplastic contamination in the region.

## CONCLUSIONS AND RECOMMENDATIONS

This study documented the occurrence of visually identified suspected microplastics in the gastrointestinal tract of wild Siganus guttatus collected from Tamisan, Pujada Bay, where 16 out of 60 individuals (26.7%) were found to contain suspected microplastics. Fibers were the predominant morphology, with blue particles being the most frequently observed, indicating possible links to common anthropogenic sources such as fishing gear, textiles, and domestic waste. These findings suggest that wild rabbitfish in the study area are exposed to microplastic contamination, reflecting the broader environmental condition of coastal ecosystems in Pujada Bay. However, due to the absence of polymer confirmation through Fourier Transform Infrared Spectroscopy (FTIR), as the recovered particles were too small, the results should be interpreted with caution and considered as visually identified suspected microplastics. In light of these findings, it is recommended that future studies incorporate confirmatory analytical techniques such as FTIR or Raman spectroscopy to improve identification accuracy. Expanding sampling efforts to include multiple sites, larger sample sizes, seasonal variation, and environmental matrices such as seawater and sediments is also essential to better understand the sources, distribution, and pathways of microplastics. Furthermore, strengthening local waste management practices and promoting community awareness in coastal areas are critical steps toward reducing plastic inputs into the marine environment. Continuous monitoring and research are therefore encouraged to support evidence-based management and conservation strategies for the sustainable protection of marine resources in Pujada Bay.

**FURTHER STUDY**

Despite providing baseline information on the occurrence of suspected microplastics in the gastrointestinal tract of wild *Siganus guttatus*, this study has several limitations that open opportunities for further investigation. Future research is recommended to employ advanced analytical techniques such as Fourier Transform Infrared Spectroscopy (FTIR) or Raman spectroscopy to confirm polymer composition and improve identification accuracy. Expanding the study to include multiple sampling sites, larger sample sizes, and seasonal variation would provide a more comprehensive understanding of microplastic distribution in Pujada Bay. Comparative analyses between wild and cultured populations of *Siganus guttatus*, as well as the inclusion of environmental matrices such as seawater, sediments, and potential food sources, are also suggested to better trace the sources and pathways of microplastics. Furthermore, studies exploring the biological and ecological effects of microplastic ingestion, including potential impacts on fish health and trophic transfer, would contribute to a deeper understanding of the implications of microplastic pollution in coastal ecosystems.

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**REFERENCES**

Abreo, N. A. S., Macusi, E. D., Blatchley, D. D., & Cuenca, G. C. (2016). Ingestion of marine plastic debris by green turtle (Chelonia mydas) in Davao Gulf, Mindanao, Philippines. Philippine Journal of Science, 145(1), 17–23. ISSN 0031 - 7683

Alburo, H. M., Geolin, K. R. C., Villegas, L. M. G., & Alburo, R. P. (2024). Occurrence, characterization, and hazard assessment of microplastics in edible tissues of commercial fishes from public wet markets in Cebu Province, Philippines. International Journal of Aquatic Biology, 12(4), 309–320. https://doi.org/10.22034/ijab.v12i4.2331

Andrady, A. L. (2017). The plastic in microplastics: A review. Marine Pollution Bulletin, 119(1), 12–22. https://doi.org/10.1016/j.marpolbul.2017.01.082

Andrady, A. L., Barnes, P. W., Bornman, J. F., Gouin, T., Madronich, S., White, C. C., & Jansen, M. A. K. (2022). Oxidation and fragmentation of plastics in a changing environment: From UV radiation to biological degradation. Science of the Total Environment, 851, 158022. https://doi.org/10.1016/j.scitotenv.2022.158022

Auta, H. S., Emenike, C. U., & Fauziah, S. H. (2017). Distribution and importance of microplastics in the marine environment: A review of the sources, fate, effects, and potential solutions. Environment International, 102, 165–176.

Barboza, L. G. A., Vethaak, A. D., Lavorante, B. R. B. O., Guilhermino, L., & Marine Microplastics Research Group. (2020). Marine microplastic debris: An emerging issue for food security, food safety, and human health. Marine Pollution Bulletin, 133, 336–348.

Barnes, D. K. A., Galgani, F., Thompson, R. C., & Barlaz, M. (2009). Accumulation and fragmentation of plastic debris in global environments. Philosophical Transactions of the Royal Society B, 364(1526), 1985–1998. https://doi.org/10.1098/rstb.2008.0205

Cowger, W., Gray, A., Christiansen, S. H., De Frond, H., Deshpande, A. D., Hemabessiere, L., Lee, E., Millan, R., Munno, K., Pagter, E., Primpke, S., & Rochman, C. M. (2021). Critical review of microplastic identification methods: A proposed framework. Analytical and Bioanalytical Chemistry, 413, 609–626.

Covernton, G. A., Pearce, C. M., Gurney-Smith, H. J., Chastain, S. G., Ross, P. S., & Dower, J. F. (2021). Size and shape matter: A preliminary analysis of microplastic ingestion by fish. Science of the Total Environment, 667, 124–132.

Cox, K. D., Covernton, G. A., Davies, H. L., Dower, J. F., Juanes, F., & Dudas, S. E. (2019). Human consumption of microplastics. Environmental Science & Technology, 53(12), 7068–7074. https://doi.org/10.1021/acs.est.9b01517

De Falco, F., Cocca, M., Avella, M., & Thompson, R. C. (2020). Microfiber release to water via laundering and to air via everyday use. Environmental Science & Technology, 54(6), 3288–3296. https://doi.org/10.1021/acs.est.9b06892

Espiritu, E. Q., Dayrit, S. A., Coronel, A. S. O., Paz, N. S., Ronquillo, P. I. L., Castillo, V. C. G., & Enriquez, E. P. (2019). Assessment of quantity and quality of microplastics in sediments, waters, oysters, and selected fish species in key sites along the bombing estuary and the coastal waters of Tilacan in San Juan, Batangas, Philippines. Philippine Journal of Science, 148(4), 789–801.

Fox, R. J., & Bellwood, D. R. (2014). Herbivores in a small world: Network theory highlights vulnerability in the function of herbivory on coral reefs.. Functional Ecology, 28(3), 642–651. https://doi.org/10.1111/1365-2435.12190

Galicia, M. L. C., Flestado, C. L. P., Magalong, J. R. S., Rivera, R. B. L., Villacorte, K. M., Sarmiento, W. P. G., & Deocaris, C. C. (2023). Assessment of microplastics in the surface water of Sitio Pulo, Navotas, Metro Manila. Applied Environmental Research, 45(1). DOI:10.35762/AER.2023001

Galarpe, V. R. K., Jaraula, C. M. B., & Paler, M. K. O. (2021). The nexus of macroplastic and microplastic research and plastic regulation policies in Philippine marine coastal environments. Marine Pollution Bulletin, 167, 112343.

GESAMP. (2019). Guidelines for the monitoring and assessment of plastic litter in the ocean. United Nations.

Gewert, B., Plassmann, M. M., & MacLeod, M. (2015). Pathways for degradation of plastic polymers floating in the marine environment. Environmental Science: Processes & Impacts, 17(9), 1513–1521. https://doi.org/10.1039/c5em00207a

Go, M. R., Ybañez, A. P., Cababat, F. A., & De La Calzada, L. J. (2024). Microplastics in beach sediments, seawater, and common fish in tourist destinations. Global Journal of Environmental Science and Management, 10(4), 1993–2008. https://doi.org/10.22034/gjesm.2024.04.30

Hidalgo-Ruz, V., Gutow, L., Thompson, R. C., & Thiel, M. (2012). Microplastics in the marine environment: A review of methods used for identification and quantification. Environmental Science & Technology, 46(6), 3060–3075.

Hirt, N., & Body-Malapel, M. (2020). Immunotoxicity and intestinal effects of nano- and microplastics: A review of the literature. Particle and Fibre Toxicology, 17, 57. https://doi.org/10.1186/s12989-020-00387-7

Hoey, A., Brandl, S. & Bellwood, D. (2013). Diet and cross-shelf distribution of rabbitfishes (f. Siganidae) on the northern Great Barrier Reef: Implications for ecosystem function. Coral Reefs. 32 (4). https://doi.org/10.1007/s00338-013-1043-z.

Hossain, M. M., & Olden, J. D. (2022). Global meta-analysis reveals diverse effects of microplastics on freshwater and marine fishes. Fish and Fisheries, 23(6), 1439–1454. https://doi.org/10.1111/faf.12701

Jambeck, J. R., Geyer, R., Wilcox, C., Siegler, T. R., Perryman, M., Andrady, A. L., Narayan, R., & Law, K. L. (2015). Plastic waste inputs from land into the ocean. ScienceMag.Org. Marine Pollution. 347(6223), 768–771. https://doi.org/10.1126/science.1260352

Karami, A., Golieskardi, A., Choo, C. K., Romano, N., Ho, Y. B., & Salamatinia, B. (2017). A high-performance protocol for extraction of microplastics in fish. Science of the Total Environment, 578, 485–494. https://doi.org/10.1016/j.scitotenv.2016.10.213

Latuconsina, H., Purbiantoro, W., & Padang, A. (2021). Feeding preference of white-spotted rabbitfish (*Siganus canaliculatus*) on different species of seagrass. AACL Bioflux, 14(6), 3242–3251.

Law, K. L., & Thompson, R. C. (2014). Microplastics in the seas. Science, 345(6193), 144–145. https://doi.org/10.1126/science.1254065

Lebreton, L. C. M., Egger, M., & Slat, B. (2019). A global mass budget for positively buoyant microplastic debris in the ocean. Sci Rep., 9(1). https://doi.org/10.1038/s41598-019-49413-5

Liang, W., Li, B., Jong, M. C., Ma, C., Zuo, C., Chen, Q., & Shi, H. (2023). Process-oriented impacts of microplastic fibers on behavior and histology of fish. Journal of Hazardous Materials, 448, 130856. https://doi.org/10.1016/j.jhazmat.2023.130856

Lusher, A. L., Welden, N. A., Sobral, P., & Cole, M. (2017). Sampling, isolating, and identifying microplastics ingested by fish and invertebrates. Analytical Methods, 9(9), 1346–1360. http://dx.doi.org/10.1039/C6AY02415G

Mizraji, R., Ahrendt, C., Perez-Venegas, D. J., & Vargas, J. (2017). Is the feeding type related with the content of microplastics in intertidal fish gut? Marine Pollution Bulletin, 116(1–2), 498–500. http://dx.doi.org/10.1016/j.marpolbul.2017.01.008

Parawansa, B. S., Ali, S. A., Nessa, M. N., Rappe, R. A., & Indar, N. (2020). Biological analysis of adult rabbitfish (*Siganus guttatus*) in seagrass and coral reef ecosystems. IOP Conference Series: Earth and Environmental Science, 473, 012006. https://doi.org/10.1088/1755-1315/473/1/012006

Peng, L., Fu, D., Qi, H., Lan, C. Q., Yu, H., & Ge, C. (2020). Micro- and nano-plastics in marine environment: Sources, distribution, and threats. Science of the Total Environment, 698, 134254. https://doi.org/10.1016/j.scitotenv.2019.134254

Prata, J. C., da Costa, J. P., Duarte, A. C., & Rocha-Santos, T. (2020). Methods for sampling and detection of microplastics in water and sediment: A critical review. TrAC Trends in Analytical Chemistry, 110, 150–159. https://doi.org/10.1016/j.trac.2018.10.029

Prata, J. C., da Costa, J. P., Lopes, I., Duarte, A. C., & Rocha-Santos, T. (2020). Environmental exposure to microplastics: An overview on possible human health effects. Science of the Total Environment, 702, 134455. https://doi.org/10.1016/j.scitotenv.2019.134455

Provencher, J. F., Ammendolia, J., Rochman, C. M., & Mallory, M. L. (2019). Assessing plastic debris in aquatic food webs. Environmental Reviews, 27(2), 171–186.

Roch, S., Friedrich, C., & Brinker, A. (2020). Uptake routes of microplastics in fishes: Practical and theoretical approaches to test existing theories. Scientific Reports, 10, 3896. https://doi.org/10.1038/s41598-020-60630-1

Rochman, C. M., Hoh, E., Kurobe, T., & Teh, S. J. (2013). Ingested plastic transfers hazardous chemicals to fish and induces hepatic stress. Scientific Reports, 3, 3263. https://doi.org/10.1038/srep03263

Santos, R. G., Andrades, R., Fardim, L. M., & Martins, A. S. (2016). Marine debris ingestion and plastic color. Environmental Pollution, 214, 585–588. https://doi.org/10.1016/j.envpol.2016.04.024

Savoca, M. S., McInturf, A. G., & Hazen, E. L. (2021). Plastic ingestion by marine fish is widespread and increasing. Global Change Biology, 27(10), 2188–2199. https://doi.org/10.1111/gcb.15533

Smith, M., Love, D. C., Rochman, C. M., & Neff, R. A. (2018). Microplastics in seafood and implications for human health. Current Environmental

Health Reports, 5(3), 375–386. https://doi.org/10.1007/s40572-018-0206-z

Teuten, E. L., Saquing, J. M., Knappe, D. R. U., Barlaz, M. A., Jonsson, S., Björn, A., Rowland, S., Thompson, R. C., Galloway, T., Tamashita, R., Ochi, D., Watanuki, Y., Moore, C., Viet, PH., Tana, TS., Prudente, M., Boonyatumanond, R., Zakaria, MP., Akkhavong, K., Ogata, Y., Hirai, H., Iwasa, S., Mizukawa, K., Hagino, Y., Imamura, A., saha, M. & Takada, H. (2009). Transport and release of chemicals from plastics to the environment and to wildlife. Philosophical Transactions of the Royal Society B: Biological Sciences, 364(1526), 2027-2045. https://doi.org/10.1098/rstb.2008.0284

van Sebille, E., Wilcox, C., Lebreton, L., Maximenko, N., Hardesty, B. D., van Franeker, J. A., Eriksen, M., Siegel, D., Galgani, F., & Law, K. L. (2015). A global inventory of small floating plastic debris. Environmental Research Letters, 15(6), 063001. DOI 10.1088/1748-9326/10/12/124006

Wright, S. L., Thompson, R. C., & Galloway, T. S. (2013). The physical impacts of microplastics on marine organisms: A review. Elsevier. Environmental Pollution, 178, 483–492. https://doi.org/10.1016/j.envpol.2013.02.031

Wright, S. L., Ulke, J., Font, A., Chan, K. L. A., & Kelly, F. J. (2020). Atmospheric microplastic deposition in an urban environment and an evaluation of transport. Environmental Science & Technology, 54(4), 2485–2494. https://doi.org/10.1016/j.envint.2019.105411

Ybañez, C. Jr. (2024). Exploring meiofaunal assemblages in Pujada Bay, Philippines: A glimpse into one of the world's most beautiful bays. Biodiversitas, 25(5), 1946-1954. DOI:10.13057/biodiv/d250511

Zhou, A., Zhang, Y., Xie, S., Chen, Y., Li, X., Wang, J., & Zou, J. (2020). Microplastics and their potential effects on aquaculture systems: A critical review. Reviews in Aquaculture, 13(1), 719–733. 733. https://doi.org/10.1111/raq.12496