JURNAL ILMU LINGKUNGAN
Volume 22 Issue 5 (2024) : 1293-1298 ISSN 1829-8907

Identification of Microplastics in *Euthynnus affinis* in Kedonganan Area, Kuta, Badung, Bali

Ayu Saka Laksmita W[1*], Desak Putu Risky Vidika Apriyanthi[1], dan Ni Putu Widayanti[1]

[1]Fakultas Ilmu-Ilmu Kesehatan, Universitas Bali Internasional; e-mail: sakalaksmita@gmail.com

ABSTRAK

Polusi sampah plastik di lautan dapat membahayakan keamanan pangan bagi masyarakat di dunia. Salah satu polusi yang paling berbahaya saat ini adalah mikroplastik. Mikroplastik adalah partikel plastik yang berukuran ≤ 5 µm dan tidak dapat larut dalam air. Ikan merupakan salah satu bahan pangan penting yang sering dikonsumsi oleh manusia karena selain rasanya yang lezat, ikan juga memiliki nilai gizi yang baik. Adanya cemaran mikroplastik pada ikan yang dikonsumsi oleh manusia tentunya akan sangat merugikan manusia. Tujuan dari penelitian ini adalah untuk mengetahui jenis dan kelimpahan mikroplastik pada ikan *Euthynnus affinis* di daerah Kedonganan, Kuta, Badung, Bali. Penelitian ini dilakukan pada bulan April hingga Mei 2023. Sampel ikan yang digunakan sebanyak 30 sampel dengan analisis deskriptif kualitatif. Partikel mikroplastik diekstraksi terlebih dahulu untuk dianalisis lebih lanjut. Hasil penelitian menunjukkan jenis mikroplastik yang ditemukan pada ikan Euthynnus affinis, yaitu jenis film, serat, dan fragmen. Sedangkan kelimpahan mikroplastik pada *Euthynnus affinis*, jenis serat merupakan jenis mikroplastik yang paling banyak ditemukan yaitu sebesar 2,1 partikel/individu diikuti dengan jenis fragmen dan film masing-masing sebesar 1,1 partikel/individu dan 0,8 partikel/individu.

Kata kunci: mikroplastik, kelimpahan, *Euthynnus affinis*, Bali

ABSTRACT

Plastic waste pollution in the ocean can compromise food safety for the community in the world. One of the most dangerous polution today is microplastics. Microplastics are plastic particles that are ≤ 5 µm in size and cannot dissolve in water. Fish is one of the important foodstuffs that is often consumed by humans because, besides its delicious taste, fish also has good nutritional value. The presence of microplastic contamination in fish consumed by humans will certainly be very detrimental to humans. The purpose of this study was to determine the type and abundance of microplastics in fish *Euthynnus affinis* in the Kedonganan area, Kuta, Badung, Bali. This study was conducted from April to May 2023. The fish samples used were 30 samples with descriptive qualitative analysis. Microplastic particles were extracted first for further analysis. The results showed the types of microplastics found in *Euthynnus affinis*, namely film, fibre, and fragment types. While the abundance of microplastics in Euthynnus affinis, the fibre type is the most common type of microplastics found at 2.1 particles/individual followed by fragment and film types at 1.1 particles/individual and 0.8 particles/individual respectively.

Keywords: microplastic, abundance, *Euthynnus affinis*, Bali

Citation: Laksmita, A. S. L., Apriyanthi, D. P. R. V., dan Widayanti, N. P. (2024). Identification of Microplastics in *Euthynnus affinis* in Kedonganan Area, Kuta, Badung, Bali. Jurnal Ilmu Lingkungan, 22(5), 1293-1298, doi:10.14710/jil.22.5.1293-1298

1. INTRODUCTION

The increasing number of human activities has caused various impacts on the surrounding environment. One of the impacts is the emergence of microplastic contamination, which has recently been known to have spread from terrestrial to aquatic areas. Currently, microplastics can be found from cosmetic appliances (Andrady, 2011) to sediments at the bottom of the Pacific Ocean(Szymańska and Obolewski, 2020). In recent years, plastic has been identified as the most important component of marine debris worldwide (Zhao, Zhu and Li, 2015). Plastic debris can cause fragmentation into particles that can be ingested by marine invertebrates. The decomposition of plastics may not occur for hundreds of years. Microplastics pose a more serious threat than larger plastic materials. Microplastics can be eaten by all marine organisms if one particle of microplastics can be shaped like food (Boerger *et al.*, 2010), (Browne *et al.*, 2008), (Lusher, McHugh and Thompson, 2013).

Plastic waste pollution in the ocean can compromise food safety for the community. Microplastics are plastic particles that are ≤ 5 µm in size and cannot dissolve in water (Hiwari *et al.*, 2019). Based on their shape and nature, microplastics are divided into 2 types, namely primary microplastics and secondary microplastics. Primary microplastics come from microbeads, capsules, fibres, and pellets. Meanwhile, secondary microplastics come from plastic waste that is carried into the ocean, breaking down into smaller plastics (Ziani *et al.*, 2023). The effects of microplastics as physical contaminants that accumulate in the human body are still not widely understood when compared to their toxic distribution and accumulation pathways. Research results show several negative impacts of microplastics that need to be considered, such as increased inflammatory responses, toxicity according to plastic particle size, the presence of adsorbed pollutant chemicals, and disruption of gut microorganisms (Wright and Kelly, 2017). In addition, the hydrophobic nature of their surface allows microplastics to adsorb and accumulate hydrophobic organic contaminants such as polycyclic aromatic hydrocarbons, organochlorine pesticides, and polychlorinated biphenyls (Mato *et al.*, 2001), (Ogata *et al.*, 2009).

Bali produces 4,281 tonnes of waste per day, of which 11% is washed into the ocean, which is feared to be consumed by humans through the consumption of marine species that have been contaminated by microplastics as food, which can have potential impacts on human health. Once ingested, microplastic uptake is distributed through the circulatory system and into tissues and cells, potentially resulting in several adverse effects (Barboza *et al.*, 2018). Consumption of microplastics can lead to obesity and cancer, in the case of women, microplastics can cause breast cancer (Alberghini *et al.*, 2023). Fish is one of the important foodstuffs that are often consumed by humans, because besides its delicious taste, fish also has good nutritional value.

The presence of microplastic contamination in fish consumed by humans will certainly be very detrimental to humans. The entry of microplastics into the body can cause various disorders in the body. Microplastics that enter the body can be toxic to the body, also plastic particles can cause physical damage to body cells and if they can be absorbed through the membrane, they can interfere with the metabolic functions of body cells (Lee *et al.*, 2023). Microplastics can also accumulate heavy metals such as cadmium, zinc, nickel, and lead (Holmes, Turner and Thompson, 2012), (Chen *et al.*, 2023). The absence of microplastic research on Euthynnus affinis in the kedonganan area of Kuta, Badung, Bali needs to be done to observe microplastics sourced from these fish considering that Euthynnus affinis is a type of marine fish that is widely consumed by Indonesians, especially in the Bali area. This fish is found in warm shallow water areas in the West Indo-Pacific region including the Indian Ocean which is directly adjacent to the southern coast of Java. The purpose of this study was to analyse and compare the abundance and types of microplastics contained in Euthynnus affinis fish that have been widely marketed and consumed by the local community.

2. RESEARCH METHODOLOGY

2.1. Time and Place of Research

This study was conducted for 2 months from April to May 2023. Fish samples were taken from Kedonganan, Kuta, Badung, and Bali. The dissection process, and analysis of the content and abundance of microplastics in *Euthynnus affinis* was carried out at the Fisheries Laboratory, Faculty of Marine and Fisheries, Udayana University.

2.2. Sampling

Fish samples were obtained from traders in the Kedonganan area. The total number of samples studied was 30 *Euthynnus affinis* with fish sizes between 26.3-50.1 cm.

2.3. Organ Sampling

The organ observed in this study was the intestine of the fish. Before dissection, the tools used were rinsed first using distilled water 3 times to avoid contamination. Fish were dissected on the abdomen, from the anus to the gills using a dissecting set to obtain the intestine of the fish.

2.4. Extraction of Microplastics from Fish Intestinal Organs

The extraction process of microplastics from fish intestines was carried out using a method similar to the previous method (Rochman *et al.*, 2015). The fish intestine was put into a measuring cup, then a 10% KOH solution was added until it was submerged to destroy the fish intestine. The measuring cup containing fish intestine and 10% KOH solution was then covered using aluminium foil and incubated for 24 hours at 60°C. The next stage is the destruction of the remaining fish intestines, by adding 30% H_2O_2 solution as much as 5 ml. The sample was then allowed to stand again for 24 hours at room temperature. After the fish intestine is destroyed, it is then filtered using 125 µm plankton net filter cloth first to facilitate sample filtration. Samples that have been filtered, rinsed with distilled water while being transferred to Whatman filter paper size 10 µm. The Whatman paper containing the sample was covered and coated with aluminium foil, then oven dried to facilitate the identification process.

2.5. Observation of Microplastic Type and Shape

The process of observing the type and shape of microplastics was carried out using a binocular microscope, with magnifications of 40× and 100×. Microplastic samples that have been filtered on Whatman paper (which has been dried) are transferred to Petri dishes to facilitate the identification process. The documentation process was assisted by a digital camera integrated with a microscope (Optilab). Microplastic particle size was obtained through the analysis process using Image Raster software.

2.6. Data Analysis

Calculation of Microplastic Abundance:

Abundance is the number or number of individuals in a certain area in a community. Microplastic abundance can be calculated by the following formula (Sanabila, Hadi and Zummah, 2022) :

$$K = \frac{Ni}{N}$$

Description:

K = Microplastic abundance (particles/ind)
Ni = Number of microplastic particles found (particles)
N = Number of fish (ind)

The data analysis process was carried out using the Microsoft Excel 2016 programme for the presentation of graphs and images. The variables observed in this study were microplastic content and abundance. The data used are the results of the type and abundance of microplastics in fish samples which are tabulated in the form of tables and figures and then analysed descriptively.

3. RESULTS AND DISCUSSION

3.1. Microplastic Type in *Euthynnus affinis*

Euthynnus affinis were observed in the study with a length of 26.3-50.1 cm. Based on the identification that has been done in this study, 3 types of microplastics were found in the stomach of Euthynnus affinis fish, namely film, fibre and fragment types. This can be seen in Figure 1.

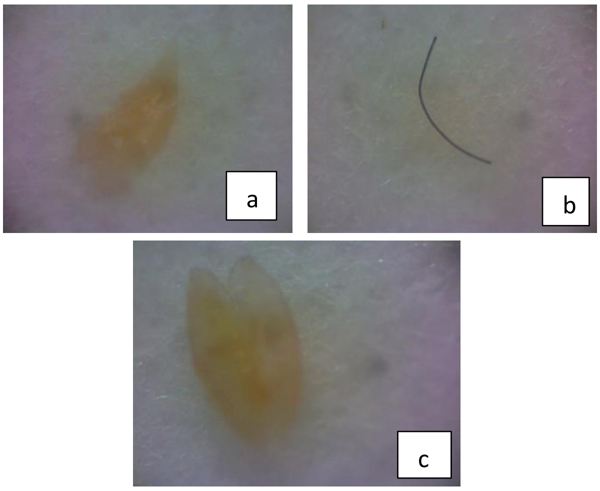

Figure 1. Microplastics Types in *Euthynnus affinis* of the Film (a), Fibre (b) and Fragment (c)

The types of microplastics found in the digestive tract of *Euthynus affinis* are film, fibre, and fragment. From the results of the study, the most common type of microplastic found was the fibre type. The presence of microplastics found in fish is related to the type of species used in the study, habitat, fish-eating habits, plastic particle density, and the presence of microplastics in the aquatic environment (Neves *et al.*, 2015). Fibre is a microplastic with an elongated and thin shape like a fishing line or net (Lie *et al.*, 2018), known to last longer on the water surface due to its relatively low density. The type of fibre found in this study can be assumed to originate from the degradation of textile laundry waste in the form of clothing fibres (Zhang *et al.*, 2017). Film is a type of microplastic that comes from some food packaging bags that have a transparent shape and colour, filament is a type of microplastic that degrades due to solar UV rays from macro waste that usually comes from plastic manufacturing plants(Acharya *et al.*, 2021). The film type of microplastic is part of a very fragile plastic product that is very easy to degrade (Browne *et al.*, 2011). While the fragments found are sourced from degradation or fragments of larger plastics (Amin, Galib and Setiawan, 2020) such as beverage bottles, rice wrappers, and fast-food packaging, besides fragment-type microplastics are not transparent.

State that as long as the biota is growing (small size), its ability to accumulate contaminants also increases, so fish with small sizes in this study are more ingested by microplastics (Hendrarto and Hadiyarto, 2011). It is the opposite where the larger the size of the biota, the age of the biota is also estimated to be higher, so that the accumulation time of pollutants has lasted longer than the biota with a smaller size, besides that it also does not rule out the the river flow around the reservoir which still has little microplastic presence. Differences in the abundance value of fish size can also be influenced by the habitat of the fish, the eating habits of the fish, and the characteristics of plastic particles or microplastics (Menéndez-Pedriza and Jaumot, 2020).

The movement of microplastic particles occurs due to the deflection of currents and waves can survive and accumulate in waters (Browne *et al.*, 2013),(Oliveira *et al.*, 2015),(Iwasaki *et al.*, 2017). Fibre-shaped microplastics are one of the microplastics sourced from the fragmentation of monofilament fishing nets and fishing rods. In this study, the most types of fibre microplastics were found (Gallowaya and Lewisa, 2016), (United Nations Environment Programme, no date). This is inversely proportional to the research the highest microplastic fragment was 94% (Wright, Thompson and Galloway, 2013). Fragments are the result of fragmentation of macro waste caused by UV radiation, seawater waves, oxidative materials from plastics, and hydrolytic properties of seawater (Dimassi *et al.*, 2022).

3.2. Microplastic Abundance in *Euthynnus affinis*

Based on the data in Table 1, the abundance value of microplastics in the observed tuna showed that the highest abundance of microplastics was 3.9 particles/individual in trader 3, followed by trader 2 and trader 1 at 2.9 particles/individual and 2.5 particles/individual, respectively. The highest abundance of microplastics in the digestive tract of *Euthynnus affinis* was found in the fibre type, which was 2.1 particles/ind followed by the fragment and film types at 1.1 particles/ind and 0.8 particles/ind, respectively. This can be seen in Figure 2.

Table 1. Abundance (Particles/Individual) of Microplastics in *Euthynnus affinis* Among Traders by Microplastic Type

Species	Microplastic Type	Abundance (Particel/Individual) Mercant 1	2	3
Euthynnus affinis	Film	0,8	0,6	0,7
	Fibre	1,2	1,5	2,1
	Fragment	0,5	0,8	1,1
	Total	2,5	2,9	3,9

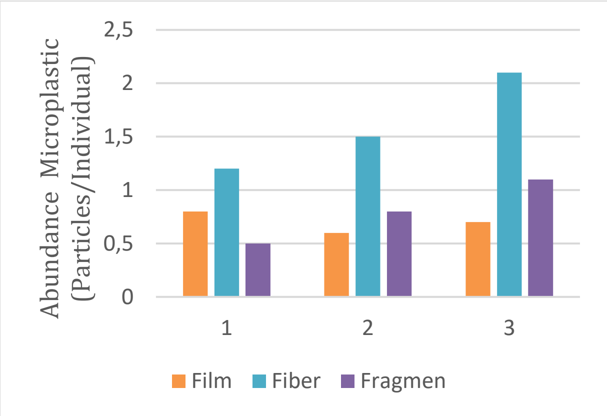

Figure 2. Total Microplastic Abundance of *Euthynnus affinis*

The abundance value of microplastics from the number of samples found in the stomach of *Barbonymus schwanenfeldii* fish in this study can have several negative impacts in the form of blocking growth for organisms that indirectly consume microplastic particles, besides that it can also cause complications in the reproductive system of fish (Fossi *et al.*, 2016). Additives or harmful compounds from plastics that bind to waste in reservoirs can cause negative biological effects such as decreased function in the digestive system of fish. Biota that consumes microplastics for a long time can cause death due to indigestible microplastic particles (Orose, Wokeh and Okey-Wokeh, 2023).

Another factor affecting the abundance of microplastics in fish is the high abundance of microplastic particles in the water. Several studiehave shown a high abundance of microplastic particles in the Bali waters. Stated that the type of fragments dominated the waters in the area, namely 48 particles. Then followed by other types of microplastics, namely 44 particles of film type and 19 particles of fibre type (Nugroho, Restu and Ernawati, 2018). Conducted in the Manta Ray feeding ground area, Big Manta Bay, Nusa Penida-Bali has resulted in line where microplastics are film and fibre types. This shows that many types of plastic waste in Balinese waters come from the type of fragments. Based on the analysis process, it is known that the average value of microplastic content in water in Bali Waters is 118 fragment particles/litre, 91 film particles/litre and 29 fibre particles/litre (Argeswara *et al.*, 2021).

Microplastics are easily ingested by low-trophic organisms, resulting in biomagnification in high-trophic organisms that feed on low-trophic organisms. Human health problems can be affected by the accumulation of microplastics in the food chain (Walkinshaw *et al.*, 2020). Chemical additives used in the manufacture of plastics, as well as pollutants and persistent organic metals adsorbed on the surface of microplastics may also be ingested by marine organisms during microplastic ingestion, increasing their toxic potential (Okoye *et al.*, 2022). Ingestion of microplastics and the potential for increased concentrations of harmful chemicals in species destined for human consumption raises concerns about human health as well (Blackburn and Green, 2022). When microplastics are ingested, the absorbed additives and chemicals can be released in digestive juices and potentially transfer to edible tissues (Yuan, Nag and Cummins, 2022).

4. CONCLUSION

The types of microplastics found in tuna (*Euthynnus affinis*) are film, fibre, and fragment. The abundance of microplastics, namely the fibre type is the most common type of microplastics found at 2.1 particles/individual followed by the fragment and film types at 1.1 particles/individual and 0.8 particles/individual respectively. The suggestions from this study are the community, especially fish traders in the market, namely the need for sufficient knowledge and information about the content of microplastics in the body of fish by educating community service counselling.

REFERENCES

Acharya, S. *et al.* (2021) 'Microfibers from synthetic textiles as a major source of microplastics in the environment: A review', *Textile Research Journal*. SAGE Publications Ltd, pp. 2136–2156. Available at: https://doi.org/10.1177/0040517521991244.

Alberghini, L. *et al.* (2023) 'Microplastics in Fish and Fishery Products and Risks for Human Health: A Review', *International Journal of Environmental Research and Public Health*. MDPI. Available at: https://doi.org/10.3390/ijerph20010789.

Amin, B., Galib, M. and Setiawan, F. (2020) 'Preliminary Investigation on the Type and Ditribution of Microplastics in the West Coast of Karimun Besar Island', in *IOP Conference Series: Earth and Environmental Science*. Institute of Physics Publishing. Available at: https://doi.org/10.1088/1755-1315/430/1/012011.

Andrady, A.L. (2011) 'Microplastics in the marine environment', *Marine Pollution Bulletin*, pp. 1596–1605. Available at: https://doi.org/10.1016/j.marpolbul.2011.05.030.

Argeswara, J.K.P. *et al.* (2021) 'Karakteristik Mikroplastik pada Daerah Feeding Ground Pari Manta, Big Manta Bay, Nusa Penida', *Journal of Marine and Aquatic

Sciences, 7(1), p. 103. Available at: https://doi.org/10.24843/jmas.2021.v07.i01.p14.

Barboza, L.G.A. *et al.* (2018) 'Marine microplastic debris: An emerging issue for food security, food safety and human health', *Marine Pollution Bulletin*. Elsevier Ltd, pp. 336–348. Available at: https://doi.org/10.1016/j.marpolbul.2018.05.047.

Blackburn, K. and Green, D. (2022) 'The potential effects of microplastics on human health: What is known and what is unknown', *Ambio*. Springer Science and Business Media B.V., pp. 518–530. Available at: https://doi.org/10.1007/s13280-021-01589-9.

Boerger, C.M. *et al.* (2010) 'Plastic ingestion by planktivorous fishes in the North Pacific Central Gyre', *Marine Pollution Bulletin*, 60(12), pp. 2275–2278. Available at: https://doi.org/10.1016/j.marpolbul.2010.08.007.

Browne, M.A. *et al.* (2008) 'Ingested microscopic plastic translocates to the circulatory system of the mussel, Mytilus edulis (L.)', *Environmental Science and Technology*, 42(13), pp. 5026–5031. Available at: https://doi.org/10.1021/es800249a.

Browne, M.A. *et al.* (2011) 'Accumulation of microplastic on shorelines woldwide: Sources and sinks', *Environmental Science and Technology*, 45(21), pp. 9175–9179. Available at: https://doi.org/10.1021/es201811s.

Browne, M.A. *et al.* (2013) 'Microplastic moves pollutants and additives to worms, reducing functions linked to health and biodiversity', *Current Biology*, 23(23), pp. 2388–2392. Available at: https://doi.org/10.1016/j.cub.2013.10.012.

Chen, Q. *et al.* (2023) 'Factors Affecting the Adsorption of Heavy Metals by Microplastics and Their Toxic Effects on Fish', *Toxics*, 11(6), p. 490. Available at: https://doi.org/10.3390/toxics11060490.

Dimassi, S.N. *et al.* (2022) 'Degradation-fragmentation of marine plastic waste and their environmental implications: A critical review', *Arabian Journal of Chemistry*. Elsevier B.V. Available at: https://doi.org/10.1016/j.arabjc.2022.104262.

Fossi, M.C. *et al.* (2016) 'Fin whales and microplastics: The Mediterranean Sea and the Sea of Cortez scenarios', *Environmental Pollution*, 209, pp. 68–78. Available at: https://doi.org/10.1016/j.envpol.2015.11.022.

Gallowaya, T.S. and Lewisa, C.N. (2016) 'Marine microplastics spell big problems for future generations', *Proceedings of the National Academy of Sciences of the United States of America*. National Academy of Sciences, pp. 2331–2333. Available at: https://doi.org/10.1073/pnas.1600715113.

Hendrarto, B. and Hadiyarto, A. (2011) 'BIOAKUMULASI LOGAM BERAT TIMBAL (Pb) DAN SENG (Zn) PADA KERANG DARAH (Anadara granosa L.) dan KERANG BAKAU (Polymesoda bengalensis L.) DI PERAIRAN TELUK KENDARI', *JURNAL ILMU LINGKUNGAN*, 9(2), pp. 45–50. Available at: http://ejournal.undip.ac.id/index.php/ilmulingkungan.

Hiwari, H. *et al.* (2019) 'Kondisi sampah mikroplastik di permukaan air laut sekitar Kupang dan Rote, Provinsi Nusa Tenggara Timur Condition of microplastic garbage in sea surface water at around Kupang and Rote, East Nusa Tenggara Province', *Jatinangor, Sumedang*, 5(2), p. 22. Available at: https://doi.org/10.13057/psnmbi/m050204.

Holmes, L.A., Turner, A. and Thompson, R.C. (2012) 'Adsorption of trace metals to plastic resin pellets in the marine environment', *Environmental Pollution*, 160(1), pp. 42–48. Available at: https://doi.org/10.1016/j.envpol.2011.08.052.

Iwasaki, S. *et al.* (2017) 'Fate of microplastics and mesoplastics carried by surface currents and wind waves: A numerical model approach in the Sea of Japan', *Marine Pollution Bulletin*, 121(1–2), pp. 85–96. Available at: https://doi.org/10.1016/j.marpolbul.2017.05.057.

Lee, Y. *et al.* (2023) 'Health Effects of Microplastic Exposures: Current Issues and Perspectives in South Korea', *Yonsei Medical Journal*. Yonsei University College of Medicine, pp. 301–308. Available at: https://doi.org/10.3349/ymj.2023.0048.

Lusher, A.L., McHugh, M. and Thompson, R.C. (2013) 'Occurrence of microplastics in the gastrointestinal tract of pelagic and demersal fish from the English Channel', *Marine Pollution Bulletin*, 67(1–2), pp. 94–99. Available at: https://doi.org/10.1016/j.marpolbul.2012.11.028.

Mato, Y. *et al.* (2001) 'Plastic resin pellets as a transport medium for toxic chemicals in the marine environment', *Environmental Science and Technology*, 35(2), pp. 318–324. Available at: https://doi.org/10.1021/es0010498.

Menéndez-Pedriza, A. and Jaumot, J. (2020) 'Interaction of environmental pollutants with microplastics: A critical review of sorption factors, bioaccumulation and ecotoxicological effects', *Toxics*. MDPI AG. Available at: https://doi.org/10.3390/TOXICS8020040.

Neves, D. *et al.* (2015) 'Ingestion of microplastics by commercial fish off the Portuguese coast', *Marine Pollution Bulletin*, 101(1), pp. 119–126. Available at: https://doi.org/10.1016/j.marpolbul.2015.11.008.

Nugroho, D.H., Restu, I.W. and Ernawati, N.M. (2018) 'Kajian Kelimpahan Mikroplastik di Perairan Teluk Benoa Provinsi Bali', *Current Trends in Aquatic Science*, I(1), pp. 80–90.

Ogata, Y. *et al.* (2009) 'International Pellet Watch: Global monitoring of persistent organic pollutants (POPs) in coastal waters. 1. Initial phase data on PCBs, DDTs, and HCHs', *Marine Pollution Bulletin*, 58(10), pp. 1437–1446. Available at: https://doi.org/10.1016/j.marpolbul.2009.06.014.

Okoye, C.O. *et al.* (2022) 'Toxic Chemicals and Persistent Organic Pollutants Associated with Micro-and Nanoplastics Pollution', *Chemical Engineering Journal Advances*. Elsevier B.V. Available at: https://doi.org/10.1016/j.ceja.2022.100310.

Oliveira, F. *et al.* (2015) 'Marine litter in the upper São Vicente submarine canyon (SW Portugal): Abundance, distribution, composition and fauna interactions', *Marine Pollution Bulletin*, 97(1–2), pp. 401–407. Available at: https://doi.org/10.1016/j.marpolbul.2015.05.060.

Orose, E., Wokeh, O.K. and Okey-Wokeh, C.G. (2023) 'Some Behavioural and Physiological Effects of Plastics (Polyethylene) on Fish', *Tropical Aquatic and Soil Pollution*, 3(1), pp. 46–57. Available at: https://doi.org/10.53623/tasp.v3i1.208.

Lie, S. *et al.* (2018) 'Measurement of microplastic density in the Karimunjawa National Park, Central Java, Indonesia', *OCEAN LIFE*, 2(2), pp. 54–58. Available at: https://doi.org/10.13057/oceanlife/o0202xx.

Rochman, C.M. *et al.* (2015) 'Anthropogenic debris in seafood: Plastic debris and fibers from textiles in fish and bivalves sold for human consumption', *Scientific Reports*, 5. Available at: https://doi.org/10.1038/srep14340.

Sanabila, A.I., Hadi, M.I. and Zummah, A. (2022) 'Identification Of Microplastics Content in Sediment, Water and Digestive Channel of Milkfish (Chanos chanos) in Sidoarjo Pond', *Al-Hayat: Journal of Biology and Applied Biology*, 5(1), pp. 11–24. Available at: https://doi.org/10.21580/ah.v5i1.12295.

Szymańska, M. and Obolewski, K. (2020) 'Microplastics as contaminants in freshwater environments: A multidisciplinary review', *Ecohydrology and Hydrobiology*. Elsevier B.V., pp. 333–345. Available at: https://doi.org/10.1016/j.ecohyd.2020.05.001.

United Nations Environment Programme (no date) *UNEP frontiers 2016 report : Emerging issues of environment concern.*

Walkinshaw, C. *et al.* (2020) 'Microplastics and seafood: lower trophic organisms at highest risk of contamination', *Ecotoxicology and Environmental Safety*, 190. Available at: https://doi.org/10.1016/j.ecoenv.2019.110066.

Wright, S.L. and Kelly, F.J. (2017) *Plastic and human health: a micro issue?*, *Environ. Sci. Technol., Just Accepted Manuscript • Publication Date*. Available at: http://pubs.acs.org.

Wright, S.L., Thompson, R.C. and Galloway, T.S. (2013) 'The physical impacts of microplastics on marine organisms: a review.', *Environmental pollution (Barking, Essex : 1987)*, pp. 483–492. Available at: https://doi.org/10.1016/j.envpol.2013.02.031.

Yuan, Z., Nag, R. and Cummins, E. (2022) 'Human health concerns regarding microplastics in the aquatic environment - From marine to food systems', *Science of the Total Environment*. Elsevier B.V. Available at: https://doi.org/10.1016/j.scitotenv.2022.153730.

Zhang, W. *et al.* (2017) 'Microplastic pollution in the surface waters of the Bohai Sea, China', *Environmental Pollution*, 231, pp. 541–548. Available at: https://doi.org/10.1016/j.envpol.2017.08.058.

Zhao, S., Zhu, L. and Li, D. (2015) 'Microplastic in three urban estuaries, China', *Environmental Pollution*, 206, pp. 597–604. Available at: https://doi.org/10.1016/j.envpol.2015.08.027.

Ziani, K. *et al.* (2023) 'Microplastics: A Real Global Threat for Environment and Food Safety: A State of the Art Review', *Nutrients*. MDPI. Available at: https://doi.org/10.3390/nu15030617.