Marine Pollution Bulletin 208 (2024) 116951

Contents lists available at ScienceDirect

Marine Pollution Bulletin

journal homepage: www.elsevier.com/locate/marpolbul

Microplastics in coral from three Mascarene Islands, Western Indian Ocean

Michelle Hamman [a], Veronica van Schyff [a,b], Robert Nee Sun Choong Kwet Yive [c], Lucian Iordachescu [d], Laura Simon-Sánchez [d], Hindrik Bouwman [a,*]

[a] Research Unit: Environmental Sciences and Management, North-West University, Potchefstroom, South Africa
[b] RECETOX, Masaryk University, Brno, Czech Republic
[c] Department of Chemistry, University of Mauritius, Reduit, Mauritius
[d] Department of the Built Environment, Division of Civil and Environmental Engineering, Aalborg University, Aalborg, Denmark

ARTICLE INFO

Keywords:
Coral
Fibres
Fragments
South Equatorial Current
Republic of Mauritius

ABSTRACT

Little is known about microplastics (MPs) in corals from the Indian Ocean. We compared MP concentrations, morphotypes, size, colours, and polymer compositions in six coral genera from three remote Mascarene islands (Rodrigues, St. Brandon's Atoll, and Agalega) of the Republic of Mauritius, on a 1200 km transect located in the South Equatorial Current (SEC). The mean MP concentration was 0.78 n/g (53 % fibres) with no significant differences between islands. Polymers were polypropylene (78 %) and polyethylene (18 %). We conclude that the SEC's MP concentrations and compositions have homogenized over thousands of kilometres across the Indian Ocean. We discuss the lack of hazardous polyurethane MPs in coral samples given obvious sources on St Brandon. To the best of our knowledge, this study is the first to report on MPs in coral from the Western Indian Ocean and the Mascarene Islands providing a baseline for further research, monitoring, mitigation, and policy development.

1. Introduction

Coral reefs cover <1 % of the ocean floor surface (Huang et al., 2021) yet provide crucial ecosystem services (Salm, 1983). Inter alia, they protect shorelines, are vital to climate resiliency, provide natural resources and livelihoods for >275 million people, is a resource for medical research, and attract tourists (Salm, 1983; Saliu et al., 2019; Reichert et al., 2021; van der Schyff et al., 2021a,b; Huang et al., 2021). Coral reefs are also among the most diverse ecosystems, supporting >3000 different coral species (Salm, 1983). Over the last decades, coral reefs experience constant impacts and degradation by local and global anthropogenic stressors, inter alia pollution, over-fishing, ocean acidification, and global warming (Soares et al., 2020; Rocha et al., 2020; van der Schyff et al., 2021a,b; Sparks and Awe, 2022).

Plastic debris constitutes a significant marine pollution problem with high concentrations in coastal areas and coral reef environments (United Nations Environment Program, 2019; Pantos, 2022; Patti et al., 2020; Pattiaratchi et al., 2022). Plastics are durable thus allowing these items to persist in the environment for decades (Fleming et al., 2022). Much of the plastic debris produced is less dense than seawater, thus allowing it to float and drift in the ocean, accumulating in subtropical gyres or ending up on coastlines and beach fronts (Kumar et al., 2021). More than 800 marine and coastal species are known to have had some encounter with marine plastic pollution, whether through ingestion, entanglement, or habitat change (United Nations Environment Program, 2019).

The latest recognised addition to the list of stressors marine organisms encounter are microplastics (MPs; Soares et al., 2020; Bejanaro et al., 2022). MPs are particles of plastic polymers <5 mm originating from any source and can be both primary MPs (created to be ≤5 mm) or secondary MPs (degraded from a larger source material; Hankins et al., 2021; Huang et al., 2021; Patti et al., 2020). The presence of MPs in the marine environment affects ecosystems in unpredictable ways. The chemical and physical properties of MPs (buoyancy, longevity, and varying densities) coupled with the hydrodynamics of the ocean causes MPs to become widely distributed (Eriksen et al., 2014; Kukulka et al., 2012; Hall et al., 2015; Jeyasanta et al., 2020). Anthropogenic siltation was already of concern for reef-building corals (Salm, 1983) and now MPs are floating freely in the waters and settling in sediments adding to the pressure (Jeyasanta et al., 2020; Bejanaro et al., 2022). MPs are persistent polymers and can absorb harmful persistent compounds from their surroundings which may be released with time (Ryan et al., 2012; Jeyasanta et al., 2020; Patterson et al., 2020; Raguso et al., 2022).

Corals intercept, trap, catch, and ingest MPs when feeding, as biofouled MP surfaces release phagostimulants causing the corals to mis-

---

* Corresponding author.
E-mail addresses: hammmichelle9@gmail.com (M. Hamman), henk.bouwman@nwu.ac.za (H. Bouwman).

https://doi.org/10.1016/j.marpolbul.2024.116951
Received 25 June 2024; Received in revised form 4 September 2024; Accepted 4 September 2024

identify MPs as food items (Hall et al., 2015; Allen et al., 2017; Hankins et al., 2018; Bednarz et al., 2021; Bejanaro et al., 2022; Mendrik et al., 2024; Yen et al., 2024). Corals encounter plastics in various ways; floating MPs that reach corals during low tide on shallow reef-crests and flats; higher density particles reaching deeper water coral colonies as they sink to the seabed; and plankton contaminated with MPs (Chapron et al., 2018; Saliu et al., 2019; Esiukova et al., 2020). A major process responsible for plastic removal from seawater is its adhesion to the coral surface (Martin et al., 2019; Yen et al., 2024). MP ingestion by corals may be hazardous as it could transfer incurred and accumulated pollutants to the coral (van der Schyff et al., 2021a; Bednarz et al., 2021). Toxic chemicals may leach from the MPs once inside the corals, accumulate, and potentially affect growth, reproduction, and survival (Rotjan et al., 2019; Raguso et al., 2022). Physically, when consuming MPs, the corals may experience a sense of false satiation and reduce real food intake which may lead to reduced coral growth and mortality (Rotjan et al., 2019). MP ingestion may also cause blockage of the gut cavity of corals leading to internal damage (Hall et al., 2015). The interactions between corals, plastic, and MPs in particular are therefore very complex (Bejanaro et al., 2022). Experimental effects studies have been conducted on coral species to understand MP consumption and effects (inter alia, Corona et al., 2020; Hall et al., 2015; Corona et al., 2020; Chapron et al., 2018; Patti et al., 2020; Reichert et al., 2018; Grillo et al., 2021; Bejanaro et al., 2022; Plafcan and Stallings, 2022; Yen et al., 2024). Environmental studies investigated MP contamination in sediment and water of coral reef environments, but not on corals themselves (Cheang et al., 2018; Hankins et al., 2018; Patti et al., 2020; Jeyasanta et al., 2020).

The Indian Ocean (IO) is home to 13–16 % of coral reefs worldwide (Huang et al., 2021; Obura et al., 2017). The types of reefs in the IO include fringing, platform, and barrier reefs, and atolls (Huang et al., 2021; Obura et al., 2017; Turner and Klaus, 2005). The Mascarenes has 705 km^2 of shallow reef habitats (Turner and Klaus, 2005). Despite the rich coral environment, studies on MP contamination in coral reefs in the IO are limited (Raguso et al., 2022; Thiemann, 2023). The United Nations Environment Program (2019) warned that Africa's coral reef ecosystems are at risk from MP pollution. Currents influence the accumulation of plastic litter along the Western Indian Ocean (WIO) islands (Barnes, 2004) which can reconcentrate debris and its related pollutants on remote coral islands (Bouwman et al., 2016). Some of the available studies in the WIO include an analysis of MPs in corals from the Maldives (Raguso et al., 2022), an experimental study looking at the effects of MPs on corals from the South African coast (Boodraj and Glassom, 2022), plastic debris quantified on the shores of St Brandon's Atoll (Bouwman et al., 2016), and MPs in sea water (Li et al., 2022). As far as we are aware, there are no published studies on the concentrations and characteristics of MPs in corals from the WIO.

Corals may have taxon-specific interactions with MPs (inter alia, Hankins et al., 2018; Axworthy and Padilla-Gamiño, 2019; Reichert et al., 2019; Soares et al., 2020; Isa et al., 2023). Due to the differences between hard- and soft corals, such as feeding, physiology, and coral structures (Ding et al., 2019), our aim was to compare MP concentrations between four hard coral and two soft coral genera along a 1200 km transect of three remote WIO islands, and to characterise the MP size, morphotype, colours, and polymer compositions between islands. Based on an earlier study in the same area focussing on metal concentrations in corals, we expected that soft corals will have higher MP concentrations than hard corals (van der Schyff et al., 2020b), and we predict that corals from the island with the highest human population will present higher MP concentrations.

2. Materials and methods

2.1. Site description

The Mascarene islands are located near the Tropic of Capricorn approximately 700 km east of Madagascar, in the southern part of the WIO, each with unique properties (Fig. 1) (Thébaud et al., 2009). We selected three of the more isolated islands for this study along a 1200 km transect and called it the Mascarene Island Transect (MIT). The three islands belong to the Republic of Mauritius. Agalega island is the most remote with a small but well-developed coral reef fringe (van der Schyff et al., 2020b) with about 300 residents in 2012 (Budoo and Mahadew, 2014). Rodrigues is the largest island among the three, with the WIO's best-developed, full-fringed reef surrounding the island (Thébaud et al., 2009; van der Schyff et al., 2020b), and a population of approximately 38,000 residents (Budoo and Mahadew, 2014). St. Brandon's Atoll has no permanent residents but has approximately 40 rotating fishermen and Government personnel, and a lagoon surface area of approximately 200 km^2 (van der Schyff et al., 2021a,b). Several shipwrecks have occurred along the atoll (Bouwman et al., 2016). The South Equatorial Current (SEC) from the east affects all three islands (Fig. 1; van der Schyff et al., 2021a; Honorato et al., 2022; Pattiaratchi et al., 2022; Phillips et al., 2021; Thiemann, 2023).

2.2. Sample collection

Fifty-one coral samples were collected in 2014 and 2015 from Rodrigues (Rod), Agalega (Aga), and St Brandon's Atoll (SBA) (Republic of Mauritius) in the Mascarene Basin of the WIO (Fig. 1). Colonies of four hard coral genera (*Stylophora* sp., *Acropora* sp., *Pocillopora* sp., and *Fungia* sp.) and two soft coral genera (*Sarcophyton* sp. and *Sinularia* sp.) were sampled from each island by scuba or snorkelling. At Rodrigues, the sampling was between Pointe aux Cornes and Pointe Grenada; at Agalega, the sampling was around Le Far Far (La Passe) of North Island; and at St. Brandon's Atoll it was on the south-eastern side of the lagoon near Isle du Sud. Sampling was random at each site, with at least six metres between adjacent colonies of the same genus. Each of the six genera was sampled three times per island, except *Sarcophyton* sp. in the St. Brandon's Atoll lagoon as it could not be found. The soft coral samples were collected using a diving knife. *Fungia* sp. occur as single free-living polyps (Hoeksema, 2014; Fig. 1) and whole individuals were collected. Hard coral fragments, approximately 10 cm^3 each, of the other genera were carefully removed from the colony with a side cutter. None of the fragments were larger than 1/8th of the total colony size leaving a good proportion of the colony to recover. Each sample consisted of skeleton and tissue. The coral samples were not identified to species level as genetic studies were not conducted. Samples were collected in the lagoons on the western side of the islands, up-current of the predominant SEC.

2.3. Microplastic extraction

Approximately 5 g of each sample was accurately weighed into 100 mL glass bottles previously rinsed with double distilled water. Following Allen et al. (2017), we first digested the entire sample (polyp and skeleton) by soaking the samples in 8.25 % sodium hypochlorite for 24 h, dissolving the skeleton in 37 % HCl for 30 min, and soaking the digestate again in 8.25 % sodium hypochlorite for 24 h. The digestions were conducted in a fume hood with the containers covered with aluminium foil to minimise extraneous contamination. Particulate material that included the MPs was filtered with a stainless steel sieve, with pore size of 25 μm, between each acid/bleach wash, separating it from the dissolved organic and inorganic matter. The custom-made stainless steel sieves were made specifically for use in the normal 47 mm-diameter spring-clamped glass vacuum filtration system. Black rubber O-rings, part of the metal sieve rim, acted as a seal when clamped. After the last filtration, the sieves were carefully cleaned, dried, and stored in petri dishes until they were counted.

Collection controls were accommodated by subtracting any long black fibres that may have come from collection and storage. Laboratory controls per batch were collected throughout the digestion and filtering

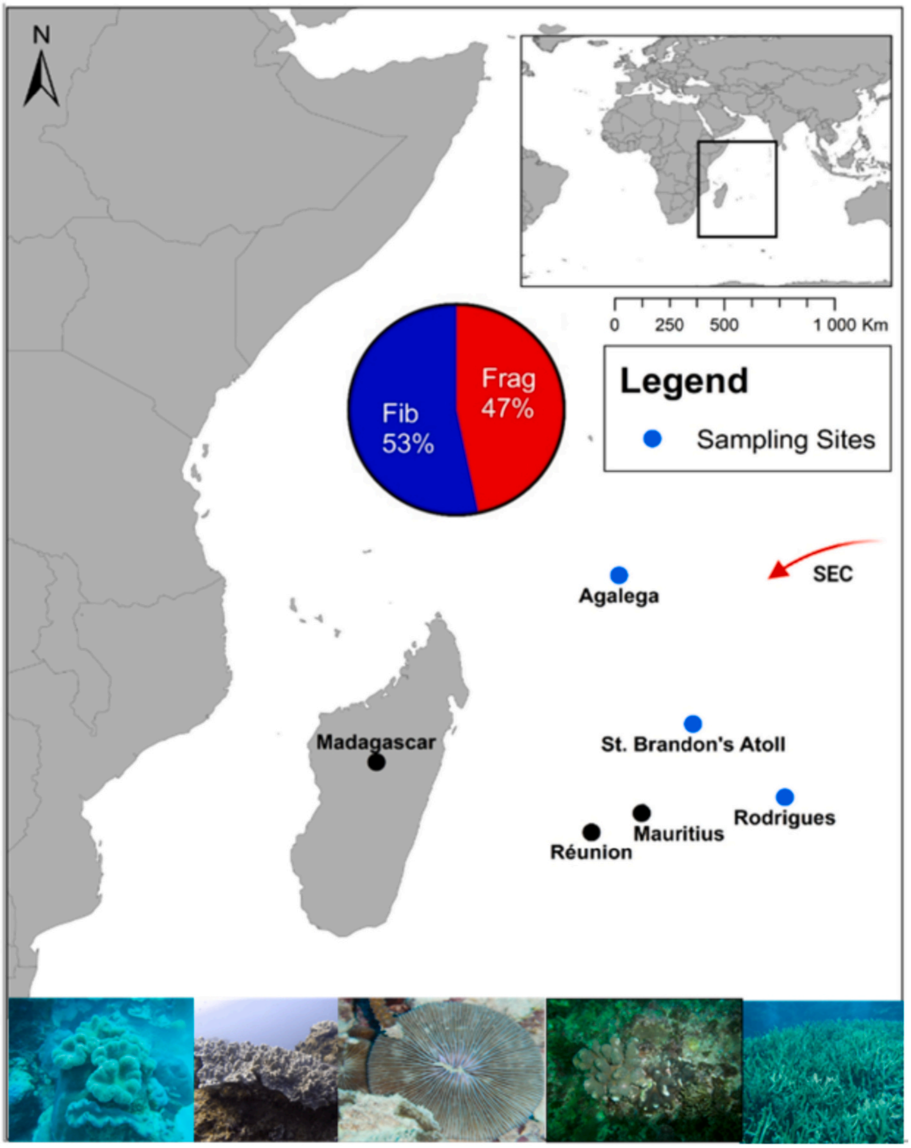

Fig. 1. Map of Western Indian Ocean (WIO) showing the three islands of the Mascarene Island Transect (MIT) that were sampled. The transect between sampling sites is over 1200 km. The South Equatorial Current (SEC) is indicated in red with approximate direction and flow. The proportion of fibres and fragments found in all coral samples is shown. The coral photographs are from left to right; *Sarcophyton* sp., *Sinularia* sp., *Fungia* sp., *Pocillopora* sp. (left) and *Stylophora* sp. (right), and *Acropora* sp. Photos by V van der Schyff. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

process by rinsing empty 100 mL glass bottles, following the same chemical procedure as described by Allen et al. (2017). The seven lab controls ensured that contamination can be subtracted from the sample counts. Contamination was subtracted per MP category (Table S1). For instance, if the control sample had three red fibres in a certain size category, three red fibres in the same size category were subtracted from each sample of the batch of that control. If no red fibres of that size category occurred in a sample, no subtractions were made.

2.4. Counting and characterisation

To quantify the MPs, each sieve was inspected, and MPs were measured in μm using a Nikon EZ 100 multi-zoom compound binocular microscope at magnifications of 1.30–1.80. Fragments (Frag) and fibres (Fib) were counted, measured, and categorised by morphotype, size, and colour as set out in Table S1. Each fragment was measured along its longest dimension; the length of each fibre was measured using a concatenated line with the microscope software. Concentrations are reported as numbers per gram (n/g).

2.5. Polymer determination; μFT-IR imaging

Eight sample extracts were selected at random and analysed using μFT-IR Imaging spectroscopy according to Maurizi et al. (2023) at the Department of the Built Environment, Aalborg University, Denmark. Two *Acropora* sp. extracts from Agalega and Rodrigues, two *Sinularia* sp. extracts from St. Brandon, one *Sinularia* sp. extract each from Rodrigues and Agalega, and one *Stylophora* sp. extract each from St. Brandon and Rodrigues. This analysis aimed to confirm the presence of plastics and polymer characterisation. From the data we determined the proportions of the various MP polymers, but not concentrations. The selected samples were re-suspended in 3 mL of 50 % HPLC ethanol, homogenized using a Vortex, and multiple aliquots were deposited onto a zinc selenide (ZnSe - ⌀13 mm, 2 mm thickness, Crystran LTD, UK) transmissive window for subsequent analysis. Sample analyses were carried out using a Cary 620 FTIR microscope, equipped with a 128 × 128 pixel MCT-FPA detector (Mercury Cadmium Telluride—Focal Plane Array) integrated with a Cary 670 IR spectroscope (Agilent Technologies, Santa Clara, CA, USA). This microscope, fitted with a 15 X Cassegrain objective, delivered a 5.5 µm pixel resolution. The IR map was collected in transmission mode, covering a spectral range of 3750–850 cm^{-1} at 8 cm^{-1} resolution, with 30 co-added scans. A separate background tile was collected before each sample with 120 co-added scans. The resulting hyperspectral images were analysed using the siMPle software (Primpke et al., 2020) v. 1.3.1β. The software correlates each IR spectrum from each pixel against a library containing 441 spectra of both organic and inorganic materials (library from Simon-Sánchez et al., 2022). SiMPle detects particles, quantifies their morphology, and automatically estimates their volume and mass (Simon et al., 2018).

2.6. Statistical analysis

We tested data for normality using the Shapiro-Wilk test (GraphPad Prism 10.2; www.graphpad.com) showing that log-transformation was required. The Dunn's test was used for the correction of multiple comparisons. Unpaired t-tests were used to compare the log-transformed MP concentration between the overall samples, hard- and soft corals, and hard- and soft corals for each of the three islands of the MIT. One-way Anova was used to compare log-transformed MP concentrations between colour-, morphotype-, and size categories, polymer composition, coral genera, and between the MIT islands. The Holm-Šidák multiple comparison test was used as post-test. Two-way Anova was used to identify the source of variation between the concentration of MP types, per genus, per island. Chi-square tests were used to compare the proportions of MP size-, colour-, morphotype-, and polymer categories between hard- and soft coral, the MIT sampling sites, and the fibre and fragment categories between the MIT sampling sites.

3. Results

3.1. Overall results (concentrations, colours, sizes)

We counted 163 MPs for an overall mean concentration of 0.78 MPs n/g in the 51 samples. Detailed results are in Table S2. One sample each of *Pocillopora* sp. (Agalega), *Stylophora* sp. (Rodrigues), *Acropora* sp. (Rodrigues), *Sarcophyton* sp. (Rodrigues), and two samples of *Fungia* sp. (Rodrigues), had no detectable MPs. All *Sinularia* sp. samples had detectable MPs. All subsequent statistics are for positive samples. For all samples combined, fibres dominated fragments (53 % and 47 %) respectively (Table 1; Fig. 1). MP concentrations were similarly distributed between MIT; 0.75 n/g in Rodrigues, 0.70 n/g in Agalega, and 0.64 n/g in St Brandon's Atoll (Table 1). The predominant MP size category was 25–300 µm for fragments, and 25–300 µm and 301–600 µm for fibres (Table 2). Purple and green was the predominant colour for fragments and blue, red and purple for fibres (Table 2). There was no statistically significant difference between overall fibre and fragment concentrations (unpaired, two-way, t-test, $p = 0.6000$, Table 1).

Table 1
Mean concentrations (n/g) of all microplastics (MP), fibres (Fib), and fragments (Frag), in all samples combined, and per island. The p-value is for un-paired, two-way, t-test of log-transformed data for fibres and fragments, and one-way Anova for differences between the three MIT islands. Additional metrics are in Table S2.

	Overall		Agalega MP	Rodrigues MP	St Brandon's Atoll MP
	Frag	Fib			
Number samples	51	51	18	18	15
Number positive samples	27	41	17	13	15
Minimum	0.19	0.15	0.15	0.06	0.18
Maximum	1.2	2.0	2.2	2.4	1.8
Mean	0.43	0.49	0.70	0.75	0.64
Geometric mean	0.35	0.38	0.52	0.49	0.51
Std. Deviation	0.30	0.41	0.55	0.70	0.48
%CV	70	83	79	92	75
p-Value	0.6000		0.9770*		

* None of the post-tests were significant ($p > 0.9$).

There were no fragments in the 901–1200 µm size category (Table 2). The concentrations of smaller fibres and fragments increased with smaller dimensions (Fig. 2a and b). However, the increase towards smaller sizes was significant for fibres ($p < 0.0001$) but not for fragments ($p = 0.2225$; Table 2). There were no differences in concentrations when categorised as colour for fibres and fragments ($p = 0.1848$ and 0.4864, respectively; Fig. 2c and d).

3.2. Hard corals and soft corals

The mean concentrations of MPs, fibres and fragments found in soft corals were higher than in the hard corals (Table S3). A near significant difference was found between the MP concentrations between the hard corals and soft corals ($p < 0.0575$; Fig. 3a). There were no significant differences between fibre and fragment concentrations between the hard- and soft corals (Fig. 3b and c).

There were significant differences for the proportions (Chi-square) between hard- and soft coral samples for fibre size categories ($p = 0.018$; Fig. 4a), fibre colour categories ($p = 0.004$; Fig. 4d), and fragment colour categories ($p = 0.006$; Fig. 4c). On the other hand, there was no significant statistical difference between the proportions of the fragment size categories between hard- and soft corals ($p = 0.31$; Fig. 4b).

3.3. Three Mascarene Islands (MIT) per coral type

A significant difference (un-paired, two-way, t-test) was found in the MP concentrations of St Brandon's Atoll between the hard- and soft corals ($p = 0.008$, Table S5). None of the other comparisons were significant. The overall MP concentrations in Agalega, Rodrigues, and St Brandon's Atoll were higher in soft corals compared with hard corals. Agalega and Rodrigues had higher fibre concentrations in soft corals, but St Brandon's Atoll had higher fibre concentrations in hard corals. Agalega had higher fragment concentrations in the hard corals, but both Rodrigues and St Brandon's Atoll had higher fragment concentrations in the soft corals. Agalega and Rodrigues had higher fibre concentrations, and St Brandon's Atoll had higher fragment concentrations (Table S5). There were no significant differences between the fibre and the fragment proportions per island (Chi-square, $p = 0.82$; Fig. 5a and b). The only significant difference between the proportions of fibre and fragment colour or size categories per island was for fragment colours (Chi-square, $p = 0.024$; Fig. 5b and d).

3.4. Microplastic concentrations per coral genus

A significant difference was found (one-way Anova, $p = 0.03$) between the fragment concentrations of all six coral genera irrespective of island (Fig. 6; Table S4). In all cases *Pocillopora* sp. had the lowest concentrations. The soft coral *Sinularia* sp. had the highest mean fibre concentration, while the hard coral, *Acropora* sp., had the highest fragment concentration (Fig. 6b and c; Table S4). There were significant differences in concentrations between *Pocillopora* sp. and *Sinularia* sp. for total MPs and fibres (Fig. 6a and b), and between *Acropora* sp. and *Pocillopora* sp. for fragments (Fig. 6c).

The only significant source of variation ($p = 0.0237$) that explained the differences between islands were fragments and fibres (type of MP; two-way Anova; Table 3). Neither the island nor genus or combinations thereof were significant sources of variation.

3.5. Polymer composition

The µFTIR analyses of eight sample extracts to determine relative polymer compositions showed a preponderance of polypropylene-based MPs (73 %) in all MIT coral combined, followed by polyethylene-based

Table 2
The concentrations (n/g) of fibre and fragment colour- and size (μm) categories in all positive samples. The p-value is for one-way Anova of log-transformed data.

Fragment colour	Black	Red	Green	Y/B[a]	White	Purple
Minimum	0.19	0.19	0.19	0.19	0.19	0.20
Maximum	0.39	0.20	0.80	0.59	0.58	0.80
Mean	0.27	0.19	0.34	0.35	0.29	0.39
Geometric mean	0.26	0.19	0.27	0.31	0.26	0.34
Std. Deviation	0.11	0.01	0.28	0.19	0.16	0.20
% CV	40	2.6	81	55	57	53
P-Value	0.49					

Fibre colour	Blue	Red	Green	Y/B	White	Purple
Minimum	0.19	0.18	0.19	0.18	0.17	0.15
Maximum	0.76	0.40	0.98	0.59	0.39	1.4
Mean	0.28	0.24	0.32	0.25	0.21	0.50
Geometric mean	0.26	0.23	0.26	0.23	0.21	0.37
Std. Deviation	0.16	0.09	0.28	0.14	0.07	0.41
% CV	55	37	87	55	34	83
p-Value	0.17					

Fragment size	25–300	301–600	601–900	901–1200	1201–1500	>1500
Minimum	0.19	0.19	0.20		0.19	0.19
Maximum	1.18	0.58	0.40		0.19	0.38
Mean	0.34	0.27	0.30		0.19	0.25
Geometric mean	0.28	0.24	0.28		0.19	0.24
Std. Deviation	0.28	0.15	0.14		0.0	0.11
%CV	80	54	48		0	44
P-Value	0.97					

Fibre size	25–300	301–600	601–900	901–1200	1201–1500	>1500
Minimum	0.19	0.18	0.15	0.17	0.19	0.19
Maximum	0.98	1.2	0.20	0.20	0.20	0.39
Mean	0.42	0.34	0.19	0.19	0.19	0.21
Geometric mean	0.36	0.28	0.19	0.19	0.19	0.21
Std. Deviation	0.24	0.25	0.02	0.01	0.0	0.06
%CV	58	75	8.2	4.8	2.3	27
P-Value	**<0.0001**					

Significant *p*-values are shown in bold.

[a] Y/B = Yellow/Brown.

MPs (19 %; Table 3; Fig. 7). Polyester, acrylic paint, silicone, polyurethane, vinyl chloride copolymer, and polycarbonate were also identified but in small proportions. *Acropora* sp. and *Stylophora* sp. from different islands showed no significant differences between polymer compositions but there was for *Sinularia* sp. ($p = 0.0046$; Fig. 7a). When data for the genera of different islands were combined, all comparisons were significantly different ($p < 0.0001$; Fig. 7b). It is evident that both hard corals and soft corals had higher proportions of polypropylene, followed by polyethylene. The hard corals that had higher polyethylene in proportion to the soft corals, with the entire polymer composition profile significantly different ($p < 0.0001$; Fig. 7c). In particular, however, there was the almost complete absence of polyurethane; only one particle in an *Acropora* sp. sample from Rodrigues.

It should be noted that the μFTIR analyses detected small fragments of MPs that were not seen during visual characterisation (Section 2.4), explaining the larger number of MPs in Table 3 compared with Table 1. The evidence of small fragments can be seen in Fig. 7d and e, where especially small fragments of polypropylene were detected in the extract of a subsample of *Acropora* sp. from Agalega.

4. Discussion

4.1. *Microplastic concentrations for all coral samples*

The main drivers governing MP concentrations in corals would be the concentrations of MP (type and size) already in the ambient marine environment (Hankins et al., 2018; Woodall et al., 2015), differences between coral genera (Hankins et al., 2018), geographical location, and the location of the sampled colony on the reef. Our study showed the presence of MPs in the coral of the MIT (Tables 1, 2, and S2). We only found two types of MPs—fibres and fragments. Fibres have been documented as the dominant MP in rivers, estuaries, and oceans (Cesa et al., 2017) and in corals (Rotjan et al., 2019; Tang et al., 2021). Fibres spend a longer period in the euphotic zone before sinking as opposed to other heavier MPs, making fibres more susceptible to being transported by currents, thus reaching isolated coral reef islands (Chubarenko et al., 2016). Fibres have also been identified as the type of MP that is most likely to cause negative effects in organisms (Qiao et al., 2019; Drzyzga, 2012; Arkatkar et al., 2010). Fibres can be ingested, leading to slowed growth, and diminished feeding and reproduction. The ingestion of fibres can occur directly from the ambient or via the food web (Chan et al., 2024). They were present in mussels (Duflos et al., 2017), oysters (Weinstein et al., 2022), sea urchins (Murano et al., 2022), squid (Bothma et al., 2024), and many others (Chan et al., 2024).

The higher proportion and concentrations of fibres compared with fragments (Fig. 1, Table 2) suggest fabrics, fishing nets, ropes, and lines as potential sources (Athapaththu et al., 2020; Ding et al., 2019). However, distance and time travelled through the ocean might also have affected the fragment/fibre profiles. On the island of Mauritius, MPs on beaches consisted of at least 50 % fragments, while fibres were 10–20 %

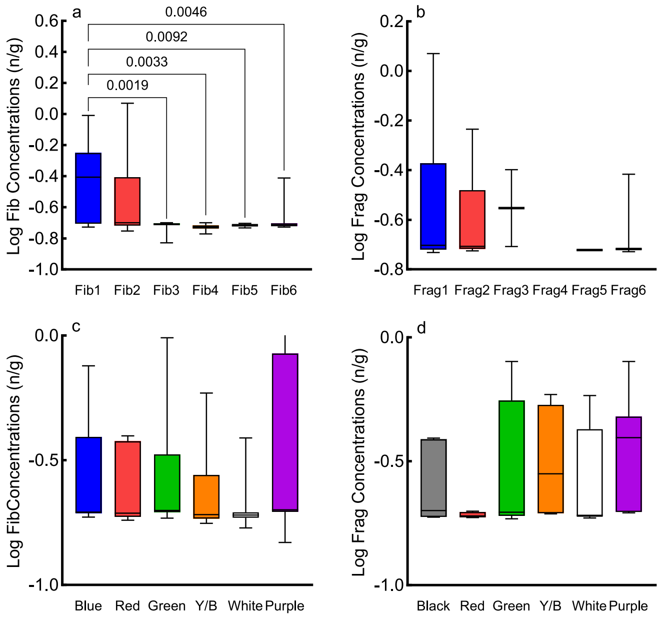

Fig. 2. Box graphs of fibre (Fib) and fragment (Frag) concentrations based on size- (μm; a and b) and colour categories (c and d), respectively. The *p*-value is for the Holm-Šidák multiple comparison post-test of log-transformed data. Fib 1 = 25–300 μm, Fib 2 = 301–600 μm, Fib 3 = 601–900 μm, Fib 4 = 901–1200 μm, Fib 5 = 1201–1500 μm, and Fib 6 ≥ 1500 μm; Frag 1 = 25–300 μm, Frag 2 = 301–600 μm, Frags 3 = 601–900 μm, Frag 4 = 901–1200 μm, Frag 5 = 1201–1500 μm, and Frag 6 ≥ 1500 μm. Y/B = yellow/brown. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

(Mattan-Moorgawa et al., 2021).

Since the Raguso et al. (2022) study is thematically and geographically the closest to what we have done, we will be referring to their results multiple times. They found films (42 %), foams (32 %), fragments (18 %), and fibres (8 %) in 38 coral samples (mainly *Porites*) from Magoodhoo Island in the Faafu atoll of the Maldives (Northern Indian Ocean), in contrast to what we found in the WIO (53 % fibres and 47 % fragments). The differences between our two studies are three-fold; 1) Magoodhoo Island is a small, densely populated island (although a desert island was also sampled), 2) it is located in monsoon affected currents (Ryan, 2013), and 3) differences in digestion, extraction, and characterisation.

Regarding MP colour, we found predominately purple and green fragments and blue, red, and purple fibres which differed considerably from Raguso et al. (2022) whose samples were dominated by brown (35 %) and pink (23 %) MPs. However, the difference in MP colour classification schemes between our studies should be noted. Nevertheless, the difference in colour compositions of the MPs is likely due to the Maldives and MIT being affected by different currents and therefore different sources. We found no differences between colours in either the hard or soft corals (Fig. 2c and d), suggesting that uptake by both coral types are not affected by colour.

4.2. Microplastic concentrations and characteristics in hard- and soft corals

Soft corals had higher total MP, fibre, and fragment concentrations (Table S3; Fig. 3a–c) but none of the differences were significant (although for total MPs, the difference was near-significant; $p = 0.0575$; Table 4; Fig. 3a). For both fragments and fibres, the smaller size classes predominated (Fig. 2a and b). This was similar to the findings of Jeyasanta et al. (2020) for sediment and water in coral reef ecosystems.

Soft corals tend to have higher concentrations of various contaminants, including metals, pesticides, and PCBs, compared with hard coral genera (van der Schyff et al., 2021a,b; Jafarabadi et al., 2018; Porter et al., 2018; van der Schyff et al., 2020b). Soft corals rely more on heterotrophic feeding, while hard corals rely on the photosynthetic by-products of its symbiotic algae for nutrition (Sheppard et al., 2009; Hording et al., 1997; van der Schyff et al., 2021a). The difference between feeding in soft corals and hard corals may explain why soft coral had higher MP concentrations than hard coral.

4.3. Microplastic concentrations among the three Mascarene islands

Finding MPs on all three islands was expected as macro plastics occur on the beaches of the MIT. The macro plastic density on the shores of St. Brandon's Atoll was 0.76 items per m shoreline (Bouwman et al., 2016). On Rodrigues it was 4410 items per m (4.41 items per km; Barnes, 2004), although from our observations during our collections this is likely an underestimation. van der Schyff et al. (2021a,b) reported macro plastic debris on the windward side of the northern island of Agalega, but this was not quantified. Patti et al. (2020) found consistent concentrations of MPs in lagoon sediments (226–333 n/kg) from the densely inhabited Naifaru Island, Maldives.

We expected that Rodrigues, the island with the highest human population of 38,000 among the three, might have had the highest MP concentrations in their coral. The sampling sites were close to the shore, here. Surprisingly, there were no concentration differences between the three MIT islands overall (Table 5). The only significant difference for MP concentrations between the hard- and soft corals in the MIT was found on St Brandon's Atoll, with the highest MP concentrations in the soft corals (Table 5, $p = 0.008$). The proportions between fibres and fragments were not statistically significant between islands (Fig. 5). The only difference we found between the MP properties was that Rodrigues

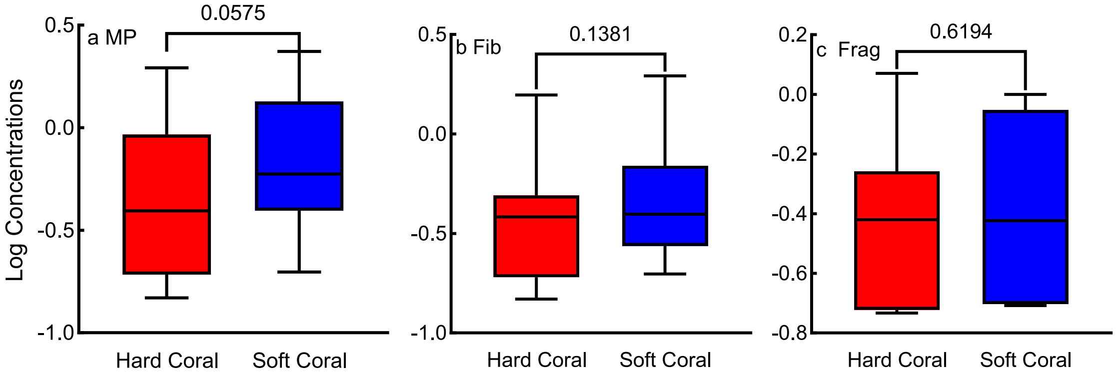

Fig. 3. Box (median, 25th and 75th percentiles) and whiskers (minima and maxima) graphs of the concentrations (n/g) of (a) all microplastics (MP), (b) fibres (Fib), and (c) fragments (Frag) in hard corals and soft corals. The p-value is for log-transformed, un-paired, two-way, *t*-tests.

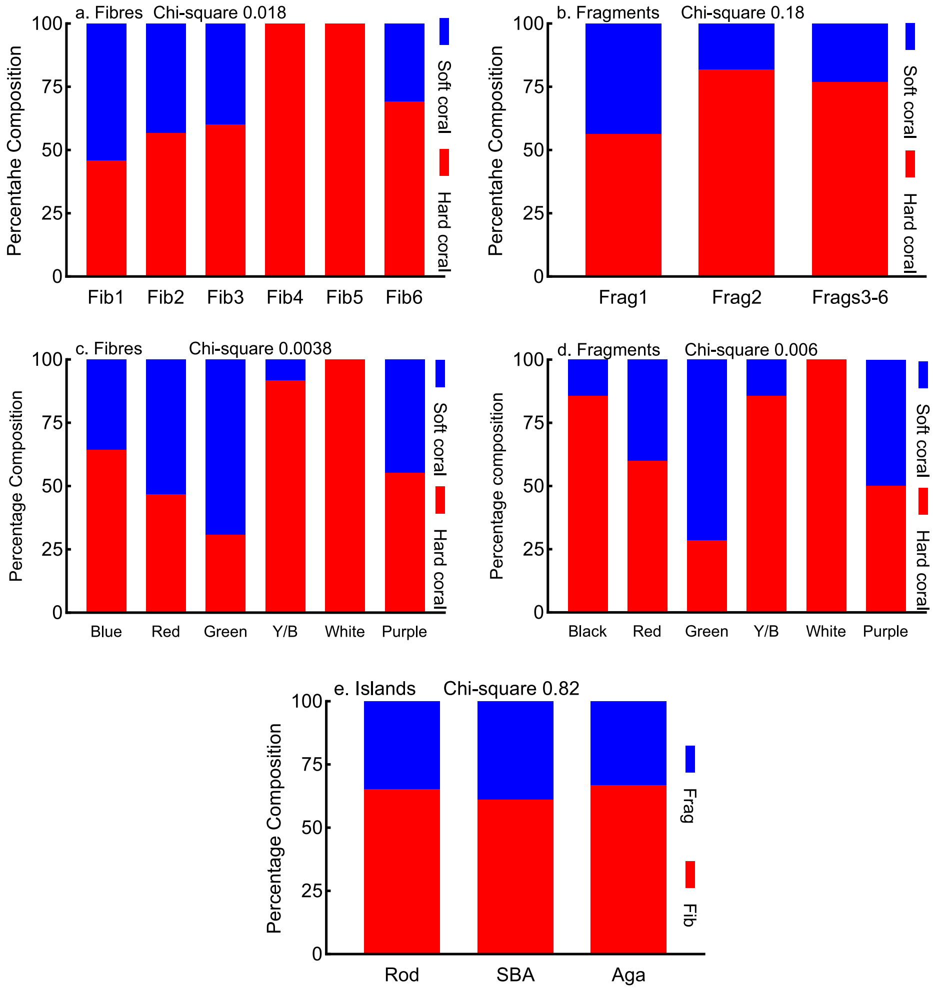

Fig. 4. Bar graphs illustrating percentage compositions of fibre (Fib) and fragment (Frag) frequencies of size categories (a and b) and colour categories (c and d), respectively, between hard- and soft corals. Fib 1 = 25–300, Fib 2 = 301–600, Fib 3 = 601–900, Fib 4 = 901–1200, Fib 5 = 1201–1500 and Fib 6 ≥ 1500; Frag 1 = 25–300, Frag 2 = 301–600, Frags 3–6 = 601 ≥ 1500. Bar graph of all fibres (Fib) and fragments (Frag) frequencies in all samples per island (e). Rod = Rodrigues, SBA = St Brandon's Atoll, and Aga = Agalega. The data for the fragment size categories 601 ≥ 1500 μm were grouped due to a lack of data in these categories (Fig. 2b). The *p*-values are for Chi-square tests.

did not have fibres of the size category 901–1200 μm, and St Brandon's Atoll corals did not have yellow/brown fragments (Fig. 6d). The likely reason is that the samples were all collected up-current (towards the east) of the MIT islands, therefore less likely to be impacted by human presence.

Since all three MIT islands have similar MP concentrations and characteristics (with some exceptions), this suggests that the currents flowing over the coral of the three islands carry in MPs from elsewhere with little MP input from local sources. Therefore, the three islands experience a largely homogenous MP background through water from the SEC. Representations of IO currents by Honorato-Zimmer et al. (2022), Pattiaratchi et al. (2022), Phillips et al. (2021), and Thiemann (2023), suggest that the three islands experience stable, mainly east-to-west currents across the width of the southern Indian Ocean (Fig. 1), resulting in similar exposures and resultant concentrations across the MIT due to vertical mixing (Kukulka et al., 2012; Eriksen et al., 2014) over thousands of kilometres. Our findings are similar in terms of concentrations and size classes to those reported by Rani-Borges et al. (2023), who investigated MP occurrence in corals from two islands (Trindade and Martim Vaz Islands) in the Atlantic Ocean affected by the Brazil Current (also called the South Equatorial Current).

The MP concentrations and characteristics (morphotype, size, colour, and polymer) in the SEC probably change along the way due to breakdown and sinking. If there was any influence of atmospheric deposition of MPs into the SEC, it can also be assumed to be homogenous. However, the situation experienced by corals on the east coast of Africa might be entirely different due to large inputs from local sources (Ryan, 2013, 2020; Phillips et al., 2021; Honorato et al., 2022; Weideman et al., 2023).

4.4. Microplastic concentrations across genera

The statistical significance between the fragment concentrations between all six genera shows that coral taxa respond differently towards plastic fragments (Table 3, Fig. 6a–c). The two coral genera with the most prominent fragment concentrations were the soft coral *Sinularia* sp. and the hard coral *Acropora* sp. (Fig. 6c). The highest fibre concentrations were in hard coral *Acropora* sp. and *Stylophora* sp. and soft coral *Sinularia* sp. (Fig. 6b). Finding the highest MP concentrations in a soft coral genus was expected as they rely on heterotrophic feeding (Section 4.2). Other studies have also found that *Sinularia* sp. and hard coral *Acropora* sp. (Ding et al., 2019; Reichert et al., 2018; Mason et al., 2022) had higher concentrations of MPs than other genera.

Raguso et al. (2022) found much higher MP concentrations in coral from the Maldives at 2.8 n/g, while our mean was 0.78 n/g. While *Pocillopora* sp. from the Maldives had the highest concentrations, *Pocillopora* sp. from the MIT had the lowest (Fig. 6). The MP concentration difference in these two studies may be due to local conditions.

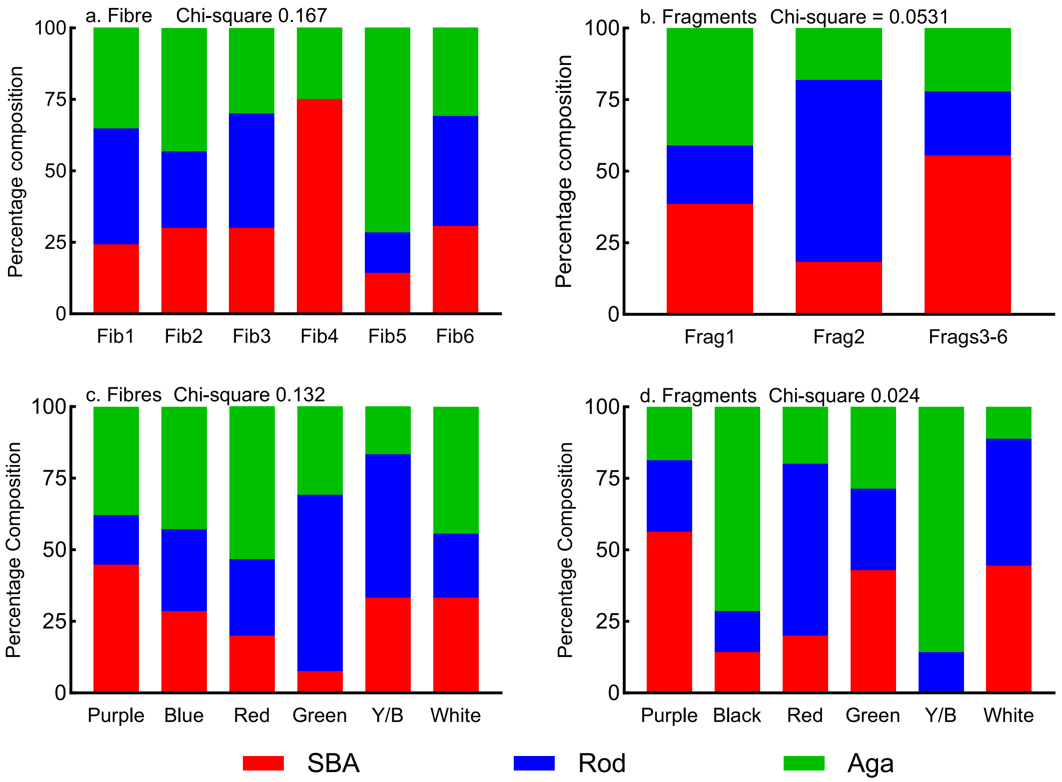

Fig. 5. Bar graphs illustrating the proportions of fibre (Fib) and fragment (Frag) frequencies (Chi-square test) of size categories (μm; a and b) and colour categories (c and d), respectively, of the three Mascarene islands. Fib 1 = 25–300, Fib 2 = 301–600, Fib 3 = 601–900, Fib 4 = 901–1200, Fib 5 = 1201–1500 and Fib 6 ≥ 1500; Frag 1 = 25–300, Frag 2 = 301–600, Frags 3–6 = 601 ≥ 1500. Rod = Rodrigues, SBA = St Brandon's Atoll, and Aga = Agalega. The data for the fragment size categories 601 ≥ 1500 μm were combined due to a lack of data (panel b). The *p*-values are for Chi-square tests. Y/B = yellow/brown. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

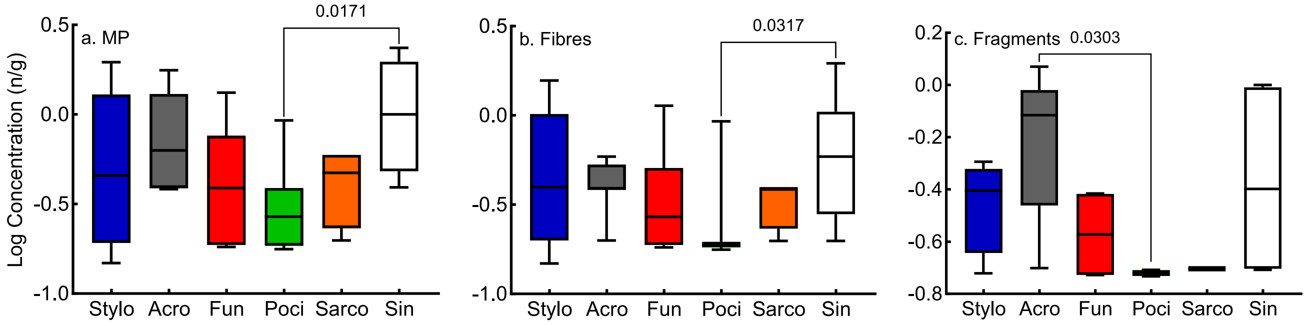

Fig. 6. Box graphs (median, 25th and 75th percentiles) and whiskers (minima and maxima) of microplastics (MPs), fibres, and fragments concentrations (n/g), respectively (a–c) for all coral genera. One-way Anova; p-values are for the Holm-Šidák multiple comparison post-test of log-transformed data. Stylo = *Stylophora* sp.; Acro = *Acropora* sp.; Fun = *Fungia* sp.; Poci = *Pocillopora* sp.; Sarco = *Sarcophyton* sp.; Sin = *Sinularia* sp.

Table 3
Sources of variation between the concentrations (n/g) of MP types between the various genera per island. The p-value is for two-way Anova. Bold values are significant at $p < 0.05$.

Source of variation	% Total variation	p-Value
Morphotype of MP	9.6	**0.0237**
Island/Genus	0.77	0.8164
Type x Island/Genus	0.65	0.7702

The Maldives has been identified as one of the most affected countries in the IO by beaching plastic particles, and could be a potential sink of missing plastics, due to the dominating monsoonal regime in the Northern Indian Ocean atmospheric and oceanic dynamics (Van Der Mheen et al., 2020; Phillips et al., 2021).

Higher MP concentrations in *Acropora* sp. may be due to its large polyps (may range between 1 and 2 mm in diameter; Reichert et al., 2018), trapping the MPs on the rough surface structure (Ding et al., 2019; Yen et al., 2024), leading to MP ingestion (Reichert et al., 2018). *Acropora* sp. may respond in the same way to MPs in the marine environment as it would to other suspended particles, trapping the particles via tentacles as prey. However, the most frequent contact between coral and MPs is with the mesenteries rather than with the tentacles (Reichert et al., 2018). *Acropora* sp. is believed to be more susceptible to MPs due to the absence of protective qualities of mucus (Ding et al., 2019; Jafarabadi et al., 2018). However, the mucus layer of *Sinularia* sp. entraps particles that may include MPs; this deserves further investigation (Ding et al., 2019; van der Schyff et al., 2020b).

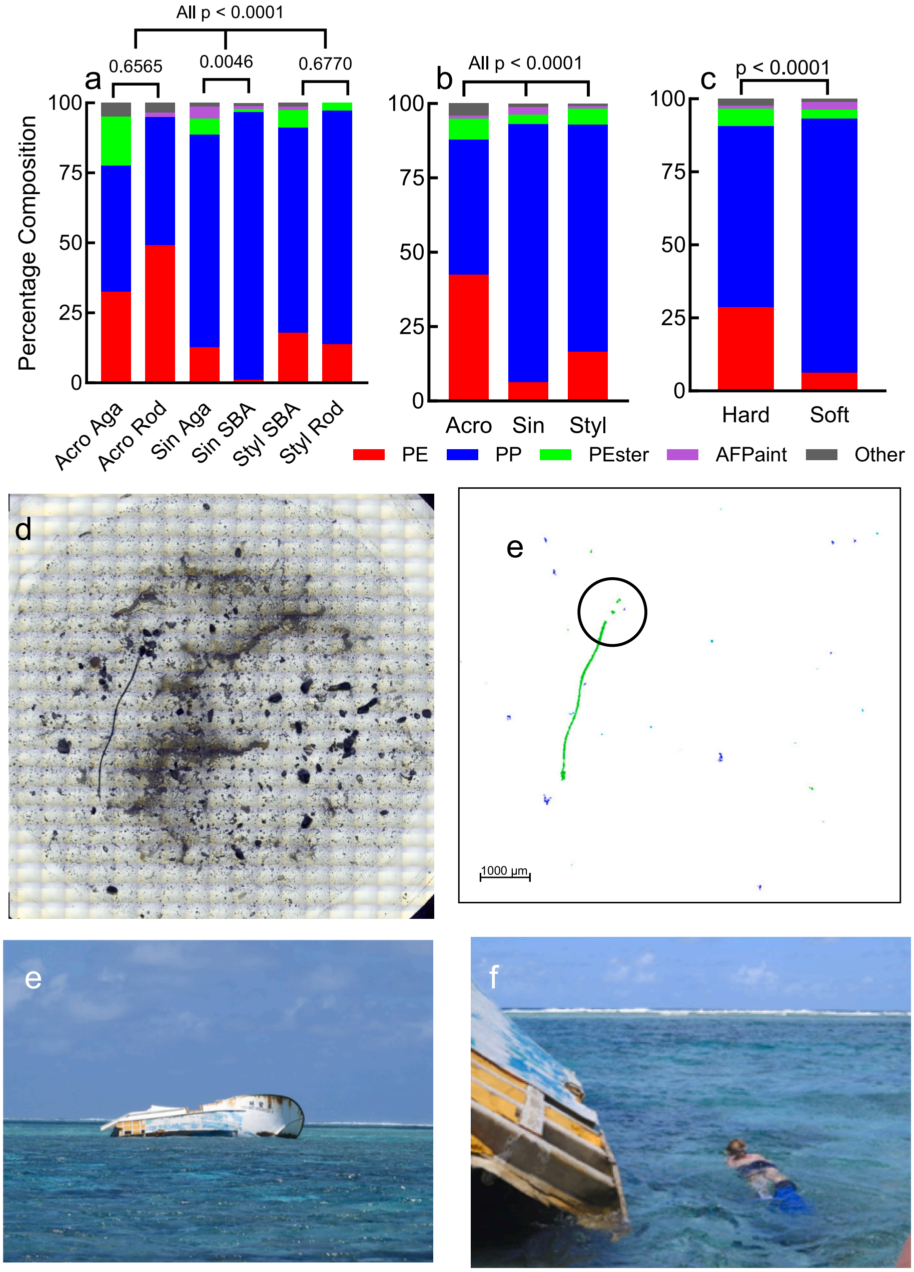

Fig. 7. Proportional polymer compositions of microplastics (MPs) in six coral samples. a: Polymer compositions of all samples. b: Polymer compositions of genera. c: Polymer compositions of hard and soft coral. p-Values are for Chi-square tests. d: Photograph of a filtered subsample of *Acropora* sp. from Agalega. e: SiMPle μFTIR map showing a polyester fibre (green) along with small fragments of polyethylene (blue). The circle shows polyester fragments possibly fragmented from the long fibre. The circle 7c. PE = polyethylene-based MPs. PP = polypropylene-based MPs. PEster = polyester. AFPaint = Acrylic-based paint. Rod = Rodrigues; SBA = St Brandon's Atoll; Aga = Agalega sp.. Styl = *Stylophora* sp.; Acro = *Acropora* sp.; Sin = *Sinularia* sp. e and f: Photographs of part of a wreck of a fishing vessel in the lagoon of St. Brandon's Atoll. Note the void compartments filled with yellow polyurethane foam. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

4.5. *Comparisons with other studies*

Our study is the first account so far of MPs in corals of the WIO which allows comparisons with other studies from the wider Indian Ocean. The MP concentrations found in the MIT (mean 0.78 n/g) had half the concentrations compared with a recent study from the Maldives (mean 1.8 n/g; Table 4; Raguso et al., 2022). Our results feature in the lower/middle concentration ranges of other comparable studies (Table 4).

The domination of fibres compared with fragments (54 % vs. 47 %, respectively) we found was not unusual (Table 2, Fig. 4; Table 4; Song et al., 2015; Bednarz et al., 2021; Huang et al., 2021; Vidyasakar et al., 2018; Patterson et al., 2020). The MP colour pattern found in other coral-related studies had little congruence with the present study, as mentioned in Section 4.1; some found more blue (Patti et al., 2020), transparent (Patterson et al., 2020; Lei et al., 2021; Tang et al., 2021), and white (Vidyasakar et al., 2018), compared with purple, green, blue, and red of the present study (Table 2; Fig. 2c and d).

Differences in background, selective morphotype uptake, and taxa, likely explain the wide differences found (Table 4). Coupled with different sample processing methods, coral genera sampled, characteristic definitions (colour and size for instance) and units of measure make it difficult to compare the information provided (Raguso et al., 2022). These common obstacles highlight the need for standardised sampling and processing of MPs in environmental matrices (Raguso et al., 2022;

UNEP-Nairobi Convention/WIOMSA, 2022).

Table 4
Polymer counts and compositions of microplastics determined by FTIR in six selected coral sub-samples.

	PE	PP	PEster	Paint	Other
Acropora Agalega	13	18	7	0	2
Acropora Rodrigues	29	27	0	1	2
Sinularia Agalega	9	54	4	3	1
Sinularia St. Brandon	1	85	1	1	1
Stylophora St, Brandon	14	57	5	1	1
Stylophora Rodrigues	5	30	1	0	0
Totals	71	271	18	6	7
Percentage composition	19	73	5	2	2
Hard corals	61	132	13	2	5
Soft Corals	10	139	5	4	2

PE = Polyethylene; PP = Polypropylene; PEster = Polyester.

4.6. Polymer composition

Hierl et al. (2021) showed that polyethylene-based MPs are incorporated into coral skeleton. Our results bear out these findings but as may be expected due to differences in location, exposure profiles, extraction and analytical techniques, and taxa sampled, there were wildly different polymer compositions. Polypropylene- (78 %) followed by polyethylene-based MPs (18 %) dominated in our samples in all corals from all islands, but there were differences nuanced by island, genus, and coral type (Fig. 7a–c). Given the location of the islands relative to the SEC and their remoteness, it is no surprise that the MP polymer compositions were dominated by lower density polymers suggesting that the denser polymers may have been lost to sinking and biofouling travelling along the SEC (Amaral-Zettler et al., 2021; Karkanorachaki et al., 2021).

Given the small proportion of the samples scanned by μFTIR, it is difficult to formulate concrete conclusions based on MP polymer compositions. The polymer composition of the soft coral *Sinularia* sp. clearly had fewer polyethylene-based MPs (Fig. 7b) when compared with hard and soft coral data (Fig. 7c). Despite the small number of μFTIR-scanned samples, the same genera from different islands had similar polymer patterns, suggesting that the background is rather homogenized as the SEC arrives at the MIT.

We also found very small particles by μFTIR analysis that were not detected through the optical microscope. Song et al. (2015) reported similar findings. Furthermore, the polyester fibre in Fig. 7e suggests fracturing at one end during the filtration, implying a brittleness that might explain all the other small fragments. Whether the brittleness was due to physical and chemical influences while in the water, biological action during ingestion, digestion, and incorporation in the skeleton, due to the extraction and filtration procedure, or all of them is likely but not known. However, this phenomenon should be kept in mind when calculating concentrations, size distributions, and associated hazard.

Plastics and their monomers have different environmental hazards. Especially polyurethane is highly ranked compared with other polymers (Lithner et al., 2011) but we only found one particle using our methods. We have observed polyurethane point sources during sampling for our study on the impacts of a shipwreck on SBA (van der Schyff et al., 2020a; Fig. 7e and f). Polyurethane particles are most certainly being released from the void compartment spaces of double-hulled fishing vessels due to abrasion and wave action. These pictures were taken during the coral sampling expedition reported here. Polyurethane, however, is not stable when treated with certain chemicals. Especially HCl 37 % will break down polyurethane (PSI Urethanes, Inc., 2024; Severe effect Rating C). Imhof et al. (2017), similarly, found no polyurethane in coral from the Maldives. We believe that hazardous polyurethane is probably missed or under-detected in coral (and other) surveys and needs closer attention, especially since the foam form of this polymer seems highly fragile and likely to break down quickly into very small particles due to high-impact waves, scouring, high temperatures, and sunlight.

4.7. Threats of MP contamination in different coral genera

MPs have various impacts on corals. One of the most common effects is changes in photosynthetic performance and alteration of metabolite profiles reported in *Stylophora* sp., *Acropora* sp., and *Pocillopora* sp. (Isa et al., 2023; Soares et al., 2020; Syakti et al., 2019; Reichert et al., 2018). Other effects occurring in *Stylophora* sp. and *Acropora* sp. include disruption of host-symbiont signalling and interference with the

Table 5
MP concentrations and characteristics in corals from selected studies.

Location	Genus species	Sieve mesh (μm)	Means (n/g)	Dominant morphotypes	Size (μm)	Dominant colours	Dominant polymers	Reference
Rodrigues Is., Agalega Is., St Brandon Atoll	*Stylophora* sp., *Acropora* sp., *Fungia* sp., *Pocillipora* sp., *Sarcophyton* sp., *Sinularia* sp.	25	0.3 0.78 1.2	Fibre, fragment	25–300	Purple, green, blue, and red	Polypropylene, polyethylene, polyester	This study
Faafu atoll, Maldives	*Porites lutea*, *Panova varians*, *Pocillipora verrucosa*	25	1.2–2.8	Film, foam, fibre	25–150	Brown, pink	Polypropylene, polyethylene	Raguso et al., 2022
Faafu atoll, Maldives	*Acropora muricata*	25	1	Fibre	100–901>	Not reported	Various phthalates	Saliu et al., 2019
Liuqiu Island, Taiwan	27 different species	0.7	0.02–1.3	Fibre, fragment	500–1000	Black, blue, red	Polyethylene, polypropylene	Lim et al., 2022
Hainan, China	*Acropora millepora*, *Galaxea fascicularis*	30	0.01–3.60 n/polyp	Fibre, fragment	500–3000	Transparent, black, green	Cellophane, polyethylene terephthalate	Lei et al., 2021
Hainan, China	*Pocillipora damicornis*, *Galaxea fascicularis*	0.7	4.97 n cm^2	Fibre, fragment	1–5000	Transparent, black, green	Cellophane, polyethylene terephthalate	Tang et al., 2021
Penjang Island, Indonesia	*Galaxea*, *Goniastrea*, *Pocillipora*, *Acropora*, *Favia*	4	2–37	Fibre, fragment, film	Not reported	Not reported	Silicone, polyvinyl chloride, polyethylene terephthalate, polyvinyl alcohol, polysulfones	Wijanti et al., 2024
Rhode Island, United States	*Astrangia poculata*	20	112 n/polyp	Fibre, round, fragment	Not reported	Not reported	Polyamides, polyester, cellulose-based fibres	Rotjan et al., 2019
Trindade and Martim Vaz Islands, Atlantic Ocean, Brazil	*Mussismilia hispida*, *Siderastrea stellata*, *Montastrea cavernosa*, *Favia gravida*	0.7	2.5–39	Fibre, fragment, film	100–901>	Not reported	Polyethylene, polyvinyl chloride, polypropylene, poly(methyl methacrylate)	Rani-Borges et al., 2023

symbiotic zooxanthellae (Huang et al., 2021), while Bejanaro et al. (2022) found little short-term effects. MP contamination may lead to bleaching, lower fertilization success, and tissue necrosis in *Acropora* sp. and *Pocillopora* sp. (Syakti et al., 2019; Reichert et al., 2018). *Fungia* sp. ingest MPs by passive adhesion and ingests and retains more biofouled MPs, but little is known about the threat of MPs in this genus (Corona et al., 2020). The presence of MPs in corals has chemical and physical effects. Some of these effects may occur in all genera, and some are species-specific (Hankins et al., 2018; Soares et al., 2020). Although there are known detrimental effects of MPs on coral, it is not possible to relate the results of short-term laboratory studies to in situ findings where corals have been exposed for decades (Bejanaro et al., 2022).

5. Conclusions and recommendations

We only found two MP morphotypes in coral from the MIT, with fibres dominating. Overall, the smallest size category (25–300 μm) had the highest concentrations. Soft corals had the highest MP concentrations which may be due to the difference in feeding strategies between soft- and hard corals. The coral genus with the highest MP concentrations was the soft coral *Sinularia* sp. and the hard coral *Acropora* sp. The differences between MP concentrations, sizes, morphotype (fibre or fragment), polymer composition, but not colour, were likely driven by species-specific interactions with MPs, more than differential exposures, if any, between the islands.

Comparisons with other studies were difficult as different sampling processing methods, coral genera selected, and units of measure were used. *Acropora* sp., we suggest, would be the most obvious genus to choose for large scale monitoring of MPs in hard corals as it is a globally distributed tropical genus and contains a large number of species (Wallace and Willis, 1994). Similarly, *Sinularia* sp. seems a good candidate for monitoring MPs in soft corals.

The MP concentrations between the MIT islands did not differ contrary to what we expected. Although there are large differences in human populations between the islands, we did not find that local sources from human populations were in play, probably because our sample were mainly taken from the up-current on the west of the islands. Therefore, the three islands likely experience a homogeneous MP background from the transoceanic SEC rather than local influences, while local sources may affect down-current corals. We recommend that seawater off islands be sampled up- and down-current to investigate effect of local (human) population.

We note the lack of polyurethane in corals from SBA despite obvious and significant local point sources. Due to the absence in our samples but visual presence on site, polyurethane needs more attention on coral reefs. Because of the high-ranked hazard of this polymer, we suggest that more attention be given to the environmental behaviour, the likelihood of uptake and breakdown of the fragile foam, and the hazards that it may pose to coral and coral reef communities.

This study is the first on MPs in coral genera from the Mascarene islands and the WIO, and serves as a baseline for coral reef related MP research and policy development for the WIO. The finding that the three remote MIT islands (covering a 1200 km transect) are exposed to a homogenous MP background in the SEC implies that only international actions can address the issue of plastics in the marine environment.

CRediT authorship contribution statement

Michelle Hamman: Writing – original draft, Visualization, Validation, Methodology, Investigation, Formal analysis, Data curation. **Veronica van Schyff:** Writing – review & editing, Validation, Resources, Methodology, Investigation. **Robert Nee Sun Choong Kwet Yive:** Writing – review & editing, Validation, Resources, Project administration. **Lucian Iordachescu:** Writing – review & editing, Methodology, Investigation, Formal analysis, Data curation. **Laura Simon-Sánchez:** Writing – review & editing, Methodology, Investigation, Formal analysis, Data curation. **Hindrik Bouwman:** Writing – review & editing, Supervision, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

Acknowledgements

Permission for the biological samples from the Mauritian Outer Island were granted by the Outer Island Development Corporation, the National Parks, and Conservation Service of the Ministry of Agro-Industry, Food Production, and Security of the Republic of Mauritius. Ethical approval was obtained from the North-West University (NWU-01275-19-S9), and funding was provided by the NRF, Blue Skies Grant (91337). We sincerely thank the Raphaël Fishing Company for logistical support. We thank Marinus du Preez, Karin Blom, Julian Merven and Jovanni Raffin for assistance with sample collection. We thank Wynand Muller for creating the map of Fig. 1. Cornel-Mari du Preez provided comments on a draft. Funding was provided by the South African Regional Cooperation Fund for Scientific Research and Technological Development (UID 65290), administered by the South African National Research Foundation (NRF). Opinions expressed and conclusions arrived at are those of the authors and are not necessarily to be attributed to the funders or others involved with this project. This article forms part of an MSc dissertation (M Hamman).

Declaration of generative AI-assisted technologies in the final editing process

During the preparation of this work the author(s) used Open Writefull in order to improve phrasing and grammar, only. After using this tool/service, the author(s) reviewed and edited the content as needed and take(s) full responsibility for the content of the publication.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.marpolbul.2024.116951.

References

Allen, A.S., Seymour, A.C., Rittschof, D., 2017. Chemoreception drives plastic consumption in a hard coral. Mar. Pollut. Bull. 124, 198–205.

Amaral-Zettler, L.A., Zettler, E.R., Mincer, T.J., Klaassen, M.A., Gallager, S.M., 2021. Biofouling impacts on polyethylene density and sinking in coastal waters: a macro/micro tipping point? Water Res. 201, 117289.

Arkatkar, A., Juwarkar, A.A., Bhaduri, S., Uppara, P.V., Doble, M., 2010. Growth of *Pseudomonas* and *Bacillus* biofilms on pretreated polypropylene surface. Int. Biodeterior. Biodegrad. 64, 530–536.

Athapaththu, A.M.A.I.K., Thushari, G.G.N., Dias, P.C.B., Abeygunawardena, A.P., Egodauyana, K.P.U.T., Liyanage, N.P.P., Pitawala, H.M.J.C., Senevirathna, J.D.M., 2020. Plastics in surface water of southern coastal belt of Sri Lanka (Northern Indian Ocean): distribution and characterization by FTIR. Mar. Pollut. Bull. 161, 111750.

Axworthy, J.B., Padilla-Gamiño, J.L., 2019. Microplastics ingestion and heterotrophy in thermally stressed corals. Sci. Rep. 9, 18193 https://doi.org/10.1038/s41598-019-54698-7.

Barnes, D.K., 2004. Natural and plastic flotsam stranding in the Indian Ocean. In: Davenport, D., Davenport, J. (Eds.), The Effects of Human Transport on Ecosystems: Cars and Planes, Boats and Trains. Royal Irish Academy, Dublin, pp. 193–205.

Bednarz, V.N., Van de Water, J.A.J.M., Grover, R., Maguer, J.F., Fine, M., Ferrier-Pagès, C., 2021. Unravelling the importance of diazotrophy in corals–combined assessment of nitrogen assimilation, diazotrophic community and natural stable isotope signatures. Front. Microbiol. 12, 631244.

Bejanaro, S., Diemel, V., Feuring, A., Ghilardi, M., Harder, T., 2022. No short-term effect of sinking microplastics on heterotrophy or sediment clearing in the tropical coral *Stylophora pistillata*. Sci. Rep. 12, 1468.

Boodraj, P., Glassom, D., 2022. Experimental exposure to microplastics does not affect the physiology of healthy or moderately bleached *Anomastraea irregularis* and *Pocillopora verrucosa* corals. Mar. Biol. 169, 1–14.

Bothma, F., Uren, R.C., Iordachescu, L., van der Lingen, C.D., Bouwman, H., 2024. Microplastics in the Indian and South Atlantic oceans translocate to gills, digestive glands, and muscle of the chokka squid Loligo reynaudii. Mar. Pollut. Bull. 202, 116371.

Bouwman, H., Evans, S.W., Cole, N., Choong Kwet Yive, N.S., Kylin, H., 2016. The flip-or-flop boutique: marine debris on the shores of St Brandon's rock, an isolated tropical atoll in the Indian Ocean. Marine Environment Research 144, 58–64.

Budoo, A., Mahadew, R.A., 2014. Mauritius. In: Ngwena, C., Grobbelaar-du Plessis, I., Combrinck, H., Kamga, S.D. (Eds.), African Disability Rights Yearbook, vol. 2. Business Print, Pretoria, p. 235.

Cesa, S.F., Turra, A., Baruque-Ramos, J., 2017. Synthetic fibers as microplastics in the marine environment: a review from textile perspective with a focus on domestic washings. Sci. Total Environ. 598, 1116–1129.

Chan, C.K.M., Lo, C.K.Y., Kan, C.W., 2024. A systematic literature review for addressing microplastic fibre pollution: urgency and opportunities. Water 16 (14), 1988.

Chapron, L., Peru, E., Engler, A., Ghiglione, J.F., Meistertzheim, A.L., Pruski, A.M., Purser, A., Vétion, G., Galand, P.E., Lartaud, F., 2018. Macro-and microplastics affect cold-water corals growth, feeding and behaviour. Scientific Reports 8, 1–8.

Cheang, C.C., Ma, Y., Fok, L., 2018. Occurrence and composition of microplastics in the seabed sediments of the coral communities in proximity of a metropolitan area. Int. J. Environ. Res. Public Health 15, 2270.

Chubarenko, I., Bagaev, A., Zobkov, M., Esiukova, E., 2016. On some physical and dynamical properties of microplastic particles in marine environment. Mar. Pollut. Bull. 108, 105–112.

Corona, E., Martin, C., Marasco, R., Duarte, C.M., 2020. Passive and active removal of marine microplastics by a mushroom coral (*Danafungia scruposa*). Front. Mar. Sci. 128 https://doi.org/10.3389/fmars.2020.00128.

Ding, J., Jiang, F., Li, J., Wang, Z., Sun, C., Wang, Z., Fu, L., Ding, N.X., He, C., 2019. Microplastics in the coral reef systems from Xisha Islands of South China Sea. Environ. Sci. Tech. 53, 8036–8046.

Drzyzga, O., 2012. The strengths and weaknesses of *Gordonia*: a review of an emerging genus with increasing biotechnological potential. Crit. Rev. Microbiol. 38, 300–316.

Duflos, G., Dehaut, A., Cassone, A.-L., Frère, L., Hermabessiere, L., Himber, C., Rinnert, E., Rivière, G., Lambert, C., Soudant, P., et al., 2017. Microplastics in seafood: identifying a protocol for their extraction and characterization. Fate impact microplastics. Marine Ecosystem 215, 74.

Eriksen, M., Lebreton, L., Carson, H., Thiel, M., Moore, C., Borerro, J., Galgani, F., Ryan, P., Reisser, J., 2014. Plastic pollution in the World's oceans: more than 5 trillion plastic pieces weighing over 250,000 tons afloat at sea. PloS One 9, e111913.

Esiukova, E., Zobkov, M., Chubarenko, I., 2020. Data on microplastic contamination of the Baltic Sea bottom sediment samples in 2015–2016. Data Brief 28, 104887.

Fleming, R.H., Barnes, C.A., Ericson, D.B., Broadus, J.M., LaMourie, M.J., Namias, J., 16 Aug. 2022. Atlantic Ocean. In: Encyclopaedia Britannica. https://www.britannica.com/place/Atlantic-Ocean (Accessed: 26 Sept. 2022).

Grillo, J.F., Sabino, M.A., Ramos, R., 2021. Short-term ingestion and tissue incorporation of polystyrene microplastic in the scleractinian coral *Porites porites*. Reg. Stud. Mar. Sci. 43, 101697.

Hall, N.M., Berry, K.L.E., Rintoul, L., Hoogenboom, M.O., 2015. Microplastic ingestion by scleractinian corals. Mar. Biol. 162, 725–732.

Hankins, C., Duffy, A., Drisco, K., 2018. Scleractinian coral microplastic ingestion: potential calcification effects, size limits, and retention. Mar. Pollut. Bull. 135, 587–593.

Hankins, C., Moso, E., Lasseigne, D., 2021. Microplastics impair growth in two Atlantic scleractinian coral species, *Pseudodiploria clivosa* and *Acropora cervicornis*. Environ. Pollut. 275, 116649.

Hierl, F., Wu, H.C., Westphal, H., 2021. Scleractinian corals incorporate microplastic particles: identification from a laboratory study. Environ. Sci. Pollut. Res. 28, 37882–37893.

Hoeksema, B.W., 2014. The "*Fungia* patella group" (Scleractinia, Fungiidae) revisited with a description of the mini mushroom coral *Cycloseris boschmai* sp. n. ZooKeys 371, 57–84.

Honorato, D., Weideman, E., Ryan, P.R., Thiel, M., 2022. Amounts, sources, fates and ecological impacts of marine litter and microplastics in the Western Indian Ocean region: a review and recommendations for actions. In: Hawkins, S.J., Lemasson, A.J., Allcock, A.L., Bates, A.E., Byrne, M., Evans, A.J., Firth, L.B., Lucas, C.H., Marzinelli, E.M., Mumby, P.J., Russell, B.D., Sharples, J., Smith, I.P., Swearer, S.E., Todd, P.A. (Eds.), Oceanography and Marine Biology: An Annual Review. CRC Press, Boca Raton, pp. 533–590.

Hording, G.C., LeBlanc, R.J., Vass, W.P., Addison, R.F., Hargrave, B.T., Pearre Jr., S., Dupuis, A., Brodie, P.F., 1997. Bioaccumulation of polychlorinated biphenyls (PCBs) in the marine pelagic food web, based on a seasonal study in the southern Gulf of St. Lawrence, 1976–1977. Mar. Chem. 56, 145–179.

Huang, W., Chen, M., Song, B., Deng, J., Shen, M., Chen, Q., Zeng, G., Liang, J., 2021. Microplastics in the coral reefs and their potential impacts on corals: a mini-review. Sci. Total Environ. 762, 143112.

Imhof, H.K., Sigl, R., Brauer, E., Feyl, S., Giesemann, P., Klink, S., Leupolz, K., Löder, M.G.J., Löschel, L.A., Missun, J., Muszynski, S., Ramsperger, A.F.R.M., Schrank, I., Speck, S., Steibl, S., Trotter, B., Winter, I., Laforsch, C., 2017. Spatial and temporal variation of macro-, meso- and microplastic abundance on a remote coral island of the Maldives, Indian Ocean. Mar. Pollut. Bull. 116, 340–347.

Isa, V., Becchi, A., Napper, I.E., Ubaldi, P.G., Saliu, F., Lavorano, S., 2023. Effects of polypropylene nanofibres on soft corals. Chemosphere 327, 138509.

Jafarabadi, A.R., Bakhtiari, A.R., Aliabadian, M., Laetitia, H., Toosi, A.S., Yap, C.K., 2018. First report of bioaccumulation and bioconcentration of aliphatic hydrocarbons (AHs) and persistent organic pollutants (PAHs, PCBs and PCNs) and their effects on alcyonacea and scleractinian corals and their endosymbiotic algae from the Persian Gulf, Iran: inter and intra-species differences. Sci. Total Environ. 627, 141–157.

Jeyasanta, K.I., Patterson, J., Grimsditch, G., Edward, J.P., 2020. Occurrence and characteristics of microplastics in the coral reef, sea grass and near shore habitats of Rameswaram Island, India. Marine Pollution Bulletin 160, 111674.

Karkanorachaki, K., Syranidou, E., Kalogerakis, N., 2021. Sinking characteristics of microplastics in the marine environment. Sci. Total Environ. 793, 148526.

Kukulka, T., Proskurowski, G., More't-Ferguson, S., Meyer, D., Law, K., 2012. The effect of wind mixing on the vertical distribution of buoyant plastic debris. Geophys. Res. Lett. 39, 1–6.

Kumar, R., Sharma, P., Verma, A., Jha, P.K., Singh, P., Gupta, P.K., Chandra, R., Prasad, P.V.V., 2021. Effect of physical characteristics and hydrodynamic conditions on transport and deposition of microplastics in riverine ecosystem. Water 13, 2710.

Lei, X., Cheng, H., Luo, Y., Zhang, Y., Jiang, L., Sun, Y., Zhou, G., Hang, H., 2021. Abundance and characteristics of microplastics in seawater and corals from Reef Region of Sanya Bay, China. Frontiers in Marine Science 8, 728745. https://doi.org/10.3389/fmars.2021.728745.

Li, J., Gao, F., Zhang, D., Cao, W., Zhao, C., 2022. Zonal distribution characteristics of microplastics in the southern Indian Ocean and the influence of ocean current. Marine Science and Engineering 10, 290.

Lim, Y.C., Chen, C.W., Cheng, Y.R., Chen, C.F., Dong, C.D., 2022. Impacts of microplastics on scleractinian corals nearshore Liuqiu Island southwestern Taiwan. Environ. Pollut. 306, 119371.

Lithner, D., Larsson, Å., Dave, G., 2011. Environmental and health hazard ranking and assessment of plastic polymers based on chemical composition. Sci. Total Environ. 409, 3309–3324.

Martin, C., Corona, E., Mahadik, G.A., Duarte, C.M., 2019. Adhesion to coral surface as a potential sink for marine microplastics. Environ. Pollut. 255, 113281.

Mason, V.G., Skov, M.W., Hiddink, J.G., Walton, M., 2022. Microplastics alter multiple biological processes of marine benthic fauna. Sci. Total Environ. 845, 157362.

Mattan-Moorgawa, S., Chockalingum, J., Appadoo, C., 2021. A first assessment of marine meso-litter and microplastics on beaches: where does Mauritius stand? Mar. Pollut. Bull. 173, 112941 https://doi.org/10.1016/j.marpolbul.2021.112941.

Maurizi, L., Iordachescu, L., Kirstei, I.V., Nioelsen, A.H., Vollertsen, J., 2023. It matters how we measure - quantification of microplastics in drinking water by μFTIR and μRaman. Heliyon 9, e20119.

Mendrik, F., Houseago, R.C., Hackney, C.R., Parsons, D.R., 2024. Microplastic trapping efficiency and hydrodynamics in model coral reefs: a physical experimental investigation. Environ. Pollut. 342, 123094.

Murano, C., Vaccari, L., Casotti, R., Corsi, I., Palumbo, A., 2022. Occurrence of microfibres in wild specimens of adult sea urchin *Paracentrotus lividus* (Lamarck, 1816) from a coastal area of the central Mediterranean Sea. Marine Pollution Bulletin 176, 113448.

Obura, D., Gudka, M., Rabi, F.A., Gian, S.B., Bijoux, J., Freed, S., Maharavo, J., Mwaura, J., Porter, S., Sola, E., Wickel, J., Yahya, S., Ahamada, S., 2017. Coral reef status report for the Western Indian Ocean. Available at: https://wedocs.unep.org/20.500.11822/28371.

Pantos, O., 2022. Microplastics: impacts on corals and other reef organisms. Emerging Topics in Life Sciences. 6, 81–93. https://doi.org/10.1042/ETLS20210236.

Patterson, J., Jeyasanta, K.I., Sathish, N., Edward, J.K.P., Booth, A.M., 2020. Microplastic and heavy metal distributions in an Indian coral reef ecosystem. Science Total Environment 744, 140706.

Patti, T.B., Fobert, E.K., Reeves, S.E., da Silva, K.B., 2020. Spatial distribution of microplastics around an inhabited coral island in the Maldives, Indian Ocean. Sci. Total Environ. 748, 141263.

Pattiaratchi, C., van der Mheen, M., Schlundt, C., Narayanaswamy, B.E., Sura, A., Hajbane, S., White, R., Kumar, N., Fernandes, M., Wijeratne, S., 2022. Plastics in the Indian Ocean – sources, transport, distribution, and impacts. Ocean Science 18, 1–28. https://doi.org/10.5194/os-18-1-2022.

Phillips, H.E., Tandon, A., Furue, R., Hood, R., Ummenhofer, C.C., Benthuysen, J.A., Menezes, V., Hu, S., Webber, B., Sanchez-Franks, A., Cherian, D., Shroyer, E., Feng, M., Wijesekera, H., Chatterjee, A., Yu, L., Hermes, J., Murtugudde, R., Tozuka, T., Su, D., Singh, A., Centurioni, L., Prakash, S., Wiggert, J., 2021. Progress in understanding of Indian Ocean circulation, variability, air-sea exchange, and impacts on biogeochemistry. Ocean Sci. 17, 1677–1751. https://doi.org/10.5194/os-17-1677-2021.

Plafcan, M.M., Stallings, C.D., 2022. Microplastics do not affect bleaching of *Acropora cervicornis* at ambient or elevated temperatures. PeerJ 10, e13578. https://doi.org/10.7717/peerj.13578.

Porter, S.N., Humphries, M.S., Buah-Kwofie, A., Schleyer, M.H., 2018. Accumulation of organochlorine pesticides in reef organisms from marginal coral reefs in South Africa and links with coastal groundwater. Mar. Pollut. Bull. 137, 295–305.

Primpke, S., Cross, R.K., Mintenig, S.M., Simon, M., Vianello, A., Gerdts, G., Vollertsen, J., 2020. Toward the systematic identification of microplastics in the environment: evaluation of a new independent software tool (siMPle) for spectroscopic analysis. Appl. Spectrosc. 2020, 741127–741138. https://doi.org/10.1177/0003702820917760.

PSI Urethanes, Inc, 2024. Urethane & polyurethane chemical compatibility. https://psiurethanes.com/urethane-and-polyurethane-chemical-compatibility/ (Visited 21 June, 2024).

Qiao, R., Deng, Y., Zhang, S., Wolosker, M.B., Zhu, Q., Ren, H., Zhang, Y., 2019. Accumulation of different shapes of microplastics initiates intestinal injury and gut microbiota dysbiosis in the gut of zebrafish. Chemosphere 236, 124334.

Raguso, C., Saliu, F., Lasagni, M., Galli, P., Clemenza, M., Montano, S., 2022. First detection of microplastics in reef-building corals from a Maldivian atoll. Mar. Pollut. Bull. 180, 113773.

Rani-Borges, B., Gomes, E., Maricato, G., de Carvalho Lins, L.H.F., de Moraes, B.R., Lima, G.V., Côrtes, L.G.F., Tavares, M., Pereira, P.H.C., Ando, R.A., Queiroz, L.G., 2023. Unveiling the hidden threat of microplastics to coral reefs in remote South Atlantic islands. Sci. Total Environ. 897, 165401.

Reichert, J., Schellenberg, J., Schubert, P., Wilke, T., 2018. Responses of reef building corals to microplastic exposure. Environ. Pollut. 237, 955–960.

Reichert, J., Arnold, A.L., Hoogenboom, M.A., Schubert, P., Wilke, T., 2019. Impacts of microplastics on growth and health of hermatypic corals are species-specific. Env. Poll. 254, 113074.

Reichert, J., Tirpitz, V., Anand, R., Bach, K., Knopp, J., Schubert, P., Wilke, T., Ziegler, M., 2021. Interactive effects of microplastic pollution and heat stress on reef-building corals. Environ. Pollut. 290, 118010.

Rocha, R.J.M., Rodrigues, A.C.M., Campos, D., Cícero, L.H., Costa, A.P.L., Silva, D.A.M., Oliveira, M., Soares, A.M.V.M., Silva, A.P., 2020. Do microplastics affect the zoanthid *Zoanthus sociatus*? Sci. Total Environ. 713, 136659.

Rotjan, R.D., Sharp, K.H., Gauthier, A.E., Yelton, R., Lopez, E.M.B., Carilli, J., Kagan, J. C., Urban-Rich, J., 2019. Patterns, dynamics and consequences of microplastic ingestion by the temperate coral, *Astrangia poculata*. Proc. R. Soc. B 286, 20190726. https://doi.org/10.1098/rspb.2019.0726.

Ryan, P., 2013. A simple technique for counting marine debris at sea reveals steep litter gradients between the Straits of Malacca and the Bay of Bengal. Mar. Pollut. Bull. 69, 128–136.

Ryan, P.G., 2020. Land or sea? What bottles tell us about the origins of beach litter in Kenya. Waste Manag. 116, 49–57. https://doi.org/10.1016/j.wasman.2020.07.044.

Ryan, P.G., Bouwman, H., Moloney, C.L., Yuyama, M., Takada, H., 2012. Long-term decreases in persistent organic pollutants in South African coastal waters detected from beached polyethylene pellets. Mar. Pollut. Bull. 64, 2756–2760. https://doi.org/10.1016/j.marpolbul.2012.09.013.

Saliu, F., Montano, S., Leoni, B., Lasagni, M., Galli, P., 2019. Microplastics as a threat to coral reef environments: detection of phthalate esters in neuston and scleractinian corals from the Faafu Atoll, Maldives. Mar. Pollut. Bull. 142, 234–241.

Salm, R.V., 1983. Coral reefs of the Western Indian Ocean: a threatened heritage. Ambio 12, 349–353.

Sheppard, C.R., Davy, S.K., Pilling, G.M., 2009. The Biology of Coral Reefs. Oxford University Press, Oxford, p. 339.

Simon, M., van Last, N., Vollertsen, J., 2018. Quantification of microplastic mass and removal rates at wastewater treatment plants applying focal plane array (FPA)-based Fourier transform infrared (FT-IR) imaging. Water Res. 142, 1–9. https://doi.org/10.1016/j.watres.2018.05.019.

Simon-Sánchez, L., Grelaud, M., Lorenz, C., Garcia-Orellana, J., Vianello, A., Liu, F., Vollertsen, J., Ziveri, P., 2022. Can a sediment core reveal the plastic age? Microplastic preservation in a coastal sedimentary record. Environ. Sci. Tech. 56, 16780–16788.

Soares, M.D.O., Matos, E., Lucas, C., Rizzo, L., Allcock, L., Rossi, S., 2020. Microplastics in corals: an emergent threat. Mar. Pollut. Bull. 161, 111810.

Song, Y.K., Hong, S.H., Jang, M., Han, G.M., Rani, M., Lee, J., Shim, W.J., 2015. A comparison of microscopic and spectroscopic identification methods for analysis of microplastics in environmental samples. Mar. Pollut. Bull. 93, 202–209.

Sparks, C., Awe, A., 2022. Concentrations and risk assessment of metals and microplastics from antifouling paint particles in the coastal sediment of a marina in Simon's Town, South Africa. Environ. Sci. Pollut. Res. 29, 59996–60011. https://doi.org/10.1007/s11356-022-18890-z.

Syakti, A.D., Jaya, J.V., Rahman, A., Hidayati, N.V., Raza'i, T.S., Idris, F., Trenggono, M., Doumenq, P., Chou, L.M., 2019. Bleaching and necrosis of staghorn coral (*Acropora formosa*) in laboratory assays: immediate impact of LDPE microplastics. Chemosphere 228, 528–535.

Tang, J., Wu, Z., Wan, L., Cai, W., Chen, S., Wang, X., Luo, J., Zhou, Z., Zhao, J., Lin, S., 2021. Differential enrichment and physiological impacts of ingested microplastics in scleractinian corals in situ. J. Hazard. Mater. 404, 124205.

Thébaud, C., Warren, B.H., Strasberg, D., Cheke, A., 2009. Mascarene islands, biology. Atoll Res. Bull. 127, 1–216.

Thiemann, T., 2023. Microplastic in the marine environment of the Indian Ocean. J. Environ. Prot. 14, 297–359. https://www.scirp.org/journal/jep.

Turner, J., Klaus, R., 2005. Coral reefs of the Mascarenes, Western Indian Ocean. Philos. Trans. R. Soc. A Math. Phys. Eng. Sci. 363, 229–250.

UNEP-Nairobi Convention/WIOMSA, 2022. Marine plastic litter in the WIO region: status, implications on the environment, human populations and effectiveness of measures and opportunities. A synthesis report. In: WIOMSA, Zanzibar, WIOMSA Series (Online). www.wiomsa.org. www.nairobiconvention.org/.

United Nations Environment Program, 2019. Plastics and shallow water coral reefs. In: Sweet, M., Stelfox, M., Lamb, J. (Eds.), Synthesis of the Science for Policy-Makers. https://wedocs.unep.org/20.500.11822/27646.

Van Der Mheen, M., Van Sebille, E., Pattiaratchi, C., 2020. Beaching patterns of plastic debris along the Indian Ocean rim. Ocean Sci. 16, 1317–1336.

van der Schyff, V., du Preez, M., Blom, K., Kylin, H., Yive, N.S.C.K., Merven, J., Raffin, J., Bouwman, H., 2020a. Impacts of a shallow shipwreck on a coral reef: a case study from St. Brandon's Atoll, Mauritius, Indian Ocean. Mar. Environ. Res. 156, 104916.

van der Schyff, V., Yive, N.S.C.K., Bouwman, H., 2020b. Metal concentrations in corals from South Africa and the Mascarene Basin: a first assessment for the Western Indian Ocean. Chemosphere 239, 124784.

van der Schyff, V., du Preez, M., Blom, K., Yive, N.S.C.K., Klánová, J., Přibylová, P., Audy, O., Martiník, J., Bouwman, H., 2021a. Chlorinated and brominated persistent compounds in hard coral, soft coral, and parrotfish from remote Mascarene islands. Chemosphere 267, 129316.

van der Schyff, V., Yive, N.S.C.K., Polder, A., Cole, N.C., Tatayah, V., Kylin, H., Bouwman, H., 2021b. Persistent organic pollutants in sea bird eggs from the Indian Ocean's Mascarene Basin. Sci. Total Environ. 771, 145348.

Vidyasakar, A., Neelavannan, K., Krishnakumar, S., Prabaharan, G., Priyanka, T.S.A., Magesh, N.S., Godson, P.S., Srinivasalu, S., 2018. Macrodebris and microplastic distribution in the beaches of Rameswaram Coral Island, Gulf of Mannar, Southeast coast of India: a first report. Mar. Pollut. Bull. 137, 610–616.

Wallace, C.C., Willis, B.L., 1994. Systematics of the coral genus *Acropora*: implications of new biological findings for species concepts. Annu. Rev. Ecol. Syst. 25, 237–262.

Weideman, E.A., Perold, V., Donnarumma, V., Suaria, G., Ryan, G., 2023. Proximity to coast and major rivers influence the density of floating microplastics and other litter in east African coastal waters. Mar. Pollut. Bull. 188, 114644.

Weinstein, J.E., Ertel, B.M., Gray, A.D., 2022. Accumulation and depuration of microplastic fibers, fragments, and tire particles in the eastern oyster, Crassostrea virginica: a toxicokinetic approach. Environ. Pollut. 308, 119681.

Wijanti, D.P., Indrayanti, E., Haryanti, D., Sibero, M.T., Widyarizia, M.E., Az Zahara, A. Q., Bachtiar, M., 2024. Characteristic and histological evidence of microplastic in scleractinian corals of Java Sea. The Egyptian Journal of Aquatic Research 50, 95–102.

Woodall, L.C., Robinson, L.F., Rogers, A.D., Narayanaswamy, B.E., Paterson, G.L., 2015. Deep-sea litter: a comparison of seamounts, banks and a ridge in the Atlantic and Indian Oceans reveals both environmental and anthropogenic factors impact accumulation and composition. Front. Mar. Sci. 2, 3.

Yen, L.P., Yong, C.L.X., Todd, P.A., 2024. The effect of coral colony morphology, coral surface condition, particle size, and seeding point on the trapping and deposition of microplastics. Sci. Total Environ. 921, 171077.

Update

Marine Pollution Bulletin

Volume 209, Issue PB, December 2024, Page

DOI: https://doi.org/10.1016/j.marpolbul.2024.117057

Marine Pollution Bulletin 209 (2024) 117057

Contents lists available at ScienceDirect

Marine Pollution Bulletin

journal homepage: www.elsevier.com/locate/marpolbul

Corrigendum

Corrigendum to "Microplastics in coral from three Mascarene Islands, Western Indian Ocean" [Mar. Pollut. Bull. 208 (2024) 116951]

Michelle Hamman[a], Veronica van der Schyff[a,b], Nee Sun Choong Kwet Yive[c], Lucian Iordachescu[d], Laura Simon-Sánchez[d], Hindrik Bouwman[a,*]

[a] Research Unit: Environmental Sciences and Management, North-West University, Potchefstroom, South Africa
[b] RECETOX, Faculty of Science, Masaryk University, Kotlarska 2, Brno, Czech Republic
[c] Department of Chemistry, University of Mauritius, Reduit, Mauritius
[d] Department of the Built Environment, Division of Civil and Environmental Engineering, Aalborg University, Aalborg, Denmark

The authors regret the inconvenience.

The name of the author Veronica van der Schyff has been corrected. The institute of said author was also updated to the correct format.

The authors would like to apologise for any inconvenience caused.

DOI of original article: https://doi.org/10.1016/j.marpolbul.2024.116951.

* Corresponding author.
E-mail address: henk.bouwman@nwu.ac.za (H. Bouwman).

https://doi.org/10.1016/j.marpolbul.2024.117057