Discover Oceans

Brief Report

Microplastic assessment of 33 marine finfish species from coastal communities on Tongatapu, Kingdom of Tonga

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Abstract
Pacific Island Countries and Territories are heavily reliant on fisheries for food security and livelihoods. However, marine pollution, including microplastic contamination, poses an increasing threat. Microplastics, plastic particles smaller than 5 mm, are widespread across marine ecosystems, raising concerns about their potential to negatively impact organisms that consume them and humans. This study provides the first dataset documenting microplastic ingestion across coastal fish species from three fishing communities on Tongatapu Island in the Kingdom of Tonga. A total of 139 fish from 33 species were sampled between November 2023 and March 2024. Microplastics were detected in 58 individuals, resulting in a frequency of occurrence of 42%, and an average load of 0.77 ± 0.10 MPs/individual. Fibers were found to be the most dominant form (71%), followed by fragments (21%) and films (8%). Polymer analysis revealed polypropylene and polyethylene as the most common materials. The results highlight species-specific differences in microplastic ingestion, suggesting varying exposure risks based on feeding behavior and habitat. This baseline dataset offers crucial insights into microplastic contamination in Tongan coastal ecosystems and establishes a foundation for future research. Continued monitoring is essential to assess the long-term impacts of microplastic pollution on marine biodiversity, food security, and human health, informing national and regional conservation strategies across the Pacific.

Keywords Fisheries · Microplastic · Pollution · Pacific Island Countries and Territories

1 Introduction

Pacific Island Countries and Territories (PICTs) rely heavily on fish and fisheries resources as a form of livelihood, with production contributing over 1.5 million tonnes annually [17]. Coastal finfish fisheries provide essential nutrition and economic support for local communities, underpinning both subsistence and commercial activities. However, these fisheries face multiple pressures such as increasing populations, urban drift, overfishing, and pollution which have contributed to declines in marine resources [10]. Among these pressures, pollution from plastics has emerged as a contaminant of increasing concern in coastal ecosystems [19].

Plastic pollution, particularly in the form of microplastics, is now widely recognized as pervasive in marine environments and potentially harmful to aquatic organisms [18, 42]. Microplastics are defined as plastic particles smaller than

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5 mm and can originate as primary microplastics from industrial or consumer products, or as secondary microplastics from the fragmentation of larger debris ([3, 5, 37]). Once in the marine environment, microplastics are readily dispersed by currents and can enter the food web through direct ingestion by primary consumers, with subsequent trophic transfer to higher-level predators ([8, 35, 38]). Ingested microplastics can cause physical harm, such as gut blockages and tissue damage, and chemical toxicity through the leaching of additives or adsorbed environmental pollutants [20, 23, 36]. The ability of microplastics to bioaccumulate [32] amplifies ecological risks and increases the potential for transfer across trophic levels, raising concerns not only for fish health but also for human consumers [2, 30].

Understanding microplastic distribution in fish is particularly important in PICTs, where fisheries are a key source of protein and economic stability [17]. Fish consumption in the PICTs far exceeds average global consumption [7], with coastal fisheries being key contributors. For example, in Tonga, recent household surveys revealed 77.9% of men and 74.1% of women considered reef fish to be very important for household consumption [43], with fishers employing a range of methods across different coastal habitats and catching a wide range of species (Tonga National Coastal Fisheries Management and Development Plan 2023–2026 p. 10–11). Quantifying microplastic ingestion in fish provides insights into pollution sources and pathways, as well as potential risks to ecosystem services and food security [25, 48]. Globally, 4.8–12.7 million tons of plastic waste are estimated to wash out into the oceans from land-based sources (based on 2010 estimates therefore likely underestimating the current situation), and in PICTs, limited waste management infrastructure increases the risk of plastics entering the marine environment [19, 26].

While some research on microplastics has been conducted in the Pacific Island region (for example in Fiji—[4, 13, 44, 47, 49], in the Solomon Islands and Vanuatu—[6], in French Polynesia—[15]), many PICTs remain largely underexplored or have considerable knowledge gaps. Existing research in the Kingdom of Tonga has focused on microplastics in surface water [29] and coastal sediments [28] and is constrained to the island Vava'u, over 200 km to the north of Tonga's capital Nuku'alofa on the main island of Tongatapu. No baseline data exist on microplastic contamination from other islands, including Tongatapu, nor on contamination in fish, limiting our ability to assess exposure and potential human health risks. Though formal household and commercial waste collection service coverage is high (93.2% and 80.0% respectively in Tonga, annual national marine plastic pollution has recently been estimated at 96.7 tons [39]. As with other PICTs, Tonga is highly vulnerable to environmental pollution, and therefore, establishing baseline data is important to assess if there are microplastics present in fish of the most populous island Tongatapu, and if so, to what extent.

Here, we present the first dataset on microplastic occurrence in coastal fish from three fishing communities on Tongatapu, quantifying the frequency of occurrence and microplastic loads across locally important species. Although we do not assess direct impacts on fish or human health, these findings establish a critical baseline for understanding contamination patterns in Tongan coastal ecosystems, guiding future investigations into potential trophic transfer and associated chemical contaminants. This baseline will inform long-term monitoring, ecological risk assessments, and mitigation strategies to protect marine biodiversity and sustain the livelihoods of communities that depend on these resources [45].

2 Methodology

Fish were sampled from three coastal communities, Ha'atafu, Kolonga, and Manuka, on the island of Tongatapu between November 2023 and March 2024 (Fig. 1), in collaboration with the Tongan Ministry of Fisheries. All fish were sourced directly from subsistence fishers, who used a range of artisanal methods, including free diving with spear/harpoon, hook and line, gill netting and trolling, within the reef system around Tongatapu. Fishing activities were not restricted to specific locations, and fishers often accessed multiple fishing grounds (within Tongatapu's reef system) within a single trip. A total of 139 fish from 33 species were sampled, with 39 individuals from Ha'atafu, 50 from Kolonga, and 50 from Manuka (Table 1). Upon landing, the gastrointestinal tracts (GITs) of the fish were carefully extracted, labelled, and preserved at − 20 °C at The University of the South Pacific Tonga Campus. Data on species identification, local names, and morphometric measurements (total length, fork length, and total weight) were recorded and are summarized in Table 1. The complete dataset is publicly accessible through the Global Biodiversity Information Facility (GBIF; [12]).

The preserved GITs were subsequently transported frozen to The University of the South Pacific in Suva (Fiji) for microplastic analysis. Microplastic extraction and identification protocols were adapted from established methodologies [14, 46, 49]. Each GIT was placed in a glass beaker and digested using previously filtered (63 µm) 30% hydrogen peroxide (H_2O_2), with a volume approximately three times that of the gut sample. The samples were incubated at 60 °C for approximately 12 h or until complete tissue digestion was achieved. The resulting digestate was filtered through a series

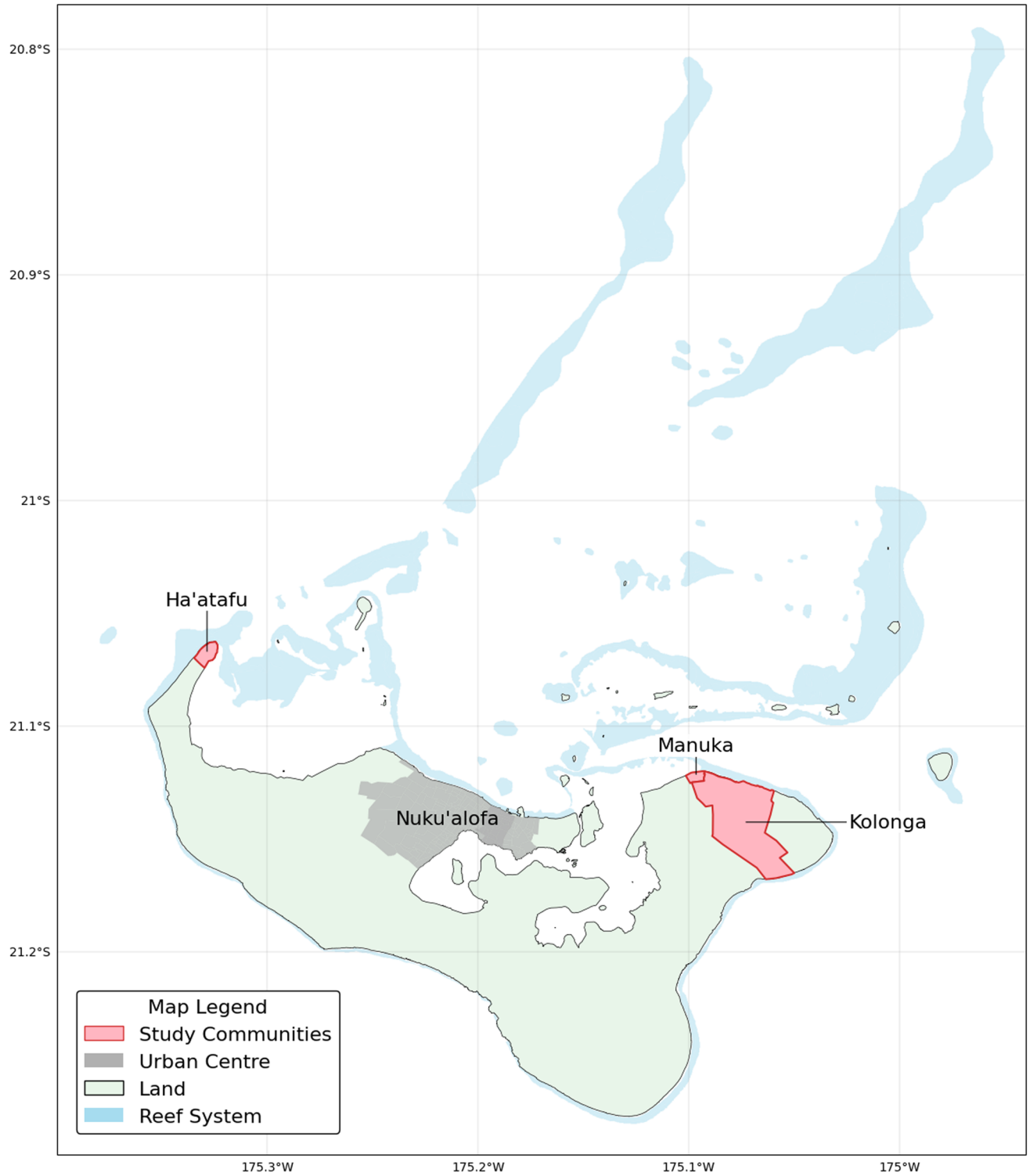

Fig. 1 Sampling locations within Tongatapu, Tonga. Communities and land area shapefiles were obtained from https://data.humdata.org/dataset/cod-ab-ton, while reef system data was obtained from https://tonga-data.sprep.org/resource/tonga-coral-reefs-shape-file-format

of stainless-steel sieves with mesh sizes of 1 mm, 250 µm, and 125 µm. Residues retained on the sieves were carefully examined in situ under a stereo microscope (Prism Optical, Banksia Scientific) to identify and categorize microplastics based on their form (fiber, fragment, film) and size class (125–250 µm, 250 µm–1 mm, > 1 mm). Polymer composition of a subset of visually identified microplastic particles was validated using Spectrum Two™ ourier Transform Infrared

Table 1 Summary of fish species sampled from fishing communities in Tongatapu, Tonga, including morphometric measurements (average ± standard deviation [SD]) for total length, fork length, and total weight. NA indicates data not available for certain measurements

Species name	Local name	Common name	Communities caught	Total no. specimens	Total length (Average ± SD)	Fork length (Average ± SD)	Total weight (Average ± SD)
Acanthurus dussumieri	Palangi	Eyestripe Surgeonfish	Kolonga	1	32.40 ± NA	29.30 ± NA	588.10 ± NA
Acanthurus mata	Palangi	Black Surgeon	Kolonga	1	30.80 ± NA	25.30 ± NA	364.60 ± NA
Aprion virescens	‘Utu	Green Jobfish	Kolonga	1	32.90 ± NA	27.40 ± NA	391.80 ± NA
Calotomus carolinus	Hohomo	Carolines Parrotfish	Manuka	1	24.60 ± NA	NA ± NA	273.90 ± NA
Caranx melampygus	Lupo	Bluefin Trevally	Kolonga	2	33.75 ± 0.49	29.50 ± 0.42	456.70 ± 58.10
Cheilinus trilobatus	Lalafi	Tripletail Wrasse	Kolonga, Manuka	3	27.26 ± 1.36	26.00 ± 1.57	313.70 ± 22.70
Conger cinereus	Tuna	Conger Eel	Kolonga	1	109.40 ± NA	NA ± NA	2375.00 ± NA
Crenimugil crenilabis	Kanahe	Fringelip Mullet	Kolonga	1	38.40 ± NA	35.00 ± NA	630.70 ± NA
Ellochelon vaigiensis	Kafakafa	Squaretail Mullet	Kolonga	3	33.30 ± 5.21	32.60 ± 4.94	539.40 ± 273.00
Epinephelus areolatus	Ngatala	Areolate Grouper	Manuka	1	26.10 ± NA	NA ± NA	271.00 ± NA
Epinephelus cyanopodus	Ngatala	Speckled Grouper	Kolonga	1	35.40 ± NA	35.10 ± NA	789.60 ± NA
Epinephelus maculatus	Ngatala	Highfin Grouper	Ha’atafu, Manuka	3	28.86 ± 5.86	31.00 ± 0.14	379.00 ± 159.00
Hipposcarus longiceps	Hohomo	Pacific Longnose Parrotfish	Ha’atafu, Manuka	5	29.50 ± 4.13	27.82 ± 4.58	442.70 ± 195.00
Lethrinus erythracanthus	Hoputu	Yellowfin Emperor	Ha’atafu	5	25.80 ± 0.52	23.38 ± 0.62	270.90 ± 25.50
Lethrinus harak	Tanutanu	Thumbprint Emperor	Ha’atafu, Kolonga, Manuka	38	29.02 ± 3.41	26.34 ± 3.20	396.90 ± 137.00
Lethrinus miniatus	Manga	Red Throat Emperor	Ha’atafu	3	31.23 ± 5.53	28.20 ± 5.04	426.30 ± 147.00
Lethrinus nebulosus	Koango	Spangled Emperor	Ha’atafu, Kolonga	13	28.55 ± 3.11	25.69 ± 2.52	353.10 ± 114.00
Lutjanus fulvus	Fate	Blacktail Snapper	Ha’atafu	1	24.50 ± NA	23.20 ± NA	227.60 ± NA
Lutjanus gibbus	Koango kula	Humpback Red Snapper	Ha’atafu	3	25.50 ± 0.91	22.96 ± 1.20	232.20 ± 29.80
Naso brevirostris	‘Ume tui	Short-Horned Unicorn Tang	Manuka	1	24.50 ± NA	23.70 ± NA	296.70 ± NA
Naso unicornis	‘Ume	Bluespine Unicorn Fish	Manuka	1	25.50 ± NA	25.00 ± NA	337.20 ± NA
Oxycheilinus digramma	Meai	Cheek-Lined Wrasse	Ha’atafu	1	24.50 ± NA	24.40 ± NA	225.60 ± NA
Parupeneus barberinus	Tukuleia	Dash & Dot Goatfish	Kolonga, Manuka	9	29.07 ± 3.19	25.32 ± 2.62	307.10 ± 91.40
Parupeneus heptacanthus	Tukuleia	Cinnabar Goatfish	Kolonga	8	30.10 ± 1.32	26.52 ± 1.18	316.10 ± 41.90
Parupeneus indicus	Tukuleia	Indian Goatfish	Kolonga	3	27.40 ± 1.55	25.40 ± 1.70	291.70 ± 37.30
Priacanthus hamrur	Mataheheva	Red Bigeye Snapper	Manuka	1	30.70 ± NA	29.90 ± NA	345.70 ± NA
Sargocentron spiniferum	Ta’a	Sabre Squirrelfish	Kolonga, Manuka	3	25.90 ± 1.60	23.03 ± 1.95	299.90 ± 71.90
Scarus dimidiatus	Hohomo	Yellowbarred Parrotfish	Ha’atafu, Manuka	5	28.68 ± 3.21	27.92 ± 2.76	432.60 ± 140.00
Scarus prasiognathos	Hohomo	Greenthroat Parrotfish	Ha’atafu	1	24.30 ± NA	NA ± NA	280.30 ± NA
Scarus rivulatus	Hohomo	Rivulated Parrotfish	Ha’atafu	8	32.25 ± 4.17	30.76 ± 3.43	562.00 ± 184.00
Selar crumenophthalmus	Sipesipa	Bigeye Scad	Kolonga	3	39.86 ± 2.05	34.73 ± 1.52	708.00 ± 67.70
Siganus lineatus	Ma’ava	Golden Lined Spinefoot	Kolonga, Manuka	7	23.67 ± 1.16	22.81 ± 1.26	231.70 ± 32.40
Siganus punctatus	Pongongo	Spotted Rabbitfish	Kolonga	1	25.10 ± NA	21.60 ± NA	246.70 ± NA

Spectroscopy (FT-IR, Perkin Elmer) and associated software (Spectrum 10 ES™, Perkin Elmer) following the protocol of Jung et al. [21]. This subsampling was necessary due to limitations associated with particle recovery and transfer between sieves and the ATR-FTIR, as well as size constraints that prevented smaller particles from being reliably analyzed. While this represents a portion of the total, the selected subset was chosen to encompass the diversity of particle types observed, minimizing potential bias in polymer type representation. To validate polymers, spectra were compared against reference polymer bands outlined in Jung et al. [21], whereby a minimum of four characteristic peaks were required for polymer identification.

To minimize contamination, all procedures were conducted in a controlled laboratory environment, and samples were carried out in batches (four batches of 30 samples, one batch of 19 samples). Equipment was thoroughly rinsed with distilled water (filtered through a 63 µm sieve before use). The samples, beakers, and solutions were covered with aluminum foil during digestion and extraction to prevent airborne contamination. Additionally, three blank controls were included in each batch of samples, totaling 15 controls throughout the study. No plastic-like particles were detected in the control samples, confirming that contamination was negligible.

Frequency of occurrence (i.e., the percentage of fish containing one or more microplastic particles) is reported in percentage (%) while microplastic load (MPs/individual) is reported as mean ± standard error (SE) to account for unequal sample sizes across species. The variation in counts reflects both the patchy natural distribution of microplastics in marine environments and the limited sample sizes for some species. Differences in microplastic counts across form types and size classes were evaluated using the non-parametric Kruskal–Wallis test, given the limited and non-normally distributed sample sizes.

3 Results and Discussion

Of the 139 fish sampled (Table 1) across the three localities, microplastic were detected in 58 individuals, resulting in a frequency of occurrence of 42% and an average load of 0.77 ± 0.10 MPs/individual. A total of 107 microplastic particles were identified across the samples (Fig. 2), comprising three form types: fibers were significantly (Kruskal–Wallis $H = 12.578$, $p = 0.0019$) the most prevalent, accounting for 71% ($n = 76$) of the total microplastics, followed by fragments at 21% ($n = 22$), and films at 8% ($n = 9$). In terms of size distribution, microplastics in the 250 µm–1 mm range were the most abundant, representing 37% ($n = 40$) of the total particles. This was closely followed by microplastic in the 125–250 µm range, which constituted 30% ($n = 32$), and those larger than 1 mm, which made up 33% ($n = 35$) of the total. However, no significant differences were detected among size classes (Kruskal–Wallis $H = 1.436$, $p = 0.488$), suggesting a relatively even distribution of microplastic particles across sizes.

Microplastic occurrence varied significantly among species (Table 2), ranging from 0% in several species to 100% in others, such as *Crenimugil crenilabis*, *Epinephelus areolatus*, and *Siganus punctatus*. The highest microplastic count within a single individual was 7 particles, found in *Selar crumenophthalmus*. In species where microplastics were detected,

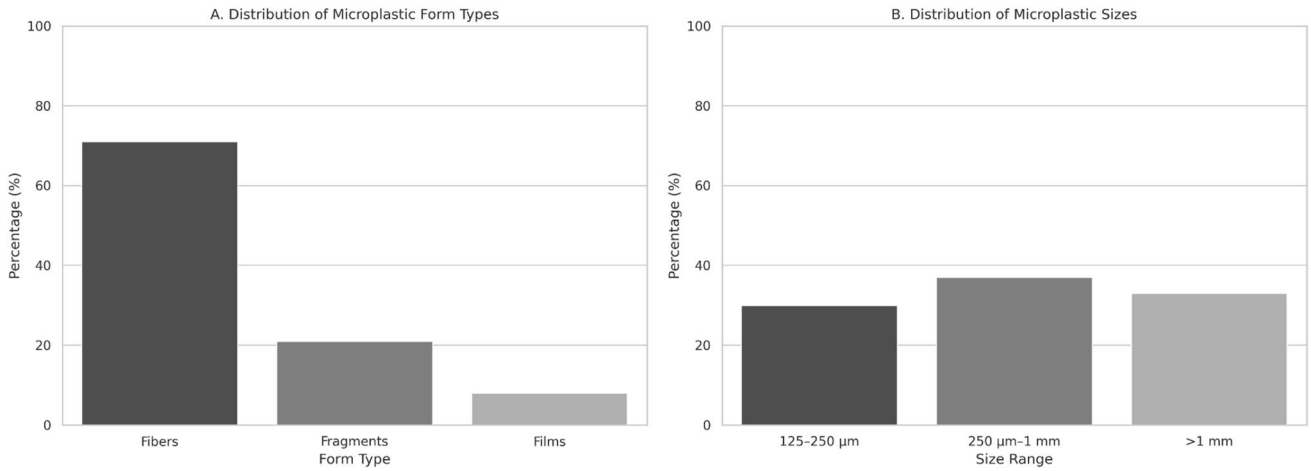

Fig. 2 Distribution of (**A**) microplastic form types and (**B**) size classes from across the 107 microplastics identified in fish guts from sites around Tongatapu, Tonga

species-specific microplastic loads ranged from 0.12 ± 0.13 MPs/individual in *Parupeneus heptacanthus* to 5.33 ± 0.88 MPs/individual in *Selar crumenophthalmus*. Fibers dominated the microplastic composition in most species, representing 100% of microplastics in *Cheilinus trilobatus, Ellochelon vaigiensis,* and *Parupeneus heptacanthus.* Films, though less common overall, were notably abundant in *Scarus dimidiatus* (33%), and the only microplastic present in *Caranx melampygus* (100%), while fragments were the only microplastic present in *Epinephelus cyanopodus*, *Lethrinus erythracanthus,* and *Hipposcarus longiceps* (i.e. 100%) (Table 2).

A subset of 35 microplastic particles, representing approximately 33% of the total microplastics identified, were analyzed for polymer composition. Eight distinct polymer types were identified, with polypropylene (PP) being the most prevalent, accounting for 34.29% of the analyzed particles (see Table 3 for a breakdown of polymer counts by form type). This was followed by polyethylene (PE) at 22.86%, polyethylene terephthalate (PET) at 17.14%, and nylon at 11.43%. Less common polymers included polyurethane (PU) at 5.71%, and ethylene–vinyl acetate (EVA), polystyrene (PS), and polyvinyl chloride (PVC), each representing 2.86% of the subset.

This study provides the first dataset documenting the occurrence and characteristics of microplastics in fish species important to local communities on Tongatapu Island, Tonga. Previous research in Tonga has only focused on microplastic contamination in surface waters and sediments, reporting microplastic presence in surface waters (1.05 ± 0.13 MP/m^3; [29]) and sediments (23.5 ± 1.9 MP/L intertidal sediment and 15.0 ± 1.9 MP/L in subtidal sediment [28],) in Vava'u. Of the 139 fish sampled across three fishing communities, the frequency of microplastic occurrence was 42%, confirming the presence of microplastics in fish that have subsistence and commercial importance, and providing critical baseline data for Tonga's marine ecosystems. It is important to emphasize that this study serves as one component within a larger research program and is not a comprehensive assessment of microplastic impacts on fish health or human health risks. Subsequent analyses aim to investigate exposure risks in greater detail, including the potential for trophic transfer of microplastics. Nevertheless, by quantifying microplastic ingestion across multiple ecologically and economically significant fish species (n = 1–38 individuals per species), this study makes available a critical dataset offering an insight into the extent of microplastic contamination in Tonga's coastal ecosystems.

The present study's findings of microplastics in fish (42%; 0.77 ± 0.10 MPs/individual) is comparable to similar efforts in other PICTs, including French Polynesia (21%; 1.25 MPs/individual; [15]), Vanuatu (38%, 2.9 ± 4.6 MPs/individual; [6]), and four coastal fish species in Fiji (35%, 0.86 ± 0.14 MPs/individual; [49]). In contrast, these values are lower than other records from Fiji, such as 74% (2.17 ± 0.16 MPs/individual [11]), 100% (4.7 ± 0.9 MPs/individual/wet season, 3.3 ± 1.3 MPs/individual/dry season; [46]), and 67% (5.5 ± 9.4 MPs/individual [13]), and slightly below the global average (49%; 3.5 MPs/individual; [50]). Taken together, microplastic ingestion in Tonga appears to be on the lower end, aligning more closely with French Polynesia and Vanuatu, while Fiji generally reports higher ingestion rates. This difference likely reflects Fiji's larger population and greater industrial activity, which may contribute to increased plastic waste inputs [16, 31], though further regional analyses are needed before drawing broader conclusions.

In terms of MP form type, fibers were the most dominant across most species, while fragments and films were significant in particular species (e.g., fragments in *Lethrinus erythracanthus* and *Scarus rivulatus*; films in *Caranx melampygus*). These findings are consistent with previous studies on fish from the region [11, 13, 46, 49], and from the previous studies of sediments in Tonga [28] which consistently depict fibers being the most dominant form type, often contributing the majority (> 50%) of all particles found. No microplastic pellets or nurdles were detected in any of the fish examined. This absence aligns with findings from other marine environments within the region (e.g. [6, 11, 47]), and beyond (e.g., [1, 24, 41]) where pellets represent a small proportion (if at all) of ingested microplastics compared to fibers, fragments and films. The lack of pellets in our samples may suggest that local microplastic inputs are more strongly associated with land-based textile and packaging sources than with industrial resin pellet spillage [27, 34]. Polymer composition in our fish (predominantly polypropylene and polyethylene, with smaller proportions of PET, nylon, and EVA overlapped with those reported in surface waters (PES, PP, PE [29],) and sediments [28], although the higher occurrence of nylon in fish may indicate additional fishing gear–related sources. Our size distribution (37% in 250 µm–1 mm, 33% > 1 mm, 30% in 125–250 µm) differed from surface waters, where particles < 300 µm dominated (40% [29],), and from intertidal sediments, where most particles were > 1 mm [28], suggesting that fish ingestion may preferentially reflect intermediate particle sizes available in their feeding environment. The even distribution across size classes in these samples reflects the observations made by Drova et al. [11] and Varea et al. [46], but differs from Garnier et al. [15], where 70% of ingested particles were < 300 µm. The observed patterns in form type and size distribution in our study, relative to other studies in the region, may reflect variation in local plastic sources, environmental transport and degradation processes, or feeding habits of the sampled species.

Table 2 Frequency of microplastic occurrence, average microplastic counts (± standard error [SE]), and microplastic characteristics across fish species

Species name	Number of individuals with MP	Frequency of MP occurrence (%)	Average MP count (Average ± SE)	Total MP count	Min – Max MP count	Microplastic form type			Microplastic size class		
						Fibers (%) [n]	Films (%) [n]	Fragments (%) [n]	> 1 mm (%) [n]	250 µm–1 mm (%) [n]	125–250 µm (%) [n]
Acanthurus dussumieri	0	0.00		0							
Acanthurus mata	0	0.00		0							
Aprion virescens	0	0.00		0							
Calotomus carolinus	0	0.00		0							
Caranx melampygus	1	50.00	0.50 ± 0.50	1	0–1		100.00 [1]		100.00 [1]		
Cheilinus trilobatus	1	33.33	0.67 ± 0.66	2	0–2	100.00 [2]				100.00 [2]	
Conger cinereus	0	0.00		0							
Crenimugil crenilabis	1	100.00	2.00 ± NA	2	2–2	100.00 [2]					100.00 [2]
Ellochelon vaigiensis	1	33.33	0.33 ± 0.33	1	0–1	100.00 [1]					100.00 [1]
Epinephelus areolatus	1	100.00	1.00 ± NA	1	1–1	100.00 [1]				100.00 [1]	
Epinephelus cyanopodus	1	100.00	1.00 ± NA	1	1–1			100.00 [1]			100.00 [1]
Epinephelus maculatus	0	0.00		0							
Hipposcarus longiceps	1	20.00	0.20 ± 0.20	1	0–1			100.00 [1]		100.00 [1]	
Lethrinus erythracanthus	2	40.00	0.40 ± 0.24	2	0–1			100.00 [2]	50.00 [1]		50.00 [1]
Lethrinus harak	22	57.89	1.16 ± 0.20	44	0–4	75.00 [33]	6.82 [3]	18.18 [8]	38.64 [17]	52.27 [23]	9.09 [4]
Lethrinus miniatus	0	0.00		0							
Lethrinus nebulosus	5	38.46	0.69 ± 1.32	9	0–4	77.78 [7]		22.22 [2]	44.44 [4]	33.33 [3]	22.22 [2]
Lutjanus fulvus	0	0.00		0							
Lutjanus gibbus	0	0.00		0							
Naso brevirostris	1	100.00	1.00 ± NA	1	1–1	100.00 [1]					100.00 [1]
Naso unicornis	0	0.00		0							

Table 2 (continued)

Species name	Number of individuals with MP	Frequency of MP occurrence (%)	Average MP count (Average ± SE)	Total MP count	Min – Max MP count	Microplastic form type			Microplastic size class		
						Fibers (%) [n]	Films (%) [n]	Fragments (%) [n]	> 1 mm (%) [n]	250 µm–1 mm (%) [n]	125–250 µm (%) [n]
Oxycheilinus digramma	0	0.00		0							
Parupeneus barberinus	6	66.67	1.11 ± 0.35	10	0–3	70.00 [7]	10.00 [1]	20.00 [2]	50.00 [5]	10.00 [1]	40.00 [4]
Parupeneus heptacanthus	1	12.50	0.13 ± 0.13	1	0–1	100.00 [1]					100.00 [1]
Parupeneus indicus	0	0.00		0							
Priacanthus hamrur	0	0.00		0							
Sargocentron spiniferum	0	0.00		0							
Scarus dimidiatus	3	60.00	0.60 ± 0.24	3	0–1	66.67 [2]	33.33 [1]			66.67 [2]	33.33 [1]
Scarus prasiognathos	0	0.00		0							
Scarus rivulatus	4	50.00	0.75 ± 0.31	6	0–2	66.67 [4]		33.33 [2]		50.00 [3]	50.00 [3]
Selar crumenophthalmus	3	100.00	5.33 ± 0.88	16	4–7	62.50 [10]	18.75 [3]	18.75 [3]	43.75 [7]	25.00 [4]	31.25 [5]
Siganus lineatus	3	42.86	0.71 ± 0.36	5	0–2	80.00 [4]		20.00 [1]			100.00 [5]
Siganus punctatus	1	100.00	1 ± NA	1	1–1	100.00 [1]					100.00 [1]

Table 3 Polymer composition of a subset of 35 microplastic particles, categorized by form type (fibers, fragments, and films). Polymers include ethylene–vinyl acetate (EVA), nylon, polyethylene (PE), polyethylene terephthalate (PET), polypropylene (PP), polystyrene (PS), polyurethane (PU), and polyvinyl chloride (PVC)

Form type	PE	PP	PET	Nylon	EVA	PS	PU	PVC
Fiber	6	10	3	4	1	0	0	0
Film	0	1	0	0	0	0	2	0
Fragment	2	1	3	0	0	1	0	1
Total count (n)	8	12	6	4	1	1	2	1
Percent (%)	22.86	34.29	17.14	11.43	2.86	2.86	5.71	2.86

Microplastic ingestion likely varies among species due to differences in feeding behavior, habitat preference, and trophic level [33, 35]. For instance, *Selar crumenophthalmus*, which exhibited the highest microplastic load, is a pelagic planktivore that actively filters water and feeds on small organisms near the water column, increasing its exposure to buoyant fibers that accumulate at the surface or in mid-water [9, 22]. In contrast, benthic or herbivorous species, such as *Parupeneus heptacanthus* or *Scarus* spp., may encounter fewer floating microplastics, with their ingestion rates reflecting local sedimentation patterns or particle settling. The distribution of microplastics in the marine environment is influenced by particle density, water circulation, and hydrodynamic conditions, which can create hotspots of accumulation or dispersal [40]. Consequently, species feeding in areas with higher concentrations of suspended or floating microplastics are more likely to ingest greater quantities, highlighting how ecological traits interact with environmental microplastic availability to shape observed ingestion patterns [9, 33].

In conclusion, this study provides an essential broad baseline for understanding microplastic contamination in Tonga's coastal fisheries, representing one of the first datasets to quantify ingestion across multiple locally important fish species. While this research offers valuable insights, it is limited by factors such as low sample sizes for some species (requiring cautious interpretation of species with limited samples), the inability to capture all size classes of microplastics, and the focus on three communities on a single island which may not fully represent national-scale patterns. Despite these limitations, the observed patterns also highlight gaps in knowledge regarding regional variability, sources of microplastics, and species-specific exposure pathways. Future studies should expand spatial coverage, replication within species, include repeated temporal sampling, and investigate trophic transfer and ecological consequences of microplastic exposure. Regular monitoring, combined with community, national and regional level mitigation strategies, will be critical to track trends, protect marine biodiversity, and safeguard the livelihoods of communities dependent on coastal fisheries.

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Author contributions R.V., A.F., and J.D. conceptualized the study and developed the methodology. S.F., E.D., S.A., and V.F. conducted the field investigations, while J.B. and P.K. conducted the lab investigations. P.K. contributed resources. K.B. contributed to data curation. The original draft was written collaboratively by C.M., E.D., S.F., K.B., A.F. and J.D. A.F. acquired funding and led project administration. J.D. conducted the formal analysis. V.M. and all other authors reviewed and approved the final manuscript.

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Data availability All data from this study is available on the Global Biodiversity Information Facility on link: [https://www.gbif.org/dataset/dca8afbe-c961-429c-a6ab-f1bfca46cf84].

Declarations

Ethics approval and consent to participate Not applicable.

Consent for publication Not applicable.

Competing interests The authors declare no competing interests.

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