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Microplastic abundance in three commercial fish from the coast of Lima, Peru.

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PRELIMINARY OBSERVATIONS OF PLASTIC DEBRIS IN THE GASTROINTESTINAL TRACT OF SEA URCHIN TETRAPYGUS NIGER

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Abstract

Plastic pollution is regarded as one of the major issues from the Anthropocene epoch. Microplastics (<5 mm) are the result of the excessive plastic production and littering, thus becoming widespread in the environment. In this study, the presence and characteristics of microplastics extracted from the gastrointestinal tract of sea urchin *Tetrapygus niger* was reported. An average abundance of 3.22 ± 0.49 microplastics per individual was found, ranging from 1 to 5. Fibers were the dominant type (75.9%), followed by fragments (24.1%). Regarding color, most of the particles found were blue > red > black > green. These results are in lower magnitude levels than those reported in others species from the same region. However, microplastics could transfer from sea urchins to predators in higher trophic levels, like marine mammals. Prospects for further research was discussed.

Introduction

Microplastics (MPs) are plastic particles smaller than 5 mm in diameter (1,2). These particle have been evidenced around the world, reaching marine (3), terrestrial (4), freshwater environments (5) and even remote areas (6). Thus, MP pollution has been regarded as ubiquitous and widespread globally. MPs are classified as primary or secondary. While primary MPs are manufactured micro-sized (e.g., face scrubs and production pellets), secondary MPs derive from the break down of larger plastics under certain environmental conditions (1).

Marine species from any trophic level may be subject to MP ingestion due to its small size (7). Upon ingestion, MPs could potentially biomagnify along the food web and reach apex predators (8). MP uptake threatens marine biota due to the adhered contaminants and leaching additives under weathering conditions (9) by causing ecotoxicological effects at a biomarker level (10). Filter feeding organisms are expected to perceive a higher exposure. However, research shows

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that marine grazers, like gastropods, could retain MPs ingested from contaminated seaweed (11,12).

Sea urchins feed by rasping on top of their feeding substrate with calcitic teeth, leaving scratches while grazing for endolithic photosynthetic organisms (13). In the sea urchin *Paracentrotus lividus*, this behavior have shown to cause a bioerosion of larger plastics into MPs (14). Since marine litter in mainly composed of plastic items (15), benthic marine grazes with specific feeding ecology could play role in the release of secondary MPs to the environment. In spite of this, information regarding the presence of MPs in sea urchins from the environment is limited compared to other benthic macroinvertebrates (e.g., bivalves).

In Peru, some studies have studied the presence of MPs in marine environments (3,16,17), and two assessing invertebrates (18,19). Here, the abundance and characteristics of MPs extracted from the gastrointestinal tract of sea urchin *Tetrapygus niger* were reported.

Materials and Methods

Study area and sample collection

In February of 2020, *T. niger* samples (n = 9) were collected from a recreational sandy beach (12°58'56.7"S 76°30'14.1"W) located in Cañete Province, Lima Region, Peru. The specimens were carefully detached from intertidal rocks during low tide. Then, samples were stored and transported to the laboratory in precleaned sealed glass containers with ice. In the laboratory, the sea urchins were stored at -20 °C until further analysis.

Microplastic extraction and identification

The specimens were thawed prior analysis. The MP extraction procedure from the soft tissues was described elsewhere (17) (Fig. 1). In brief, a clean cut was made along the circumference of the sea urchin using clean sharp scissors and the gastrointestinal tract was extracted by cutting from the esophagus (not including the Aristotle's lantern) to the rectum. The tissues were weighted and placed in a screw cab test tube filled with 10% (w/v) KOH for tissue digestion. The tubes were then shaken manually and incubated at 60°C overnight. The whole digestate was vacuum filtrated through a Whatman 41 filter paper. The filters were placed in closed petri dishes. Filters were scanned using a stereomicroscope. MPs larger than 100 µm were identified based on their morphology and characteristics and classified into fibers, fragments, films and microbeads. The color of the MPs was also recorded.

Since identifying the polymer type of the MPs is generally a mandatory procedure (20,21), the results from this study are regarded as preliminary. Herein, MPs are referred to "suspected microplastics".

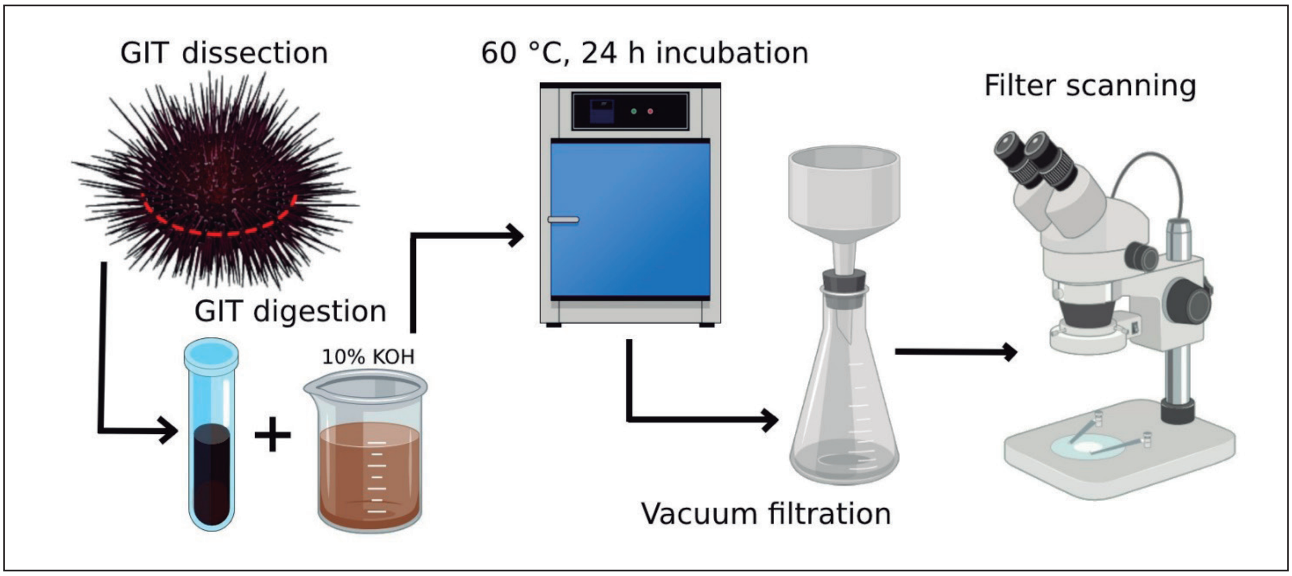

Fig. 1. Procedural steps for MP extraction and identification from the gastrointestinal tract of sea urchins.

Quality control

Quality control measures followed the ones described as mandatory by Dioses-Salinas *et al.* (4). In general terms, lab coats and polymer free gloves were worn at all times. Plastic materials were avoided and metal and glass wear were preferred. All the surfaces were wiped clean with distilled water, samples and reagents were covered when not in use. Liquids were prefiltered using the glass filtration apparatus' sand core plate.

An airborne blank was conducted by placing a wet filter on the work surface for as long as the batch treatment lasted. Also, a 10% KOH blank was prepared by filtering the same amount of reagent used in the samples. Upon inspection, no fibres or suspicious particles were found in the blanks. Thus, quality control measured deemed sufficient.

Results

MP particles were observed in all of the sea urchins. A total of 29 MPs were observed. Mean MP concentration was 3.22 ± 0.49 MP per individual (MP/ind. ± SEM) and 0.07 ± 0.01 MP per gram of wet weight (MP/g ± SEM). Individual occurrence ranged from 1 to 5 MPs per individual. Regarding morphology, films and microbeads were not found. The majority of the MPs were fibres (75.9%), followed by fragments (24.1%). Blue colored particles were the most abundant, followed by red, black and green (Fig. 2).

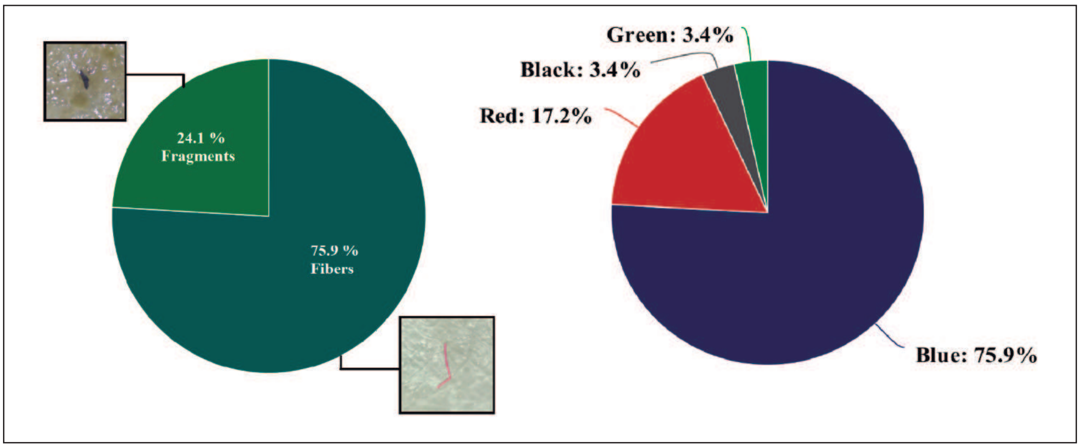

Fig. 2. Charts showing the percentage of MP morphotypes and color.

Discussions

A general low prevalence of MPs is reported in *T. niger* when compared to fish and bivalves from the Lima Region reported in previous research (17,19). MP intake by sea urchins are likely to be directly influenced by their foraging activity. Studies with periwinkles demonstrated macrophytes to be a viable vector for MPs (11,12). However, the likeliness of MPs to attach to biofilm surfaces in intertidal rocks used as foraging grounds for benthic invertebrates are unknown.

The dominance of fiber particles in marine species is commonly reported in literature (17,19,22,23). Importantly, Perez-Venegas (24) evidenced Otariids from the Peruvian and Chilean coast to have ingested mainly fibers. This indicates that MPs may pass from prey to predator, scaling to higher trophic levels. Although the information regarding the presence of MPs in superficial waters is lacking in Peru, publications on marine sediment reported little to no fibres in their samples (3,16). This may be due to the smallest particles being overlooked, as these studies aimed for the "larger" MPs ranging from 1 to 5 mm.

Various ecotoxicological studies have demonstrated that MPs can cause ill effects on sea urchins at early stages of development (25–28). For instance, in *Lytechinus variegatus*, production pellets cause anomalous development of embryos (27), while polystyrene and polymethyl methacrylate microplastics induced a decrease in fertilization success in *Sphaerechinus granularis* and caused transmissible damage (28). Indeed, the bioavailability of MPs may pose a threat to the development and survival of sea urchin populations.

Here, a preliminary assessment was carried out reporting the presence of MPs in sea urchins from the coast of a sandy beach in Peru. This is the first known study to evidence such particles in echinoderms from this region. A general low prevalence was observed, although the MP morphologies are similar to those reported in literature. Further studies must focus on tracking the sources of MPs in the Peruvian coastline, intake mechanics based on feeding ecology and MP assessment at various trophic levels.

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