Microplastics in Commercially Exploited Fish from Grenada, W.I.

La Occurrencia de Micro-plásticos en el Tracto Intestinal de Pescados Explotados Comercialmente en Grenada

Presence de Micro-plastique dans Système Digestif des Poissons Pêchés Commercialement a la Grenade, Caraibes

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ABSTRACT

Microplastics are small (generally less than 5 mm diameter) particles produced for industrial purposes or formed by breakdown of anthropogenic debris. These particles have become prevalent in many of the world's oceans and the occurrence of microplastic in the intestinal tracts of marine fish is a concern to human and ocean health due to pollutants and pathogens associated with plastics. Studies have shown that the incidence of microplastics in marine fish varies with species and location, though causes of variation are not well understood.

Data on incidence of microplastics in commercially exploited fish in the eastern Caribbean Sea has not previously been reported. Many eastern Caribbean islands have high coastal population densities, variable waste management strategies and the region is vulnerable to natural disasters including hurricanes and flooding.

Prevalence of microplastics in six fish species harvested for human consumption in this region were studied. Intestinal tracts of pelagic, semi-pelagic and demersal fish obtained from Grenadian fishermen were examined. Harvested tissue was digested in 10% KOH, passed through a 180 µm sieve and retained particles were observed at 20X magnification to identify type, color and size. 97.1% of fish observed contained microplastics regardless of life histories. Our findings underscore the importance of future studies to identify contaminant levels in commercially exploited fish in the eastern Caribbean. This will contribute to understanding of the health risks and aid the design of risk reduction strategies for plastic contamination.

KEYWORDS: Microplastics, marine fish, pollutants, pathogens, Grenada

INTRODUCTION

Microplastics are defined by the United Nations Environment Programme (UNEP) and the United States National Oceanic and Atmospheric Administration (NOAA) as pieces of plastic polymers that are less than 5mm in diameter or length. Primary microplastics are manufactured to carry out a range of functions while secondary microplastics come from lost, abandoned or discarded equipment that has broken down in the environment (GESAMP 2015). The density of different types of polymers relative to water varies and while most polymers would be expected to sink due to greater density than water, buoyancy is affected by many other factors such as entrapped air. Consequently, microplastic is found floating and on the sea floor.

Plastics have both direct and indirect impacts on sea life. Direct impacts are damage to and accumulation in the digestive system, leading to malnutrition (Wright et al. 2013), oxidative stress, inflammation and fibrosis (GESAMP 2015). Indirect impacts include deleterious effects of exposure to chemical additives in the plastics, compounds adsorbed from the environment, most commonly petroleum hydrocarbons (GESAMP 2015), and microorganisms that colonize rafts of floating plastics (Zettler et al. 2013).

While the deleterious effects of contaminants associated with plastic are well documented, the impact of microplastics in the marine environment on humans has yet to be determined. The release of plastic into the environment is a relatively new phenomenon of the last 50 years; the detection of microplastics in wildlife is even more recent. Data is being accumulated on concentrations of microplastics in the food chain from zooplankton to fish, along with incidence of chemical contaminants in both the microplastics and tissue harvested from organisms (Bouwmeester et al. 2015), but there is still much research needed to understand potential hazards to humans.

The geographical coverage of plastic in the marine environment has been well documented in most of the northern hemisphere with the exception of the Caribbean Sea, though modeling based on proxy indicators of probable sources predicts significant levels of microplastics should be found there (Eriksen, et al. 2014). Small island developing states import large quantities of consumer goods and the accompanying packaging, but the lack of resources to adequately dispose of waste and poor waste disposal practices results in significant amounts of plastic entering the ecosystem. The Caribbean also bears a disproportionate burden of waste from the cruise ship industry (UNEP 2016). The problem is compounded by waste being swept into the sea by hurricanes, heavy rainfall and flooding.

Here we report the incidence of microplastics in fish harvested for human consumption in the Eastern Caribbean identified through examination of the intestinal tracts of fish purchased from Grenadian fishermen.

METHODS

This study focused on six fish species with three different life histories - demersal, semi-pelagic and pelagic (Table 1). Research was focused on a variety of species of commercially exploited fish available in Grenada. Fish were acquired from local fishermen, purchased from the local fish market or caught by spearfishing. Fish were weighed (total weight) and the fork length measured. Digestive tracts were removed, and intestines and stomachs were weighed. A liver sample was taken from each fish, and frozen for future analysis of potential contaminants.

Following the protocol of Foekema et al. (2013), samples were placed in a 10% potassium hydroxide (KOH) solution and placed in a water bath at 60°C for a number of days (length of incubation was determined by sample size). Laboratory instruments were thoroughly rinsed with water before the analyzing of any sample to ensure there was no contamination. Samples were passed through a No. 80 standard testing sieve, of mesh size 180 µm. Digested organic material passed through the sieve and the remains were plastic, other inorganic material and any pieces of biological material that had not been digested by the KOH. The sample remains were washed thoroughly with water to remove any remaining KOH from the sample. The remains were then scooped out of the sieve and placed into a glass petri dish. Water was used to remove the remaining material to ensure all of the sample was removed from the sieve. The sample was then examined under the dissecting microscope to look for any microplastic. Any possible microplastic particles were removed from the glass petri dish and placed onto a microscope slide for closer examination under the compound microscope. Samples were examined by two people, and microplastic particles were visually confirmed as plastic by two people.

A number of controls were run in order to establish the accuracy of the protocol. A piece of known plastic that was found on a scuba dive was run through the entire methodology and was used to compare to the pieces of suspected plastic. A cosmetics product with micro-beads was also run through the experiment for the same purpose. A blank sample of distilled water was used to establish that no contamination was occurring during the laboratory process.

RESULTS

In total, 34 fish guts were analysed and 33 of these samples contained microplastic particles (97.1%) (Table 2). 32 samples contained microplastic fibres (94.1%), and 9 samples contained microplastic film pieces (26.5%). Overall, 14 pieces of microplastic film and 272 microplastic fibres were found (Table 3, Figure 1).

Microplastic fibres were the most common type of microplastic found. All species of fish in the study were found to have microplastic fibres in their digestive tracts. Only two samples had zero microplastic fibres (one Red Snapper that contained a single piece of microplastic film and one Barracuda that contained no microplastic). The control sample contained no microplastic, and so it can be concluded that the microplastic particles are not from laboratory contamination.

In total, 14 pieces of microplastic film were found in 9 different samples (Figure 2). 50% of the Red Snapper and Mahi Mahi samples were found to have microplastic film pieces in their digestive tracts, 40% of the Blue Runner samples and 17% of the Mutton snapper samples contained microplastic film pieces. No microplastic film was found in the Barracuda or Red Hind samples. Our single Yellowfin Tuna sample had the most pieces of microplastic film per sample (5 pieces).

Table 1. Detail of fish examined in this study. * = single fish studied.

Common Name	Scientific Name	Type
Red Snapper	*Lutjanus buccanella*	Demersal
Red Hind	*Epinephelus guttatus*	Demersal
Mutton Snapper	*Lutjanus analis*	Demersal
Barracuda	*Sphyraena baraccuda*	Semi-pelagic
Blue Runner	*Caranx crysos*	Semi-pelagic
Mahi Mahi	*Coryphaena hippurus*	Pelagic
*Yellowfin Tuna	*Thunnus albacares*	Pelagic

Table 2. Number of samples containing microplastic particles.

Species of fish	Number of samples analysed (n)	Number of samples containing microplastic	Number of samples containing fibres	Number of samples containing film pieces
Lutjanus buccanella	6	6	5	3
Epinephelus guttatus	6	6	6	0
Lutjanus analis	6	6	6	1
Sphyraena baraccuda	6	5	5	0
Caranx crysos	5	5	5	2
Coryphaena hippurus	4	4	4	2
Thunnus albacares	1	1	1	1

Table 3. Number of microplastic fibres in each sample (– indicates sample not obtained).

Species	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	Total
Red Snapper	0	7	2	25	25	7	66
Red Hind	1	15	1	10	2	1	30
Mutton Snapper	6	2	10	2	10	24	54
Barracuda	9	9	7	0	25	1	51
Blue Runner	4	1	12	20	8	-	45
Mahi Mahi	1	9	6	6	-	-	22
Yellowfin Tuna	4	-	-	-	-	-	4

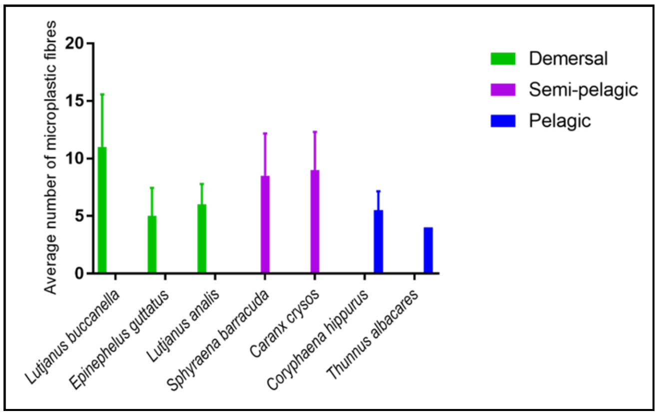

Figure 1. Average number of microplastic fibres found in each species. Error bars indicate the mean ± S.E.M.

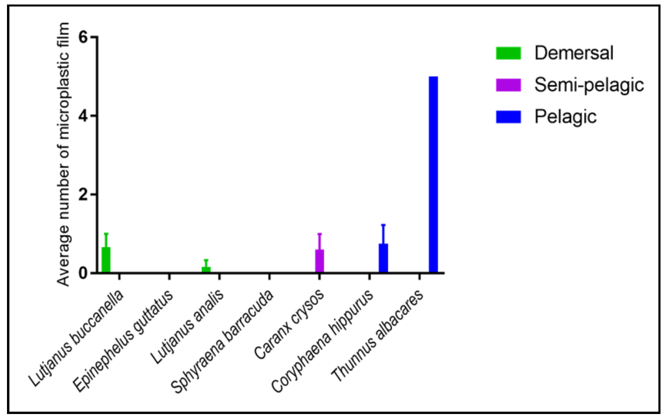

Figure 2. Average number of microplastic film pieces found in each species. Error bars indicate the mean ± S.E.M.

DISCUSSION

Microplastics were found in the majority of samples inspected, regardless of life history, demonstrating that the incidence of microplastics in commercially exploited fish in Grenada is widespread and further investigation into the effects of microplastic in the food chain should be considered.

Plastic debris and microplastics are now ubiquitous in the marine environment (UNEP 2013), and this research indicates that this is also true in Grenada. Microplastics have recently been found in deep sea creatures, including lobsters, sea pens and sea cucumbers (Taylor et. al. 2016). This raises the question of where are these plastic particles coming from? A recent study at The University of Plymouth has shown that up to 700,000 microfibres may be released from a single washing machine cycle, potentially contributing microplastics to the marine environment (Paddison 2016).

Further research is needed to determine the origin of microplastics found in fish in Grenada. It is possible that microplastic film found in fish in Grenada is from plastic grocery bags that are decomposing in the ocean The microfibres could be from nylon rope (as a number of our fibres found were blue), from washing machine outflow, or unknown sources. Future research on the chemical composition of microplastics from Grenada fish may shed light on the origin of the microplastic particles. A better understanding of the sources of microplastics may help in the formulation of solutions to plastic pollution.

The findings of our study indicate a need for further investigations. The fish chosen for this study are commercially exploited in Grenada, and as such the results are important to the people of the Caribbean island. The abundance of microplastic particles found in these fish is concerning, especially when combined with the knowledge that plastics can hold contaminants (Teuten et. al. 2009). Plastic debris in the marine environment can contain organic contaminants, including polychlorinated biphenyls (PCBs), and these can transfer from plastic to fish (Teuten et. al. 2009). It is known that PCBs are carcinogenic and can cause disruption to the endocrine system (UNEP 2013), indicating microplastics in fish is a public health concern.

Fish liver samples from Grenada and plastics from this project can be analyzed for contaminant loads and compared. This may indicate if contaminant transfer has occurred, and if there are any public health concerns relating to fish consumption.

A number of limitations were experienced throughout the study. A number of samples were partly undigested even after extended periods in KOH and incubation. It became apparent that the KOH solution was unable to fully digest crustacean shells and fish vertebrata. This undigested material made the samples difficult to analyse. Whilst this was a limitation in examining for microplastics, it may be possible to link diet and microplastics in fish. During the study it was noted that some samples contained almost all fish vertebrae and no crustacean shells or vice versa. We are interested in investigating links between fish diet and the presence of microplastics. Amongst the undigested material it was not possible to be certain that all microplastics present were found. In many cases where a large quantity of undigested material was present, owing to time constraints it is possible that not all microplastics were found. Confirmation of microplastics was by visual confirmation only due to the lack of mass spectrometer access. To date it has also not been possible to weigh the microplastics found as we lack access to a sensitive enough scale.

Plastic in the marine environment is of great concern. Action is needed to reduce the amount of plastic that gets into the environment. One solution is to move away from our heavy reliance on plastics, especially single use plastic products. A number of countries have already made great progress with this. In 2015, a small charge of five pence was implemented in the United Kingdom for plastic grocery bags. In July of 2016, figures showed that the plastic bag usage was down 85% (Smithers 2016). Both Jamaica and Guyana announced in 2016 that they will be banning Styrofoam in early 2017 (Jamaica Observer 2015, GY Buzz 2015). We hope that other countries can move to encourage their populations to reduce their use of plastics.

KEYWORDS: Microplastic, fish, pollution, Grenada, plastic

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