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Evidence of Translocation of Micro plastics in Melon, Blubber, and Other Tissues of Marine Mammals

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Abstract

Large amounts of micro plastic particles are consumed by marine mammals, most likely through direct consumption from sediment or seawater, as well as trophic transfer (i.e., through prey that has consumed plastic). Micro plastics have been discovered in the faeces and stomachs of pinnipeds and cetaceans as well as in their digestive tracts. Although the translocation of ingested micro plastics in various aquatic species' organs has been reported, marine mammals have not been the subject of this investigation. The lipid-rich, highly specialized tissues of marine mammals may make them more vulnerable to lipophilic micro plastics. Here, we present the presence of micro plastics in four different tissues (the acoustic fat pad, blubber, lung, and melon) from twelve different marine mammal species, including masticates, odontometers, and others. The sizes, mass concentrations, and particle counts range from 24.4 μm to 1387 μm, 0.59 μg/g to 25.20 μg/g, and 0.04 to 0.39 particles/g, respectively.

Keywords: Micro plastics; Marine mammals; Tissues.

Introduction

Using a combination of Raman spectroscopy and pyrolysis gas chromatography with mass spectrometry, twenty-two individuals were screened for micro plastics. Sixty-eight percent of the subjects had at least one micro plastic particle in any one of the four tissue types. Polyethylene and fibres were the most frequently observed polymer and shape, respectively. According to these results, a certain amount of swallowed micro plastics may move around the bodies of marine mammals, endangering human and marine mammal health. For humans, exposure can occur both directly through consumption for those who depend on marine mammals for sustenance and indirectly through consumption of the same prey resources by people worldwide. Some of the people under examination match samples that were taken more than 20 years ago, indicating that this process and the associated exposure risk have already happened [1-4].

Methodology

According to data from 2010, plastic pollution in oceanic environments is expected to increase at an average annual rate of 8.75 million metric tonnes, having an adverse effect on economies, societies, and ecosystems. It is well known that 1288 marine species consume plastics on a regular basis. 54% of the approximately 400 species of fish that have been reported to ingest microplastics—plastic particles measuring between 1 μm and 5 mm—are significant to the fish industry. In the past ten years, the amount of plastic that marine fish have consumed has more than doubled; fish are eating plastic more frequently over time. Additionally, microplastics are consumed by marine mammals accidentally while hunting prey [5].

Additionally, marine mammals consume micro plastics through trophic transfer—the ingestion of lower-trophic level organisms that have themselves consumed plastic—or accidentally through the water column when capturing prey. Depending on the species and foraging strategy, baleen whales are thought to indirectly consume between 200,000 and 10 million micro plastic particles through contaminated prey each day.

There are still a lot of unanswered questions about the effects of micro plastic exposure, particularly for marine mammals. It is challenging to draw conclusions about the effects of mixtures and types of micro plastics in nature because studies addressing the effects of exposure frequently use environmentally irrelevant plastics and concentrations. Changes in gene expression, reduced growth, inflammation, tissue perforation, abrasion, and denuding, oxidative stress, and immune system dysfunction are a few of the effects that have been noted. Both immediate and long-term effects on human health could result from the translocation of micro plastics in marine mammals [6-8].

As of this writing, Iceland has declared that it will stop its commercial whaling by 2024, but Norway, Japan, and Iceland still engage in commercial whaling and the consumption of whale products. Native American communities may be at risk for food safety, food quality, and food availability if microplastics are found in harvested tissues. Furthermore, the presence of plastic in the tissues of marine mammals may serve as a warning to consumers that consuming different seafoods may expose them to microplastics, as these animals are sentinel species whose diet overlaps with both commercial and small-scale fisheries. Therefore, the purpose of this study was to determine whether microplastics are moving to different parts of the bodies of marine mammals. To do this, opportunistically obtained samples from stranding events were examined using a combination of Raman Spectroscopy and Pyrolysis-Gas Chromatography/Mass Spectrometry [9, 10].

Results

Of the 17 non-control samples (16 individual animals) that were subjected to MAE Py-GC/MS analysis, 12 were lost owing to a mid-cycle system failure that was probably brought on by the digested

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tissue's leftover lipids (discussed below). This left five samples (from five individuals) with high-quality, usable data. Three of the five samples (60%) that contained blubber tissue had microplastics detected by MAE py-GC/MS. These samples included a gray whale, a bearded seal, and a bottlenose dolphin (Table 2). Dolphin JPIER024 had 380.0 µg of total PVC, or 25.2 µg PVC/g of blubber. Gray whale 2019031 from Alaska was found to contain 9.5 µg PVC/g blubber (140.0 µg total PVC). Lastly, 8.87 µg PVC in total (0.59 µg PVC/g blubber) was discovered in the bearded seal EB19PH022's blubber tissue.

Discussion

The idea that microplastic particles are migrating to different marine mammal tissues—certainly, the blubber, melon, acoustic fat pad, and caudal lung—is supported by the identification of different plastic polymers using both MAE-Py-GC/MS and Raman spectroscopy. In this instance, as in the case of other smaller animals, microplastics were discovered outside of marine mammals' gastrointestinal tracts. Three routes of exposure are possible: ingestion, inhalation, and skin contact. Research on dermal contact in humans or animals is very limited, but exposure through these two routes is thought to be more significant. But it's also unclear how much marine mammals internalize microplastics through inhalation.

Plastic particles seen here would need to have traveled from the gastrointestinal tract to the organs under investigation in the event of ingestion. Though some theories exist, the underlying mechanisms of translocation remain unknown. After ingestion, translocation is assumed to happen through paracellular diffusion between adjacent cells' tight junctions for particles smaller than 130 µm or transcellular uptake through intestinal epithelial cells into circulatory fluid. Since many of the plastic particles seen here are larger than this threshold, intestinal tissue abrasion and perforation may otherwise facilitate the plastic particles' ability to translocate. A number of investigations have also found particles in other species that exceed the theoretical size range for translocation, underscoring the need for more study to identify the underlying mechanisms.

Given that fibers were the most frequently observed shape in this study, they may enter the circulatory system more easily, suggesting that shape plays a major role in translocatability. It is also possible, though, that the tissues' frequency observations are caused by the fibers' exposure simply being higher than that of other shapes that have been seen. The next most and least frequent shapes were fragments and foams, respectively, with relative frequencies among the three shapes in line with observations of relative frequencies in the surroundings.

Conclusion

Although the presence of microplastics in the gastrointestinal tracts of marine mammals has been previously reported, this is the first study to show that microplastics are also translocated and deposit into different tissues of marine mammals. The effects of microplastic translocation to the tissues examined here (melon, caudal lung, acoustic mandibular jaw fat, and bulbar region) as well as to other organs and tissues must therefore be investigated, with an emphasis on eliciting dose-response relationships. Furthermore, since many of these particles were larger than what could be explained by paracellular diffusion or transcellular uptake, figuring out how these enter the circulatory system will help us better understand how long microplastic particles remain in the body. Are these particles there to stay or are they transient. The ultimate goal would be to create a biomarker that would enable the assessment of risk to wild populations, native subsistence users, and marine mammal consumers worldwide by enabling the evaluation of microplastic contaminant loads in living individual animals, possibly through biopsy or fecal sample. The presence of microplastics embedded in internal organs highlights the pervasiveness of the plastic pollution problem plaguing the oceans and their inhabitants, which has implications for humans. It is yet to be determined whether the concentration of microplastic in the tissues examined here poses a health threat to marine mammals.

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