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Microplastics in Fiddler Crabs (genus Uca)

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Abstract:

Microplastics, as defined by NOAA, are small plastic pieces less than five millimeters long, which cannot be seen with the naked eye. The production of plastic products and plastic use has exponentially increased since the start of plastic usage. Consequently, the amount of plastic waste has also increased greatly. Plastic waste that has been thrown out by humans into the environment breaks down into microscopic pieces, causing harm to organisms that live there. The purpose of this study was to see if there were microplastics passing through fiddler crabs (genus *Uca*), collected from the marsh at Waties Island, SC. Fecal samples from the crabs were teased apart and examined under a microscope to quantify the number and the types of microplastics present. Microplastics were found in almost every sample taken, indicating that microplastics are present in even in this relatively pristine environment. The effects of the intake of microplastics on fiddler crab survival and reproductive fitness will have profound impacts on other organisms through predation and other processes, since fiddler crabs are an important low trophic organism at Waties Island, SC.

Introduction:

The amount of plastic production and plastic use has exponentially increased since 1940, reaching 322 million tons of plastic production in 2015 (Zhang 2017). Plastic is used for many products, as well as being a major source of packaging for consumer goods, since it is a low cost, versatile, light weight, strong, and easy to manufacture material (Andrady, 2011). Plastic is easy to make and easy to use, which is why it became so popular to use. Consequently, the amount of plastic waste that has been thrown out by humans into the environment has increased exponentially as well. According to Zhang (2017), in 2010 it was estimated that 4.8 to 12.7

million tons of plastic waste entered the oceans, and they predict that by 2025 that will increase by an order of magnitude. Not all waste is disposed of properly, which is a main reason why plastic waste ends up in the oceans. The term “mismanaged waste” is a term defined by Jamebeck et al. (2015), as material that is littered, or not disposed of properly, including the waste in dumps and waste in open, uncontrolled landfills. This mismanaged waste can enter the ocean via waterways on land and be transported by wind and/or tides (Jamebeck et al., 2015). This plastic waste accumulates in the oceans, but this plastic will eventually break down into microscopic pieces, called microplastics, which as defined by NOAA, are small plastic pieces less than five millimeters long, which cannot be seen with the naked eye. Since people cannot see the plastics, most do not realize they are present in the environment and that they can harm organisms. These microplastics make their way into the ocean, and the amount of microplastics in the ocean, in the sediments, and consequently in marine organisms are at an all-time high, with concentrations reaching 100,000 particles per m^3 (Wright et al., 2013). For example, microplastics can potentially clog the gills of filter feeds, causing them to not effectively eat. Microplastics are ingested by organisms, especially filter, suspension, and deposit feeders, and the microplastics can cause blockages and internal abrasions in these organisms. Microplastics are also harmful to these organisms because plastics leach toxins as well, which can disrupt endocrine function (Wright et al., 2013). People can understand the effects of large plastic waste to marine organisms, but it is more difficult to understand the effects of these microplastics on these marine organisms.

Low trophic, filter-feeding organisms are the first organisms to be affected by the presence of microplastics. Fiddler crabs (genus *Uca*) are a dominant low trophic, filter-feeding organism that are present on Waties Island, SC, which is a pristine, undeveloped marsh/ beach system. Theoretically, there should not be any waste on Waties Island, as there might be in more populated areas, such as Myrtle Beach, SC, which is a huge tourist area. One might believe that there should not be microplastics present at Waties Island. Fiddler crabs (genus *Uca*) are an important indicator of how healthy the marsh/beach system is, since they are on the bottom of the food chain. The purpose of this study was to see if there were microplastics passing through fiddler crabs (genus *Uca*), collected from Waties Island, SC.

Methods:

In the fall of 2018 and the spring of 2019, fiddler crabs were collected from Waties Island, SC. The crabs were brought back to the lab at Coastal Carolina University and placed in plastic containers, in the fall, and glass containers (Image 1) in the spring, along with sea water, which was also collected from Waties Island. After sitting the lab for several days, five of their biggest fecal samples were taken, using a small pipette, and placed in a petri dish and teased apart using forceps. The fecal matter was examined under a dissecting microscope. The samples were examined to quantify the number and type of microplastics present. The crabs were returned to their environment after looking at their fecal samples.

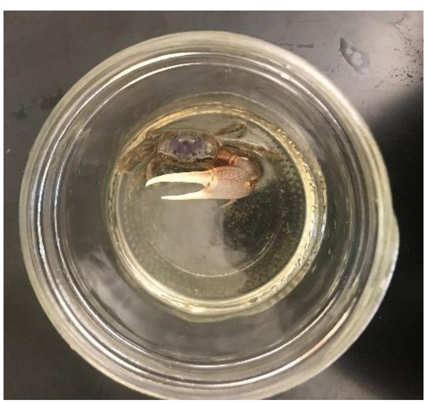

Image 1. A fiddler crab (genus *Uca*) collected in the spring of 2019, in a glass container in the lab at Coastal Carolina University.

Results:

Microplastics, specifically microfibers, were found in almost every sample taken. In the fall (Figure 1), there were 116 microfibers found in the ten fiddler crabs that were collected, with all average of 11.6 microfibers per crab. There were some samples with no microfibers found, but there were other samples with 30-40 microfibers found, which could have skewed the average. In the spring (Figure 2), there were 118 microfibers found in the twenty fiddler crabs that were collected, with an average of 5.9 per crab. There were some samples with no microfibers, but the highest for the spring was just above 20 microfibers.

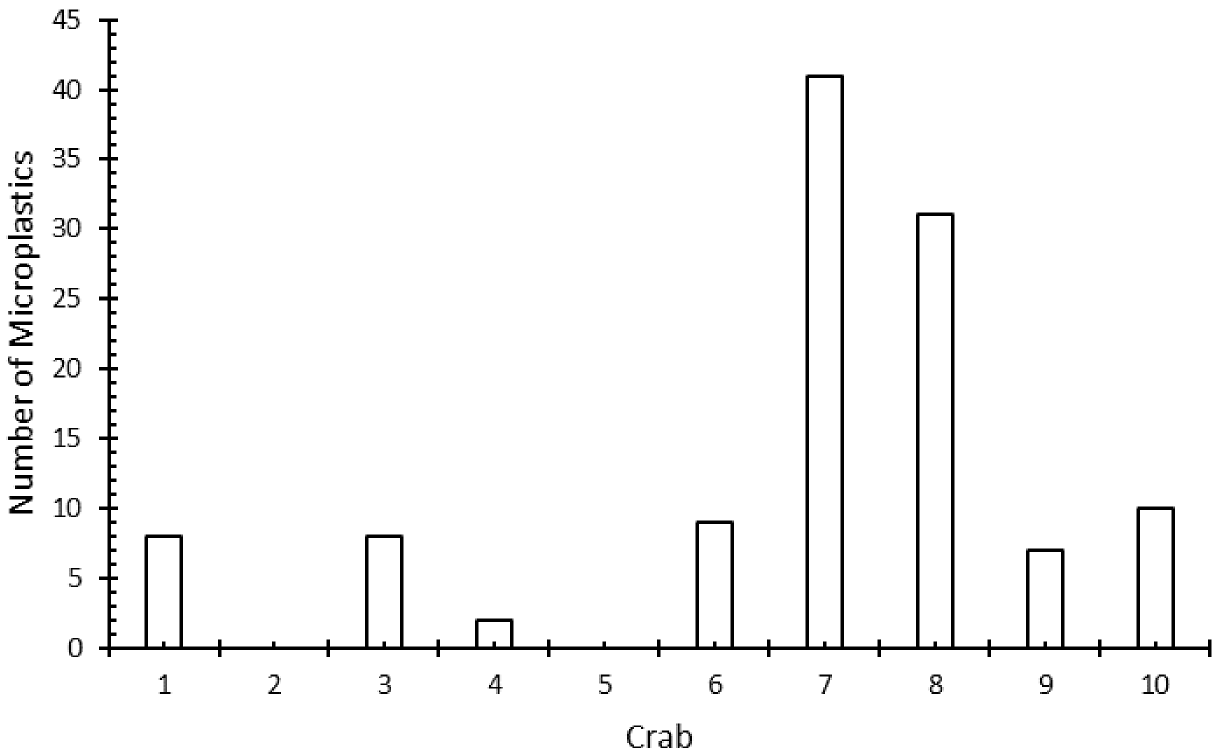

Figure 1. This figure shows the amount of microplastics, specifically microfibers, found in the fecal samples of ten Fiddler crabs (genus *Uca*), collected from Waties Island, SC, in the fall of 2018. In total, there were 116 microfibers counted, with an average of 11.6 microplastics per crab.

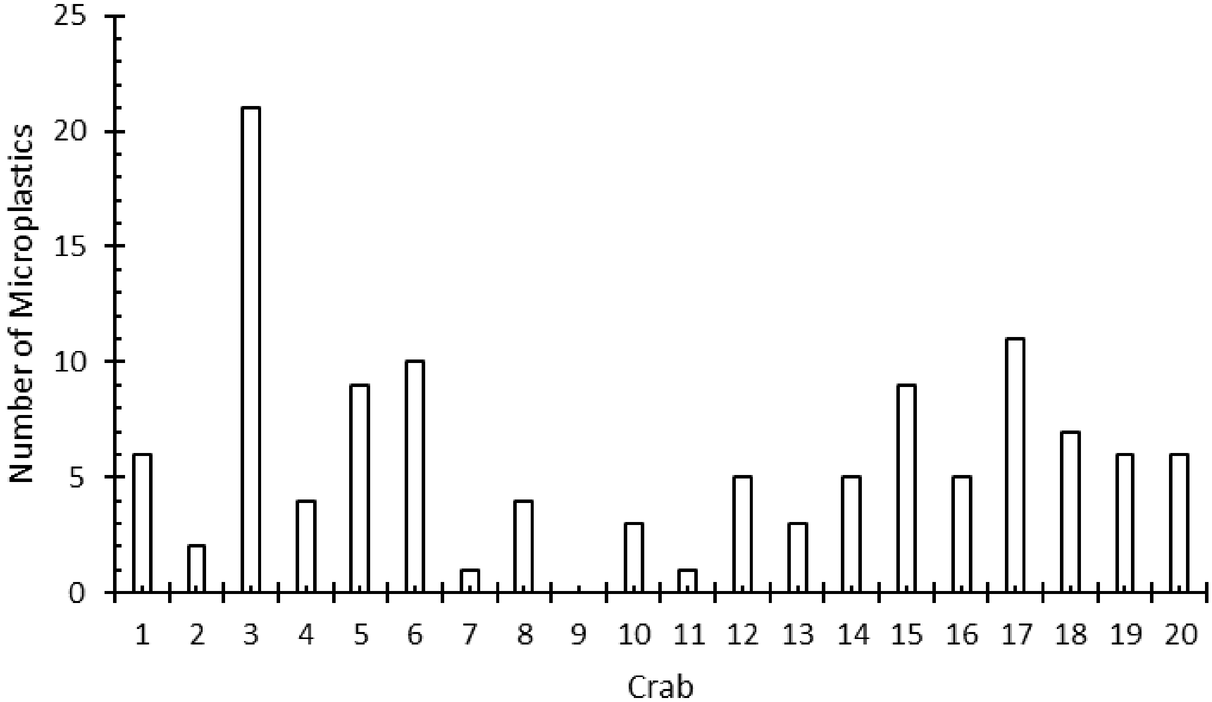

Figure 2. This figure shows the amount of microplastics, specifically microfibers, found in the fecal samples of twenty Fiddler crabs (genus *Uca*), collected from Waties Island, SC, in the spring of 2019. In total, there were 118 microfibers counted, with an average of 5.9 microfibers per crab.

Discussion:

There were microplastics found in almost all of the samples taken, indicating that there are microplastics present in this relatively pristine, under-developed environment. All the plastics found in this study were microfibers, specifically. There are two general categories of microplastics- microbeads and microfibers. Microbeads can be from a variety of sources, such as exfoliating beads in beauty products and polyethylene particles in toothpaste. Microfibers are threadlike remnants, typically 6 to 175µm in diameter and 250 to 6250 µm in length (Carr 2017). Although it is not certain the source of microfibers into the environment, specifically in the oceans, with more research being done, it is thought that a source of these microfibers is from water discharge from washing machines to wastewater treatment plants, where these microfibers may be small enough to get through the filtration system (Carr 2017). If the microfibers get through the filtration system, they can make their way to the ocean via waterways on land. There are other ways that microfibers can get into the environment. Fabric degrades when clothing is worn over and over again (Carr 2017), so microfibers could get put directly into the environment simply by falling off of clothing that people wear. Anything made out of a fabric material can shed fibers which can get into the environment and travel via atmosphere (Carr 2017). No matter where the microplastics came from, they can be transported across the oceans via currents, get mixed by physical mechanisms such as Ekman transport and currents, and make it to the shoreline via onshore and offshore transport, where these microplastics get onto the beaches, salt marshes, and other benthic sediments (Zhang 2017).

Microfibers found in the feces of the fiddler crabs in this study could have been from the microfibers in the water that flood the marsh system that the crabs live in, since the ocean circulates globally. The microfibers virtually could have come from anywhere. Another possibility is they could have come from the shedding of microfibers from clothing. Even though Waties Island is "untouched by humans," students from Coastal Carolina University are out there for labs to do research, and fibers easily could be falling from their clothing and make its way into the marsh and consequently in the fiddler crabs. Intertidal flats, such as mangroves and salt marshes, potentially are sinks for these microplastics, since the dense vegetation could keep the microplastics floating there (Zhang 2017), which might explain why there were microfibers found in the salt marsh at Waties Island. The exact source of these microfibers at Waties Island, SC, is not known.

Fiddler crabs are important to the environment that they live in since they are low trophic organisms, meaning they are at the bottom of the food chain. Higher trophic organisms eat them and in turn ingest whatever is in the fiddler crab, including microplastics. Fiddler crabs are filter-feeders, so whatever is in the water and sediments that they filer through passes through them, including microplastics. The intake of microplastics could ultimately effect the survival of fiddler crabs, which would have profound impacts on other organisms and the environment they live in. For example, fiddler crabs are a major source of food for birds and other organisms (Zeil et al., 2006). Besides being on the bottom of the food chain, fiddler crabs burrow in the sediments, and their burrows play a huge role in the intertidal ecosystem since the burrows allow water to get into the substratum (Zeil et al., 2006). Burrows provide oxygen-rich environments for roots and soil microbes, playing a huge role in the nutrient recycling process and microbial ecology of the marsh, as well (Zeil et al., 2006). With an increase of microplastics, there could potentially be a decline in fiddler crab numbers, either from microplastics blocking their gills, clogging their digestive track, or toxins being leached from the plastics, which can disrupt endocrine function. A decline in fiddler crabs would disrupt a healthy marsh/beach system, such as Waties Island, SC.

Waties Island, SC, is relatively “untouched” by humans but microplastics are still present in this environment. This raises the question about microplastics present in more heavily populated areas, such as Myrtle Beach, SC. A further study that could be done is to look at low trophic, filtering-feeding organisms in more populated areas to see if microplastics are present, and how many are there, compared to this low human interaction environment at Waties Island.

Conclusion:

Although it is not certain where these microplastics came from, microplastics are present at Waties Island, SC, since it was found in this study that microplastics, specifically microfibers, are passing through Fiddler crabs (genus *Uca*), which are a dominant low trophic, filter-feeding organism in this environment. These microplastics could have a profound impact on the survival of fiddler crabs, which could in turn disrupt the healthy ecosystem currently present at Waties Island, SC.

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