Journal of Ecology and Toxicology

Mini Review Open Access

A Relevant Tool for Microplastic Toxicity Evaluation Using Paramecium Bursaria

Klaus Lever*

Department of Social Science, Halland, Sweden

Abstract

MPs, which are also referred to as microplastics, are typically tiny wastes of plastic with diameters ranging from one to five millimeters. This tiny plastic debris, which is common in aquatic systems, poses a serious threat to the aquatic biota. Even though metazoan animals are mostly used to test MPs' toxicology, there are times when their applications are limited due to their high cost, limited ecological niche, or ethical concerns. This indicates that monocellular eukaryotes, also known as protozoa, which are prevalent in nature and are also referred to as eukaryotes, can be utilized to evaluate the toxicity of MPs. Monocellular eukaryotes are also referred to as eukaryotes. These eukaryotic organisms are also known as eukaryotes. Monocellular eukaryotes are another name for eukaryotes. These eukaryotic organisms are also known as eukaryotes. We continued our investigation of the behavioral and molecular changes by employing P. bursaria as a protozoan model and MPs-exposed Paramecium bursaria (P. bursaria). Our findings indicate that P. bursaria underwent a number of modifications following the adoption of MPs. An increased level of oxidative stress, a slower speed, altered avoidance strategies, and the possibility of endosymbiotic disruption were among the changes. P. bursaria underwent significant and quantifiable changes in response to MP exposure. Overall, this study demonstrated that P. bursaria is a promising alternative for the toxicological evaluation of MPs and that it can be used to evaluate the toxicity of other environmental contaminants.

Keywords: Toxicological Tool; Protozoa; Unicellular Organisms; Paramecium Bursaria; Microplastics

Introduction

The size of the plastic debris is primarily what determines its negative effects on the local biota [**1**]. Aquatic ecosystems are gravely endangered by plastic contamination. Large pieces of plastic, like fishing lines and bottle caps, can physically entangle a wide range of aquatic organisms [**2,3**]. These enormous wastes of plastic can also be broken down into microplastics (MPs) through photo-oxidation, biodegradation, and physical abrasion [**4**]. Due to their small size, which typically ranges from one millimeter to five millimeters, MPs are emerging as a threat to aquatic biota. As a outcome, numerous aquatic species can get closer to them, most likely through direct ingestion or trophic transfer.

Up to this point, numerous investigations have been conducted into the possibility of toxic MPs. Due to the elusive concentration of this novel contaminant in the aquatic system, various concentrations, ranging from 102 to 1010 particles/mL, were chosen to evaluate acute or chronic impacts on aquatic animals from various trophic positions in experimental settings. The metabolic functions of mysid shrimp (Neomysis japonica), hermit crabs (Pagurus bernhardus), zebrafish (Danio rerio), monogonont rotifers (Brachionus koreanus), and zebrafish (Danio rerio) as well as monogonont rotifers (Brachionus koreanus) were examined to see if they had changed or if It is essential to keep in mind that studies involving animals with multiple cells, such as metazoans, account for the majority of our knowledge of MPs. On the other hand, very little is known about how MP affects unicellular protozoans. Furthermore, there is currently a lack of awareness regarding alternative protozoan-based methods for assessing MP toxicity [**5-7**].

The broad group of single-celled organisms that can be found in nature are called protozoans. One of these microscopic animals, Paramecium, is of particular interest to the scientific community because it has served as a useful model organism in eukaryotic biology and biomedical research [**8**]. Paramecium, a genus of ciliates with short cilia arranged in rows on the membrane, was the first ciliate to be observed due to their relatively large size. Since their discovery, a number of culturing protocols have been developed that make it relatively simple to cultivate and maintain Paramecium cultures with minimal effort, low cost, and fewer ethical considerations. In addition, it was later demonstrated that Paramecium engaged in complex but quantifiable behaviors like avoidance and pursuit of prey in response to external stimuli. It is now possible to link phenotypic shifts to genotypes and learn about the genomes of several Paramecium species thanks to advancements in sequencing technology. Paramecium is an excellent model organism for evaluating MP toxicity because of all of these characteristics. Recent studies have demonstrated that MPs are utilized in Paramecium; However, additional research is needed to investigate the potential effects on Paramecium, particularly the behavioral and molecular changes caused by MPs uptake [**9,10**].

Discussion

The distribution of MPs, transporter pathways,and potential effects on aquatic life have all been the subject of numerous studies. The aquatic environment now faces a new threat from MPs. MPs, for instance, are capable of absorbing and enriching toxic chemicals, altering behavior, obstructing the intestinal tract, and hindering the growth and reproduction of Daphnia magna and Danio rerio. Unicellular eukaryotes like P. bursaria remain a mystery despite the fact that the toxicity of MPs has been evaluated in a number of aquatic species. When P. bursaria

***Corresponding author:** Klaus Lever, Department of Social Science, Halland, Sweden, E-mail: lever@klaus.com

Received: 07-Jan-2023, Manuscript No: jety-23-86074, **Editor assigned:** 10-Jan-2023, PreQC No: jety-23-86074 (PQ), **Reviewed:** 24-Jan-2023, QC No: jety-23-86074, **Revised:** 27-Jan-2023, Manuscript No: jety-23-86074 (R), **Published:** 31-Jan-2023, DOI: 10.4172/jety.1000149

Citation: Lever K (2023) A Relevant Tool for Microplastic Toxicity Evaluation Using Paramecium Bursaria. J Ecol Toxicol, 7: 149.

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was used as a model for unicellular eukaryotes, we discovered that MPs were to blame for the behavioral and oxidative stress-related changes. Instead of learning about the harmful effects of MPs at concentrations that are relevant to the environment, the primary objective of this study is to determine whether P. bursaria exposure to MPs could outcome in behavioral and molecular changes. As a direct consequence of this, a platform that can be further tailored to comprehend the toxicity of MPs as a whole or of MPs that are associated with other contaminants is made available. We believe that unicellular organisms like P. bursaria could be a useful tool for future toxicity studies due to their low cost, lack of ethical considerations, and ease of cultivation.

Due to their similarity to their natural prey and small size, MPs may be consumed by plankton. Because P. bursaria naturally consumes bacteria of sizes ranging from nm to m, MPs with a diameter of one meter were chosen for this study. Our findings indicate that P. bursaria only consumes MPs in moderate and high concentrations. The absence of fluorescent signals in cells exposed to MPs at low concentrations suggests that P. bursaria engages in active food selection to differentiate MPs from natural prey. Other species of plankton demonstrate that mechano- and chemoreceptors probably play a role in this, despite the lack of specific mechanisms. P. bursaria, on the other hand, discovered food vacuoles containing aggregated MPs because this built-in mechanism does not prevent it from absorbing MPs as MP concentrations rise. Punctate staining also revealed that MPs may have been transported from food vacuoles to cortex and trichocysts in a manner comparable to that of endosymbiotic zoochlorellae. Due to the nature of this imaging method, we are unable to rule out the possibility that punctate signals originate from surface-bound MPs; Additional research is required to accurately identify the MP position.

Conclusions

MPs altered the behavior and molecular makeup of P. bursaria. Changes in the symbiotic relationships between the infected P. bursaria, decreased avoidance, and elevated oxidative stress were among the symptoms. As this study demonstrated, P. bursaria was found to undergo behavioral and molecular changes upon exposure to MPs. P. bursaria could be a useful tool for determining the toxicity of novel pollutants like MPs in aquatic or experimental settings, according to this.

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