THE IMPLICATIONS OF HEIGHTENED PPE USE DURING COVID-19 ON MARINE HABITATS

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Diatoms and P. tricornutum

The marine diatom is a single-celled alga. They are the only organism on the planet with cell walls composed of transparent, opaline silica (Diatoms.org, 2021). In its ecosystem, diatoms are an important source of food for the entire food web due to their production of energy-rich long-chain fatty acids (Diatoms.org, 2021). Beyond their function as a primary producer, diatoms produce 20-30% of the air we breathe through carbon fixation and are vital for the assessment and monitoring of the biotic condition of the water (Diatoms.org, 2021). The organism *Phaeodactylum tricornutum* is a form of a diatom and as the only species in its genus, *P. tricornutum* differs from other diatoms due to its ability to grow in the absence of silicon and survives without making silicified frustules (Wikipedia Contributors, 2022).

In the field of biotechnology, *P. tricornutum* has shown potential as an energy source, due to its rapid growth rate and production of lipids. Biotechnological researchers have found that limiting nitrogen exposure can induce neutral lipid accumulation in *P. tricornutum*, indicating possible strategies for improving microalgal biodiesel production (Wikipedia Contributors, 2022).

Covid-19 and its Correlation to Marine Pollution

Throughout the Covid-19 pandemic, the use of personal protective equipment (PPE), such as face masks, was globally promoted for individual use as a method of control over the spread of the virus. In 2020, data indicated a consumption of approximately 129 billion face masks for 7.8 billion people across the globe per month during the year (Sendra et al., 2022). This widespread use of face masks not only created upwards of 0.39 million tonnes of PPE waste but also facilitated increased exposure to elements such as magnesium, nickel, and zinc in marine

environments. The outcome of this situation has led to illegal plastic waste disposals increasing by 280% worldwide (Sendra et al., 2022).

In the article *Products released from surgical face masks can provoke cytotoxicity in the marine diatom Phaeodactylum tricornutum*, the researchers seek to first study the rate at which products from face masks are expelled into the water. Additionally, they intend to demonstrate the effects of these products being present in marine environments by assessing the toxicity to the diatom *Phaeodactylum tricornutum*. The toxicity of the compounds is assessed by measuring and quantifying significant changes in the photosynthetic apparatus and intrinsic properties of the microalgae cells.

Within this research, the use of *P. tricornutum* provides insightful results and information to the experiments being conducted. This is due not to the fact of the organism's unique traits, but to the nature of what an organism such as *P. tricornutum* contributes to ecosystems and habitats. As a diatom, the organism tells researchers information about the environment it is in because of its particularity to their surroundings. If the photosynthetic products of the species change in quantity or if the organism shows changes in cell size, measures of these characteristics are indicative of what is going on in the environment. Additionally, as a primary producer in an ecosystem, changes in photosynthetic products can have detrimental "bottom-up" effects at higher trophic levels given that microalgae, like diatoms, are food producers for >70% of the world's biomass (Sendra et al., 2022).

Research Methods and Materials

In this study, researchers fragmented and degraded surgical face masks sourced from a local pharmacy in Spain. They created two simulations of face mask degradation in water, the first being a whole face mask submerged in water, and the second being a fragmented face mask

submerged in water (Sendra et al., 2022). The fragmented face masks were cut with scissors sterilized with ethanol. Each face mask was cut into pieces of approximately 2 mm. The marine water for this experiment was sourced by a boat in a clean offshore area of Cadiz Bay, located in Spain (Sendra et al., 2022). In addition to fragmenting and degrading the face masks, the researchers performed an analysis of the materials present in the masks using Fourier transformed infrared spectroscopy (FTIR) through the Bruker Alpha System.

For this study, it was also necessary for the researcher to perform a microalgae assay with the marine diatom *Phaeodactylum tricornutum* prior to conducting the experiment. The specimen was sourced from ICMAN Marine Microalgae Culture Collection, and was chosen because of its standardized use in toxicology screenings (Sendra et al., 2022). Cells were grown in a filtered (0.2 μm) marine culture medium (pH: 8.2) and F/2 marine medium without EDTA for two weeks prior to the experiment (Sendra et al., 2022).

Research Findings

At the conclusion of this study, researchers found that microalgae populations that were exposed to whole face masks submerged in water showed little deviation from standard cell density in the 72 hour range of this experiment. Additionally, they found that the microalgae populations exposed to fragmented face masks submerged in water showed a significant dose-dependent decrease in cell density at both the 24 hour and 48 hour intervals (Sendra et al., 2022). After the 48 hour interval, the researchers observed that the microalgae species exposed to the fragmentation water showed a cell density 7.11 times lower than the controls (Sendra et al., 2022).

Research Discussion

Within this research, various figures were created to visually quantify the results and findings. In figure 3, the charts display the marine diatom's, *Phaeodactylum tricornutum,* response to both the water from the whole facemask and the water from the facemask fragments. Segmented into two figures, figure 3A and 3B, the charts reflect observations from each 24 hour interval across a 72 hour period.

In figure 3A, the cellular densities for both microalgae populations were recorded, with respect to the control group, across different dilutions of the marine water. The observed trend showed that the microalgae population exposed to the fragmented face mask water showed a larger decrease in cellular density than the whole face mask water population across the period. In the 48 hour interval, the lowest record of cellular density with respect to the control was noted at dilution factor one.

In figure 3B, the percent presence of reactive oxygenated species (ROS) for both microalgae populations were recorded, with respect to the control group, across different dilutions of the marine water. A clear increasing trend was observed for the microalgae population exposed to fragmented face masks with respect to the control group after the 24 hour and 48 hour intervals, but was found to be most significant after the 72 hour interval.

Both figures show a significant difference in reactions from *Phaeodactylum tricornutum,* with a clear indication that species was more negatively impacted by the water with fragmented face masks across all dilutions with respect to the control group.

Further Application

The methodology utilized in this research proved to be effective in demonstrating the cytotoxic effect of face mask pollution on marine diatom populations and allowed researchers to draw conclusions on the environmental impacts that this could cause. This methodology would

be beneficial to use in other research cases that seek to investigate environmental impacts. By analyzing the effects on a primary producer, researchers can analyze how this trend will move up a food chain and apply this to real world data, including consumer products and population trend forecasting.

References

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