SCIENTIFIC LITERACY PAPER

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Studies have shown that the use of surgical masks release toxins into the environment that are negatively influencing some marine diatoms. The water from face masks would cause cellular changes in the diatoms and the water from fragmented masks showed higher toxicity than whole ones. These lifeforms play an important role in the environment and the increased use of masks during the Covid-19 outbreak has polluted their living space. Not only is this a problem for survival the marine life, but *phaeodactylum tricornutum* is a species that plays an important role in biotechnology that has led to many advancements that humans rely on.

Diatoms are photosynthesizing algae that have a hard, silica based, cell wall that is known as a frustule (UCL no date). They are found in most aquatic environments that have little to any moisture including fresh and marine waters, soil, etc. (UCL no date). As stated in an article by UCL-London's Global University, they are only capable of limited movement on a certain substrate, and they are autotrophic organisms, meaning they make their own food. These algae have been studied since the late 1800's, but only became a topic of interest in the 1900's. Due to its diverse structure, it is predicted that the earliest diatoms were present in the Jurassic period but could have an even earlier evolutionary line.

The specific diatom that is discussed is the species *phaeodactylum tricornutum*. *Phaeodactylum tricornutum* is a diatom that has been used for developments in biofuels and other various biotechnology fields like recombinant protein expression etc. (Bañuelos-Hernández et al. 2015). Its biosynthetic capacity and high growth rates made it the perfect host for these technological advancements to take place (Bañuelos-Hernández et al. 2015). This organism has also had reports of it consisting of certain functional antibodies like a monoclonal human immunoglobin protein that is against the hepatitis B surface protein (Bañuelos-Hernández et al. 2015). As stated in the same article, *P. tricornutum* is a perfect organism for this experiment to

be conducted on because of how it secretes proteins. This would make detecting the toxicity levels in the environment far easier than it would be in other organisms because the *P. tricornutum* secretions can be measured as well as its cell density to detect changes.

Covid-19 was the cause of a drastic increase in the number of surgical masks purchased each year (Sendra, M. et al. 2022). The journal entitled," Products released from surgical face masks can provoke cytotoxicity in the marine diatom *phaeodactylum tricornutum*", stated that in the year 2020, the demand for personal protective equipment increased 207 times since 2019. Considering it was also legally required for people to wear masks due to the pandemic, it is understandable why the increase happened during that time and was expected to continue increasing. It was estimated that in the year 2020, a total of 129 billion face masks were used per month across the globe. This is extremely detrimental to the environment because it increased the amount of plastic waste dumped into the ocean, further damaging the marine environments. Face masks not only make up a large portion of the waste, but many also contain additives that are toxic and leave a chemical footprint.

In the paper, "Products released from surgical face masks can provoke cytotoxicity in the marine diatom *phaeodactylum tricornutum*," (Sendra, M. et al. 2022) researchers outlined their procedures and materials used in their experiment. They stated that the brand of surgical masks used were produced by Lync Med in Beijing, China, that were sold in local pharmacies. To evaluate not only the impact of the surgical masks in water, but also the difference between whole and fragmented masks, the masks were tested both whole and cut up. The masks were evaluated for inorganic matters in the different layers to compare later to the water samples collected. The three different groups would be the control, or water without a mask, the whole face mask, and a fragmented face mask. The tools used in the experiment were all cleaned prior

to use and the water collected from Cadiz Bay in Spain was filtered multiple times and tested for pH, salinity, and organic matter. The three groups would sit for a month, the first seven samples collected from each in the first week, then one sample per week for the three after that. The two analyses that would be tested on the samples were inorganic analysis and the analysis of fibers released (Sendra, M. et al. 2022).

After the samples had been collected, according to Marta Sendra and the other authors of the research paper, the samples were filtered through a polycarbonate filter. The filter was then evaluated under an optical microscope for the fiber analysis to count the fragments and fibers as well as their length and area. The inorganic materials analysis involved the researchers collecting the water into a metal free flask and using ICP-MS to evaluate the concentrations of certain metals present in the water. This would be compared to the pre-concentrations taken of the water before the experiment was conducted. The samples were lastly analyzed with Fourier-transformed infrared spectroscopy to find the functional groups of the compounds released into the water (Sendra, M. et al. 2022).

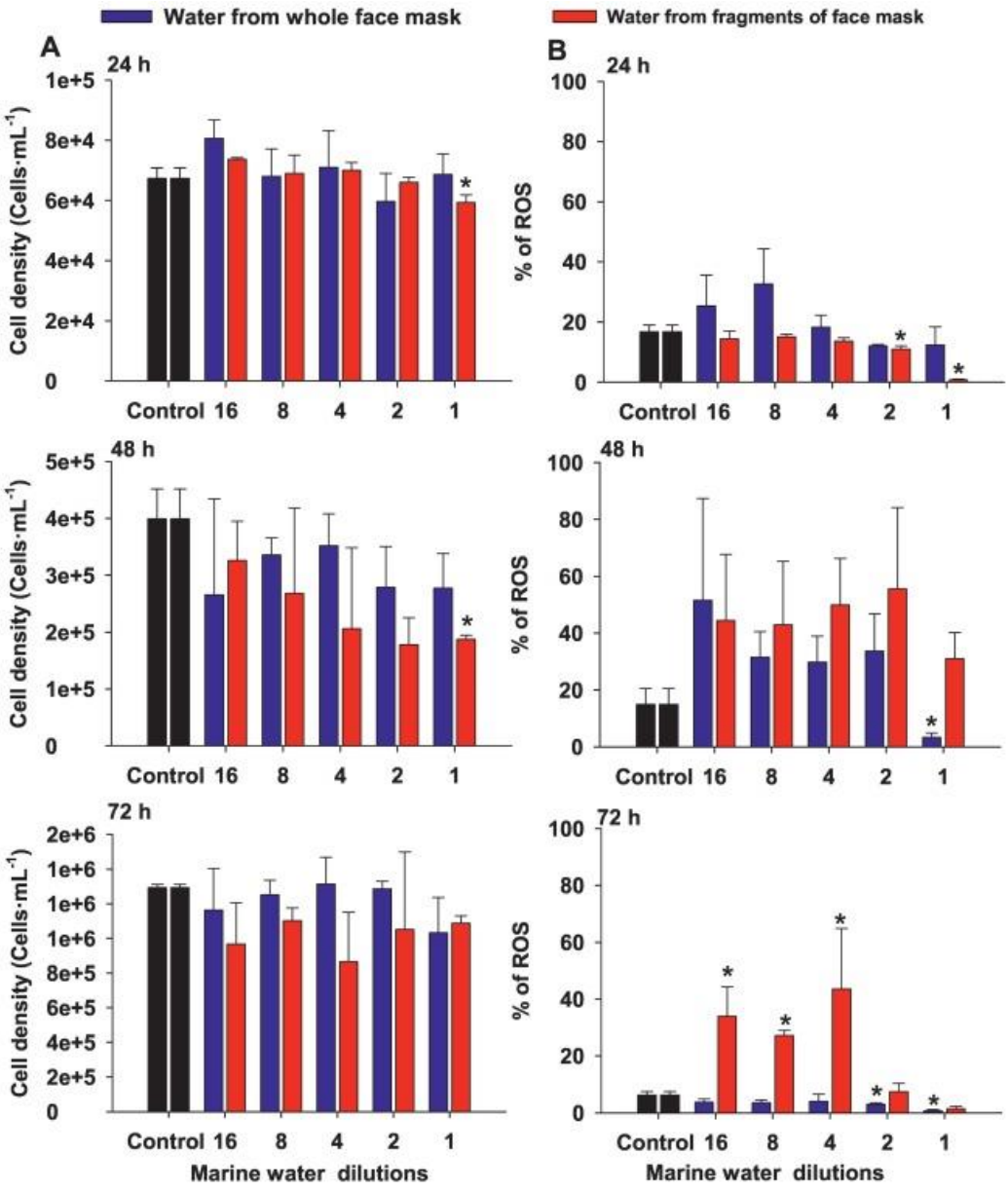
To study the microalgae toxicology, the samples were then filtered and diluted four times to create five tests which the *phaeodactylum tricornutum* were then subjected to (Sendra, M. et al. 2022). This would allow the researchers to evaluate the impact of the water obtained from the experiment on the microalgae. As stated in the article "Products released from surgical face masks can provoke cytotoxicity in the marine diatom *phaeodactylum tricornutum*," (Sendra, M. et al. 2022), growth inhibition bioassays were developed to test the cell density of the algae after three days. The standard cell density of the microalgae was 10^4 cells per mL before exposure to the effected water. In addition to cell density, cell volume, cell complexity, and presence of chlorophyll *a* were tested as well (Sendra, M. et al. 2022).

The results lined out in the paper by Marta Sendra and the other authors, showed that the different layers of the face masks all had different chemical compositions and were mainly made of different materials (Sendra, M. et al. 2022). They also found that there were no significant differences between the control and water subjected to the face masks except in regard to Magnesium, Zinc, and Nickle (in order of appearance), which were found in higher amounts in the fragmented face mask water. There were traces of alcohols and amine groups found in the samples with he masks that were not present in the control. Fragments and fibers were also found in both samples and had significantly higher numbers in the fragmented masks.

Figure 1 shows the cell density of the *phaeodactylum tricornutum* population after being exposed to the fragmented and whole face mask water over 24, 48, and 72 hours (Sendra, M. et al. 2022). The group with the whole face mask showed little change while the group with the water from the fragmented mask had a significant decrease in the cell density as the exposure went on. This trend was lost in the 72-hour portion of the experiment (Sendra, M. et al. 2022). The second part of figure 1 shows the percentage of intracellular ROS in the microalgae populations exposed to the same waters (Sendra, M. et al. 2022). The most significant result of this data was the extreme increase in percentage of ROS in the fragmented water after 72 hours of exposure which was 6.98 times higher than the control.

This method of research could be later used to test the effects of various other man-made materials on the environment. Some of these items could include common plastics that end up in the ocean, residues or by products that come from fishing boats, or even different metals that we use to build oceanside structures. This could be used to test the effects of any material or object on the sea-life or other microorganisms and hopefully could then be used to improve the quality of man-made materials used near and in the ocean.

Figure 1: Cell Density and Percentage of Intracellular Reactive Oxygen Species



This figure was obtained from, “Products released from surgical face masks can provoke cytotoxicity in the marine diatom *phaeodactylum tricornutum*,” (Sendra, M. et al. 2022).

Sources:

Sendra, M. et al. (2022) “Products released from surgical face masks can provoke cytotoxicity in the marine diatom *phaeodactylum tricornutum*,” Science of The Total Environment, 841, p. 156611. Available at: https://doi.org/10.1016/j.scitotenv.2022.156611.

Bañuelos-Hernández, B., Beltrán-López, J.I. and Rosales-Mendoza, S. (2015) Production of biopharmaceuticals in microalgae, Handbook of Marine Microalgae. Academic Press. Available at: https://www.sciencedirect.com/science/article/pii/B9780128007761000182 (Accessed: October 30, 2022).

Diatoms (no date) UCL. Miracle. Available at: https://www.ucl.ac.uk/GeolSci/micropal/diatom.html (Accessed: October 30, 2022).