Catching Plastics: Which Species of Algae can Best Catch Microplastics

Abstract

Microplastics have been rapidly spreading throughout the environment and found in humans. Therefore, it is pertinent that there is a system to catch microplastics. In the meantime, there is a possible solution, algae. This plant can grow in almost any condition and has been shown to be able to catch microplastics. In the Great Lakes scientists observed algae catching microplastics leading to projects about their ability to catch microplastics(Peller et al. 275). This can not be a permanent solution because microplastics can be toxic to their host(Zhang et al. 1287).

In this experiment, 6 different species of algae were tested for their ability to capture microplastics. Cladophora, Oscillatoria, Closterium, Oedogonium, Synedra, and Volvox algae were grown for a week and then 50 microplastic beads from a facial scrub were added. The first trial four of the six species tested could catch microplastics when grown in a flask with microplastics for one week. New cultures of: Cladophora, Oscillatoria, Closterium, Oedogonium, were each split into three petri dishes with 125 microplastics (facial scrub) and grown for 2 weeks. Samples were analyzed at one and two weeks. Week one there was significant growth in all algae, and all captured four or more microplastics. In week two, there was more growth in size and number of captured microplastics. Oscillatoria algae was able to catch all of the microplastics. This algae grows along the bottom of its surface, probably causing the microplastics to be anchored to the bottom of the petri dish.

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Question:

How does the type of algae affect the amount of microplastics that can be collected?

Hypothesis:

Cladophora algae will collect microplastics the best because it is a very long algae and is easily entangled making It more able to catch microplastics.

Independent Variable:

The type of algae

Dependent Variable:

The amount of microplastics collected

Controlled Variable:

The amount of time the algae grew and the conditions that they grew in

Background Research

Microplastics are everywhere. They are in the water we drink and the food we eat at every level of the food chain. Microplastics are the broken down forms of any plastic, except they are now extremely small, and can start to do real damage. One major source of water for roughly 30 million people, Lake Michigan, has several tons of microplastics within it (most microplastics weigh fractions of a gram). Currently there are no innovations that can successfully remove microplastics from water (Blok). However, this does not mean that there is nothing that can help contain microplastics.

In the Great Lakes a certain strand of algae, Cladophora algae, have been identified as mass stressors for fresh water wild life (Peller et al. 276). During the removal of the algae scientists found that there were mass amounts of microplastics stuck in the algae fibers (Peller et al. 276). This causes there to be microplastics at the base of the whole food chain, because there are microorganisms that will eat the micro-plastic infested algae. But the more important thing is that very hairy algae has the capability to capture the algae (Peller et al. 279).

Micro plastics can also kill their algae hosts (Zhang et al. 1287). They are killed by the microplastics by them stopping photosynthesis (Zhang et al. 1282). When these blooms (large amounts of algae) die off due to excess amounts of microplastics they spread across the water; which is even more toxic then before because now they are smaller so they can go more places ("Algae and microplastics together in the American Great Lakes). However, it is also inconclusive that microplastics kill off algae. In a meta analysis (an analysis of several different studies) there appeared to be no effect of microplastics on algae (Reichelt, Gorokhova). There for the information is disputed as to whether or not there would be a harmful effect on the algae when exposed to microplastics.

Microplastics are at every level of the food chain, and are damaging the environment in every biome. This keeps happening as more and more plastic is created every single day. There are a few new innovations that can help clean up the water; however, there is a possibility that humans could just turn to nature. It is already documented that algae can temporarily hold microplastics in one place. It is also documented that there are excessive algae blooms. This could turn into a benefit for people by using the overgrown algae to help with the micro-plastic problem. The only inconclusive questions are would this kill the algae, thus spreading more, smaller microplastics; and which algae would be able to take in the most microplastics.

Microplastics can have several effects on our environment. Micro plastic pollution is a major problem occurring all over the world. They are toxic and they can also cause malformations in almost every species of animal. However, if it is possible to remove them from the environment then one problem of many facing this planet in the 21st century would be solved.

Materials:

1. Algae culture Kit
    a. Oscillatoria algae
    b. Closterium algae
    c. Oedogonium algae
    d. Synedra algae
    e. Volvox algae
    f. Cladophora algae
    g. Alga-Gro Freshwater Medium
    h. Petri dishes
    i. Sterile Pipets
2. Microscope (AmScope ST-30-2L) (including camera lenses to take photos)
3. Microplastics (From Clean and Clear Morning Burst Facial cleanser) (These are semi large microplastics that can be easily differentiated from the algae)
4. Tweezers (to remove microplastics from algae)
5. Flasks, 250 mL (to culture the algae and allow it to grow)
6. Gloves (to avoid contamination of the algae)
7. Goggles (to protect eyes at any given time)

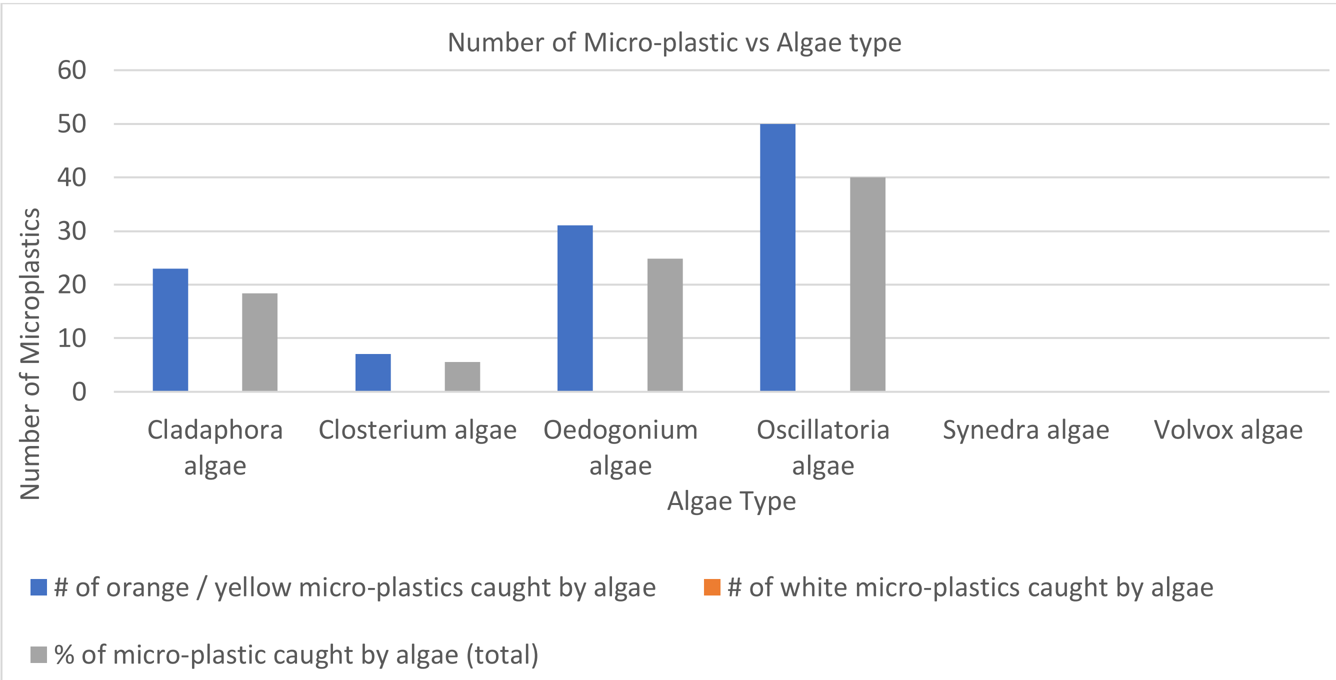
Procedure:

1. Hands were washed using CDC guidelines on hand washing to avoid any contamination of the algae
    a. Hands were placed under lukewarm water
    b. Soap was applicated and hands were removed from the water
    c. The soap was scrubbed in for 20 seconds
    d. The soap was rinsed off of hands
    e. A paper towel was used to dry off hands
2. Gloves were put on using a sterile method
    a. The thumb and forefinger were used to apply glove to the left hand
    b. Theis was repeated for the right hand
3. The algae (Cladaphora algae, Closterium algae, Oedogonium algae, Oscillatoria algae, Synedra algae, Volvox algae) was opened the same day it was received in the mail.
4. The caps were loosened to allow for the algae to be exposed to air in a new habitat.
5. The algae was placed in indirect sunlight.
6. The gloves were taken off with a CDC approved method to ensure there is no contact with the skin.
    a. The right hand used the thumb and forefinger to pinch the glove int eh palm of the and.
    b. The glove was then pulled off with the fingers staying in this position.
        i. The glove came off inside out.
    c. The left glove stayed in the right hand.
    d. The three middle fingers on the degloved left hand were placed under the glove in the right wrist.
    e. The fingers were pulled forward taking the glove with it.
    f. The gloves were put inside of one another while the right glove was being taken off.
    g. Both gloves were immediately disposed of.
7. All equipment was boiled for 15 minuets to be sterilized.
    a. Tongs were used to place and remove the materials in the water and oven mitts were worn when dealing with the hot water/pot.
8. Hands were washed
    a. See step one for full method
9. Gloves were put on
    a. See step two for full method
10. 5 mL of water from the original container of algae was combined with 100 mL of distilled water
11. Gloves were taken off
    a. See step six for full method
12. Hands were washed
    a. See step one for full method
13. The algae grew in indirect sunlight for 7 days
14. Hands were washed
    a. See step one for full method
15. Gloves were put on
    a. See step two for full method
16. The algae was then moved into Petri dishes along with 10 mL of distilled water
17. Gloves were taken off
    a. See step six for full method

18. Hands were washed
    a. See step one for full method
19. To avoid cross contamination hands were washed again
    a. See step one for full method
20. Gloves were put on
    a. See step two for full method
21. Microplastics were removed from the facial cleanser
22. The microplastics were added to the Petri dishes and left to sit for 3 days
23. Gloves were taken off
    a. See step six for full method
24. Hands were washed
    a. See step one for full method
25. Hands were washed
    a. See step one for full method
26. Gloves were put on
    a. See step two for full method
27. Algae was removed form growth containers
28. Algae was placed in a metal strainer (with very small holes)
29. Algae was put into Petri dishes to be analyzed under a microscope
30. Gloves were taken off
    a. See step six for full method
31. Hands were washed
    a. See step one for full method
32. The microplastics were counted and removed (placed into another Petri dish) using tweezers as the counting process went on
33. The the microplastics are recounted to ensure a correct count was done initially
34. The count was then recorded and made into a data table
35. Hands were washed
    a. See step one for full method
36. Gloves were put on
    a. See step two for full method
37. All algae was placed into a flask and 3 tablespoons of bleach were added
38. Once the algae had sat in the bleach for 20 minuets to completely kill the algae, it was dumped down a kitchen sink.
39. Gloves were taken off
    a. See step six for full method
40. Hands were washed
    a. See step one for full method

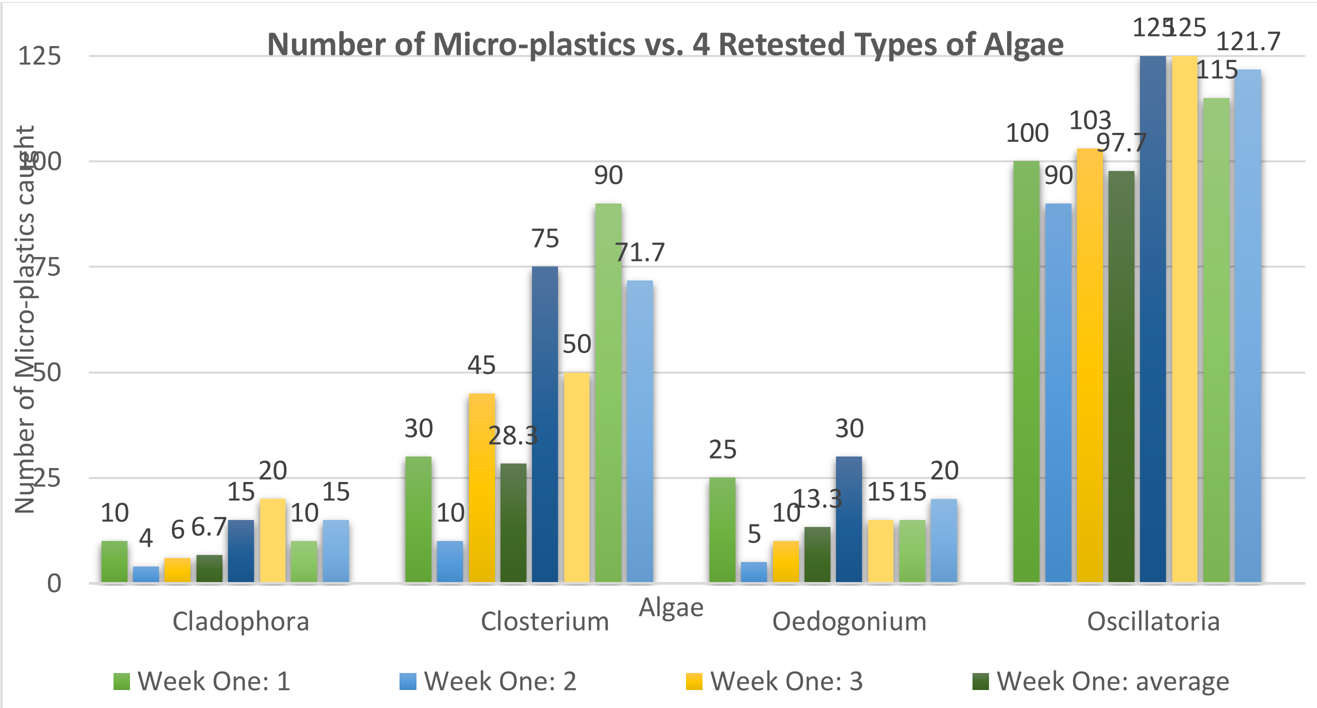
Data Analysis Chart and table examples:

Test Number One



Algae Type	Cladophora algae	Closterium algae	Oedogonium algae	Oscillatoria algae	Synedra algae	Volvox algae
# of orange / yellow microplastics placed in algae and water mixture	50	50	50	50	50	50
# of white micro-plastic placed in algae and water mixture	75	75	75	75	75	75
# of orange / yellow microplastics caught by algae	23	7	31	50	0	0
% of micro-plastic caught by algae (total)	18.4%	5.6%	24.8%	40%	0%	0%

Test Two:



	Cladophora	Closterium	Oedogonium	Oscillatoria
Week One: 1	10	30	25	100
Week One: 2	4	10	5	90
Week One: 3	6	45	10	103
Week One: average	6.7	28.3	13.3	97.7
Week Two: 1	15	75	30	125
Week Two: 2	20	50	15	125
Week Two: 3	10	90	15	115
Week Two: average	15	71.7	20	121.7

Discussion:

One factor that could have contributed to the results yielded was that the Cladophora algae did not grow at anywhere close to the same rate as any of the other algae. While all algae grew to about the size of the surface area of the bottom of the petri dish or flask (some got even bigger), the Cladophora algae stayed roughly the same size. The small size of the algae might have contributed to the amount of microplastics it was able to catch. One thing that happened in this experiment was that the microplastics broke down. Small parts of the microplastics broke off of one another and there were small figments being caught up in all the algae alongside the original microplastics. These breakdowns did not affect the experiment and only the microplastics that retained a spherical shape were counted. In the second test, no white microplastics were used and that is because in the first test they floated in the water so they were introduced but never caught because the algae could not attach themselves to the white microplastics. They might have floated because they were mostly made up of polystyrene meaning that there are a lot of air bubbles in the plastic.

Conclusion:

Oscillatoria algae is the most successful at catching microplastics. This is most likely due to the fact that Oscillatoria algae is a mating alga, so it grows along the bottom or sides of whatever surface it is on, pining the microplastics down between it and the bottom of the petri dish. The Closterium and Oedogonium algae were both successful at catching microplastics, not as successful as the Oscillatoria algae. Synedra and Volvox algae were not able to catch any microplastics probably because, the algae is smaller than the microplastics and they are not able to penetrate the algae and then bond together similarly to the Closterium algae. So, any algae that is the same size or smaller than the Volvox and Synedra algae might not be able to catch any microplastics.

Ideas For Future Research:

One way that the experiment could be expanded is by initially growing the Cladophora algae for longer than introducing the microplastics, because it would be good to know if the Cladophora algae is able to catch mass amounts of microplastics with a greater size. This is because, Oscillatoria algae only grows along shorelines and is not in the body of water itself so there is limitations on how much microplastics it can catch. Another way to continue this research would be to grow Oscillatoria algae in various environments (ie. the surface it grows on would be different: rocks, sand, pebbles, etc.). This would give data on where the Oscillatoria algae could have the most impact to catch microplastics.

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