Bioremediation of Polyurethane in Soil using *P. Microspora*

Soil plastic breakdown in-situ by Amazonian fungi

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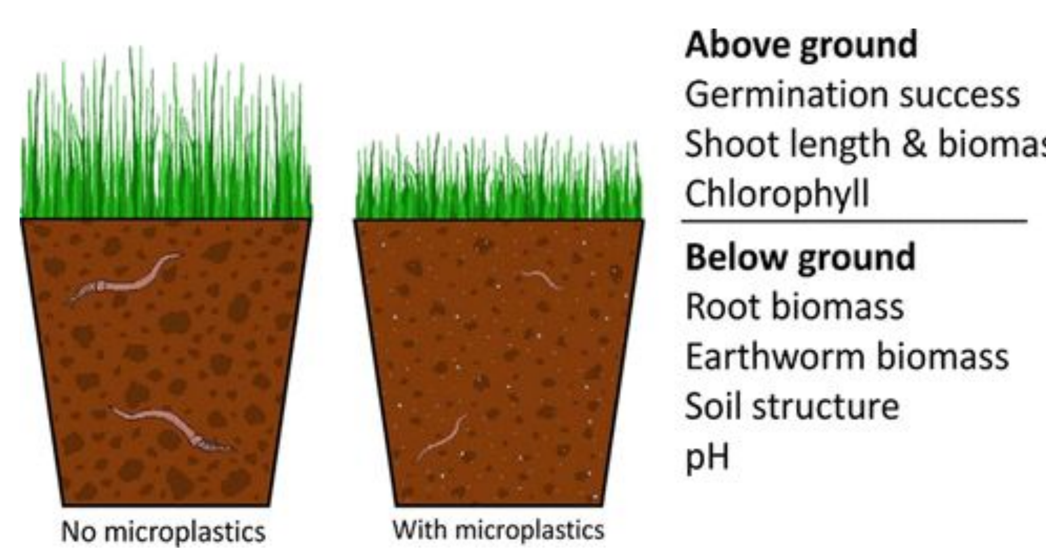
Abstract

It can take hundreds to thousands of years for plastics to break down in the environment. As they break down, they form tiny pieces of plastics called microplastics. Microplastics are formed from many different types of plastic materials, including textile fibers, cleaning and personal care products, and many types of packaging. As plastics are ubiquitous in consumer products, microplastics are a very common and prevalent problem now, and will be long into the future. Microplastics end up in water and soil, where they leach chemicals and contaminants into these natural resources. Researching how these microplastics interact with soil can lead to ways to treat this contamination. In a lab setting, the fungus *Pestalotiopsis microspora* has shown promise in breaking down plastic, but its ability in-situ is untested. This experiment seeks to see if *P. microspora* can break down microplastics within recreated natural conditions to assess their potential as a form of bioremediation.

Motivation

Microplastics and all of their implications are not fully understood. We wanted to contribute to this emerging and exciting field. We also had an interest in the environment, specifically in soil, the foundation of nearly all land-based life on earth. By pursuing avenues of bioremediation of soil, we aim to offer potential solutions to the problems associated with microplastics in soil, including lower pH, lower seed germination, lower plant biomass, lower earthworm biomass, accumulation of toxic metals, and alterations in soil stability, all of which impact crucial soil functions.

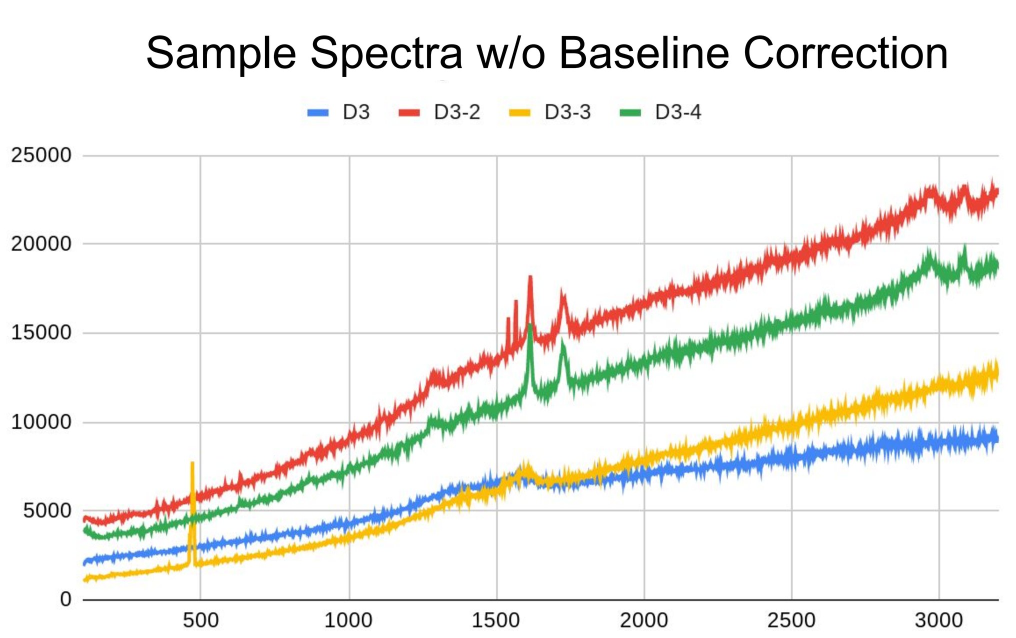


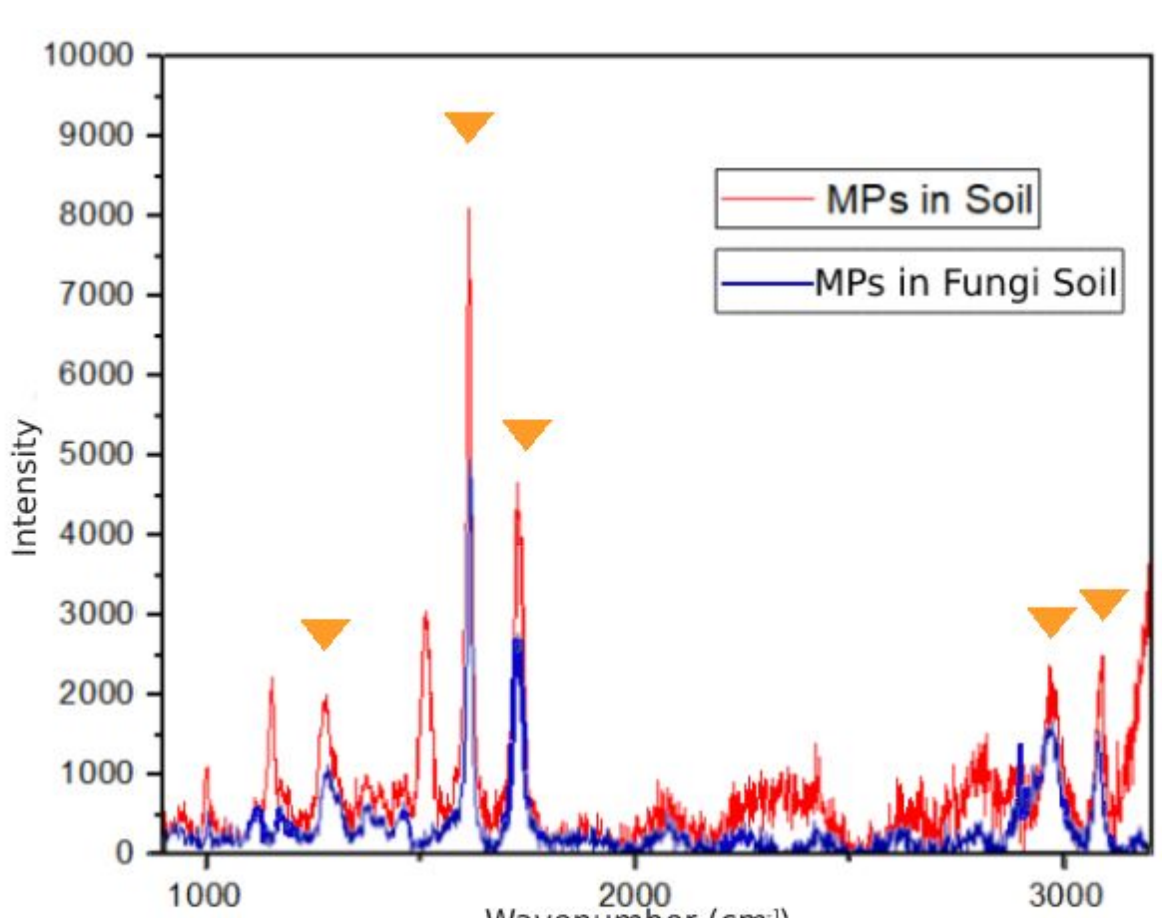
Methods

First, we gathered the plastics polyurethane and polyethylene as powders to mix into the soil samples. In each sample there was 1 gram of plastic (either polyurethane or polyethylene). Each sample contained 50 grams of soil, along with biochar and fungi samples, where we used 1.5 and 1 grams respectively to create a control soil, biochar, fungi, and biochar&fungi for each plastic. We sprayed the samples with water once weekly, along with keeping the samples at 28 degrees celsius, for 8 weeks. At Argonne, we used a 735nm laser to create Raman spectra for each sample in order to compare differences in the chemical composition of the samples to evaluate the effectiveness of mushroom and biochar methods. Along with Raman spectroscopy, we also used an SEM to image soil samples.

Data Analysis

We graphed the individual soil samples using Excel, and we chose samples with peaks in the same corresponding regions as our polyurethane spectra to make sure the sample was a MP. We averaged out the intensities of the MP samples based on their soil medium, and used OriginLab to remove background fluorescence. From there, we graphed the fungi MP data over the control MP data to find our results. Our biochar and polyethylene results did not give conclusive data.

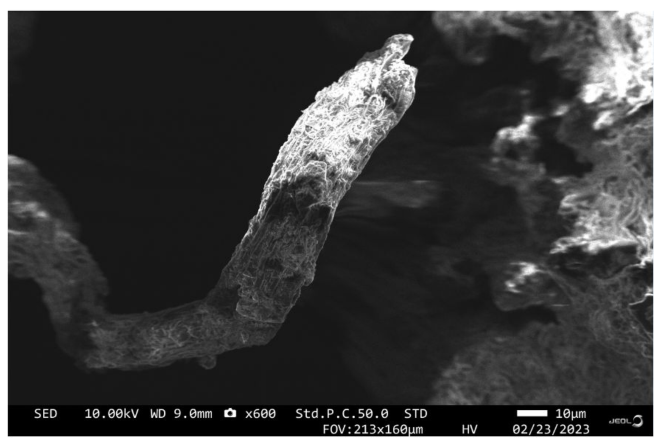




SEM Imaging

Potential *P. microspora* rhizomorph

***P. microspora* hyphae**



Density separation test

Conclusion

According to the graphs above, the soil that is contaminated with microplastics and without fungi has high peak that are very pronounced. The soil with the fungi also has peaks, but the peaks are, on average, 40.81% less intense than the other sample across the 5 indicator sites. This decreased intensity tells us that the polyurethane was degraded significantly by the fungi over a tiny period of time relative to the normal breakdown rate of polyurethane. Therefore, we proved *P. microspora* is a very effective tool for soil bioremediation. However, we could not prove the effectiveness of biochar on soil remediation, as well as the ability to break down polyethylene in a similar fashion.

Next Steps

-Extension on time to see the extent to which the fungi degrades the plastic as well as periodic testing to monitor the rate of degradation
-Isolation of MPs using density separation to get more consistent results
-Grow fungal cultures before placement into soil to have even better growth of the fungi
-Utilize other remediation agents, such as biochar, to assist the fungi
-Apply the fungi remediation to soil with new qualifications for success, such as maintaining pH, plant biomass, germination, and earthworm biomass

References

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