Rock-Eating Fungi

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Abstract

Mycorrhizal fungi share a symbiotic relationship with almost 80% of all known plant species on Earth. The give and take relationship is driven by the fungi's ability to acquire essential nutrients in rocks and minerals and make them accessible for plants. A common and important nutrient needed by all life is phosphorus for the generation of ATP and the building of proteins and DNA. In this experiment, we observed the ability of a fungi, *amanita bisporigera*, to utilize a mineral source to obtain nutrients needed to grow versus having the nutrients supplied by chemicals in solution. The fungi released various acids as shown by a decrease in pH during the growth period which we assumed were used to help dissolve the mineral sources and release needed elements. It was also seen that acid phosphatase (an enzyme used to release chemically bound phosphate) levels were higher in flasks where fungi were given a chemical source rather than in fungi with a mineral nutrient source. Fungi grown with granite versus a chemical nutrient solution had a higher biomass (evidence of more growth) but the fungal mats strongly attached grains and crystals to their hyphae, which could have accounted for most of the weight.

Background

Growth limiting factors, such as the bioavailability of essential nutrients, have a great impact on the structure of ecosystems. These nutrients, such as phosphorus (P), calcium (Ca), potassium (K) and magnesium (Mg), exist in soils but can be locked up in minerals and inaccessible to plants. Because of their earlier colonization of land, fungi have developed biochemical and biophysical weathering abilities which help them to utilize mineral sources in ways which plants cannot. This lead to the devolvement of a symbiotic relationship between plants and fungi called a mycorrhiza.

Mycorrhizal fungi are commonly found colonizing root tips and supplying plants with P and important metals in exchange for photosynthetic carbon compounds. The fungi use organic acids and carbonic acids as a chemical means to break down rock material. Also, fungal hyphae follow natural cracks or grooves on mineral grains and cause etching of the surfaces, weathering the rock further and releasing nutrients. These processes play an important role in the generation of soils and the mobilization and redistribution of key elements. Because they have the ability to thrive in nutrient poor soils, fungi along with other microorganisms, make the soil fit for other life. This is one of the many reasons they have become an important topic in soil ecology and in the restoration and conservation of natural habitats.

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Objective and Methods

Amanita bisporigera, or Destroying angel, being grown on culture plates of potato dextrose agar

❖ To observe the growth of the mycorrhizal fungi *amanita bisporigera* and its growth given a mineral nutrient source (granite) vs. a chemical nutrient source.

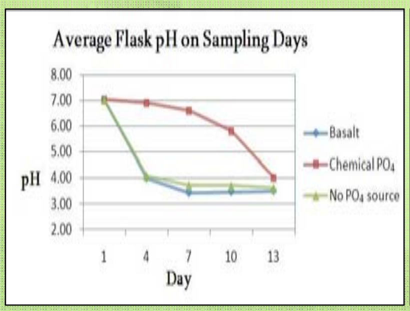
- Fungal mats were added to flasks given a nutrient solution containing a carbon (C) and nitrogen (N) source. Granite was added as a nutrient source to some flasks, and a modified Melin-Nokrans solution was given to other flasks. The fungi were grown for 13 days with consistent shaking of flask solutions. Samples were taken every 3 days for pH analysis and acid phosphatase assay.
- We hypothesized that the fungi given granite would expend more energy in acquiring nutrients from the granite and less into biomass growth. We expected the fungi grown in the Melin-Nokrans media to have more biomass in than the fungi grown with granite. Also, we'd expect to find a greater change in pH and phosphatase activity in flasks with granite.

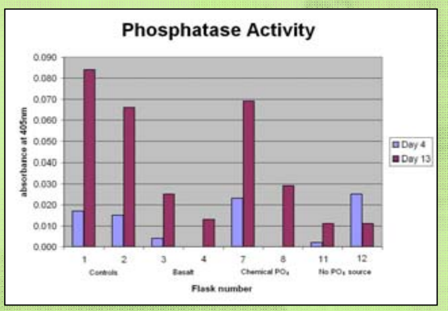
❖ To observe biochemical activity of *amanita bisporigera* in the obtainment of phosphorus from either a mineral (basalt) or chemical source

- Using similar methods as above, in this experiment the fungi were grown with either basalt as a source for P or were given a chemical P source along with the C and N sources. No trace metals were added.
- For this experiment, we hypothesized that the solution in the flasks would become steadily more acidic as the fungus grew, and that flasks with a mineral source would have a lower pH than those without, signifying the release of organic acids to dissolve the basalt. Also, a higher phosphatase activity would be detected in flasks given basalt.

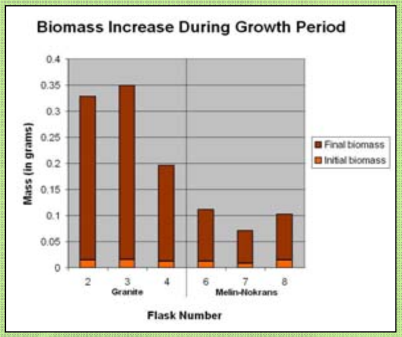
Results

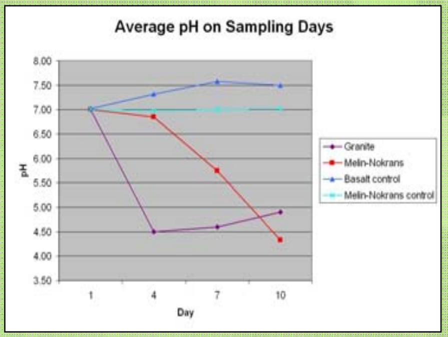
Fungi Grown in Basalt





Fungi Grown in Granite





Discussion and Conclusions

❖ Fungi grown with basalt:

Observations were made of fungal mats adhering tightly to the basalt grains. Fungi grown in flasks with basalt showed a faster decrease in pH than those which contained a chemical P source. This could indeed signify a greater release of organic acids by fungi to dissolve nutrients locked in the basalt, but it was also found that high levels of phosphate (PO_4) can form a buffer which can delay the lowering of pH despite an increase in the release of organic acids. Thus, further experiments would have to be performed to get an accurate sense of levels of organic acids being produced by the fungi in the presence of mineral sources, or the amount of chemical P given would be significantly reduced. Acid phosphatase assays suggested that the fungi given a chemical source produced more of this enzyme than those with a mineral source. This does not necessarily mean the granite-grown fungi did not use this enzyme, but rather may have housed more of it in their hyphae than was released into solution. In the end, we did not see a significant difference in the pH levels of either set of flasks.

❖ Fungi grown with granite:

Again in this experiment, fungal mats adhered to the granite grains. The pH trend remained the same as before, and again the PO4 can be accounted for as a buffer in the Melin-Nokrans solution. It was found that the biomass of the fungi grown with granite was increased more than those grown with the chemical nutrient solution. This goes against the initial hypothesis, but the greater mass could be accounted for by crystals and mineral grains that were precipitated and attached to the fungal hyphae. To test how the fungi utilized important nutrients, a cation analysis of the samples may be done in the future to determine the release of metals into the solution from the minerals being dissolved and etched.

Acknowledgments

We'd like to thank the Department of Civil and Environmental Engineering at North Western University for the use of their equipment and lab facilities. We'd also like to show our gratitude to Rich Warta, the department's lab director for help with acquiring supplies and equipment needed for the experiments, as well as Joel Moore. We would also like to thank NSF-REU grant 0648972 for support.

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