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Research Plan

The Effect of Aster amellus and Carex morrawii on the Absorption of Metals in the Groundwater

A: Rationale

Heavy metals are non-biodegradable and can cause several long-term health issues, such as bone defects and respiratory problems. The coast of Long Island is tested yearly for heavy metal accumulation due to potential health concerns (Status and Trends: LISS Environmental Indicator, 2019). Groundwater contamination has become a significant issue today as it is responsible for unsafe drinking water, as well as, wildlife damage (Toxic Substances, n.d.) With increases in industrialization and disturbances in the natural biogeochemical cycles, heavy metal concentrations of lead, barium, and mercury have increased within the soil (Ali, et al. ,2013). According to the Long Island Sound Study, zinc, mercury, and copper levels in drinking water have been found to be rising between 2000 and 2018 (Status and Trends: LISS Environmental Indicator, 2019).

One way to address the pollution is through phytoremediation. Phytoremediation uses terrestrial or aquatic green plants, to remove, contain, inactivate, or degrade harmful environmental pollutants (Vassilev et al., 2004). Plants absorb metals and store them in their aerial shoots like they do for water and nutrients. An increasing number of cost-effective phytoremediation techniques are being researched to remove metals from both the soil and ground water. One technique within phytoremediation is phytoextraction. By decreasing the availability of the heavy metals in ground water and soil, ecosystems will become healthier and more robust.

B. Research question

Which plant *(Aster amellus* or *Carex morrowii)* will be able to absorb metals from the groundwater most effectively while maintaining its own health?

Hypothesis

Aster amellus, belonging to the *Asteraceae* family, is well-known for removing pollutants from the environment via phytoremediation (Nikolić, M. 2015). Although research has not been done on the specific metals being absorbed, it does exhibit phytoremediation promise. Past experimentation of perennials contributes to the idea that both plants have the ability to absorb materials, but further research still needs to be done. (Merkl et al. 2004).

C. Procedure

General Information:

1. All XRF results will be calculated internally within Bruker S1 Titan XRF using S1 SYNC software
2. Primary Drinking Metals in 2% HNO_3will refer to a pre-made solution containing 100ppm arsenic, 100ppm chromium, 10ppm silver, 50ppm barium, 100ppm lead, 50ppm cadmium, and 50 ppm selenium.
3. Primary Drinking Water Metals in 5% HNO_3 will refer to a pre-made solution containing 20 ppm mercury
4. Prior to experimentation, download the Bruker Toolbox 1.7.0.128 and instal onto a computer

Setting up the Bruker S1 Titan XRF Device (per manual):

1. Press the on button of the Bruker S1 Titan XRF and allow the machine to warm up for 5 minutes
2. Place the Bruker S1 Titan XRF machine into the accompanying stand and allow the opening at the top of the stand to align with the front of the machine. The machine should be in a vertical position

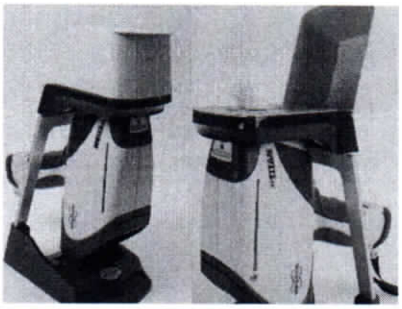

Figure 1. The set-up of the Bruker S1 Titian XRF during experimentation (Bruker.com, 2018)

3. Using the included USB cable, connect the cable into the Bruker S1 Titan and a computer (view step 4 in General Information)
4. On the computer, open up the Bruker Toolbox and click "Utilities" followed by "System Setup" and then "Connections". To ensure the USB is connected click "Enable USB"
5. Bring the computer screen back to the original page so that "Ready to Set" is seen in a green box at the top of the page

Preparation and Experimentation of Aster and Japanese Sedge

<u>Aster and Japanese Sedge Preparation</u>

1. Collect a flowering Aster plant and obtain a large pot.
2. Fill ¾ of the pot with soil from derived from a natural ecosystem and create a 3 in. well in the middle.

3. Place the Aster plant in the well and flatten the remaining soil to create a smooth top
4. Remove a leaf and flower petal from the plant and set aside for XRF.
5. Poke 2 holes that are one inch deep, 2 holes that are 1.5 inches deep, and 2 holes that are 2 inches deep. This is done from the top of the soil to the base of the plant
6. Apply 250 microliters of Primary Drinking Metals micrograms/mL in 2% HNO_3 and 250 microliters of Primary Drinking Water Metals micrograms/mL in 5% HNO_3 at the base of each hole
7. Fill in the holes and water the plant with 50mL of deionized water
8. Continue to water twice a week (preferably Mondays and Thursdays) during the duration of experiment.

<u>XRF of Aster and Japanese Sedge:</u>

1. Place a small sample of leaves derived from the Aster place a small sample into a 50ml weigh boat, covered with saran wrap.
2. Set-up the Bruker S1 Titan XRF machine.
3. Place the Aster sample on the head of the machine and allow 80 seconds for the machine to process results.
4. Record the composition of elements (ppm).
5. Repeat steps 1-4 for each sample.
6. Place a small sample of soil from the Aster plant into a plastic dish, covered with saran wrap.
7. Set-up the Bruker S1 Titan XRF machine.
8. Place the sample on the head of the machine and allow 80 seconds for the machine to process results.
9. Record the composition of elements (ppm).
10. Repeat steps 6-9 for each sample.
11. Repeat steps 1-4 and 6-9 for Japanese Sedge

Risk and Safety

- Gloves, gowns, and goggles will be used to prevent the substances from coming in contact with the skin or eyes.
- Various hazardous substances and devices will be used during the duration of the experiment.
  - An X-ray fluorescence machine will emit a ray at the targeted source. When in use, the device will be covered with the included protective shield to avoid any safety concerns. The XRF machine has a locked top cover which prevents the beam from leaving the device. Proper procedures are to be followed to minimize personal risk while testing. The cover will be checked for cracks before use.
  - The 2% HNO_3 (100ppm arsenic, 100ppm chromium, 10ppm silver, 50ppm barium, 100ppm lead, 50ppm cadmium, and 50 ppm selenium) and the 5% HNO_3 (20 ppm mercury) will be disposed of in the toxic heavy metal container to be removed by NYIT facilities.
- Micropipette tips will be properly disposed after use into the designated trash disposal, without contact to any surfaces.
- Following the experiment, contaminated soil/plant matter will be disposed of in a sealed hazardous waste container. The container will be properly disposed of by NYIT facilities.

D. Bibliography

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NO ADDENDUMS EXIST