Teacher's Notes for Chemical Competition in Plants Laboratory Exercises

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Lab Objectives-

These lab exercises were designed to enhance students' understanding of the concept of chemical competition in ecology. They use the moss *Sphagnum* to illustrate the concept, which shows students that competition occurs between plants. Many of the traditional examples show competition as a physical battle between animals. By using the chemical alteration of the environment by *Sphagnum*, a teacher can also review the concept of pH, in a biological framework. As a result, the lab can be used in either an ecology unit or a chemistry unit, within a biology course. The lab was designed for 10^{th}-12^{th} grade classrooms.

Pre-lab Preparation-

The lab is a fairly simple set-up and there are very few "tricks" to getting the lab to work. Once the materials are gathered, they can be set-up in either a cafeteria style lab where the students can gather their own materials and bring them back to their seats, or partitioned into "kits" for each the lab groups. As with any lab, smaller groups will allow more contact time per student and, in theory, better understanding of the material.

The salt described in the lab can be common table salt, which is readily available at any grocery store. The suggested amount can be altered, which may in turn have slight alterations to the rate at which the pH changes, and/or the final level of pH that the moss is able to achieve. This may even be something that can be adjusted by students as an extension of the lab.

What is *Sphagnum* moss?

The genus *Sphagnum* (common name peatmoss) comprises many species, which are typically recognized and rather easily distinguished from other mosses by their upright stem with a dense cluster of tightly packed terminal branches forming like a head (also named *capitulum*; **Fig. 1)**. Below the capitulum, the branches are more widely spaced, given the plant a feathery appearance (**Fig. 2)**.

Fig. 1. *Sphagnum.* The plants are upright, and the upper branches are clustered into compact heads.

The *Sphagnum* leaf

The leaves of mosses are typically only one layer thick except for the midrib. *Sphagnum* lacks a midrib, and its leaves are composed of two types of cells: green photosynthetic cells alternating with large clear, dead cells (**Fig. 3**). The dead cells have pores and hence the entire cell can be filled with water. With half the cells of peatmosses being dead and potentially filled with water, it is not surprising that peatmosses can hold perhaps as much as 200 times their own dry weight in water!

You can find out more in a short chapter on ***Sphagnum*** in free on-line book by Dr. Janice Glime entitled ***Bryophyte Ecology***.

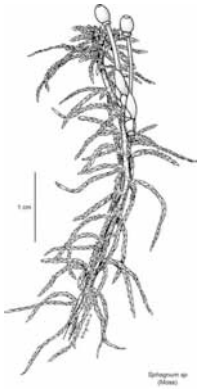

Fig. 2. *Sphagnum* habit. From Vanderpoorten & Goffinet (2009)

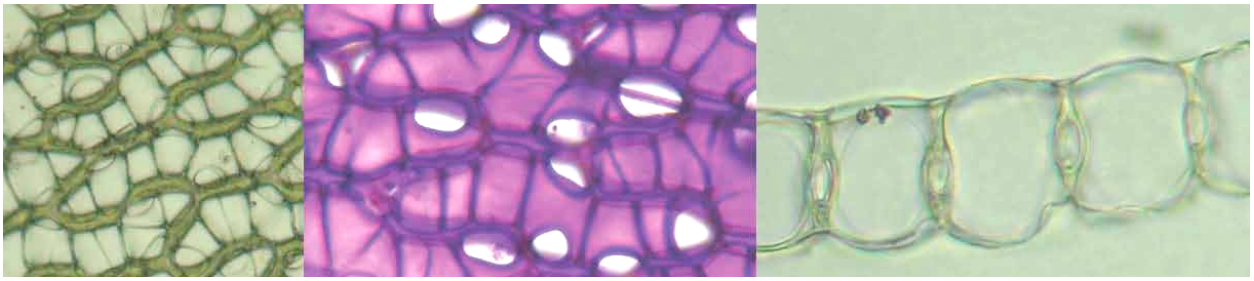

Fig. 3. Architecture of the *Sphagnum* leaf. Left: alternation of narrow green photosynthetic cells and large empty, dead cells. Middle: when stained with Gentian violet, the pores in the walls of the dead cells are clearly evident, since the stain binds to the cell wall only. Right: the cross section of the leaf reveals more clearly the alternation of small photosynthetic cells sandwiched between the larger dead cells.

Where do we find *Sphagnum* moss?

Peatmosses are found in wetlands or along brooks in forests (**Fig. 4)**. The moss is often found in "stands" of many individuals forming soft cushions or more often mats. They can easily be collected by gently pulling the plants out of the soft substrate of the wetland that they inhabit. Be sure to ask landowners for permission before colleting plants. Collection permits are necessary to collect plants on state or federal lands.

Fig. 4. Peatmosses grow in wet habitats, typically with little water flow. At high latitudes in both hemispheres they form extensive peatlands, dominating the vegetation (left; Patagonia). Such *Sphagnum* dominated vegetation may also occur at high altitudes in tropical latitudes. In more temperate zones, *Sphagnum* may occur along brooks (right; New England forest).

Peatmosses are commercially harvested and are used by florists and nurseries for their water retaining properties. *Sphagnum* mosses for this lab exercise may be purchased at your local florist, nursery, or online through **Carolina Biological Supply**.

Fig. 5. Commercially available peatmosses from a local nursery.

Collecting *Sphagnum*

The moss can be collected a few days prior to the lab activity. Live peatmosses are best kept in a closed plastic container in a fridge for a few days or in a well lit but cool room. Although they can be kept for a long time in a fridge, fungi may develop (since they do not need any light), so it is best to collect plants only a week or so in advance, and keep them damp and exposed to some sunlight for best storage. At the start of the lab, clean the material, removing all dead organic material attached to the plants and if needed cutting of the lower portions of the stem. The smallest amount of debris on the moss samples can provide enough ions in the water to effect the results. So especially if you run the second exercise, this step is key to have meaningful results.

How much *Sphagnum* do you need?

This depends on the size of your beakers. The moss should loosely fill the container with enough space for mixing of the water (**Fig. 6**)

Where to acquire other non-moss aquatic plants (ex. *Elodea,* Duckweed)?

A non-moss aquatic plant is needed for exercise 2. Several options, including *Elodea* and Duckweed are available from **Carolina Biological Supply**. Alternatively, aquatic plants could be collected from a local pond or lake. Be sure to ask landowners for permission before colleting plants. Collection permits are necessary to collect plants on state or federal lands.

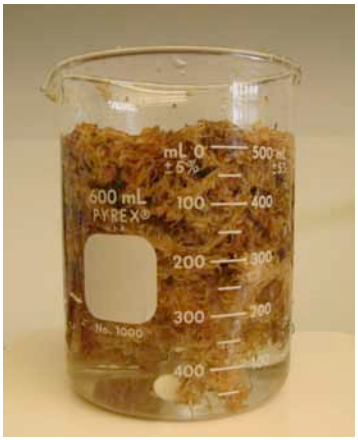

Fig. 6. Commercially available peatmosses in a laboratory beaker in water.

Protect your environment

Invasive plants are often accidentally introduced. It is always good practice to kill and dispose of exotic plant material properly by autoclaving or oven-charring and not throwing them out in the compost or in the sink. This is especially important if you obtain exotic plants for this laboratory, any plants not native to your area, even if they are from within the United States.

Data Collection

The suggested data collection units are the various digital data collected units available, (ex. Vernier Lab Quest, Pasco Spark). These interfaces will allow students to connect one, or more, pH probes, collect accurate data at set time intervals, and then export that data for later analysis. The lab is set-up to have students work with a single probe, adding the salt half way through the lab (exercise 2), but a student group could also have multiple probes for use so that they can collect the data from both the experimental (with salt) and control (without salt) groups simultaneously. Data collection could be modified by using digital pH meters or pH strips. The pH strips could be dipped at regular intervals to show the changes in pH that will occur over the course of the lab, but they would not give the details that the digital options would offer.

References

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