

Bryophytes & Pteridophytes (the free-sporing plants)

Before Coming to Lab Exercise: The Free-sporing Plants in the Field

Step 1: Read the introductory remarks and list of characteristics of the Bryophytes (p.3) and Pteridophytes (p.8). Be mindful of which lineage lacks vasculature, which has a poorly developed cuticle, and which lineage(s) require the presence of external water for swimming sperm during fertilization.

Step 2: Then, in the callout boxes of the diagram of a stream below, write in your predictions (hypotheses) for the abundances of each lineage in the locations (A through E) pointed to in the diagram.

Rules:

1. For each lineage, use each abundance value only once across all 5 location boxes (e.g., do not put the same abundance value, e.g., 2, for bryophytes in two different boxes).

2. Do not use the same abundance value for both lineages in the same box (e.g., if you've predicted bryophytes to be abundant in Area A, then do not also list pteridophytes to be abundant there as well – instead use "common," "not so common," or some other abundance value for the pteridophytes in that box).

Step 3 (optional): During the lab or on your own, visit the stream actually diagrammed below in the Bush, at the entry to the main trail, just upstream from the Conestoga River and about 10 m upstream from the small foot bridge-entrance to the main trail. See bryophytes and pteridophytes in their typical habitat. How well did your predictions hold up to real observations?

Abundance Codes:

1 (abundant) 2 (common) 3 (no so common) 4 (v. sparse) 5 (absent)

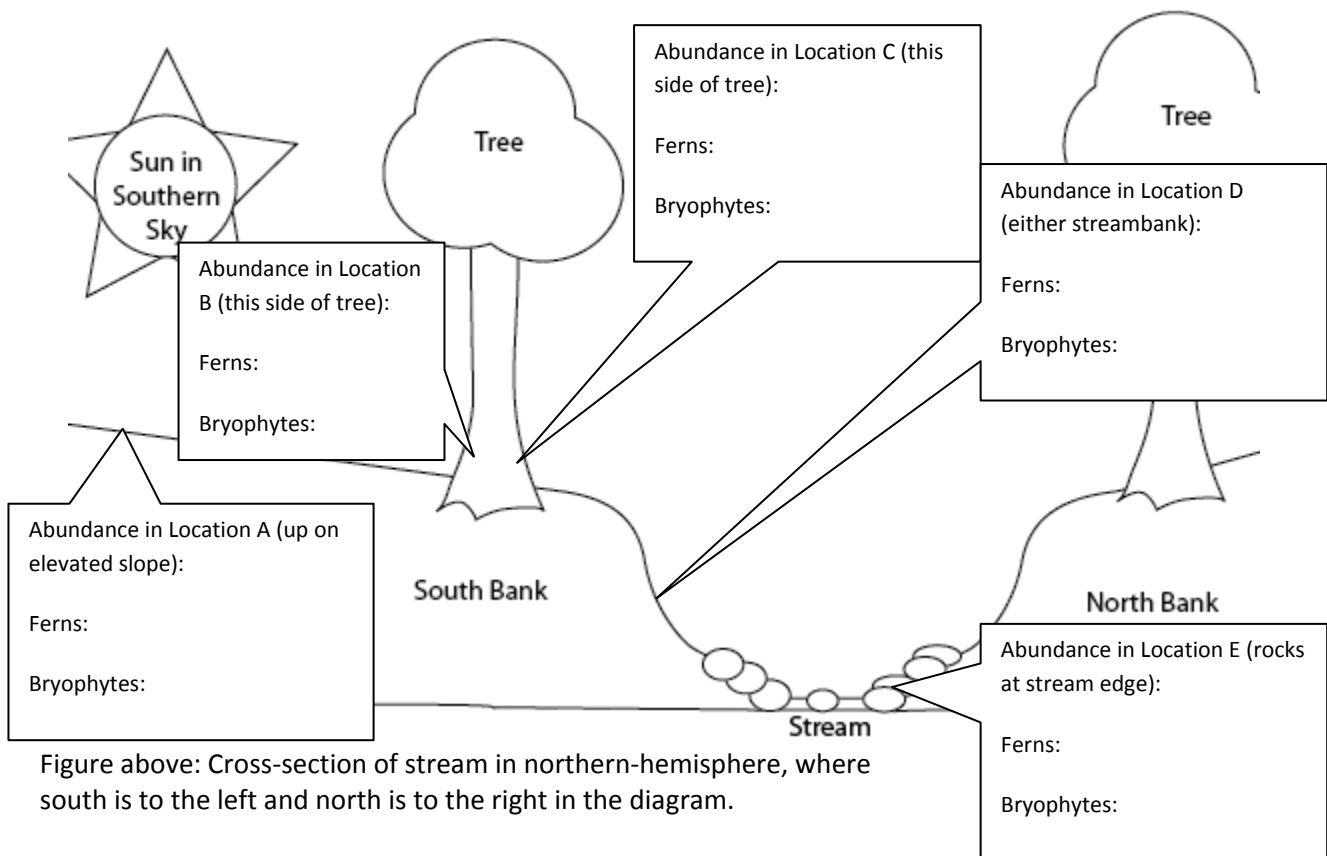


Figure above: Cross-section of stream in northern-hemisphere, where south is to the left and north is to the right in the diagram.

Proceed to Actual Lab Exercises

I. Bryophytes

Bryophytes is a general term for the non-vascular, free-sporing plants we know as mosses, liverworts, and hornworts. Their characteristics are as follows:

- No xylem or phloem (i.e., non-vascular);
- No seeds or pollen (free-sporing: spores are released from sporophyte and must find moist spot to grow);
- Cuticle absent to poorly developed;
- Gametophyte large (relative to other plants): it is the green, persistent, dominant phase of the life-cycle;
- Require external water for fertilization (i.e., sperm from male gametophyte must swim to egg of female gametophyte);
- Gametophytes have simple dichotomous branching if at all; sporophytes smaller than gametophytes & unbranched;
- No true leaves or roots.

A. Liverworts (p. 376 in Stern)

We will focus our study on the so-called thalloid/thallose liverworts, which have very simple vegetative structure to the gametophytes – in that their body consists of a thallus (flattened body) that is *not* differentiated into stem, leaf or root. The thallus has unicellular projections called rhizoids that help anchor the plants to the substrate and may also absorb water.

1. GAMETOPHYTES.



a) Labeling of Picture with aid of Book Figures.

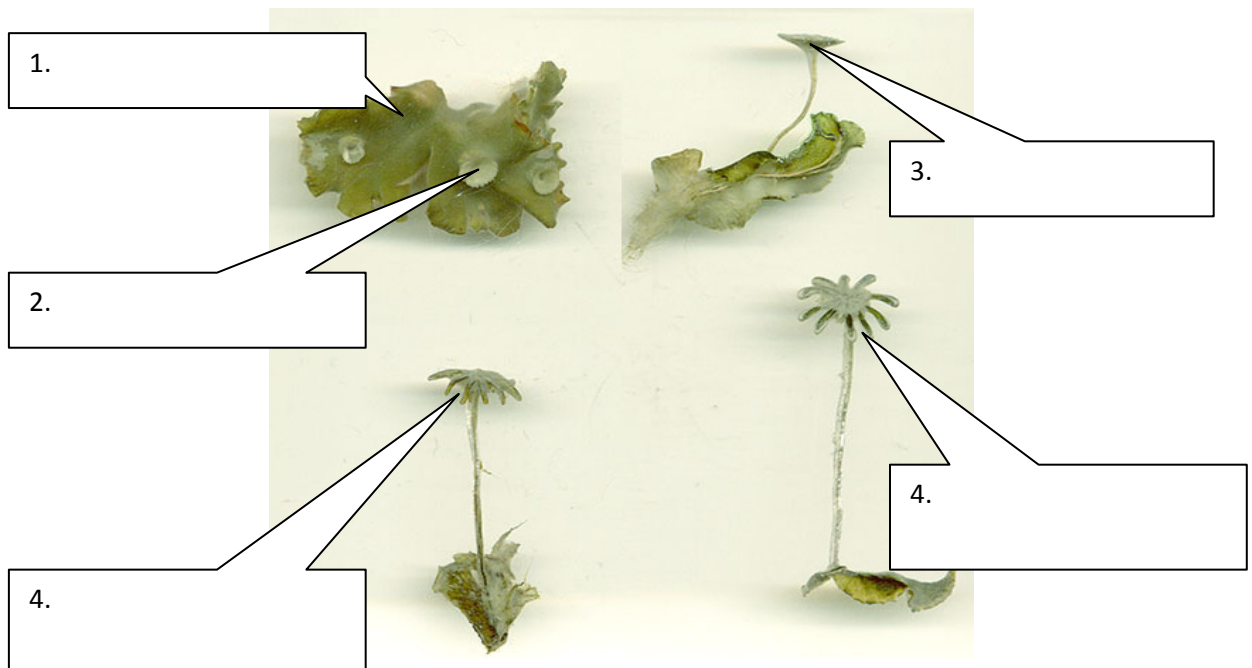
Based on Figures 20.6 & 20.4 in Stern, label the pictures below with the appropriate term.

Thallus- the flattened green body of a thalloid liverwort.

Gemmae Cup- a cup like structure that produces little clonal discs that, when ejected from the cup by rain drops, can grow into a new liverwort plant.

Antheridiophore- a stalk holding antheridia.

Archegoniophore- a stalk holding archegonia.





Which parts above are from a female gametophyte? 3 or 4?

Which are from a male gametophyte? 3 or 4?

b) Living or Pickled Material, Dissecting Scope, & BOOK.

From back/side of room, grab a portion of thallus and take it back to your bench to examine. It will be from a species of *Marchantia* &/or *Conacephalum*.

Study Figure 20.5 from Stern. Then, with a dissecting scope, look at the top surface and observe the polygonal outlines of the air chambers that were diagrammed in Fig. 20.5.



Go up to 40 x magnification and draw your field of view, labeling the features as they relate to Fig. 20.5.

We will not call the pore in Fig. 20.5 a stoma since it cannot be opened & closed (i.e., it is always open) b/c there are no guard cells surrounding it as in angiosperms or gymnosperms (higher plants).

If available, observe the prepared slide cross-section of a thallus, with detailed attention given to air chamber anatomy, comparing to Fig. 20.5 from Stern.

c) Prepared Slides & Compound Scope.



Obtain prepared slides of liverwort antheridium and archegonium from the side/back of room. Observe and draw the following structures at high mag & use Fig. 20.6 in Stern to help you.

Antheridium

Archegonium

2. SPOROPHYTES.

The sporophyte is the diploid, spore-producing organism in the plant lifecycle. In liverworts it is very small (microscopic), simple, short-lived, and nutritionally dependent upon the female gametophyte.

a) Prepared slide: *Marchantia* sporophyte & Cmpd Scope.



From the side/back of the room. Liverwort sporophytes are small (< 2 mm long) and so really only visible with the compound scope. Make observations and drawings of the sporophyte in this slide, use Stern Fig. 20.7 primarily (and Fig. 20.6 secondarily) to aid in labeling your drawing.

B. Mosses (p. 380 in Stern)

The gametophytes and sporophytes of mosses are a bit more advanced than thalloid liverworts in their structure. Examine living material of various species available.

1. GAMETOPHYTES and SPOROPHYTES.

a. Living Material of Various Species.

Be sure you can recognize and interpret all you see as follows:

- 1) Gametophytes. The conspicuous green and leafy plants are the gametophytes.
 - a) This is the multicellular, haploid phase of the life cycle.
 - b) The “leaves” on this gametophyte are really not true leaves and are rather called phyllids (they are not vascularized, are not organized into tissues –being only 1 cell thick except at the midrib).

- 2) Sporophytes. On some of the female gametophytes (those which carried the egg and the archegonium) there are long stalks (either light green or brown) terminating in a capsule. These are the sporophytes and they are multicellular and diploid. They are rooted by a foot in the archegonium base of the female gametophyte, then they have a long, unbranched stalk (called a seta) terminated by a sporangium (called the capsule). The young capsules wear a calyptra (capsule cover, actually the top of the archegonium that was torn off as the sporophyte started to grow out of it). This calyptra will come off when the capsule is ready to release its spores.

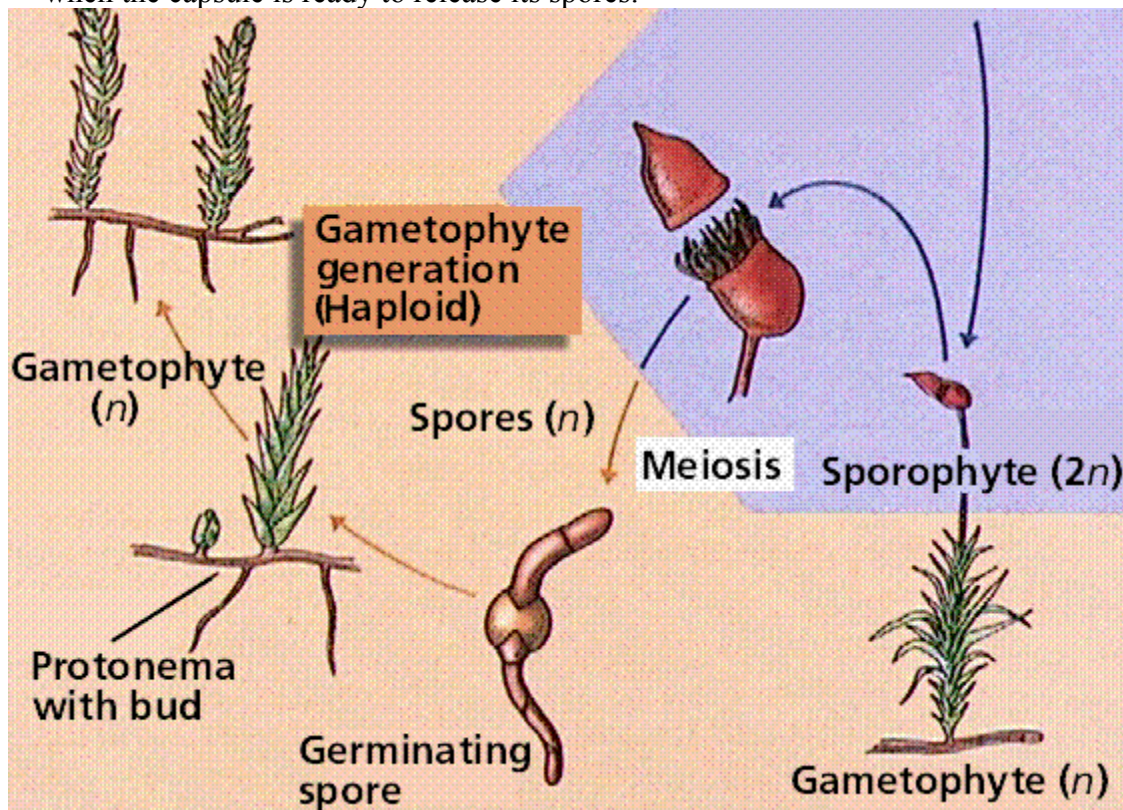


Figure Above: phases of a moss lifecycle. Note that the germinating spore first develops into a filamentous, alga-like form called a “protonema” (juvenile phase of the gametophyte).

b. Microscopic Observations.

From the back/side of the room. Using the compound microscope, make observations of the vegetative and reproductive parts of various moss species.

1) Prepared Slide & Cmpd Scope: Female Gametophyte w/
Archegonium.



Make drawing of an archegonium atop a female gametophyte.

2) Prepared Slide & Cmpd Scope: Male Gametophyte w/
Antheridium.



Make drawing of antheridium atop a male gametophyte.

II. Pteridophytes

Pteridophytes is a general term for the vascular, free-sporing plants we know as ferns, lycopods (club-mosses, horsetails and scouring-rushes). Their characteristics are as follows:

- Xylem & phloem (for conduction & support);
- No seeds or pollen (free-sporing: spores must find moist spot to grow);
- Gametophyte very small, inconspicuous, short-lived, at or just below the soil surface;
- Sporophyte dominant, large, photosynthetic, persistent phase of the life-cycle;
- Require external water for fertilization (sperm must swim through water on surface of gametophyte to fertilize egg in archegonium);
- Most species (except *Psilotum*) have leaves & roots.

A. Whisk-ferns (p. 389 in Stern)

The representative we will study in this lab is the genus *Psilotum* (pronounced with a silent “P”). Characteristics of sporophytes (and, where specified, the gametophytes) are as follows:

- No roots;
- No leaves (only enations, which are minute leaf-like appendages lacking vasculature);
- Sporophyte with dichotomous branching;
- Groups of 3 sporangia fused to form synangium;
- Gametophyte unbranched, less than 2 cm long, underground and not photosynthetic.

1. Living *Psilotum* Plant & Naked Eye & Cmpd Scope

Potted plants in side/back of room or there is one pot near the sink of each 8-student bench.

a. Vegetative Characteristics.

This funny looking plant resembles the earliest vascular plants we see in the fossil record.



What organs (leaf, stem, and/or root) is missing on these sporophytes?

Contrast the branching pattern in this plant with that of a pine tree. Why does this look so odd?

b. Sporangia.

The sporangia on this species appear 3-lobed b/c they actually consist of 3 fused sporangia which, together, the structure is called a synangium. At maturity they are yellow/brown.



Is there an enation subtending each synangium? Draw this.

c. Spores.



Extract some spores from mature (yellow to brown) synangia. Make a wet mount, cover with coverslip, observe at high mag and draw them.

B. Lycopods (aka club-mosses, ground-pines, spike-mosses) (p. 391 in Stern)

Characteristics of sporophytes (and, where specified, the gametophytes) are as follows:

- Roots;
- Spirally arranged microphyll leaves (small, simple, and with just one vein per leaf);
- Sporophyte with dichotomous branching;
- Sporangia semi-lunar or kidney-bean shaped, born in the axil of sporopylls, typically aggregated into strobili;
- Gametophyte short-lived, variable in form, but small (<8 mm), amorphous and colorless (when underground) or green (when on soil surface).

1. Living & Herbarium Material of *Lycopodium*.

Side/back of room. There various specimens of *Lycopodium* & close relatives such as *Diphasiastrum* & *Huperzia*.

a. Vegetative Characteristics.

Study the vegetative parts of these plants.



Although they are not mosses, why do you think laypersons gave them the name “club-mosses” or “spike-moss”. Hint: how do they resemble mosses?

Name one anatomical and one ploidal (referring to haploid vs. diploid) difference between the green plants of true mosses and these lycopods.

b. Reproductive Characteristics.

Study the sporangia and (if present) strobili of these plants.

2. Prepared Slides of Strobilus with Cmpd Scope



From side/back of room. Draw a strobilus that has been sectioned longitudinally. Be sure to label sporophylls, sporangia, spores (or spore mother cells).

3. If available: Living Material of Resurrection-fern.

From side/back of room. The resurrection-fern is not actually a fern but the spike-moss species *Selaginella lepidophylla*. Note the dry (dormant) plant and the plant which has been soaked in water for about 24 hours and is coming back to life. These plants can remain dry for years and come back to life with some water and light. Learning how the plant is able to do this is an area of active research: as you can imagine, plant scientists (and others interested in aging, prolonging life, and even prolonged manned spaceflight) are very interested in this.

C. Horsetails & Scouring-rushes (p. 397 in Stern)

Characteristics of sporophytes (and, where specified, the gametophytes) are as follows:

- Roots;
- Stems (internodes) hollow, ribbed, many species' cell walls impregnated with glass-like silica;
- Whorled microphylls fused in collar at node;
- Branching (if present) whorled (not dichotomous);
- Sporangia in strobili at ends of stems;
- Gametophyte short-lived, small (<8 mm), lobed and "lettuce-like", above ground, green.

Branching forms are generally called horsetails, nonbranching forms are called scouring-rushes. One extant genus, *Equisetum*, with 15 species.

1. Living & Herbarium Material of *Equisetum*.



a. Study the various specimens for the characteristics above. Make drawings where necessary.

b. Test the scouring potential of *Equisetum hyemale* (a local species of scouring-rush) by take the stems and rubbing them against the palm of your hand or against another stem.



Can you hear and feel the abrasion?

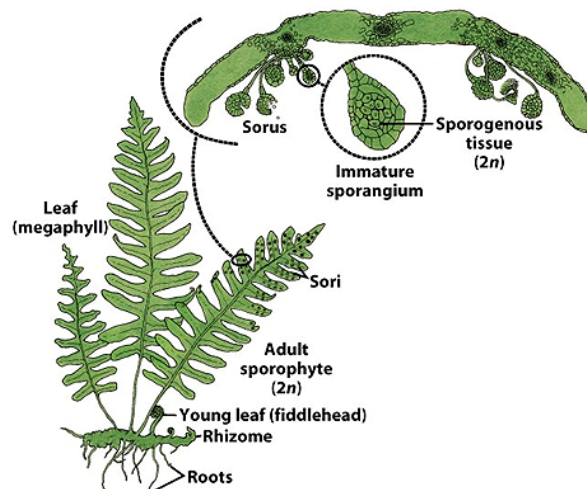
What in the stems (specifically the cell walls) causes this?

D. Ferns (p. 401 in Stern)

Characteristics of sporophytes (and, where specified, the gametophytes) are as follows:

- Roots;
- Leaves macrophylls and alternate, often pinnate, with young leaves resembling fiddleheads;
- For some reason or another, fern leaves are traditionally called fronds;
- Stem a rhizome, leaves therefore appearing to come from ground;
- Branching various and not diagnostic of the group;
- Sporangia clusters sori, (singular sorus) on undersides of leaves;
- Sori “naked” or covered by flap of tissue called indusium;
- Leptosporangia;
- Gametophyte short-lived, small (<8 mm), hear-shaped, above ground, green.

1. Sporophyte.



a. Herbarium Specimens.



At side/back of room. Compare 3 different fern species for leaf form, as well as sorus shape, abundance, distribution, and indusia. Refer to Stern Fig. 21.20 (p. 404).

Wood Fern

Christmas Fern

Hay-scented Fern

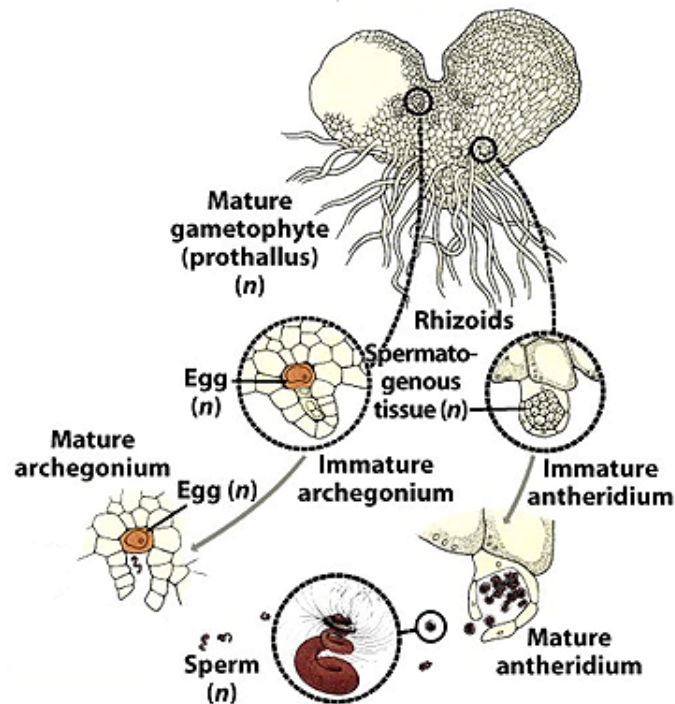
b. Living Specimens.

At side/back of room. These living plants may or may not have sori on them. Make observations of these living plants and revel in their beautiful foliage. NASA has investigated one of these plants, the Boston fern, quite extensively and found that it can remove many airborne indoor air pollutants (such as formaldehyde, a carcinogen used in iron-free plants and as part of the fire-retardants used in carpets, blankets, toys). Thus, it is a healthy plant to keep around the house.

Boston Fern

Christmas Fern

2. Gametophyte.



a. If available: Living Fern Gametophytes & Microscopes.

Study first with dissecting scope to see shape and rhizoids on bottom, then make wet mount and look for cellular detail and antheridia / archegonia with compound scope.



Do you see any gametophytes with young sporophytes growing from them?

III. Ethnobotanical references if you are inclined to learn more about the uses of bryophytes and ferns

Nwosu, MO. 2002. Ethnobotanical studies on some pteridophytes of southern Nigeria. *Economic Botany* 56: 255-259.

Thieret, JW. 1956. Bryophytes as economic plants. *Economic Botany* 10: 75-91.