PBIO 111: Winter, 2002

Lab 6: Hepatophyta, Anthocerophyta & Bryophyta (The Bryophytes)

INTRODUCTION

The plant kingdom is usually subdivided into bryophytes (the three Divisions Hepatophyta, Anthocerophyta, and Bryophyta) and vascular plants. The bryophytes and vascular plants differ in whether the haploid or diploid phase is the dominant stage of the life cycle. In this laboratory we will introduce you to the three groups of bryophytes: liverworts, hornworts and mosses. **Be sure to diagram and label all pertinent structures seen in lab.**

Bryophytes, like all members of the Kingdom Plantae, have a **sporic life cycle** with a **heteromorphic alternation of phases ("generations")**. The zygote divides mitotically to produce an **embryo**. Through continued mitotic divisions, the embryo develops into a diploid **sporophyte**. Eventually, certain cells of the sporophyte divide meiotically to produce **spores**. Each spore has the potential to develop into a haploid **gametophyte**, which produces gametes by mitosis.

In bryophytes, the gametophyte is the dominant phase of the life cycle. It is the most complex and longest lived vegetative body, and it lives independently. The sporophyte is typically smaller, and is dependent on the gametophyte for both support and nutrition. (In contrast, the sporophyte is the dominant phase of the vascular plant life cycle.)

EXERCISE A: HEPATOPHYTA. LIVERWORTS (pp. 407-412 in text)

Liverworts may be **leafy** or **thallose**. Thallose liverworts grow flat on the ground and do not show much shape differentiation. Leafy liverworts have leaf-like lobes allong the thallus. *Marchantia* is a typical thallose liverwort.

- **!** Examine living specimens of leafy liverworts, if available. Note that their appearance is very different from the thallose liverworts you will be examining next.

- **!** Examine living vegetative *Marchantia*. The plant you see is the gametophyte phase. What is its ploidy level?

- **!** Examine living *Marchantia* under a dissecting scope. Look for **rhizoids** on the lower (ventral) surface. What is the function of rhizoids? What is their ploidy level?

On the upper (dorsal) surface, look for **gemmae cups** containing multicellular **gemmae**. What are gemmae? Are they involved in sexual or asexual reproduction?

! Examine a prepared slide of the **thallus** (body) of *Marchantia* (see also text p.408-409).

Notice (1) the green **chlorenchyma tissue** (containing chloroplasts) that makes up the upper layer of the thallus, (2) the air pores in this layer, (3) the nonphotosynthetic storage tissue (below the chlorenchyma), and (4) the rhizoids (unicellular) and **scales** (multicellular) along the lower surface of the plant body.
What is the function of the air pores? Of rhizoids? *Marchantia* gametophytes are unisexual, so there are separate male and female plants. The female gametangia (**archegonia**) are located on the ventral surface of the **archegonial head** which sits atop an **archegoniophore**. These are the structures that look like small palm trees.
Numerous male **gametangia** (**antheridia**) are clustered on the slightly concave dorsal surface of the **antheridial head**, which sits atop an **antheridiophore**. The antheridial head functions as a **splash cup**. Raindrops splash flagellated sperm from the antheridium to the archegonial head where they swim into an archegonium and fertilize the egg. The resulting zygote develops into a sporophyte.

! There may be living gametophytes available on which reproductive structures can be seen. If so, Identify the archegoniophores and antheridiophores.

What do the antheridia and archegonia produce, and by what process of cell division?

! Examine prepared slides of *Marchantia* antheridia and archegonia (see also p.408). What are the ploidy levels of the various structures?

In the antheridium, identify the **spermatogenous tissue** on the inside (this will develop into sperm) and the surrounding **sterile jacket cells**.
In the **archegonium**, identify the **egg cell**, the **neck cells**, and the **venter**. At maturity the archegonium forms the **calyptra** (see p. 410).

! Examine a prepared slide of *Marchantia* containing a mature sporophyte (see also pp. 408 & 410). The sporophyte is hanging on the underside of an archegonial head.

Identify the **foot**, **seta** (stalk), and **sporangium** containing spores and **elaters** (structures that aid in spore dispersal). Identify the **calyptra** (enlarged archegonium).
What is the ploidy level of the sporophyte? The spores? The calyptra? Are the spores

produced by meiosis or mitosis?

EXERCISE B: ANTHOCEROPHYTA. HORNWORTS (pp. 412-413 in text)

Anthocerophyta is a small division. Hornwort gametophytes resemble those of liverworts, but the sporophyte is an upright elongated structure that emerges from the flat gametophyte like a horn.

***Anthoceros*:**

! Examine the preserved specimen of an *Anthoceros* gametophyte with attached sporophytes.

EXERCISE C: BRYOPHYTA. MOSSES (pp. 412-422 in text)

Moss gametophytes have stems and leaves but no roots. Their small leaves are tightly clustered on the stem. Moss leaves are typically only a single cell thick. The leafy gametophyte is the second stage of the gametophyte phase. The first stage, the **protonema**, is produced by a germinating spore. Leafy gametophytes develop from bud-like structures on the protonemas. Multicellular **rhizoids** anchor the gametophyte.

At maturity, most gametophytes produce gametangia. These may be located at the stem tip in the upright, unbranched 'cushion' mosses, or on a lateral branch in the prostrate, 'feathery' mosses. In many species, antheridia are aggregated in splash cups at the tips of certain gametophytes while archegonia are clustered in heads at the tips of other gametophytes. Although archegonia and antheridia do not occur on the same branch, they may occur on the same (bisexual) gametophyte, or on different (unisexual) gametophytes. A film of water is required for the flagellated sperm to reach the egg, and sperm release and fertilization is often facilitated by raindrops.

The resulting sporophyte grows out of the top of the leafy gametophyte. The sporophyte consists of a **foot** that anchors it into the archegonium, a long stalk (**seta**) and a **capsule** (sporangium). The capsule may be covered with a **calyptra** (the upper part of the archegonium that broke away from the rest of the archegonium when the sporophyte emerged; often a lighter color than the capsule). The lid of the capsule is called the **operculum**. Under the operculum is a ring of **peristome teeth**. These teeth line the opening of the capsule. In some species, they open and close in response to changes in humidity and help discharge the spores.

! Examine the demo slide of moss protonema. What is its ploidy level? What other stage of the life cycle develops from the protonema?

! Examine the living and preserved mosses on display. On each one, identify the **gametophyte** and **sporophyte**.

! Look at the moss gametophyte with a sporophyte, which has been set up under a dissecting scope as a demonstration.

Identify the seta, calyptra (if present), capsule, operculum, and peristome. What is the ploidy level of each? Is the calyptra part of the gametophyte or sporophyte phase?

! Look at the *Mnium* gametophyte and sporophyte under the dissecting scope. Identify the calyptra, operculum, and the peristome teeth on the sporophytes. Which of these are sporophyte and which are gametophyte?

Watch the teeth for a few seconds. The heat of the microscope lamp often causes them to open and close.

! Look at the *Polytrichum* gametophyte and sporophyte under the dissecting scope.

The peristome here functions differently from that of most mosses. The teeth do not move. Rather, they are attached to a membranous disc at the top of the sporangium. Spores escape through the tiny slits between the teeth, like salt from a salt shaker, when the sporophyte is blown around in the wind.

! Examine antheridial heads of *Mnium* (if available), which have been set up under a dissecting scope as a demonstration. Do you understand how the sperm are dispersed from these heads?

! Examine a prepared slide of *Mnium* antheridia (see also pp. 417). Identify the **spermatogenous tissue**, **sterile jacket layer**, and **paraphyses** (sterile structures surrounding the antheridia). The paraphyses help maintain a moist microenvironment for the antheridia.

! Examine a prepared slide of *Mnium* archegonia (see also pp. 417). Identify the **egg**, **neck cells**, and **venter**.

! Examine a prepared slide of a *Mnium* sporangium. Identify the apical operculum, the subapical peristome, and the **sporogenous tissue** (stained reddish) flanking the central **columella**.