Sorting the mosses from the liverworts

As a beginner, one soon learns to differentiate mosses and liverworts in the field. However, it is not always quite so straightforward, as **Sharon Pilkington** explains.

▲ The moss *Neckera crispa* (left) and the liverwort *Plagiochila porelloides* (right). *S. Pilkington*

Most of the time mosses look like mosses and liverworts look different enough to place them in the correct dichotomous key. However there is a small group of mosses that look rather like some leafy liverworts, and these can be confusing when first encountered.

These mosses are complanate (laterally compressed) so that they have a flattened growth form. They include all of the British species of *Neckera* and *Fissidens*, most species of *Plagiothecium*, *Homalia trichomanoides*, *Hookeria lucens*, *Pseudotaxiphyllum elegans* and a handful of others.

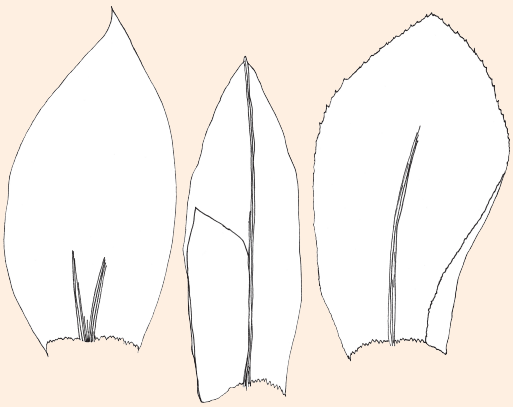
Fortunately, there are a number of ways of distinguishing any moss from any leafy liverwort. Broadly, they can be considered in three main groupings:

- leaf shape and arrangement;
- leaf cell and rhizoid characters;
- capsule structure and development.

Leaf shape and arrangement

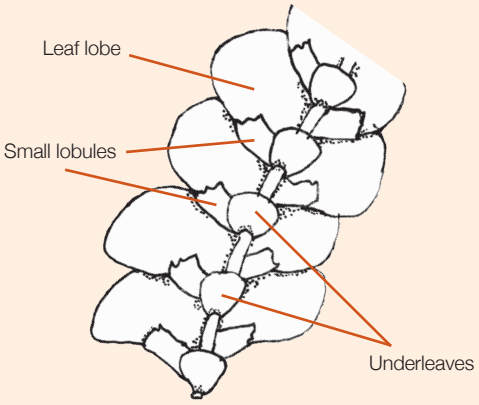
Moss leaves are usually entire and – with the exception of *Fissidens* species – are not deeply lobed or folded, whereas leafy liverworts have leaves that can be either lobed or unlobed. Some liverwort genera, e.g. *Frullania*, *Scapania* and *Lejeunea* have complex folding that produces a smaller lobule/pouch/sac next to the primary leaf lobe.

If the leaf has a nerve, then it must belong to a moss, though a few species of complanate moss e.g. *Hookeria lucens*, do not have a nerve at all. Other mosses have very short (often double) nerves that are difficult to see, e.g. *Neckera* and *Plagiothecium* species. Leafy liverworts never



▲ Examples of typical leaf shapes and midribs of (from left to right) the moss genera *Plagiothecium*, *Fissidens* and *Homalia*. *S. Pilkington*

▼ Example of a typical folded liverwort leaf and underleaves (*Marchesinia mackaii*). *S. Pilkington*



▼ The liverwort-like moss *Hookeria lucens*. *S. Pilkington*

have true nerves, although a few species, e.g. *Frullania tamarisci* and *Diplophyllum albicans,* have lines of modified cells that may give the impression of a pale nerve.

The insertion of the leaves onto the stem is also important. Most mosses – even apparently complanate ones – have leaves that spiral around the stem [look at the position of the leaf bases rather than the lamina (leaf blade)]. The exceptions are genera such as *Fissidens*, *Schistostega* and *Distichium* which have distichous leaves (in two ranks on opposite sides of the stem). Most leafy liverworts have leaves arranged in two ranks on opposite sides of the stem (inserted either obliquely or transversely) and their leaf bases are never spirally inserted. Some liverworts with folded leaves may appear to have four rows of leaves, e.g. *Diplophyllum albicans*, *Porella platyphylla* and *Scapania undulata*. If a plant also has a row of underleaves, then it must be a leafy liverwort as mosses do not possess them. Not all liverwort species have them either, but when they are present they can be found on the lower surface of the stem (often amongst the rhizoids) and are normally smaller and a different shape to the main stem leaves. Sometimes underleaves are very small and have to be looked for with a microscope.

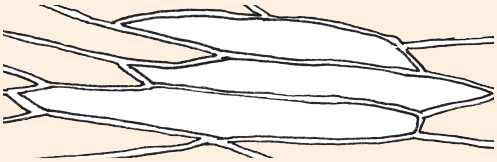
Leaf cell and rhizoid characters

An examination of leaf cells under a high-power microscope can reveal other differences. If they have trigones (corner thickenings) or oil bodies inside the cell, then without doubt the plant

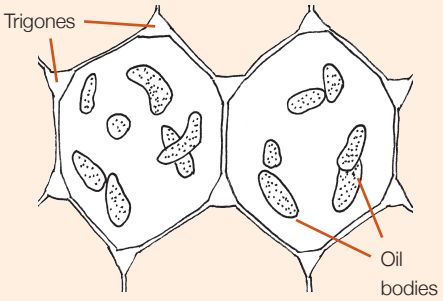
is a liverwort. However, they are not characteristic of all leafy liverworts and it is important to know that oil bodies rarely persist in dried material.

Complanate, pleurocarpous mosses also usually possess long, narrow leaf cells which contrast markedly with the shortly hexagonal to isodiametric proportions of their liverwort counterparts. Watch out for *Hookeria lucens* though, which has short leaf cells.

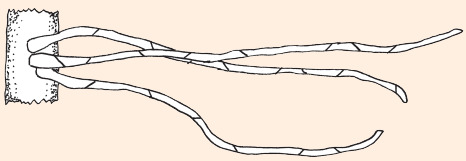
Looking at the structure of rhizoids can be helpful – mosses always have multicellular and often branched rhizoids, whilst those of liverworts nearly always consist of a single elongate cell.



▲ Typically elongated, pleurocarpous moss leaf cells.



▲ Idealized leafy liverwort cells.



▲ Multicellular moss rhizoids, showing oblique cell walls. *All drawings S. Pilkington*

▲ Examples of moss (*Tortula muralis*, top) and liverwort (*Lophocolea bidentata,* bottom) capsules. *I. Atherton*

Capsule structure and development

If the plant has capsules then it should be easy to tell if it is a moss or a liverwort as differences in capsule and seta (stalk) structure are pronounced. For example, moss capsules come in a wide range of shapes e.g. globose, cylindrical, pear-shaped and urn-like, and are often held above the plant on a wiry, often brightly coloured seta. Moss capsules can be orientated in many different ways and usually dehisce (break open to shed their spores) at maturity by means of a lid. The capsule may or may not have teeth around the opening to control spore release. Exceptions include mosses in the genera *Archidium*, *Andreaea* and *Sphagnum*, as well as many small, cleistocarpous mosses, e.g. *Microbryum*, *Ephemerum* and *Aphanorrhegma*, in which the capsules release their spores by rupture or decay.

In contrast, leafy liverworts typically produce an erect, globose capsule on a weak, white seta which quickly withers after the capsule matures. The capsule ruptures along four lines to peel open and release the spores, and never has a lid. Among the spores are unique spiral structures called elaters which play an important role in liberating the spores.

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