Studying the alternation of generations of Bryophytes in the laboratory

Leslie A. Kent, Queen Elizabeth Grammar School, Wakefield, West Yorkshire

The Bryophytes – mosses and liverworts – are an interesting group of plants showing a clear alternation of generations. They are common, easily cultured in the laboratory and demonstrate well the diversity of plant life.

The alternation of generations in the Bryophytes

Bryophytes are small, green land plants restricted to areas of permanent moisture. Lacking any waxy cuticle to prevent water loss, they would soon desiccate in dry air; this is the reason they are limited to such moist conditions – an interesting topic to raise when discussing the functions of waxy cuticles in lower school. A Bryophyte consists of either long, thin stems, off which grow whorls or rows of leaves, or a green leaf-like thallus. The plants have rhizoids which attach them to the substrate on which they live.

Generally, liverworts and mosses show alternation of generations between *gametophyte* (producing sex cells) and *sporophyte* (producing spores), which is typical of green plants.

Lunularia cruciata, the Crescent Cup liverwort, is unusual because it reproduces asexually and has no sporophytic generation. Buds (gemmae) develop in the 'crescent'-shaped gemmae cups. Rainfall disperses the gemmae to form new gametophytes. Despite this primitive life-cycle and mode of dispersal, *L. cruciata* is extremely common.

Summaries of Bryophyte life-cycles can be found in most good A-level textbooks, but I have not found a better book for species details than Watson's *British mosses and liverworts* (1963).

The morphologies of the alternating generations are quite different in both mosses and liverworts. They are therefore described as showing *heteromorphic* alternation of generations.

To really appreciate these plants you must observe them for yourself. Although many people claim never to have seen liverworts, they are remarkably easy to find (together with mosses) in dark, wet places. For example, they grow under rocks on the banks of well-shaded rivers. During my PGCE course at Leicester I discovered that many of the city's parks had rivers running through them which provided excellent habitats for Bryophytes. Even in the centre of Leicester in the spring and summer months, Bryophytes are visible and common (but you do have to be very dedicated to the cause if you are to walk through the centre of a city in your welly boots carrying jam jars). Bryophytes are common on many man-made surfaces which are sheltered, dark and wet, for example, between paving slabs and in guttering pipes. (It is obviously wise to know what fluids flow in the river or pipe before handling specimens yourself or inviting a class to handle them.)

It is far more motivating, I feel, to bring these organisms into the classroom rather than to describe them. To see them and their alternate generations actually flourishing in the science laboratory is fascinating, especially as so many people claim not to have seen them, even though they are so plenteous when you look in the right places. Talking about their life-cycles in an abstract and probably incomprehensible way does these much ignored yet interesting organisms no justice at all.

Keeping Bryophytes in the laboratory

As has already been said, Bryophytes must always be kept moist. It is probably a fair assumption that they should also be kept in humid conditions. I have found a satisfactory way of keeping them is as follows.

Collect specimens from the wild. As with any collection it is good practice to note the date of collection and its location. This should be recorded on good quality paper and written in sharp pencil so that the label can be stored with the specimen and not spoil in the moist container atmosphere. It may also be useful to note some characteristics of the habitat in which you find your specimens, e.g. rock type, shading and details of the water system you have found it in, etc. These notes are invaluable in relocating a new supply of your specimen should the need arise and will most definitely help in its identification.

Some of the soil, or if possible the rock, on which they are growing should also be collected. Never take more than you have to, to conserve the population in that locality and minimise disturbance. It is also important to note any conservation initiatives at present in the area (you may be disturbing protected environments or even breaking the law). The best method of transport of specimens is in jam jars with their tops open. These can be suspended and carried in simple string cradles so that gravity keeps them upright.

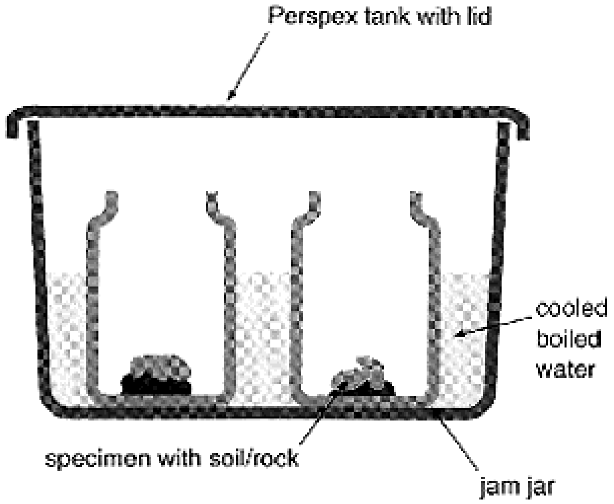

Figure 1
Diagram of apparatus used to keep Bryophytes alive in the laboratory

Place your specimens in their open jam jars into a Perspex tank and gradually fill the tank with cool boiled water until the jam jars begin to float (Figure 1). Do not put water into the jam jars unless your specimens are beginning to dry out: it is preferable to use water from the location at which the specimen was obtained.

Place a Perspex lid over the top of the tank and place it in a cool, dimly lit position. This will provide a humid, near natural environment for your Bryophytes. Every so often the water will need changing in the tank, or topping up. Rotting specimens should be removed to prevent infection of healthy ones. This system has kept specimens healthy for a trial period of eleven weeks.

Mosses can also be stored dry. They should be wrapped in newspaper before being left somewhere dry and warm. These dried specimens can usually be completely rehydrated even after several years of storage.

I have found that gametophyte-generation mosses can be induced to produce sporophyte-generation structures by the addition of weak, cold tea. I have yet to refine this method as to the exact strength of tea, but please test away if you teach this subject, or have spare tea left over in the pot! Adding tea produced, in about three days, a three-centimetre tall seta in common thread moss, with a large immature capsule at its tip. This response seems analogous to that in fungi, which produce their fruiting bodies when conditions become unfavourable for hyphal growth. I postulate that the tea, being acidic, produces an environment unsuitable for the growth of moss, and the moss therefore becomes sexual to disperse its spores before it is prevented from reproducing by the changing environment. No similar effect has been observed in liverworts, so I am presently considering other cues that may induce sporophytic growth, such as temperature, moisture and day length (could this be a possible topic for investigation?).

Bryophytes in the curriculum

Life-cycles and alternation of generations have been dropped by many examination boards. But I feel there is still scope for bringing unusual plant life into the laboratory to stimulate children's interest in the diversity of the living world around them. I have already emphasised the fact that few people recognise that they have ever seen a liverwort; as liverworts are remarkably common in our temperate climate this is a surprise.

Plant diversity is included in key stages 3 and 4, and A-level, and details of the alternation of generations in Bryophytes were still included in some A-level syllabuses at the time of writing this article. As Bryophytes lack waxy cuticles it is useful to compare them with waxy leafed plants. They can often be totally dried, stored and rehydrated as a result of being able to absorb or lose water from their entire surface. A simple investigation, which could be made more complex for A-level, might be to measure and compare the loss in mass under dry conditions of different Bryophytes. Students could consider the biological significance of the capacities of different species to withstand desiccation. These species in turn could be compared with other groups of plants from other environments and the biological significance of the evolution of a waxy cuticle evaluated.

Biology is often accused of being the 'science of dead and pickled things' illustrated only by preserved specimens ordinarily kept at the back of the classroom with years between usage. Also, many directives dissuade us from bringing living animals into the classroom because of the risk assessments involved and the increase in children's allergies. It is ironic that biology is in fact the study of 'living things'.

Plants remain accessible and their needs are simple. As well, many Bryophytes are unusual and relatively unknown and yet can be found by the discerning in both natural and man-made habitats.

I would appreciate feedback on this science note, including any better ways of keeping Bryophytes or problems with this method, as well as any further findings associated with this interesting group of terrestrial plants.

References and further reading

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