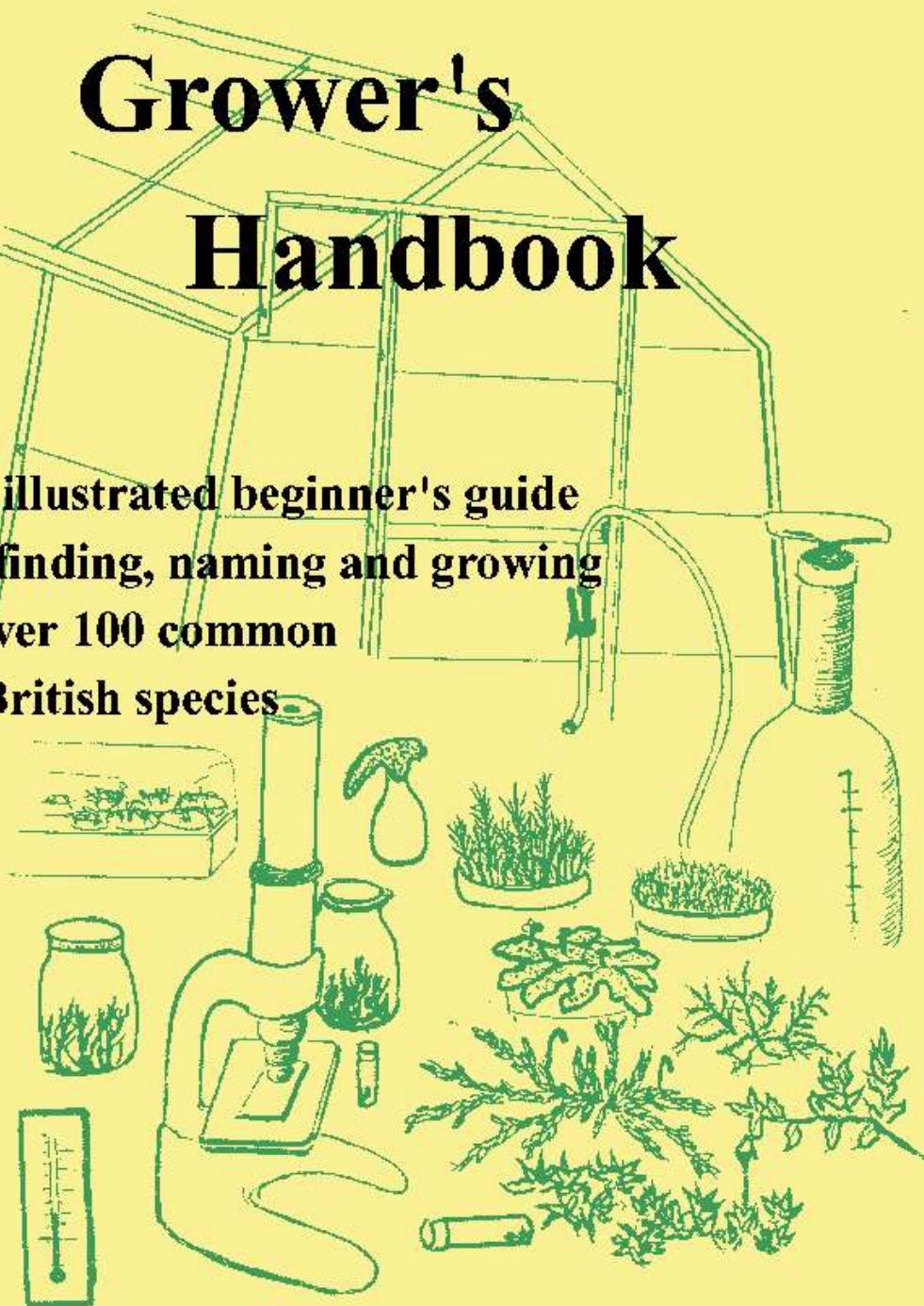


Moss

Grower's Handbook

An illustrated beginner's guide
to finding, naming and growing
over 100 common
British species



Michael Fletcher

Original publication details:

Text and illustrations © by the author
ISBN 0 9517176 0 X

Printed by SevenTy Press
70 South Street
Reading
Berkshire RG1 4RA

February 1991

This August 2005 [minor corrections 2 March 2006] Acrobat version is based on the text of the last Microsoft Word version ('2nd edition *in prep.*', postscripted 'spring 2003') by Michael Fletcher, that was previously available via the BBS website. No substantial changes have been made to this text. It uses the illustrations (including a re-scanned cover) of the printed 1991 first edition, and adheres as closely as possible to that format and its characteristic individualities. The index has been regenerated, using taxa and selected other words largely following Fletcher, although some words have proved impracticable to index and others have been added. The list of contents has also been regenerated, and both are now hyperlinked. This version was edited, adapted and updated (taxonomic names and references) for the British Bryological Society's website, by Sean Edwards, with many thanks to Roy Perry for proof-reading and general suggestions.

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Introduction

Growing mosses and liverworts is a big subject. With nearly 1000 species in the British Isles alone, and well over 15,000 worldwide, they exceed in numbers the known species of cacti, succulents, alpines, or ferns.

Also, mosses occupy habitats more diverse than the whole flowering plant kingdom. From the depths of a dark cave to the twigs of a tall tree, each niche has its specialised plants. Some grow on the mainland of Antarctica, where nothing else save lichens and algae can survive, and some in the world's hot deserts.

They began to interest me in the early 1960s. My interest took an obvious and familiar form, as a living collection. I soon saw that these humble plants were the biggest horticultural challenge I had ever found. There is a small but devoted band of botanists who have an especial love for and interest in mosses, and who make a lifetime's study of them, but for some reason a tradition of growing them had never become established. Indeed mosses were generally considered so specialised that the cultivation of most species was virtually impossible. That idea has still not been fully dispelled.

Certainly their needs in cultivation are unfamiliar and varied, yet as much as 90% of the British moss flora can be grown with techniques and equipment well within the reach of most amateur gardeners. Indeed many mosses are incredibly tough and persistent, if treated in the right way.

This is in one sense a difficult book to write. I offer it especially to people who are already skilled or dedicated growers of other specialised plants, be they succulents, orchids, or alpines, but who may be complete beginners so far as mosses are concerned.

Such people will want help in naming their plants as they find them, yet this book obviously cannot be an adequate guide to their identification. It aims to give hands-on encouragement, starting with the commonest plants, the easiest to name, and the easiest to grow.

Each section introduces a few new plants and a few new ideas on growing them. I hope many readers will also find these ideas useful in growing other kinds of plants, as I have done.

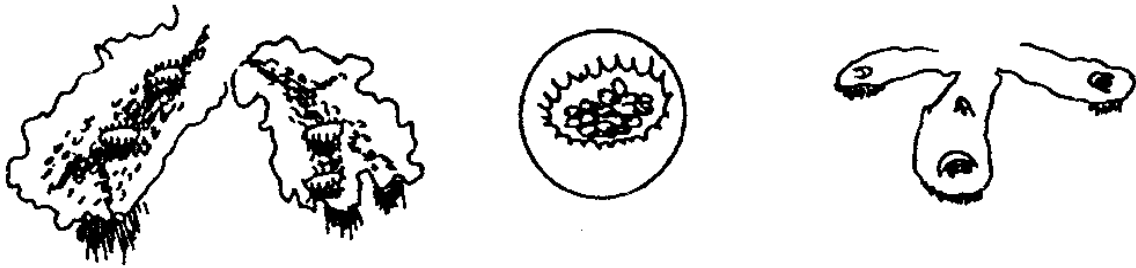
On the other hand I hope this handbook will interest people who already know a great deal about mosses, but who have not yet grown them successfully. I ask them to forgive the very elementary descriptions and sketches of the very commonest species, and the emphasis on such mundane objects as flowerpots and garden sprays. Though they have inspired so much interesting and sophisticated experimental work, mosses are not high-tech plants. They will grow as well in a jamjar or cold frame as in a laboratory, – better perhaps. Unique collections, of genuine scientific interest perhaps, can be built up on a windowsill. They need patience and understanding, not money.

That is part of their attraction.

1. Large common liverworts

One of the largest, the commonest, and surely the strangest looking of all liverworts, is *Marchantia polymorpha*. Through a lens, its flat crawling stems, its elegant cups full of oval green “eggs”, and its umbrella-shaped male and female fruit stalks look like something from science fiction, rather than from a suburban garden. It has probably been grown more often than any other liverwort. There was once a Dutch cactus nursery, specialists in strange plants, which offered a *Marchantia* for sale – at a high price. Its catalogue did not even say which species.

However there is no need to send off an order to Holland. It can be found in any garden centre, growing on paths or around container plants. It is a horticultural weed, but can be found almost anywhere where there is wet soil – by rivers and streams, under gutters, or in wet shady garden beds. It is even commoner in towns than in the countryside, especially where there is an extra source of water, such as a dripping gutter. While looking for it, a gardener will be likely to find another species. *Lunularia cruciata* is fond of garden paths and soil in and around greenhouses, but can tolerate drier places than *Marchantia*. It is smaller and shinier, of a bright fresh green, and without any darker central band. The most obvious difference is that it has little egg-like gemmae, not held in circular cups, but in structures shaped like crescent moons, hence its generic name.



Botanists used to think that these were primitive plants, but it seems they are among the most complex and highly evolved of liverworts. Though leafless, the creeping stems, called thalli, are thick, with a tough upper skin and breathing pores (stomata,) through which they can breathe and regulate water loss, just as most flowering plants do. These pores can easily be seen even without a lens, as tiny spots on the smooth upper surface of the plant.

Underneath, both of these plants have a fuzzy white growth of fine root like hairs (rhizoids) which penetrate into the soil and draw up water, just like the roots of flowering plants. *Marchantias* and *Lunularias* can be grown in the same way as conventional plants. They simply need to be pressed onto soil – any reasonable soil will do – in a flowerpot, and watered, just like a geranium or a *Primula*, or any other pot plant. They will tolerate hot sun, though they do not particularly like it. Because they are small – by normal gardeners' standards – they tend to get rather soggy and messy if kept too wet, if for instance, they are stood in a saucer of water. *Marchantia* will shrivel up and die if you let it dry up completely, but a few of the little gemmae, or a small piece, will often survive and regenerate. *Lunularia*, being smaller, is more easily overgrown or spoilt if kept too wet, but is rather more drought-resistant. As a wild plant it grows in drier places, often on slopes or banks. If kept out of the sun, it can even be left dried out and dormant in the summer.

Leafy or shrubby flowering plants are cooled by air circulating among the stems and leaves. So long as the air is not heated above about 50°C, and they have plenty of water, they will probably not be

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harmful by sunshine, though some ventilation may be necessary in a sunny greenhouse. Compact leafless plants such as globular cacti are not air-cooled in this way, and despite coming from deserts, may paradoxically be more vulnerable to sunburn. These liverworts are vulnerable for the same reason. Therefore, in a greenhouse, or indoors, and certainly in an enclosed frame or propagator, they must be shielded from hot sunshine. The nearer to the greenhouse roof they are, where hot air collects, the more vulnerable they are.

These two were the first liverworts I ever noticed and started to grow. They are likely to arouse the curiosity of any plant lover. Someone who is interested should look for *Marchantias* in early summer, when the difference between the female inflorescences (left) and male (right) is obvious.



A third common species is *Conocephalum conicum*. It is larger than the first two. It has no gemma cups, and fruits are rare. The upper surface is smooth, and of a fresh green colour. When brushed or bruised, it gives off a refreshing smell – a little like the smell of apples, but more pungent. It is not an urban weed, but is found in more natural habitats, usually by streams and riversides, on permanently moist soil, rocks or brickwork. It is a very easy plant to keep. It does not mind water logging or deep shade. However the soil must always be moist. Drought will kill it, as surely as it will kill a fern or a *Primula*. It is even large enough to hold its own in a garden bed or on damp bricks, so long as the ground never dries out completely. A 20-year-old patch on a brick border in my Reading garden died in the summer drought of 1989.

These three species grow quite fast. A few shoots will expand to fill a pot or pan within a few months. Presently new shoots will have to grow over the old ones, and become more loosely attached, and more vulnerable to drying out. Within a year or two, the whole culture needs to be cleaned out and restarted, by pressing the best shoots firmly onto fresh soil.

In Britain, there are not many other species in the same order as these – the *Marchantiales* – though British *M. polymorpha* now comprises three similar taxa. Some other species are dark green translucent plants of permanently wet places. Of those resembling *Marchantia*, some are rare, but more resistant to summer drought. Smaller, but widespread on bare soil, are *Riccias*, of which the two commonest are *R. sorocarpa* with a deep groove down the middle, and *R. glauca*, without. I do not have an up-to-date worldwide list of the genus *Marchantia*. I have grown up to 20 distinct ones, mostly from other living collections. They are all rather similar, and so far as I can judge, can all be grown in a similar way. The family *Marchantiales* as a whole is much larger and more varied, containing several hundred species, all of them leafless, and most with creeping thalli. The greatest diversity of species is in warmer and drier climates, as in the Mediterranean and South Africa. Several striking species of other genera have been grown here or elsewhere in Britain, though nobody has yet built up a comprehensive collection.

2. Bags, jars, and sandwich boxes

When I was a university student, from 1958 onwards, I had no plants which needed to rely on regular care and attention. However I kept a few small ferns in jamjars with a handful of peat in, standing on my desk, or in a corner of the room, not too far from a window. There they sat quite happily, with the lid firmly closed, even during the long vacations. Without realizing it, I had re-invented the Wardian Case, so popular in Victorian times. Water, air, and even dead insects, were slowly recycled in a little enclosed ecosystem. The only attention they needed was a light spray of water every few weeks, and the wiping away of algae on the inside of the glass.

When I had a flat with a small garden, in 1962, I put a glass tank with a lid in the shade of a bush, and soon filled it with ferns, clubmosses and mosses, especially from North Wales. As I became aware of the wide variety of mosses which existed, I found that most could be kept alive in that tank, or in a jamjar, or even a clear Perspex sandwich box. However it soon became obvious that keeping mosses alive was quite a different matter from actually growing them well, and that the spindly little shoots in sandwich boxes were quite different from those of the wild plants. At the time I did not yet realize just what a horticultural challenge these plants would prove to be. Yet there are probably thousands of people who have kept bits of moss in this way, for a time. A collection of bits and pieces in jamjars, or even in plastic bags, is not a long-term proposition, but it is a beginning, and with patience and careful observation, anyone who is interested can build on the experience gained in this way.

A more convenient way of keeping a lot of material is in seed trays, each covered with a sheet of glass or a plastic propagator. Nowadays stiff transparent plastic is widely available from hardware shops. It is safer to handle than glass, and with care, can be sawn to the desired size. Easiest of all, seed trays can be draped in polythene. They can then be put in the open air, in a shaded place. When I first became interested in mosses, I soon filled several trays like this. If I have a lot of new material to look at, and not much time to deal with it, I may still put everything into a tray, cover it with a piece of glass or a plastic bag, and spray it thoroughly. This is fine as a temporary measure, for a few days, or even weeks, but I soon saw that it was no way to keep mosses permanently. I remember being frustrated and puzzled by their poor response, however thoroughly I watered them.

For a start, it is obvious that many mosses do not grow in damp enclosed places. Some of the most interesting ones – and often, the hardest to grow – are found on dry rocks and trees, or exposed to full sunshine. For these, an enclosed tray or cold frame is quite unnatural. It is only a matter of time before they decay or become overgrown. Yet even these drought-resistant species seemed to dry out and to become dull and tired, however cool and damp their surroundings. Keeping the trays wet, or putting a layer of peat in the bottom to hold water, only seemed to make matters worse. They appreciated an occasional spraying with water, but that still left the problem of what to grow them on, if anything. Gradually it became clear that the way we plant and water “normal” plants is irrelevant for most mosses. They are fundamentally different in their needs, which are far more varied than the needs of the more familiar flowering plants.

Anyone can collect twenty or thirty species and keep them alive for a few months in the way just described. That gives time to experiment, and to learn. What the next few chapters will do is to introduce different groups of mosses and liverworts which even a beginner can find in Britain with little trouble. For each group, I shall introduce one or two ways of keeping and propagating them on a more permanent basis.

3. *Sphagnum* growing

Most gardeners are familiar with dead *Sphagnum*. It is stuffed into hanging baskets to hold moisture. Its remains form peat, which has long been ripped up and marketed as the panacea for all gardening problems. Yet the live plants deserve a better fate.

All *Sphagna* need a habitat which is wet and acid. They will not be found elsewhere. In the South and East of England, some of our few remaining acid heathlands, with their characteristic flora of heather, bracken and birch, are still being threatened. Only the wetter parts of these dry lowland heaths support *Sphagna*. These areas of boggy ground are often quite small, and vulnerable to drainage or disturbance. For conservation reasons, the sale and the use of *Sphagnum* peat is being phased out, for these are among the most characteristic of all British plant habitats, and their continuing loss is one of Britain's greatest conservation problems. If you know of such a place, where sundew and *Sphagnum* grow, do not trample or disturb it unnecessarily, and collect only very sparingly. Technically, the collection of even a few shoots of a common moss can be illegal, especially in nature reserves, in which some of our remaining lowland *Sphagnum* bogs are now protected. Another threat to these *Sphagnum* habitats is commercial peat extraction. I have used *Sphagnum* peat for many moss cultures, but have found that the coconut-fibre substitute is an adequate for this purpose. If kept soaked in acid water, it supports excellent growth of *Sphagnum*, and of all other mosses and liverworts of similar habitats I have yet tried growing on it.

Most of our upland and mountain regions have high rainfall and acid soil. Here *Sphagna* are to be found almost everywhere, and the variety of colours and forms is obvious. Even a casual visitor should find several species in a short time. It is fair to warn that *Sphagna* are easy and delightful plants to grow, but often hard to identify. There are about 30 species in Britain, and very few people who can confidently name most of them on the spot. Sometimes two gatherings of quite different size, colour and general appearance prove to be the same species. The very common *S. denticulatum* and its varieties are especially variable.

Firm identification needs a microscope, a good textbook, some experience, and the methodical examination of leaf and stem characters. The main stem has leaves which can only be seen by pulling off the branches, or in some cases, the head of the plant. Stem colour varies, as does the presence of a translucent outer layer of enlarged cells around the stem. The branches may be erect or hang down, sometimes being pressed against the main stem. The differing shapes of the branch leaves, from rounded to sharply pointed, are easy to see with a lens, as is their arrangement, sometimes in well-defined rows. The most obvious features, the varied and attractive colours, are unfortunately unreliable in naming many of the common species, and even the most experienced Sphagnologist must check some gatherings under a microscope. The delightful pictures in some popular books may give some idea of the beauty and variety of our 30 or so British *Sphagna*, and may enable a few intelligent guesses to be made about their names, but little more. However, there can be no better way to arouse an interest in these plants, and a desire to identify them, than to start growing them.

They must be kept wet, which is easy. Plastic flower pots can be stood in a shallow tray, a seed tray without drainage holes perhaps, which is kept topped up with standing water. That is a familiar idea to most plant growers, though *Sphagna*, unlike familiar plants, have no roots, and simply soak up water like blotting paper. It is equally important to keep the conditions acid. *Sphagna* should be grown on peat. Normal soil, or anything containing lime, is fatal to them. The biggest practical

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problem is to ensure an acid or lime-free water supply. Hard tap water, being alkaline, will kill them, not immediately perhaps, but certainly within a few weeks. In one university greenhouse I know, a drum of distilled water stands on the staging. Most gardeners will opt for the cheaper traditional solution – a water butt – the larger the better. The cleaner and higher the roof from which rainwater is collected, the better also. Most greenhouses have not a large enough catchment area to reliably supply all the plants they may contain. I collect water from the main roof of the house. One refinement which many gardeners will find a labour-saver was that the tap in the water butt by the house in Reading could be connected to a hose which ran down the garden, to fill another water butt in the greenhouse, seventy feet away. This may seem rather a lot of trouble to take if all you want to do is keep a bit of that bright red *Sphagnum* (probably *Sphagnum capillifolium*) from last summer holiday, but there is a bonus. Anyone who arranges a good store of rainwater and can grow *Sphagnum*, can also grow other mosses, also insectivorous plants such as sundews, Venus Flytraps (*Dionaea*) and pitcher plants (*Nepenthes*), and other interesting things which other less enterprising gardeners find difficult or impossible to keep. The essentials are so simple: a bag of peat or acid fibre, a waterproof tray, and a supply of rainwater.

The most attractive feature of *Sphagna*, to a grower, is the range of colours they can show, ranging from the rare *S. fuscum*, of a dark khaki, through greens, reds and oranges, to the pale glaucous ochre of *S. papillosum*, found on rather dry heathlands. Unfortunately, one of the commonest, *S. recurvum*, is very variable in colour. These colours only develop well in sunshine, or at certain seasons. I have grown a few *Sphagna* in jars, but plants in such enclosed containers or in small frames or propagators are always in danger of overheating, and therefore must be shaded, so the plants will remain a dull green. If well ventilated, or in the open, *Sphagna* do not mind summer sunshine, though in a greenhouse they appreciate shade. They must never dry out completely. In their tolerance for water logging, *Sphagna* are unusual among mosses.

Over thirty years, I have on three occasions lost a number. In the hot summer of 1976 I forgot to move the trays into shade during a two week holiday. Many dried out, and some died. In 1986 I stood the trays in the open air, but did not put netting over them. Blackbirds turned the plants over, looking for grubs. The plants and labels got so mixed up that some were lost or never sorted out. During my more recent illness, all the cultures dried out during five years of almost total neglect, and most were lost. Birds can be a problem, as many gardeners know. Many mosses can be successfully grown in the open air. However they do need to be protected from disturbance, especially in spring, when birds will collect them for nesting material. The simplest protection is plastic netting. Wire netting should not be used, since the zinc leached out of it may be toxic to many mosses.

The biggest advantage of growing plants in the open is that they are washed clean by natural rainfall. *Sphagna* which are grown in a sunny site in a greenhouse lose a lot of water by evaporation in summer, and can become mucky and encrusted. Such sickly *Sphagna* can be seen in greenhouse collections of insectivorous plants. If the water is at all alkaline, these deposits soon disfigure and damage them. The cure is to spray thoroughly from above, and literally to wash them off. For doing this, a large garden spray is essential. For growing mosses on any scale, such a spray is the most vital single piece of equipment. It is a sad reflection on our destructive society that these pump-up garden sprays are promoted not primarily for watering, but for dispensing chemicals such as mosskillers and weedkillers. They are invaluable for watering, cleaning and spraying plants – not just mosses – and as a source of high-pressure water for D.I.Y. jobs.

Among the British *Sphagna* there are wide ecological differences. It does not seem essential to cultivate most of them. *S. papillosum* is a common large species of sunny sites, usually ochre-coloured. Medium sized, and very common, is *S. recurvum*, with stem leaves bent back (recurved). Its varieties

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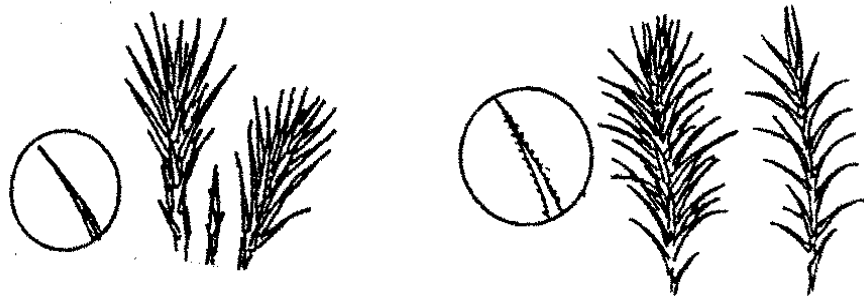
can come in almost any colour, though the bright red forms are the most attractive. Trailing in pools, its fine branches having a look like “a drowned kitten” is *S. cuspidatum*. Very common, in sun or shade, and with its many varieties, colour forms and related species, is *S. denticulatum*, with its branches often a little curved to one side “like cow horns”. Preferring some shade, at least in drier parts of the country, is the large green *S. palustre*, like *S. papillosum*, but greener. In boggy shaded woods is found the smaller *S. fimbriatum*, with ragged ends to the stem leaves, and with it, one of the smallest species, *S. tenellum*. *S. squarrosum* is quite distinctive, with recurved leaves giving the branches a prickly appearance. A few, especially *S. quinquefarium*, may be found on well-drained sloping banks in wet western woods, and on mountainsides. If well shaded, these can tolerate slight desiccation, and may be grown in shaded humid conditions, not waterlogged.

The more brightly coloured ones only develop their colours in sunny situations, and should be grown accordingly. Some species have a strongly northern or western distribution, though I never noticed any difference in their tolerance to high temperatures. Also, a few *Sphagna* from the Southern hemisphere, from Tasmania and Papua New Guinea were treated like the British ones. There are about 250 species of *Sphagna*, worldwide. Many of them are variable or hard to identify, and some of their taxonomic problems still need study in culture. This genus alone could become the subject of a large, attractive and valuable living collection.

4. Polytrichum and other large mosses

Anyone who finds a *Sphagnum* habitat, and is looking at mosses generally, will certainly find many other kinds. There are so many, the beginner will soon feel overwhelmed. It pays to be selective. However, most mosses and liverworts can easily be kept alive for a time in the way described in Chapter 2. Those from drier places are best set aside in this way, at least for now. However some others, especially those of wet acid heathland, can be grown in the same way as *Sphagnum*.

Among the largest and most obvious mosses are *Polytrichum*. *P. commune* often occurs among *Sphagnum*, and can be grown in the same way. It is the largest British species, and can make dark green tussocks up to a foot tall. On drier heathland, two other species are common. They are large compared to most mosses, but smaller than *P. commune*. Both have a hair point on the end of each leaf. In *P. piliferum*, less than an inch tall, it is white, and the tufts may have a silvery appearance. In *P. juniperinum*, a slightly larger plant, the hair point is reddish.



In acid woodlands a fourth species is common. It may reach three or four inches in height. In drier parts of Britain it needs shade. It is *Polytrichastrum formosum*. The leaves usually have a trace of red at the tips, but no hair point. A good hand lens is helpful, since it makes it easy to see another clear-cut difference; *P. commune* and *P. formosum* can look very similar. They have flat or slightly incurved leaves, like those of a tiny *Yucca*. The leaf tips of *P. piliferum* and *P. juniperinum*, which tend to grow in drier places, have their margins tightly inrolled, giving the leaf a spear like tip.

All four species can be grown like *Sphagnum*, in plastic pots of peat, stood in trays of rainwater. In a greenhouse, they do not enjoy hot sunshine. Some shade is desirable in summer, and they may grow better in fairly high humidity. However, unlike *Sphagna*, they can survive desiccation, especially *P. piliferum*. Any intelligent plantsman, on first finding *P. formosum* and *P. piliferum*, will see that they do not grow in waterlogged places. These two can be left dry, in plastic or clay pots of peat and/or lime-free builder's sand, in part shade or full sun, and allowed to dry out during the summer. If watered well from September till May, they will grow quite fast in spring and autumn. However all these four species are quite sensitive to "lime" formation on the shoots and leaves. This "lime" can become the major problem for moss growers, and it is worth looking at it in some detail.

Mosses are fundamentally different from flowering plants and ferns. They mostly have little or no vascular tissue, that is, internal tissue designed to carry water. That is why most mosses are small. Water can only slowly diffuse up through the plant, from the soil. This works well enough for smaller mosses, say up to about a quarter of an inch tall. Larger mosses usually absorb water directly through the whole plant surface. This is why they need spraying from above. Watering the soil in which they grow does little or no good. Some larger mosses draw up water from the soil, not through their rhizoids and stems, but externally. They soak it up like blotting paper. This is how

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Sphagnum remains moist. However, rooted plants can absorb the water and nutrients they need selectively, and in general can leave in the soil any dissolved substance they do not want. Mosses cannot select in this way. If the soil contains dissolved substances, they are drawn up along with the water, and as it evaporates, they make a deposit on the leaves and stem.

It is perhaps significant that the mosses and liverworts which have been most widely grown in the past are those with strong rhizoid (root) systems, which are most like flowering plants, and least troubled by lime. To grow most of the others, the grower must usually find some way of preventing these deposits from forming. One obvious way is to keep the plants moist or enclosed, so that there is less evaporation, and therefore less deposits are formed. Another almost opposite approach is to keep the soil so dry that there is never any free water. A third approach is to use totally lime and nutrient-free soil – pure peat perhaps – and water only with distilled water. This does not work for lime-loving plants, and anyway does not completely eliminate these deposits.

All these methods help, but none are entirely right for *Polytrichum*. It is usually sensible to imitate the conditions in which plants grow naturally. There is one important factor in the environment which very few plant growers or botanists seem to take account of. It is the impact of falling rain. Take some plants – any plants – from indoors, or from a greenhouse, and put them outside for a week during rainy weather. The dirtier, dustier and more neglected, the more encrusted with lime or infested with insect pests they may be, the better. As rain washes them clean, the difference is obvious. Mosses can be grown under cover, but most will only flourish if the cleansing and leaching action of rain is simulated by thorough and reasonably frequent spraying. A large garden spray is not just a convenience, but the most essential single piece of equipment.

Polytrichums have strong rhizoids, but also draw up water along capillary channels, up the stems, around the leaf bases and up the leaves themselves. Even if you bring home a tuft on its original soil, if it is left waterlogged in a dry place, as on a windowsill or in a greenhouse, it will soon begin to spoil as deposits build up on the leaf tips. The remedy is simple. It is, to wash them off with a spray of rainwater. Once this problem is mastered, these are easy plants to maintain. My surviving cultures are over 20 years old. They may need replanting every year or two onto fresh peat, as the old shoots begin to die. They will grow all through the year, except perhaps in the very hottest or coldest months, making their strongest growth in spring. On fresh peat, new shoots soon appear, thrusting up from underground stolons.

In one respect I have failed with *Polytrichums* and allies. Male and female organs are on separate plants, and both are striking. The capsules are among the largest of any moss, but only one of my cultures has produced them in recent years. Other British *Polytrichums* include *P. strictum*. It grows among *Sphagnum*, like *P. commune*, but in wet hilly and mountainous areas. It has shorter leaves and narrower stems, the lower parts of which are covered with a white felted growth of tomentum, which conducts water. It may be grown like *P. commune* or *Sphagnum*. *Polytrichastrum longisetum* is less common. It looks like *P. formosum*, but with wider translucent margins to the leaves. Microscopic examination may be needed to confirm its identity. *P. alpinum* is a rather nondescript plant, superficially like *P. formosum*. It is occasional in mountainous places, among steep or even overhanging rocks, or on acid soil in rock clefts. *P. sexangulare* is a highly specialised plant of snow patches – hollows on the highest Scottish mountains, which are covered with snow for over 9 months a year. It will not survive without special treatment. Another species, formerly included in *Polytrichum*, but now placed in another genus, is *Pognatum urnigerum*. It is rare in the South, but frequent on wet soil banks and by streams in hilly areas. It is a typical *Polytrichum* shape, but young shoots are of a striking pale glaucous blue-green colour. A related but smaller plant, *Oligotrichum hercynicum*, with blunt incurved bright green leaves, is frequent on acid soil banks in the West and

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North, becoming more luxuriant and abundant higher on mountains, and reaching the highest Scottish summits.

These four can be grown waterlogged, but on acid mineral soil rather than peat. I have found washed sand, as supplied by D.I.Y. and builders' merchants, to be acceptable, as a layer over peat. None like hot summer sunshine, which will kill them in a greenhouse. They are less easy to keep. Chapter 13 discusses the problem of growing these cold-loving plants. *Pogonatum aloides*, formerly called a *Polytrichum*, is mentioned later, and has a quite different habitat.

Polytrichums and their allies are very unusual among mosses in having thick leaves. Most mosses have delicate leaves a single cell thick. The very common *Atrichum undulatum* is related to *Polytrichum*, and like *Polytrichum*, has a broad band along the middle of the leaf, which is reinforced and thickened by ridges made of cells projecting from the top of the nerve (lamellae). However the margins of the leaves are thin and translucent. The leaves also have teeth along the edges, visible through a lens, and a characteristic wavy (undulate) appearance. It could be confused with the even larger and more delicate *Plagiomnium undulatum* which also has undulate but less pointed leaves, and creeping stems. It grows on damp sheltered soil.



These two can be grown on soil, rather than peat, and do best in moderate or high humidity, as in a propagator. There are several frequent species of *Mnium*. The commonest is *Mnium hornum*, described in Chapter 6, which has upright stems. Most, like *Plagiomnium affine*, have arching stems and wide delicate leaves, but less undulate. All grow fast and easily on damp soil, in a cool shady place.

In a related genus is *Rhizomnium punctatum*. It is about a half-inch tall, or more. Its large round leaves with a strong border are very distinctive. It grows best on rotten logs in acid swamps, and can tolerate deep shade. A lens will show the brown filamentous growth around the base of the stems (protonema) by which it spreads, and from which new shoots arise. On damp or wet rotten wood in a plastic pot, and in high humidity, it spreads fast but rather unpredictably, making most of its new shoots in spring. *Plagiomnium undulatum* can grow on chalk or lime-rich soil. Apart from that, these plants need acid or neutral soil. Lime or hard tap water is likely to kill them. If you collect them to grow, collect also a small bag of soil from the place where you have found them. A quite small amount will do. They can be put into a pot of peat with about a dessert spoonful of soil on top.

A careful look at acid ground will reveal many other mosses and leafy liverworts, mostly smaller than any mentioned in this chapter. Some of them are described in Chapter 6.

5. Garden mosses

This chapter is not about growing mosses in your garden. It is about finding them. It is also, in part, about attitudes.

I once met two young Japanese ladies, visiting England as part of their training to become qualified tourist guides in their own country. They were eager to further their training by administering and explaining a Japanese Tea Ceremony to their uncomprehending English acquaintances. More rewarding, for me anyway, than the strange green liquid we tasted together, was a glance in a Book of Useful Phrases they had brought with them from Japan. Among other things, it contained this quaint dialogue;

TOURIST. *“Why is there so much moss on the stones in a Japanese Garden?”*

GUIDE. *“Because it is the object of a Japanese gardener to encourage the things of nature as much as possible.”*

Considerable sums of money are spent each year in persuading British gardeners to bash, burn, and poison as much of the ‘things of nature’ as possible, including the mosses on our lawns, on our paths, and even on our walls and trees. When greater sums of money can be made out of persuading British people to grow mosses rather than kill them, then it will surely become a mass pastime, promoted by the so-called “Gardening Industry”. Meanwhile, it is only remote and mysterious people like the Japanese, who encourage mosses on their rockeries and monuments, or even devote gardens to an appreciation of their quiet beauty. The Japanese have philosophical ideas about landscapes, and about simplicity and repose, which are expressed in their traditional gardens. Those ideas are quite different from those expressed in British gardening advertisements, and in so many British gardens, crammed with lurid mass-produced bedding plants, gardens from which everything wild, everything unpredictable or mysterious or complicated is supposed to be excluded, and in which everything is supposed to be under total control – except perhaps the weather. To people who promote this kind of gardening, mosses are surely the ultimate irrelevance

One of the most interesting exercises for any gardener, if he or she can defy these attitudes, is to observe things, rather than do something to them. It needs no tools, no money, and very little energy – just, perhaps, a pencil and notebook. Very few gardeners ever make a deliberate survey of what is actually in their own garden – be it a survey of insects (“pests”), of birds’ nests, or of wild plants (“weeds”). I recommend making a survey of your garden mosses.

I made such a survey in Reading in 1963, on the week I moved into our house there. Among the squashed and abandoned children’s toys, the builder’s rubble, and the heaps of rusty bedsprings, were only 20 species of wild plants, including fruit trees, and various scraps of grass which had survived trampling by a family of children. Yet there were as many as 14 kinds of moss. The first lesson to be learned from such an exercise is that really thorough searching of a small area, even an unpromising one, may reveal more kinds of mosses than a superficial look in an apparently far more attractive place. Any reasonably civilised garden should have about a dozen kinds, though some may need intensive searching with a lens to discover. A lawn should hold a few, a piece of cement, or a brick or stone wall should have 3 or 4, even in the most polluted town, and a soil or cement path at least half a dozen more. In this chapter, I will concentrate on those which are most likely to be found on soil.

If you are reading this book, you may want to gather some, identify them, and try growing them in

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a flower pot. As a gardener, you will not want to merely observe your plants. You will want to control them. And you will soon discover – as I did – the maddening fact that many mosses, even from your own garden, seem resistant to any kind of control or cultivation. If you try to grow those same mosses in a flowerpot instead of killing them, you can expect many disappointments. In a frame, a greenhouse, or even outside, although they may enjoy the same climate, the same position and the same soil, many will refuse to flourish or even survive, until you have begun to understand their cultural needs. I will give descriptions of a few of the commonest garden mosses, and a few ideas for growing them. It is the ideal way to learn, for whenever a culture fails you can replace it, and check the conditions in the spot you took it from.

Most gardens are unlikely to contain any liverworts except *Lunularia* and perhaps, in a wet corner, *Marchantia*. I have already mentioned these. More rarely, shady lawns may have a leafy liverwort, *Lophocolea cuspidata*, described in the next chapter. Looking at the mosses, you will soon see the distinction between two main groups. There are those with creeping or branching stems (pleurocarps) and those with close-packed upright stems arising directly from the soil (acrocarps). I will describe first some pleurocarps, since the common garden ones are relatively large.

On a lawn, unless it is very shaded, or the soil is very acid, the obvious mosses will be creeping pleurocarps. *Brachythecium rutabulum* is the commonest large species. It is one of our commonest British mosses. It is equally likely on paths or garden beds. Also common, even on the humblest lawn or the dullest housing estate, is *Kindbergia praelonga*. This has a quite different appearance. Its pinnately branched stems may be distinguished with a lens from those of other similar mosses. This will show its distinctive feature, that the stem leaves are much wider than the leaves on the branches.



A piece of turf has a history, no less than an ancient tree or a medieval hedgerow. Older lawns – if they have not been wrecked with chemicals – may contain orchids or other small flowering plants of interest. Mosses may be part of that history. A former professor of botany near Reading owned a magnificent lawn on chalk soil, containing mosses characteristic of an almost vanished habitat – the flower-studded chalk turf which once covered much of the Chilterns – mosses which are now rare in the surrounding countryside. Botany students visited, to admire and to study them. Few homeowners can boast of such a thing, but many older lawns contain *Rhytidiadelphus squarrosus*, a very characteristic plant, with leaves strongly recurved. Some lawns, especially on wetter clay soil, may have *Calliergonella cuspidata*. The individual leaves of this, though blunt and lacking a nerve, are so

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tightly rolled together at the shoot tips as to make a point which feels quite sharp when touched.



Shady lawns and paths may have *Rhynchostegium confertum*, like *Kindbergia praelonga* but irregularly branched, with weaker straggling stems. On acid lawns, heathland mosses may grow, including *Polytrichums*, which look very dark green against the grass, and under trees, woodland species may occur, such a *Mniums* and *Atrichum undulatum*. For these plants, the choice of soil is obviously no problem. A little of the soil on which they were growing is sure to be suitable. When choosing a soil, it is worth remembering that most mosses can only exploit the surface layer. There is no point in giving them more than a half-inch or so of soil, at most. If they are in a flower pot, it is often convenient to fill the pot with peat or fibre, and to put a sprinkling of the appropriate soil on top of that.

One of the few botanists who has published an account of his efforts to grow mosses was Professor Paul Richards. In "A book of Mosses", a King Penguin Book, in 1950, he wrote;

"I have found that most mosses grow well either in earthenware pans, glazed on the inside, or in ordinary porous flower-pots or pans stood in an inch or two of water. The pot or pan should normally be covered with a sheet of glass, as even if it is standing in water, the moss may dry out in warm or dry weather."

"A situation for the moss garden should be chosen which is protected from direct sunlight, at least from April to September. An ordinary unheated greenhouse is suitable, provided there is shade from the summer sun and precautions are taken against overheating"

In subsequent articles, he described similar ways of growing large liverworts. My experience is similar, but differs in two important respects. There are so many unpredictable factors that it would be rash to give precise guidance on how best to grow the plants I have just mentioned. I will only say that with the exception of *Calliergonella cuspidata*, these mosses above do not like being waterlogged. I have grown them all in clay pots (well drained), on a shaded shelf of a greenhouse.

I did not have the benefit of a cool shaded site for the collection in Reading, as this book makes plain. The species mentioned above were sprayed frequently, but were allowed to dry out for long periods in warm summer weather, when the temperature in the greenhouse, despite shading, was too high for healthy growth. In cooler autumn and spring weather they grew fast, filling a pot within a few months. At these times they could be covered with polythene sheeting, which kept them moist for days on end. Cultures may deteriorate after a year or two, or become overcrowded. When they do, they are best replanted onto fresh soil.

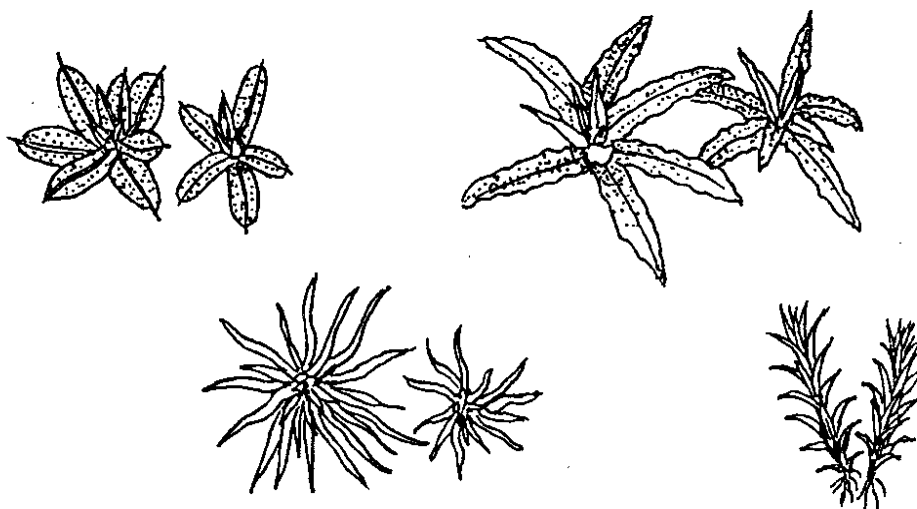
Once you have a system that works, and start looking for new but similar mosses from further afield, it becomes important to notice what kind of soil they are growing on. The distinction between acid and alkaline soils becomes obvious, as one learns to recognise the plants, and especially the mosses, associated with each kind of soil. The texture of the soil may also be important. Mosses of sandy soil will usually not flourish on clay, or vice-versa. When collecting mosses to grow on any scale, it is a

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good idea to keep plants from the same locality together, and to bring back also a small plastic bag of soil from the site. A small spoonful of this soil, sprinkled on top of peat or fibre, will be quite sufficient for most of them. In general, the smaller the plant, the more important it is to choose the right soil or substrate for it. However the important thing at first is to establish a place, and find a way of planting and watering, which works for a few of the commoner ones.

Anyone who can grow just the few creeping species mentioned already could in theory build up a sizeable collection, and one of considerable scientific interest. Even just in lowland Britain, there are over 30 species of *Brachythecium*, *Eurhynchium* and related genera alone, which can be grown in similar ways. Here are usually more species of acrocarps in the average garden, though they are smaller. The exact species depend very much on the nature of the soil. Many will be difficult for a beginner to identify.

Bright yellow-green plants with a white hair on the tip of a broad leaf are probably *Tortula muralis*. It is usually on brickwork, cement or walls, and is described and drawn in Chapter 7, but is so common that it may turn up on soil or paths as well. Plants of a similar colour, but without the hair point, are usually *Didymodons* or the closely related *Barbulas*. These are a large group, with about ten reasonably common species. Some are not at all easy to identify. Several are likely in gardens, especially on paths. *B. unguiculata* has a rather solid leaf with a sharp tip. *B. convoluta* is usually paler, lemon-green, and also with a slightly wavy leaf. *D. fallax* has short narrow leaves, twisted and incurved when dry.



D. insulanus has longer narrow leaves, irregularly twisted. These all like a lime-rich soil, well drained, (use clay pots, not plastic), and plenty of light. They only grow well if kept in high humidity, and thoroughly sprayed with water, but are well adapted to cope with long periods of drought. I have long treated them as seasonal growers, on a rather warm greenhouse shelf with diffuse sunshine, and watered freely between October and April, leaving them dry and dormant in summer. In later years most have grown well on lime-rich "mounted" cultures, as described in Chapter 8.

Few gardens are without a *Bryum* or two and few towns or suburbs without five or ten of the fifty known British species. Plants of this genus can be the most difficult of all to identify. On soil, especially in cracks of paths and pavements, is the silvery *B. argenteum*, (see illustration page 19), an unmistakable plant. Its shoots, like tiny silvery fir cones, are a beautiful sight under a good lens. Often growing with it, but of a darker green, is *B. dichotomum*. This tends to disappear in summer, at least in the drier parts of Britain.

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Two common and very similar species on soil in gardens and fields, in Berkshire and elsewhere, are *B. rubens* and *B. subapiculatum*. Like many other plants of this genus, the last three have tiny bulbils or tubers, visible through a $\times 10$, or better, a $\times 20$ lens. The position of the bulbils may make it possible to distinguish these three; *B. dichotomum* sometimes has no bulbils, sometimes a lot. They are green, and borne among the leaves near the top of the stem. There are actually several very similar species, mostly rather rare. *B. rubens* has a few reddish bulbils in the leaf axils at the bottom of the stem. *B. subapiculatum* has tubers on its underground rhizoids. They are often bright red, and can then be spotted with a good lens, despite being buried in the soil. I will not delve further into the mysteries of this genus, except to say that even in central Reading, at least ten species of *Bryum* seemed to occur, mostly on walls and tarmac. Some defied identification.



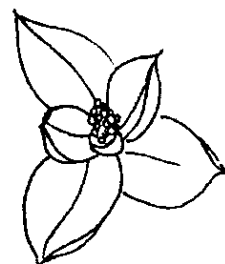
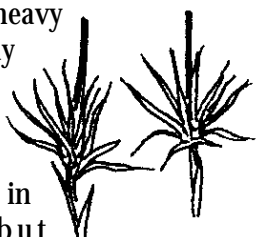
Fissidens are most distinctive mosses, with their leaves folded flat, forming on each stem a small stiff fernlike shape. A garden on clay soil may well contain *F. bryoides*, or the larger and slightly paler *F. taxifolius*. A strong lens or microscope will show the pale border of narrow cells on the leaf of *F. bryoides*.



Gardeners who laugh at the idea of growing mosses often say "I have some in my greenhouse!" This is a pretty sure thing, for anyone who keeps their pot plants wet enough is soon going to get *Leptobryum pyriforme*, with its delicate tufts of fine wavy leaves, and probably also *Funaria hygrometrica*, a budlike plant with a large lopsided spore capsule. Both fruit freely, though *Leptobryum* is a rather delicate plant, and rarely grows luxuriantly in the open air. They are the commonest "weed" mosses in greenhouses, but rarely persist for long in one place, especially if this happens to be a flower pot where a deliberate attempt is being made to grow them!

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Two other tiny curiosities are likely on heavy loam or clay soils. Both are short lived annuals, dying away in summer, but leaving spores for



next year. They are *Tortula truncata* and *Phascum cuspidatum*. They freely produce their characteristic fruits. *Phascum cuspidatum* fruits are on such a short stem as to be almost hidden among the leaves.

All these acrocarps have a strong rhizoid system, and can draw up water very effectively from the soil. They grow fast and well, and can tolerate waterlogging, drought, some sunshine, except in high summer, moderate shade, or any combination of these conditions. The trouble is that they are so small, and that things happen so fast, especially with the short-lived annual species, that within a couple of weeks, cultures are sure to contain a mixture of several species, and the one you started with (or thought you did) has died, or is replaced by something different. If you have taken a lot of trouble to identify the original plant, this is most annoying. They are, after all, ephemerals, so I suppose a plant that disappears in culture is behaving as it would in its natural habitat! It helps, to start fresh cultures fairly frequently, every six months or so, and as carefully as possible, on fresh soil, using tweezers and a magnifying glass to pick out the individual shoots you want. The pots can be wrapped in Clingfilm for a week or two to keep them moist, and to stop unwanted spores and fragments contaminating them. I nowadays keep ephemerals on "mounted" cultures, on a thin layer of soil on pieces of polystyrene tile. This gives far better control over what is actually being grown, and I have managed to keep track of them far better in recent years. Even so, you may not get reliable results, especially with the *Tortulas* mentioned above. Indeed, serious long-term collections of some of these small ephemeral plants may be best kept in test-tube cultures. I give a few ideas on how to make "mounted" and test-tube cultures later.



I make no attempt to list other likely garden mosses, even in footnotes. I have given some idea of the variety of mosses you may find in even a quite ordinary garden. If you manage to name even half of them at first, it will be no small achievement, and to attempt to grow them, especially the smaller or more nondescript ones, involves considerable skill. Yet it is not wasted effort, for the same techniques can be applied to hundreds of other species, and to many other very small plants. Anyone who starts a similar project with mosses from outside Europe may encounter dozens of inconspicuous species which have never been grown by anyone before. Some of them are likely to be new to the country concerned, or even new to science.

Many people, including some who have asked me about it, approach moss growing from a different direction. They are less concerned with acquiring, naming or growing lots of species, and more interested in creating mossy landscapes, or encouraging mosses in their gardens generally. The Japanese moss garden, with its use of rocks and gravel, is the only relevant tradition I know, but is only one of many possibilities. Mosses rarely compete with larger plants. They grow on rocks, walls or trees, where there is little or no soil, and little competition. They only make conspicuous growth in places where flowering plants are stunted or absent.

To try growing mosses in the fertile soil of a garden bed is usually as futile as trying to grow parsnips

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on top of a bare wall. Where the soil is too acid, too deeply shaded, too low in nutrients, or too thin and dry for normal garden plants to survive, there will mosses flourish. Likewise, in severe climates, on the highest Scottish mountains, or in high Arctic tundras where little else can grow, there also mosses may predominate. More rarely, moss-dominated places can be found, such as old lead or copper mines, chemical waste sites or zinc-contaminated ground under electricity pylons, where the soil is too poisoned to support normal vegetation. Few gardeners would wish to create such habitats, even where it might be possible to do so. Nevertheless, if you want mosses to play a noticeable part in any garden, a suitable habitat must be created. The most likely habitats will contain little or no soil.

There is no need to import pieces of rock, for cement and tarmac make excellent habitats. When fresh, they are hostile, but after a few years' weathering, they are sure to become covered with mosses unless something prevents their growth. Some will be garden mosses already described, but, especially if exposed to sunshine, many will be walltop mosses, described in a later chapter. My own garden in Reading was full of old bricks. They were used to make paths, borders, and retaining walls to some garden beds. They were slightly porous and alkaline, and they supported a rich growth of mosses. The retaining walls especially offered some scope for introducing mosses deliberately, including a few which do not naturally grow in Reading. So did a rather exposed north-facing brick wall at the front of the house, on top of which several unlikely species became established, after being glued onto the bare bricks. I used a waterproof spirit-based glue (Uhu) or, in later years, a silicone-based flexible sealing compound. There is usually not the slightest chance of success in sticking mosses on walls in this way, without a good understanding of which species are likely to survive in a particular place. Sloping surfaces, but not usually vertical ones which receive little rain, are best for mosses. It would not be sensible to gather any mosses except the very commonest ones described in this chapter, for use in such plantings. Better far to create or conserve the garden habitat, and then see what grows in it. Herbicides have their uses, since they kill flowering plants but usually leave mosses and liverworts unaffected. One could use them, for instance, to create a grass-free moss lawn, which would of course be a great improvement, needing no mowing! It would also be safer, since wet grass, is often slippery after rain. There is an unusual garden in the Cotswolds whose owner once weeded out all herbs, leaving only carpets of native mosses. However he did not introduce new species, nor know which ones were growing there.

Many mosses need higher humidity than is likely in a garden. A moss-covered log for instance, moved from woodland, is likely to lose much of its cover within months. Where water runs from a gutter or overflow, especially into a shaded corner, there may be a small wet area where *Marchantia*, *Conocephalum*, or perhaps some mosses may flourish better than elsewhere. An acquaintance has used *Marchantia* as ground cover at the wet margins of a garden pond. Many mosses and liverworts of wet places could be grown thus, so long as the distinction between acid, neutral and basic conditions is understood. A garden fountain splashing onto rocks can also encourage waterside mosses to grow.

A bank or slope of peat blocks (or peat-substitute blocks) is a good habitat for acid-loving mosses, and a pond filled with wet acid peat might well support *Sphagna* and associated plants, including mosses. There are other natural habitats which might be recreated or imitated on a small scale, even in a small garden, and which might support a few characteristic species of mosses or hepatics. A sunny wall top, for instance, with a thin layer of soil on top, can provide a home for some very characteristic mosses. There are lots of other possibilities which I have never tried, and never seen done convincingly by anyone else.

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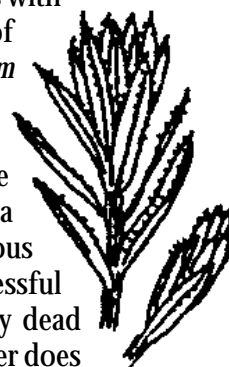
Only someone who has learnt to appreciate wild plants, including mosses, and who has gained some understanding of their habitats, is likely to achieve anything, or even to see what those possibilities might be. However, the small size of so many mosses makes it difficult and uncertain to keep track of introductions, however carefully they may be made and observed. In general, I think one is likely to learn more about mosses, and to achieve more, by studying those which are already in a garden, and by trying to grow them under controlled conditions, than by introducing new species to the garden itself.



6. Acid woodland mosses and hepatics

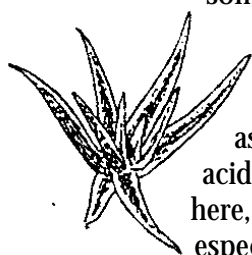
Most people ignore the evidence of their own eyes, and assume that mosses grow only in damp shady places. Certainly, mosses may seem larger and more abundant in woods, but even here, many interesting species are small and inconspicuous. I will start with the largest and most obvious ones. The moss flora depends very much on the type of soil, and on the local climate. In drier lowland regions, woodlands with acid, neutral or chalky soil respectively, each have their own distinctive species.

Acid woodland will usually be dominated by pine, birch and bracken, perhaps with heather in clearings, and unfortunately, in many places, advancing thickets of *Rhododendron*. Wet hollows may have *Sphagnum*. In such a wood, *Mnium hornum* is likely to be the commonest large acrocarp, on stumps, on tree bases, and on the ground, especially where there is some shade. It is up to an inch tall. In late winter and spring, male plants with their terminal rosette, and female plants, with fruit, are common and obvious. In spring the young shoots are a pale bright green, strikingly different from the dull tired shoots of the previous year. With it may grow *Polytrichastrum formosum*. These are the most successful species on the woodland floor. Most smaller mosses are overwhelmed by dead leaves, and are therefore confined to banks, stumps and slopes, where leaf litter does not accumulate so much.

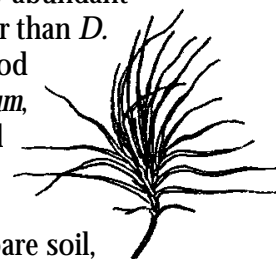


In open or drier places, and in clearings which get more sun, is a different flora. *P. juniperinum* is very common, often among colourful lichens of the genus *Cladonia*. With it are likely to be *Campylopus introflexus* and *Pohlia nutans*. The *Campylopus* is a remarkable plant. When mature, it has white hair points, which curl inwards and cross over when dry, to make little silvery stars against the dark green leaves. It is not native, but a colonist from the southern hemisphere. *Pohlia nutans* resembles a tall slender *Bryum*. Sometimes the leaves are loose and spreading, sometimes rolled into a tight catkin-like shoot. The two genera are related. In most *Bryums* the nerve reaches the leaf tip. In *Pohlia*, it fades out just short of the end. *Dicranum scoparium* is one of the most widespread acrocarps. It is commonest in acid places, but can grow almost anywhere, loosely attached to the ground, in thin turf, on banks, or on tree stumps. It is very variable, especially in size. The leaves may be straight and symmetrically arranged, or curved to one side (secund).

Often in an acid wood, especially a damp one, there are large silvery-green hummocks of *Leucobryum glaucum*. The leaves are blunt and swollen, made of hollow cells that absorb water and give the plant its strange colour and texture. Almost as common in the West, and locally abundant elsewhere, is *Dicranum majus*. Though also variable in size, it is usually larger than *D. scoparium*. The leaves are always turned to one side (secund). A good distinction is that the leaves are all about a centimetre long. In *D. scoparium*,



some are shorter. A smaller plant which is common and likely to be noticed is *Dicranella heteromalla*. The fine silky leaves, always secund, form a dark green velvety turf, usually on a bank or patch of sloping bare soil, as by the base of a tree. In similar places, indeed anywhere on acid ground, may be found *Ceratodon purpureus*. The leaves may be long, as shown here, or shorter, as shown in the next chapter. Rotting tree stumps are worth especially careful examination. On them may be found *Tetraphis pellucida* and

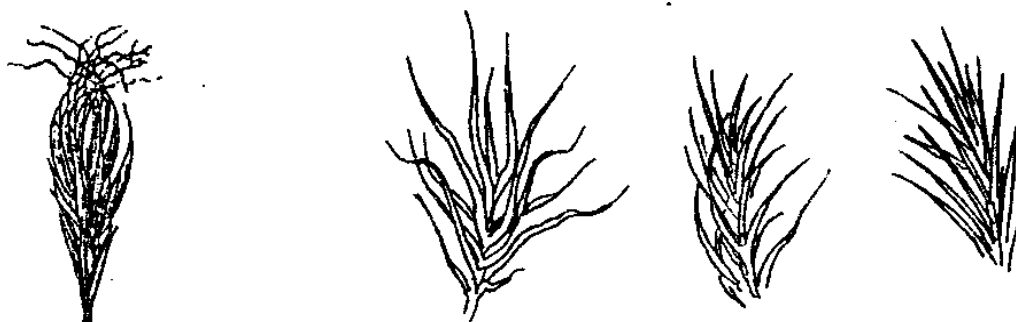


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Aulacomnium androgynum, two remarkable mosses described in Chapter 9, and with them, leafy liverworts.

Most of these plants are not difficult to grow. All can be kept on peat. However there is an important difference between those with strong rhizoids, like *Mnium hornum*, and those without, like *Dicranum scoparium*. In general, those with rhizoids can grow in plastic pots, which hold soil water, which they can extract and use. *Mnium hornum* should be shaded, and prefers moderate or high humidity. *Pohlia nutans* grows strongly in waterlogged peat, in full sun or shade, and fruits freely in spring.

The *Campylopus*, as should be obvious from its habitat, will endure sunshine and drought. In a clay pot of peat, it will persist for years, even in hot sun. However, like other *Campylopus* species, it will spread slowly or not at all, unless it is kept constantly moist for part of the year. If sprayed often enough in the winter months it will spread a little, but the best way to propagate *Campylopus* is to keep it constantly moist, in a plastic pot in a humid frame (out of hot sunshine). In these conditions it will spread quite fast over a fresh peat surface. Loose leaves and leaf fragments will also rapidly sprout new rhizoids. It can be kept this way, or when a good tuft has formed, transferred to a clay pot and hardened off in drier conditions, like a young bedding plant. *Campylopus* can also be grown like *Sphagnum*. Venus Flytraps (*Dionaea*) in flower shops are often on wet peat, surrounded by *Campylopus paradoxus*. This is a fairly common British species without hair points, which forms thick tufts with a reddish brown tinge below. It can flourish on waterlogged peat in full sun, but soon becomes rather mucky with lime on the leaf tips.



Though all *Campylopus* are lime haters, this deposit does not immediately damage them, since the lime forms well away from the growing point of the shoot, which is buried below the long leaves. However they need high humidity, or thorough and frequent spraying with rainwater, or both, to keep them clean and healthy for any length of time. There are many mosses like this, which are quite specialized in comparison to more familiar garden plants, yet which can be grown well enough in several distinct ways. *Campylopus* is quite a large genus, with 12 British species. Some are large rare plants of the extreme West, best kept on peat in high humidity. Even the common lowland ones can be troublesome to name, and leaf sections may have to be cut with a sharp razor and examined under a microscope. All may be grown like *C. introflexus*.

Dicranum scoparium is rather different. Perhaps the nearest approach to it among familiar horticultural plants are the "air plants", the little Bromeliads which have been popularised by Clive Innes in recent years, which rely entirely on overhead spraying, and need no soil at all. I have most of the larger British species of *Dicranum* on peat, in clay pots, in light shade, remaining dry for much of the summer months. In winter they are sprayed as often as convenient. A light mist spray will revive them, but an occasional heavier spray, completely wetting the tufts, will keep them healthier. Even

so, the peat or soil on which they grow may be dust-dry for part of the year.

Dicranum is also a large genus. Most of the 14 British species are occasional plants of mountain regions, or are very rare. A plant with wavy crinkled leaves, especially if found on chalk or limestone, might be *D. bonjeanii*. More likely, it is just another form of *D. scoparium*. A microscope and a serious reference book are needed to sort them out. Other smaller *Dicranums* may be found on tree trunks in woods. They are epiphytes, and are mentioned in Chapter 11. *Dicranella heteromalla* relies more on soil water. It can spread quite fast over fresh acid peat or loam, in a plastic pot, or if in higher humidity, on well-drained soil in a clay pot. *Ceratodon purpureus* is similar, but does better on acid mineral soil or mounted peat or acid loam, not too deeply shaded. *Leucobryum glaucum* persists on dry peat, but, like *Campylopus*, will only spread by protonema if kept moist.

The commonest pleurocarp on acid heaths, and on and around trees in acid woods, is probably *Hypnum cupressiforme*. The various forms (now mostly recognised as distinct species) can all be grown in clay pots, on peat, and are drought-resistant. Abundant, and often growing with it on tree boles, is a moss with little bushy upright stems, up to an inch tall, and tapering pointed branches, curled to one side. This is *Isoetecium myosuroides*. It may be grown in the same way.



On damp stumps, soil banks and shaded tree bases may be found species of *Plagiothecium*. The leaves are usually turned so as to give the shoots a flattened appearance (complanate). Unfortunately, the two commonest lowland species may be rather hard to tell apart without a microscope. *P. succulentum* and *P. denticulatum* are both glossy yellowish plants which shrivel and curl up when dry. If kept moist and shaded, both grow vigorously on any acid or neutral loam. A smaller plant with similarly flattened glossy shoots is *Pseudotaxiphyllum elegans*. It is silvery green, not yellowish, and usually on soil or peat, not tree bases. It is confined to acid habitats, and will only survive on peat or acid loam, mounted or well drained. These last five pleurocarps can be kept on acid loam, shaded and in moderate humidity. They must be well-drained, not wet.

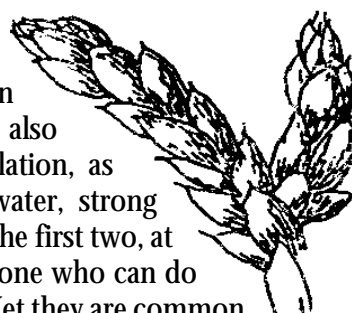
In woodland clearings and thin acid turf, especially among heather, are several large pleurocarps. The commonest is *Hypnum jutlandicum*, which has hooked shoot tips with a silvery gloss. There are also two species with red stems. Both may form extensive mats. *Pleurozium schreberi* has rounded leaves and blunt simply branched stems. *Hylocomium splendens* makes elegant bipinnate fronds with bright red stems and very fine branches like those of *Thuidium tamariscinum*, (see next chapter) but of a darker translucent green.



Both are demanding plants in cultivation. They survive if kept fully enclosed and moist, as suggested in Chapter 2, but make only poor straggling growth. They are lime haters, usually confined to strongly acid places, and the least lime accumulation on the tips of the stems will damage and destroy

them. I have failed with both several times in the past, but they will grow if kept on dry well drained peat, in part sun or light shade, and sprayed with clean rainwater. I find that wet soil or water from below are eventually fatal to them. They need high humidity to grow at all well, as during the winter, but if shaded can patiently endure weeks or even months of drought and dormancy in summer. Like most of the plants mentioned in this chapter, they have in recent years been covered with polythene and in high humidity for most of the year, but when conditions became too warm, in April-May, have been allowed to dry out. Until about September, they were sprayed only in the coolest and dampest weather, if at all. Another factor in their cleaner appearance and more successful growth has been the use of a finer spray of water most of the time.

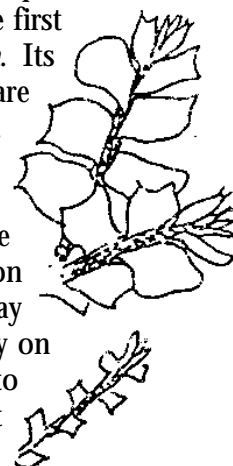
Pseudoscleropodium purum is a large coarse common plant of thin turf, with swollen irregular branches, and no trace of red colour in the stems. It can be found on any kind of soil, including chalk, but like the last two, needs well drained soil and overhead spraying to remain healthy. These are large, obvious and beautiful plants, but they are also among the most difficult of all mosses to grow. Lime accumulation, as described in Chapter 4, on *Polytrichum*, is the problem. Clean water, strong drainage and completely lime-free acid conditions are essential for the first two, at least. Few people have ever kept them alive for very long, and anyone who can do so is likely to succeed with almost all large pleurocarpous mosses. Yet they are common enough, and can be gathered and experimented with, with a clear conscience.



Wet western woodlands, especially oakwoods of the kind to be found in North Wales, are among the most spectacular of all mossy habitats. The boulders and trees are covered with deep mats of pleurocarpous mosses. Especially conspicuous are two species unlikely to be found in the drier parts of Britain.

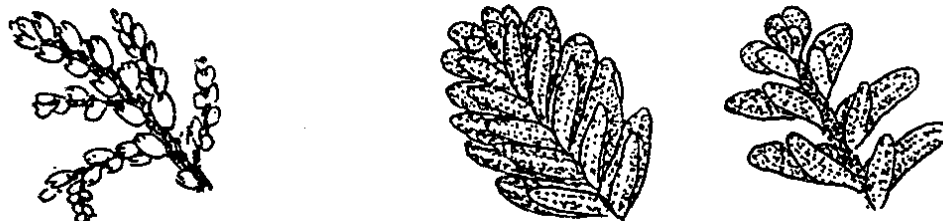
Rhytidiadelphus loreus is a larger relative of the more widespread *R. squarrosus*, as found in lawns. Its arched stems may be several inches long. *Plagiothecium undulatum* has flattened shoots, like its relatives, but is a much larger plant of a characteristic whitish green colour, with wavy (undulate) leaves. Both appreciate shade, high humidity and frequent spraying.

Several leafy liverworts are common in acid woodland, in even the driest parts of Britain. Most are confined to stumps, or to steep banks of shaded soil. The first leafy liverwort any beginner is likely to find is probably *Lophocolea heterophylla*. Its wide leaves, set sideways on the stem, and its pale delicate appearance, are obviously different from those of any moss. The leaves always vary in shape. Some have two sharp teeth, while some are rounded. It grows on tree stumps, shady tree boles, and especially on decaying logs, in almost every wood in lowland Britain. Young shoots are often much smaller than mature ones. Two other *Lophocoleas* are common. Both have a pair of sharp teeth on every leaf, with no blunt-lobed leaves at all. *L. bidentata* is usually on soil. It may sometimes be found on shady lawns and flower beds. *L. cuspidata* is usually on wood. It is unfortunate that these two, though so common, can be so hard to tell apart. According to some recent authors, they are not even distinct species. In wet places such as streamsides, pond margins and boggy woods, may be found species of *Chiloscyphus*, similar to *Lophocolea*, but with all the leaves rounded, lacking any sharp teeth.



Shaded banks of acid soil, such as are found in the Chiltern beechwoods, are likely to have two or

three other smaller hepatics, all very different, and giving some idea of the great range of shapes and forms among these little plants. *Lepidozia reptans* can form wide patches. Its intricate branches and three-pronged leaves are hard to see, let alone to appreciate, without a good lens. *Diplophyllum albicans*



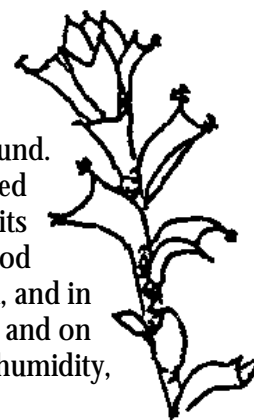
is also common. Its flattened shoots, and leaves with a lower portion folded upwards, resemble those of the moss *Fissidens*, but with rounded tips. The cells in the middle of the leaf are larger and more translucent than those at the sides, giving the impression of a pale nerve. A third species is quite different in habit, creeping close to the ground on steep or vertical acid soil banks, or in damp shaded recesses. It is *Calypogeia fissa*. It often has modified almost leafless upright stems at the ends of the shoots, with clusters of pale gemmae at the tips. They may be the most conspicuous part of the plant. Other *Calypogeias* are less common in the Southeast. They can usually be named with a lens. *C. arguta* is smaller, with the two teeth diverging "like a pair of bunny's ears". *C. muelleriana* has the leaves notched, but without sharp teeth.



In trying to grow these, and other plants like them, it will soon be found that they are less forgiving of mistreatment than most mosses. In particular, if they dry out, they will die completely. Exposure to hot sun is quickly fatal. They should be kept in a small propagator, or on the completely shaded floor of a greenhouse, probably in a plastic pot, always moist, but not waterlogged. All need acid soil. The *Lophocoleas* grow well on wet peat or rotten wood. So do the non-British *Lophocoleas* I have kept, and *Lepidozia reptans* likewise. It prefers to be well drained, but needs higher humidity, as in an enclosed frame or a glass tank. I grow it, and the *Diplophyllum*, on acid loam. Some *Calypogeias* are kept on peat, some on acid mineral soil, mostly in plastic pots. They are among the most shade-tolerant of plants, and can grow in as little as 1% of full light, as measured with a photographic exposure meter, in conditions so dim that they face little or no competition. Though they can cover a few square inches within a year, their small size is a problem. After a year or so they get overcrowded or go mouldy, especially if the culture is too wet, and a new culture should be started.

A few good shoots can be pulled out and laid onto a fresh pot of soil. For handling single shoots of such small plants, tweezers and a lens are very helpful.

In drier or more exposed heathy places, two other leafy hepatics may be found. *Lophozia ventricosa* is the most widespread of this large genus. The two-lobed leaves are usually tipped with pale powdery gemmae. It is so small that its fate is uncertain in a flower pot. It can be kept on well drained peat in a good light, but not in direct summer sunshine. In western and northern Britain, and in Scotland, several other *Lophozias* are common on rocks and walls, in turf, and on banks. I find most of them grew best on mounted peat in fairly high humidity, though they tolerate gentle desiccation in summer.

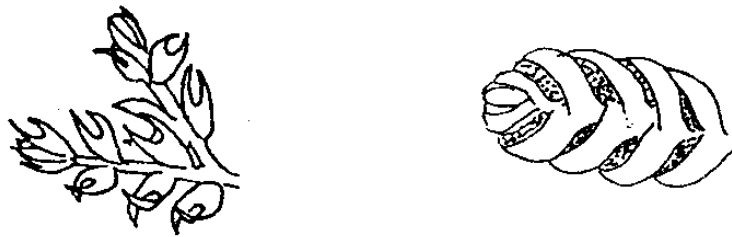


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The ultimate challenge for a beginner is to find a species – any species – of *Cephaloziella*. They are the smallest of British hepatics. They are seriously small. Even the best material looks like the fluff from the bottom of a Hoover bag, only less interesting. Yet through a strong lens or a microscope, a fully formed plant can be seen, with branching stems a few cells thick, and forked leaves. A good way to find them is to lie flat on a patch of heathy ground, among *Polytrichum* perhaps, and examine the soil minutely with a lens. Though it will never become popular with your average gardener, this is an exceptionally interesting genus to ecologists, since several species grow on rocks or soil associated with lead or copper deposits, in places toxic to most other plants. There is virtually no hope of identifying most of the 12 British species unless male and female plants can be found. This usually needs careful and intensive work, in the habitat, with a lens. One of the commoner ones, *C. divaricata*, may have clusters of red gemmae on the tips of tiny erect shoots.

Surprisingly for such small plants, they have grown strongly. Most of mine are in plastic pots, waterlogged in winter, but exposed to sun and high temperatures, and perhaps also to prolonged drought in summer. They are very unusual among liverworts in tolerating, and even enjoying such conditions. Some are on acid clay, some on peat, a few on samples of lead-rich soil from Derbyshire. One minute, rare, and very exceptional plant, *C. baumgartneri*, which is confined to a few warm sheltered limestone sites on the South coast, can be grown on small lumps of chalk. Some species form a sort of avenging black or green fuzz, capable of swamping plants many times their own size.

A large and quite different selection of hepatics can be found in wet places, in swamps, by streams, and on damp tracks and disturbed soil. In general, they are easier to grow than hepatics of drier or well drained habitats, since it is very easy to provide the wet conditions they like, by standing pots in trays of rainwater. The largest and most obvious plant, not mentioned so far, is *Pellia epiphylla*. It is a large leafless (thalloid) plant, like *Marchantia*, but of a translucent dark green. It will be found in permanently wet places such as ditch sides, and is very vigorous if kept waterlogged and shaded, on peat or acid soil. Smaller plants likely to be found nearby, or in similar places, include *Cephalozia bicuspadata*, with forked leaves, and *Nardia scalaris*, with simple rounded leaves. These too can be kept



on wet or waterlogged shaded acid soil. The *Cephalozia* is, in my collection, a vigorous and common weed of wet peat, clay and acid loam, producing abundant fruit in spring. Several other species, though with slightly different leaf shapes, may be hard to identify, but are not rare on rotten stumps or in *Sphagnum* bogs. *Nardia* is uncommon in the South and East, but abundant in wetter and hillier country.

I have often been asked if it is necessary to grow mosses on their original soil. That, of course, would limit the possibilities for propagating them. It is not necessary, but acid, lime-free soil or peat is needed for almost all the plants in this chapter. A collection of half-dozen or so different kinds of soil is essential, if you hope to grow species from a variety of places. If used sparingly, a small bagful can serve for dozens of cultures of these tiny plants. As suggested earlier, when collecting plants, it is a good idea to collect also a small bag of soil similar to that on which they are growing.

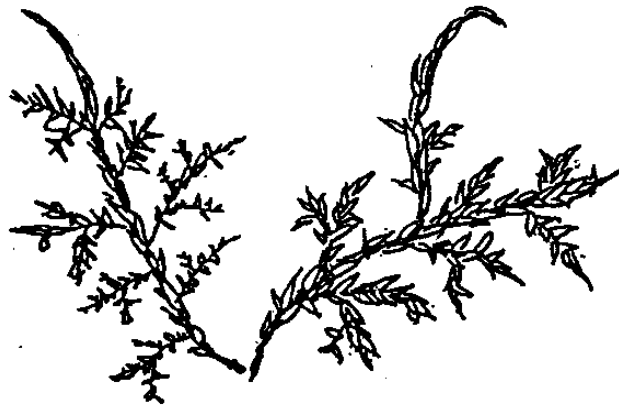
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A spoonful of this soil, on top of a flowerpot of peat or fibre, is quite sufficient. A collection of a half-dozen contrasted soils, not forgetting their different textures, a modest plastic bag of each, will suffice for dozens of cultures, of almost all our common mosses and liverworts.

In wetter parts of the country, from Hereford westward, or from Derbyshire northwards, a rich, varied and unpredictable flora of tiny liverworts may be found on damp soil and paths. Do not neglect paths, however small and squashed their vegetation may appear. And do be prepared to get right down to ground level with a good lens, and to use it. I once sat down with two knowledgeable companions, to examine a grassy bank on which we had seen an unusual moss. The place held our attention, but we only found the most interesting plant of all – a liverwort – after twenty minutes searching with lenses – within a yard of where we were sitting.

I have described the flora of acid heath and woodland, not because this is the most widespread habitat, nor because it is especially rich in mosses, but because it is the most distinctive. Even a complete non-botanist should be able to recognise a hundred acres of heather and bracken. This section may give some idea of the mosses and hepatics likely to be found in such a place, and of how to grow them. Yet many other mosses are at least as common as some of the heathland species described here. One of the strangest things is to walk across a heath, and suddenly come upon a piece of cement, or a pile of soil or garden rubbish. On it will be found half a dozen of the garden mosses described earlier – species which are completely absent from the undisturbed heathland all around. An old piece of cement or a brick wall, miles from anywhere, even in remote mountain country, will have *Tortula muralis*, and perhaps a *Barbula* or two growing on it, just like a piece of old cement in a suburban garden.

It is this affinity which many mosses have for a particular kind of place, or for a particular kind of rock or tree, which gives them such a reputation as specialised, and difficult or impossible to keep alive. Small as they are, it is their behaviour, no less than their appearance, which makes them such fascinating plants to study, and to grow.



7. Mosses on walls

A “good” wall, an old wall of brick, cement or natural stone, is certain to have several mosses on it. It will also provide a variety of different niches, so even mosses from the same wall may differ widely in their environmental needs. In the countryside, many walls are covered with luxurious creeping mosses. In large towns, most walls have only acrocarps. In city centres, *Tortula muralis*, with a hairpointed leaf, and the dark dingy green *Ceratodon purpureus*, are the commonest.



They are also among the most pollution-resistant. In Westminster Square, or elsewhere in central London, one can see how limestone walls have been literally dissolved away by sulphur dioxide, diluted by rain to form sulphuric acid. Yet even here, stunted tufts of these two species can be found, often with *Bryum argenteum*.

For all their hardihood, these are not easy plants to grow, unless you finally abandon any idea that mosses need shade and moisture. My greenhouse in Reading, devoted to mosses, was aligned east to west. The top level of staging was just below the glass, and hanging above it were sheets of aluminium-coated plastic, which provided partial shading in summer. On any sunny summer day, temperatures there went above 40°C. After 1995, when the overhanging lime trees were removed, I often recorded temperatures of over 60°C, even in September. Cacti placed there were scorched and killed by the heat and glare. Yet that shelf was full of mosses, many of them small or rare ones, yet successful. Only for a few hours, on the dullest and wettest day, or between October and March, and when covered in polythene, did these long-suffering plants remain continuously moist for a day or two, and have a chance to grow. For the rest of the year, they were dry. This oven-like environment may not have been the best way to grow the three species mentioned so far, but it worked. All they needed was to be kept moist and in a good light, for a few months in the winter. *Tortula muralis* likes cement, brick, and lime, so it has been in a clay pot, filled with peat, perhaps, but with some cement or chalky soil on top. It fruited in spring, just like the “wild” plant outside.

Ceratodon is a nondescript plant. It is allegedly very troublesome for a beginner to name. It grows in a great range of habitats, including acid heathland (see last chapter). The best urban material is on wet walls or in gutters, where it forms big messy waterlogged tufts of a deep dark green. It often fruits. Held up against the light, the young fruit stalks (setae) in spring are a remarkable wine-purple colour, hence the specific name. With practice, the characteristic rolled leaf margin and the slight sideways curl to the leaf can be recognised. I have grown it usually in full sun, in clay or plastic pots, on peat or acid soil, or on mounted peat or loam. A form with a short hairpoint (v. *conicus*) grows on chalk soil, but is much less common.

Even stranger, these, and other wall plants, do not only grow without soil, but some of them

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strongly dislike any kind of soil. *Bryum argenteum* has been described as needing nitrogen. It is the commonest town moss, but the only "natural" habitat in which it is abundant is said to be on rocks around some seabird colonies. It has failed miserably here, many times, in flower pots of soil, yet it can be reliably grown in "mounted" cultures, as described later.

Away from the most severely polluted town centres, other plants can be found. The most obvious is *Grimmia pulvinata*. The dense rounded felt-like silvery tufts are more distinctive than the individual shoots. Like many mosses of dry rocks and walls, it has a long white hairpoint on each leaf. Among them can usually be found the fruit, on a characteristic short curved seta.



Another unrelated moss with a hairpointed leaf is far less conspicuous, but surprisingly common on town walls. It is *Orthotrichum diaphanum*. It forms small tufts on the tops of walls, but also thin dingy layers on the vertical sides, where lime-rich water trickles down. It is especially fond of limestone, and may also be found on the bases of trees, even in towns. Sharp eyes, or a lens, are needed to see the small hairpoint, or the capsule on its short stalk, half-hidden among the leaves.

Schistidium apocarpum s.l. can make wide mats of dark dirty green or ginger-brown, on tarmac or cement, and in wetter climates than in Reading, on walls also. It has a very small hairpoint, hardly to be seen without a lens, but differs in habit from *Orthotrichum* in that the stems are tough and wiry, with irregular creeping branches in older tufts. The capsules are tucked among the leaves at the tips of the stems, with a striking circle of bright red teeth around the opening.

If you try to grow these, common as they are, you are entering almost unknown horticultural territory, and must expect slow results, and many failures. They had probably never been kept alive for any length of time under cover, until I tried my hand at them. Attempts to grow them on any kind of soil usually failed. So here is a way of planting that is essential for *Grimmia* and *Orthotrichum*, and which works for many hundreds more. About half my cultures are not on soil at all, but on "mounted" cultures, as described here.

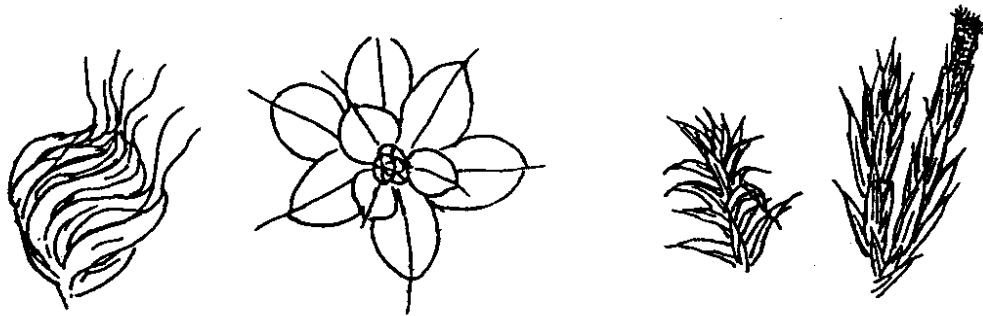
You need a plastic pot, preferably a square one, which fits better, an expanded polystyrene ceiling tile, a razor blade, and a tube of spirit-based glue (I have usually used Uhu) Do not use water-based or solvent-free glues, which may not be waterproof, and, more serious, may dissolve, to poison mosses. The planting medium, soil, rock or tree bark, should be crushed or grated to roughly the consistency of coarse sand.

Cut a square of the tile to fit in the pot, which is merely used as a convenient holder, and spread glue thinly on one side. It is easiest to rub two pieces of tile together, to spread the glue thinly and evenly over both of them. Then cover it with the crushed or grated substrate, perhaps first sticking on the original moss gathering, or a small part of it, on its substrate. I mass-produce these mounts, ready for later use. I may cut up a whole tile, to make up to 50 at a time, using the desired substrate, peat, powdered granite or limestone, especially. Planting is then very easy. A small tuft of moss can be glued to the tile, or better, its base pushed into it, using the sharp end of a label or a pencil. Or it can be attached by spearing it with a spine (I use *Berberis* spines). Or the plant, if small, may simply be laid on the wet surface, held by water surface tension, until it has started to grow, and to attach itself.

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If you are already growing mosses in flower pots, put this culture among them, and treat it likewise. Even single shoots of the smallest plants can be confidently handled in this way that would be quickly lost in a flower pot. The method can be used for most smaller mosses and hepatics, so long as it is remembered that they dry out faster, and may need to be kept in higher humidity than those in flower pots.

Bryum capillare is the largest plant mentioned in this chapter so far. It is very common on soil, and on rocks and walls, and can form large tufts. It is a dark translucent green when wet, and has broad leaves with a hairpoint, spirally twisted in a characteristic way when dry.



These plants differ in their cultural needs. *G pulvinata* and *Orthotrichum* are less shade-tolerant. The less compact shoots of *Schistidium* need higher humidity to grow well, as in winter, covered in polythene. All are best in “mounted” cultures. *Bryum capillare* is the only one of them which can be reliably grown in a pot of soil. I have grown it, and several rarer but similar species of *Bryum*, on that hot sunny greenhouse shelf, on loam, in plastic or clay pots, or on mounted cultures. Other *Bryums* are common on brick walls. They include *B. caespiticium*, a little smaller than *B. capillare*, with a much narrower erect silky leaf, and *B. radiculosum*, which is typically a much smaller plant of an intense dark green colour. When stunted, they can be almost impossible to distinguish, but when fertile, the short dark red capsule of *B. radiculosum*, and the longer pale yellow-brown capsule of *B. caespiticium* are quite distinctive. *B. dichotomum* may also grow on walls.

All the plants in this chapter can be kept in the open air, though the mounted polystyrene cultures are too fragile to last well. Up to ten kinds of moss went on quietly for many years, on a piece of stray asbestos I once brought home, and left on a sunny verandah roof. New asbestos is now unavailable, being a serious health hazard to those who work with it, or who inhale the dust, but old asbestos roofs usually support a rich flora of moss and lichens. It is a pity that modern roofing substitutes are less attractive to these plants.

Some older walls, and more especially, old brick bridges, have another distinct habitat – shaded permanently moist clefts and recesses, in which different species may be found among the ubiquitous *Tortula muralis*. Much less common, and far smaller, indeed among the smallest of British mosses, is *Gyroweisia tenuis*, on damp deeply shaded mortar or brickwork, resembling a minute *Barbula*. Almost as small, and rarer, but probably awaiting discovery in many towns, are two other similar species of similar habitats – *Leptobarbula berica* and *Didymodon australasiae* v. *umbrosus*. These two share the distinction of having only been described as new species in recent years. These can be grown on crushed chalk, in plastic pots, damp and shaded. Being so small, they are better kept on mounted chalk, and more humid. They have a southern distribution, and have actually grown better in my warm greenhouse than I have seen them growing wild.

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Many other acrocarps can be found on walls. Much depends on the local climate, the age and situation of the wall, the level of air pollution, and the type of natural rock, if any, occurring locally. *Pseudocrossidium revolutum*, though small, has leaves with margins strongly revolute, and makes small bright green tufts on old mortar. Unusually, it prefers the hotter drier South side of walls. It grew in Reading on well drained or mounted chalk, on that hot sunny shelf.

Didymodon rigidulus is a little larger, of a dull dingy yellow-green. Its identity should be checked with a microscope, which will show two- or three-celled oval gemmae among the leaves. It can be grown likewise, but does not like such extreme heat and sunshine. Commoner than these is *Didymodon vinealis*, on old sloping or vertical cement and wall or on compacted chalk or limestone soils. The large tufts, narrow tapering leaves and bright yellow-green colour make this a conspicuous plant. There is another common plant, *Syntrichia intermedia*, which resembles *T. muralis*, but is much larger, forming hoary tufts up to several inches across. It is more typical of roofs, but has increased dramatically in Reading and elsewhere since about 1970, on walls, pavements and old cement. It can be grown mounted, or in a clay pot of cement rubble, in full sun. In the wetter West and North especially, many other species occur on natural rocks, and some may occur on brick walls. The mosses of acid walls (of slate, granite, etc.) are quite different. Some are mentioned in the chapter on mountain mosses.

The most obvious large pleurocarp on walls is often *Homalothecium sericeum*. It has glossy golden-yellow shoots, the tips upturned when dry, and very narrow leaves. It is best grown rather dry, in a clay pot of well-drained chalk soil or mortar rubble.

Hypnum cupressiforme and its relatives are among the commonest of British mosses, growing in almost every natural habitat in the country. They vary, especially in size, A large and very striking species, (*H. lacunosum*) grows in acid turf. A smaller one grows on trees, and in the West and North, a still smaller threadlike form (*H. andoi* 'form *filiforme*') is found on rocks and trees. It can all be very confusing. The pale form to be found on acid heaths, with rather glossy hooked tips to the stems, is *H. jutlandicum*. What they all have in common is a leaf without a central nerve (check with a good lens) which is slightly or strongly turned to one side. They have recently been reclassified into as many as 8 or 9 distinct species. I grow most of these forms/species, which remain distinct in culture. Some are mounted, some are in clay pots, well drained, on peat, or loam, and with chalk or limestone added for *H. lacunosum*. They need regular spraying with rainwater when growing, but tolerate some sunshine and prolonged drought in summer.



Though less common in unpopulated parts of the country, *Brachythecium velutinum* is frequent in towns and on garden walls, in southern England at least. It is quite small, but fruits freely in spring. It prefers shade, and can be grown either in a clay pot of soil, or mounted, with a little soil or rock. It resembles *Rhynchostegium confertum*, a very common garden moss, but there are differences, especially in the seta and capsule. It has narrower glossier leaves, and often prefers the slightly drier tops and sides of walls, rather than the sheltered soil nearby. On well-shaded walls, especially around the base, a very small pleurocarp is common, with stems no thicker than fine green cotton. *Amblystegium serpens* is equally at home on paths, stones, tree bases, or shaded soil. It can be grown, moist and well shaded, on neutral or lime-rich soil, in a clay pot, or mounted.

In theory, any moss or hepatic which grows on natural rocks – and there are hundreds of them –

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can turn up on a suitable wall. One of the rarest of all mosses, *Brachythecium appleyardiae*, described recently as a new species by the late Mrs. Appleyard, is known in only a few British sites, and nowhere else in the world. One site is a fairly ordinary wall in a Somerset village, where it is abundant.

There have been remarkable changes and improvements in the moss and lichen flora of Reading, and of many other southern British towns, in the past thirty years, connected with the introduction of smokeless zones and the resulting cleaner air. Anyone who makes a careful note of the mosses on a particular wall, or in a particular street, should keep it as a permanent record, and perhaps even publish it locally, as a basis for comparison in years to come.

8. Chalk and limestone mosses

Much of southeast England is a chalk landscape, in which acid-loving plants will not normally be found. The chalk turf, close-cropped by sheep, which once covered large areas of our downs, was studded with wildflowers, especially orchids, making it one of Britain's most attractive wild flower habitats. Now there are often only remnants, many of them protected in nature reserves.

The most characteristic mosses of sunny chalk turf are uncommon or small. It may be hard to find any at all in dry weather. The most obvious are *Barbula*, *Bryums* and common pleurocarps. They include several garden species, and also the large inflated shoots of *Pseudoscleropodium purum*. In vintage chalk turf, often associated with interesting flowering plants such as orchids and rockrose, more specialised mosses are likely to be found. Most of these are small acrocarps, yellowish-green, and hard to identify. *Weissia longifolia* v. *angustifolia* is one. It is a small plant, the leaves of a bright yellow-green, rather solid, but twisted, and narrower than those of any *Barbula*.

Some pleurocarps are characteristic of chalk. *Homalothecium lutescens* is one. It has narrow silky yellowish leaves, creased along their length (plicate). Plicate leaves are also a feature of several less common species of *Brachythecium*, sometimes also found on chalk. *Entodon concinnus* is very local, but sometimes abundant on warm sunny south slopes, and on sand dune turf. It looks like a miniature *Pseudoscleropodium*. These last two be grown on chalk soil, strongly drained (i.e. in clay pots), and can tolerate long drought and some sunshine, even in a greenhouse. They need reasonable light, and should be kept moist and well sprayed when growing, in at least the cooler months of the year.

x 2



x 4



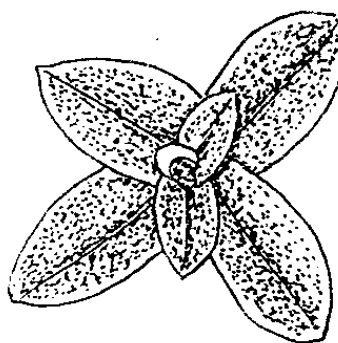
Shaded chalk turf in thickets and by wood margins may be a more attractive hunting ground. The large and striking *Rhytidiadelphus triquetrus* is common. With it is often *Thuidium tamariscinum*, a very common and widespread plant whose large frond like stems make it one of the most attractive and obvious of British mosses. Neither is easy to grow well at first. Both need some shade and strong



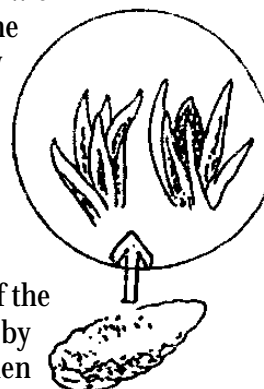
drainage (use clay pots). In the past I found *Thuidium* to be very vulnerable to lime accumulation, damaging the shoot tips. It can grow very vigorously on mounted chalk cultures, covered in polythene to give high humidity for at least part of the year.

A third striking moss is *Thamnobryum alopecurum*, which sometimes covers damp glades in chalk woods with a thick springy carpet. It is the largest common dendroid (treelike) moss, with creeping stolons and stiff black erect stems at least an inch tall, sometimes reaching four inches. It is also common on shaded limestone rocks and walls, and on wet rocks by streams in the West. It is hardy and persistent in culture.

Under trees, especially beech trees, conditions are very different. Many mosses here are on banks or tree roots, where they are not smothered by dead leaves in autumn. Some of the species may also be found in gardens, and others may be troublesome for a beginner to name. *Cirriphyllum crassinervium* is like *Brachythecium rutabulum*, but smaller, neater, and usually yellower, with a more concave leaf. Also worth looking out for is the large leafy liverwort *Porella platyphylla*, which can form big drooping tufts of a dark dull green on tree roots. It is unusual among liverworts in tolerating dry exposed habitats, even in the Southeast, though it is certainly best kept shaded in culture. It also grows on rocks and walls, especially in limestone areas.



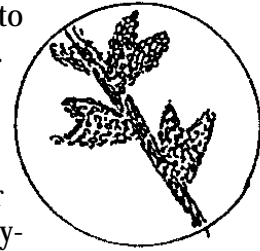
The acrocarp *Encalypta streptocarpa* has blunt dull yellow-green leaves. Though larger than those of any *Barbula*, they curl up when dry, making the plant hard to see. This too can be kept like the pleurocarps above, dry in summer, on well-drained chalk soil. Quarries may have chalk cliffs, apparently devoid of plant life. However damp chalk faces may have a growth of green algae, making a dark stain which may contain mosses too. A tiny moss in such a place, with narrow leaves, hardly visible without a lens, is probably *Seligeria calcarea* or the similar *S. calycina*. In this genus are several British species. They are not very common, and are hard to find, let alone to identify, without fruit, for they are among the smallest of British mosses. These two *Seligerias* are often found on damp chalk stones or bits of loose chalk in woods, on limestone rock faces, and rarely, even on the damp sides of limestone walls in towns (as in Reading, and in the Winter Gardens in Bath).



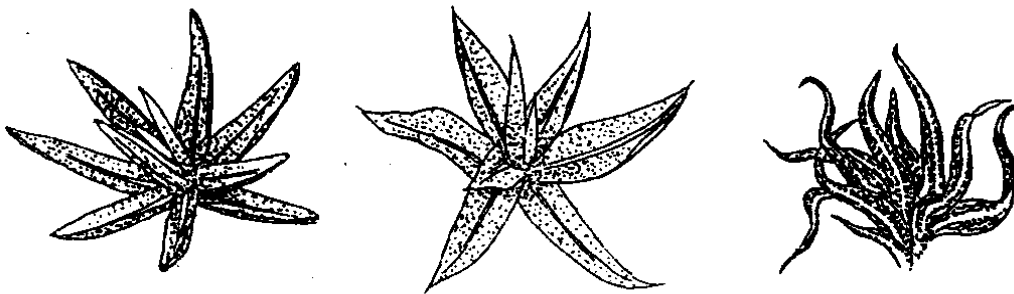
One cannot grow these tiny *Seligerias* like normal plants. Take a fragment of the rock on which they are growing, and inoculate small pieces of similar rock by scraping off a few shoots and smearing or squashing them against it. Then wrap it in cling film and keep it moist for a few months. If they take hold, new shoots will appear on the new stone, springing from rhizoids which have penetrated into the porous surface. It can be an uncertain process. I have also grown them on mounted limestone in high humidity, at least in winter.

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Damp ground on a chalk quarry floor, or damp hollows in shady chalk turf, may support two hepatics. One is a small leafy plant, *Leiocolea turbinata*. It needs to be constantly moist, not waterlogged, nor ever dry, and tolerates deep shade. I once kept some on a piece of chalk in a plastic sandwich box for about ten years, with no attention at all, so it should do well on lumps of chalk in a closed jamjar. There are several other species of *Leiocolea* with a more northern or alpine distribution, which have similar cultural needs. The other hepatic is a leafless liverwort, *Aneura pinguis*, with rather shapeless greasy-looking dark green thalli, like those of a small sickly *Pellia epiphylla*. It may be grown like *Pellia*, but does not like deep shade, and needs alkaline, not acid conditions.



Chalk or limestone country in the West or North, or near the sea, has some conspicuous mosses which are rare or absent in southeast England. *Trichostomum flavovirens* has a slightly "hooded" leaf, and *T. brachydontium* a broad solid one, like that of *Barbula unguiculata*, but with a plane margin, not rolled inwards. More widespread on rocks and walls in the West or North, wherever there is a trace of lime, is *Tortella tortuosa*, with very twisted narrow leaves of a bright pale yellow-green. These, and other British species of these genera, may be grown in strongly drained chalk or limestone in clay pots, in a dry sunny position, and sprayed frequently and kept moist in winter, if not in summer. They also grow well on mounted chalk or limestone cultures.



In western and northern Britain, most rocks are acid. Limestone is relatively rare, as are some of the plants which grow on it. Where it does occur, the wetter and cooler climate allows many other lime-loving mosses and hepatics to grow. The largest areas of sub alpine limestone are in the Pennines in Derbyshire, and further north, in the Yorkshire Dales. Their rich and distinctive flora of ferns, mosses and flowering plants make them among the most interesting parts of Britain for botanists. Most of their mosses can be grown by anyone who has successfully kept the commoner southern species. Especially striking is *Neckera crispa*. The flattened frond like stems with crinkled leaves can be up to two or three inches long, making patches a yard across, or more. They rise up from firmly attached creeping stolons. Though drought resistant, and occasionally found on shaded southern chalk, it is fond of sheltered vertical limestone cliffs, and is best grown in shade and high humidity, in a mounted lime-rich culture.

There are also many hepatics of sheltered limestone rock which are rare or absent from the drier South, including species of *Scapania*, and of the tiny creeping *Lejeuneas* and their relatives. These must be grown on limestone, strongly drained, in clay pots, or mounted. While they hate waterlogging, and tolerate gentle desiccation, they need shade, shelter, and constant high humidity when actually growing. They should only be collected sparingly, and can be difficult to bring home in good condition. One general point is the importance of good drainage for these plants. Few plants which grow on limestone are likely to thrive in non-porous plastic pots, except *Leiocolea* and *Aneura*. That

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is to be expected, for limestone and chalk are porous, and usually form well-drained habitats.

Yet there are other exceptions. On wet limestone rocks, and in seepages on old walls may be found mosses which revel in wet alkaline conditions, and which, even in habitat, are often encrusted with calcareous matter. One is *Didymodon tophaceus*, a rather undistinguished moss which can form dull-coloured tufts and mounds where water seeps out of limestone or calcareous clay. It fruits freely in spring. If its habitat were not so different, it could be mistaken for *Ceratodon purpureus*. It can be kept waterlogged, in strong light like *Sphagnum*, but on chalk or calcareous soil, it is unusual in growing best in conditions where it becomes encrusted with lime, forming large persistent tufts with a lifespan of 2-3 years. Other smaller and less abundant mosses of similar habitats prefer more shade, and a harder rock, or a mounted substrate.

Another general point about soil is worth making here. For these plants, chalk or limestone is essential, but only in small amounts. A pinch of limestone fragments on top of a pot of peat is enough. A lump of limestone from the countryside, or from an old wall, or waste ground, can be kept handy, and broken into fragments with a hammer as needed. Acid soil can easily be made alkaline in this way. However it is no good adding peat to an alkaline soil. The mixture remains alkaline. That, surely, echoes the experience of many gardeners. To grow lime-loving cabbages on acid soil, simply add lime. To grow lime-hating rhododendrons on chalk soil – that is far more difficult.

I have found that lime-loving mosses have been slightly more successful and persistent here, statistically speaking, than lime haters, mosses of peat or acid soil, which have been slightly more likely to have been lost. The slow accumulation of lime from water (even from rainwater contaminated by windblown dust), and from traces of soil splashed around when watering, can slowly raise the pH. of a culture. Hence the importance of using rainwater for watering almost all these plants. Even for the limestone plants mentioned in this chapter, rainwater is usually preferable.

9. Definitions and descriptions

Some people have difficulty understanding the definitions of cacti and succulents. They will have trouble with these definitions as well. However, one thing is plain. A moss is a moss. There are about 600 kinds in the British Isles, and probably over 12,000 worldwide. Clubmosses are related to ferns, not to mosses. Reindeer moss is a lichen. Neither of these are mosses. Then things start getting tricky.

A liverwort is a hepatic. To be more precise, the plants commonly called liverworts, the large *Marchantias* and suchlike, as described in Chapter 1, are large leafless hepatics. Most hepatics are small, and have leaves. There are about 300 kinds of hepatic in the British Isles, mostly with leaves. Many are very rare, or confined to extreme western or alpine habitats. Some are so minute, they are unlikely ever to be noticed except by an expert, let alone be given any common name. Some have evolved complex or bizarre leaf shapes, unlike those of any other plant. Mosses and hepatics are distantly related. Collectively, they are called bryophytes. They seem to date back to the Carboniferous era, and beyond, and they differ fundamentally from every other plant and animal on earth, save some fungi, bacteria and algae. However, the difference is not easy to explain to a layman.

People have three kinds of cells. There are male sperm cells, which can swim, and have one set of chromosomes, and there are passive female egg cells, also with one set of chromosomes. After they have fused, all other human cells, male or female, from the moment of conception onwards, have two set of chromosomes. That is the way the animal kingdom is organised, down to the humblest flatworm or jellyfish, and beyond. Flowering plants are organised in the same way, except that the male cells have lost their tails, and cannot swim. They have evolved into drought-resistant pollen grains, which must be carried passively by wind or insects, to an unfertilized flower with female parts.

Ferns and their relatives, such as horsetails, clubmosses, *Selaginellas*, and so on, are organised more like animals. They have male cells which contradict our ideas about the differences between the two kingdoms. Their male cells have tails like animal sperm, and swim actively towards an unfertilised female cell, guided by chemical signals. When they fertilise one, a new plant begins to form, now with two sets of chromosomes. However the mature plant eventually produces single-celled spores, each with only one set of chromosomes, which float away, and germinate into something quite different.



This something different, called a prothallus, looks like a small delicate leafless liverwort. It has a very simple structure, and only one set of chromosomes in each cell. It is this, not the mature plant, which eventually produces male and female organs. Fertilisation can only occur when the prothallus is wet, so that the male cells can swim through a film of water. The fertilised female cell now has a second set of chromosomes, and develops into an adult fern.

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A moss spore also germinates into something unlike the adult plant. The so-called protonema usually consists of filaments, strings of cells like those of some small alga. They branch and spread. From them, like the first fronds of a fertilised fern prothallus, the leafy shoots arise. However appearances



are deceptive. No male or female cells have been produced, nothing has been fertilised, and the adult moss or hepatic still has only one set of chromosomes in each cell. The fact that a moss appears to have roots, stems and leaves, like other plants, is a co-incidence of parallel evolution. Except for the prothallus of a fern, it has no analogies and no known relatives in the entire vegetable kingdom. Nobody has ever found a missing link, nor any other plant intermediate between a bryophyte and anything else. They are a unique and isolated group, though a large and successful one.

The mature plant eventually produces male and female cells on tiny inflorescences. Acrocarps have them at the tips of the shoots, pleurocarps at the sides. Like flowering plants, some mosses produce both sexes on the same plant, or even on the same inflorescence. Some only produce inflorescences of one sex, and another distinct plant of the other sex must be nearby for fertilisation to occur. Some never seem to produce inflorescences capsules or spores at all, and are always sterile, only spreading vegetatively. Some mosses have the male cells surrounded by a rosette of modified leaves. In *Polytrichum* these are obvious, and often bright red, resembling small flowers. The male cells need a film of water to swim through. When one reaches a female cell and fuses with it, a new structure begins to form. Wrapped in a tiny sac, the new tissue, now with two sets of chromosomes in each cell, forms a stalk (a seta) and, at the top, a capsule, in which the next generation of spores will develop. In hepatics the stalk is thin, white, and delicate. It collapses and dies within days. The capsule is dark, and splits into four to release the spores.



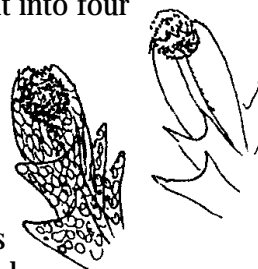
In all mosses except *Sphagnum*, the seta is tough, wiry and persistent. The capsule has an opening through which spores are shaken out, as if from a pepper pot. The opening is usually fringed with a delicate set of teeth, produced in multiples of four, and called a peristome. This structure often helps to identify different genera and species, and defines their relationships. A moss capsule often has also a temporary lid, called a calyptra. The distinction between acrocarps (upright mosses) and pleurocarps (creeping mosses) is more than one of habit. Acrocarps have their seta and capsule at the end of the shoot, pleurocarps at the side.

Liverwort capsules, before their stalk elongates, are usually wrapped in modified or enlarged leaves which form a "perianth". In many, like *Cephalozia*, these leaves form a conspicuous translucent bag enclosing the young fruit. *Sphagnum* capsules appear more like those of a liverwort than those of

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other mosses, being lifted on a soft white stem, and those of *Andreaea* split into four valves when ripe. Otherwise there is no overlap between the two groups, nor any outward sign of a common ancestry.

All this – and more – is in every university biology textbook, and in some school textbooks too. Even the most lucid explanation is bound to seem complicated. It is no wonder that many of those who first encounter mosses in botanical textbooks find them dull and complicated. Yet anyone who tries to grow mosses will appreciate what is happening better, if they understand a little about their life cycle.



Mosses can be grown from spores, but outside a laboratory it is an uncertain process. What is more intriguing is that every part of the normal plant is interchangeable. Any part of a moss plant, so long as it contains a single healthy cell – a fragment of a leaf, or of protonema in soil, for instance – can produce new shoots, or new rhizoids, directly. Or it can produce new protonema. This may spread across the soil as a fine green film, and then form hundreds of new shoots. Slender rhizoids, or stout rhizomes, as in *Polytrichum*, may spread underground, and produce new shoots some distance from the parent plant. Furthermore, any soil in which an acrocarpous moss has been growing is likely to contain a few rhizoids. If a fragment of such soil is cultivated, the moss is likely to re-appear. Mosses are in fact incredibly flexible plants, able to re-appear or to colonise in the most unexpected ways.

Sometimes the protonema is the most obvious part of the plant. If you look at a patch of freshly exposed soil, especially clay soil, in damp autumn weather, you may see small green stains, an inch or two across. Each of these may represent protonema from a single spore or fragment of some ephemeral moss. Presently a whole tuft, hundreds of stems, may appear, all from one spore. Growing tiny fragments or spores, a lucky grower may get the same result, but until identifiable leafy shoots arise, there is no way of knowing if the protonema is of the species it was intended to grow. Only the most careful of sterile cultures can be relied upon, not to produce something else instead.

Moss protonema may look featureless in comparison with the mature leafy shoots, but has complexities of its own. There is often a distinction between green protonema, which photosynthesises, and brown protonema, which may grow down into the soil, and can lie dormant, awaiting another season. Some mosses make fragile erect protonemal branches which break off to spread the plant, or specialised underground cells which can lie dormant for years, before germinating when conditions are right. In recent years protonema has been the subject of many interesting observations and pieces of research. In many mosses, the protonema is scarcely visible, and only in the youngest plants, but there are some British mosses in which the protonema is the most noticeable part, and which I once had trouble in keeping on a long-term basis.

On shaded banks of acid soil, especially vertical clay banks in hilly districts, an intensely deep green felt like growth of protonema can often be seen. From it spring the small stiff shoots of *Pogonatum aloides*, which resemble miniature Aloes, or plants of the related genus *Polytrichum*. Some shoots will often be found with flower-like male inflorescence. The large distinctive fruit is common and conspicuous. It is thus a fine plant for demonstrating the life cycle of mosses. It can be grown on damp acid clay, in deep shade, and shoots, leaves, or pieces of protonema put on fresh soil every few months. It has not been very vigorous in culture for me, and may have found greenhouse temperatures too high for comfort.

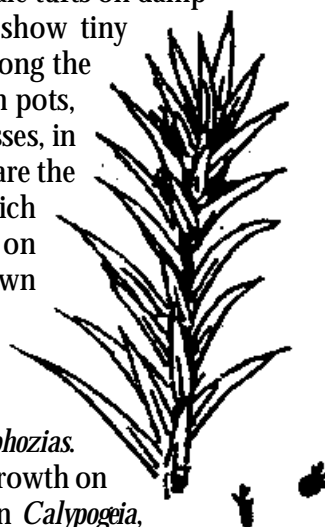
A less common plant of deeply shaded acid rock clefts and cave entrances is *Schistostega pennata*. The leafy shoots are like those of a feeble *Fissidens*, but are so small, they are hardly likely to be noticed. Its unique glory is its protonema, which contains enlarged transparent cells, designed, as lenses, to

focus the faint light of their dark habitat onto the speck of chlorophyll they contain. Like the lens in a cat's eye, they also reflect light back, and someone looking at it in a dark cave, may see an eerie glow like green fire, shimmering against the dark rock or soil.

I have kept *Schistostega* on acid sandy soil in enclosed plastic or glass containers (jamjars, etc.), in a dark cool corner of a greenhouse and even, for a time, on a bookshelf on an indoors landing. It is easily overrun by other mosses or hepatics, but fresh cultures, planted on with tweezers and a lens, can colonise fresh soil quite quickly. It grew fast in jamjars indoors, its fluorescent green protonema reflecting back the faint light from a light or window.

Apart from this remarkable ability to spread by means of protonema, or to regenerate from tiny fragments, many mosses produce special small shoots, bulbils or gemmae, which are designed, like seeds, to fall off, to spread around, and to grow. Those of *Bryum dichotomum*, *B. rubens* and *B. subapiculatum* were mentioned in Chapter 5. Many other mosses, especially those of arable fields and disturbed ground, produce tubers. They are usually buried in the ground, like microscopic potatoes.

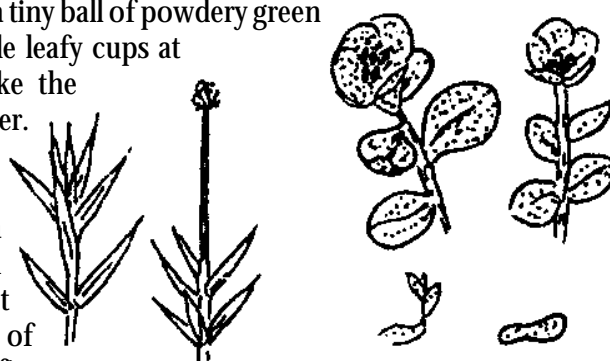
In a related genus, *Pohlia*, there are several small species which make pale tufts on damp acid or neutral soil, woodland paths, and so on. A lens will often show tiny specialised shoots or bulbils of a variety of curious shapes, tucked among the upper leaves. These small plants are best grown on damp acid loam, in pots, or mounted, but they can appear as weeds among other cultivated mosses, in various soils and situations. Less obvious, except under a microscope, are the round or oval gemmae, growths often only one or two cells in size, which are produced by many small acrocarps. Sometimes they are clustered on the tips of the leaves, and can be seen through a lens. They give a brown fuzzy look to the leaf tips of *Ulota phyllantha* and *Orthotrichum lyellii*, mosses which grow on trees in unpolluted areas. Advice on growing these comes later.



Leaf tip gemmae are common on many leafy liverworts, especially *Lophozias*. They make a pale, or green, or brown or even bright reddish powdery growth on the tips and edges of leaves, or on the tips of specialised stems, as on *Calypogeia*, mentioned earlier. There are two very distinctive liverworts which are reasonably frequent in lowland Britain, and which have remarkable gemmae. Both grow on decaying wood, or on peaty banks in acid woodland. They are usually about 5 mm. tall.

Aulacomnium androgynum makes little stalks with a tiny ball of powdery green gemmae at the top. *Tetraphis pelucida* has little leafy cups at the top of the stem, containing gemmae, like the gemma cups of *Marchantia*, but much smaller.

Both can be grown on peat, or better, on decaying wood, and prefer shade. Indeed, they will grow well in quite a dark corner of a greenhouse. They can survive drought, but will only flourish if they are not allowed to dry out too often. On wet rotting wood, the gemmae of *Tetraphis* grow in a strange way. They develop first into little leafless plants like small liverworts or fern prothalli, before putting up a normal leafy shoot.



There is another very different *Aulacomnium* species, a striking large golden-green plant. Typically, it creeps among *Sphagnum*, and may be grown in the same way. *Aulacomnium palustre*, like *A.*

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androgynum, often makes elongated stems with clusters of gemmae at the tips. They get everywhere. It can be a vigorous weed in wet peaty cultures. It has even grown upside down in the grooves of my greenhouse roof, where condensation collected. These specially adapted gemmae and deciduous shoots are less common among pleurocarpous mosses (though *Aulacomnium palustre* looks and grows like a pleurocarp, it is not one).

Growing plants from gemmae poses the same problem as growing them from spores or other small fragments. You start with something so small you cannot see it, or check its progress. It is likely to be washed away, dried up, or overwhelmed by something else, and you will never know what happened to it. Mounted cultures are far better in this respect. In a good light, and with a $\times 20$ lens, it is possible to keep track of single shoots, gemmae or small pieces of protonema, and weedy mosses and algae are less likely, less invasive, and more easily removed.

Another useful technique for growing something very small is to make the cleanest possible culture on a pot of fresh soil. The soil surface can be sterilised by wetting it with bleach, then leaving it for a day or two, for the bleach to dissipate. The plant can then be added, and the whole pot wrapped in cling film. Keep it shaded, and when something green begins to spread, remove the cling film and turn a lens on it. If it doesn't look like the plant you want, start again. If it does, discard the cling film, and water thoroughly, especially if algae are present. After a few weeks, algae get a hold anyway, however clean the culture to start with. They will eventually poison or overwhelm almost any mosses in an enclosed pot of soil. Soil which is sprayed with water reasonably often, and reasonably forcefully, will remain cleaner, as the algae are washed away.

It certainly adds to the interest, to understand how mosses spread and propagate. However, growing them from gemmae, tubers or protonema, is usually less reliable than starting with a mature plant, or at least, with a plant that can be recognised.

And as for spores...

If you really want to do it the hard way, test-tube cultures may be the only option

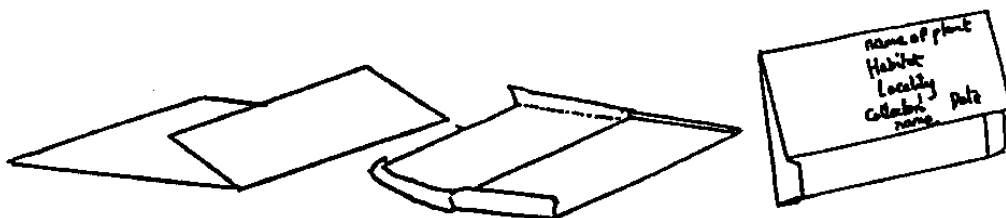
10. Ethics

Victorian botanists and plant lovers, especially fern and orchid fanciers, scoured the countryside, aided by the newfangled railways, digging up rare and curious plants to grow in their gardens, or in some cases, to sell. Commercial nurserymen stripped whole areas of rare or desirable species. Populations of some native British plants, it is believed, have never recovered.

The interest in mosses also increased greatly in the nineteenth century, and a Moss Exchange club was organised. Members held excursions and collected herbarium specimens, which they sent in annually, for an exchange with other enthusiasts. The custom continued until the late 1960s when, for conservation reasons, it was discontinued. I revived plants in a few such exchange packets, and even now, still have one or two growing. Though a commercial market never developed for mosses, this exchange certainly put temptation in the way of any contributor finding a rare or unusual moss – the temptation to collect as much good material as possible. The rarer the plant, the greater the temptation, and the greater the bargaining power of the specimens. One such moss, *Cyclodictyon laetevirens*, was deliberately and repeatedly collected from its only known site in Cornwall. When it became extinct, the rarity value of the herbarium packets inevitably increased still further. Similar barbarisms are committed on a far greater scale today, by those who plunder tropical orchids, birds, or even butterflies, serving a market in which endangered species often fetch hugely inflated prices. *Cyclodictyon laetevirens* is rare or occasional on wet deeply shaded rocks in western Ireland, and recently re-found in Cornwall. It is related to the larger and commoner *Hookeria lucens*, but is an attractive plant in its own right. It grew fast and well here until 1996, on wet shaded peat or granite, in high humidity, and fruited in autumn.

Yet these exchanges were valuable. In an age with few textbooks, knowledge could best be gained from actual specimens, and contributors could study a greater range of plants than they might ever gather personally. The contributors laid the foundations of our modern knowledge. Even now, when looking at hard-to-name species or unusual material, there is no substitute for a comparison with reliably named herbarium plants.

A herbarium packet also expresses one of the most basic principles of science in general, and of botany in particular – that a permanent record should be made of any plant or event of interest. Only a minority of amateur plant growers keep such records, yet cultivated wild plants become scientifically worthless if their habitat details are lost. A collection of mosses and hepatics – almost



all of which are likely to have been collected from the wild – will have no scientific value unless a secure record is kept of their origins, backed up, whenever possible, by herbarium specimens. Mosses are almost uniquely convenient plants for making into herbarium packets. They are small and easily preserved in a dry state. A half sheet of plain A4 paper is all that is needed.

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Such a herbarium packet provides a permanent record. It should usually contain some of the actual plant and (in my opinion, equally informative) a fragment of the soil or substrate on which it was growing. On the top of the packet should be written the name (if known) the location, and a brief description of the habitat, perhaps a map reference, a date and collector's name, and also perhaps, a comment on the distinguishing features of the species, and a note or sample of any associated plants. Details of how the plant is being grown, and of how it responds in culture, can also be conveniently written on later.

The slow accumulation of millions of such packets, all over the country, over the decades, can become any museum curator's nightmare. I had about 40 shoeboxes full, many of which I never looked at again. They were given to Reading University botany department when we moved in 2002, and 99% of them will never be of any use to anyone again. The problem is – I have no idea which 99%. It can be sad to look at the faded yellowing specimens gathered by past generations of botanists. Yet hidden in even these ancient packets may be valuable information, undreamed of by those who collected them, or as yet unknown.

For instance; most years, one or two species of moss or hepatic are still being added to the British list. Some are plants which have been confused with close relatives, and are only distinguished for the first time by careful comparison of living plants, and by combing through old herbarium collections. Some are genuine new discoveries, and some are recent arrivals, introduced from elsewhere in the world. Their origins, their history and their distribution, can often be traced by looking in those dusty drawers and boxes.

One of the greatest problems for botanists in Third World countries is that the herbarium collections made by pioneering botanists are usually in a First World country. Among them are often first gatherings of new species. They may be the type specimens on which the original descriptions were based, and without access to them, many plants (not just mosses) are impossible to name. The loss of millions of specimens in Berlin in 1945 still causes problems for botanists, including bryologists. Some countries are now reluctant to allow herbarium specimens, even of mosses, to be taken away, and many insist – rightly – that duplicates be left in their own land.

Apart from their usefulness to bryologists, these packets may contain information of wider interest. Nineteenth century gatherings made from trees in England contain luxuriant material of species now rare or extinct, and provide dramatic evidence of the disastrous effects of air pollution during the Industrial Revolution. Among the greatest dangers to the human race today are the greenhouse effect, the rise in carbon dioxide levels, and the damage to the protective ozone layer in the upper atmosphere. How real are these changes? How have mosses been responding to them? How will they respond in future? And what about the rest of the planet? Some of the answers may well lurk in those old herbarium packets. Old gatherings of *Bryum argenteum* from the Antarctic, for instance, provided evidence in the 1990s that the ozone layer was being damaged, and ultra-violet light levels increasing there, before direct measurements began.

The first moral then, is clear. If you become seriously interested in these plants, you will make many collections of possible scientific value. Label the cultures securely. Keep a record and a herbarium. Keep them methodically, and keep them in a safe place.

A tedious topic, and one often neglected, is the labelling of living plants. It is more essential even than labelling a herbarium and keeping a catalogue – if the cultures are to retain any scientific value. Yet it is not easy. There are practical problems. Plant labels – for what they are – are expensive. Chinagraph fades, Indian ink cracks, plastic goes brittle in sunshine. For what it is worth, my own way of labelling may be of interest.

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I use floor tiles, the flexible ones, as found in Homebase, etc., but choosing those without an adhesive backing, when I can. They are cut into label-sized pieces with scissors. This is hard work unless the tiles are first softened, by soaking in hot water. Why bother? Because you can then write on both sides with an ordinary sharp lead pencil, and the writing is permanent – at least up to 20 years, perhaps more. The tiles come in several colours, so plants can be colour-coded. I use red labels for tropical plants, yellow for Mediterranean ones, and so on. You can make them any size or shape you want. They can even be cleaned with an abrasive cleaner (“Vim”), and re-used. No commercial labels I know of have all these advantages.

Even so, labels get lost, or have accidents. They fall out of pots. They get covered with algae. Passing snails graze on the algae, and their rasping tongues remove the graphite writing – and the information too. Lime deposits may obscure them. Mosses may grow over them (many mosses grow better on the labels than on the substrate provided!), or chemical reactions in wet soil may stain them with a dark deposit. It is a regular chore here, to check for faded or missing labels, and to replace them. Sometimes their information has been lost, and must be recovered from another source.

I put most of the information on the herbarium packet onto the label as well. It may be written very small. It may be illegible to everyone in the world except me, but so long as a few words, or the number, or even part of the number, can be deciphered, the rest of the information can be recovered from the catalogue or, less conveniently, from the herbarium packet. Labels with nothing but a name or number on them, as seen in many collections, are less informative for a visitor. Also, if labels carry only the minimum of information, it is far harder to replace that information, if any of it be lost. At a more practical level, I always have a good stock of fresh labels and a sharp pencil to hand. Otherwise, human nature being what it is, I would more often succumb to the temptation, when making a transplant or a new culture, to “leave the labelling till later”.

I have over 600 species of bryophytes still growing, in over 2,000 cultures, and have managed to restore the labels on over 99% of them since my illness. Yet if only 1% of these labels were lost annually, any long-term scientific value these cultures might have would be greatly diminished.

There is the legal and ethical position of anyone who picks wild plants to consider. Parts of this book are an incitement to break the law. Technically, it is illegal to uproot any wild plant – even a tuft of moss – without the permission of the landowner. The total enforcement of such a law would make it illegal even to pull up a piece of chickweed. In Germany it is now illegal to collect the commonest species of *Sphagnum* or *Dicranum*. This ridiculous law has annoyed many botanists. Yet the responsibility remains, not to gather mosses without conserving such information as they might provide. Even the most experienced bryologist often cannot name some difficult species at sight, but needs to check them microscopically. A beginner can spend frustrating hours trying to name even common ones. Yet the time spent naming them, and the time which may be saved by keeping the specimen for comparison another time, gives even packets of the commonest species some value. They should usually be kept.

A bryologist who behaves responsibly is unlikely to endanger any rarities by collecting them, except in a few places which a beginner is unlikely to discover unaided. A Victorian gardener stealing wild ferns or orchids had to take a complete plant. A Victorian moss-hunter would take the best material to fill his herbarium packets, but when collecting from a restricted habitat like a single tree or a small rock outcrop, it is easy to remove most of the population of any species. Nowadays, there is rarely any excuse for gathering more than a few shoots, even if it is obviously abundant. This is even truer for someone who intends to grow the moss. I have, on occasions, grown cultures from a single shoot. It can be done. It is also worth remembering that many habitats are more likely to be

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damaged by heavy boots than by acquisitive fingers. *Sphagnum* bogs are especially vulnerable to trampling. Fortunately, the average walker avoids squelching into them.

Victorian fern collectors, even if they often collected wild plants in a way we now think unacceptable, did at least develop the skills of keeping them alive, and propagating them. Some of their cultivars still survive. For some reason, there never grew up a similar tradition among members of the Moss Exchange Club, of growing mosses and hepatics. Perhaps there were just too many species, and too few enthusiasts. Members' efforts were concentrated almost entirely on finding, naming and describing them. Indeed, the idea took hold that mosses and hepatics were far too specialised to be kept alive, let alone grown well. When a new or rare species was found, a herbarium packet at least guaranteed the survival of the scientific evidence. It is still expected, when a species new to the country, or to a county, is found, to make a herbarium specimen (however small) which must be checked by a referee, and deposited as a voucher specimen.

I have had several extremely rare British mosses growing here, some of them known only from one site, or from one small area. They do not seem different from their commoner associates of similar habitats, or more "difficult". Embarrassingly, several were given or collected in 1995, shortly before my illness, though these too have survived. Yet because even the commonest mosses are so rarely grown, there is virtually nobody who would feel confident about keeping and propagating such rarities. Anyone who has worked through the suggestions in the earlier chapters of this book, and successfully kept most of the commoner species they mention, would be in a far better position to do this.

Growing rare or endangered flowering plants, at least, has become a more acceptable idea in recent years. However, if the hope is to contribute to their conservation, it can only be a short-term measure. A private collection cannot last longer than one human lifetime, and even the most prestigious botanic gardens may lose plants over the years, through neglect, misfortune, or changes of personnel. Yet private collections are a huge resource, and a reservoir of horticultural skills which could be used far more, to conserve and propagate plants – even mosses – diverting some energy perhaps, from the keeping of millions of boringly similar garden and greenhouse plants. There exist organisations which link private collectors together, in which plants are freely exchanged and given away, and whose members accept, in return, certain responsibilities. Their object is to create and maintain a permanent network of collections in which endangered garden varieties and cultivars, and sometimes also wild plants, are systematically exchanged and propagated, and their future assured.

There are a few very rare or endangered British mosses and hepatics which have legal protection. To collect them without a licence is now a criminal offence. In some cases, their long-term management plan includes setting up a reserve population in culture. But who is going to do that? Who has the necessary experience, even with commoner ones? Most specialist plant societies have informal plant exchanges, and are served by dedicated commercial growers who rarely make much money, but who have, and provide, a lot of enjoyment, by propagating promoting and selling the newest, the rarest and the most fashionable plants they can. Nothing remotely like this has ever happened among bryologists. Perhaps – some day – it will. Even so, more than once, I have persuaded someone else to grow a moss, lost it myself, and then scrounged a piece back again. The truth of one old gardeners' proverb is self-evident. *The best way to keep a plant is to give it away.* Anyone who becomes seriously interested in mosses and liverworts will certainly wish to join the British Bryological Society. Details are in the Appendix.

Another conservation possibility is to re-introduce extinct or threatened plants to suitable habitats. This is an unusual and often controversial thing to do. Certainly, sites of outstanding scientific

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interest – which may be the only suitable places for such plants – should never be tampered with in this way, except after consultation with the Nature Conservancy Council, and with those who manage the site. However I can see no objection to introducing endangered plants to less elite habitats, even perhaps to a garden. It would be quite irresponsible to collect wild material of any except the commonest species for such transplant experiments, without a considerable knowledge of the plant and of the habitat concerned, and of how to grow mosses generally. I mentioned a few introductions to my garden in Reading. All these survived until 1996, without attention for five years. A well-judged introduction, unlike a greenhouse culture, may persist for decades without any maintenance.

However there is generally little scope for introducing mosses to a garden, other than those which might occur anyway, unless an appropriate habitat can be created for them. Otherwise, it would be out of the question to gather wild material of any except the commonest wild plant for this purpose. However, as Chapter 6 suggested, there is no reason why one should not create a habitat, say a backyard Sphagnum bog, or a mud-capped wall. A retired Oxford botanist, for instance, maintained a “traditional” Oxfordshire stone wall in his garden, by putting an annual dose of lime-rich soil on top. On this, a few characteristic mosses, such as *Encalypta vulgaris* persisted, though they were dying out elsewhere in the county, as people stopped maintaining such walls.

I had about thirty kinds of mosses in my Reading garden. Less than half were introduced, and most introductions died out. Yet, despite the dry polluted climate, there were some surprising successes. For instance, spare bits from greenhouse cultures were put on low brickwork at the edges of garden beds. Pleurocarps of warmer and drier climates, and of lime-rich rocks and soil grew best, notably *Eurhynchium meridionale*, a Mediterranean species, very rare in Britain.

It could be said that introducing mosses in this way is upsetting the local flora. The reply must be that every gardener who digs up ground elder and plants rose bushes is doing just that, anyway. And of course, garden plants may escape and upset wild habitats. Himalayan Balsam *Impatiens glandulifera* is spectacular along the Thames in summer, and Buddleia (*Buddleja*) has done more to beautify our towns and waste ground than all the municipal park-keepers in the country. Our worst foreign invader has probably been *Rhododendron ponticum*, which looks good in flower, but swamps everything else, and has become a major problem in many National Parks. Other countries have suffered far worse invasions, such as the *Opuntia* plague in Australia, and have responded with severe restrictions on the importing or growing of many plants, especially cacti.

It is hard to imagine any introduced moss menacing the British landscape or economy in this way. The most aggressive moss introduction so far has been *Campylopus introflexus*, from the Southern hemisphere. It may have displaced native *Campylopus* species in some places, but is a striking addition to our flora, and has hardly become a nuisance.

I once inquired at a local Customs office in Reading, about getting an import licence for live mosses, as one can do for flowering plants. Someone made a remark (I think facetiously) about checking the regulations for fungi, but otherwise my enquiry aroused no interest. My parcels of mosses have passed unhindered to and fro between several countries, labelled; “Bryophytes; Botanical specimens. No commercial value.” However, there is a real danger, not from the plants, but from associated small animals. The voracious flatworms from New Zealand which have colonised parts of the British Isles, notably the Orkney Islands, have devoured and, in some places, almost exterminated earthworms. They are the kind of unpleasant and damaging creature that could inadvertently be introduced in moss tufts and soil.

I suggest that anyone growing mosses from other countries should abide by the regulations for

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growing imported plants – so far as possible. It is impracticable to separate many mosses from the soil in which they are growing. Yet the regulations for flowering plants may require that the plants be treated with an insecticide (I use Derris dust) and be kept under cover, at least for a few months. These are sensible precautions, and anyone introducing foreign wild plants, including mosses, should abide by them. There is one last suggestion about introduced mosses, not only from abroad, but also from other parts of Britain.

There are not many people who can identify the more “difficult” species, and there is still a great deal of taxonomic work to be done, even perhaps on the commonest species, and even in the most populated parts of Britain. Therefore, no introduction should be made which might confuse future bryologists, without making a permanent record of it. Striking and easily recognised exotics are no problem, but material of common, “difficult” or variable species like *Bryum capillare* and *Brachythecium rutabulum* should not be willfully introduced from distant parts. In countries where the moss flora is less well known, or even in less well-studied parts of the British Isles, it would be unhelpful to introduce any mosses or hepatics at all, unless it were quite certain that nothing like them grew nearby. Similar concerns have been raised about the practice of planting wildflowers along motorway verges – using commercial seed derived from foreign strains of British wildflowers.

Finally; anyone who becomes knowledgeable about any aspect of natural history will soon see one of the greatest ethical issues of our time – the conservation of our planet's wildlife heritage, not just in distant rainforests, but also in that patch across the road.

The first step in conserving and safeguarding anything is to find it and identify it. To make a full and reliable list of the plants on any site is a valuable skill. For mosses, it is a very rare skill indeed, and one which may take many years hard work to acquire. Even today, in Britain, the most intensively studied country on Earth; good habitats are being destroyed because nobody knows what is in them, or because too few people care. It is the duty of every good citizen to try to stop habitat destruction, even for obscure mosses or unpopular insects, no less than for pretty flowers or cuddly mammals.

11. Epiphytes

In most large English cities, tree trunks used to be a lifeless black or grey, or stained with vivid green algae (*Pleurococcus*), or perhaps with the khaki-green crust of the lichen *Lecanora conizaeoides*. Mosses were absent, and on most city trees, they still are.

A rewarding moment for anyone from London or the polluted Midlands, is a first look at a roadside trees in Ireland, in west Scotland, or in western Wales, where the air is clean. Here mosses, hepatics, and large conspicuous lichens grow not only on the bases of trees, but high up the trunks and branches, even on the twigs. Ten or more species of moss can often be found on a single tree, some of them rare or absent from polluted parts of Britain. At least three quarters of British people live in places where the epiphytic flora has been largely destroyed by air pollution.

Many people found it hard to believe, at first, that these apparently sensitive plants could be kept alive in the centre of Reading. The main pollutant is sulphur dioxide from burning coal and oil. Only unusually high levels of sulphur dioxide damage mosses directly, by bleaching them. It is the habitat which is wrecked. Reacting with rainwater to form sulphuric acid, the gas makes the bark of trees and the surface of rocks too acid to support them. It is very noticeable that acid rocks – slate and sandstone – and acid tree bark – oak, alder and conifers – are most affected, and have the poorest growth of mosses in polluted areas. Alkaline rocks such as limestone, and alkaline tree bark, especially elder, sycamore and, where it still exists, elm, are more likely to support mosses and lichens, since they are better buffered against the acid. Even in the dirtiest towns, where tree trunks are devoid of life, mosses may be found on cement, limestone, and asbestos.

However, the effects of pollution can be more complicated. An early discovery, from reading literature on air pollution, was that sulphur dioxide is an unstable gas. Inside a house, it is soon absorbed onto surfaces. That is why bronchitis sufferers were safer indoors during the killer smogs of the past. In an enclosed greenhouse or frame, it is unlikely to damage sensitive mosses. Even outdoors, polluted air moving through a screen of trees has much of the sulphur dioxide filtered out. Sometimes sensitive epiphytes persist in sheltered valleys and woods, while becoming extinct all around. Also, average sulphur dioxide levels have fallen in most towns in the past fifty years, and the very high peak levels of the past no longer occur. As a result, the epiphytic flora of the more densely populated parts of Britain has improved, and some sensitive species have been refound, even near London, in recent years. Lead pollution, hydrocarbon haze, and ozone from traffic fumes, whatever their effects on people, are not having the same disastrous effect on epiphytic mosses. In practice, then, air pollution is unlikely to be a problem for most people trying to keep epiphytes in a greenhouse. Yet they are among the most difficult mosses to keep anyway. They are very different in their cultural needs from most flowering plants and terrestrial mosses. Few can be grown on soil.

Pleurocarps are the most conspicuous. *Hypnum cupressiforme* grows almost everywhere. Even the small form with almost straight leaves (now known as *H. filiforme*), which is common on trees in the West, can be kept on peat, in a clay pot. So can *Isoetium myosuroides*, which is abundant on tree bases and trunks in woods. In damp sheltered places, many terrestrial mosses can be found on trees, as well as on the ground. They may include *Amblystegium serpens*, *Brachythecium rutabulum*, and *B. velutinum*.

On basic bark, *Homalothecium sericeum*, and more rarely, *Neckera crispa*, *N. complanata* and *Homalia trichomanoides* may be found. The last two both resemble *Neckera crispa*, but are smaller. In *Neckera* the leaves are nerveless, and the shoots curled down, *Homalia* has a faint nerve, and the shoots usually curl up. All can be found also on strongly drained chalk soil, or limestone rocks or old

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sheltered limestone walls. They can be grown accordingly. They are not as highly specialised as some epiphytes, and do not normally grow on the higher and more exposed trunks and branches. Even so, they grow equally well on neutral or lime-rich mounted cultures of tree bark, given sufficiently high humidity when actually growing.

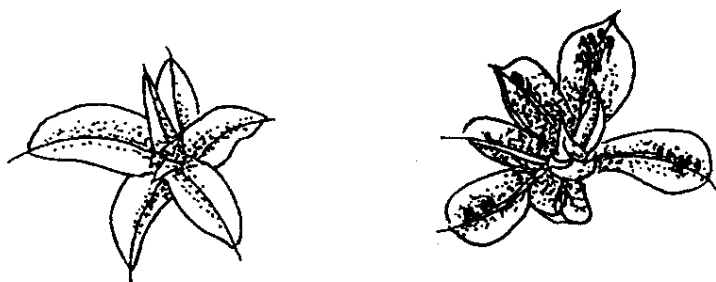
There is a big difference between the acid bark of pine, oak, and alder, and the more alkaline and nutrient-rich bark of sycamore, ash, elder, and elm. In moderately polluted areas, only trees with alkaline bark support epiphytes. I have made many mounted cultures using grated elm or sycamore bark, but it may be as effective and convenient to make mounted peat cultures, and to sprinkle a pinch or two of powdered limestone or finely grated alkaline bark on them, when needed. Epiphytes can of course be kept on pieces of their original tree bark. However, that offers no guarantee of success. Most are drought-resistant, and will survive, even for a year or two, in quite dry conditions. The more specialised ones will soon die if they are kept too moist or shaded, and even more, if the substrate gets soggy. I have kept almost all my epiphytes on grated tree bark or peat, mounted on polystyrene, as described in Chapter 7.

These little mounted cultures may seem quite fiddly to make at first, but become easy with practice. The substrate should be grated, crushed, or otherwise prepared in a loose dry powdered form. Bark can be grated with a small hand plane or grater, peat sieved to a fine powder, rock crushed with a hammer. To get an even layer of glue, take two pieces of polystyrene, ready cut to size with a razor blade, so they will fit in the flower pot, put some glue on one (I use Uhu), and rub the two together, to spread the glue evenly. Press each piece into the powdered substrate, then sprinkle more substrate on top, and press it down with a finger. The object is to get a fairly continuous layer which will not wash off when watered. The mount can stand in a plastic pot, either more or less horizontally or, better for many epiphytes, at a steeper angle, or even vertically, to ensure that water never collects on the surface. It is worth sitting down to use a whole tile, making 30-40. even 50 mounts at a time, and keeping them ready for use

When it is used like this, only a small amount of substrate is used, and the nutrients may be washed away by watering within a few years. If so, the moss, now stranded on bare polystyrene, will appreciate replanting, or a little fresh substrate sprinkled over it. Planting the moss is now very easy. The tiniest shoot or fragment can be pressed into the polystyrene with a pencil point, or the tip of a label, or tufts or mats of moss stuck on with a trace of glue. Pleurocarps may be held in place by surface tension, or speared by a *Berberis* spine, and new shoots soon attach themselves, needing no glue at all.

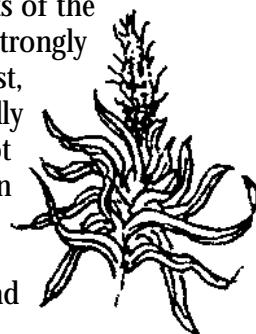
Epiphytes can be very patchy in their distribution. There may be only one or two "good" trees in a wood, perhaps the oldest or most sheltered ones. The mosses on them should then be collected only very sparingly. It is not necessary to match the bark exactly. Bark from a different kind of tree, or fine peat, will usually do for the planting, but the distinction between acid and alkaline bark should be observed and followed, as noted above. Another useful indicator can be to look at the lichens on a tree. If there are orange lichens present (*Xanthoria*), the tree is likely to have alkaline bark, and sometimes, as near a busy road or a dusty lime quarry, even oak or pine can support lime-loving plants. Mosses from alkaline trees should of course be mounted on alkaline bark.

They might include the ubiquitous *Bryum capillare*, or the very similar *B. subelegans*. A *Syntrichia* is characteristic of alkaline trees. It is *Syntrichia laevipila*, resembling *Tortula muralis*, but with a more



solid-looking leaf, and a shorter hairpoint. On older shaded trees, or on elder bushes, species of *Zygodon* grow, their triangular bright yellow leaves looking like those of a *Barbula*. With them, or further up the tree in drier positions, may be found *Orthotrichum* species. *Orthotrichum diaphanum* is the commonest, and was mentioned as a moss of walls, even in towns. It is the only *Orthotrichum* with a hairpoint. There are many other species. Other common ones on trees are larger. *O. affine* often has capsules tucked among the leaves. *O. lyellii* very rarely fruits, but may have gemmae on the upper surface of its leaves, as mentioned in Chapter 9. There are several other species, mostly impossible to name without capsules.

Growing among them, or on more acid tree bark, except in the dirtier parts of the country, will be *Ulotas*. Those which grow on trees have leaves which are strongly crisped when dry, and hairy calyptras. *Ulota bruchii* and *U. crispa* are commonest, and can be hard to tell apart. Capsules are often present. *U. bruchii* is usually larger. Near western coasts, *Ulota phyllantha* is sometimes abundant. It does not fruit, but its gemmae are usually conspicuous, and form fuzzy brown tufts on the leaftips, rather than being spread over the leaf, as in *Orthotrichum lyellii*. It is rare and stunted inland, but may be recolonising places where it was once eliminated by air pollution. It has even been refound recently on Hampstead Heath, in north London.

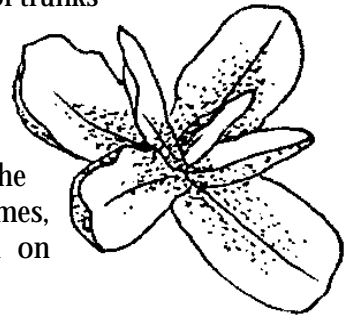


Ulotas and *Orthotrichums* are the most specialised epiphytes, found even on exposed twigs – where the air is clean enough, as in parts of Wales. None has ever succeeded here on soil in flower pots, nor even on pieces of original bark. All are now on mounted cultures. Being plants of exposed habitats, it is not sensible to keep them shaded or constantly moist, yet they dry out within minutes under normal greenhouse conditions. While they can withstand this, and will tolerate frequent drying and wetting better than almost any other moss, they need very high humidity for a reasonable length of time, if they are to make worthwhile growth. Indeed, if the air around them is saturated, they can absorb water from the air and start growing without being watered at all. They also seem less tolerant of shade than many mosses. They grew better in Reading after the removal of the two lime trees. They were on a top shelf, with almost full north light, covered with polythene, almost continuously moist from October to March, and only intermittently watered in spring and autumn. In warmer summer weather, the polythene was removed, and they were left quite dry, even exposed to some sunshine. Even under ideal conditions, they are slow-growing plants, hardly spreading by protonema. It takes at least a couple of years for one shoot to make a small tuft. As might be expected, many mosses of bare rocks grow in similar conditions, on similar mounted rock cultures.

Pleurocarps which grow on alkaline tree bark are more likely to be found also on rocks, or even on the ground. Some have been mentioned. However there are several rarer and more specialised epiphytes. The least uncommon include; *Leucodon sciuroides*, on old, sometimes sunny tree trunks. It

has narrow creased (plicate), glossy leaves. Near the south coast, *Leptodon smithii* is locally frequent. Its small pinnately branched stems curl up when dry. *Cryphaea heteromalla* is more widespread, and of medium size. It has creeping stolons and erect branches, often with fruits sticking out of the side on a very short seta. It needs strongly alkaline conditions, and is often found on elder. *Leskea polycarpa* grows on muddy roots, tree trunks and stones, by lowland rivers. It is small, a little larger than *Amblystegium serpens*, but of a pale colour, unlike any other pleurocarp mentioned in this book. It is frequent by the Thames at Reading, fruits freely, and has even turned up, though rarely, on walls and kerbs in the suburbs of the town. These, and other similar rarer species, can be grown on mounted alkaline bark, or on well-drained rock or soil in clay pots, and in rather dry well-lit conditions. They are less critical in cultivation than *Orthotrichum*.

Many lowland rivers provide a rather special habitat, where tree roots or trunks are covered at times with silt, by high or flood water. Though they may look mucky and dirty, such muddy trees and roots often have a very distinctive moss flora. If they are dry, splash a little water on them and any mosses which are present will spring into life. *Syntrichia latifolia* is likely to be one. The unusual shape of the leaf makes the reason for its name obvious. Like *Leskea*, it is common by the Thames, and sometimes turns up on sheltered muddy tarmac, and even on pavements.



Several other pleurocarps are common by lowland rivers, on muddy trees, cement and stonework. They are not really epiphytes. In a slightly longer book, they would deserve a chapter of their own. I formerly found them hard to keep through the summer, since they may die if kept wet or waterlogged in warm summer weather. They are better mounted on a hard surface, wet in winter, and perhaps sprinkled with a little mud to simulate the mud left by a river in flood. Like most pleurocarps, they have in recent years been left mostly dry in summer, tolerating drought better than might be expected

Lower down a tree root or a river bank may be some other very obvious large mosses. Since they spend most of their lives underwater, they hardly qualify as epiphytes, yet, strangely, some can occur on intermittently flooded trees by rivers, well above the waterline. *Cinclidotus fontinaloides* has large blunt laves with thick margins, and straggling stems, several inches long. *Fontinalis antipyretica* looks very different. Its trailing underwater stems, a foot long or more, make it one of the largest British mosses. The leaves are keeled, giving the stems a triangular cross-section. It is a popular aquarium plant. It persists here if treated like an epiphyte. Though it will stand gentle drying in summer, it needs very high humidity, as under a sheet of polythene, to grow at all well. In fishtanks, it makes thin straggly growth underwater. Attached to stones in cold mountain streams may be found the darker more slender *F. squamosa*, which may be grown likewise, but in neutral water, with no chalk or limestone.



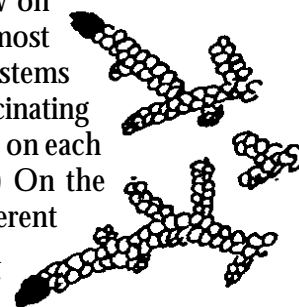
Acid trees, notably oak, have a less varied moss flora, except in the remote and unpolluted parts of the country, and in a few ancient forests where beginners should not collect. Yet some of our commonest epiphytes are tolerant of acid conditions. They even became commoner, and perhaps replaced less tolerant species, as tree bark became more acid a result of air pollution. In the South-east, the most widespread epiphyte of all is probably *Dicranoweisia cirrata*. It is often found on wooden fence



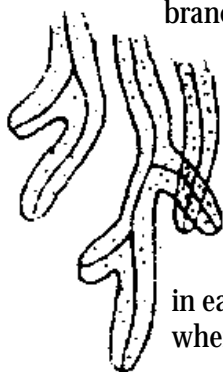
posts, and on the bases of suburban trees, making green cushions with twisted leaves. The tufts are darker green, and more compact than those of *Ulota*, the leaves and stems shorter. The small fruit is usually present, quite hairless, and raised well clear of the leaves.

Two small *Dicranums*, *D. tauricum* and *D. montanum*, are less common, but have increased in recent years, on similar acid trees. *D. tauricum* forms dark green patches on the boles or branches. The leaves, finer than the finest needle, are rigid and brittle. If you lick a finger and press it against this moss, dozens of tiny leaf tips will break off and stick to it, visible through a lens. *Dicranum montanum* has leaves twisted, and not brittle. It may be confused with the much commoner *Dicranoweisia cirrata*, but has far narrower and finer leaves. These are small, slow-growing plants, and should be on firmly compressed peat in a clay pot, or better, mounted on acid bark, and rather dry.

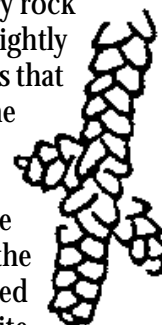
Except in the most humid ravines in the far West, few hepatics grow on trees. Few are common enough to mention here. *Frullania dilatata* is the most widespread, in Britain at least, of this large worldwide genus. The dark stems creep flat against the bark. Only through a microscope can its fascinating structure be appreciated. The main leaves are in two flattened rows, one on each side, and each leaf has a little pouch at the base (the "postical lobe") On the underside of the stem is a third row of smaller leaves, of a quite different shape (the underleaves). Literature about hepatics is full of technical terms, which describe the strange structures and complex, leaf arrangements which these plants have evolved.



In western Britain, *Frullania tamarisci* is even more common, sometimes on every rock and tree. It is rare in the East. It has main leaves less rounded, perhaps slightly pointed, and is often of a brown or purple colour. The easiest rough distinction is that it is very rarely fertile, whereas *F. dilatata* usually has the distinctive perianth (the sac which surrounds the young fruit), on the ends of some of its branches. Another distinction is that through a strong ($\times 20$) lens,



F. tamarisci can be seen to have patches, or a line along the middle of the main leaf, of larger translucent cells, giving the impression of a fine nerve. *Radula complanata* is distantly related to *Frullania*, and has a similar leaf structure, but looks quite different. Its pale green stems with rounded leaves are pressed very flat against the bark. In the East, it grows only in damp sheltered woods. *Metzgeria furcata* is an oddity, a tiny thalloid (leafless) liverwort that grows in quite dry places, even in eastern England. It is quite frequent on the shaded trunks of large trees, especially where water runs down in wet weather.



Further west, where the climate is wetter, and the air cleaner, other *Metzgerias* are sometimes common. They may grow on the smaller branches and twigs of trees, as well as on the trunks, especially in damp valleys and near streams. Both produce abundant small gemmae, by which they spread. Those of *Metzgeria fruticulosa* are clustered at the ends of the branches, those of *M. tenerata* scattered along the sides. Both need high humidity, as in an enclosed frame, to grow well in cultivation, and are best grown on mounted bark. Yet they also need strong drainage, and tolerate neither deep shade nor sunshine, making them quite tricky to keep.

Another genus of hepatics is *Lejeunea*, part of a huge worldwide tribe of many hundreds of related and often very similar species. In this and related genera alone, there are about 15 kinds in Britain. All are tiny, most are rare, and only *Microlejeunea ulicina* is likely to be found by a beginner, except in

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the extreme West. Though hardly larger than a *Cephaloziella*, it has a complex leaf structure, with tiny pouches, a few cells across, at the base of each leaf. Through a microscope it is a beautiful sight, but in the field can be seen only a pale green stain in the crevices of a tree, perhaps in a sheltered wood. A good lens is needed even to see it, and a knife, to gather a little of the bark on which it is growing. Planting these tiny hepatics on mounted bark is the only way to keep them, but is not difficult. All can withstand gentle desiccation for long periods, if kept humid and shaded. Waterlogging will quickly and completely kill them, as will any exposure to warm sunshine. The mounted substrate should be sloping or vertical, or in a clay pot, to absorb surplus moisture.

On the other hand, like all mosses, epiphytes can only grow when they are moist. They need to be sprayed with clean lime-free water, but are so small that, except in moist weather in midwinter, they can dry out again within minutes, even in a quite damp greenhouse, and therefore have little chance to make any growth. Nor do most epiphytes grow well in warm summer weather. When temperatures go above about 30°C, as is probable at times in any greenhouse, they are only likely to be weakened, or to go mouldy if kept wet. It is best to keep them always well-shaded and humid, covered in polythene perhaps, but not wet when high temperatures are likely, and slightly moist for the rest of the year, letting them dry out gently at times. *Lejeuneas* tolerate a combination of shade and warmth quite well. They will grow in an enclosed frame or glass tank, or even in a test-tube, in a cool greenhouse, or in a dim light indoors, as described later.

Epiphytes are one of several groups of mosses and liverworts which have hardly ever been kept alive before. There is a great range of preferences between them. *Leptodon smithii*, a southern and Mediterranean species, will curl up and endure fierce and prolonged summer sunshine undamaged, even in a greenhouse. At the other extreme, some hepatics, such as *Lejeuneas* and *Radulas*, which are confined to deeply shaded woods, or to the most humid places in the far West, will tolerate virtually no direct sunlight, even in winter.

Yet, like so many mosses and hepatics, they are all very hardy and persistent plants, if the conditions are right. Getting the conditions right – that is the challenge.

12. In vitro

Ever since Louis Pasteur's experiments in the early 19th century, it has been understood that bacteria exist almost everywhere, and that the only way to keep food fresh, or to culture most microscopic organisms, is to exclude unwanted bacteria. Growing sterile cultures on a nutrient medium, in a test-tube or a Petri dish, is an essential in many biological projects, and techniques for doing it have long been familiar, to scientists, at least. In more recent years these techniques have been extended to higher plants. Orchid seeds were first germinated on a sterile nutrient medium in the 1920s, and the method is now widely used. Scientists, some commercial growers, and even a few enterprising amateurs, are making increasing use of similar methods, to make meristem cultures of other hard-to-propagate plants and seedlings. Since many bryologists are trained biologists with access to laboratory facilities, it is natural that sterile cultures have been used for growing mosses. They have been attempted for many mosses that do not like life in a test-tube, and the failures may have helped to reinforce the mistaken idea that mosses cannot be grown without sophisticated methods and equipment. Nevertheless, for certain groups of mosses, sterile cultures are well worthwhile.

Small acrocarps of disturbed ground, fields and garden beds, are often difficult to identify. Another very difficult group is in the genus *Bryum*. Many years ago, Dr Harold Whitehouse of Cambridge became interested in these, and cultured them in glass test-tubes, on an agar solution containing common plant nutrients. Since they were growing in a transparent medium, the rhizoids, which are normally hidden in soil, could easily be seen. On the rhizoids of many species, tiny tubers formed in culture. They could be far more easily seen and studied than the tubers on wild plants, which are invariably mixed up with soil, and often with the tubers of other species growing alongside them.

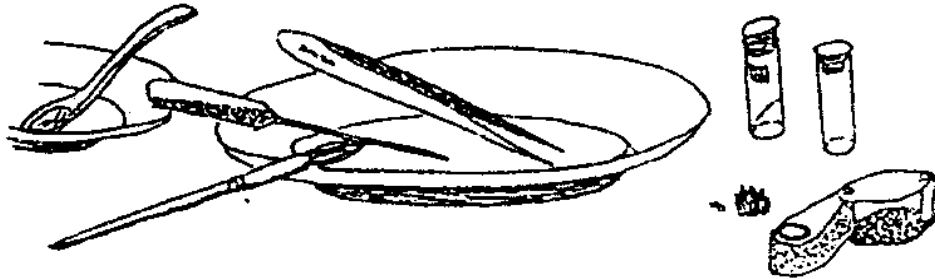
It soon became obvious from these cultures that even in Britain, there were several little-known or even undescribed species, some of them quite common, which could at last be readily identified by looking at the shape, size, or colour of these tubers. The result has been a major contribution to our knowledge of these plants. Dr Whitehouse also kept pure cultures of many very small or short-lived mosses for many years, in a way which would have been impossible or very difficult, in flower pots or unsterilized cultures. The most difficult task, outside a laboratory, would be to make a suitable nutrient solution, though such solutions can be bought commercially. However, for some years Fisons have been marketing a nutrient gel, "Cleargel" for use in rooting cuttings, which is available in some shops and garden centres. It can be used to grow at least some mosses, without the need to mix chemicals or go to specialised suppliers.

The most difficult task is to sterilize the test-tube, the nutrient, and the moss itself. Domestic bleach offers a far easier way of sterilizing things than heating them in an oven or autoclave, but it has the disadvantage, that any trace of bleach remaining in a culture will kill the plant you wish to grow. Fortunately, there seems to be no need for completely sterile cultures. A successful test-tube culture must contain only the species of moss desired, and none other, to avoid confusion. It should be free of minute animals which might eat it, and free of algae, which can eventually poison most mosses in test-tube culture. It need not be free of bacteria and fungi. The result may look far less attractive than a plant growing normally in soil, but if the lid is waterproof, so that the culture cannot dry out, it can be left for long periods in a cool shaded place, without further attention.

Like mounted cultures, test-tube cultures are worth preparing in batches before they are actually needed. I have started by soaking test-tubes in a 10% solution of "Happy Shopper" domestic bleach, then rinsing them in hot tapwater, which, like boiled water, is unlikely to contain live algae or spores.

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A little Cleargel can be scooped on a very small spoon, screwdriver or similar implement, which has also been sterilized with bleach, and put at the bottom of the tube. Unlike agar, this gel cannot be easily melted and run into the bottom of the tube, so this is the messiest part of the preparation. Lids, if any, can be similarly bleached, or the tubes sealed with bits of clingfilm, or with polythene and rubber bands. They may still smell of bleach, so it is probably a good idea to set them aside for a few days before use, so that any remaining traces evaporate or are broken down. The whole operation should be carried out indoors, in a place reasonably free from draughts and dust. Once opened, the original pot of Cleargel must of course be kept completely clean and covered.



Sterilizing the moss takes some preparation and practice, and it is worth dealing with a fair-sized batch of plants on one occasion. It is most convenient to set out a strong lamp, tweezers, a pipette, a good lens, some fresh kitchen tissues or porous toilet paper, and two or three saucers of clean water, together with an empty saucer – preferably a white one, on which tiny fragments of moss can be easily seen.

To sterilize, only a few drops of diluted bleach are needed. I have used about a 10% solution of Happy Shopper bleach, but different brands may be best used at different concentrations. The intention is to kill any algae or spores on the plant surface, but not the plant itself. With tweezers, take a single clean shoot, or a single leaf or stem fragment, or perhaps two or three small shoots, but no more. If there is any soil on them, rinse it off in water. Place them on the empty saucer, add a drop of the dilute bleach with a pipette, or in any other convenient way, enough to completely cover them, shake the fragments around in it with the tips of the tweezers, and watch them through a lens.

After a time, from a few seconds to a few minutes, the edges or tips of the leaves will become bleached, the green colour disappearing. At this point, before the whole plant has lost its colour and been killed, remove it with tweezers, rinse it in clean water, and blot off any traces of water and bleach by putting it on the tissue. Repeat the rinsing and blotting process two or three times, to completely wash it, then put it on the Cleargel in the test-tube with the tweezers, and put on the lid.

If the specimen becomes bleached in less than about 10 seconds, you will probably not rinse off all traces of bleach quickly enough to prevent the plant from being killed completely. A more dilute solution of bleach will be needed. If the rinsing and blotting is not thorough enough, it will also die. However, so long as even only one or two cells survive, it will regenerate. With most cultures, it will soon be obvious whether the plant has started to grow. It should produce new protonema within a week. If not, and if it is no longer green, you have overdone the bleaching and killed it, and must start again. Too weak a mixture will not kill algae, especially if there is the least trace of soil in the culture. They will form green blobs or a green stain, and are likely to poison the moss in the culture within a few months, though it will usually outgrow them at first.

The results, in my hands at least, were much less attractive to look at than flower pot cultures. Some

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mosses of acid soils did not grow in such cultures, perhaps because I used alkaline tapwater for rinsing and sterilizing. Nor did most hepatics. I concentrated on acrocarps, especially *Bryums*, *Tortulas* and their relatives, and on ephemeral mosses, (*Phascum* etc.). Within these groups, the initial success rate was fairly high, about 80%, though most did not grow in hot summer weather. These were all plants which produce protonema fairly freely. Many also make tubers. Some, in test-tubes, are reluctant to make any normal leafy shoots at all. However even the slowest of epiphytes, such as *Orthotrichum*, can make quite large amounts of protonemal growth, in a far shorter time than under more "natural" conditions.

Labelling test-tube cultures can be tricky. Adhesive paper tags fade or decay, or are nibbled by insects. Chinagraph pencils can write directly on glass, but are usually too blunt, and may wear or rub off. Since the object was to try out test-tubes as a means of long-term storage, I made about 100 such cultures in 1990, which were left for 4 years untouched, in a shaded corner of the greenhouse. About half died in this time. Algal contamination was occasional, but more likely causes of death were too deep shade, high temperatures, and perhaps unsuitability of the growth medium. Unfortunately, the trial was spoilt by the failure of the different labelling systems I tried. Only the labels for groups of cultures survived. The clearest conclusion was that many died, but that almost all the *Bryums* (though I did not always know which ones) were viable after 4 years, regenerating from protonema when put on mounted loam.

It seems fairly easy to move plants between sterile and conventional cultures. Almost all my sterile cultures were started from cultivated material. Conversely, sterile cultures in their blob of Cleargel can be simply pulled out of the test-tube, and planted like normal material of the same species.

There is one compelling reason for growing mosses in test-tubes. It has nothing to do with the advantages to botanists who may wish to do serious taxonomic work on difficult species, as already mentioned. It has more to do with the personal problems of hard-pressed and semi-bankrupt students – especially botany students. Test-tubes are small. Ten will fit in a jacket pocket, a hundred in a bicycle saddlebag, and five hundred in a rucksack. A university student who is turned out of his hall of residence on the last day of term, to make room for money-spinning conferences – as they usually are these days – can take a reasonable proportion of the British moss flora home with him, growing in test-tubes. Then he can leave them in a shady place under his parents' rosebushes during the long vacations, while he sweats to pay off his student loan.

This is not a frivolous point. A large proportion of the people who are interested in mosses first became aware of them while studying botany in 6th forms or at universities – at precisely that stage in their lives when they were most footloose, most hard-up, and least able to maintain a garden, a greenhouse, or any other conventional collection of living plants. Their personal circumstances conspired to reinforce the message from past generations of academics – that real botanists do not grow plants, but squash them flat, dry them, and put them in paper packets with a Latin name on.

Far from being difficult to grow, mosses are in some ways uniquely convenient. Even the most rootless student, or the inhabitant of the most claustrophobic urban flat or maisonette, can hope to build up an interesting and worthwhile collection of these tiny plants.

13. Mountain mosses

There is a great contrast between the inhabited parts of Britain and the barren windswept uplands which cover much of the country. Though most of these uplands are rather featureless, and botanically poor, the cool wet climate encourages the luxuriant growth of mosses. In steep rocky and mountainous country, as in the Lake District, there are many more habitats, and many more species, enough to overwhelm most beginners. Good advice to beginners is, not to start in such rich areas, and more especially, not to try collecting, identifying or growing large numbers of mosses from the mountains, until you have some experience with at least a few lowland species. After gaining that experience, it is far easier to appreciate the different mountain habitats and their distinctive flora, even if most of the species are still unfamiliar.

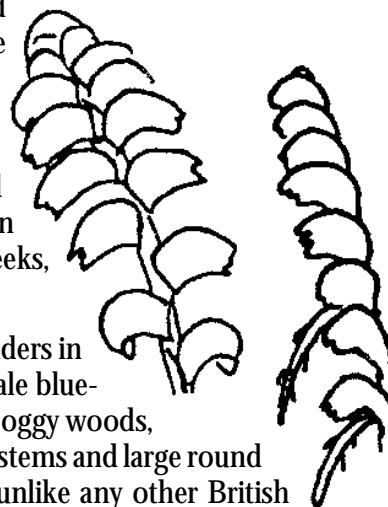
No real plant lover ever tackles a mountain in the mindless manner of the typical tourist. The unremitting application of alternate feet to an eroded path, the straight route to some blasted summit and down again – this is a waste of botanical time. Most of the best plants will be found well below the summits – even near sea level, in the wettest parts of Wales and Scotland. The botanist will often follow a stream, preferably into steep ravines and gorges whose banks are dripping with wet cushions of vegetation, and where even the sheep cannot reach the flowers and nibble them. In a place like this, an experienced bryologist can record a hundred kinds of moss before lunch. It would be unreasonable to try to describe even a proportion of them.

Steep western oakwoods, full of rocks and boulders, are often covered in a deep layer of large mosses, and are an easier place to start looking. The largest and commonest are often *Rhytidiadelphus loreus*, like *R. squarrosus* but larger. *Dicranum majus*, *Hylocomium splendens* and *Isoetecium myosuroides*, described earlier. Of the 40 or more species common in such woods, most are less obvious. It is on the steepest boulders and rock faces that the greatest variety of smaller ones will usually be found. There are certain also to be leafy liverworts. The wetter the climate, the larger and more varied they become. *Plagiochila asplenioides* and the smaller *P. porelloides* are likely. They occur also in lowland Britain, but there are other smaller western *Plagiochilas* which have more strongly toothed leaves. *P. spinulosa* is the commonest. Others are rarer and mostly smaller still.



Lepidozia reptans may grow more luxuriantly than in the lowlands. *L. pinnata*, which makes large pale cushions, is locally common in the far West. In this genus are other smaller, less common species. *Bazzania trilobata*, is even more striking. Its arched and flattened shoots can be 3-4 inches tall, with large three-pronged leaves. Like some other large leafy hepatics, it makes specialised stems, pale, almost leafless, and pointing downwards, called flagellae. They are often covered with rhizoids, and in their function resemble the roots of flowering plants. Growing as they do on steep slopes, all these need strong drainage. In culture, wet soil or waterlogging will quickly kill most of them. They can be grown on *Sphagnum* peat or acid fibre, in clay pots. According to my experience since 1990,

they often make cleaner and more reliable growth on mounted peat. They can tolerate moderate or deep shade, and must be protected from all direct sunshine. Above all, they only grow well in high humidity, and are almost certain to need an enclosed frame or a covering of polythene, at least in summer, to grow well. On the other hand, so long as they are well sheltered and humid, they can be left to slowly dry out for long periods, even in summer. *Plagiochilas* are the most tolerant, and can be left for weeks, unwatered and unattended, if they are well shaded and humid.



On wet bare soil, by trickles of water and riversides, and on boulders in and by streams, there is a different selection of species. Large pale blue-green tufts are probably *Philonotis fontana*. On shaded wet soil in boggy woods, on banks or stream sides, *Hookeria lucensis* frequent. Its flattened stems and large round leaves with glistening cells are quite distinctive. It looks quite unlike any other British moss, resembling, rather a large liverwort. Dark straggling mosses with wiry stems and blunt leaves, on boulders in or by water, are usually *Racomitrium aciculare* or *R. aquaticum*. On such boulders are usually mats of pleurocarps. A creeping moss which resembles *Brachythecium rutabulum* is probably *B. rivulare*. It can be distinguished by the patch of inflated transparent cells at the corner of the leaf, where it joins the stem.

There will also be many hepatics, especially *Scapanias*, with their complex folded leaves. On damp shaded soil, *Nardia scalaris* and *Diplophyllum albicans* are very common, together with several other *Nardias* or related plants with round leaves, which can be hard to name. Though all these may grow apparently side-by-side, they have widely differing needs in culture. The hepatics of wet shaded soil are relatively easy to keep. They need shaded acid or neutral soil, and constant moisture. A plastic flower pot in a tray of water on the damp cool greenhouse floor, with fairly frequent spraying and a little standing water, suits them well. So does a small frame or propagator in a shady place outdoors, or by a sunless window. *Brachytheciums* and other pleurocarps do not like too much shade, or wet warm conditions, so unless they can be kept quite cool, it is better to keep them rather dry, and grow them like the garden *Brachytheciums* mentioned earlier. *Dichodontium palustre* makes big pale tufts by streams, with recurved (squarrose) leaves. It is unlikely to survive for long in a warm greenhouse. With artificial light, I have kept it through a hot summer on the floor, cooled a few degrees by a nearby refrigerator, and on wet soil in a refrigerator. Paradoxically it has also survived, in a very stunted form, on rather dry mounted soil, in the same conditions as other small *Dicranellas*. In contrast, *Philonotis* species grow well on waterlogged soil in a good light, even in fairly hot sunny conditions, though they need replanting each year.

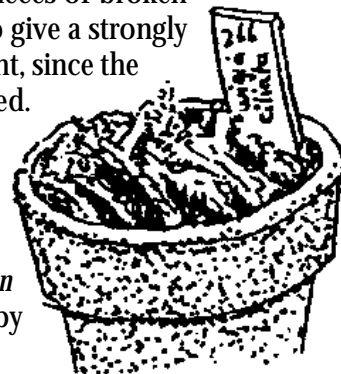
The *Scapanias*, with erect stems and folded leaves, are very striking, especially *S. undulata* which makes large brightly-coloured purple, red or green tufts, in weakly flowing water. These are probably the most difficult waterside plants to keep. I have found them very unpredictable in their response to cultivation, and cannot offer reliable advice on growing *Scapanias* of wet habitats. Those of drier habitats are best mounted, shaded, and in high humidity. It must be remembered that even mosses and hepatics which grow side by side in the same habitat may need very different cultural treatment.

Exposed boulders on mountains have relatively few species, all of necessity adapted to harsh conditions, and frequently dried out by sunshine and fierce winds. *Hypnum cupressiforme* is likely, and where a little humus has collected, one or two common species of *Polytrichum* and *Campylopus*. Of more interest to a visitor from the lowlands will be *Racomitriums* and *Andreaeas*. *Racomitrium* is a remarkable genus. Two riverside species have been mentioned. There are several others. The

commonest and most striking is *R. lanuginosum*, which makes large hoary creeping carpets. At high altitudes, and on barren screes and summits, it is often the most abundant plant, covering large areas. Most of the *Racomitriums* of dry rocks (though not those of wet rocks) are common also on acid walls, as of slate in mountain regions. They are much rarer in the drier lowlands, on thatch, heathland, old cinders, and acid tombstones. Equally common on mountain boulders, even on high summits, is *R. heterostichum*, a densely tufted plant like a *Grimmia*. It varies from olive-green cushions, which can be quite large, to tiny black tufts (now considered a separate species, *R. affine*), but usually with a small hairpoint, visible under a lens. A more hoary plant with spreading leaves when dry and prominent hairpoints, creeping closely pressed against the rock, may be *R. canescens* s.l. There may be creeping patches of the dark purple hepatic, *Frullania tamarisci*. Among these, and among the many colourful mountain lichens, will be small tufts of other mosses, so black that even when moistened and examined under a lens, they appear lifeless. They are *Andreaeas*, probably *A. rothii*.

Growing these extraordinary plants will never be a hobby with a mass following. The first thing to understand is that they are adapted to a nutrient supply which, by ordinary gardeners' standards, is fantastically low. They get all the nourishment they need from hard acid rock and clean mountain rain. The second thing to understand is that they grow strongly, even on the highest and coldest mountains, where summer weather is hardly warmer than December in Berkshire, and certainly wetter and windier. The third is that they can stand drought of almost unlimited severity, and yet spring to life within seconds when moistened. When a dry tuft of *Racomitrium lanuginosum* is sprayed, the change from lifeless grey to bright hoary green is almost too fast for the eye to follow.

I can only suggest three fairly distinct ways to grow *Racomitriums*. Pieces of broken roof slate or hard granite can be wedged into the top of a clay pot to give a strongly drained permanent surface of hard acid rock. Slate is most convenient, since the parallel strips leave many gaps into which the moss can be pressed. Such cultures may be unsuccessful in a greenhouse, since nutrients collect in the pot, or in the gaps between the pieces of slate. Other mosses such as *Bryum dichotomum* soon appear, and eventually outgrow the *Racomitrium*. I had one, in which *R. canescens* grew on acid sand in moderate shade, but needed weeding to remove *Ceratodon purpureus*. However, in the open, these nutrients are leached away by rain, and the weed mosses discouraged.



The oldest such culture I have, on pieces of hard acid sandstone, wedged into a clay pot, was made in 1989. It became covered in young shoots of *R. heterostichum*, which colonised new sandstone fragments, despite being on an exposed sunny south-facing veranda, outdoors. Most of my *Racomitrium* cultures were on mounted granite. Some were treated like epiphytes, but some of the streamside *Racomitriums*, being more shade-tolerant, were on shadier lower shelves, and kept moist for a larger part of the year, perhaps even through the summer. Third, some were in constant high humidity, quite shaded on a cool lower shelf, on well-drained or mounted peat, mostly as chance associates among delicate hepatics.

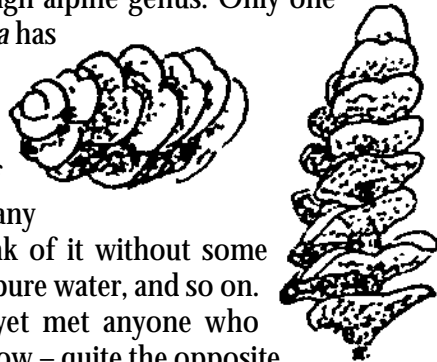
Racomitrium is one of the most widespread and abundant genera of high arctic-alpine mosses. Any cultural method that works for *Racomitrium* is likely to work for many other mosses of exposed acid rock. They include the very attractive *Hedwigia stellata*, (not at all shade-tolerant) and many of the British species of *Grimmia*. I have found *Grimmias* more tolerant of hot sunshine, and of shade and mistreatment. Most can be grown on mounted rock cultures, though they are slow, taking at least 3-4 years to make good tufts, which can then persist for 10 years or more. So far as I know, virtually none of these mosses of rocks have been kept alive elsewhere in cultivation until recent years – if

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at all. Among the mosses on more sheltered rocks may be a few hepatics. Species of *Lophozia* are quite common, especially on thin humus, rock and turf ledges, or on somewhat sheltered boulders. They are best treated like the common lowland *L. ventricosa*, fairly well shaded, on strongly drained or mounted peat.

Higher on mountains, especially in the far West, and above 1500 feet, other small hepatics grow on cliffs or boulders, with minute tight-packed leaves. *Gymnomitrium crenulatum* makes small coppery-red or black patches. On bouldersides or cliffs, *G. obtusum*, with rounded leaf lobes, and *G. concinnatum*, with more pointed lobes, make silvery-green, grey or ochre tufts. They are often in places blasted clear of snow by winter blizzards, whose scouring action destroys most other plants. More abundant than these, making large rubbery mats of tiny silvery white stems in or by icy cold mountain streams, is *Anthelia julacea*. Unlike *Racomitrium*s, these cannot survive drought or hot sunshine. Therefore they cannot be left dry and dormant in hot summer weather. Nor can they tolerate high temperatures. At best, in the coolest corner of a lightly shaded garden or greenhouse, they will languish for a year or so before dying, or getting overgrown by other mosses.

The same may be said of *Marsupellas*, a large and mostly high alpine genus. Only one species is really common and abundant. *Marsupella emarginata* has erect shoots and shallowly bilobed leaves. It makes tufts, sometimes of a deep reddish-brown colour, common on wet rocks by cold mountain streams. These must be among the most difficult of all bryophytes to grow. Only if you can keep *Marsupella emarginata* is it worth trying to grow any of the others. It is probably a waste of time to even think of it without some experience, and a well-organised infrastructure, a supply of pure water, and so on. Yet among cactus and succulent experts, I have never yet met anyone who despises a plant because it is small, unusual, or difficult to grow – quite the opposite. The new, the obscure and unusual, the plant which nobody else can keep alive, this is the challenge which a real enthusiast seeks out and cherishes.



In early days, my rather forlorn strategy was to split cultures of these difficult plants, and to try contrasted conditions, a well-lit but hot hotter dry top shelf, or a cooler but shaded position on the greenhouse floor. In general they survived longer on the well-lit shelves, despite the higher temperatures, but death was inevitable for many of them. In early 1990 I brought an electricity supply into the greenhouse in Reading, and installed a Growlux light and an old refrigerator. The results confirmed my belief that these plants need strong light and low temperatures, or better, a combination of the two. The refrigerator door was taken off and replaced by a transparent plastic door, held shut by the magnetic strips used in the “Magnelite” double-glazing system. The inside was poorly lit, but offered a variety of summer night time temperatures between 2-8°C., and daytime summer maxima in late afternoon between 10-20°C, depending on the weather.

Among the more demanding alpine plants, *Marsupellas*, *Anthelia julacea* and a few alpine mosses remained in better condition for longer when refrigerated. Some made vigorous growth, but there were still problems, and some were still scarce, unhealthy, or dead. One problem was that condensation on the ice box removed water vapour, keeping the dew-point below freezing. Humidity inside the refrigerator was therefore low. Also, although waterlogging is less damaging at low temperatures, some of the hepatics, especially the small *Marsupellas* and *Gymnomitrium*s, like so many other mosses and liverworts, hate wet soil. They needed mounted cultures, even when refrigerated. Such cultures, of course, dry out faster anyway. Therefore most cultures inside a refrigerator were covered in polythene, to keep them in high humidity. Some later mounted cultures

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were more successful and suggested that, like many other mosses and liverworts, some small high alpiners can tolerate drier and warmer conditions than might be expected.

Many gardeners may think the idea of a refrigerator in a greenhouse inherently ridiculous. Yet it makes a lot of sense. I have seen three attempts to grow mosses using refrigeration. One was a fairly conventional north-facing greenhouse in south Scotland, with a rather noisy air conditioner blowing cold air over some mosses from the Antarctic islands. The others have been in enclosed rooms or growth chambers, with light and temperature under automatic control. I once also heard mention of a collection kept in an old refrigerated shop display cabinet. Some ideas might be beyond the means of most gardeners, yet a humble domestic refrigerator costs little to acquire, secondhand, and less to run. Cool air may spill out, to keep day temperatures on the greenhouse floor a few degrees cooler than outside.

Just as British farmers have woken up to the fact that over much of the Southeast, irrigation can improve crop yields, so may enterprising plant growers yet discover that many familiar plants, especially alpiners, can be grown better if given lower night-time temperatures in summer than a normal greenhouse can provide. Spitzbergen, for instance, has a surprisingly diverse flowering plant flora, with many endemic species, all adapted to a growing season of at most 3 months, and to a summer temperature averaging 5°C. The alpine house at Kew Gardens has a display of high alpiners and Arctic plants on a refrigerated bench. It is the soil and roots, rather than the air above the plants, which are cooled. Some of these plants spend their winters at -6°C in a freezer.

In late 1994, I picked out about 30 mosses and liverworts in gatherings from north-east Greenland (Peary Land) made by a friend that summer. Most were simply put among their British relatives, rather than in the refrigerator, some mosses even on the hot exposed top shelves, and few were immediately harmed by this unlikely treatment. Some soil cultures were kept at, or just above, freezing by the refrigerator icebox. Most of the hepatics (some also occur as Scottish high alpine species) were on mounted cultures, in high humidity. Though unrefrigerated, most survived hot weather in summer 1995. In the British Isles alone, there are dozens of high alpine hepatics and many alpine mosses (especially *Andreaeas*) which neither I, nor anyone else, has yet kept healthy. Those I have grown often behave in surprising ways. Virtually nothing is known about the growth rates or ecology of many of them. Any reader who rises to this challenge and keeps them for any length of time will certainly add to the sum of scientific knowledge. Given a cool greenhouse and a less hostile local climate, even refrigeration may be less necessary than well-drained mounted culture conditions. I commend these arctic-alpine plants to anyone who is willing to experiment, at least with the common ones.

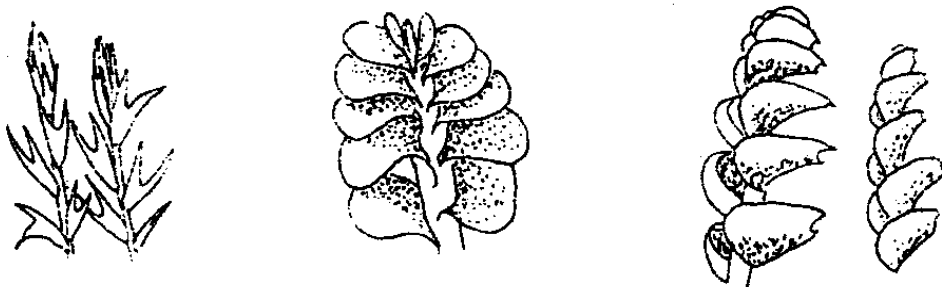
Paradoxically, a refrigerator is also a promising heat source. The motor is a heat pump, and a heat pump can deliver more heat than an electric fire or heater with the same power consumption. The cool air sinks, and the warm air from the radiator on the back moves upwards. For a gardener who has only a few plants to keep warm in winter, a frame put on top of a refrigerator, to catch the warm air from the radiator could make better sense than a conventional electric heater. Refrigerators, it is true, are bulky, mainly because of the insulation in the case. Yet, if some pundits are right, we will all be conserving energy by using heat pumps, in fifty years time.

On a mountain, it is usually a good idea to look at the north side. Steep north-facing turf slopes often have a rich hepatic flora. This is especially true of those which get little direct sunshine, or which are shaded by tall bilberry or heather. In such places there is a specialised flora of strange and sometimes spectacular hepatics with a strongly western distribution. Even the commonest are confined, in Wales and the Lake District, to the wettest and most mountainous parts. On the higher

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or wetter mountains of west Scotland and western Ireland there are several more. They often grow best at about 2000 feet above sea level, soaked by mist and drizzle for 200 days in the year, or more. Many of them are absent from Europe, or found in only a few sites outside this country. Strangely enough, their close relatives are often found in the wet forests of high tropical mountains. They clung on here through the Ice Ages, on bleak hills in the far West.

Some are too rare to mention, but *Herbertus aduncus* ssp. *hutchinsiae* and the similar *H. stramineus*, with their erect stems and two-pronged leaves, form conspicuous orange, yellow or brown-green tufts, which may easily be noticed. *Mylia taylorii* has pale rounded leaves with large coarse cells. It too forms large tufts of a pale ochre-green, sometimes tipped with dull red. *Anastrepta orcadensis* has leaves of a complex shape, elegantly swept to one side of the stem. These species grow at least as far south as Snowdonia.



In the past, they generally persisted here for a long time if shaded and well drained. Poor drainage or sunshine would quickly kill them. They need high humidity to grow at all, yet in an enclosed frame or container, growth can become etiolated and unnatural, especially if too deeply shaded. Most can flourish on mounted peat (and some on peat in clay pots) well-shaded, and covered with polythene to maintain high humidity throughout the year. If kept moist and humid, they continue to grow better than might be expected in warm summer weather. Sometimes they can also be grown in wet peat, especially *Herbertus*, but kept thus, they often get mucky and overgrown.

Most of our mountain country is composed of hard acid rocks. Lime-rich and nutrient-rich rocks soils are rare at high altitudes. Where they occur, they support a distinctive flora which is also rare. Beginners should not seek out such places, since the moss flora of some of them may have suffered from the past activity of collectors. Yet my impression, strangely enough, is that most of these rarities are easier to grow than the more widespread plants of more barren acid rocks and soil. It is the barrenness, the low level of nutrients in most mountain habitats, which is hard to reproduce in culture, even more than the climate. However, one common mountain habitat does offer more nutrients than open moorland or bare rock. In damp or overhanging rock clefts, especially where there is some seepage of water, or where soil has collected, several distinctive mosses often grow.

There may be *Pohlias*, especially *Pohlia cruda*, which has young shoots of an astonishing iridescent blue-green colour. There are also acrocarps which form large rounded tufts or cushions in rock clefts. The bright yellow-green *Bryoerythrophyllum ferruginascens*, with older leaves and stems often a striking brick-red, is on lime-rich rocks. *Anoetangium aestivum* resembles a small *Barbula*, of a brilliant yellow-green. *Gymnostomum aeruginosum* has narrower dull green leaves. *Grimmia torquata* is a rather pale blue-green above, the dead stems dark below, the leaves with a short white hairpoint. These three can make large bulging tufts on steep or vertical wet rocks. They are not plants that can be reliably named without experience, or a microscope, or both. There are many other similar but rarer species, especially in the mountains of central Scotland. *Bartramia pomiformis* is a larger plant, with long sharp leaves of a bright glaucous green. Individual stems resemble those of a *Polytrichum*, though

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of about half the size. It also occurs rarely on shaded acid banks in lowland Britain. The round capsule resembles a tiny apple.

All grow well here on mounted cultures. I have found crushed granite the most useful substrate, or peat. Traces of lime can be sprinkled on for the *Bryoerythrophyllum*, and perhaps some neutral soil for *Pohlia cruda* and the *Bartramia*. They tolerate shade well, and if shaded, are not troubled by long periods of desiccation in summer. The most obvious liverworts in mountain clefts are often *Conocephalum conicum*, sometimes rather stunted, but still easily recognised by its smell, and the similar but red-edged *Preissia quadrata*. The *Preissia* can be grown like *Lunularia*, but is less tolerant of waterlogging than *Marchantias*. If it fails to flourish in culture, too wet a soil is a likely cause. Considering its habitat, *Preissia* is surprisingly tolerant of summer drought. Such damp crevices and overhangs are common at the base of mountain cliffs, and are always worth examining.

There are thousands of growers who specialise in alpine flowering plants. Among alpine mosses there is an even greater range of habitat preferences, and an even greater range of challenges to horticultural skill. They occupy many niches where no flowering plants can gain a hold. One habitat which only the young and fit may ever see is the snow patch flora of the highest Scottish mountains, where a specialised moss and hepatic flora is covered in snow for up to 10 or even 11 months a year. I had some plants from such habitats, mostly in the refrigerator.

I hope this chapter has given some idea of the challenges, the mysteries and unsolved problems, involved in growing such plants. Yet the most casual visitor to the mountains may hope to find a few attractive species which can be kept without too much fuss, in a propagator, a greenhouse, or even a jamjar on a windowsill. And even one or two survivors make better mementos of our wild and wonderful mountain scenery than anything to be found in a tacky souvenir shop.

14. Managing a collection

Much human activity involves collecting and classifying things. A typical shop or household will contain thousands of objects. Except in the untidiest home, they are not left in amorphous heaps, but arranged and classified into a series of sub-collections, set within a framework of rooms, furniture, and the house itself. Cutlery is in a kitchen drawer, clothes in a cupboard, books on a shelf, and so on.

A living collection of plants must likewise be set in a framework. Without it, any large collection of plants will fall into chaos. The framework may be a garden, a tray of test-tubes, a windowsill or propagator, a cold frame or enclosed shelf, or of course, a greenhouse. Again, a successful large collection of plants will not be arranged at random, but rather as a series of smaller sub-collections, like the objects in a home or shop. My main moss collection is housed in a 10x12 foot aluminium greenhouse, on aluminium staging when in Reading, but now on modular plastic shelves. The plants and methods may be unusual, but the framework is quite conventional. Yet even within one greenhouse, there can be a very wide range of conditions, and different groups of plants may be treated in very different ways. I will start by describing some of the mini-collections, apart from the main greenhouse, which I have seen, or have made for myself.

A few tubs or flower pots on an outdoor patio can constitute a collection. They do not have to be filled with *Lobelias* and *Pelargoniums*. The large liverworts, *Marchantias* and so on, will do as well, though they are not so colourful. Any reasonable soil will suit them. If they dry out completely, they are damaged. The big common liverworts are better kept in the shade, since drought and hot sunshine will kill them, just like *Lobelias*. They take a few weeks to get well rooted, and until they are, they need more careful watering, like anything that is newly planted. I had half-a dozen such pots on a north-facing cement border in Reading. In dry summer weather they got washing-up water tipped over them every few days. For most of the year, rain was enough. When going away on summer holidays, I covered them with a plastic bag to keep them moist. There are of course more elegant ways of growing such plants, as in the Reading university greenhouse, where a collection containing many fine pots of *Marchantias* enjoyed a daily wetting with distilled water.

Another mini-collection in Reading was probably unique. It resembled the outside windowsill collections of small cacti and succulents which I kept in student days. On the sunniest possible south-facing verandah, where even *Sempervivums* might shrivel and die, were a dozen small acrocarps, in plastic pots and seed trays. Flourishing after several years were *Tortella nitida*, *Bryum torquescens*, the large yellow Mexican *Pleurochaete luteoalba*, and (until insect larvae ate it) *Bartramia stricta*, a Mediterranean species. *Racomitrium heterostichum* (mentioned in the last chapter) and some *Grimmias* were scarce, on slate in clay pots. Among hardy cacti and succulents nearby, and on south-facing outside windowsills, were several common urban mosses. They were obviously all plants of dry sunny habitats. They were never watered, however dry the weather, and made most of their growth in winter.

Another mini-collection contained test-tubes. They lived on a shaded shelf of the greenhouse, with a few of current interest indoors, by the living room window. They could equally well have been in a shaded site outdoors, as Dr Whitehouse sometimes kept his collections. Only a hardened biologist would put test-tubes of moss on a laboratory bench, next to a fluorescent light, but it has been done.

An old brick walltop in the garden, and some cement, were home to some non-local mosses, some long-established, some stuck on in later years with silicone bath sealant. It hardly amounted to a

collection, but about 10 non-local species persisted and in some cases spread, though slowly. All were pleurocarps of dry rock or tree habitats. Notable successes for ten years or more were *Pterogonium gracile* (abundant) and *Leptodon smithii* (slow but steady). Later trials of several other species, especially of *Racomitrium*s and *Hedwigia ciliata* were promising. Most were transplants of surplus material from greenhouse cultures. As suggested in Chapter 5, it would be irresponsible to collect any except the commonest mosses for such transplants, but their persistence and growth on an ordinary wall near the middle of Reading was surprising, suggesting that there is still a great deal to be learnt about their ecology.

Until the day sunshine is privatised, growing plants by artificial light might seem rather pointless. However, if electricity is available, it can make very good sense. Normal filament lights are useless for plants, and normal fluorescent lights are rather ineffective. Always use lights designed for plant growth, as sold by aquarists, or by specialists in horticultural equipment. I hear that the fashion for home-grown cannabis has created a flourishing market for such equipment. Such lights emit the wavelengths of light most effectively used in photosynthesis. Using such a light, plants can be grown indoors, or in an insulated enclosure, and need no expensive greenhouse heating. Some plant growers, especially in the severe Canadian climate, grow exotic plants in basements, using artificial light, but needing no extra heat in winter. Such a light can be used in a greenhouse, if electricity is available. Always use a circuit-breaker plug, since the risk of a short-circuit caused by damp is far greater than indoors. It can boost the growth of winter-growing plants like Poinsettias and some specialised *Mesembryanthemums*, at a time of year when natural daylight in Britain is inadequate. A wide variety of collections could be built around such lights, with far better control over temperature and daylength than most gardeners ever achieve. For a few years, I had a 40-watt fluorescent light in the main greenhouse devoted to mosses. It supported about a square metre of vigorous plant growth in an enclosed box.

Just for the experience, I also kept some ordinary jamjars in the Reading house, with a little peat in the bottom, on a landing shelf. They confirmed my early experience that plants in enclosed containers like this often persist, but become etiolated and unnatural. There are a few mosses and hepatics which will grow reasonably well. Removing the lids to look at them and water them was rather time-consuming, when it had to be done. They dried out slowly, but stayed moist for a month or two without attention. However *Schistostega pennata* was outstandingly fast and successful on sand. In a pot in a jamjar, in a plastic tickle-bud holder, or in any small transparent container. The disposable plastic sweet jars from confectioners are ideal, and make a good way of growing larger mosses, most *Selaginellas* and ferns, many small houseplants, cuttings, and so on. For removing the labels and glue, try Boots "Sticky Stuff Remover"!

An aquarium with a plastic lid proved a more convenient home for an indoor collection. It was on a landing, and contained some houseplants. They included forms of *Begonia rex*. Winter in the Reading house was rather cool for this plant, with January temperatures on the landing averaging 13°C, ranging from (+5)-10-15°C., and the *Begonia* sometimes suffered catastrophic leaf loss in the late winter, though the hardier species, *Begonia boweri* and *B. maculata* flourished. Most bryophytes failed. Only a few hepatics would grow in these very dim and almost constantly humid conditions, but some of them were of great interest. They included several rare and very minute hepatics of the *Lejeunea* family, notably *Cololejeunea calcarea*, *Aphanolejeunea microscopica*, and *Drepanolejeunea hamatifolia*, also a *Frullania*. *Calypogeia arguta* was an abundant weed, and some small rare *Lophocoleas* did well. Even fewer mosses survived, among them *Leucobryum glaucum*. It was convenient to keep nearby a small handspray full of rainwater, and to spray them every few days, when passing up and down the stairs. Even here, desiccation played a part. For a few weeks in April and August, sunshine got in

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for 20 minutes or so each day. This was enough to gently dry out the mounted cultures, to check or kill *Calypogeia arguta*, and to stop it overrunning the other small hepatics. One curiosity was a small patch of *Lejeunea patens* which grew over a *Begonia* leaf, just as tiny epiphyllous *Lejeuneas* grow over leaves in tropical rainforests. It lasted two years, until the leaf died. None of these survived four years neglect during my more recent illness.

Somewhere between a jamjar and a greenhouse in the conditions it can provide, is a plastic propagator or shaded cold frame. My own mosses were until 1986 in glass-sided frames, and I once saw another promising moss collection, started by an enthusiast in a garden frame. Enclosed frames and propagators can of course be set up on the staging of a greenhouse. They are an easy way to provide the high humidity which is helpful for many mosses, and essential for most hepatics.

However, enclosed containers, whether they be jamjars, cold frames or test-tubes, can all quickly overheat in bright sunshine. A high priority must therefore be to keep them shaded. This prevents their use for growing sun-loving plants, except perhaps in a frame which is thoroughly and reliably ventilated when the sun shines. My own collection was housed until 1986 in tiers of glazed frames on a wooden framework. Since air could circulate around them, these frames remained generally cooler than a greenhouse, but being small and enclosed, had this disadvantage, that when the sun did shine into them, they could quickly get very hot at times. They were also less convenient to work on or look at than a greenhouse, especially in wet weather.

Plants were moved to a conventional greenhouse in 1986. It was in an unpromising site near the centre of Reading, in a south-facing brick-walled garden with a warm dry urban microclimate. The greenhouse itself was aligned east to west, and closely hemmed in on the east and south sides by walls. Until 1994 it was overhung by two large lime trees, and partly shaded on all sides by other trees. It became very dark in summer, though some afternoon sunshine still got in, making it very hot indeed. After the lime trees were felled, it got full sun almost all day. The door and ventilator were opened a little in summer, but there was usually less ventilation than one would expect in a greenhouse, even one devoted to heat-loving plants.

The plants were on aluminium staging, three layers high, with another layer of plants also standing on part of the floor. There was no shading painted on the glass, since a priority, especially before the lime trees were removed, was to get enough light to the lower shelves. Light was reflected around by curtains of aluminium-coated plastic, the material sold in camping shops, as "survival blankets", or by sheets of aluminium foil. These curtains were, and are, the most striking feature of the interior. The reflective film has a wider horticultural usefulness, not only for shading, but for redirecting light to where it is needed, but it must be used with care. The combination of reflected and direct sunlight may be useful in winter, but can cause rapid and lethal overheating of greenhouse plants in summer.

A water butt in the greenhouse could be connected, via its own tap and a hose, to another by the house. Rainwater from the house roof could be piped to the greenhouse. This was a great labour-saving arrangement, to be recommended to any greenhouse owner. A reliable supply of lime-free water is essential for any large general collection of mosses, and beneficial in any greenhouse.

Thermometers scattered around showed a surprising situation, though something similar must occur in most greenhouses. On a sunny day, the upper part was far warmer than the outside air, even with ventilation. There was a steep temperature gradient, and the floor, especially at the more shaded end furthest from the door, was cooler than outside on warm sunny days. I once, for instance, recorded a shade temperature of 50°C on a top shelf, and at the same time, 21°C on the floor, with an outside temperature of 25°C. The water butt was a heat sink, the water in it cooling the air around, which

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sank and collected on the floor. These great temperature differences have to be reckoned with, and can be exploited. Delicate hepatics – mostly mounted cultures of small leafy liverworts – survived on the floor, in aluminium trays covered with polythene sheets. They were cool in summer, and in the constantly high humidity grew well, though they would have died almost instantly in the heat of the day on an upper shelf. Meanwhile the drought-resistant plants on the top shelves were being baked, among them even some Arctic and alpine mosses which seemed no less drought-resistant than their relatives from milder climates. Yet these in turn were warm enough to grow on sunny winter days, even in the severest cold weather.

It is disappointing how few greenhouse owners have more than one thermometer, even those with valuable collections and substantial greenhouse heating bills. Such temperature differences must have an equally great effect on many flowering plants. Any intelligent grower with a greenhouse should find them worth recording and exploiting.

There was an equally great difference in the amount of light reaching different places. The reflective sheeting was arranged to direct light to the lower shelves, while also completely diverting all direct sunshine from most of them, especially those containing hepatics. Yet the differences, especially in summer, were as great as those between Greenland and Egypt. Each shelf of the staging formed a mini-collection, with its own distinctive microclimate and management needs.

The shelves could be covered with polythene, to keep the plants on them moist. All shelves had a few things in common. All were usually watered by spraying with the large pump-up spray. Sometimes I removed the nozzle, soaking some plants and soil with a coarse heavy spray, like that from a garden hose, sometimes they got a light misting, just enough to cool and moisten the plants and the air around them. I have already emphasised the importance of thoroughly spraying mosses with rainwater, the more often, the better, when they are not dry and dormant. It can be done several times a day if you feel so inclined, but they will get by on one or two waterings a week, or less, if conditions are otherwise right.

Best of all, they can, with a little planning, be left unattended for 2 or 3 weeks. The few trays that must stay wet, such as those of *Sphagnum*, were topped up with water, and perhaps moved to a shadier position and covered with polythene. In general, the plants on the lower shelves, being cooler, were moist for more of the time. When plants are dry, the polythene covers may be rolled up, and the plants ignored. Any plant that might benefit from remaining moist in summer can be moved to a cooler lower shelf. In the hot summer of 1990, over three quarters of the mosses and some of the hepatics were dry for up to three months. Their revival in mid-September was astonishing to watch. Just as a cactus grower must resist the temptation to water in winter, so must a moss grower resist the temptation to water most mosses when conditions are too warm or too dry for good growth. Many of these plants will survive under conditions far drier and warmer than in habitat.

Yet it takes some conviction to impose such apparently harsh treatment on these tiny plants. Even some hepatics are drought-resistant. Most hepatics have always been on the floor, or on the third shelf down, but even some of these dry out gently in hot weather. Much could depend on the site of the collection. In a greenhouse with a cool north aspect, especially in the north of the British Isles, most mosses could be kept growing all summer. Plants like *Sphagnum* were kept wet but exposed, and the hotter and drier the weather, the more often their trays needed checking, and topping up with water. However the one essential piece of advice is that most mosses or hepatics, if conditions get too hot or dry, cannot in general be saved by waterlogging. That will often kill them, faster and more thoroughly than desiccation. One of the great advantages of mounted cultures can be that they

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dry out so quickly in summer. A plant that is watered just before the sun comes out can be dry and dormant again within minutes. The same plant in a flower pot may stew in wet soil for hours, after the temperature has risen high enough to damage it.

Many plant growers fear some disaster while they are on holiday, and have to make arrangements for watering, shading and ventilating their precious collections. Most of this moss collection could be left to dry out quietly at any time of the year, whenever I was busy, or away from home. Geraniums, houseplants and pet animals all proved a bigger headache at holiday times. In this respect, mosses and hepatics are easier to keep than many houseplants. Such watering and attention as they need can be fitted around a busy or irregular routine.

The top shelves, despite being warmer and drier, have always been crowded. Most *Sphagna*, permanently waterlogged, but best shaded in summer, were there. Any hepatics on the top shelf were best kept shaded in summer. *Cephaloziellas* and *Riccias* were allowed to dry out in summer, others such as *Anthoceros* and *Riccardias* needed to be always kept wet. For the rest, the top shelf contained xerophytes. *Tortulas*, *Bryums*, *Barbular*, high epiphytes and plants of exposed rocks were mostly on mounted cultures. Management for these was simple. Nothing was watered in the summer. Sometimes, on a cool cloudy day, they got a spraying, but there was little point in regular watering, since they were usually dry again within a few hours, and could make no useful growth. To moisten any moss when the temperature is above 25-30°C will damage or weaken it, though mosses that are already moist and growing may continue to grow, apparently happily, in temperatures as high as 35°C. Unless they can grow, repeated wetting and drying are more stressful than remaining dormant. The higher the temperature, the more stressful it is.

That, at least, is my general impression. A moss or hepatic that is damaged, as by crushing or cutting, or by exposure to harmful chemicals (such as bleach), or by being moistened when too warm, or after a damaging drought, will usually give off a characteristic smell. I do not know the cause, save that it is obviously the smell of some substance which is bound inside a healthy plant, but which escapes from an stressed one. I take it as a sign that the plant is being stressed or damaged.

In September or October, regular watering became worthwhile for these exposed plants. They were, and are, still mostly covered with polythene, and kept almost continuously moist until next March or so, with little or no direct sunshine to dry them out. Early autumn is a good time for replanting those which have not been growing well. The plants on these top shelves were at their most interesting in the darkest part of the winter.

Parts of some lower shelves got diffuse sunshine. Until the lime trees were felled, some shelves were too dark in summer for any except the most shade-tolerant species. In particular, there are very few mosses which tolerate a combination of waterlogged conditions, deep shade, and high temperatures. The combination of poor light and high temperatures, especially high night-time temperatures, seems lethal to many mosses and hepatics. It is a central problem in growing some of the most "difficult" ones, and is worth discussing, since it has a wider horticultural importance.

All normal plants fix carbon by photosynthesis. There is an optimum temperature range for photosynthesis. Few plants can fix much carbon at below 5., though they include most mosses. Most grow best at temperatures above 10°C. Many plants, especially tropical ones, use a form of photosynthesis which works best above about 16°C. On the other hand, plants lose carbon by respiration. The loss increases with temperature. There is therefore, for any species of plant, a best daytime temperature for growth, a temperature at which it gains most carbon. Above this best temperature, carbon loss increases. If it gets too hot, the carbon loss exceeds the gain, and the plant cannot grow at all, however good the conditions are otherwise. This best temperature varies between

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species. Obviously, it is likely to be higher for tropical plants than for arctic and alpine ones.

Net growth is the difference between carbon loss and carbon gain. A plant growing in inadequate light will gain less carbon through photosynthesis, and is therefore less tolerant of high temperatures. The plants which are best adapted to a combination of poor light and high temperatures are those of tropical forests. It is perhaps no coincidence that most successful house plants come from such habitats, since they evolved to cope with the same combination of conditions as is found in most buildings.

At the other extreme are plants of strongly lit cold habitats. They obviously include many alpiners. The small alpine cactus, *Pediocactus simpsonii*, from the high mountains of Colorado, long had a reputation as ungrowable. No combination of compost or watering could be found which would prevent it from wasting away in England, until an enterprising cactus grower took four plants, grew two normally, and put the other two in a refrigerator each night for a summer season. Unlike the controls, they gained weight and flourished.

Many mosses seem to have an optimum temperature for growth at around 10-15°C., but seem less troubled by hot days than by warm nights, during which time carbon loss presumably continues. Also, unlike cacti, an entire moss plant can become desiccated and inert. In this state, many mosses, even Arctic and alpine ones, can stand temperatures that would be lethal to most flowering plants. However, after growing well in spring, and not suffering too much in hot June weather, mosses may languish or go mouldy in late summer. The worst weather for them is warm and overcast, with high night-time temperatures. The plants most affected have been those with a northern or alpine distribution, plants which cannot be dried out and left dormant in summer, and especially plants of cold watery habitats, mountain streamsides and so on. Some are mosses, but most of these problems have been alpine hepatics. Some were discussed in the chapter on mountain mosses.

A preoccupation of many greenhouse owners is to keep things warm in winter. The mosses have always been unheated. They freeze when outside temperatures go below about -2°C, usually get chilled to -5°C most winters, and have been as cold as -13°C. One rare *Sphagnum* from NW Scotland, *S. strictum*, may once have been damaged. The astonishing thing is that I have seen no other obvious damage to mosses from frost, not even to the many tropical ones. With hepatics, the position is not so clear. Many *Marchantias* and their relatives are hardy, but may show marks on their thalli after frost, which seems to check their growth. *Pellia epiphylla* and *Riccardias* seem unaffected by cold, but some hepatics of similar appearance, such as the erect frondose *Pallavicinia xiphoides* from New Zealand have become quite miserable after a severe winter. The related genus *Moerckia* has thin translucent thalli with a thicker midrib. It is a warm-temperate genus with few British species, and does not like severe winters. Strangely, there is a very striking species *M. blyttii* with a crisped and curly thallus, which is almost confined to Scottish snow patch vegetation. I lost my first culture of this species one winter, in a way which suggested frost damage. In habitat it is of course covered by deep snow for most of the year. *Anthoceros*, a strange genus of thalloid hepatics, tend to disappear in cold winters, though some species are British natives. They re-appear in spring, and grow best in warm summer weather. On the other hand, in midsummer 1992 I put two cultures of Scottish snow patch plants into a freezer at -15°C. They were being overrun by weedy mosses and hepatics. They were pretty thoroughly destroyed by the sudden freezing, mosses as well, but out of the dead mush emerged some surviving shoots of a high alpine *Marsupella*.

A small greenhouse at Reading University is devoted to mosses and liverworts, especially *Marchantias*. It is warmed enough in winter to keep out frost, and the *Marchantias* seem to grow better for it. I would suggest that anyone growing similar plants on any scale might consider treating them likewise.

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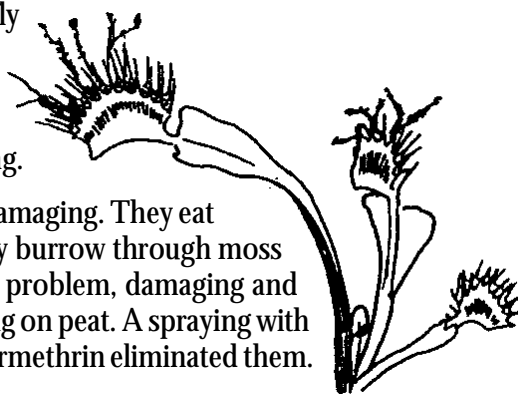
For mosses, frost is not a problem.

Anyone who maintains a large plant collection must be concerned about weeds, pests and diseases. I have encountered no obvious diseases peculiar to mosses and liverworts. In warm weather, cultures may go mouldy. This is perhaps the most obvious problem. The damage can be sudden and fatal, but moulds are very delicate, and can usually be checked or stopped, either by drying out the plant completely, or by spraying it thoroughly, and if possible, moving it to a cooler or better-lit place. If that fails, try replanting, or await cooler weather, and watch for recovery.

Few mosses or hepatics are nutritious. Most seem to contain repellent chemicals, and are rarely eaten. I have watched tiny springtails apparently nibbling moss protonema. Woodlice can build up large populations in a damp greenhouse, and may then devastate certain plants. I have used a variety of insecticides against them, but have not yet found one which damages mosses, nor one which is effective against woodlice for more than a short time. Rather than soak the plants in noxious chemicals, it is pleasanter and more effective to keep the greenhouse and plants clean and well swept, and to trap and evict straggling woodlice. Slugs and snails make a mess, but rarely damage these plants, and only eat young shoots or setae. I once left a set of herbarium packets on a shelf in the mosshouse. Hungry snails, finding no normal plants to eat, devoured the paper packets, but left the unpalatable mossy contents alone. The cure seems to be the hedgehog which visited one summer. There were hardly any snails in the garden or greenhouse next season.

More troublesome are insects whose larvae eat humus or moss. If there is a piece of old shaded tarmac or cement nearby, watch it over a season. A cover of mosses will develop, but there will come a time, probably in autumn, when it disintegrates as burrowing larvae eat away the rhizoids. Birds will then turn over the tufts to eat the larvae or get nesting materials, and the messy remains will provide nutrients for the next moss crop. Mosses grown outdoors eventually suffer a similar fate, though birds at least can be kept off, with netting. The most obvious insects which have bred in this collection have been midges, craneflies, and small moths. Their larvae live in wet soil.

Pots containing peat can be half-emptied by cranefly larvae, which eat peat and humus, though the plants growing in it are not directly harmed. Incidentally, Venus Flytrap [*Dionaea*] plants catch adult craneflies very effectively. Their legs stick out. It is quite disgusting.



Other larvae, probably of moths, have been far more damaging. They eat decaying material, but may spread fungus decay as they burrow through moss tufts. Between 1987 and 1989 they were an increasing problem, damaging and destroying many healthy plants, especially those growing on peat. A spraying with a long-lasting insecticide containing dimethoate and permethrin eliminated them.

Midges persisted, as proof that there was something in the greenhouse environment to remind the many Scottish mosses of their origins. Midge larvae have disrupted some cultures, especially of hepatics, making them go mouldy. Sometimes the flying adults got swatted or sprayed with fly-killer, in a rather ineffective way. Dry or mounted cultures, and those covered with polythene, were less likely to be troubled by them. Apart from the Venus Flytraps *Dionaea muscipula*, butterworts [*Pinguicula*] and sundews [*Drosera*], especially the long-leaved *D. capensis*, used to catch lots of small insects, and seemed to be a useful control measure, flourishing among the *Sphagnum*. Another greenhouse I knew, containing mosses and liverworts, also bred midges, whose larvae caused similar damage, destroying some cultures. These problems hardly affected most of my collection, since mounted cultures contained little or no soil, and dried out faster, offering far less

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scope for these unwanted insects to lurk or to breed. Also, polythene sheets draped over parts of the collection made it harder for airborne insects to get to the plants underneath.

Traditional greenhouse pests, greenfly, whitefly, mealy bugs, and so on, are irrelevant to a moss grower. Incidentally, I am familiar with them among my cacti and succulents, but find that regular vigorous spraying with plain water, of the kind mosses enjoy, so discourages and damages these familiar greenhouse pests that no insecticides are necessary. It is a very simple and obvious idea, to simulate natural rainfall by spraying plants, rather than by tipping water on the soil around them. Yet like other ideas which arise in trying to grow mosses, it has a wider usefulness.

As for weeds; It can be quite difficult to establish a pure culture of any one moss. Anyway, there is usually not much point in it. So long as conditions are right for the plant which is intended, it should hold its own against competitors, with one reservation – that many mosses are quite short-lived. Ephemerals may have a life cycle measured in weeks, which is why they are the hardest to keep for a long time. Many others languish unless given fresh soil every year or so. Replanting is an opportunity to pull out and discard unwanted species. In cultures on waterlogged soil, things can also happen quite fast, and some species, especially *Marchantias* and *Bryums*, can be very invasive, completely covering them within a few months. It is often worth weeding out the unwanted plant with tweezers. The exact technique depends on the species involved, but invaders can rarely be exterminated in this way. At worst, the desired plant can almost always be refound, and a new clean culture started. Once again, the invader will often reappear, but so long as the desired plant has some room to grow, it is rarely lost.

The worst invaders, in the experience of other moss growers, are *Marchantias*, whose gemmae are easily splashed around, and overwhelm everything. Once they get onto wet fertile soil, they are very hard to eliminate. They only grown in the small minority of my cultures which are on wet neutral soil, and are rarely a nuisance. In an interesting reversal of this situation, some of my *Marchantias* have at times been overrun by tiny *Cephaloziellas*. On the other hand, many mosses, especially those of sunny dry ground, kept in dry conditions, and mosses and hepatics of trees and rocks, when grown on mounted cultures, can persist, unchallenged by invaders for many years, so long as the conditions are as dry and low in nutrients as in habitat. Any invaders of such cultures (*Bryums* are commonest) can be pulled out with tweezers.

More troublesome weeds are algae. A test-tube culture contaminated by algae is eventually doomed, yet algae are everywhere, and it is not possible to make any greenhouse culture without them.

Filamentous algae make long green threads, which soon form a dense mat. Only vigorous shoots of larger mosses can struggle though it. These algae are rather sporadic, and only grow on a few cultures, on wet neutral or lime-rich soil containing plenty of nutrients. They will not, for instance, grow on peat. They are very easily killed by drying, but a mat of dead algae is not much of an improvement on the live ones. Sometimes the mat can be lifted off or broken up, leaving the moss with fresh soil to colonise, sometimes moss shoots must be extracted and put onto fresh soil, preferably a soil lower in nutrients. These algae are not toxic, and do not directly kill mosses or liverworts. Many mosses lift their shoots clear of the enveloping gunge, or even grow underneath it. I have often left some to battle on unaided.

Single-celled algae, especially blue-green ones, are also everywhere. They are especially vigorous on chalk and limestone. They re-appear after drought, but take a long time to get going again, so in frequently dry cultures they are less of a nuisance. Lime-rich or nutrient-rich cultures, even mounted cultures, if they are continuously wet for a few weeks, are often discoloured by them, and many mosses which can spread rapidly on fresh soil fail to go on doing so after a time. It is probable that

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some algae, especially blue-green ones, discourage competitors by chemical means. For this reason, a moss that is not spreading on an alga-contaminated culture will often benefit from replanting. Also, a culture covered in clingfilm has a very limited life, as little as a couple of weeks, before algae spread across it. However a pot of soil can be enough to break up the soil surface and wash away most of the algae, allowing the moss to go on spreading. Clay pots, especially if usually damp, soon develop a green film of algae or accumulated lime around the rim. This too is worth scrubbing off occasionally with a wet thumb or an old toothbrush, or the plant put in a clean pot, if only for appearance's sake. This can a time-consuming task.

On the other hand, all mosses must compete to some extent with algae, and some grow quite successfully in cultures covered with them. The gelatinous algae which form rubbery translucent olive-green lumps on limestone or chalk soil, often appear in suitable cultures. They are more of a curiosity than a nuisance. The algae in this collection might be as varied and interesting as the mosses, but I know very little about them.

Rather rarely, I even have trouble with lichens, though most lichens are more difficult to grow than mosses. A *Cladonia*, probably *C. pocillum*, sometimes spreads over mosses on well-drained basic soil on the top shelves. Small *Collemas* can be grown, and have appeared uninvited on intermittently wet chalk or clay, and on mounted limestone cultures. These are more of a curiosity than a nuisance, though they can discourage mosses. Some *Cladonias*, *Collemas* and other large lichens, especially *Peltigeras*, can be grown in a similar way to mosses, but that is another subject.

Another basic problem can be to recognise the species one is actually trying to grow, and it can be a real problem. Just as a helpful child who does not know the difference between chickweed and Dahlias can wreak havoc when weeding a garden, so a person who cannot distinguish immature shoots of difficult-to-name mosses will never be confident of keeping them. In flower pots of soil, I have sometimes found myself growing the wrong species – of *Bryum* and *Dicranella* especially. On mounted cultures, this is much less of a problem. Far commoner is the basic problem, familiar to all bryologists, of not being able to identify what you collected in the first place. But then, of course, the plants that cannot be named are often the most interesting.

There is one very good reason for not even trying to make pure cultures of freshly collected plants. Many mosses and hepatics have an remarkable affinity for a particular habitat. Where one unusual plant is found, there will often be others. If the main species grows well, its original associates will probably survive as well. Many of my own cultures contain several species from the original habitat. Some were not noticed when collecting, and were only discovered as long as ten years after. Sometimes these are more interesting than the main plant. It is worthwhile to deliberately mix and cross-culture mosses from the same site in a way which would be impractical with larger plants. In this way, any one species is far less likely to be lost completely, and can be observed growing in different cultures, interacting with other species, and under a range of conditions. Much of what I have learnt about growing these plants has come from seeing things survive or grow where they were not expected. Nevertheless, unwanted mosses and hepatics will overrun many cultures, perhaps, in time, most of them. Never despair. Even if 99.9% of a culture is dead, or is of the wrong species, the desired plant can almost always be refound. Be prepared to use a good lens to search for it, and a pair of tweezers, to remove and replant any possible surviving shoots.

In the 1970s I wrote to many people, and discovered only about a dozen collections of live mosses and hepatics, worldwide. Most belonged to professional botanists, and most, though not all, were in highly artificial surroundings, in test-tubes or growth chambers. Even so, I was surprised at the diversity of these few collections. Another surprising and embarrassing thing was that some of these

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people generously sent me new and fascinating plants, which they had in some cases grown successfully for many years – and that some of those plants died as soon as I got them. That does not mean that bryophytes are especially temperamental, for many gardeners have had similar experiences. A plant that flourishes for one grower will often inexplicably die in the hands of another. It is a reminder that a collection of plants, just like the collection of objects in a house, reflects the personality of its owner, both in the choice of plants, and in the way they are treated.

The only other group of plants I have grown on any scale are cacti and succulents. Many other people grow them, and in comparing collections, I note many differences between one collection and another, and between my own efforts and those of other people. Likewise, other people who grow mosses and hepatics may discover quite different methods that work better for them, and report quite different results. Also, in other parts of the country, and especially in the wetter and cooler North, many of these plants would probably behave quite differently in cultivation.

There are many pieces of equipment available from horticultural suppliers, some of them unavailable a few years ago, which might be worth trying. The most interesting is probably mist propagating equipment. I have not been tempted to use it, partly because it is expensive, but mainly because hard tapwater is so obviously unsuitable for most mosses. Also, even soft tapwater may be contaminated by copper or other substances harmful to mosses, dissolved from the supply pipes. There is also the thought that any collection that relies on high-tech equipment may face disaster – should that equipment fail. Nevertheless, I have seen some fine large pleurocarps grown under a mist propagator.

There is probably no other group of plants about whose cultivation so little is known, or which offers so much scope for experiment. And there can be few other groups of plants which an enthusiast can so easily see in their natural habitats. It is not that too few people are interested in them. I have sometimes found, in casual conversation, that someone admits to having tried to make and keep a moss garden, usually in a jamjar or a saucer. Many children are fascinated by the world of minibeasts and tiny plants which is revealed by a good lens. Yet these interests too rarely develop into a more sustained interest in mosses, let alone an interest in growing them.

While many orchid or succulent lovers can only daydream about visiting distant lands and seeing their plants growing wild, a couple of dozen mosses, including some quite interesting ones, can be found, even in central London. It is not of course that central London is an especially exciting place for plant hunters, nor that distant lands are not worth visiting. It is, rather, that an interest in wild plants, or in any other branch of natural history, is an incentive to visit, to look at, and to enjoy places and landscapes. I doubt if there is any other group of British plants, the study of which could draw a student to visit a greater variety of extraordinary and sometimes beautiful places.

Some botanists, when they visit places of interest, bring home herbarium specimens of their plants, some notebooks, and some photographs – while some are content with only memories. I hope this handbook shows that, if it is done responsibly and intelligently, any serious student of mosses can do something even more worthwhile. He, or she, can keep and make as many photographs, as many herbarium specimens and notebook entries as desired. But best of all, it is possible to bring back, to keep – and to study, propagate and enjoy – the living plants.

Nevertheless, the idea that mosses are unreasonably difficult or impossible to keep alive, or to grow, has not been fully dispelled, even now. It is a false idea. If not before, during all the years between 1966 and 1996, as I built up this unique collection, my experience from 1996 to 2,003 has given a dramatic and extraordinary demonstration of just how hardy and persistent these tiny plants can be.

Postscript: Spring 2003

The first edition of this book was published in 1986. I printed 500 copies myself, and sold mainly to members of the British Bryological Society. By 1994, almost all had been sold, and I prepared a second edition. This postscript may perhaps serve as an apology to those who ordered a copy, of it, and who were disappointed.

The mid-nineties was an exciting time, bryologically. I had recently gathered – in some cases under Nature conservancy license – some of the rarest, most endangered and most spectacular of British mosses, notably *Thamnobryum angustifolium*, *Bryum schleicheri* var. *latifolium*, and *Thamnobryum cataractarum*, and had been sent other new species of outstanding interest, notably *Zygodon conoideus* v. *lingulatus*, a new British discovery, and *Paludella squarrosa*, long thought extinct in Britain, but recently refound at a new site. Also, the two huge lime trees which had overshadowed the mosshouse were felled in 1995, and I could at last look forward to it receiving sufficient light in the summer and autumn, to support better growth of the mosses inside it.

As a cactus grower, I had always been aware of the many other specialist societies, whose members far exceeded the number of active bryologists, and most of whom have always grown the plants that interested them. It was – and remains – my belief, that many more people would take an interest in mosses, that they would be more widely studied, and that their conservation would be more effectively achieved, were a tradition ever to become established of growing them, as I had long been doing.

Printing of the second edition of this book had been almost completed – sufficient to provide a hundred or so copies, at least, by the end of 1995, and I began by bringing them to the attention of the Hardy Plant society, and the Alpine Garden Society. The book was reviewed positively, and a few orders were received.

Then disaster struck.

In the Spring of 1996, I was becoming increasingly absent-minded and erratic. In June, I was diagnosed as having a brain tumour, and spent six months in hospital. I was not, for a time, expected to survive, but was sent home, half blind and helpless, in December that year.

I have no clear memories of the time between 1995 and 2000, but it is plain that during those years I was unable to do anything useful in the garden or elsewhere, nor to tend the moss collection. My wife rang the late Dr Watson, formerly of Reading university, who had long shown an interest in this collection. “*What shall I do with them all?*” she asked. “*Keep on watering them*” was his advice.

It was a forlorn task for a wife who had far more urgent preoccupations. It was also a hopeless task, for I had been unable to arrange any shading for the moss house since the year after the lime trees had been removed. For the next three years, they received the full force of the summer sun, with no ventilation or shading.

In the spring of 2000, I remember beginning to look in the mosshouse. I managed to replace a missing pane of glass, and to put up some shading. During that summer, I began to water the plants. I also remember a max.-min. thermometer hanging below an upper shelf, but not in direct sunshine, which had not been reset for some years. It had recorded a maximum of 182°F. (83°C.) Many seed trays and flower pots on the top south shelf, exposed to the full force of the sun, had become even hotter than this, and the plastic had been melted and deformed by the heat.

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The mosses were, of course, in a sad condition. In 2001 I attempted to re-catalogue and replant all the survivors, but made little progress. However, a few new collections were made, and despite my damaged eyesight, I became aware that the moss flora of Reading had continued to change, and to improve. Some interesting *Brachythecium*s and epiphytes were refound, even around my home near the town centre.

In January 2002, having sold our Reading home, we moved to Frome, in Somerset. For two months, the mosses in their flower pots and seed trays were spread over the new lawn and garden, some of them covered with polythene. In March, they were put into their new and present home.

They are now in an aluminum greenhouse like the one in Reading, but set out on modular plastic shelves. They are in every way better situated than before, on the open north side of a tall hedge of *Cupressus macrocarpa*, which provides complete shade for 8 months of the year. That curse of suburbia has its uses! Summer shading in 2002 was like that in Reading, but a Norway maple to the east provided shade on summer mornings. The summer temperatures, by day and, more especially, by night, are lower here than in central Reading, the winters milder, rainfall and humidity are higher, and air pollution much lower. Fine large *Orthotrichum* species grow on trees nearby. The plants have responded dramatically. For the first time, in 2002, I kept almost all of them moist and growing throughout the summer, covered in polythene, and watered, as before, with a pump-up spray filled from a new water butt by the house. They started, or went on growing, all summer. In that autumn, I also re-catalogued the survivors, and started giving individual attention, replanting, etc., to the many that needed it. Growth continued in the winter, better than in previous years. Many plants, once feared lost, have now re-appeared, and the rarities collected or given in 1995, and mentioned above, all survive, though at present some are in very small quantity,

In March I went with a group from Headway, the association for people with brain injuries, to Florida. It was not a botanical excursion, and several of our party were wheelchair-bound, but even around the hotels and tourist sites, some mosses and a few hepatics could be found, mostly on trees. They have flourished in culture, their large green tufts providing a striking contrast to the surviving fragments in many of the older cultures around them.

Eventually I shall put some bryological material, including my accession catalogue and an up-to-date census of the living plants, on my website, also a list of species of interest, mostly hepatics, which have been lost, and which I would like to grow again. I hope to regain sufficient health, for a few years at least, to restore the collection, and to enjoy tending it.

More important, my experience gives a dramatic warning of the dangers and shortcomings of relying on private collections for the long-term conservation of rare or endangered plants. I believe that a permanent, comprehensive, living collection of bryophytes – especially British ones – should be set up at an institution where the public can see them, where the interest of plantmen and -women may be aroused by them, where methods of caring for them and propagating them can be refined and publicized, and where continuity of care can be assured for rare or endangered species, and for historic cultures.

I would be glad to assist with such a project in any way I can, and to make my own plants available, to help set it up.

List of pictures

The small drawings are not intended as botanical illustrations, nor to show all the details needed for firm identification of the species. In combination with the text, they may give a fair idea of the appearance of a typical mature shoot, as seen through a good lens.

Very small plants are shown enclosed in a circle, as they might appear through a good $\times 20$ lens or through a low power of a microscope.

By each name is given the page number and position of the illustration, and an approximate magnification. Please note this is a linear magnification, thus " $\times 2$ " indicates that lengths have been doubled, and shows the plant as it would appear under a $\times 4$ lens ($4=2\times 2$), $\times 3$, as under a $\times 9$ lens and so on.

- Abietinella abietina* 31 left, $\times 2$
Anastrepta orcadensis 60 right, $\times 3$
Atrichum undulatum 10 right, $\times 1$
Aulacomnium androgynum 38 left, \times
Bazzania trilobata 56, $\times 2$
Barbula convoluta 14 top right
B. unguiculata 14 top left
These are both about $\times 2$ but *Barbula*s vary greatly in size. Smaller plants are common.
Brachythecium rutabulum 12 right. About $\times 2$ but there is some variation in size, and much variation in overall appearance and colour.
Bryum argenteum 18, $\times 4$
B. capillare 28 left, $\times 2$. Some forms, especially in wet hilly areas, can be much larger.
B. dichotomum 15 left
B. subapiculatum 15 right
B. rubens 15 middle. These 3 species are also shown on back cover: About $\times 4$.
Calliergonella cuspidata 13 middle, $\times 2$
Calypogeia fissa 23 below, $\times 2-3$
Cephalozia bicuspidata 24 left, $\times 3$
Ceratodon purpureus 19, 26, $\times 2$. The leaves vary greatly in length, depending on the habitat, but their width is fairly constant
Cinclidotus fontinaloides 49 left, $\times 1$. Underwater stems may be much longer than shown.
Dicranum majus 19 below, $\times 1$
D. scoparium 20 right, $\times 1$, but much smaller forms are also common.
Didymodon fallax 14 bottom right
D. insulanus 14 bottom left
These are both about $\times 2$ but *Didymodon*s vary greatly in size. Smaller plants are common.
Diplophyllum albicans 23 right, $\times 2$
Encalypta streptocarpa 32 right, $\times 3$
Eurhynchium confertum 13 below, $\times 2$
Fissidens bryoides 15 left, $\times 2$
Fissidens taxifolius 15 right, $\times 2$
Fontinalis antipyretica 49 right, $\times 1$
Frullania dilatata 50, $\times 2$
F. tamarisci 50 above, $\times 2$
Funaria hygrometrica 16 above, right $\times 3$
Grimmia pulvinata 27, $\times 3$
Herbertus hutchinsiae 60. A shoot tip only is shown, $\times 3$. It forms large left. tufts in which individual stems may be several inches long.
Homalothecium lutescens 31 right
H. sericeum 29. Both about $\times 3$. The second species may be larger.
Hylocomium splendens 25, $\times 1$
Hypnum cupressiforme 21 left, medium form $\times 2$
Isoetecium myosuroides 21 right, $\times 2$
Kindbergia praelonga 12 left, main shoot, $\times 2$
Leiocolea turbinata 33, $\times 10$
Lejeunea ulicina 51, $\times 8$
Lepidozia reptans 23 left, $\times 3$
Leptobryum pyriforme 16, 16 left, $\times 2$
Lophocolea heterophylla 22, $\times 3$
Lophozia ventricosa 23 $\times 3$
Lunularia cruciata 2 right, $\times 1$
Marchantia polymorpha male 2 left, $\times 1$, male

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- & female inflorescences 3, ×1
Marsupella emarginata 58 large shoots ×2-3.
Much smaller forms are common. .
Metzgeria furcata 50, ×2
Mylia taylorii 60 middle, ×2
Nardia scalaris 60 right, ×3
Neckera crispa 51, ×1
Orthotrichum diaphanum 27 ×3-4
Plagiochila asplenioides 55 left, ×3
P. spinulosa 55 right, ×3
Plagiomnium undulatum 10 right, ×1
Pleurozium schreberi 21, ×1
Pohlia annotina or similar species 38, ×3-4
Phascum cuspidatum 16 below left, ×4. Plants
often have a more long pointed leaf
Polytrichum juniperinum 8 right.
P. piliferum 8 left. Both ×1. Stems, especially
cf P. juniperinum, may be longer.
Porella platyphylla 32 left, ×2

Rhytidiadelphus squarrosus 13 left, ×2
R. triquetrus 31 left, ×2
Schistidium apocarpum 28 right, ×3

Seligeria sp. 32, ×10
Syntrichia laevipila 48 left
Syntrichia papillosa 48 right
Tetraphis pellucida 38 right, ×4
Thuidium tamariscinum 31 right: A small
frond, ×2. Larger ones may be several
inches long, and up to an inch wide.
Tortella tortuosa 33 right, ×2. Tufts of this
plant are often 2-3 inches across.
T. flavovirens 33 left
Tortula latifolia 49, ×2-3,
T. muralis 26 right, ×2
T. truncata 16 below right, ×3. Another
species, almost equally common, is T.
davalliana, which is very similar, but
about half the size.
Trichostomum brachydontium 33 middle
×3-4. In inland areas it is rare and only
small stunted shoots may be found.
Ulota bruchii or crispa 48, ×2 or ×3. Of these
two very similar spp., U. crispa tends to
be slightly smaller.

[the magnifications above, applied to the reproduction in the 1991 (185 × 130 mm) edition, and might be expected to be roughly ×1.4 more in this A4 version]

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Useful books

R. Phillips; Grasses, ferns, mosses and lichens of Great Britain and Ireland. 1980, pub. Ward Lock, then Pan Books and Macmillan, £16.99 paperback.

Only a small part of this book is devoted to mosses and hepatics, and there is little text. Nevertheless the superb photographs of over 200 species should stimulate an interest, and greatly help in naming plants. An excellent buy for a beginner.

E.V. Watson; British Mosses and Liverworts. 1981, 3rd edition, pub. Oxford University Press, £40.00 paperback.

An essential book for all bryologists. Though not a complete flora of the British Isles, it fully describes all except extremely rare or critical species. The many line drawings make this a pleasant and accessible book to use in finding and identifying plants.

H.N. Dixon; The Student's Handbook of British mosses. 3rd edition, 1924, reprinted 1954, pub. Sumfield & Day, £2 10s 0d hardback (OP).

For most of the last century this has been the definitive work. Though rather out of date, much of it remains usable, and it is far cheaper than more recent floras.

A.J.E Smith; The Moss Flora of Britain and Ireland. 2nd edition, 2004, £120 hardback, also available in paperback, and

A.J.E Smith; The Liverworts of Britain and Ireland. 1990, £45.00 hardback

Both published by Cambridge University Press,

Very comprehensive and up-to-date works.

J.A. Paton; The Liverwort Flora of the British Isles. 1999, pub. Harley Books, £60 hardback..

Very comprehensive and up-to-date work.

Suppliers

For greenhouses, staging, propagators, horticultural lights, humidity chambers, mist propagator equipment, etc.,

Two Wests and Elliot;

Unit 4, Carnwood Rd., Sheepbridge Industrial Estate,

Chesterfield,

Derbyshire S419RH.

Most general horticultural supplies, as suggested in this handbook, can be found in garden centres, hardware shops etc. However the smaller sizes of clay pots (under 3") which I have found so useful, are hard to come by. I have been unable to find a reliable supplier, and have relied largely in heirlooms and gifts.

Sphagnum peat and washed builders' sand are useful, but commercial composts are likely to be too nutrient-rich for most mosses. Soil is best collected, in small amounts, from semi-natural sites rather than from cultivated fields or gardens. Apart from the top layer, which can be discarded, such soil is usually fairly free from seeds and spores of unwanted plants.

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A good quality $\times 10$ or $\times 20$ handlens is essential for enjoying and studying these small plants. A beginner should start by getting one, even though they may be hard to find in a local shop.

Mosses and hepatics make easy and rewarding subjects for microscopic study. A good quality $\times 100$ is sufficient to show all the details of leaf, stem and cell structure, normally needed for accurate identification. Even children's toy/educational microscopes may prove useful to beginners for a time at least and at a fraction of the cost of a more substantial instrument.

For microscopes, lenses, test-tubes, tweezers, and all kinds of equipment for botanists and naturalists;

Bio Science Supplies

14 Long Mill, North Wednesfield, Wolverhampton, W. Midlands WV11 1JD

Bio Science supplies have some botanical textbooks also in stock, including the main reference books mentioned above.

For microscopes, lenses and accessories;

Hampshire Micro,

Oxford Rd. Sutton Scotney, Winchester, Hants, S021 3JG

Societies

The National Council for the Conservation of Plants and Gardens, at The Pines, Wisley Gardens, Woking, Surrey GU 23 6QB, encourages the conservation of endangered plants, mostly horticultural forms and varieties in private collections, by the systematic exchange of plants and information. This organisation should interest anyone who owns living collections of historic interest or potential scientific value.

All students of these plants will wish to become members of the British Bryological Society.

Membership secretary; Mark Pool,

91 Warbro Road, Babbacombe, Torquay, Devon, TQ1 3PS

Annual subscription £20.00

Members receive each year two volumes of the scientific publication, the "Journal of Bryology", and two informal bulletins. Field meetings are held in the Easter and summer holidays, and weekend meetings, combining field work with lectures, or with the study of particular topics, are held in the autumn.

I acknowledge the help and encouragement of many members of the British Bryological Society over the years, Without that help it would hardly have been possible to pursue an interest in these plants. I acknowledge comments on this book by Mr. A. R. Perry, of Cardiff.

Moss Grower's Handbook

[this page updated from original back cover of 1991 printed edition]

There are over 1,000 species of mosses and hepatics the British Isles, and over 15,000 worldwide.

Though mostly small, they are the most fascinating and diverse of all plants. They have adapted to virtually every land habitat on earth.

Despite their interest and variety, very few people have ever made a serious attempt to grow mosses or hepatics. This handbook mentions about 300 kinds, and contains illustrations of 110 common and conspicuous ones. It also gives ideas and techniques for growing and propagating almost all the British flora, something which has never been attempted before.

Though often novel, these ideas can be applied to many other plants hitherto unknown in cultivation or considered difficult to grow. They are all within the scope of any keen amateur gardener or plant lover, and need no special equipment or training.



£4.00

ISBN 0 9517176 0 X