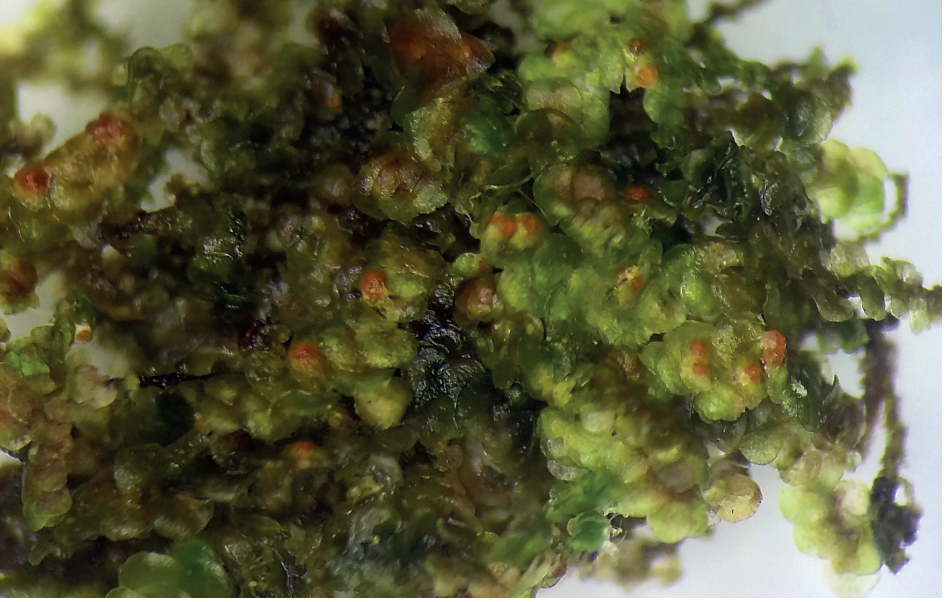
A brief introduction to bryophilous fungi in Britain and Ireland

George Greiff invites us to consider the fascinating microfungi associated with bryophytes

Bryophytes are often considered to be plants with almost supernatural abilities to resist colonisation and infection by other organisms. This misconception results in naturalists regarding mosses and liverworts in relative isolation and has led to the neglect of suites of interesting bryophilous organisms, particularly microfungi. Despite the large number of highly experienced bryologists in Britain and Ireland, very few have dared to consider the specialised and bizarre saprophytic and parasitic fungi associated with bryophytes. This article has been written with the aim of encouraging bryologists to consider these tiny fungi, and perhaps to even begin to record them.

Most fungi associated with bryophytes are ascomycetes. This diverse group of fungi includes the familiar *Sarcoscypha austriaca* (Scarlet Elf Cup) and *Chlorociboria aeruginascens* (Green Elf Cup). Many moulds, such as the infamous 'Black Mould' of damp houses, *Sachybotrys* spp., and many plant pathogens (including *Hymenoscyphus fraxineus*, Ash Dieback) also fall into this group. What unifies all of these fungi is the fact that they have a stage in their life-cycle in which they form spores in little sacs termed asci. Most of these asci contain eight ascospores and the asci may be surrounded by sterile filaments called paraphyses. All of these structures are microscopic. The fruitbodies of most bryophilous fungi are very small in comparison to the species mentioned above, with most being completely undetectable in the field. Although this makes bryophilous fungi relatively difficult to work with, it is fascinating to consider their remarkable adaptations and microniches on their hosts.

△Fig. 1. *Lizonia emperigonia* on *Polytrichum commune*, infecting the antheridial cups and turning them black. When examined with a hand lens, the individual perithecia (fruiting bodies containing asci) can be seen. All photos by G.R.L. Greiff.



◁Fig. 2. *Bryocentria brongniartii* forming orange spots on host *Frullania dilatata*.

Fig. 3. *Periantria frullaniae* in a perianth of *Frullania dilatata* with a fruitbody perforating through the perianth wall to shoot out its spores.

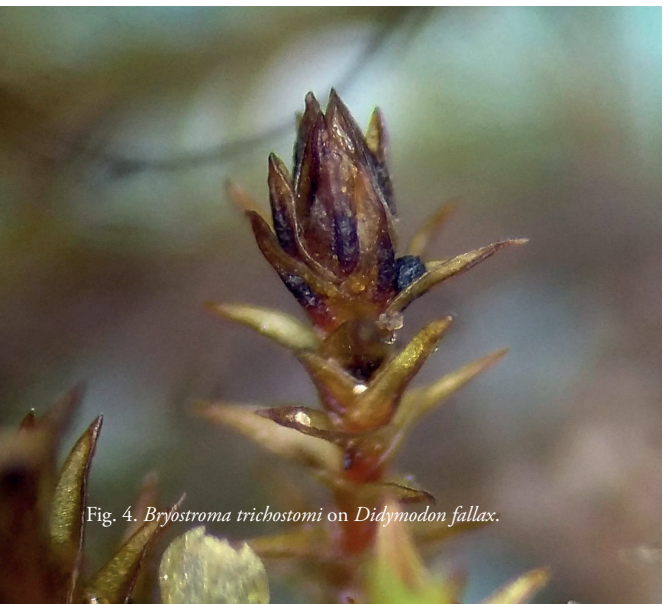


Fig. 4. *Bryostroma trichostomi* on *Didymodon fallax*.

Bryophilous fungi appear to be more common than bryologists expect. Many are host-specific, so bryologists could be considered better equipped to work on them rather than traditional mycologists. The frequent leafy liverwort *Frullania dilatata* has at least ten bryophilous ascomycetes that may be associated with it, some of which are highly specialised and host-specific (Döbbeler, 2006; Fig. 2). Perhaps the most remarkable of these is the fungus *Periantria frullaniae* which colonises only the perianths of the host, devouring them from within before boring holes through the warty perianth wall to shoot out its spores into the air (Fig. 3). Another interesting species on *F. dilatata* is *Bryonectria callicarpa*, which only grows on the undersides of large mats of the host.

It is generally more difficult to notice microfungi on mosses than on liverworts as the former are often more three-dimensional. *Bryostroma trichostomi* is an occasional colonist of several species in the Pottiaceae, forming relatively large, solitary fruitbodies in the leaf axils of host plants (Fig. 4). Some bryophilous fungi have even more surprising microniches. The minute fruitbodies of *Bryomyces microcarpus* may develop between the toothed hyaline hairpoints of *Racomitrium lanuginosum* (Fig. 5), and a diverse array of species, including *Potriphila navicularis*, are frequently found growing between the lamellae of the leaves of Polytrichaceae (Fig. 6). Species in the genus *Lizonia* also infect Polytrichaceae,

▷Fig. 5. *Bryomyces microcarpus* var. *rhacomitrii* on a leaf of *Racomitrium lanuginosum*. Hyphae and fruitbodies are visible.

often growing inside the antheridial cups of male plants and turning them black (Fig. 1). A variety of macroscopic, vividly orange Pezizales colonise the rhizoids (and rarely persistent protonemata) of bryophytes and may be found on the soil alongside, appearing to be free-living. Most of these are highly host-specific; for example, *Lamprospora hispanica* on *Aloina* species and *Octospora itzerottii* on *Pterygoneurum ovatum* (Fig. 7).

As well as including a range of diverse species, bryophilous fungi have diverse modes of nutrition. Saprotrophs live on decaying organic matter and most of those that are able to colonise bryophytes are very poorly known, partly because some may be able to decompose vascular plants as well. Many of these obscure species are found on the old sporophytes of various mosses. *Leptochlamys thecicola* appears to be common, particularly on Polytrichacean sporophytes. Other species, such as *Bryocentria* spp., are necrotrophs that kill their hosts during successful colonisation (Nordén *et al.*, 2015). These may be conspicuous in the field as they form obvious, radiating necrotic patches, particularly on epiphytic liverworts (Fig. 8). A great number of fungal associates, however, appear to be biotrophic. These species colonise their hosts and extract nutrients without causing much damage, so they are often the most difficult of all to detect. A further group of fungi, those symbiotic with liverworts, have been the subject of much more study and are not covered

Fig. 6. *Potriphila navicularis* on the leaves of *Polytrichastrum alpinum*. Laterally compressed, black ascomata form between the lamellae of the host.

Fig. 7. *Octospora itzerottii* on *Pterygoneurum ovatum*.

△Fig. 8. *Bryocentria hypothallina* causing necrotic patches on *Metzgeria furcata*. The fruitbodies of the fungus are invisible to the naked eye but may be seen with a hand lens as tiny orange spots around the edges of the bleached areas of the host thallus.

by this article (Pressel *et al*., 2010).

Another fascinating aspect surrounding bryophilous fungi is that a great many species remain undescribed or are only known from the type collection. The majority of the work done on these fungi has been by individual workers in France and in Germany (Döbbeler, 1978, 1997, 2002; Felix, 1988; Racovitza, 1959). It is becoming apparent that the British Isles, a stronghold for European bryophytes, holds several new and undescribed bryophilous fungi.

I have established a separate herbarium to keep records of bryophilous fungi found in Britain and Ireland, and any contributions from the Society would be most welcome. Please don't hesitate to contact me for additional information and resources.

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