Meeting**Report**

BBS Autumn Meeting:

University of Sussex, 11–13 September 2009

David Streeter reports on an excellent Autumn meeting, held in honour of Jean Paton's 80th birthday.

The 2009 Annual Meeting was held at the University of Sussex from 11 to 13 September. The occasion was special in that the opportunity was taken to celebrate the 80th birthday of Jean Paton MBE with a specially designed programme of papers and a conference dinner. Altogether 56 members and guests attended the conference, and it was especially good to welcome Barbara Crandall-Stotler and Raymond Stotler from Southern Illinois University, and Herman Stieperaere from the Nationale Plantentuin van België.

Publications Committee, Conservation and Recording Committee and Council all met on Friday evening with the main programme taking place on Saturday morning and afternoon. The full programme of papers was as follows:

▷ Chris Preston, Colin Harrower & Mark Hill
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▷ Dave Genney
Priorities for bryophyte conservation – a Scottish perspective (p. 35)

▷ Sam Bosanquet
Peatland bryophytes in Wales (p. 37)

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The function and evolution of stomata in bryophytes (p. 38)

▷ Gordon Rothero
Feeling the heat? Monitoring change in snowbed bryophyte communities in Scotland (p. 40)

▷ David Holyoak
Marsupella profunda*: conservation problems with a colonist* (p. 41)

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Melding molecules and morphology in liverwort phylogeny (p. 43)

▷ David Long
British liverwort floras 1741–1999: from Johann J. Dillenius to Jean Paton (p. 44)

▷ Mark Hill
Sixty years a queen; vice-county recording since 1947, with observations on where Jean Paton went and what she found (p. 46)

The AGM followed at 1600 and the President's report was published in *Field Bryology* vol. **100**, pp. 66–67. The AGM was followed by a meeting of the Tropical Bryology Group. The Conference Dinner was the formal celebration of Jean Paton's birthday. The President conveyed the Society's congratulations and presented her with a bouquet.

The conversazione followed the dinner for which Jean Paton displayed a collection of memorabilia illustrating aspects of her career, and five members provided posters.

On Sunday we visited the Francis Rose reserve at Wakehurst Place as guests of the Royal Botanic Gardens Kew.

◁ Wakehurst Place, Sussex, site of the Sunday excursion. *Ian Atherton*

△ Jonathan Sleath presents Jean Paton with a bouquet at the dinner held in her honour. *Ian Atherton*

ABSTRACTS OF TALKS

The distribution of British and Irish liverworts: a new analysis – *Chris Preston, Colin Harrower & Mark Hill*

The last classification of the distribution of all the British and Irish liverwort species was an association-analysis published by Michael Proctor in 1967. This was based on the vice-county records collated by Jean Paton for the fourth edition of the *Census Catalogue of British Hepatics* (1965). The new analysis presented in this talk was based on the 10-km square records held in the BBS database at BRC. A clustering algorithm was initially used to group the 300 species into 10 clusters, the number of clusters being specified at the outset. The similarity of each species to the overall distribution of those in each of the 10 clusters was then tested and species moved if they were more similar to another cluster than to the one in which they were currently placed. This testing was repeated until no species moved. The 10 clusters were named after the species with the best fit. There was one cluster of 32 widespread species characterized by *Metzgeria furcata*, and five clusters which formed a series increasingly restricted to the north and west, named after *Diplophyllum albicans* (40 species). *Saccogyna viticulosa* (19 species), *Marsupella emarginata* (37 species), *Harpalejeunea molleri* (30 species) and *Bazzania tricrenata* (21 species). The remaining four groups were those named after *Cephaloziella stellulifera* (27 south-western species), *Odontoschisma sphagni* (22 species from bogs), *Preissia quadrata* (17 calcicoles of the north and west) and *Anthelia juratzkana* (55 rare montane species). The *Cephaloziella stellulifera* group held a high proportion of threatened species, followed by the *Anthelia juratzkana* group.

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Priorities for bryophyte conservation – a Scottish perspective – *Dave Genney*

Bryophyte conservation is a complex area of which the following are just some of the more important issues and solutions.

THREATS

Rhododendron ponticum is a non-native invasive shrub that thrives in Scotland's oceanic woodlands. Unfortunately, this is the very habitat that supports some of our most important oceanic bryophyte communities. The dense shade under its canopy kills all but the most shade tolerant species and can devastate a local flora. Control of *Rhododendron* is expensive and requires a number of follow-up visits to be successful. It is important to prioritize control at sites where their impact on native species and habitats is greatest.

Over- or under-grazing by wild deer or domestic herbivores can have major implications for woodland bryophytes. Over-grazing for long periods can mean that old trees are not replaced and the canopy becomes too open. Under-grazing can be equally damaging and see bryophytes shaded out by dense sapling regeneration or increased bracken and bramble cover. Striking the balance between over- and under-grazing can be difficult to achieve, and requires coordination and cooperation between graziers, dear estate managers, foresters and Scottish Natural Heritage (SNH).

Climate change has already been discussed as a serious threat (Genney, 2010).

Although the patchwork of mixed-age heather that results from well-managed muirburn can benefit many species, burning of hepatic heath can be disastrous for internationally important bryophyte communities. In Scotland, muirburn is guided by the Muirburn Code which promotes avoidance of sensitive habitats.

PROTECTED SITES

Many of the most important Scottish sites for bryophytes are given legal protection though a series of protected sites. Sites of Special Scientific Interest (SSSIs) are the building blocks of Scotland's protected areas, and just over 1,450 SSSIs form part of the wider GB series. Of these, bryophytes are a recognized feature of 65 Scottish sites. The important features of each SSSI are described in a citation, which also lists a range of activities that can only be carried out with consent from SNH. The management requirements for each site are set out in a statement that SNH uses to maintain sites in a healthy condition through close working with their owners. A 6-year cycle of Site Condition Monitoring (SCM) determines whether bryophyte features are likely to be maintained in the medium to longer term. To produce this assessment, a set of important bryophyte habitat attributes are assessed against targets; for example, there should be a particular range of woodland canopy cover. Direct monitoring of rare and typical bryophytes is also carried out.

DATA

Bryophyte distribution data are critical for effective bryophyte conservation. It allows better planning decisions, informs policy, allows conservation status assessments, and can also stimulate interest in bryophytes for many people. Species distribution data can come from commissioned surveys, but by far the most important source of data is from BBS members. The Threatened Bryophyte Database is an invaluable tool for conservation (Hodgetts, 2009). With widely available data, there is less chance that important species are accidentally damaged. Availability of BBS records on the National Biodiversity Network's Gateway provides the greatest chance that bryophytes are taken into account and conserved effectively.

IMAGE

Effective bryophyte conservation needs a good PR campaign. Bryologists must continue to promote their importance and beauty so that as many people as possible value them. In an ideal world, bryophytes would receive the same level of public support as birds! However, bryologists can still have a big impact, e.g. by raising awareness of the vital ecosystem services that bryophytes perform, such as flood prevention and as a global carbon sink.

EDUCATION AND TRAINING

Bryophyte habitat and management requirements also need to be communicated effectively. This has been advanced over the past 3 years by Plantlife Scotland's *Lower Plants and Fungi Project*. This project has provided targeted training events for Scottish conservation agency staff on, for example, dead wood management. It has also produced a range of booklets to promote good management and identification guides for important habitats. The project has helped to introduce more people to bryophytes by producing a *Wild and Wonderful World of Scottish Mosses and Liverworts* leaflet, organizing public walks and training rangers to give their own walks and talks.

Although this paper is a very brief overview of bryophyte conservation priorities, it should be clear how important the BBS is to bryophyte conservation. By continuing to collect data, provide expertise, and nurture the next generation of bryologists, mosses and liverworts will be in safest possible hands.

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Peatland bryophytes in Wales – *Sam Bosanquet*

The Countryside Council for Wales (CCW) is in the fourth year of a 6-year study of the vegetation, ecology and condition of Welsh lowland peatlands. These are highly varied, ranging from tiny basin mires less than 1 ha in extent, but with exceptionally complex patterning, to vast fen/swamp complexes near the Welsh coast covering 200 ha or more, and including swathes of species-poor reedbed. The base-poor *Sphagnum* mires of mid-Wales contrast with the tufa-forming rich-fens of Anglesey. 191 sites have been covered to date, some during the preceding CCW lowland grassland survey; at least 76 remain unsurveyed.

Site floristics and condition are the main focuses of the survey, requiring detailed mapping. Bryophytes are key components of the vegetation and are therefore studied in reasonable detail. Observations include:

Sphagnum magellanicum and *S. balticum* on cut peat surfaces less than 80 years old, suggesting colonization from unknown sources. *S. magellanicum* remains widespread but scarce in Wales but seldom produces sporophytes, whilst *S. balticum* is only known to be extant at a single site. The ability of these species to colonize peat cuttings is encouraging for bog regeneration.

Tomentypnum nitens has been lost from at least three of its 10 Welsh sites and has declined at most of the others because of scrub encroachment and a lack of grazing management. At this species' only Cardiganshire site, a peat core revealed basiphilous bryophytes such as *Climacium dendroides* and *Scorpidium cossonii* 35 cm below the current vegetation surface, whereas *Tomentypnum* is now intermixed with *Sphagnum squarrosum*. This indicates relatively recent acidification of the surface, which is probably an additional threat to this rare moss.

Bog bryophyte diversity could provide a proxy for bog condition. Welsh peatland bryophytes have been assigned scores according to a subjective assessment of their restriction to intact raised bogs, and these scores have been used to rank sites. The least disturbed Welsh bogs, especially Cors Fochno, have the most consistently high scores for their bog bryophytes. Regenerating peat cuttings with *Sphagnum recurvum s.l.* fen (NVC M4 & M5) tend to be poor for liverworts, whereas established bog with *Sphagnum papillosum* is usually richer. Liverworts act as a convincing proxy for overall bog bryophyte diversity and therefore condition.

Scapania paludicola is widespread in mid- and north Wales and is particularly frequent in neutral mires alongside *Sphagnum inundatum* and *Sarmentypnum exannulatum*.

Amblystegium radicale grows in humid reedbeds in south-west Wales, especially when *Riccardia chamedryfolia* is abundant.

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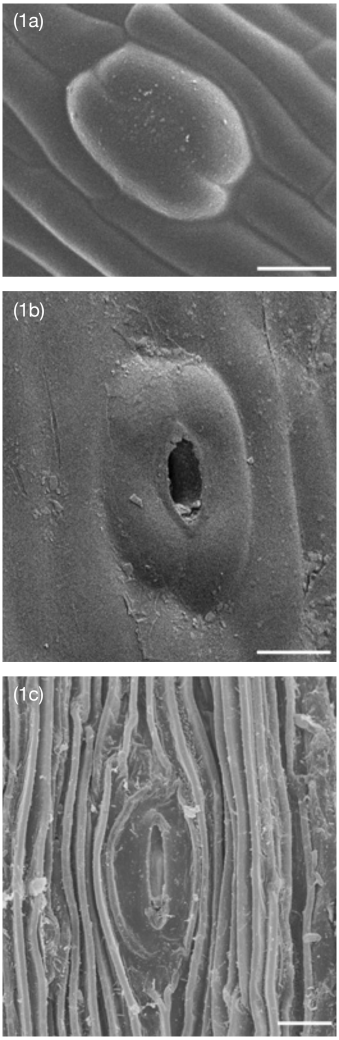
The function and evolution of stomata in bryophytes – *Jeff Duckett, Ken P'ng, Karen Renzaglia & Silvia Pressel*

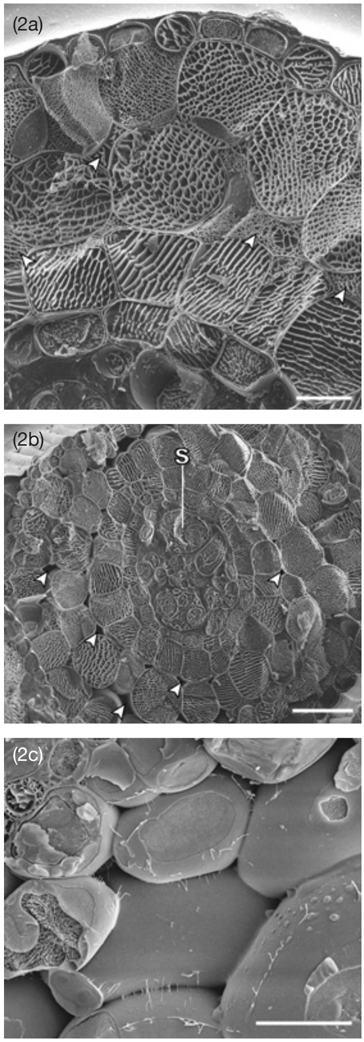
It was most fitting that this celebration of Jean Paton's 80th birthday should include a presentation on stomata. Two of Jean's most seminal early works were on stomata in British bryophytes (Paton, 1957; Paton & Pearce, 1957); 52 years later these remain indispensably authoritative accounts. Apart from a flurry of excellent cytological and functional studies – Sack & Paolillo (1973) and Garner & Paolillo (1973) showed that the stomata of *Funaria* are able to open and close, at least when young and that, like those in higher plants, they are sensitive to abscissic acid; while Maier's (1974) and Boudier's (1988) findings that the stomata of *Sphagnum* lack subsomatal air spaces lead to the conclusion that they should best be considered as pseudostomata (Cox *et al.*, 2004) – the last half century saw virtually no new advances in our understanding of bryophyte stomata. This was almost certainly due to a lack of suitable experimental technologies; thus, Jean's decision to leave stomata and thereafter pursue liverworts was a very wise move.

It is widely assumed that stomata, one of the key innovations in land plants, are homologous across land plants (Raven, 2002). This hypothesis fits neatly with 21st century total evidence phylogenies that place liverworts firmly at the base of the land plant tree (Shaw & Renzaglia, 2004; Renzaglia *et al.*, 2007). Accordingly, stomata first evolved in mosses (± *Sphagnum*) and are thereafter present from polytrichalean mosses and hornworts into higher plants. Embedded in this notion of stomatal homology is a further assumption that their principal function (and the selection pressure driving the same) is regulation of gaseous exchange (Raven, 2002), though this is certainly not the case in *Sphagnum* where the pseudostomata are covered with the calyptra until the sporophytes are almost mature (Cox *et al.*, 2004; Duckett & Ligrone, 2004; Duckett *et al.*, 2009).

However, with new tools at hand we now stand at the break of a new dawn for major advances in understanding of stomatal evolution and function in bryophytes. On the one hand, genomic data-mining should reveal whether or not bryophytes possess the same stomatal genes as higher plants and, on the other, cryo-scanning electron microscopy (cryo-SEM) coupled with ion milling and X-ray microanalysis (enabling direct detection of possible potassium fluxes between guard cells and epidermal cells like those in higher plants), can now be used for incisive functional studies.

Our current research using cryo-SEM is producing novel functional data that lead to exciting, conflicting and challenging hypotheses awaiting the application of genomic technologies. In *Sphagnum*, the role of the numerous pseudostomata is facilitation of sporophyte desiccation (Duckett *et al.*, 2009; Beerling & Franks, 2009). A detailed study across hornworts has revealed that stomata open after the sporophytes emerge from the involucres, thereafter remaining in this condition and being unaffected by darkness and desiccation (Fig. 1a–c); there is no evidence of potassium fluxes between the guard cells and surrounding cells. An even more surprising discovery is that the intercellular spaces in the outer assimilatory layers in the sporophytes are initially mucilage-filled (Fig. 2a) (as is always the case in hornwort gametophytes) and that water evaporates producing air-filled spaces only after the stomata open (Fig. 2b). The same observations on the leaves of vascular plants show that here, in dramatic contrast, the intercellular spaces are gas-filled from the outset and long before the stomata open (Fig. 2c). We therefore conclude that the principal role of hornwort stomata is facilitation of sporophyte desiccation, as previously suggested by Lucas & Renzaglia (2002). This very different function, taken together with the strikingly different origins of the intercellular spaces, suggests that hornwort stomata are not the same as those in higher plants. Studies in progress on mosses are yielding similar results together with the additional





◁ Fig. 1. Cryo-SEM images, surface views. (a, b) *Paraphymatoceros minutus*. (a) Closed stoma from inside an involucre; (b) newly opened stoma immediately above an involucre. (c) *Phaeoceros laevis*, open stoma flanked by desiccated and shrunken epidermal cells well above the dehiscence point on a sporophyte. Bars, 20 µm.

◁ Fig. 2. Cryo-SEM images, cryo-fractured preparations. (a, b) *Anthoceros agrestis*. (a) Sporophyte within an involucre with mucilage-filled intercellular spaces (arrowed) in the assimilatory tissues; (b) gas-filled intercellular spaces (arrowed) above an involucre; spores and pseudoelaters embedded in mucilage (S). (c) *Podocarpus nivalis*, gas-filled intercellular spaces in a very young leaf before stomatal ontogeny. Bars, (a, c) 20 µm, (b) 50 µm.

finding that, in most species, a possible closing mechanism is absent.

Thus we present three novel, challenging and conflicting questions for future research. (1) Did stomata first appear in bryophytes as structures that facilitated sporophyte desiccation and spore dispersal, and was their role in gaseous regulation in vascular plants a later secondary acquisition? (2) Did stomata in vascular plants evolve independently of those in bryophytes? (3) Or did stomata first evolve in early land plants as sites of gaseous exchange and were subsequently co-opted in moss and hornwort sporophytes as structures facilitating drying out, capsule dehiscence and spore discharge?

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Feeling the heat? Monitoring change in snowbed bryophyte communities in Scotland – *Gordon Rothero*

When snow falls it rarely stays in the same place for long, and this is particularly true of snow in the Scottish hills. Here the wind blows the snow onto lee slopes where it can accumulate to prodigious depths. As the prevailing winds are from the south and west, the snow tends to accumulate on slopes with north and north-easterly aspects, slopes which also receive limited insolation. On the bigger hills the snow patches persist right into the summer, leaving a short growing season, limiting the growth of higher plants and favouring vegetation dominated by lower plants. However, winters in Scotland have been noticeably less snowy since at least 1980 and snow patches have melted out earlier; the presumption must be that this is having some effect on snowbed vegetation.

◁ Ciste Mhearad, Cairngorm, a classic snowbed site. *Gordon Rothero*

This project, funded by Scottish Natural Heritage and carried out in cooperation with the University of Bergen and the Royal Botanic Gardens Edinburgh was designed to do two things. The first was to revisit most of the snowbed sites that I visited in 1989 and 1990, and resample the snowbed communities I studied then, in an attempt to discern any change within the communities. The second was to set up a series of baseline transects across a number of snowbeds plus taking a series of site photographs so that any future change can be monitored. It was planned that sites in the Cairngorms would be covered in 2007 and a selection of sites elsewhere in the Highlands surveyed in 2008. This was broadly successful, although the weather was not kind and two further transects were not completed until 2009 (thanks to funding from the BBS). By the end of the field work some 20 transects had been set up involving almost 500 quadrats and 115 of the 1989–90 plots had been resampled. Most of the sites involved are well above 1,000 m and not close to the road, so this involved some very long days, but fortunately in wonderful places.

It is important to stress that the resampling did not involve fixed plots; quadrat data were gathered in similar stands on the same sites in both periods, but not from exactly the same places. So, the data can only provide information on changes within the community, not on spatial changes. The results here indicate that the bryophyte communities are much the same now as in 1989–1990, but with some significant increase in the frequency and cover of some vascular plants. Comparison of photos taken in 1989 with those from 2007 also provides evidence of some marked changes, particularly in the cover of vascular plants like *Juncus trifidus*, *Deschampsia flexuosa*, *D. cespitosa* and *Nardus stricta*.

Setting up of the baseline transects was a time-consuming exercise, trying to select a suitable line with good natural markers at each end and trying to snatch location photos in the spells when the clouds lifted. These are dynamic sites, but it is hoped that the large boulders selected as markers will remain for some time. If possible, a selection of these transects will be revisited in 5 years or so, to test out how viable relocating the line is, although funding is always going to be a problem. Another fundamental problem may be finding the right combination of skills in a surveyor, as it helps to have both a fondness for being alone in the big hills and a moderate obsession with *Marsupella*!

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Marsupella profunda*: conservation problems with a colonist* – *David Holyoak*

The small liverwort *Marsupella profunda* Lindb. was added to the British flora by Paton (1990), who recognized it amongst specimens of *M. sprucei* (Limpr.) H.Bern. she had collected in West Cornwall between 1965 and 1971.

Because of the restricted range of *M. profunda* and its apparent rarity throughout Europe, it is: (a) listed on Schedule 8 of the Wildlife and Countryside Act (as amended); (b) listed on Appendix 1 of the Bern Convention; (c) listed on Annex II of the EC Habitats and Species Directive (Council Directive 92/43/EEC); it is the only Annex II 'priority' species occurring in Britain; (d) in *Biodiversity: The UK Steering Group Report* (1995) it was placed on the 'Short List of Globally Threatened/Declining Species', classed as Critically Endangered in Britain and as a '*Species of global conservation concern*', and an Action Plan for its conservation was presented. Most of these conservation designations were established on the assumption that its true status was already known, i.e. prior to any really extensive targeted surveys being made of its status in the UK or elsewhere.

In 1990, *M. profunda* was not known to survive at any of its Cornish sites, which had become overgrown with gorse or bramble or been destroyed, although Jean Paton suggested that '*it must surely*

▷ Employees of Goonvean Ltd moving a large boulder with *M. profunda* growing on it (February 2007). The boulder was on a site being used as a spoil tip for china-clay waste at Trelavour Downs, East Cornwall. The translocation was carried out under licence from Natural England. *David Holyoak*

still be around somewhere'. A search at the same Cornish sites in early 1993 by Nick Hodgetts, Jean and Ron Porley resulted in the species being refound in very small quantity at Tregonning Hill, but nowhere else.

A field study of *M. profunda* in Cornwall during March–April 1996 was carried out under English Nature's Species Recovery Programme (Holyoak, 1996). This study revealed that a tiny population still persisted on granitic rocks at Tregonning Hill, but found much larger populations at two 'new' sites in West Penwith (Leswidden and Lower Bostraze) where it mainly grew on clay-waste surfaces. Jean participated in the Leswidden find and checked all voucher specimens. Realization that the species is an early-successional colonist on China-clay spoil led to further surveys for English Nature, resulting in new finds of large populations at working clay pits in East Cornwall (Holyoak, 1999).

Subsequent conservation actions on paper to protect *M. profunda* in West Cornwall have included notification of Tregonning Hill as a SSSI (on 23 December 1994) and notification of Lower Bostraze and Leswidden as a SSSI (on 8 November 1996). In East Cornwall three sites (at Carclaze, Prosper Pit and south of Treviscoe) were also notified as SSSIs and at the same time proposed as a candidate SAC during 2000, despite strong recommendations to avoid notifying sites at working clay pits (Holyoak, 1999). Since 2000, the clay companies have mainly refused access to their land in East Cornwall for any wide-ranging surveys of the species.

Conservation results on the ground have only partly justified the actions taken on paper. At Tregonning Hill SSSI the largest population seen was of just 15 cm^2 on a single boulder in 1998. In 1999, when the site was proposed as a candidate SAC, there was even less of it (1.5 cm^2), and by 2005 it had become extinct at the site because of encroaching brambles and no suitable unshaded habitat remains.

At Lower Bostraze and Leswidden the extent of open habitat has declined progressively since 1996 as gorse and heather have colonized clay surfaces. Glyphosate herbicide has been used annually to slow vegetation succession on the best areas. New ground was cleared mechanically at both sites. Intensive annual management has slowed declines of *M. profunda* at both sites, but by 2009 a need for more drastic clearance work at Lower Bostraze was becoming apparent.

The three SSSI sites in East Cornwall all showed major declines by 2009, despite intermittent scrub clearance. However, adjacent unprotected areas had gained much larger populations near two of the SSSIs.

The Second Report under Article 17 on the implementation of the European Community Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora (92/43/EEC) (JNCC, 2007) was based largely on monitoring of the SAC sites for *M. profunda*, so it was able to give only a gloomy report on prospects. This emphasizes that even the limited and artificial bureaucratic objective of reporting favourable conservation status in the UK was not being met by designating SACs for *M. profunda*.

M. profunda has also become a nuisance to the clay companies:

(1) Instances of accidental damage on SSSIs has exposed the companies to potential risk of prosecution.
(2) Discovery of *M. profunda* in large quantities on the route for a new road at Greensplat led to extensive translocation (under licence) of rocks with patches of the plant.
(3) Discovery of *M. profunda* on the location for a new quarry spoil tip led to last-minute translocation of boulders with patches of the plant (under licence) to the edge of a neighbouring SSSI.
(4) *M. profunda* currently occurs on the site of a planned 'eco-village' of 1,000 new homes.

In conclusion, discovery of additional large populations of *M. profunda* in Cornwall suggests that it is now much less immediately threatened globally than it appears to be on paper. Hence, conservation efforts should focus on maintenance or provision of newly bared habitat for the regional metapopulations, with much less concern over individual sites that have small populations.

Statutory protection of sites as SSSI and SAC has sometimes proved to be valuable (e.g. in West Cornwall), since it can help to ensure appropriate habitat management activity, but it can also be counter-productive (as in East Cornwall). Quarrying by the China-clay companies provides most of the new habitat for the species in East Cornwall. Hence, a partnership with the clay companies should be developed so they have an interest in protecting *M. profunda* rather than in seeking to prevent it being surveyed on their land.

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Melding morphology and molecules in liverwort phylogeny – *Barbara Crandall-Stotler*

Although many tools in the past have modified our views of bryophyte phylogeny, none have impacted our systematic schemes and concepts of evolution as much as those of molecular biology. The mitochondrial intron data of Groth-Malonek *et al.* (2005) and multi-locus DNA sequencing studies of Qiu *et al.* (2006), for example, have unequivocally established that mosses, liverworts and hornworts comprise separate lineages, as sometimes argued (Crandall-Stotler, 1986), and that liverworts are the first divergence of land plants.

> An **intron** is a region of DNA within a gene that is not translated into protein.

Phylogenetic studies focused on resolving relationships within liverworts, such as Forrest *et al.* (2006) and the collaborative '*Assembling the Liverwort Tree of Life*' project (see http://bryophytes.plant.siu.edu/posters_ATOL.html), have challenged traditional, morphology-based concepts of most taxonomic units and led to major modifications in liverwort classification. Our recently published classification scheme (Crandall-Stotler *et al.*, 2009) attempts to integrate morphological and molecular data sets and reconcile their incongruence. Some of the unforeseen relationships now recognized in the classification include the placement of *Blasia* at the base of the complex thalloid lineage, and the placement of *Monoclea* and *Riccia* in derived lineages, close to *Dumortiera* and *Conocephalum*, respectively.

Studies of mature sporophytes of *Phyllothallia* show that it has several anatomical characters in common with elements of the Pallaviciniales where it is now resolved, rather than the Treubiales where it had been placed, and new studies of *Pleurozia* confirm that its elaborate water sacs are ventral, not dorsal, and its strange tubes are unique structures, not sterile perianths.

In contrast to these examples in which related taxa have highly divergent morphologies, in the Jungermanniidae morphological convergence often obscures underlying genetic divergence. For example, *Jungermannia* and *Jamesoniella*, traditionally placed in the same family based on their similar facies, are consistently resolved in different suborders in molecular studies. A similar scenario occurs in analyses of *Lophozia* (De Roo *et al.*, 2007), which support its transfer to the Scapaniaceae, the recognition of several segregate genera, and the transfer of *Leiocolea* to the Jungermanniaceae.

While such realignments may seem spurious, critical re-evaluations of morphological features often provide additional support for them. Thus, despite a growing reliance on molecular tools to classify and/or identify organisms, morphological studies must still play a critical role in deciphering relationships and documenting biodiversity. Intrinsic characters of spermatid architecture, sporeling and branch ontogeny, androecial and gynoecial organization, capsule wall anatomy and sporogenesis are reliable markers of evolution that should be melded with molecular markers to produce a meaningful, total evidence phylogeny.

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British liverwort floras 1741–1999: from Johann J. Dillenius to Jean A. Paton – *David G. Long*

Britain has more liverwort floras than any other country in the world, no less than 10 spanning 259 years. Jean has some very distinguished predecessors, so writing a new flora demands some very special qualities: exceptional ability, patience, attention to detail, sheer dedication and not least the ability to draw plants. Jean, fortunately, has all these qualities, but has certainly needed them over the 34 years spent researching and writing her flora. Over these 259 years the number of liverwort species has steadily increased and now stands at 299. My four ‘giants of hepaticology’ and their ground-breaking liverwort floras in this story are J.J. Dillenius, W.J. Hooker, S.M. Macvicar and of course Jean Paton. These are the authors who have made major leaps forward in our knowledge. The others in between have largely synthesized the work of earlier authors, apart perhaps for W.H. Pearson.

The first important British bryologist was Johann J. Dillenius, who was Sherardian Professor of Botany in Oxford from 1734 until he died in 1747. He was a correspondent and friend of Linnaeus who visited him in Oxford in 1736. His major work *Historia Muscorum* was published (in Latin) in 1741, but with a later English edition in 1768. It was a remarkable publication, both in its excellent illustrations, and its detailed Latin descriptions (using polynomial names). Dillenius was a field botanist and this shines through his descriptions. Dillenius' friend Carl Linnaeus' *Species Plantarum* was published 12 years later and is the starting point for liverwort nomenclature. He published the first binomials for plants, including 44 species of liverwort. Linnaeus' liverworts were largely based on Dillenius' work as described by Pekka Isoviita in 1970. Therefore Dillenius' *Historia Muscorum* and his herbarium are extremely important in correctly interpreting Linnaeus' liverwort names, as in the case of *Jungermannia undulata*, now *Scapania undulata*, first described by Dillenius but given a binomial by Linnaeus.

Our second hepaticologist is the Scotsman James Dickson who worked as a nurseryman in London and became interested in bryophytes. He made several field trips in Scotland and described his new discoveries in his 4-volume *Fasciculus Plantarum Cryptogamicarum Britanniae* (1785–1801). One example of his new species is *Jungermannia adunca* (now *Herbertus aduncus*) described by Dickson from '*Alpibus Scoticis*', but later demonstrated by Johannes Proskauer that his type specimen actually came from western North America, not Scotland, probably collected by Archibald Menzies.

The second 'giant' is Sir William Hooker, who became one of Britain's most famous botanists and Director of Kew Gardens, but before that he had been Professor of Botany in Glasgow for 21 years and was author of many important works on cryptogamic plants, particularly bryophytes and ferns. One of the most important is his *British Jungermanniae* (1816), which covered only leafy liverworts, with exceedingly detailed descriptions and illustrations, for example *Jungermannia hutchinsiae* (now *Jubula*) which Hooker named after Miss Hutchins of Bantry who sent him specimens.

It took 58 years for the next liverwort flora to appear, by Benjamin Carrington in 1874–1875. Although he had a drawing of *Marchantia polymorpha* on the front cover, his work covered only 29 leafy liverworts as it was sadly abandoned due to his ill health. However, his name is commemorated in some of his discoveries like *Plagiochila carringtonii* and *Radula carringtonii*. The next, Mordecai Cubitt Cooke was a remarkable man, a polymath – he dabbled in many things and was a prolific author. He was first and foremost an outstanding mycologist based at Kew gardens and was certainly not a hepaticologist; his biographer John Ramsbottom of Kew commented that his *Hepatic Flora* (1907) '*did not add to his reputation*'. In 1912, Cooke did an interview for the *Morning Post* on his 87th birthday which led to erroneous report of his death – a notice in the *Kew Bulletin* stated that '*he peacefully passed away at his residence*'; Cooke later said the report was '*much exaggerated*'!

William H. Pearson worked his whole life in the textile industry, but must have had a lot of spare time as he published both his *Hepaticae of the British Islands* in 1899–1902 and many papers on liverworts from far-flung corners of the globe, such as New Zealand and New Caledonia, and was one of the founders of the BBS in 1922. Pearson's flora was a considerable advance on his predecessors; it was the first truly comprehensive flora. The drawings lacked the critical detail of Hooker's, and the book was soon overshadowed by Macvicar's as a practical flora. Henry W. Lett is perhaps the least well-known of our liverwort flora-writers, but he was a very important figure in the development of bryology in Ireland. He was a contemporary of Pearson and Macvicar, and acknowledged the help he got from Macvicar. Perhaps his greatest bryological moment was the discovery of *Adelanthus dugortiensis* on Achill Island (now *A. lindenbergianus*).

The next of our 'giants' is Symers Macvicar whose work (1912) became the Standard British Liverwort Flora for 78 years – it is concise and practical, still very useful today for its taxonomic notes and acute observations. He married into a wealthy family and was able to live on his wife's estate in Moidart in the oceanic west of Scotland. He was the first hepaticologist to become really familiar with our oceanic liverworts. He discovered many new species in Scotland. His work is a model of a good synoptic flora.

Although Tony Smith's liverwort flora (1990) has been superseded by a later book, his contribution to British bryology has nevertheless been enormous, particularly his pivotal role in the BBS mapping scheme which led to the excellent *Atlas*. During the war, as a schoolboy Tony and his mother had a very fortunate escape when they had to flee Singapore before the Japanese invasion. In the confusion they boarded the wrong ship and eventually got to Australia, but the ship they should have boarded was lost at sea.

Our fourth 'giant' is with us today; Jean and her outstanding contributions to hepaticology over many decades is the reason for our celebrations. Eric Watson in his 'Foreward' summarized some of the qualities of her work very aptly: '*the quality and completeness of the illustrations… far surpass what is to be found in any other British bryophyte flora known to me*', '*Mrs Paton's long and intimate experience of these plants in the field*', [the illustrations] '*a triumph indeed*' and '*a landmark in the study of British liverworts*'. I would like also to mention Jean's husband, 'Pat', whose skills as an artist (in inking the plates) are a major contribution to her liverwort flora. In her own words, '*over the years, Pat spent hundreds of hours inking most of the figures*'.

I would summarize the important attributes of a good liverwort flora as follows, and all of these qualities are exemplified by Jean's book:

- ▷ clear, precise descriptions, incorporating data from living plants
- ▷ well-constructed keys using most easily-observed characters; alternative keys where useful, e.g. gemmae in *Scapania*
- ▷ attention to detail, e.g. oil bodies, cuticles
- ▷ full details of reproductive structures, gemmae, androecia, gynoecia, perianths, sporophytes
- ▷ accurate cell range measurements
- ▷ understanding and description of variation within species
- ▷ diagnostic taxonomic notes for critical taxa
- ▷ information on fruiting, frequency of reproduction
- ▷ cytological information
- ▷ precise ecological information
- ▷ good summary of geographical distribution
- ▷ high-quality illustrations of all features of plants
- ▷ good illustrated glossary

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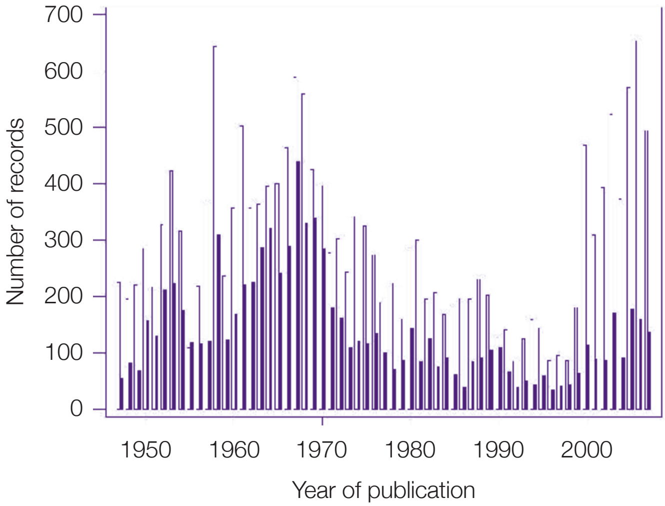
Sixty years a Queen: vice-county recording since 1947, with observations on where Jean Paton went and what she found – *Mark Hill*

Starting in 1947 after an interruption during the Second World War, lists of vice-county records have been published annually up to the present. Records since 2000 have been added electronically to the BBS database held at the Biological Records Centre (BRC). Prior to that, some were added while others were not. Inclusion was not systematic, and there was a gap during 1990–1999 following the *Atlas of the Bryophytes of Britain and Ireland*.

DATA AND DATA PROCESSING

In an effort to eliminate the resulting backlog and check for other omissions, I decided to capture all vice-county records from 1947–1999, by submitting photocopied pages for optical character recognition (OCR). This activity was performed by the Research Councils' Joint Reprographic Services at Swindon. On 2 November 2007, they very efficiently processed the 860 printed pages. All I had do was to transform electronic output into usable data. For the analysis that follows, additional statistics were added from the annual reports



◁ Fig. 1. Total numbers of records of mosses (open bars) and liverworts (solid bars) in each year.

of the Recorders for 1997–2006 (published 1998–2007).

RESULTS

At the end of the process, there were 22,532 usable records. Numerous early records were of varieties that are no longer recognized. Records from notices of new species and from revisions were mostly not published with the vice-county records. Only those that were published with the vice-county records are included.

There were two phases of high recording activity (Fig. 1). In the first phase, 1952–1972, there was much activity in Ireland, with more than 500 Irish vice-country records in 1958 and 1967. After 1971, Irish vice-county recording was at a much lower level, averaging only 49 per year from 1972 to 1997. The nadir was 1997, with two Irish vice-county records.

Table 1. Top 20 recorders over the period 1947–1999

Recorder	No.	Recorder	No.
Paton, J.A.	1,924	King, A.L.K.	551
Crundwell, A.C.	1,265	Fitzgerald, R.D.	542
Long, D.G.	792	Hill, M.O.	519
Appleyard, J.	743	Blockeel, T.L.	456
Warburg, E.F.	731	Ratcliffe, D.A.	386
Wallace, E.C.	710	Rose, F.	367
Lobley, E.M.	602	Perry, A.R.	353
Fitzgerald, J.W.	592	Synnott, D.M.	328
Duncan, U.K.	567	Milne-Redhead, H.	307
Corley, M.F.V.	557	Jones, E.W.	287

CONTRIBUTION OF INDIVIDUAL RECORDERS

For the calculation of totals for individual recorders, recorders were given points for records, 1 for a solo record, 0.5 for contributing to a pair (A & B), 0.333 for a triplet (A, B & C) and 0.25 for a quadruplet (A, B, C & D). Using this scoring system, the top 20 recorders accounted for 12,580 records (Table 1), more than half of the total 22,532 records. It will come as no surprise to those familiar with the period that Jean Paton and Alan Crundwell were the most prolific contributors.

On average, the most prolific recorder in each year found about 16% of the records. In 11 out of the 53 years, the top recorder found more than 20% of the total. From 1969 to 1972 and again in 1977 and 1980, this person was Jean Paton, with a clear maximum of 40% of the records in 1971. She is indeed the queen of vice-county recording.

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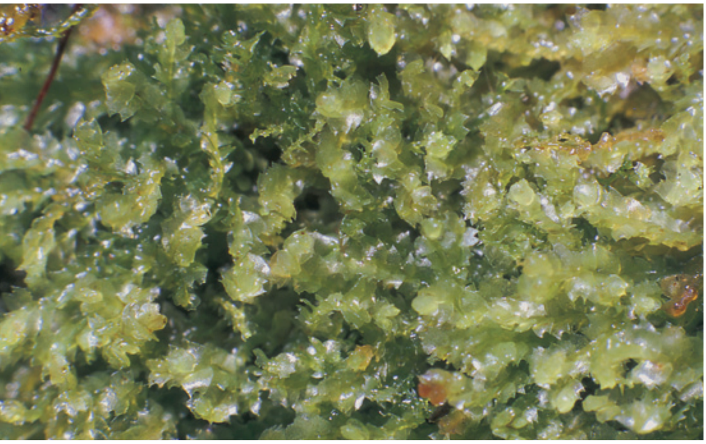
◁ Left. Jeff Duckett (yes, it is Jeff) and Mark Pool search for *Syntrichia latifolia*. *Ian Atherton*

◁ Right. There's always one! Has Mark Hill spotted something the rest of the group missed? *Ian Atherton*

▽ Centre left. *Harpanthus scutatus*. *John Birks*

▽ Bottom left. *Dichodontium pellucidum*. *Des Callaghan*

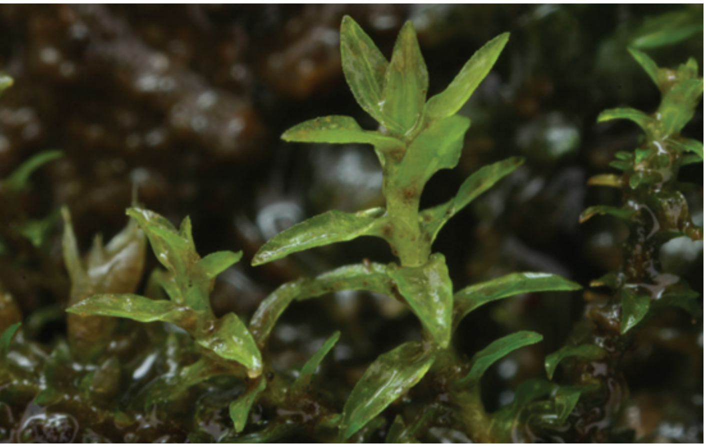


EXCURSION TO WAKEHURST PLACE,

On Sunday 39 members joined the excursion to RBG Kew's Wakehurst Place Gardens and Tilgate Wood, which Kew have designated the Francis Rose Reserve. We were met and welcomed by Andy Jackson, head of RBG Kew, Wakehurst Place who stayed with the party for the rest of the day.

Car parks are well known to be irresistible to a dedicated few and both *Didymodon nicholsonii* and *Syntrichia latifolia* dutifully made the list even before the excursion started!

On the walk through the gardens to the wood, the large patches of *Phaeoceros laevis* by the



◁ Left. Jonathan Sleath admires patches of *Phaeoceros laevis*. *Ian Atherton*

▽ Centre left. *Phaeoceros laevis*. *David Holyoak*

▽ Bottom centre and right. BBS members in the Francis Rose Reserve at Wakehurst Place. Jean Paton is just in shot on the far right). *Ian Atherton (centre) & Robin Stevenson (right)*

stream side were much admired together with fine *Dichodontium pellucidum*. Tilgate Wood is one of the best Central Wealden woodlands with fine outcrops of the Lower Tunbridge Wells Sand long famous for their Atlantic bryophytes. The wood's particular speciality, *Harpanthus scutatus*, was soon found together with *Scapania umbrosa*, to delight our special guest. Diligent searches of material post the excursion also revealed *Blepharostoma trichophyllum* mixed with other species. Several nice colonies of Tunbridge Filmy-fern, *Hymenophyllum tunbrigense*, growing well on the rock outcrops were also admired. Altogether 64 species were recorded and added to Wakehurst's database, with thanks to Richard Fisk for keeping the day's tally.

I would like to express my thanks to Andy Jackson and his staff for the trouble that they took to make the visit so enjoyable and especially for providing the transport to the wood.

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