BBS Autumn Meeting

The Natural History Museum, London

10–12 September 2010

Jeff Duckett reports on the 2010 BBS AGM paper reading session and field meeting held in the magnificent Natural History Museum in London.

The 2010 Autumn Meeting was held in the Natural History Museum (NHM), a familiar location for many visiting bryologists, but a first as the venue for an official BBS occasion. Over 40 members and guests attended and it was good to welcome again Herman Stiperaere from the Nationale Plantentum van België. The fact that his journey to London took far less time than several others travelling should perhaps remind us that continental Europe is now very accessible for future meetings.

The Publications Committee, Atlas Steering Group combined with the Conservation and Recording Committee, and the Council meetings were held on the Friday afternoon, the main programme taking place on Saturday. The fact that our slightly later starting time of 10.30 enabled many members to travel to London on the day rather than having to stay overnight should be borne in mind when next the Society contemplates a meeting in the capital.

For the first time, the programme of seven papers included two on Irish bryophytes, four about work relating to museums, in keeping with the venue, and a review on the molecular biology of *Physcomitrella* which was a major revelation to all participants. The full programme was as follows;

Jo Denyer – *Progress and plans for encouraging bryophyte recording in Ireland* (p. 47)

Rory Hodd – *Hepatic mat vegetation in the west of Ireland; ecological requirements and responses to climate change* (p. 47)

Martin Godfrey – *Why museums matter* (p. 49)

Andy Cuming – *The* Physcomitrella *genome project* (p. 49)

Jo Wilbraham – *Bryophytes of Réunion Island* (p. 49)

Jeff Duckett & Silvia Pressel – *Thursley Common NNR since the great fire of 2006* (p. 50)

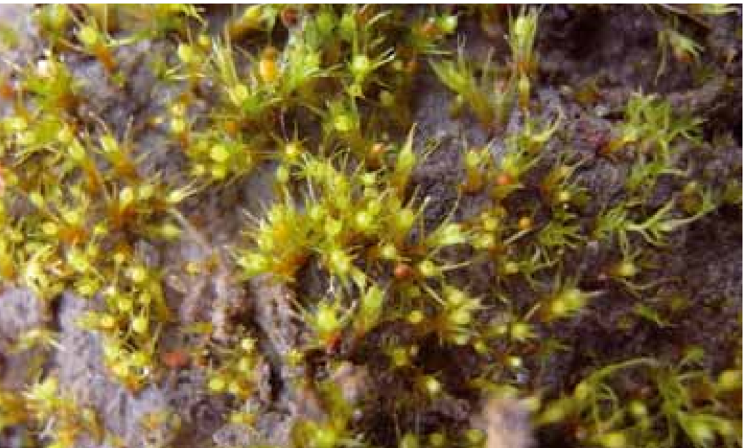
Silvia Pressel & Jeff Duckett – *Bryophyte surfaces; new functional perspectives from cryo-scanning electron microscopy* (p. 50)

Before the AGM at 1600, Jeff Bates introduced a new project on bryophyte phenology that will be over-seen at the NHM by Silvia Pressel (see *Ecology Matters*, *Field Bryology* 102, p. 46). The President's report was published in *Field Bryology* 103, p. 79. After a truncated conversazione (we had to vacate the Museum at 1800) and an impromptu meeting of the Tropical Bryology Group, most members enjoyed dinner at a nearby Italian restaurant.

I would like to thank all the staff at the Museum for contributing to the success of the meeting. The meeting rooms and food were excellent, all the PowerPoint presentations were free from technical glitches and everyone was directed past the dinosaurs to the correct venue in this very large building.

EXCURSION TO HAMPSTEAD HEATH

In perfect weather, 14 members joined the Sunday excursion to sample some of the 141 species recorded from the Heath situated less than 10 miles from the centre of London. When the party dispersed after an open-air lunch at Kenwood House, the list had increased to 144. The three additions were as follows. (1) *Cololejeunea minutissima* was found on an oak by Mark Hill, the only previous Middlesex records of this spreading species being from the northern boundary of the county. (2) A *Fossombronia* yet to produce mature spores was found by Ken Adams growing in one of the scrapes dug out of the Kenwood bog in May 2009 with the aim of encouraging the growth of sphagna. Some 18 months later, these scrapes are covered with a monoculture of *Pseudephemerum nitidum* and there is no evidence of colonization by the sphagna, although nearby *Sphagnum fimbriatum* produced abundant sporophytes in the summer of 2010. (3) Male *Gyroweisia tenuis* was found on the Bird Bridge. This species had been previously



△ Left. Bryologists below the parapet of the Bird Bridge, Hampstead Heath – makes a change from the bottoms-up position! Mark Hill, Liz Kungu and Jonathan Sleath examine *Gyroweisia tenuis*. *J. Duckett*

△ Right. *G. tenuis* on old brickwork of the Bird Bridge. *J. Duckett*

◁ *Pseudephemerum nitidum*. *Jonathan Sleath* misidentified in the field by Jeff as *G. viridulum*, a species found on calcareous stonework in Highgate cemetery and elsewhere on the Heath. The presence of the calcifuge *Aulacomnium androgynum* growing with the *Gymnostomum* immediately raised suspicions that the substratum was wrong, for this is a calcicole species. Fossicking through the literature, Mark Hill discovered that the abundant tubers on the Bird Bridge plants exactly matched those illustrated by Whitehouse & During (1986) for *Gyroweisia tenuis*.

Unfortunately, wanton felling of the ivy-covered trees in the dell below the bridge, supposedly to prevent a dangerous build up of water during storms had completely destroyed the Heath's population of epiphyllous *Metzgeria violacea* (Duckett, 2008).

▽ Top. *Orthotrichum pulchellum*, an increasingly frequent species on elders. *J. Duckett*

▽ Bottom. Sward of *Riccia fluitans* at Sandy Heath. *J. Duckett*

△ *Metzgeria violacea* on the trunk of a recently felled tree in the dell below the Bird Bridge. This liverwort was no longer present as an epiphyll on the ivy covering the felled trees. *J. Duckett*

It is unlikely to persist for very long on the trunks of the felled trees, but it does occur on spreading branches of mainly willows and turkey oaks in several other places on the Heath.

In addition to admiring fine views of London, the party also enjoyed seeing a good range of the epiphytes that have recolonized sallows, elders and particularly turkey oaks on the Heath in recent years. These include *Frullania dilatata*, *Metzgeria consanguinea*, *Radula complanata*, *Cryphaea heteromalla*, *Orthotrichum pulchellum*, *O. lyellii*, *Ulota bruchii*, *U. crispa*, *U. phyllantha* and *Zygodon conoideus* with abundant protonemal gemmae. The now pan-capital introduction *Hennediella macrophylla* (Duckett & Pressel, 2008) was observed along the path to the final destination: one of the pools on the Sandy Heath to see *Riccia fluitans*. Whereas in previous years this species formed a dainty sprinkling on the water surface, in September 2010 it formed swelling swards. Inexplicably, the *Riccia* was confined to but one of several adjacent ponds and has not been seen for many years on the Concert Pond where once it was abundant.

References

Duckett, J.G. (2008). Epiphyllous and epifungal liverworts on Hampstead Heath. *Field Bryology* 95, 8–10.

Duckett, J.G. & Pressel, S. (2009). London's changing bryophyte flora. *Field Bryology* 98, 30–46.

Whitehouse, H.L.K. & During, H.J. (1986). *Leptobarbula berica* (De Not.) Schimp. in Belgium and The Netherlands. *Lindbergia* 12, 135–138.

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PROGRESS AND PLANS FOR ENCOURAGING BRYOPHYTE RECORDING IN IRELAND – *Jo Denyer*

Interest in bryophytes and bryological recording in Ireland has increased in the last few years. This is encouraging as many areas are currently under-recorded (despite much historical recording of hotspot areas such as Co. Kerry).

Resident bryologists, such as the late Mrs King [an amateur bryologist and Dublin Naturalist Field Club (DNFC) member] who added 40 species to the Irish list, Daniel Kelly (Trinity College Dublin), Donal Synott (formerly of the National Botanic Gardens, Glasnevin) and Neil Lockhart (National Parks and Wildlife Service), have done much to add to our post-1950 knowledge of Irish bryophytes. Crucially they have also played a key role in promoting general interest and research into bryophytes, such as the Irish bryophyte *Red Data Book* project led by Neil Lockhart, with David Holyoak and Nick Hodgetts. The publication of this eagerly anticipated book will occur in 2011 and it is hoped that this will promote the conservation of bryophytes in Ireland.

Of course the BBS has also contributed to filling gaps on the Irish bryological map, most recently with the successful Cork and Kerry summer meetings. These created approximately 11,150 records, including over 100 new VCRs and over 100 records of proposed *Red Data Book* species. Perhaps the most important element of this meeting though was the high participation of Irish members (who outnumbered visiting bryologists) and the time taken by BBS experts to give tuition to enthusiastic Irish beginners. This came at a time when the DNFC had started an initiative to promote bryophytes to those interested in natural history. As part of this project we have held meetings in areas local to Dublin: introducing beginners to bryophyte ecology and using the new *Field Guide* to aid identification.

The high level of interest in bryophytes shown by local naturalists spurred me on to gain funding for a mini-flora of part of the Wicklow Mountains National Park in 2010. For this project, recording meetings were held throughout the year, led by visiting BBS experts or myself, and 11 volunteers undertook to record a tetrad by themselves. Several of the participants are now becoming involved in recording elsewhere in Ireland, and this is very encouraging.

As a result of all this recent activity, Ireland now has five Regional Recorders (covering North and South Co. Kerry, Co. Dublin, Co. Wicklow, Co. Meath and Co. Louth) and a newly formed BBS Dublin Regional recording group. Looking to the future, we hope to maintain and develop local interest and expertise (and fill in major gaps for the 2012 *Atlas*) by holding a range of BBS meetings in Ireland over the next couple of years. These will include summer meetings in 2012 in North Co. Mayo and Co. Antrim. Anyone who would like to be involved in these meetings, is interested in joining the BBS Dublin group, or would like to help out with training in Ireland, please contact me.

Acknowledgements

Many thanks to all who have helped promote bryology in Ireland and who have given me invaluable help with the Wicklow bryophyte recording project and the Dublin regional BBS group and DNFC (especially Declan Doogue, Melinda Lyons and Katherine Duff), Neil Lockhart, Maurice Eakin, the Wicklow bryophyte project volunteers, Heritage Council, Gordon Rothero, David Chamberlain, Nick Hodgetts, Sam Bosanquet, Chris Preston and Mark Hill.

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See also Jo's article in this issue on pp. 12–17.

HEPATIC MAT VEGETATION IN THE WEST OF IRELAND: ITS ECOLOGICAL REQUIREMENTS AND POTENTIAL RESPONSE TO CLIMATE CHANGE – *Rory Hodd & Micheline Sheehy Skeffington*

The mixed northern hepatic mat is a community of large leafy liverwort species of northern Atlantic distribution in Europe, which occurs only in the west of Ireland and western Scotland, on humid, shady north-facing mountain slopes (Ratcliffe, 1968).

In Ireland, this community is usually dominated by *Herbertus aduncus* subsp. *hutchinsiae*, with *Pleurozia purpurea* and *Bazzania tricrenata* frequent at many sites. *Bazzania pearsonii*, *Mastigophora woodsii* and *Scapania ornithopodioides* are locally widespread where conditions are suitable, but are restricted to hepatic mat vegetation in Ireland. The very rare *Plagiochila carringtonii*, *Scapania nimbosa* and *Adelanthus lindenbergianus* in Ireland are also restricted to hepatic mat vegetation. These species all have disjunct distributions: within Europe, they are restricted to areas with a highly oceanic climate and occur elsewhere in areas of perennially humid climate, such as in the Himalayas, British Columbia, tropical African mountains and Antarctica.

In Ireland, the northern hepatic mat community is restricted in distribution to the mountain ranges of the far west; in Co.s Kerry, Galway, Mayo and Donegal, where a hyper-oceanic climate is prevalent (Crawford, 2000). This climate is characterized by high and frequent rainfall, high levels of cloudiness and a low temperature range between summer and winter. The constituent species of hepatic mats require very specific conditions, including frequent rainfall, constant humidity and shade from strong sunlight (Ratcliffe, 1968). Therefore, they are restricted to north- to north-east-facing slopes, at altitudes seldom < 400 m, up to > 900 m.

In order to describe in detail the hepatic mat vegetation throughout its range in Ireland, 25 x 25 cm relevés were taken from stands of hepatic mats in Kerry, Galway, Mayo and Donegal. Analysis of these data shows that there are distinct differences in the habitat and composition of hepatic mat vegetation throughout its range in western Ireland. In the northern region of Ireland, in Donegal, hepatic mats usually grow under a tall, open canopy of heather (*Calluna vulgaris*), similar to what has typically been recorded in many sites in Scotland (Averis *et al.*, 2004). However, in the south of Ireland, in Kerry, as well as parts of Mayo, hepatic mat vegetation grows on open, grassy and rocky slopes in deep corries and rarely under a canopy of *Calluna*. There are also differences in the species composition of the hepatic mats between the regions.

There are a number of threats to the future survival and success of hepatic mat vegetation in Ireland. The most pressing and apparent of these is overgrazing. This has led to the loss of much hepatic mat vegetation, in particular in the Twelve Bens of Connemara (Holyoak, 2006; Long, 2010). On a local scale, erosion can be a threat, such as in one of only two Irish sites for *Scapania nimbosa* on Corrán Tuathail in Co. Kerry, where a popular route to Ireland's highest peak has led to much slippage and erosion of the slope on which it grows.

Another factor that may have a significant effect on hepatic mat vegetation is potential climate change, and the resultant possible changes in rainfall patterns and increases in temperatures. If summer rainfall were to decrease, it could lead to a decrease in the length of the growing season of the bryophytes as a result of drying out, resulting in a decreased competitive ability. Increased temperatures could also lead to more competition, while if there were an increase in extreme precipitation events, hepatic mats on steep slopes could become dislodged. Due to the uniqueness of this community within Europe, it is of great importance to conserve all remaining stands in good condition and to monitor any future changes in its composition and distribution.

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References

Averis, A.M., Averis, A.B.G., Birks, H.J.B., Horsfield, D., Thompson, D.B.A. & Yeo, M.J.M. (2004). A*n Illustrated Guide to British Upland Vegetation*. Peterborough: JNCC.

Crawford, R.M.M. (2000). Tansley Review no. 114. Ecological hazards of oceanic environments. *New Phytologist* 147, 257–281.

Holyoak, D.T. (2006). Progress towards a species inventory for conservation of bryophytes in Ireland. *Proceedings of the Royal Irish Academy* 106B, 225–236.

Long, D.G. (2010). The tragedy of the Twelve Bens of Connemara: is there a future for *Adelanthus lindenbergianus*? *Field Bryology* 100, 3–8.

Ratcliffe, D.A. (1968). An ecological account of Atlantic bryophytes in the British Isles. *New Phytologist* 67, 365–439.

See also Rory's article in this issue on pp. 2–11.

WHY MUSEUMS MATTER – *Martin Godfrey*

Martin Godfrey read a paper in which he argued for the importance and value of specimen-based collections. A summary of his views were published in *Field Bryology* 103, p. 84.

THE *PHYSCOMITRELLA* GENOME PROJECT – *Andy Cuming*

A summary of the points covered in Andy's talk was written up as a full article in the previous issue of *Field Bryology* (103, pp. 9–13).

BRYOPHYTES OF RÉUNION ISLAND – *Jo Wilbraham*

Jo presented an overview of the bryophyte diversity of Réunion Island and discussed outcomes of the BBS Tropical Bryology Group fieldwork expedition of 2008 (see also *Field Bryology* 97, pp. 24–31).

Réunion is a tropical, volcanic island situated 700 km east of Madagascar and 200 km south-west of Mauritius in the Indian Ocean. For its small size (2,512 km^2), Réunion has a rich bryophyte flora. This rich diversity may owe something to the wide range of available habitats and the variable precipitation regime that is characteristic of the island. Presently, 30% of Réunion is under the protection of a National Park; however, pressures of land use change and the introduction of invasive alien species are major challenges for conservation.

The bryophyte flora has a comparatively long history of exploration and is fairly well documented with collections, though mainly from the 19th century. The first and only moss flora of Réunion was produced by Bescherelle in 1880 and includes 209 species. The current checklist holds approx. 430 mosses and 250 liverworts and hornworts. A staggering 15% of the moss flora of Réunion is considered endemic. However, these numbers fluctuate with new discoveries and taxonomic revisions. This high endemism indicates a need for critical review of certain complex groups, such as the Hypnaceae.

In September 2008, a team of 17 bryologists, mostly members of the BBS Tropical Bryology Group, assembled on Réunion for 2 weeks to participate in a taxonomic workshop and field meeting hosted by the Université de la Réunion and La Réunion Parc National. The aim was to increase knowledge of the unique bryophyte flora of the island, and included sessions testing identification keys on fresh specimens, participant-led seminars presenting recent taxonomic work, and fieldwork trips to make collections of bryophytes from highly diverse and/or poorly known areas. An important aspect of the meeting was the close involvement with local botanists and conservation managers who were interested in learning more about the diverse bryophyte flora of the island. Results of the meeting so far include 36 new bryophyte records for the island; additional specimens available for taxonomic work and an increase in the detailed distribution data available for species on the island. These data are currently being used to assess species and areas most in need of conservation attention.


△ *Plicanthus hirtellus* (left) and *Pleurozia gigantea* (right). *J. Wilbraham*

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THURSLEY COMMON NNR SINCE THE GREAT FIRE OF 2006 – *Jeff Duckett & Silvia Pressel*

An article describing the current status of the Common will appear soon in a future issue of *Field Bryology*.

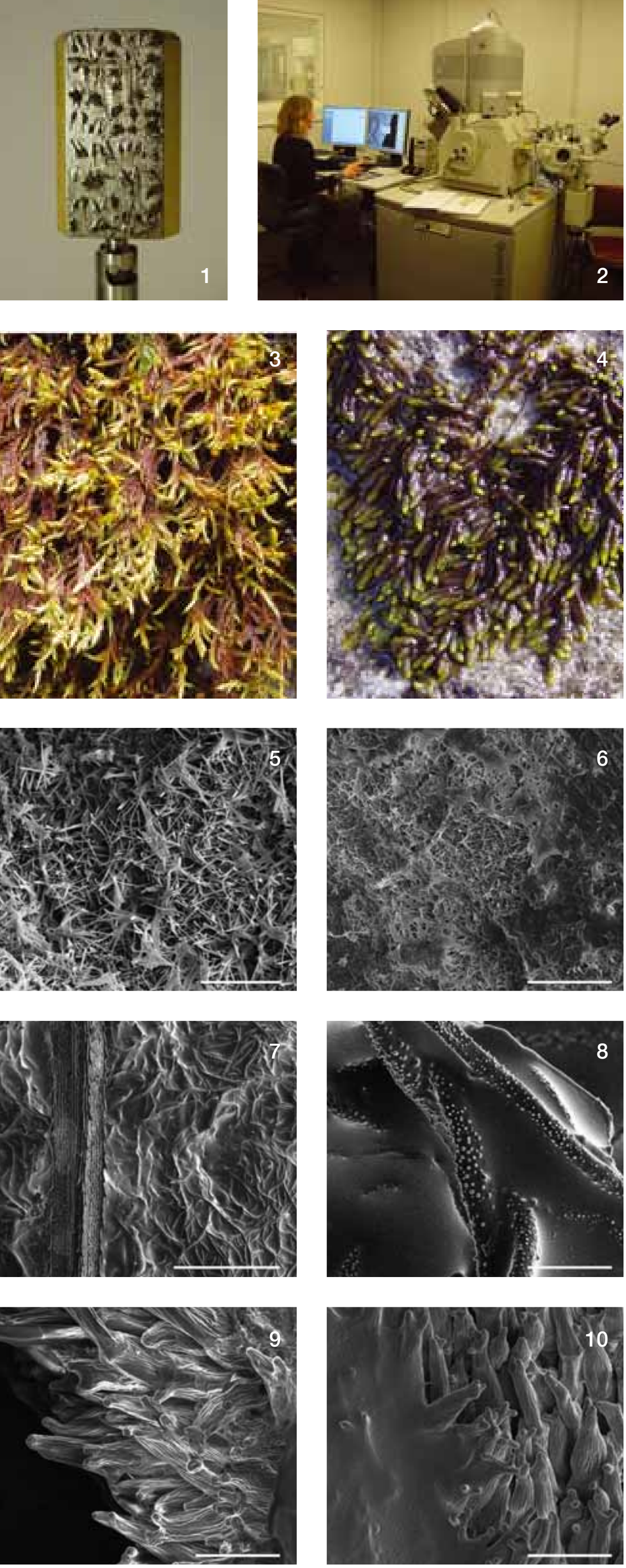
BRYOPHYTE SURFACES; NEW FUNCTIONAL PERSPECTIVES FROM CRYO-SCANNING ELECTRON MICROSCOPY – *Silvia Pressel & Jeff Duckett*

The diverse and exquisitely beautiful surface ornamentations in bryophytes are an absolutely invaluable tool in taxonomy. Except for the very obvious water-repellent properties of surface waxes that prevent waterlogging, and hence depression of gaseous exchange associated with this, the functional significance of other surface features remains largely a matter for conjecture, lacking any incisive experimental foundation apart from Proctor's (1979) dye experiments. These showed that water travels rapidly in the channels between moss leaf cells, leaving the papillae, which appear to be water-repellent, high and dry. Thus, the interstices between leaf papillae would appear to be associated with rapid wetting. In addition, it is likely that the papillae also increase evaporation rates under drying conditions, thus facilitating the shutting down of metabolic activities and hence reducing the loss of carbon from respiration under water stress (Proctor, 1979, 1982). As to peristome ornamentation, perhaps the other most diverse and ornate superficial feature of bryophytes, the only reference to function of which we are aware are passing comments by Lewinsky (1993) and Vitt (1973); '*if any, this remains unknown.*' It seemed to us most unlikely that peristome ornamentation is there simply to help bryophyte taxonomists!

There are various technical problems associated with attempting to elucidate the functional significance of surfaces and, in particular, whether these are hydrophilic or hydrophobic. For light microscopy, specimens have to be mounted in water and, although the presence of air films and bubbles is a quick confirmation that waxes are water-repellent, – a situation also readily apparent to the naked eye in taxa with water-repellent glaucous surfaces, e.g. liverworts like *Anthelia* and *Douinia*, and mosses like *Philonotis calcarea* and *Pohlia cruda* (Proctor, 1984) – determining whether or not other surfaces are hydrophobic or hydrophilic is much more problematic. Conventional scanning electron microscopy gives a much more detailed picture of bryophyte surfaces. However, the standard preparative techniques (viz. treatment with organic solvents and critical point drying) remove surface waxes (Heinrichs *et al.*, 2000; Pressel *et al.*, 2010, 2011).

The much more recently available technique of cryo-scanning electron microscopy (cryo-SEM), is different from other electron microscope techniques and allows for the direct visualization of possible interactions between biological tissues and water, and for direct observations of specimens at different stages of de- or rehydration (Duckett *et al.*, 2009). Living specimens are carefully mounted on a metal stub (Fig. 1) which is then plunged into liquid nitrogen slush to preserve their hydrated state in a frozen condition. Once frozen, specimens are quickly transferred to a high vacuum cryogenic preparation chamber to prevent contamination and the build-up of ice. Ice is sublimed off the surface by raising the temperature up to –90°C for 5 minutes, and the samples are then cooled to –130°C and sputter-coated with a thin layer of gold/palladium (Fig. 1) to prevent charging under the electron beam. Inside the microscope the samples are observed on a cold stage with the temperature maintained at –130°C (Fig. 2). We are now using this new tool to gain novel functional insights on a variety of bryophyte surfaces.

Our cryo-SEM analyses of the southern hemisphere moss genus *Rhacocarpus* (Pressel *et al.*, 2010) have provided wonderful insights into the water relations of its remarkable trilamellate cell wall whereby a thick, porous outer layer ensures rapid



◁ 1. Specimens mounted on a metal stab and sputter-coated with a thin layer of gold/palladium. 2. Cryo-scanning electron microscope. 3, 4. *Rhacocarpus purpureus* dry (3) and wet (4), Table Mountain, South Africa. 5–10. Cryo-scanning electron micrographs. 5, 6. Dense investitures of waxes on the gametophytes of *Lepidozia argentea* (5) and *Anthelia juratzkana* (6). 7, 8. *Bartramia pomiformis*; wax-covered hydrophobic leaf next to highly hydrophilic papillose rhizoids (enlarged in 8). 9, 10. *Crossidium squamiferum*; highly hydrophilic leaf lamellae. Note the water in 10. Bars, (5) 5 µm; (6) 10 µm; (8–10) 20 µm; (7) 200 µm. *Silvia Pressel & Jeff Duckett*

water uptake and retention, whilst a highly hydrophobic, cuticle-like layer prevents waterlogging. Thus the cell wall of *Rhacocarpus* is a supreme adaptation to habitats experiencing alternating rapid drying (Fig. 3) and heavy precipitation (Fig. 4), and most likely prevents the depressed metabolism recorded in waterlogged *Sphagnum*.

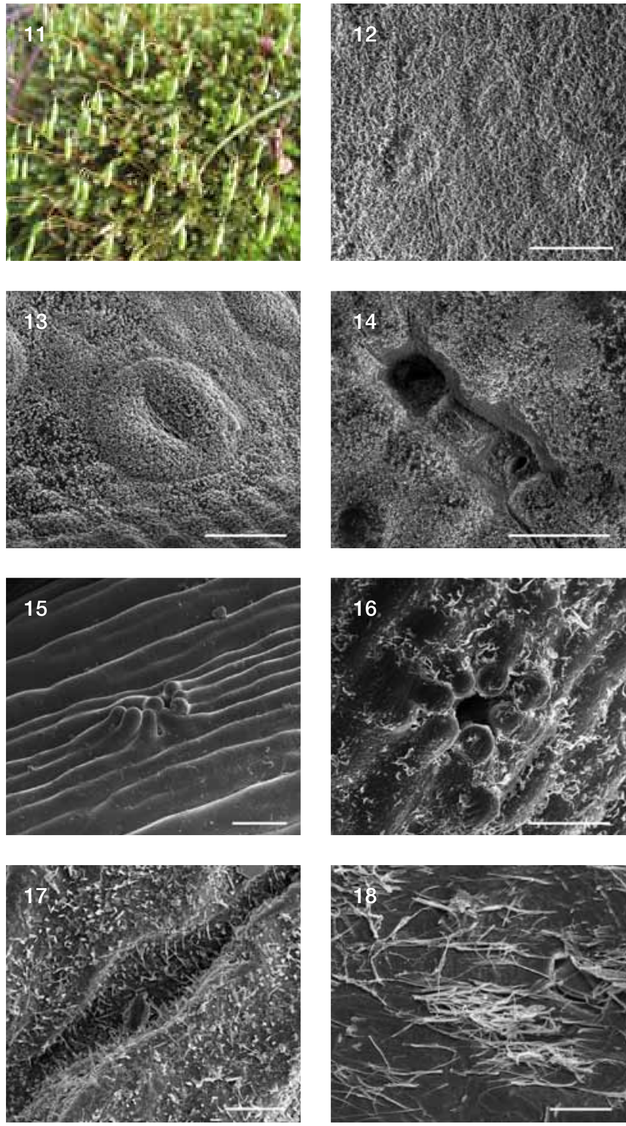
Our current survey of moss and liverwort gametophyte surfaces is revealing that dense investitures of waxes are widespread. Whilst their presence in taxa growing in niches below overhanging banks (e.g. *Bartramia*, *Calypogeia* and *Lepidozia* spp.; Fig. 5) and caves (e.g. *Schistostega*) where waterlogging would certainly impede gaseous exchange 'makes sense', the abundant waxes of taxa growing in permanently wet situations but with flowing aerated water where gaseous diffusion is unlikely to be limiting [e.g. *Anthelia* (Fig. 6), *Philonotis* and *Pohlia* spp.] are more surprising.

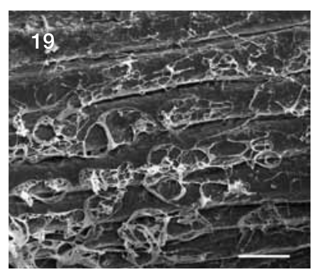
In contrast to leaves, all the rhizoid systems that we have examined to date, including representatives from the Polytrichales, Dicranales and Bryales, are invariably hydrophilic. Most striking is the contrast between the wax-covered hydrophobic leaves in the Bartramiaceae and their papillose and highly hydrophilic tomentum-forming rhizoids (Figs 7, 8).

Turning to leaf wall ornamentation proper, we can confirm Proctor's (1979) conclusions from his dye experiments; water does indeed flow within the channels in striated walls and between papillae. Particularly rapid is the uptake of water between the surface papillae in the Andreaeales, Grimmiales, Pottiales, Hedwigiales and Orthotrichales, and between the leaf lamellae in various pottialean genera like *Aloina*, *Crossidium* (Figs. 9, 10) and *Pterygoneuron*. The ornamented leaf surfaces of all these taxa, which grow in habitats experiencing intermittent and often rapid de- and rehydration, and thus where the ability to rehydrate rapidly is most beneficial, conspicuously lack waxes. On the other hand, in polytrichalean leaves, where avoidance of waterlogging and the consequent depression of gaseous exchange (Proctor, 1979, 1982, 1984) are vital, abundant waxes prevent the ingress of water between the leaf lamellae. All those who have sectioned *Polytrichum* leaves cannot fail to have noted the air bubbles trapped between the lamellae.

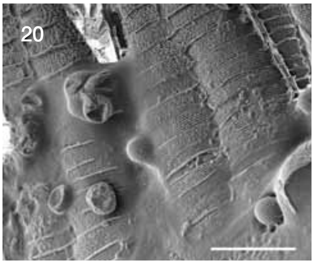
Although the presence of distinctive water-repellent surface waxes on the sporophytes of the Polytrichales is well documented, what did surprise us was their occurrence on a wide range of other moss capsules, including many that appear smooth and shiny to the naked eye (Fig. 11). Thus the shiny, green, undehisced capsules of *Bartramia* and *Plagiopus* (Fig. 12) have a surface investment of waxes matching that in *Polytrichum* (Fig. 13), and the same is true for *Mnium* (Fig. 14). These sporophytic waxes clearly prevent the accumulation of water depressing gaseous exchange on the capsules. *Orthotrichum* is particularly interesting in this context. The protruding cells around immersed stomata maintain an air space between the capsules and the persistent calyptra, whilst the accumulation of surface waxes prevents the ingress of water inside the calyptra (Figs. 15, 16).

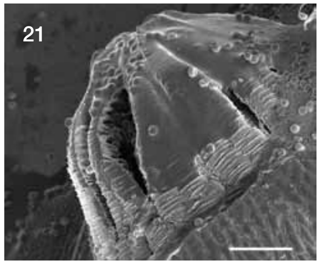
Both sporophytic and gametophytic waxes in many taxa have a highly distinctive morphology e.g. fine rods around the stomata in *Tetrodontium brownianum* (Fig. 17) and both rods and fine whorls in *Pylaisia polyantha* (Figs. 18, 19). Thus in the future waxes may provide new characters helpful in resolving taxonomic problems as has been shown





▷ 11. *Mnium hornum*; young shiny green capsules. 12–19. Cryo-scanning electron micrographs. 12–14. Capsules of *Plagiopus oederi* (12), *Polytrichum formosum* (13) and *Mnium hornum* (14) covered in water-repellant surface waxes. 15, 16. *Orthotrichum anomalum*; the protruding cells around immersed stomata are smooth in young capsules (15) and become increasingly covered in waxes as the capsules mature (16). 17–19. Examples of types of wax morphology: fine rods around a stoma in *Tetrodontium brownianum* (17); rods (18) and fine whorls (19) on the sporophyte of *Pylaisia polyantha*. Bars, (12–16) 40 µm; (18) 5 µm; (17, 19) 10 µm. *Silvia Pressel & Jeff Duckett*





◁ 20–21. Cryo-scanning electron micrographs showing highly hydrophilic ornamentation on the peristome of *Rhynchostegium confertum*. Water is rapidly taken up between the ornamentation (20) and causes the teeth to close (21). Bars, (20) 40 µm; (21) 100 µm.
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for those on the leaves in the Plagiochilaceae (Heinrichs *et al.*, 2000).

As to peristomes, we have found a major difference between those in the Polytrichales and other mosses which can be directly related to conditions associated with spore discharge. In the former group, where the spores are expelled from the capsules when raindrops fall on the epiphragm under wet conditions (Watson, 1971), the peristome teeth are water-repellent, thus preventing the apertures from becoming occluded by water. In contrast, water is rapidly taken up and lost from between the ornamentation on the peristomes of all the bryopsid mosses we have examined to date (examples include *Funaria*, *Coscinodon*, *Grimmia*, *Schistidium*, *Fissidens*, *Dicranella*, *Didymodon*, *Syntrichia*, *Tortula*, *Bryum*, *Mnium*, *Amblystegium*, *Rhynchostegium* and *Hypnum*), leading to their rapid closure (Figs. 20, 21) in wet conditions and accelerating their opening under dry conditions. However, we now need to expand the range of taxa studied to investigate suggestions (L. Kungu & K. Adams, pers. comm.) that particular patterns (e.g. orientation of striations) in peristome ornamentation are more conducive either to opening or closing of the teeth under wet conditions.

As for taxa with only rudimentary or no peristomes (e.g. *Weissia* spp.) ingress of water around the spore mass is prevented by highly water-repellent capsule rims.

At long last there is now a function for peristome ornamentation.

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References

Duckett, J.G., Pressel, S., P'ng, K.M.Y. & Renzaglia, K.S. (2009). Exploding a myth; the capsule dehiscence mechanism and the function of pseudostomata in *Sphagnum*. *New Phytologist* 183, 1053–1063.

Heinrichs, J.H., Anton, H., Gradstein, S.R., Mues, S.R. & Holz, I. (2000). Surface wax, a new taxonomic feature in Plagiochilaceae. *Plant Systematics and Evolution* 225, 225–233.

Lewinsky, J. (1993). A synopsis of the genus *Orthotrichum* Hedw. (Musci, Orthotrichaceae). *Bryobrothera* 2, 1–59.

Pressel, S., P'ng, K.M.Y. & Duckett, J.G. (2010). Cryo-scanning electron microscope study of the water relations of the remarkable cell wall in the moss *Rhacocarpus*. *Nova Hedwigia* 91, 289–299.

Pressel. S., P'ng, K.M.Y. & Duckett, J.G. (2011). An ultrastructual study of the liverwort *Mizutania riccardioides* Furuki *et* Iwaksuki: new insights into its systematic affinities and unique surface ornamentation. *Bryologist* 114, 38–51.

Proctor, M.C.F. (1979). Structure and eco-physiological adaptation in bryophytes. In *Bryophyte Systematics: Systematics Association Special Volume 14*, pp. 479–509. Edited by G.C.S. Clarke & J.G. Duckett. London & New York: Academic Press.

Proctor, M.C.F. (1982). Physiological ecology, water relations, light and temperature responses, carbon balance. In *Bryophyte Ecology*, pp. 333–382. Edited by A.J.E. Smith. London: Chapman & Hall.

Proctor, M.C.F. (1984). Structure and ecological adaptations. In *The Experimental Biology of Bryophytes*, pp. 9–37. Edited by A.F. Dyer & J.G. Duckett. London & New York: Academic Press.

Vitt, D.H. (1973). A revision of the genus *Orthotrichum* in North America, north of Mexico. *Bryophytorum Bibliotheca* 1, 1–108.

Watson, E.V. (1971). *Structure and Life of Bryophytes*, 3rd edn. London: Hutchinson & Co. Ltd.