

# Desert Island Delights: the Bryophytes of Ascension Island

## Background

In 2013 and 2014 Silvia and Jeff were privileged to take part in two expeditions exploring the bryophytes of Ascension Island as part of a DEFRA Darwin Initiative; *Implementing a Darwin Initiative Biodiversity Action Plan for Ascension Island*. Catherine, the resident botanist was able to explore virtually every nook and cranny on the Island and make year round detailed observations on the phenology of the bryophytes (very much a first for a tropical island) and to visit the Natural History Museum in London where she tracked down all the earlier bryophyte collections including several endemics known only from the type specimens. A grant from the BBS Bequest Fund allowed Howard the opportunity to indulge his fetish for sectioning problematic Pottiaceae from the Island. The multiple aims of our collective endeavours included the production of a fully illustrated Flora and Identification Guide to the Bryophytes, the establishment of a comprehensive bryophyte

herbarium on the Island, drawing up bryophyte conservation strategies and projects, producing baseline data on bryophyte distribution for monitoring climate change, and to train members of Ascension Conservation.

Silvia and Jeff's visits to the Island benefitted greatly from guidance in the field by Stedson Stroud (Fig. 2), the doyen of Ascension botany, and by Jolene Sim a member of the conservation team, to some distinctly awkward/almost inaccessible places. Their predilections are the narrowest of traverses along very steep banks with forbidding cliffs below and with the odd bit of rock climbing thrown in (Summer House Ridge and Stedson's Ledge - named after Stedson Stroud, below Elliot's Path) (Fig. 3). Needless to say our struggles were worth the effort as the destinations almost always produced new discoveries like *Didymodon icmadophilus*. To calm our fears, whenever we slipped, which was often, frantic grabbing of the nearest shrubby vegetation revealed this to be covered with *Colura tenuicornis* (A.Evans) Steph. Mercifully



The authors **Silvia Pressel**, **Howard Matcham**, **Catherine Supple** and **Jeff Duckett** describe their recent bryological activities centred on Ascension Island

△Figure 1. Bryophyte-free lowlands with the cloud-covered top of Green Mountain in the background. All pictures by C Supple/J Duckett/S Pressel

the only long term damage was to the backside of Jeff's shorts: for future reference, the only cure for the blue staining from the berries of Koster's Curse (*Clidemia hirta* (L.)D.Don) is to dye your clothes the same colour.

Ascension is a small (91km<sup>2</sup>) oceanic volcanic island 1660Km from Africa and 2250Km from South America, 7 degrees south of the Equator and just west of the Mid-Atlantic Ridge at the junction of the African and South American tectonic plates. It is some 1 million years old and has a dry tropical oceanic climate with little seasonal variation (20-31 degrees year round). Around the coast annual rainfall is only 130mm but increases to 680mm at 660m along the ridge of the highest peak, Green Mountain (859m) which regularly experiences high winds and drizzly clouds. Ascension boasts around 25 endemic vascular plants and, before our work, around 15 endemic bryophytes.

The Island is probably best known to

philatelists and as the refuelling stop for flights to the Falkands. Lacking any continuously running water the Island does not immediately spring to mind as a bryophyte mecca and, if you are in search of a desert island paradise, it does not tick many boxes. When Darwin made a brief visit on the outward voyage of the Beagle he wrote '*The island is entirely destitute of trees, in which, and in every other respect, it is very far inferior to St. Helena. Mr Dring tells me, that the witty people of the latter place say "we know we live on a rock, but the poor people of Ascension live on a cinder" the distinction in truth is very just*' (Darwin, 1839, p.587). The entire coastline appears to be a bryophyte desert but, just to make doubly sure, we did make brief excursions to see nesting boobies, frigate birds and over a quarter of a million sootie terns (Fig. 4). We can now advise all future bryologists: *don't bother these are all totally bryophyte-free*. To add to our misery there are only two swimming beaches one aptly



△Figure 2, left. Stedson examines bamboos covered in bryophytes on the way to Dew Pond, summit of Green Mountain.

Figure 3, right. Jolene, Catherine and Silvia *Anogramma*-spotting on Summer House Ridge.

named Comfortless Cove about a mile from the capital Georgetown where, in the past, sick seamen were taken to die. However, whilst on confessions we did take occasional time out from our early mornings and late evenings devoted to specimen sorting to observe egg-laying and hatching turtles and the carnage by frigate birds and black fish on hatchlings emerging after dawn. In the absence of much fresh fruit Silvia also ate an awful lot of wild raspberries (*Rubus nanus* S.Watson) and a few guavas (*Psidium guajava* L), both introduced.

Most of the bryophyte collections from the Island derive from what seems to be haphazard sampling by non-bryologists whose primary focus was on other things, or who were just passing through en route to St Helena, the

Falklands or Antarctica, for example the Challenger Expedition of 1875 and the voyages of the Scotia 1902-1904 (Cardot, 1912; Rudman Brown, 1906; Stephani, 1894, 1912-1916). In fact, the first dedicated bryologist to visit the Island and make a systematic attempt to collect the bryophytes prior to our expeditions was Martin Wigginton in 2005 en route from completing the fieldwork for his St Helena flora (Wigginton, 2012). Working from Brian O'Shea's (1995, 2006) and his own (Wigginton, 2009) invaluable checklists Martin compiled a list of species comprising 2 hornworts, both endemic, 17 liverworts with 2 endemics and 28 mosses with 11 endemics making a grand total of 47 species. This represents a slight advance on the total of 43 given by Ashmole and Ashmole





(2000). Following his visit to the Island, Martin raised the total to 63 but his additions did not include any further endemics. Consequent on our work, involving much cross checking with ancient collections and type specimens, removing dubious records for which no specimens exist and misidentifications, the totals now stand at 4 hornworts, 23 liverworts and around 50 mosses.

The bryophyte flora of Ascension Island is small compared with the mainland continents of South America and Tropical Africa and even the nearest (1,300 km to the southeast) island of St Helena which boasts about 110 species.

Like most Islands, Ascension has been changed out of all recognition by man's activities including the almost obligatory introduction of goats, rabbits, sheep, donkeys, cats, mice and black rats (for some arcane reason brown rats have always died out). Though goats and feral cats have both been eradicated rabbits remain a problem for the native vegetation and rats for the ground nesting birds. Because of the barren nature of the original treeless landscape of Ascension Hooker, following his visit in

1843, suggested that introductions would be a good idea and today the Island boasts over 200 introduced plants ranging from large trees to shrubs and annual herbaceous plants (Ashmole & Ashmole, 2000; Fairhurst, 2004). As you would expect this has not been an unqualified success and many of the habitats of native plants like the large endemic marattiaceous fern *Pitsana purpurascens* (de Vriese) Murdock have become severely overgrown. But, on the positive side, Green Mountain on Ascension now famously boasts the only man-made cloud forest in the world (Wilkinson, 2004) and paradoxically this has been much to the benefit of the bryophytes. A large number of species of previously natural terrestrial habitats have spread and now thrive in profusion as epiphytes and epiphylls, or grow in previously open places that have become shaded by the trees. The fact that almost all the epiphytes also occur in native habitats makes a strong case for their native status and we suspect that only a handful of taxa are possible human introductions onto Ascension. These include 3 species probably imported on introduced trees;

▽ Figures 4 - 6, left to right. Having examined every sooty tern's nest in the main wideawake colony on Ascension, Jeff is satisfied that this is totally bryophyte-free. Carpet of *Bryum arachnoideum* baking in the sun. *B. arachnoideum* fruiting during the wet season.





◁Figures 7-10, top to bottom. The walls of the Old Marine Barracks covered in bryophytes, including large colonies of *Fossombronia husnotii* (lighter patches). A cushion of the rather problematic *Chinoloma bombayense*. The endemic *Lophocolea ascensionis*. The aromatic *Symphogyna brasilienses*. Note the orange antheridia.



*Radula boryana* (F.Weber) Nees & Mont., first collected by Phil Lambdon in 2009, and the now likely extinct *Leucodon bescherebellii* Broth. & Geh. and *Callicostella ascensionis* (Müll.Hal.) Broth. (Geheeb, 1910). A *Sphagnum* and *Phaeoceros laevis* in conservation plant pots at the Red Lion are also likely introductions as is *Campylopus introflexus* at present confined to just a very limited area along Elliot's Path. Since the several native *Campylopus* species growing in the same habitat are extremely vigorous these may restrict its spread. We remain sceptical about native *Sphagnum* on the Island since there appear to be no habitats suitable for the old record, but with no specimen, of *S. violascens* Müll.Hal. (Rudman Brown, 1904; Cardot, 1912).



The absence of common cosmopolitan species is a further indicator of the native status of nearly all the bryophytes. Ascension is a *Ceratodon purpureus* and *Tortula muralis*-free island, where even the missionary moss *Octoblepharum albidum* Hedw., failed to arrive. Another notable absence is any member of the Grimmiaceae, surprising given the range of apparently highly suitable volcanic rocks; the report of *Grimmia kidderi* James, without a specimen or locality, is almost certainly an error. Sadly one of the earliest bryophyte collections from the island, magically labelled *Targionia hypophylla*, Richard 1831. Voyage de LRichard 18, is in fact *Plagiochasma rupestre* (J.R.&G. Forst.) Steph. var *rupestre*. We have not seen *Targionia* on the Island and, given our extensive fieldwork, its occurrence is unlikely.



### ***The bryophyte zones and habitats***

Above the completely bryophyte-free coastal parts of Ascension is a species-poor zone stretching from around 230m up to 600m.

Flat areas with fine grained substrata clay are dominated by carpets of *Bryum arachnoideum* Müll.Hal. (all the silvery *Bryum* on Ascension fit the description of this species (Frahm, 2002) rather than *B. argenteum*) often covering several square metres (Figs. 5, 6) whilst gravelly soils and banks are characterised by often pure swards of *Trichostomum brachydontium* which appears to be regularly eaten by Ascension's land crab (Fig. 19). Though not significant in terms of preserving the Island's bryophyte diversity, like cryobiotic crusts in desert regions across the world, these habitats are highly sensitive to disturbance by grazing animals. The eradication of goats from Ascension and the abandonment of Grazing Valley for pasture have greatly benefitted these communities. We now have accurate mapping of their lower limits: their upward or downward migration will be a future barometer of climate change.

Rocky outcrops, and particularly shaded crevices at these lower altitudes, support *Lejeunea laetevirens* Nees & Mont., *Frullania ericoides* (Nees) Mont, *F. angulata* Mitt., *Microlejeunea africana* Steph., *Campylopus aureonitens* (Müll.

Hal.) A.Jaeger, *Fissidens cryptoneuron* P.Varde, *Leptophascum leptophyllum* and *Weissia brachycarpa* var nov., whilst epiphytes on introduced trees are restricted to small colonies of *Cololejeunea cardiocarpa* (Mont.) A.Evans, *Frullania ericoides*, *F. angulata*, *Lejeunea laetevirens*, *Microlejeunea africana* and *Weissia brachycarpa* var nov.

Species richness increases rapidly with ascending altitude until open banks and exposed rocks, at around 600m, support over 20 species including the aforementioned plus *Riccardia amazonica* (Spruce) Schiffn. ex Gradst.& Hekking, the endemic *Racopilum naumannii* Müll.Hal., *Calymperes erosum* Müll.Hal. *Campylopus pilifer*, *C. aureonitens*, *C. incrassatus* and, *Fissidens* spp. Most species seem to have little or no preference for different rock types or to slopes of different aspects. Man-made clinker faces along the major paths around Green Mountain and on the walls of the Old Marine Barracks (Fig. 7) at the end of the metalled road up Green Mountain are favourite habitats for *Fossombronina husnotii*, *Plagiochasma rupestre* var *rupestre*, the endemic moss *Hyophila ascensionis*

▽Figure 11. Stunningly colourful bryophyte communities on exposed banks towards the top of Green Mountain.





Cardot and another moss with long curled and fragile leaves (Fig. 8) which, after long examination and study of the type specimen, we are calling *Chionoloma bombayense* (Müll. Hal.) P.Sollman. Not only does this moss boast the biggest number of synonyms (over 40) but the name covers a frustratingly large number of specimens with widely disparate morphologies.

Rocks with intermittent run-off are the habitat for *Anomobryum julaceum*, *Philonotis* spp., *Bryum rubracostatum* Müll.Hal., *Poblia annotina* and *Scopelophila cataractae*, whilst deeply shaded damp overhangs contain quantities of *Leptobryum pyriforme*, *Symphyogyna brasiliensis* Nees & Mont., *Riccardia amazonica* and the endemics *Gymnostomum bescherellei* Broth. & Geh., *Lophocolea ascensionis* Steph. (Fig. 9) and *Racopilum naumanii*. For those with a nose for bryophytes *Symphyogyna brasiliensis* is readily detected by its highly aromatic smell that persists for many years in herbarium specimens (Fig. 10).

Perhaps the most stunning and colourful bryophyte communities are those on the exposed

banks above the paths and on the cliffs extending to the top of Green Mountain on the south side of Elliot's path (Figs. 11, 12). These comprise multicoloured swelling tufts of *Anastrophyllum piligerum* (Nees) Steph., *Frullania* spp., *Isotachis aubertii* (Schwaegr.) Mitt., *Mastigophora diclados* (Brid. ex F.Weber)Nees and *Campylopus* spp. growing over which are abundant stems of *Cephaloziellas* and Lejeuneaceae. Broken ground between these is colonized by an *Entosthodon* identified, from spore ultrastructure, as the Réunion species *E. borbonicus* Besch.

Aside from the banks and rocks, the paths themselves on Green Mountain (Elliot's, Bishop's, Cronk's and Dew Pond) commanded much bryological attention. As well as being one of the prime habitats for *Anthoceros cristatus* Steph. and *Phaeoceros evanidus* (Steph.) Cargill & Fuhrer comb.nov. here we found three distinct but as yet unnamed *Brachythecium* spp. and a range of tuberous *Bryums*.

The final, highly striking bryophyte zone is above 700m where regular cloud cover maintains continuously moist cloud forest conditions. As in typical tropical cloud forests the tree branches, twigs and trunks are festooned with epiphytes (Figs. 13-16) whilst the leaves sport



△Figure 12, top. *Mastigophora diclados* and *Campylopus aureonitens*. Figures 13, 14, left to right. *Pandanus* festooned with epiphytes. An underscribed species of *Riccardia* growing on bamboo.





△Figure 15. Bryophyte 'balls' on giant bamboo, Dew Pond, summit of Green Mountain.

an extensive populations of epiphylls. However, the epiphyte flora is very species poor with only single representatives from the Pilotrichaceae (*Lepidopilidium pallidifolium* (Mitt.) Vaz-Imbassahy & D.P. Costa) and Sematophyllaceae (*Acroporium megasporum* (Duby) M.Fleisch.) and lacks several families typical of continental cloud forests (e.g. Meteoriaceae). In fact the only member of the Macromitraceae present on the Island is *Schlotheimia percuspidata* Müll.Hal. and this is confined to bare exposed rocks.

Perhaps unique to Ascension are the balls of *Campylopus arctuatus* (see comment below) *Anastrophyllum* and *Mastigophora* growing on the nodes of the giant bamboo that surrounds the Dew Pond at the summit of Green Mountain (Fig. 15). Growing out at right angles from the internodes are large quantities of an undescribed species of *Riccardia* (Fig. 14).

One of the major tenets of Island Biogeography theory is that sexual reproduction is reduced compared with the mainland counterparts of the same species. In line with this we have failed to find a single perianth on any of our numerous gatherings of the three species of *Frullania* and sporophytes are absent from the quantities of *Campylopus* and *Calymperes* we collected (Fig. 18). Most notably carpocephala have never been seen on the *Marchantia pappeana* despite Catherine's round the year observations: all

it can seem to manage are one or two gemma cups. On the other hand *Plagiochasma*, the only other complex thalloid liverwort on the Island, produces sex organs and sporophytes throughout the year particularly after rain. The same non-seasonal sporophyte production is the norm in a range of taxa including *Anastrophyllum piligerum* (Fig. 17), *Cheilolejeunea ascensionis* (Hook.f & Tayl.) Grolle, *Cololejeunea cardiocarpa*, *Symphyogyna brasiliensis*, *Dicranella ascensionica* Mitt. In Mellis., *Microdus limosus* Besch., *Entosthodon borbonicus* and *Philonotis* spp. but a small minority appear more seasonal. The sporophytes of *Weissia brachycarpa* var. nov. and *Dicranella pygmaea* (A.Br. Bis) Paris mainly mature in the early part of the year. Sporophytes have never been found on three of the endemics *Racopilum naumannii*, *Gymnostomum bescherellei* and *Hyophila ascensionis* with the last species producing distinctive axillary gemmae illustrated here for the first time (Figs. 22, 23).

### **Meanwhile back in the laboratory**

Howard, Silvia and Jeff divided the identification work on our nearly 1000 specimens whilst Catharine's task has been producing distribution maps: the latter revealing that the commonest species (*Trichostomum brachydontium*, *Bryum arachnoideum*, *Lejeunea laetevirens*, *Frullania ericoides*, *Microlejeunea africana*, *Campylopus*





*aureonitens* and *Weissia brachycarpa* var. nov.) are almost continuously distributed on the Island above 250m. In the past months leaf sectioning has become a cottage industry to confirm the identity of the three *Calymperes* species on the Island (*C. afzelii* Sw., *C. erosum* and *C. pallidum* Mitt. – under the expert guidance of the NHM’s resident Calymperaceae expert Len Ellis), and over 60 collections of *Campylopus*. The latter, after much robust badinage between Silvia and Howard, turned out to be the most speciose genus with at least 7 species plus one likely new taxon that does not match anything previously described by Frahm (1985, 2010) and possible merging of *C. arcuatus* (Brid.) A.Jaeger and *C. smaragdinus* (Brid.) A.Jaeger as simply different habitat forms. The other speciose genera are *Fissidens* (another of Howard’s covert passions) and *Bryum* including the very poorly known

species *B. rubracostatum* whose tubers are illustrated here for the first time (Figs. 24, 25). The only other tuber-bearing moss turned out to be *Dicranella staphylina* which is just as scrappy on Ascension as it is in Britain.

Jeff’s penance was the liverworts, but which in the end turned out to be fairly straightforward. Our numerous *Cephaloziella* collections were clearly referable to either *C. divaricata* or *C. turneri* (Paton, 1999) but with their variability on Ascension overlapping completely with the descriptions of two of the West African taxa, *C. vaginans* Steph. and *C. biokoensis* Váňa et F. Müller described in Jones’s West African flora (Wigginton, 2004). Similarly numerous *Riccardia* collections were either the common tropical species *R. amazonica* (Spruce) Schiffn. or a new species. Sadly *Fossombronia hamato-hirta* Steph., originally described as an endemic by

△ Figures 16-19, clockwise top to bottom. Lovely epiphytic *Campylopus arcuatus* in the cloud forest at the summit of Green Mountain. Abundantly fruiting *Anastrophyllum piligerum*. In contrast, none of the three *Calymperes* spp., here *C. erosum*, produce sporophytes and are often, with *Trichostomum brachydontium*, subjected to the ignominy of being eaten by land crabs. Next page, Figures 20-25, clockwise top to bottom. Abundantly fruiting *Fossombronia* spp., here *F. indica*, made identification work possible. Catherine admires the only population of *Marchantia pappeana* on a wet cliff face at Stedson’s Ledge. The endemic *Hyophila ascensionis* and its distinctive stellar gemmae. *Bryum rubra-costatum* produces abundant rhizoidal tubers.

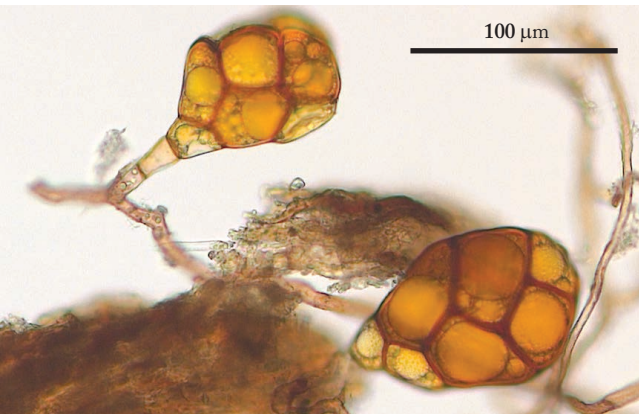
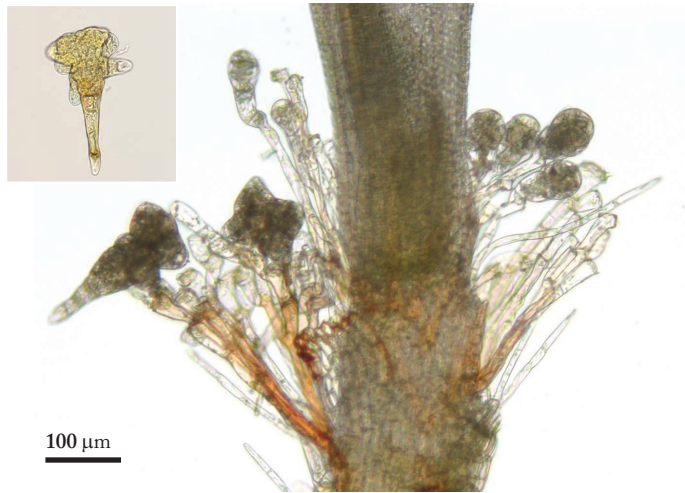




Stephani (1894), is identical in spore morphology and colourless rhizoids to *F. husnotii*. A second species with purple rhizoids is the widespread African *F. indica* Steph (Fig. 20).

Though most of the liverworts are also found on the West African mainland particularly in cloud forests some stand out as having distinctly odd distributions. For example the pantropical *Anastrophyllum piligerum*, very common both on banks and as an epiphyte on Ascension, is only known from two localities on mainland Africa in Rwanda and Zimbabwe (Vána, 1993). Whereas *Anastrophyllum* is highly fertile on Ascension, the common African *Mastigophora diclados*, which grows with it, is sterile. A *Lejeunea*, originally collected by Martin Wigginton in 2005, and subsequently found to be one of the most widely distributed liverworts on the Island, is the South American xerophytic species *L. laetevirens*. In South America this species is rarely fertile (Gradstein & da Costa, 2003) and on Ascension we have yet to find a perianth.

Endemic liverworts are now reduced to just 2 species, *Lophocolea ascensionis* and the undescribed *Riccardia*. The only extant *Marchantia* is *M. pappeana* Lehm. which grows





△ Figures 26, 27 top to bottom. The endemic *Anthoceros cristatus* and its highly ornated thallus. Its lace-like lamellae are even more striking when viewed under the scanning electron microscope (SEM).

only on a permanently wet cliff face at Stedson's Ledge (Fig. 21). Tantalizingly a herbarium specimen from 1889 without a locality turns out to be *M. berteriana* which we failed to find. Most likely it was growing in 'a drip' that has subsequently dried out like the one that saved the explorer and privateer William Dampier and his crew, shipwrecked on Ascension in 1701, from dying of thirst, and which now bears his name.

As to the four hornworts, three species are almost certainly native to the Island with *Phaeoceros laevis* a likely introduction as this is mainly confined to conservation green houses for endangered vascular plants. When growing together with *P. carolinianus*, which is widespread

in natural habitats, the male plants stand out as clearly distinct from the monoicous thalli of the latter species. Of the two endemic species, described by Stephani (1916), intensive research on *Anthoceros cristatus* by Juan Carlos Villarreal confirms this status for the moment, although it may well be the same as an unidentified *Anthoceros* on St Helena (Wigginton, 2012). With its lace-like lamellae *A. cristatus* must be one of the prettiest hornworts in the world (Figs. 26, 27). What really got our pulses racing was the discovery that a small *Phaeoceros*, common along paths and banks on Green Mountain, produces large dorsal tubers unlike those found on any other hornwort (Figs. 28, 29). The type specimen of *A. floribundus* Steph. also has these plus yellow spores which makes it a *Phaeoceros* and not an *Anthoceros*. Much to our astonishment, spore ultrastructure and the tubers exactly match those of *P. evanidus*, a species recently described from the tropical northeastern region of Australia (Cargill & Fuhrer, 2008).

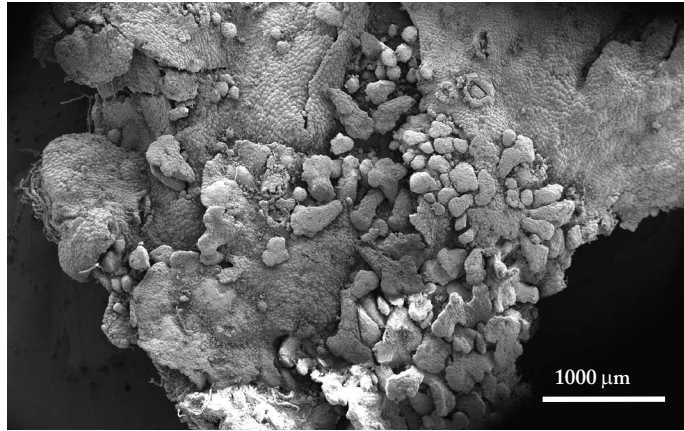
### **Bryophyte conservation**

Despite the small size of Ascension and the wholesale destruction of natural habitats very few of the bryophytes are actually seriously threatened with extinction. This is happily the case for all the endemics and the introduced trees and shrubs now support diverse and flourishing bryophyte communities. However, this is not to say that the introductions do not pose threats for the future: though the survival of the majority of the individual taxa is not at risk some of the prime bryophyte habitats certainly are. For most places in the world over collecting is usually highlighted in accounts of conservation. Apart from a small number of taxa viz. *Frullania apicalis*, *Anomobryum julaceum*, *Didymodon icmadophilus*, *Epipterygium tozeri*, *Scopelophila cataractae*, *Splachnobryum gracile* Besch., this is

almost certainly not the case for Ascension as most species occur in several localities and where these are more restricted they tend to be rather abundant.

Shrub encroachment over rocky exposures along the aptly named Windy Corner and bare banks along Elliot's and Bishop's paths on Green Mountain is almost certainly the biggest cause for concern as these are the only locality for *Frullania apicalis* Mitt. Equally important is Summer House Ridge, where we found *Didymodon icmadophilus* and *Scopelophila cataractae*, and which supports the largest population of the endemic fern *Anogramma ascensionis* (Hook.) Diels once thought extinct. At the same time as the rediscovery of this fern in 2009 Phil Lambdon also collected *Splachnobryum gracile* a species which we failed to re-find. Fortunately topography and inaccessibility almost certainly insure this largely pristine bryophyte habitat against threats from invasive introduced species and grazing animals.

Any conservation activity that requires clearing vegetation and/or digging normally entails months of negotiations for the necessary permissions, risk assessments plus miles of other red tape. In 2011 Ascension Conservation cleared a large bank above Elliot's Path to encourage the growth of the endemic fern *Ptisana purpurascens* (de Vriese) Murdock. Seeing that this was proving to be a great success, when Silvia and Jeff visited the Island in 2012 they recommended smaller scale clearance of open banks on Bishop's Path to encourage re-establishment of original bryophyte communities. Not only did the Conservation team agree with this measure but, within 2 weeks of them leaving the Island in 2012, they all took time off and completed the work (Figs. 30, 31). The recolonization of the cleared areas is now re-establishing some of the primeval Ascension bryophyte communities.



△ Figures 28, 29 top to bottom. *Phaeoceros evanidus*. Note the yellow spores (top) and the large dorsal tubers viewed under the SEM (bottom).

Regular mowing along the paths and their verges is needed to maintain areas of bare soil where ephemeral species thrive. Particularly important are the roadside verge between the Red Lion and the Old Marine Barracks, the only locality for *Epipterygium tozeri*, and the beginning of the Dew Pond track and the south side of Elliot's Path up to the first tunnel for maintaining the largest populations of *Anthoceros cristatus* and *Phaeoceros evanidus*. The only two *Ficus benghalensis* L. trees along the Dew Pond track that support *Radula boryana* need to be preserved, although this species has also been found on the ginger *Alpinia speciosa* (Blume) D.Dietr. along Elliot's Path. We must also highlight the walls of the Old Marine Barracks. These are covered with diverse bryophytes including quantities of the endemic *Hyophila ascensionis*, not to mention several endemic ferns. Cleaning of these would be a conservation



catastrophe (Fig. 7).

A further species that must be considered highly vulnerable is the largest liverwort on the Island *Marchantia pappeana*. Though it covers several square metres of the vertical bank above Stedson's Ledge, were this to dry out the liverwort would almost certainly disappear, which was probably the fate of *Marchantia berteriana* growing in another permanently moist drip that has long since dried out. The absence of sporophyte production by *M. pappeana* and the rarity of gemma cups indicate that the establishment of new colonies is unlikely. However, were *M. pappeana* to die out in the wild, it would almost certainly continue to thrive in the conservation greenhouses at the Red Lion.

Pride of place for remarkable discoveries on Ascension must go to *Physcomitrium flexifolium* Mitt. a moss critically threatened with extinction on the world scale: it has never been seen since the original collections, with no localities, between 1803-5 on St Helena. Thus its appearance in the greenhouses at the Red Lion on Ascension with no sightings in natural habitats was most unexpected. This moss, like the fern *Anogramma* before it, most certainly merits an *ex situ* conservation programme.

### What next?

Looking to the future, several articles that tidy up the taxonomic changes necessitated by our studies are in preparation whilst molecular identification of the fungal endophytes in the thalloid liverworts and hornworts and endemic ferns is part of our ever widening global survey

(Bidartondo *et al.*, 2011; Desirò *et al.*, 2013; Field *et al.*, 2014; Pressel *et al.*, 2010). Should an ongoing application for funding be successful we hope to extend our Oceanic Island studies to include the Brazilian islands of Trindade and Fernando de Noronha. Appropriately for Ascension Island the resurrection of the 'extinct' fern has been commemorated by a set of stamps; a set on the Island's bryophytes is also planned.

### Acknowledgements

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### References

- Ashmole, P. & Ashmole, M. (2000) *St Helena and Ascension Island: a Natural History*. Oswestry: Nelson.
- Bidartondo, M.I., Read, D.J., Trappe, J.M., Merckx, V., Ligrone, R. & Duckett, J.G. (2011) The dawn of symbiosis between plants and fungi. *Biology Letters* 7:574-577. DOI: 10.1098/rsbl.2010.1203
- Cardot, J. (1912) Les mousses de l'expédition nationale antarctique eocossaise. In: Bruce, W.S. (ed.) *Scottish National Antarctic Expedition. Report of the Scientific Results of the Voyage of SY Scotia*. Scottish Oceanographical Laboratory, Edinburgh, pp 55-68.
- Cargill, D.C. & Fuhrer, B.A. (2008) Taxonomic studies of the Australian Anthocerotophyta II: the genus *Phaeoceros*.



## The bryophytes of Ascension Island

<Figures 30-33 left to right. Reclamation site on Bishop's Path and sign highlighting restoration work. Whilst Silvia went to great lengths (... or heights) to find new hornwort localities, Jeff preferred a more laid back (...or down) approach.

*Fieldiana, Botany* 47: 239-253.

**Darwin, C. (1839)** *Journal of researches into the geology and natural history of the various countries visited by H.M.S. Beagle under the command of Captain Fitzroy R.N. from 1832 to 1836.* Henry Colburn, London.

**Desirò, A., Duckett, J.G., Pressel, S., Villarreal, J.C. & Bidartondo, M.I. (2013)** Fungal symbioses in hornworts: a chequered history. *Proceedings of the Royal Society B* 280: <http://dx.doi.org/10.1098/rspb.2013.0207>

**Fairhurst, W. (2004)** *Flowering Plants of Ascension Island South Atlantic Ocean.* Higham Press Ltd., Alfreton.

**Field, K.S., Rimington, W.R., Bidartondo, M.I., Allinson, K.E., Beerling, D.J., Cameron, D.D., Duckett, J.G., Leake, J.R., Pressel, S. (2014)** First evidence of mutualisms between ancient land plants and fungi of the Mucoromycotina and their responses to Palaeozoic changes in atmospheric CO<sub>2</sub>. *New Phytologist* doi: 10.1111/nph.13024

**Frahm, J.-P. (1985)** Africanische *Campylopus*-Arten (Dicranaceae, Musci). *Bryophytorum Bibliotheca* 31. J Cramer, Berlin, Stuttgart.

**Frahm, J.-P. (2010)** *Mosses and Liverworts of the Mascarenes and Seychelles.* An Illustrated Field Guide: Herstellung und Verlag, Books on Demand GmbH, Norderstedt. ISBN 9783842300248

**Frahm, J.-P. (2002)** The taxonomic status of *Bryum arachnoideum* C.Müll. and *B. lanatum* (P.Beauv.) Brid. *Tropical Bryology* 21: 53-56.

**Geheeb, A. (1910)** *Bryologia Atlantica. Die Laubmoose der atlantischen Inseln.* *Bibliotheca Botanica* 73.

**Gradstein, S.R. & da Costa, D.P. (2003)** *The Hepaticae and Anthocerotae of Brazil. Memoirs of the New York Botanical Garden* 87.

**O'Shea, B.J. (1995)** Checklist of the mosses of sub-Saharan Africa. *Tropical Bryology* 10: 91-98.

**O'Shea, B.J. (2006)** Checklist of the mosses of sub-Saharan Africa. *Tropical Bryology Research Reports* 6.

**Paton, J.A. (1999)** *The Liverwort Flora of the British Isles.*

Harley Books, Colchester, England.

**Pressel, S., Bidartondo, M.I., Ligrone, R. & Duckett, J.G. (2010)** Fungal symbioses in bryophytes: New insights in the twenty first century. *Phytotaxa* 9: 238-253.

**Rudman Brown, R.N. (1906)** Contributions towards the botany of Ascension. *Transactions and Proceedings of the Botanical Society of Edinburgh* 23:199-204.

**Stephani, F. (1894)** Hepaticarum species novae. V-VI. *Hedwigia* 33: 1-11.

**Stephani, F. (1912-1916)** Species hepaticarum 5:1-896. Genève et Bale: Georg et Cie, Lyon, même Maison.

**Vána, J. (1993)** Taxonomic Results of the BRYOTROP Expedition to Zaire and Rwanda 11. Cephaloziaceae, Cephaloziellaceae, Gymnomitriaceae, Jungermanniaceae, Lophoziaceae. *Tropical Bryology* 8: 99-103.

**Wigginton, M.J. (Ed.) (2004)** E.W. Jones's Liverwort and Hornwort Flora of West Africa. *Scripta Botanica Belgica* 30.

**Wigginton, M.J. (2009)** Checklist and distribution of the liverworts and hornworts of sub-Saharan Africa, including East African Islands. *Tropical Bryology Research Reports* 8.

**Wigginton, M.J. (2012)** *Mosses and liverworts of St Helena.* Pisces Publications for St Helena Nature Conservation Group, Newbury, England. ISBN 9781874357513

**Wilkinson, D.M. (2004)** The parable of Green Mountain: Ascension Island, ecosystem construction and ecological fitting. *Journal of Biogeography* 31: 1-4.

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