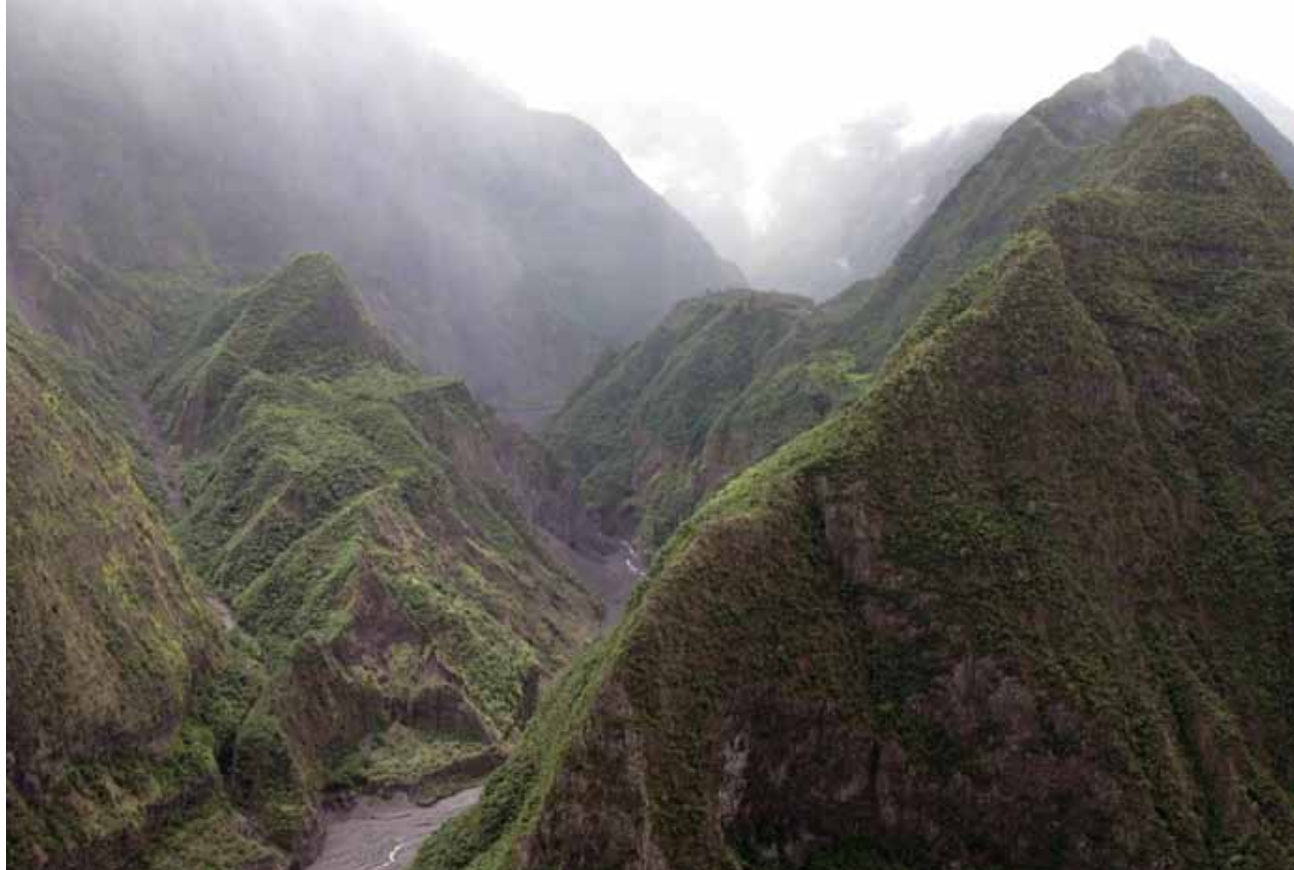
Last September, an international team of bryologists participated in a taxonomic workshop and field meeting on La Réunion. **Jo Wilbraham** was one of several BBS members who attended this exciting event, and here she recounts her experiences and describes the current status of the bryoflora of this Indian Ocean island.

Bryophytes & volcanoes: La Réunion Island



La Réunion is an oceanic island in the Mascarene Archipelago, situated 700 km east of Madagascar and 200 km south-west of Mauritius in the Indian Ocean. This region is part of a recognized hotspot of biological diversity which includes Madagascar and the West Indian Ocean Islands. La Réunion was formed 2 to 3 million years ago as a result of volcanic activity and the island still has one of the most active volcanoes in the world; the Piton de la Fournaise. The mountainous interior of the island soars to 3,069 m at the summit of the Piton des Neiges, which is the highest peak in the Indian Ocean. Surrounding the Piton des Neiges are three immense canyons which were formed from the eroded remnants of this long extinct volcano: the Cirques of Cilaos; Mafate and Salazie. The island is elliptical in outline, with dimensions of approximately 60×45 km (2,512 km²). For a relatively small island there are a wide array of habitats, ranging from coastal *Pandanus* groves to montane cloud forests and alpine peaks. This variety of habitats, abundant rainfall (which can reach 10 m annual rainfall in the mountains) and a dramatic range in altitude allows La Réunion to harbour a very rich and interesting bryophyte flora. A large proportion of natural areas in the central highlands are in a well-conserved state, though increased habitat loss from urbanization, agriculture and the spread of alien invasive species threatens the rich natural heritage of the island. There is an increasing urgency to document and monitor this biodiversity, particularly the less well-known groups such as bryophytes, in order to assist in the development of conservation strategies and management of protected areas.

Bryological exploration on La Réunion

The Mascarene Islands have a comparatively long history of bryological exploration and they are well documented with collections (mostly from the 19th century). The first and only moss flora of La Réunion was produced by Émile Bescherelle in 1880 and includes 209 moss species. A recently published checklist of Réunion mosses (Ah-Peng & Bardat, 2005) records 404 moss taxa from the island, with the largest moss families being the Calymperaceae, Dicranaceae, Hypnaceae, Orthotrichaceae, Pottiaceae and Sematophyllaceae. Approximately 18% of the recorded moss flora is considered endemic to La Réunion, though Ah-Peng & Bardat (2005) suggest that a number of these alleged endemics are an indication of taxonomic problem areas rather than true endemism. For example, 11 of the 72 endemic moss species are in the family

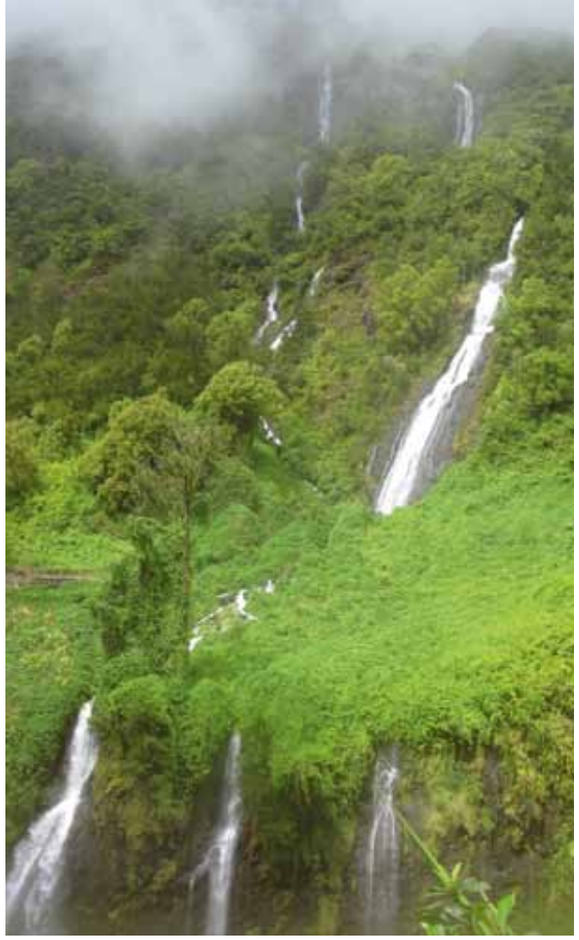
◁ Lava flows of the Piton de Fournaise. *Jo Wilbraham*

△ Forested mountainsides on La Réunion. *Jo Wilbraham*

Hypnaceae, which is a difficult family to identify and in great need of taxonomic revision in the Mascarene Islands. A flora of the liverworts and hornworts of La Réunion has yet to be produced, though more recently several researchers have contributed to the knowledge of these groups with published taxonomic treatments and checklists. There are currently 281 liverwort and hornwort taxa recorded from Réunion (Ah-Peng *et al.*, 2008), with approximately half of the Réunion liverwort flora belonging to the Lejeuneaceae. The production of a liverwort and hornwort flora of the Mascarene Islands is currently in progress, led by Jacques Bardat (Muséum National d' Histoire Naturelle, Paris) and Claudine Ah-Peng (University of Cape

Town/Université de la Réunion). This flora will be an illustrated book, including identification keys, species descriptions, ecological notes and distribution maps of the liverworts and hornworts of these islands. Completion of a moss flora for the Mascarenes will involve a larger collaborative effort involving several members of the BBS Tropical Bryology Group. Once completed, these textbooks will be used to encourage bryology among local students and assist with conservation planning on the island.

In September 2008, a team of 17 bryologists, mostly members of the BBS Tropical Bryology Group, assembled on La Réunion for 2 weeks to participate in a taxonomic workshop and field meeting hosted by the University de la Réunion and La Réunion Parc National. The aim of this taxonomic workshop was to bring together bryologists researching tropical African/West Indian Ocean Island bryophytes in order to collaborate in researching the bryophyte flora of the Mascarenes. The workshop was a mix of sessions based at the university (which involved testing identification keys on fresh specimens); participant-led seminars presenting recent taxonomic work on a family or genus and fieldwork to make collections of bryophytes from under-surveyed areas on the island. An important aspect of the meeting was the bryological fieldwork with local botanists and conservation managers who were interested in learning more about the diverse bryophyte flora of the island. The attendees of this meeting were Claudine Ah-Peng, Roger Lala Andriamiarisoa, Jacques Bardat, Ida Bruggeman-Nannenga, Len Ellis, Terry Hedderson, Itambo Malombe, Howard Matcham, Tamás Pócs, Ron Porley, Ana Seneca, Lars Söderstrom, Pierre Stamenoff, Dominique Strasberg, Benito Tan, Jo Wilbraham and Nicholas Wilding. Our group represented a wide array of countries which included France,



△ Waterfalls cascading down the steep forested mountainsides of the Cirque de Salazie. *Jo Wilbraham*

Hungary, Kenya, Madagascar, the Netherlands, Norway, La Réunion, Singapore, South Africa and the UK.

I had the opportunity to join the team and contribute research into the taxonomy of the moss family Orthotrichaceae, which I have been working on at the Natural History Museum, London (NHM). The Orthotrichaceae is a large diverse family and the Mascarenes are an interesting geographical region in which to study this group. *Cardotiella* is largely restricted to the Mascarenes and Madagascar from where four of its six species are endemic. Also, the monospecific genus *Leiomitrium* is endemic to the Mascarene Islands where it has a particular stronghold on La Réunion. The pantropical *Macromitrium* and *Schlotheimia* are particularly diverse in this region and are very understudied. I am currently revising the taxonomy of these two genera in the Mascarene Islands using the large collection of historical material at the NHM (which includes Bescherelle's herbarium) and specimen loans of recently collected material such as Theo Arts' collections which are held at the National Botanic Garden of Belgium. Representatives of the subfamily Orthotrichoideae are less well-represented on La Réunion, with two species of *Zygodon* and one species of *Ulota*. The large and complex genera *Macromitrium* and *Schlotheimia* are conspicuous elements of the bryophyte flora in the lower montane forests. An unresolved taxonomy with numerous species described, yet often poorly known, make these mosses very difficult to identify satisfactorily. I have been working through herbarium specimens at the NHM, deciphering the characters of species occurring on La Réunion and matching original descriptions and type specimens to species concepts. Having spent a good deal of time in the herbarium with eyes firmly glued to the microscope, the opportunity to travel to La Réunion enabled me to observe these plants in the field and gain some experience of their ecology and field characteristics as well as collecting additional specimens for study.

△ *Macromitrium mauritianum* (top) and *Syrrhopodon mahensis* (bottom). *Jo Wilbraham*

Bryophytes and volcanoes

On our first day of fieldwork we visited the Piton de la Fournaise, one of the most active volcanoes in the world. The lava flows on the eastern slope of the Piton de la Fournaise are a surreal lunar landscape, known as Le Grand Brulé, which at first sight seemed an unlikely habitat for bryophytes. At its most dramatic point, a 300 m-wide section of lava rock, still smouldering in places, stretched into the sea. Between 2004 and 2007 an ecological study investigating the colonization of bryophytes on these lava flows was carried out by Claudine Ah-Peng, which has increased our understanding of the ecology of these pioneer species in this volcanic environment (Ah-Peng *et al.*, 2007). On lava flows laid down by different eruptive episodes, the various stages of colonization can be studied and compared. Where ferns and lichens had begun to colonize the bare rocks, the diversity of bryophyte species was surprisingly high. The first successional bryophytes to colonize included *Campylopus aureonitens*, *Bryum billardii* and small hepatics. During Claudine's survey work, one lava flow had 70 species recorded, predominantly in the family Lejeuneaceae.

Leaving the smoking lava fields behind us, we travelled a short distance to visit the forest climax community of these lava flows. The Mare Longue Réserve Naturelle, on the south slope of the Piton de la Fournaise, is a lowland rainforest which has had 500 years to develop over a bed of lava rock. The Mare Longue forest represents

an important area of lowland rainforest on La Réunion which is a habitat increasingly threatened by pressures from urbanization and development. The forest comprises a low canopy about 25 m high with a dense understorey of ferns and shrubs. Walking through the forest was made awkward by the volcanic boulders and occasional deep holes hidden by vegetation and dim light. A blanket of epiphytic bryophytes and filmy ferns covered the trees. This forest had only a brief list of recorded bryophytes, so the recording efforts of the group greatly enhanced the data available for this important reserve.

Fieldwork in the lowland rainforests

The eastern side of the island receives the highest rainfall with a rain shadow leaving the western coast very dry. Consequently, there is a very different bryophyte flora associated with the two sides of the island. Another excursion to the lowland forests in the east of the island took us to the Grand Étang, a popular picnic spot and an interesting area of secondary rainforest for bryophytes. We allowed ourselves a couple of hours to bryologize along the forest tracks, and a typical 'bryological pace' meant that most of the party did not actually reach the 'large pool' at the end of the trail. A number of interesting epiphytes were found at the edge of the dense forest, such as *Dendroceros borbonicus* and *Colura* sp., epiphytic on twigs at the trackside. Tamás Pócs demonstrated the rare liverwort *Iwatsukia jishibae* (Cephaloziaceae) growing on rotten wood. On the soil banks we found the thalloid liverworts *Symphyogyna brasilensis* (a close relative of *Pallavicinia lyellii*, which is also found on the island) and *Dumortiera hirsuta*.

Into the mountains

Large parts of the remote highlands are accessible only by foot, and so a good deal of the island interior is still very under-recorded for bryophytes. The Plaine des Palmistes is a rich area for bryophytes in the highlands south-west of the three Cirques. We had a brief visit to a unique habitat of *Pandanus montanus* mire at 900 m altitude, which is being studied as an ecological plot by the University de la Réunion. This site had not previously been surveyed for bryophytes, though in the short time we had to visit this site we found several very interesting specimens, particularly the Sphagna, which are being worked up at the moment. This area is currently under threat from development and so we hope our additional data on the remarkable bryophytes found here will help support its protection. One of the bryological highlights of the trip for me was our visit to the mossy elfin forest in the Plaine des Palmistes. The forest was predominantly *Acacia heterophylla–Erica* species with a low canopy shrouded in mist. Thick hummocks of epiphytic bryophytes were draped over the branches. Particularly notable were the large hepatic species adorning the tree branches, such as *Mastigophora diclados*, *Herbertus* sp., *Plicanthus hirtellus* and *Pleurozia gigantea*. The Cirque de Salazie is the wettest of the interior massifs and on a particularly rainy day we drove up the winding hairpin bends towards the Piton Marmite. Low cloud occasionally lifted to reveal spectacular waterfalls cascading down the steep forested mountainsides. We stopped at 1,850 m altitude to bryologize amongst the ericaceous elfin forest around the roadside. These ericaceous shrubs had a dense epiphyte cover of Orthotrichaceae (*Macromitrium*, *Schlotheimia* and *Zygodon*) and low visibility hid some potentially perilous balancing on cliffsides to collect specimens. These trees proved particularly rich in epiphytes and I later found I had collected ten species of Orthotrichaceae from only three or four trees, which represents around a third of the Orthotrichaceae species known from the island. Le Maido, at the western edge of the Cirque de Mafate, provides one of the most impressive viewpoints on La Réunion. The road up from the coast climbed alarmingly steeply to reach the peak of Le Maido at 2,200 m altitude. The vegetation was subalpine *Erica–Hypericum* bush with rocky ravines, invaded by *Ulex europaeus*. Le Maido is the only known locality of the endemic *Grimmia maido*.

▽ *Mastigophora diclados* (left), *Pleurozia gigantea* (centre) and the epiphytic hornwort *Dendroceros borbonicus* (right). *Jo Wilbraham*

Workshop seminars

Our trips into the field were punctuated by seminars given by members of the group on their family of particular interest – usually comprising a presentation discussing the taxonomic features followed by a microscope session for the group to test out new identification keys. Len Ellis started off the series with an insight into the Calymperaceae (a family of the tropical lowlands) with an illustrated presentation of his key to the species found on La Réunion. Ida Bruggeman-Nannenga discussed the 32 species of *Fissidens* known on the island. She demonstrated the little known characters of the leaf costal section and features of the peristome teeth as useful clues to identification. I presented my recent studies into the Orthotrichaceae (particularly *Macromitrium*) on La Réunion. Benito Tan offered a 'two for one' lecture on both the Hookeriaceae and Sematophyllaceae, elucidating the current circumscription of these two large families. The Lejeunecaeae and Lepidoziaceae were covered in two sessions by Tamás Pócs, who gave thorough presentations illustrating the generic characteristics. Itambo Malombe presented his key to the species of *Cheilolejeunea* on La Réunion, which he is studying for his doctoral thesis.

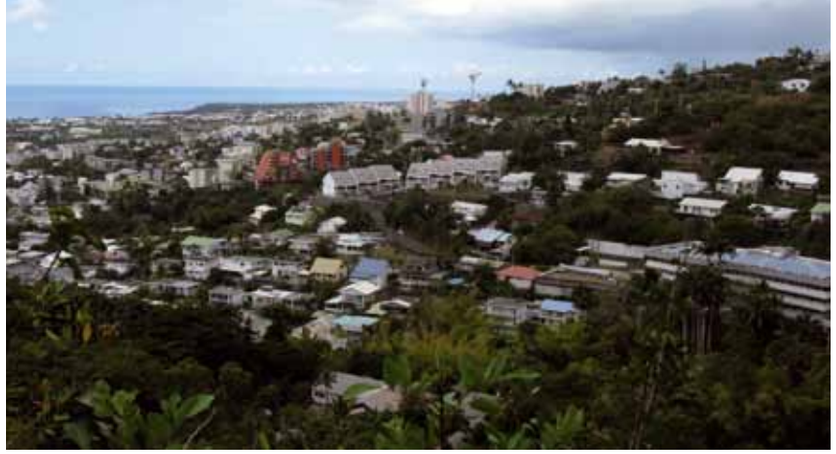
Bryophyte conservation on La Réunion

La Réunion is the best preserved of the Mascarene Islands with an estimated 30% of the native forest still intact (Strasberg *et al.*, 2005). However, the pressures of urbanization around the coastal strip and lowlands; the transformation of habitats for agriculture (predominantly sugar cane plantations) and the introduction of invasive alien species are major challenges for conservation. The majority of the population of La Réunion live in the coastal towns and increasing population pressures mean towns are spreading up the hillsides and putting pressure on lowland forest habitats.

Problems with invasive species were evident as we travelled around the island and came across plants reminiscent of the English countryside. For example, *Anthoxanthum odoratum* seeds were sown some years ago as a food crop for goats and this grass is now widespread on the island. Similarly, *Ulex europaeus* is becoming a problem in many regions, such as on Le Maido, where conservation managers are currently working to eradicate it. In 2007, the Parc National des Hauts de la Réunion was established, with a catchment area covering 42% of the island. The core area of park is a region of 1,000 km² which includes most of the rugged interior and the volcano. Such a scheme will go towards increasing protection of animal and plant life and encourage sustainable development on the island. Ron Porley led a seminar session on bryophyte conservation which led to an interesting discussion on conservation issues for tropical bryophytes. This highlighted the need to identify important conservation areas for bryophytes on La Réunion and, as far as is possible, production of a 'red list' indicating species most at risk from extinction.

The future

Much work has already been achieved on recording the bryophyte diversity of La Réunion and an extensive database of distribution records, maintained by Pierre Stamenoff, is being increased further by the recording efforts of this meeting. The collected specimens are currently being studied and our new and interesting records for La Réunion will be published in a series of papers. We are also working towards a provisional 'red list' for the bryophytes of La Réunion and we hope that this will highlight the bryophyte species most in need of conservation and also indicate important areas for bryophytes on the island. Further details about the bryophytes of La Réunion can be found on the BBS Tropical Bryology Group website at **www.nhm.ac.uk/hosted_sites/bbstbg/mascarenes.htm**



△ Top left. St Denis in the north of the island, illustrating urbanization pressures on the lowland forests.

Bottom left. Group photo of the workshop participants (the author is on the far left).

Right. A coastal *Pandanus* grove.

All photos Jo Wilbraham

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