

Over the past 20 years the Royal Botanic Garden Edinburgh (RBGE) has been involved with many botanical expeditions to Yunnan Province in south-west China, organized through our 'twinning' agreement with the Kunming Institute of Botany in Yunnan. In 2010, our colleagues in the institute offered to organize an autumn expedition to south-west Sichuan Province, to the north of Yunnan – part of the Qinghai–Tibetan plateau and the Hengduan Mountains, the eastern extension of the Himalaya. Thanks to generous funding from The Royal Horticultural Society, Alpine Garden Society and other sponsors, four of us set out for China on 25 August 2010 for over a month. The primary focus of the expedition

as Wolong. It also has several big mountains, including the famous 'Minya Konka' (now Gongga Shan, 7,556 m) at one time claimed by the explorer Joseph Rock to be the highest mountain in the world. Our study area lay on the Tibetan plateau south-west of Chengdu and included the catchments of three large rivers – the Yalong Jiang, Litang Qu and Shuiluo He, all of which flow south eventually to join the Jinsha Jiang (Yangtze River).

Past bryological exploration of Sichuan

The Austrian Heinrich Handel-Mazzetti during his stay in China from 1914 to 1918 visited Sichuan twice, travelling north from his base near Lijiang in Yunnan Province, to the southern counties of Sichuan, between 21 March and 23

Bryophyte exploration of

was to be collection of herbarium specimens and seed of plants of potential horticultural interest, but I was able to focus on bryophytes. My colleagues were two horticultural staff members from RBGE, John Mitchell (expedition leader) and Ross Irvine, and David Wallbridge who had just finished his horticulture training at RBG Kew, and had secured his funded place on the expedition by open competition.

Sichuan Province

Sichuan is a large province covering 220,000 square miles, with a population of over 110 million people. Many of these live in the central Chengdu Plain, a rich agricultural and industrial basin. Sichuan has around 9,000 native species of higher plants, about one-third of the Chinese total. It has many rich and biodiverse forests, for example the network of Panda reserves such





Following his report from the Gaoligong Shan mountains in the October 2008 issue of *Field Bryology* (96), **David Long** takes us a little further north on another bryological adventure in south-west Sichuan.

South-west Sichuan, China

June 1914 (Huili, Dechang, Xichang, Zhaojue and Yanyuan Counties) and again from 23 July to 11 August 1915 (to Yanyuan and Muli Counties). His bryophyte collections are enumerated by Brotherus (1929), Nicholson *et al.* (1930) and Piippo *et al.* (1997), and were the first bryophytes to be collected in Sichuan. Since that time relatively few non-Chinese bryologists appear to have collected in Sichuan. A Finnish/Chinese expedition visited north-west Sichuan in 1991 which resulted in a liverwort checklist for the province (Piippo *et al.* 1997). M. Higuchi and colleagues from the National Science Museum, Tokyo, visited Sichuan in 1996 and reported the discovery of a new liverwort species, *Exormotheca bischleri* Furuki & Higuchi (Furuki

& Higuchi, 2006). However, numerous Chinese bryologists have collected in Sichuan, sometimes in collaboration with the American bryologists S. He and P.L. Redfearn, and their collections have been widely utilized in compilation of recent Chinese bryophyte floras such as Wu & Wang (2000). Bryophytes known from Sichuan province are enumerated in the checklists of Piippo (1990) and Redfearn *et al.* (1996). Thus much is known about Sichuan bryophytes, but as with almost all of China, many regions are poorly explored and new discoveries will always result from careful fieldwork.

The 2010 expedition

On 25 August we flew to Chengdu, capital of Sichuan, where we met our Chinese colleagues who had driven up in two 4×4 vehicles from Kunming – Dr Meng Ying, a specialist on *Poly-*

▲ Limestone mountains north of Jiulong. *D. Long*

◀ A Tibetan village lady at Pengbuxi. *D. Long*



gonatum, and two of her students, Deng Tao and Liu Ya-Hui. They proved to be exceptionally able organizers and field botanists, and along with two drivers made up a very enthusiastic and lively team. After some last-minute shopping we set off westwards on the Chengdu–Lhasa highway, at first a new motorway but later a normal but very busy road with lots of big trucks and big potholes. Our first stop was in Moxi, close to the huge Gongga Shan mountain, clothed at lower elevations in wet broadleaf forest, but our permits did not allow collecting in the nature reserve other than along the roadside. Our next stop was Kangding, a large town tightly wedged in a steep-sided gorge with cloud-shrouded mountains all around, then west to cross the Zheduo Shan pass at 4,996 m altitude – we were now truly into an alpine landscape of granite rocks and screes and dwarf *Rhododendron* heath, vegetation we were to experience regularly over the next 4 weeks.

We then continued west, crossing the extensive flat plain of the Tagong Grasslands grazed by innumerable yaks to the small town of Xinduqiao where we reached the real edge of the Qinghai–Tibet plateau. Still following the Chengdu–Lhasa highway, our next stops were in Yajiang, then Litang, the latter a truly Tibetan town with a picturesque reconstructed monastery; we stayed in the friendly Potala Hotel for several enjoyable days. Day trips south and west of Litang included a couple of days on a new road

through a beautiful mountain landscape at over 4,000 m on the route to the huge Genyen Shan (which we never saw due to cloud). After leaving Litang, we headed south along the valleys of the Litang Qu and Shuiluo He rivers and their tributaries to the remote outposts of Xiangcheng and Daocheng, quite close to the Yunnan border. As we could not complete the planned southern loop (part of the road proved to be non-existent) we retraced our route to Xinduqiao, then south again to Jiulong, our final destination. Jiulong County proved to be a wonderful area with beautiful Tibetan villages, friendly people, richly forested valleys and, best of all, a high pass across limestone mountains with extensive mossy cliffs and screes – a superb botanical finale.

Collecting methods

Bryophytes were collected in the field into folded packets made from ‘rite-in-the-rain’ paper. Enough for two to four (or more) duplicates of each collection was collected where possible in the field. Notes on locality, habitat and substrate were recorded on the packets, and GPS readings and altitudes recorded in a notebook. Each evening, specimens were sorted and cleaned,





- ◀ Far left. The expedition group: from left to right Ross Irvine, David Long, Liu Ya-Hui, Mr Zhang (driver), Mr Baima (driver), John Mitchell, Dr Meng Ying, Deng Tao and David Wallbridge. *D. Long*
- ◀ Centre. Collecting on limestone scree on the Jichou Pass north of Jiulong. *D. Long*
- ◀ Left. Expedition vehicles near Take. *D. Long*

three broad groups, broadleaf forests and scrub, conifer-dominated forests and alpine vegetation. The bryophyte interest of these three zones is outlined below, although in many localities these habitats intergraded, for example some temperate broadleaf forests may have had conifers removed by logging, and effects of grazing and burning have often transformed forests into scrub or grassland. Consequently, the bryophytes often overlap between these broad habitat types.

Broadleaf forests and scrub

and data written up in a notebook. Selected liverworts were cleaned and placed in small ziplock bags with silica gel for DNA extraction. Packets were dried using cool air by means of two electric fans. No heat drying was used (in contrast to vascular plants). When dry, packets were bundled in A4-sized ziplock bags and packed into cardboard boxes for shipment. Two batches were mailed to Kunming and the final batch was taken by car. The whole collection was finally mailed to Edinburgh from Kunming for sorting, packeting, labelling and identification. 738 bryophyte collections were made over 22 days in the field, between 25 August and 25 September, consisting of 503 mosses and 235 liverworts, but no hornworts.

Main habitats and their bryophytes

The expedition investigated habitats largely in the cool temperate and alpine zones, from 2,780 to 4,900 m altitude. The habitats fall into

Wet mossy broadleaf forests were relatively rare; those we encountered occurred between 2,780 and 4,000 m on Erlang Shan, Gaversi Shan and south of Jiulong, and were dominated by *Acer*, *Rhododendron*, *Viburnum*, *Ribes*, etc. Moss epiphytes were relatively few, with the rarity of families Meteoriaceae, Pterobryaceae and Neckeraceae a particularly striking contrast with Yunnan, and also limited numbers of species of leafy liverworts such as *Metacalypogeia alternifolia*, *Frullania*, *Herbertus*, *Lepidozia*, *Plagiochila* and *Bazzania*, and no epiphyllous Lejeuneaceae. Species such as *Conocephalum japonicum* and *Hookeria acutifolia*, frequent in Yunnan, were rare. Large mosses were abundant in the ground layer including *Dicranum*, *Hylacomium*, *Rhytidiadelphus triquetrus* and *Rhodobryum ontariense*.

Most other broadleaf forests encountered were rather dry in character, with small sclerophyll trees such as *Quercus semecarpifolia* which were

often reduced to scrub by grazing. These had a limited ground bryoflora with *Abietinella abietina*, *Entodon*, *Hypnum*, *Rhytidium rugosum*, *Thuidium*, etc. and noticeably few leafy liverworts. However, the tree trunks and branches of shrubs had interesting epiphytes such as *Orthotrichum*, *Ulot* (two species which are new to science), *Leucodon secundus* and *Zygodon*. Rock outcrops amongst scrub, especially on the more basic schists and slate, had interesting thalloid liverworts such as *Asterella leptophylla*, *Conocephalum salebrosum*, *Mannia californica*, *Reboulia hemisphaerica*, *Plagiochasma* and *Targionia hypophylla*. Boulders amongst the scrub often had *Grimmia* and *Racomitrium* species, as yet unidentified, and *Hedwigia ciliata*.

Two valleys with relatively dry scrub (between Jiawa and Mula, and east of Daocheng) were especially interesting with damp mossy banks under the shrubs with a very rich assemblage of liverworts, including *Aitchisoniella himalayensis*, *Asterella leptophylla*, *Exormotheca bischleri*, *Mannia californica*, *Plagiochasma* sp., *Preissia* sp., *Reboulia hemisphaerica* and several *Riccia* spp. The *Preissia* may be a completely new species with very large flat-topped receptacles, *E. bischleri* is endemic to Sichuan Province, and has only been collected once previously, while *A. himalayensis* is new to China and is an interesting and unusual monotypic genus known only from the north-west of the Himalaya of India, and considered to be extremely rare and endangered. Two colonies were found.

Conifer-dominated forests with Fir (*Abies*), Spruce (*Picea*) and Larch (*Larix*), 3,300–4,200 m

Coniferous forests were widespread, the most bryologically interesting being dominated by Fir (*Abies*) in valleys with a higher rainfall, whereas on drier slopes spruce (*Picea*) was dominant, and

in other areas Larch (*Larix*). These forests always contained an understorey of smaller woody broadleaves, such as *Acer*, *Betula*, *Rhododendron*, and *Sorbus* species, etc., and were best-developed in areas south-west of Litang, around Daocheng, several parts of Jiulong County and north of Kangding. These forests were humid and had a rich development of bryophytes on the ground, on living trees and logs, and on rocks and along streamsides. Larger terrestrial mosses included *Actinotuidium hookeri*, *Hypnum*, *Dicranum*, *Hylocomium*, *Neckera*, *Polytrichum*, *Prilium crista-castrensis*, *Rhodobryum ontariense* and *Rhytidiadelphus*.

Epiphytes were frequent, for example the leafy liverworts *Bazzania*, *Herbertus*, *Plagiochila*, *Scapania*, *Lophozia* and *Frullania*, and the mosses *Dicranum*, *Leucodon secundus*, *Neckera*, *Pseudoleskea*, *Paraleucobryum*, *Ulot* (sp. nov.) and *Zygodon*. In only one forest south of Jiulong larger liverworts such as *Anastrepta orcadensis* were more in evidence, especially a large *Scapania* species and *Anastrophyllum alpinum* on the mossy base of a *Rhododendron*. On rotten stumps and logs *Buxbaumia punctata* was found in one site, and more commonly *Anastrophyllum ellipticum*, *Jamesoniella*, *Lophozia incisa* and *Tritomaria exsecta*. Rock outcrops (especially when calcareous) were always of interest with *Bartramia*, *Encalypta*, *Plagiopus oederianus*, *Ptychomitrium*, *Timmia* and *Tortella tortuosa*.

Alpine zone, with Juniper/ *Rhododendron* scrub, open rocks and screes, *Kobresia* meadows, marshy streamsides and lake margins, 3,980–4,900 m

The expedition targeted many alpine areas for their interesting vascular plants, on high passes such as the Zheduo Shan, Gaversi Shan, Tuer (Rabbit) Pass, the Litang to Lamaya road, the Jiawa to Dewu road, south-east of Daocheng



1. *Exormotheca bischleri* with receptacles, mixed with *Fossombronina*. 2. *Aneura crateriformis* in a calcareous flush. 3. Gorge with dry *Quercus* scrub. 4. *Athalamia pinguis* with conspicuous ventral scales. 5. *Leucodon secundus*, an epiphyte on evergreen oaks. 6. *Mannia californica* on shady, calcareous soil. 7. *Aitchisoniella himalayensis* with its unique receptacles, a new record for China. 8. *Pressia*, possibly a species new to science. D. Long





and on the new airport road north-west of Kangding. Most of these areas were on granite, where cliffs, boulder fields and dry screes were studied along with streamsides, marshes and lake margins. Open slopes had a limited flora, but *Rhytidium rugosum* and *Abietinella abietina* were very common. Damp soil patches amongst dwarf *Kobresia* clumps had a flora of tiny liverworts including *Anthelia juratzkana*, *Lophozia decolorans* and *Marsupella* spp.; in places Splachnaceae colonized dung or animal remains, particularly *Tetraplodon angustatus* and *Voitia nivalis*. The acidic granite rocks were often colonized by *Racomitrium* and *Andreaea* species. The liverwort flora amongst the granite boulders was disappointingly limited with few large liverworts apart from *Anastrepta orcadensis* and *Scapania* spp. Lake margins and marshy areas were surprisingly poor for bryophytes – not a single *Sphagnum* was seen, though of interest were *Aulacomnium palustre* and *Climacium dendroides*.

In sharp and welcome contrast to the granite, the spectacular high-level limestone which outcropped extensively on the high pass north of Jiulong at between 4,400 and 4,620 m had a rich calcicole bryoflora, particularly on cliff ledges and boulders: *Blepharostoma trichophyllum*, *Campylophyllum halleri*, *Cirriphyllum cirrosium*, *Clevea hyalina*, *Ctenidium*, *Didymodon giganteus*, *Distichium capillaceum*, *Mannia controversa* subsp. *asiatica*, *Meesia uliginosa*, *Mnium*, *Myurella*, *Oreas martiana*, *Preissia quadrata*, two *Schistidium* spp., *Timmia* and *Tortella tortuosa*. This was an outstandingly rich bryoflora, comparable to that on the Yulong Xue Shan and Da Xue Shan mountains in Yunnan.

Significant finds

During the expedition particular focus was given to complex thalloid liverworts (the Marchantiidae) because of current research interests at RBGE. Not only did south-west Sichuan prove to be of great interest for these



1. *Oreas martiana* in alpine heath. 2. Mountains of the Zheduo Shan, north-west of Kangding. 3. *Buxbaumia punctata* on a log in an *Abies* forest. 4. *Asterella leptophylla* with its delicate receptacles. 5. A typical mossy *Abies*/*Rhododendron* forest south-west of Jiulong. 6. *Rhodobryum ontariense* on humus in a conifer forest. D. Long

plants, but also the wet summer meant that these plants were very conspicuous and in excellent fertile condition. *Riccia* species were found almost everywhere (but because of taxonomic difficulties no identifications can easily be made at present), but the best find was undoubtedly *Aitchisoniella himalayensis*, listed in the World Red List of Bryophytes and new to China. *Exormotheca bischleri* was also of great interest as it is endemic to Sichuan and was found in excellent fertile condition. One collection of *Preissia* may be a new species as it is much larger in size than the widespread *P. quadrata* (which was also found in two sites). Both *Mannia* species seen, *M. californica* and *M. controversa* subsp. *asiatica*, were new to Sichuan, as was *Clevea hyalina*.

Other liverworts new to Sichuan included *Aneura crateriformis*, *Calycularia crispula*, *Lophocolea minor* and *Tritomaria exsecta*, and the mosses *Campylophyllum halleri*, *Meesia uliginosa*, *Orthotrichum obtusifolium*, *Saelania glaucescens*

and *Voitia nivalis*. However, a large proportion of the bryophytes are provisionally identified only to genus level, and the help of specialists around the world is actively being sought for identifications. In this way many other interesting finds are expected.

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