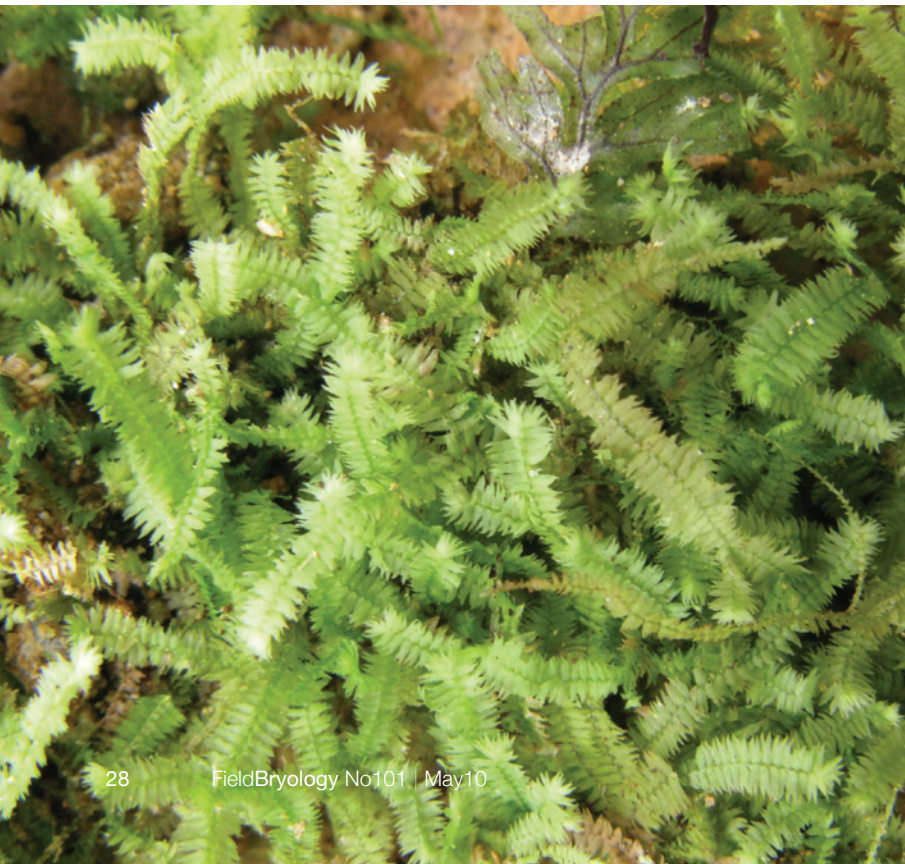


The rediscovery and conservation status of *Bazzania bhutanica* in Bhutan



Prior to 2009, only one colony of *Bazzania bhutanica* was known from Bhutan. However, during an investigation last winter, a second colony was discovered.

David G. Long,
Baboo Ram Gurung
and **Rebecca Pradhan**
describe the story behind this species, its ecology and the threats to its existence.

Bhutan is a small kingdom in the east Himalayan Mountains sandwiched between India and China (Tibet), still relatively unexplored for bryophytes, but nevertheless known to have a rich bryophyte flora. Mizutani (1967) recorded six species of *Bazzania* from Bhutan, although three of these [*B. tridens* (Reinw. et al.) Trevis., *B. himalayana* (Mitt.) Schiffn. and *B. sikkimensis* (Steph.) Herz. were erroneous records originating from the Kalimpong district, West Bengal (former 'British Bhutan')]. His reports of *B. imbricata* (Mitt.) S.Hatt., *B. griffithiana* (Steph.) Mizutani and *B. appendiculata* (Mitt.) S.Hatt. were based on specimens collected by William Griffith in Bhutan in 1838.

As a result of a number of botanical expeditions in the late 1970s and 1980s many bryophytes were collected by DGL. Study of the liverworts from these visits was led by the late Riclef Grolle and resulted in publication of a checklist (Long

△ Tongsa Dzong, one of the splendid religious fortresses of Bhutan. *D. Long*

◁ *B. bhutanica* at one of its two known localities at Buduni near Samtse in south-west Bhutan, where it is critically endangered due to pressures of deforestation and development. *D. Long*

& Grolle, 1990), which increased the number of *Bazzania* species known from Bhutan to 14. Study of the mosses has progressed more slowly, but it is hoped to publish an updated moss checklist soon. Many new records for Bhutan and a few species new to science emerged from the liverwort collections; one of the latter was *Bazzania bhutanica*, discovered in 1982 and published as a new species by Kitagawa & Grolle (1987).

During a week at Samchi (now Samtse) in south-west Bhutan, close to the Indian border, in February/March 1982, a number of ravines and stream valleys leading down to the Indian plains were explored by A.J.C. Grierson and DGL, and



△ Above: *Meteorium buchanani* (Meteoriaceae), a common epiphyte in mossy temperate oak forests in Bhutan. D. Long
 ▷ Centre: *Wiesnerella denudata* (Wiesnereallaceae), a rare, complex thalloid liverwort found along streams in humid temperate broadleaf forests in Bhutan. D. Long
 ▷ Right: *Bazzania tridens* growing on shady rocks in the same ravines where *B. bhutanica* was relocated. D. Long

a few bryophytes were collected as well as many flowering plants. It was in one of these ravines that *Bazzania bhutanica* was discovered. These foothills of the Bhutan Himalaya have in the past supported luxuriant subtropical forests (Grierson & Long, 1983) rich in large and often valuable trees such as *Ailanthus grandis*, *Bombax creiba*, *Pterospermum acerifolium*, *Shorea robusta*, *Terminalia myriocarpa* and *Tetrameles nudiflora*, but over the past century intermittent logging has removed many of these trees and much of the forest is now secondary. Nevertheless, along many streams in valleys and ravines, reasonable forest cover has sometimes survived and such places are important refugia for trees, shrubs, lianas, herbs and bryophytes characteristic of those forests. The primary human activities in these forests are firewood and fodder harvesting, and cattle grazing, both of which are sustainable in moderation, but a significant threat to biodiversity if over-indulged.

The data given on the original collection was: Bhutan, Samchi District, ravine at Buduni W of Samchi, 26°54' N, 89°03' E, subtropical

forest, on crumbling shady rock face, 380 m, 1 March 1982, D.G. Long 10532 (E, KYO, NICH, JE).

At the time of collection, its significance was not realized and no detailed records of ecology, population size, threats, etc., were made, though the bryophyte species *Fissidens javanicus* Dozy & Molk., *Pallavicinia lyellii* (Hook.) Carruth. and *Solenostoma truncatum* (Nees) R.M.Schust. ex Vána & D.G.Long were collected in the same locality.

A set of the 1982 liverworts was sent to Riclef Grolle in Jena, and his preliminary study of Long 10532 led him to believe it might be a new species, and he therefore sent it to N. Kitagawa in Nara, Japan, who confirmed its distinctness. This led to its description as a new species (Kitagawa & Grolle, 1987). They noted that *B. bhutanica* was very distinctive and different from all other known *Bazzania* species though it showed similarities to the related genus *Acromastigum*, but they regarded these as superficial and more important characters, such as branching pattern and stem anatomy, confirmed its placement in



Bazzania. Since that study, Meagher (2006) has described a new species, *Bazzania scalaris*, from Papua New Guinea, and suggested that its closest relative is *B. bhutanica*, though this differs from *B. scalaris* in that 'the cuticle [of *B. bhutanica*] is strongly asperous and often coarsely verruculose, the cells of the lateral leaves have evenly thickened walls and indistinct trigones, and the lobes of the lateral leaves are only weakly spreading' and 'the leaves are much shorter and more or less contiguous to slightly imbricate'. To date *B. scalaris* is the only known close relative of *B. bhutanica*.

Over recent decades the 'Bryophyte Specialist Group' of the IUCN Species Survival Commission has been compiling a global 'Red List' of bryophytes (Anonymous 2009), and following discussions with DGL, four liverworts from Bhutan were included on that list along with an evaluation of their conservation status: *Andrewsianthus ferrugineus* Grolle (Endangered), *B. bhutanica* (Critically Endangered), *Scaphophyllum speciosum* (Horik.) H.Inoue (Vulnerable) and *Schistochila macrodonta* W.E. Nicholson (Endangered). The 'CR' status accorded to *B. bhutanica* was due to the view that it was considered to be facing an extremely high

◁ Mossy temperate mixed conifer/broadleaf forests on the Dochu La, east of the capital, Thimphu. D. Long

risk of extinction in the wild in the immediate future because of its 'occurrence estimated to be less than 100 km², area of occupancy estimated to be less than 10 km²' and 'known to exist at only a single location'.

As *B. bhutanica* had not been seen in the wild for 27 years, it was considered urgent and important that an attempt be made to re-find the plant and clarify its current status. WWF awarded a small grant in 2009 to BRG to undertake this investigation and through RP an approach was made to DGL to assist with a new survey. DGL was able to visit Bhutan for 3 weeks in November/December 2009 and all three of us undertook 2 days of field work at Samtse to carry out a search for *B. bhutanica*. On 6 December 2009 we re-located the plant in the original locality at Buduni and also in a new locality nearby at Lafeti Khola, and were able to collect small voucher samples, record more detailed ecological data, reassess the threats and take digital images of the plant and its habitat. The details of these collections are as follows:

Bhutan, Samtse District, Buduni Kholsa ravine west of Samtse, 26°54'26.8"N, 89°04'05.8"E, 295 m, steep-sided valley in degraded subtropical forest, on soil in exposed vertical face of river terrace by stream, 6 Dec 2009, Long, Pradhan & Gurung 38845 (THIMPHU, E); Lafeti Khola valley west of Samtse, 26°54'27.3"N, 89°03'52.1"E, 296 m, steep-sided valley in degraded subtropical forest, on vertical river terrace face by stream, 6 Dec 2009, Long, Pradhan & Gurung 38854 (THIMPHU, E).

The two localities are ecologically almost identical, in stream valleys in degraded subtropical forest, with trees such as *Castanopsis indica*, *Chisocheton cumingianus*, *Duabanga grandiflora*, *Lithocarpus fenestratus*, *Litsea salicifolia*, *Pandanus furcatus* and *Tetrameles nudiflora*, shrubs including *Boehmeria macrophylla*, *Callicarpa arborea*, *Hyptianthera stricta*, *Piper* sp. and *Wendlandia grandis*, climbers such as *Calamus latifolius*, *Glycosmis cymosa*, *Lepisanthes senegalensis*, *Mikania micrantha*, *Rhaphidophora*

hookeri and *Pothos scandens*, and the large ferns *Angiopteris* sp. and *Cyathea spinulosa*. The *B. bhutanica* plants formed yellow-green mats closely appressed to a vertical, gravelly, north-west-facing bank (an eroded ancient river terrace), in the Buduni ravine with about 50% cover in an area of approximately 5 × 1 m, closely associated with a *Hymenophyllum* species and the bryophytes *Pallavicinia lyellii*, *Fissidens* sp. and *Bazzania tridens* (Reinw. et al.) Trevis., which was more bluish-green in colour than *B. bhutanica*. In the Lafeti site *B. bhutanica* was more abundant than at Buduni, occupying 30–40% cover on a vertical bank of approximately 10 × 2 m. The associated bryophytes were as at Buduni, though *Hymenophyllum* was absent. In both sites, the colonies were heavily shaded by overhanging shrubs.

In terms of conservation, both sites are highly vulnerable to immediate and future threats. Immediate threats are any increase in forest clearance by villagers for firewood and fodder for livestock, and over-grazing by cattle, both of which will cause further loss of tree and shrub cover, and therefore destroy the shade and humidity vital to the survival of *B. bhutanica*. Longer-term threats appear to be severe: a new National Development Plan under preparation in Bhutan is likely to include Samtse and its surrounding area as a zone for industrial and housing development (on account of its proximity to India), and both sites for *B. bhutanica* are likely to be destroyed if this development goes ahead. Even if the immediate sites were protected, nearby development would probably lead to abstraction of the water supplies from these valleys and the greatly increased human population would add to degradation and possibly over-grazing of these localities.

Our conclusion is that, in spite of the discovery of a second population of *B. bhutanica*, its status

at Samtse as Critically Endangered is fully justified and should be maintained. We strongly recommend that a search for further colonies in other parts of southern Bhutan be undertaken as soon as possible, and recommend to the Royal Government of Bhutan that future industrial development be zoned in a more appropriate area.

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◀ The subtropical foothills of south-west Bhutan near Samtse showing one of the many small stream valleys descending to the plains on the Indian border. D. Long