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***Bazzania bhutanica* (Lepidoziaceae, Marchantiophyta) – a critically endangered liverwort recorded in Indian bryoflora**

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Bazzania bhutanica N.Kitag. & Grolle, a critically endangered species previously known only from Bhutan, has been recorded for the first time in Indian bryoflora from West Siang District of Arunachal Pradesh. The species is characterized by typical 'Acromastigum-like' appearance, crenulate leaf and underleaf margins and 2–3-lobed underleaves.

In the present state of our knowledge, the genus *Bazzania* Gray is represented in India by 13 species, viz. *B. appendiculata* (Mitt.) S.Hatt., *B. assamica* (Steph.) S. Hatt., *B. bidentula* (Steph.) Steph. ex Yasuda, *B. himalayana* (Mitt.) Schiffn., *B. orientalis* (Steph.) Parihar, *B. oshimensis* (Steph.) Horik., *B. ovistipula* (Steph.) Abeyw., *B. pearsonii* Steph., *B. praerupta* (Reinw., Blume & Nees) Trevis., *B. sikkimensis* (Steph.) Herzog, *B. sumbavensis* (Gottsche ex Steph.) Steph., *B. tricenata* (Wahlenb.) Trevis., *B. tridens* (Reinw., Blume & Nees) Trevis. (Sharma and Srivastava 1993, Singh 2001, Das and Singh 2006, Zhou et al. 2012). The genus is most prolific in the eastern Himalaya and the north-east India where all the species, except *B. oshimensis*, are present, followed by the western Ghats with seven species and western Himalaya with two species. *B. appendiculata*, *B. assamica*, *B. bidentula*, *B. himalayana* and *B. sikkimensis* are confined to the eastern Himalaya, including the north-east India, alone in Indian bryoflora, whereas others are common between two or more bryo-geographical regions of the country (Mizutani 1967, Sharma and Srivastava 1993, Singh 1996, Das and Singh 2006, Singh and Nath 2007, Manju et al. 2008, Singh et al. 2008, Daniels 2010, Singh et al. 2010, Eshuo and Chaturvedi 2011, Das and Sharma 2012, Singh and Barbhuiya 2012, Manjula et al. 2013, Schwarz 2013). Stephani (1924) reported *B. pusilla* (Steph.) S.Hatt. (= *Mastigobryum pusillum* Steph.) from 'India Orientalis' – Kudremukh in Karnataka. Recently Schwarz (2013) also listed it from Karnataka. This species, however, has been treated as a synonym of *B. ovistipula* by Mizutani (1967) and Sharma and Srivastava (1993). Similarly, *B. imbricata* (Mitt.) S.Hatt., reported from the eastern and

western Himalaya, has recently been synonymised with *B. tricenata* by Zhou et al. (2012). The occurrence of *B. intermedia* (Lindenb. & Gottsche) Trevis., earlier reported from Nilgiri Hills (Stephani 1908), has been considered doubtful by Mizutani (1967), Sharma and Srivastava (1993) and Daniels (2010).

During the course of the present study on liverworts and hornworts of the eastern Himalaya, we came across a hitherto unknown species of the genus from West Siang District in Arunachal Pradesh. A review of relevant literature revealed it is *B. bhutanica* N.Kitag. & Grolle, a species so far known only from Bhutan. A detailed description and illustration of the species has been provided to facilitate its easy identification in Indian bryoflora. With the present addition, the number of species of *Bazzania* represented in Indian bryoflora has gone up to fourteen.

Bazzania bhutanica N.Kitag. & Grolle in J. Hattori Bot. Lab. 61: 269. 1986. (Fig. 1: 1–25)

Plants pale brown to yellowish in herbarium material. Shoots 15–20 mm long, 1.0–1.6 mm wide including leaves, branching lateral pseudodichotomous type, flagelliform branches 1–4 per plant, ventral intercalary, arising from underleaf axils, slender, 5–8 mm long. Stem oval – orbicular in outline in transverse section, 125–160 × 135–170 µm, 7–9 cells across diameter, undifferentiated; cortical cells in a single layer, subquadrate – rectangulate, 13–26 × 13–28 (–35) µm, moderately thick – thin-walled, pale yellow; medullary cells subquadrate, polygonal – rectangulate, 11.0–27.0 × 14.5–28.0 µm, thin-walled – moderately thick-walled, hyaline to yellowish. Rhizoids

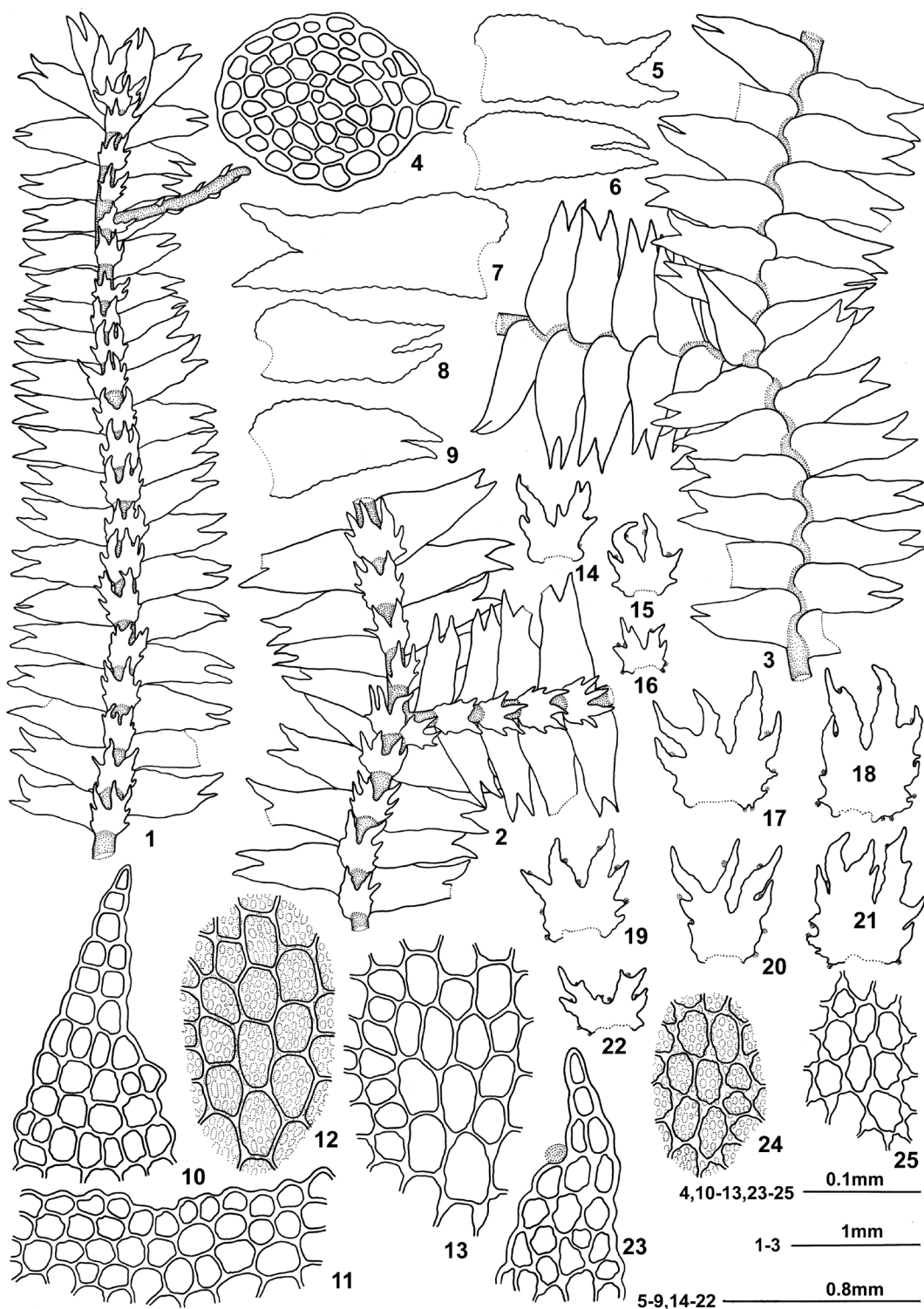


Figure 1. *Bazzania bhutanica* N.Kitag. & Grolle (1) a portion of plant in ventral view. (2) the same showing branching (3) a portion of plant in dorsal view. (4) transverse section of the stem. (5-9) leaves. (10) cells at leaf apex. (11) cells at leaf margin. (12) cells at leaf median. (showing surface ornamentations). (13) cells at leaf base (showing vitta). (14-22) underleaves. (23) apical underleaf cells. (24) cells at underleaf median. (25) cells at underleaf base. (All figures drawn by S. Singh Deo from S. Singh Deo 50911A.)

not seen. Leaves fragile, caducous, contiguous to loosely imbricate, incubous, obliquely inserted, asymmetrical, oblong – rectangulate, 0.5–1.1 mm long, 0.25 – 0.5 mm wide, deeply bilobed to 1/4–1/3 of leaf length, lobes narrowly triangular – lanceolate, acute – subacute, almost equal in size, 8–13 cells long, 4–7 cells wide at base, 1–3 (–4) cells uniseriate toward apex, (1–) 2–4 cells biseriate below, subparallel – occasionally divergent, sinuses deep, narrow, 'V'-shaped, dorsal margin slightly arched, base slightly dilated, extending up to middle of stem, ventral margin straight, base simple, occasionally connate with underleaf base, both margins crenulate, cells thin-walled with indistinct-nodulose trigones, intermediate thickenings absent; apical and subapical leaf cells subquadrate, rectangulate – polygonal, 17.5–30.5 × 13.0–27.0 µm; marginal leaf cells subquadrate – polygonal, 14.5–21.0 × 16.0–25.5 µm; median leaf cells, polygonal – rectangulate, 19.0–52.0 × 17.5–35.0 µm; basal leaf cells polygonal, subquadrate – rectangulate, 16–36 × 20–28 µm, vitta cells larger, 37.0–63.0 × 17.5–41.5 µm; surface coarsely verrucose; oil-bodies not seen; leaf near the branch emergence unlobed, triangulate with acute apex and rounded base. Underleaves contiguous, distant in apical portion, transversely inserted, making a 25°–45° angle with the stem, subquadrate – rectangulate, twice as wide as stem, 0.2–0.6 mm long, 0.2–0.4 mm wide, deeply 2–3-lobed, with large marginal teeth looking almost like lobe, apex acute – acuminate, lateral margin entire – crenulate, cells thin –

slightly thick-walled with nodulose trigones, intermediate thickenings absent; apical and sub apical underleaf cells rectangulate, polygonal – subquadrate, 16–35 × 8–24 µm; median underleaf cells polygonal, 24.0–43.0 × 14.5–27.0 µm; basal underleaf cells polygonal, 24.0–43.0 × 9.5–24.0 µm; surface coarsely verrucose. Fertile plants not seen.

Habitat. Terrestrial, growing on soil enriched with humus in tropical forests in association with *Frullania apiculata* (Reinw., Blume & Nees) Dumort., *Bazzania sumbavensis* (Gottsche ex Steph.) Steph., *Radula obscura* Mitt., *Calyptogeia arguta* Nees & Mont. ex Nees and the species of *Jungermannia* and *Pallavicinia*.

Distribution. India [eastern Himalaya (Arunachal Pradesh – present study)], Bhutan (Fig. 2), (Kitagawa and Grolle 1986, Long and Grolle 1990, Long et al. 2010).

Specimens examined. India, eastern Himalaya, Arunachal Pradesh, West Siang District, on way to Tato from Kaying, 94°38'35"E, 28°32'43"N, ca 680 m, 22.08.2011, S. Singh Deo 50906F, 50911A (CAL).

Discussion

Bazzania bhutanica is characterized by 'Frullania type' terminal branching (Fig. 1: 2,3); stem undifferentiated



Figure 2. Map of Arunachal Pradesh (India) and Bhutan showing distribution of *Bazzania bhutanica*.

with the cortical cells not forming a hyaloderm (Fig. 1: 4); leaves contiguous to loosely imbricate, asymmetrical, oblong – rectangular, deeply bilobed with crenulate margins and coarsely verrucose surface (Fig. 1: 1–3, 5–13); underleaves usually contiguous, deeply 2–3-lobed with entire to crenulate lateral margins, sometimes with large marginal teeth which appear like lobe and coarsely verrucose surface (Fig. 1: 1, 2, 14–25).

Unlike other Indian species of the genus, *B. bhutanica* has a characteristic ‘*Acromastigum*-like’ appearance because of crenulate leaf and underleaf margins and 2–3-lobed underleaves. But the similarity with the genus *Acromastigum* A. Evans ends there as *B. bhutanica* never has ‘*Acromastigum* type’ branching and shows undifferentiated stem with 15–19 vertical rows of non-hyalodermous cortical cells as compared to usually seven rows of cortical cells, which are much larger than medullary cells and form a distinct hyaloderm in the former.

Bazzania bhutanica differs from all Indian species of the genus in having crenulate leaf margins and deeply lobed underleaves. However, it resembles *B. scalaris* D. Meagher, a species known from Papua New Guinea, in having bilobed leaves, crenulate leaf margins and deeply lobed underleaves. But, it differs from *B. scalaris* as the latter has widely spreading, subopposite to almost alternate leaves, smooth leaf and underleaf surface and thick-walled leaf cells with strongly nodulose, bulging and often confluent trigones (Meagher 2006).

Bazzania bhutanica is included in IUCN Red list of threatened species under Critically Endangered (CR) category as it was known only by the type collection from Buduni Kholsa in 1982 with less than 100 km² of area of occurrence and 10 km² of area of occupancy (Bryophyte Specialist Group 2000; see also Long et al. 2010). Recently the species was once again collected from its type locality as well as a nearby locality at Lafeti Khola in Samtse (Samchi) District in Bhutan by D. G. Long and party in 2009 (Long et al. 2010). According to them (Long et al. 2010), both the localities are ‘highly vulnerable to immediate and future threats’ because of various anthropogenic activities and the proposed developmental plan that might lead to the degradation, or even total destruction of natural habitats of the species. With the present discovery of the species from India, about 580 km east-northward from the hitherto known localities of the species, the area of occurrence of *B. bhutanica* has definitely increased, but the area of occupancy of the known Indian populations is again less than 10 km². The Indian habitat of the species, though not under any immediate anthropogenic influence, is highly vulnerable to slash-and-burn agriculture prevalent in entire north-eastern region of the country, in addition to what Long et al. (2010) have already outlined as immediate threats for its Bhutanese counterpart.

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