

STATUS OF FAMILY LOPHOZIACEAE (HEPATICAE) IN INDIASMITA SRIVASTAVA¹, S.C. SRIVASTAVA² AND K.K. RAWAT³¹*Department of Botany, University of Lucknow, Lucknow*^{2,3}*CSIR National Botanical Research Institute, Rana Pratap Marg, Lucknow***ABSTRACT**

Status of family Lophoziaceae in India has been discussed in the light of recent investigations and our own observations on Indian taxa. A total of 19 taxa have been recognised under eight genera including *Isopaches* Buch., *Lophozia* (Dumort.) Dumort., *Schistochilopsis* (N. Kitag.) Konstant., *Anastrepta* (Lindb.) Schiffn., *Anastrophyllum* (Spruce) Schiffn., *Tritomaria* Schiffn. ex Loeske, *Tetralophozia* (R.M. Schust.) Schljakov and *Plicanthus* R.M. Schust. Four taxa viz., *Anastrophyllum minutum* var. *himalayanum* var. nov., *Lophozia udarii* sp. nov., *Lophozia indica* sp. nov. and *Schistochilopsis incisa* var. *himalayana* var. nov., have been described as new to science. *Sphenobolus longkyrdumii* A.P. Singh & V. Nath is proposed as synonym under *Metahygrobiella albula* (Mitt.) Grolle (family Cephaloziaceae Mig.), hence excluded.

Keywords : Morpho-taxonomy, Liverworts, Lophoziaceae

INTRODUCTION

Family Lophoziaceae (Dumort.) Dumort. is a large family of about 280 globally distributed species (De Roo & al., 2007). A number of recent studies particularly based on genetic analysis and phylogenetics not only suggest exclusion of various elements earlier placed under family Lophoziaceae but also provide some interesting findings (Schill & al., 2004; Yatsentyuk & al., 2004; De Roo & al., 2007; Konstantinova & Vilnet, 2009; Vilnet & al. 2009; Söderström & al., 2010).

In India, the family has been treated very casually resulting in a complete lack of knowledge of the same. Whatever work has been done so far, remains restricted to sporadic taxonomic description, or listing of some taxa in floras. Hence, in the light of the above mentioned recent findings as well as due to lack of adequate information on several Indian taxa of Lophoziaceae, it was felt desirable to provide an updated complete account of various taxa of the family known from this country. The family was earlier treated in India as subfam. Lophozioideae Cavers under family Jungermanniaceae with genera: *Anastrepta* (Lindb.) Schiffn., *Anastrophyllum* (Spruce) Steph., *Chandonanthus* Mitt., *Lophozia* (Dumort.) Dumort., *Sphenobolopsis* (N. Kitag.) Konstant. (as *Lophozia*), *Tritomaria* Schiffn. ex Loeske (Parihar & al., 1994), *Andrewsianthus* R.M. Schust. (Bapna & Kachroo, 2000) and *Sphenobolus* (Lindb.) Berggr. (Singh & Nath, 2007). However, In the light of recent molecular studies, a number of shifts have been suggested regarding the status of various taxa (see Schill & al., 2004; Yatsentyuk & al., 2004; Heinrichs & al., 2005; Forrest & al., 2006; He-Nygren & al., 2006; De Roo & al., 2007; Vilnet & al., 2008; Cradall-Stotler & al., 2009; Konstantinova & Vilnet, 2009; Vilnet & al., 2009; Söderström & al., 2010) which created a need for a comprehensive revision of the group to fulfill the lacuna in Indian bryology.

The family Lophoziaceae has been treated differently by different workers. It was earlier treated either as a separate family (Grolle & Long, 2000) or as part of Jungermanniaceae (Schuster, 1984; Crandall-Stotler & Stotler, 2000; Dumsholt, 2002). Schuster (1974) without marking any affinity between Lophoziaceae and Scapaniaceae, stated them apparently related. Subsequently, Schuster (1984) treated it under family Jungermanniaceae as subfam. Lophozioideae Cavers, and his system of classification of hepaticae is being instantly followed by numerous workers even till date. Schuster (2002) once again did not treat them separately. On the other hand Grolle and Long (2000) treated Lophoziaceae (including subfam. Lophozioideae Cavers and subfam. Jamesonielloideae Inoue) separate from Jungermanniaceae. Yatsentyuk & al., (2004) and Schill & al., (2004) demonstrated the nesting of Scapaniaceae Mig. in Lophoziaceae clades, supported by De Roo & al., (2007). Yatsentyuk & al., (2004) proposed to either merger of Scapaniaceae and Lophoziaceae or removing some

elements of the latter, which are closely related to Scapaniaceae. Following Yatsentyuk & al., (2004), Heinrichs & al., (2005) included Lophoziaceae into Scapaniaceae followed by Forrest & al., (2006), He-Nygren & al., (2006), De Roo & al., (2007) and Heinrichs & al., (2007). However, on the other hand Grolle and Long (2000), Crandal-Stotler and Stotler (2000) and Dumsholt (2002) treated it under Jungermanniaceae. Söderström & al., (2010) separated Anastrophyllaceae Söderstr., De Roo and Vilnet from Lophoziaceae on the basis of molecular studies and kept *Anastrophyllum* (Spruce) Steph., *Anastrepta* Lindb., *Barbilophozia* Loeske, *Chandonanthus* Mitt., *Crossocalyx* Meylan, *Gymnocolea* Dumort., *Hamatostrepta* Váňa and Long, *Isopaches* Buch, *Neorothocaulis* Söderstr., De Roo & Vilnet, *Orthocaulis* H. Buch., *Plicanthus* Schust., *Schlajakovia* Konstant. & Vilnet, *Schljakovianthus* Konstant. & Vilnet, *Sphenolobopsis* R.M. Schust. & N. Kitaag., *Sphenolobus* (Lindb.) Berggr. and *Tetralophozia* Schust under this family. Though final status of the family continues to be disputed, the family Lophoziaceae has now been accepted as polyphyletic in origin (Yatsentyuk & al., 2004; De Roo & al., 2007; Schill & al., 2004; Vilnet & al., 2008, 2009; Cradall-Stotler & al., 2009; Söderström & al., 2010). As the final status of family Lophoziaceae including its allied families like Anastrophyllaceae is still under scrutiny, we therefore, hesitate to segregate the members of Anastrophyllaceae for now. Hence, a total of eight genera with 19 taxa have been discussed under family Lophoziaceae to ascertain the present status in India.

MATERIAL AND METHODS

The present study is based on fresh as well dried herbarium specimens, deposited in Lucknow University Hepatic Herbarium (LWU) as well as obtained from overseas Herbaria (FH, NICH, NY). Types of new taxa have been deposited in the Lucknow University Heptaic Herbarium (LWU).

Key to the genera of Lophoziaceae in India

1. Leaves strictly 2-lobed 2
- 1a. Leaves lobe number variable, 2-4(-5)-lobed 4
2. Plants appressed *Isopaches*
- 2a. Plants suberect to erect 3
3. Leaves spreading, dorsal lobe never folded over ventral; lobes 1/8-1/10 of the leaf length; leaves obliquely inserted at dorsal surface; dorsal half of leaf base decurrent; ventral half of leaf base transverse with reflexed margin; lobe apex always obtuse *Anastrepta*
- 3a. Leaves antically secund, dorsal lobe folded over ventral; lobes 1/4-1/3(-1/2) of the leaf length; leaves transversely inserted at dorsal surface, dorsal half of leaf base transverse; ventral half of leaf base slightly decurrent without reflexed margin; lobe apex acute, subacute to obtuse *Anastrophyllum*
4. Leaf margin entire 6
- 4a. Leaf margin denatate 7
5. Leaves 2-4(-5)-lobed, dorsal half rarely folded over the ventral; stem dorsiventrally differentiated internally *Lophozia*
- 5a. Leaves (2-) 3-4 lobed, dorsal half folded over ventral, stem not dorsiventrally differentiated internally *Tritomaria*
6. Leaves irregularly lobed *Schistochilopsis*
- 6a. Leaves 3-4 lobed 8
7. Leaves symmetrically 4-lobed, transversely inserted; leaf cells with indistinct trigones *Tetralophozia*
- 7a. Leaves asymmetrically 3-lobed, obliquely inserted; leaf cells with bulging trigones *Plicanthus*

Isopaches Buch., Mem. Soc. Pro F. Fl. Fenn. 8: 287. 1932 .

Plants appressed to substratum; with gemmiparous, ascending to erect slender stems. Cortical layer with uniformly thickened cells; medullary cells thin-walled. Leaves succubous, canaliculate, broadest above middle, obliquely inserted, bifid about 1/3 of their length with pointed lobes. Leaf cells uniformly thickened, in moist conditions thin-walled with small trigones. Underleaves lacking.

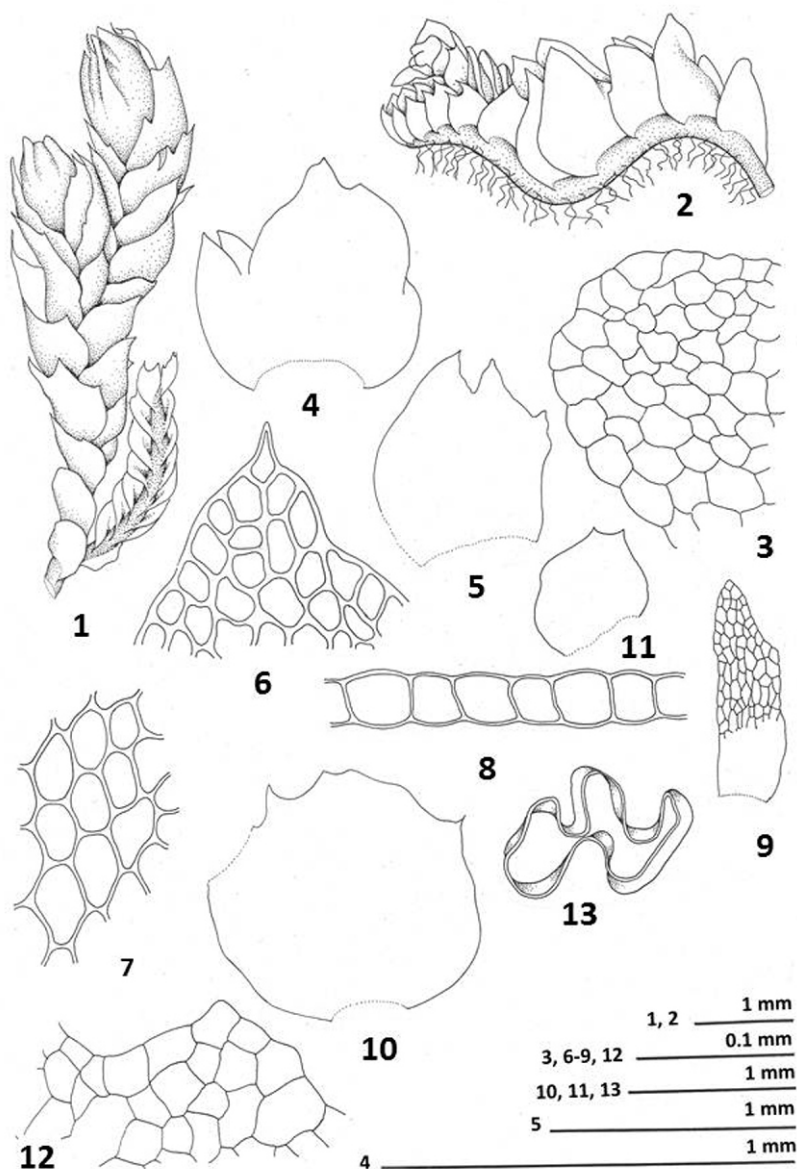


Fig. 1. *Isopaches decolorans* (Limpr.) H. Buch. 1. Plant with young perianth, dorsal view. 2. plant, lateral view. 3. Stem T.S. 4, 5. Leaves. 6. Apical and sub-apical cells of leaf. 7. Mid-basal cells of leaf. 8. Leaf T.S. 9. Underleaf. 10. Bract. 11. Bracteole. 12. Cells of perianth mouth. 13. T.S. of perianth (after Rawat and Verma, 2013).

Dioicous. Perianth cylindrical below but 3-5 plicate above, gradually contracted to lobulate mouth.

Type : *I. bicrenatus* (Schimdt.) Buch.

The genus is represented in India with single species, *I. decolorans* (Limpr.) Buch. (Long, 2005 as *Laphozia decolorans*; Rawat & Verma, 2013)

Isopaches decolorans (Limpr.) Buch., Mem. Soc. F. Fl. Fenn. 8: 288. 1932. Rawat & Verma, Nat. Sci. 11(9): 119. 2013. *Lophozia decolorans* (Limpr.) Steph., Sp. Hepat. 2: 147. 1902. *Jungermannia decolorans* Limpr., Jahresb. Schles. Gesell. Vsterl. Kult. 57: 116. 1880. (Fig. 1)

Plants small, 2.0 - 4.5mm in size, pale green to bright green when fresh, whitish to yellowish brown when dr, succulent, growing in dense patch, creeping, closely appressed to substratum; shoots occasionally branched, branching 'Frullania-type'. Stem elliptical in cross-section, fleshy, 147-212µm across, up to 10 cells wide; cells

undifferentiated, $16 - 23 \times 13 - 26 \mu\text{m}$ in size, thin walled, atrigonus. Rhizoids numerous, scattered along the ventral surface except the shoot apices. Leaves succubous, obliquely inserted, closely imbricate producing julaceous habit, concave, broader than long, $0.68 - 1.1 \times 0.49 - 0.85 \text{mm}$ in size, unistratose; ventral insertion oblique; dorsal insertion transverse; margins hyaline, decolourate, entire, occasionally with few one-celled projections appearing as small tooth near subapical margin, rarely with a large 4-6 cells high and 3-4 cells broad tooth or lobe at the dorsal base of leaf; apex bilobed, rarely with a third small to large lobe, lobes unequal, acute, terminating in a single elongated apical cell, $19 - 22 \times 13 - 16 \mu\text{m}$ in size; subapical cells $13 - 26 \times (9.7) 13 - 16 \mu\text{m}$; median cells $(13) 19 - 23 \times (13) 16 - 23 \mu\text{m}$ in size; basal cells $16 - 29 \times 13 - 16 \mu\text{m}$ in size; cells slightly thick-walled; trigones indistinct except at apices; cuticle smooth. Underleaves variable in shape and size, rounded lobed to elongate. Rhizoids numerous. Gemmae not seen.

Dioecious Male and female plants are same in size. Male plants very rare in population. Androecia terminal; bracts similar to leaves, with one antheridium per bract; antheridia spherical to elliptical; stalk biseriate, short. Gynoecia terminal; bracts larger than leaves, 2-3lobed; bracteoles smaller, 2-3-lobed. Perianth green, elongate, 5-plicate, mouth lobulate, lobes denticulate, teeth 1-2-celled. Mature sporophytes not observed.

Habitat : Growing on partially shady road side slopes with *Solenostoma* sp. and *Diplophyllum nanum*. The locality receives heavy snowfall during the winters.

Type : Austria, 1879, Breider J. s.n. (G!)

Range : Austria, Bhutan, Bulgaria, Camerron, Canada, China, Congo, France, Equatorial Guinea, India, Italy, Nepal, Norway, Scandinavia, Switzerland, Russia, Tanzania, Uganda, (Schuster, 1951b, Müller, 1954; Arnell, 1956; Ladyzhenskaya and Zhukova, 1971; Schljakov, 1974; Long, 1979, 2005, 2011; Vana, 1982; Bizot et al., 1985; Potempkin, 1990, 1993; Mwasaga, 1991; Müller, 1995, 2006; Schuster, 1995; Schuster and Konstantinova, 1996; O'Shea & al., 2003; Bakalín, 2005a; Sabovljević and Natcheva, 2006; Aleffi & al., 2008; Oyesiku, 2008; Potempkin and Sofronova, 2009; Zhang & al. 2013).

Distribution : Sikkim, Arunachal Pradesh (Tawang) (Long, 2005; Rawat and Verma, 2013)

Specimens examined : India : Arunachal Pradesh, Tawang town, c. 2950mts., 27 April 2002, K.K. Rawat and M.S. Azeem 15598/02, 15607/02 (LWU).

Long (2005) reported this species from Sikkim Himalaya as *Laphozia decolorans*. Though Buch (1933) suggested the synonymy of *Lophozia decolorans* into *Isopaches decolorans* quite long time back, however, got established recently by De Roo & al., (2007) on the basis of phylogenetical studies. Rawat and Verma (2013) recently reported this species from Arunachal Pradesh also.

Anastrepta (Lindb.) Schiffn., in Engler & Prantl, Nat. Pflanzenfam. I, 3: 85. 1893. *Jungermannia* Sect. *Anastrepta* Lindb., Lindberg & Arnell, Kgl. Sv. Vet.-Akad. Handl. 23: 40. 1889.

Plants medium to large, pale green to brownish green or reddish brown, scattered or in caespitose patches, on soil covered rocks or humus; branching simple, sparse, always postical intercalary. Stem prostrate to suberect, ascending, subrounded to elliptical in transverse section, differentiated into small, thick-walled cortical and large, thin-walled medullary cells. Leaves succubous, alternate, imbricate to contiguous, obliquely inserted on the antical half with long decurrence and transversely inserted on the ventral half of the stem, subvertically erect to subhorizontally spreading, secund dorsally, antical margin convex at the base and postical leaf margin strongly decurved or reflexed, leaf abaxially concave, cordate, ovate to broadly ovate, unequally bilobed; lobes much smaller in comparison to leaf length, apex obtuse to blunt with shallow to crescent sinus; cells moderate-sized, thin-walled, with minute to large trigones. Underleaves absent or vestigial. Cuticle smooth or faintly verrucose. Gemmae (1-) -2 celled, angular.

Dioicous. Male bracts intercalary, in 2-5 pairs, saccate, similar to the leaves but smaller in size. Perianth cylindrical-obovoid, deeply plicate above middle, gradually contracted to narrow mouth.

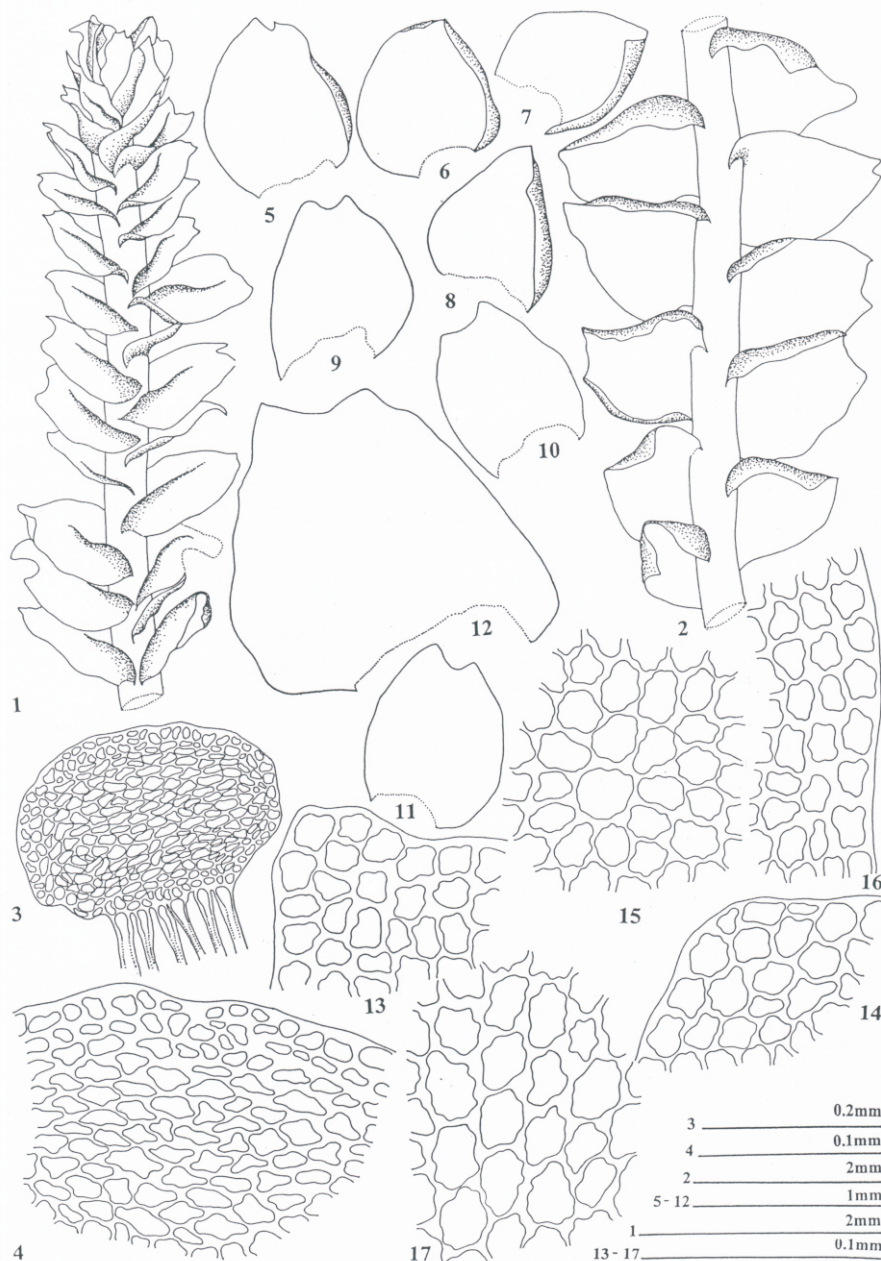


Fig. 2. *Anastrepta orchadensis* (Hook.) Schiffn. **1.** Plant, dorsal view. **2.** Portion showing reflexed leaf ventral lobe. **3.** Stem, cross section. **4.** Enlarged portion of cross section of stem. **5-8.** Folded leaves. **9-12.** Inflated leaves. **13, 14.** Apical cells of leaf. **15.** Median cells of leaf. **16.** Marginal cells of leaf. **17.** Basal cells of leaf (Figures drawn from: 1, 3, 5-11, 13-17 from NICH 201016; 2, 4, 12 from NICH 312159).

Type : Jungermannia orchadensis (Hook.) Schiffn.

In India, the genus is represented by a single species, *A. orchadensis* (Hook.) Schiffn. According to Schuster (1951a) *Anastrepta* is a specialized derivative from its close relative *Lophozia*. This specialization seems to be in its growth habit (strongly ascending and suberect) but the mode of leaf insertion is transverse on the ventral half in *Anastrepta* in contrast to other species of Lophozioideae which are transversely inserted on dorsal half and the difference in the stem anatomy make *Anastrepta* absolutely distinct from *Lophozia* (see Kitagawa, 1966).

Further, Schuster (1981) described a number of criteria which delimit *Anastrepta* and suggest affinity of this genus to include it in subfamily Lophozioideae as suberect growth, curved at apex, stem with distinct and firm

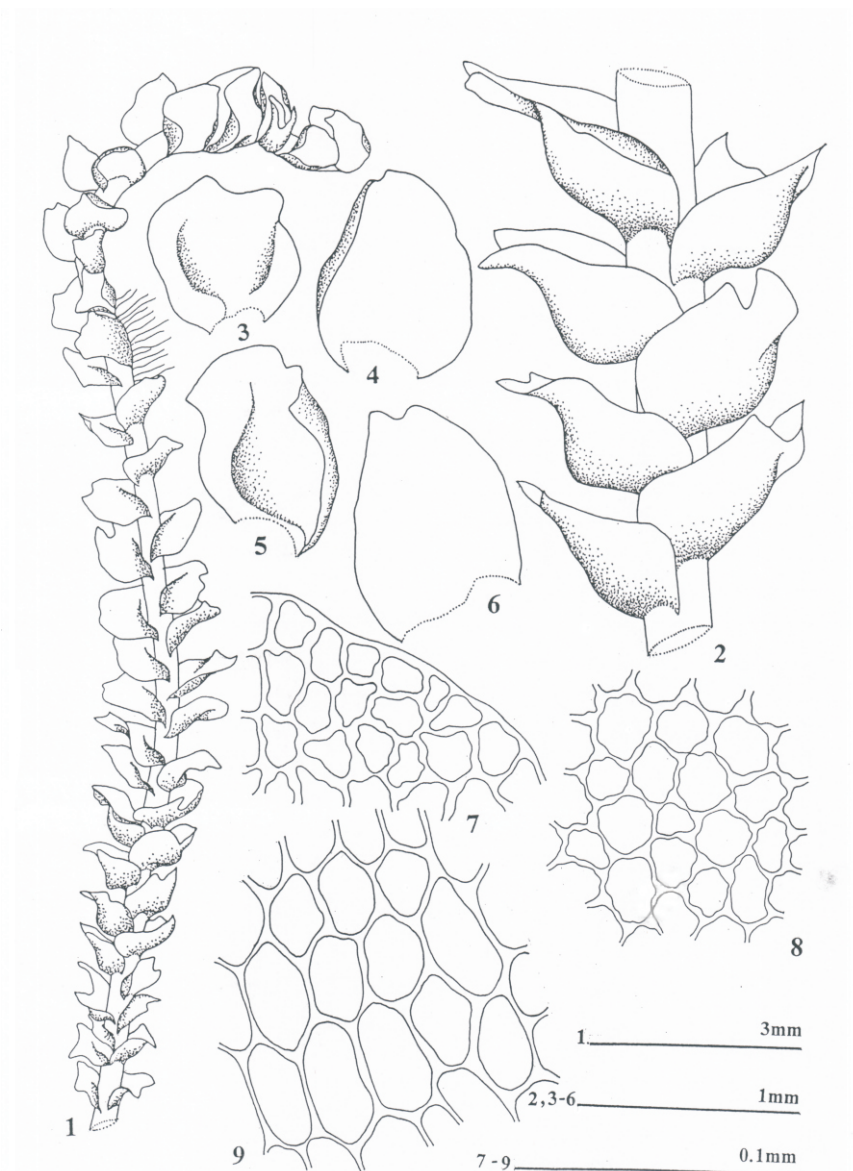


Fig. 3. *Anastropta orcadensis* (Hook.) Schiffn. 1. Plant portion with male inflorescence. 2. Same, enlarged. 3-6. Male bracts. 7. Apical cells of male bracts. 8. Median cells of male bract. 9. Basal cells of male bract. (All figures drawn from NICH 312195).

cortex, branching lateral intercalary, capsule wall 5 - stratose, female bract connate with bracteole, presence of gemmae, abundant rhizoids, pluriplicate perianth with rounded plicae and male bract 1-2 androus with distinct paraphyses.

Anastropta orcadensis (Hook.) Schiffn., in Engler & Prantl, Nat. Pflanzenfam. 1, 3: 85. 1893. *Anastropta sikkimensis* Steph., Sp. Hepat. 6: 119. 1917. *Jungermannia orcadensis* Hook., Brit. Junger. pl. 71. 1816. (**Fig. 2,3**)

Plants medium to large, 8 - 30mm long, 0.9 - 1.5 (-1.95)mm wide (with leaves), pale green, brownish to reddish-brown, scattered or in caespitose patches on soil covered rocks or humus; shoots simple to sparingly branched; branches sparse, always postical intercalary. Stem rigid, subterete, upcurved at apices, subrounded, elliptical to more or less flattened in transverse section, 0.30 - 0.34mm and 14-16 cells wide laterally, 0.18 - 0.20mm and 15-18 cells wide vertically; differentiated into cortical and medullary cells; cortical cells in 2-3 layers, smaller, thick-walled, pigmented, subrounded, polygonal to sub-quadrate, 3.8 - 11.4 × 7.6-15.2µm in size; medullary cells larger, thin-walled, non-pigmented, flattened, oblong, polygonal to octagonal, 15.2 - 26.6 × 7.6 - 11.4µm in size. Rhizoids numerous, scattered on ventral surface of the stem.

Leaves imbricate to contiguous, alternate, succubous, subvertically erect to sub-horizontally spreading, leaf insertion different on both sides of stem, obliquely inserted on the antical half with decurrence and transversely inserted on postical half, leaf abaxially concave, antical leaf margin convex at base, postical leaf margin strongly decurved and reflexed, cordate, ovate to broadly ovate, 0.54 - 0.78 (-1.29)mm long, 0.60 - 0.66 (-1.32)mm wide, almost as long as wide, widest above the base, shortly bilobed; lobes broadly triangulate, 1/10 - 1/8 of the total leaf length, antical lobe slightly smaller than postical, 3-7 cells high, 7-10 cells wide, postical lobe 4-7 cells high, 9-16 cells wide, lobe apex subacute, sometimes obtuse to blunt, sinus shallowly rounded to lunate, (0.09-) 0.12 - 0.18 (-0.24)mm deep, 0.21 - 0.27 (-0.45)mm wide; cells minute to medium sized, thin-walled; apical cells small, rounded to subrounded with minute trigones, 9 - 15 × 9 - 18µm in size; median cells rounded, subrounded to polygonal with distinct trigones, 12 - 24 × 9 - 18µm in size; marginal cells small, polygonal, more or less isodiametric, 12 - 18 × 9 - 15µm in size; basal cells large, subrounded, polygonal, slightly elongated with large trigones, 18 - 33 × 15 - 21µm in size. Cuticle smooth to faintly verrucose. Gemmae not seen.

Dioicous. Male plants upto 28mm long, 0.72 - 0.90mm wide (at male bract portion); male inflorescence both terminal as well as intercalary; bracts in 2-5 pairs, almost leaf-like but smaller in size, saccate, ovate to subquadrate, 0.54 - 0.75mm long, 0.60 - 0.72mm wide; cells thin-walled, trigones minute to absent; apical cells rounded to subrounded, 9 - 18 × 12 - 18µm in size; median cells subrounded, 9 - 27 × 12 - 27µm in size; basal cells large, subquadrate, elongated, polygonal, 30 - 45 × 15 - 21µm in size. Female plants not seen.

Habitat : On soil covered rocks, humus or rotten logs in the subalpine coniferous forest, rarely ascending to the alpine zone (Kitagawa 1966).

Type : *Jungermannia orcadensis* Hook., Scotland, ex Hb. Hooker (PC!)

Range : Bhutan, China, Czech Republic, France, Germany, India, Java, Japan, Nepal, Taiwan, United States of America. (Mitten, 1861; Grolle, 1966; Hattori, 1966; Kitagawa, 1966; Frahm, 1987; Pippo & al., 1997; Aicardi & al., 1998; Kučera and Vána, 2003; Staples and Imada, 2006; Singh & al., 2010).

Distribution : Manipur (Ukhrul), Sikkim (Dzongri, Tsomgo Lake), West Bengal (Darjeeling, Sandakphu, Phalut) (Hattori, 1966; Singh & al., 2010).

Specimens examined : India: Patria Darjeeling (Phalut-Sandakphu), c. 3200 - 3550m.; June 6, 1960; Hara & al., 201016 (NICH). Nepal: East Nepal, above Topke Gola; c. 3650m.; June 18, 1972; Z. Iwatsuki 312159 (NICH).

Anastrepta orcadensis was reported from India (Sikkim Himalaya) as *Jungermannia orcadensis* on the basis of collections of J.D. Hooker (Mitten, 1861). Chopra (1938, 1943) listed two species of *Anastrepta*, *A. orcadensis* and *A. sikkimensis* from Darjeeling. Later, Kitagawa (1966) synonymized *A. Sikkimensis* under *A. orcadensis*. Herzog (1939) listed *A. orcadensis* from Tsomgo lake in Sikkim Himalaya. Later on Parihar (1961-62), Hattori (1966, 1971) and Kitagawa (1975) also listed it from Eastern Himalaya. Grolle (1966), Mizutani (1979) and Parihar & al., (1994) listed this species both from Eastern Himalaya and Nepal.

This plant can be easily differentiated with other Lophoziaceae taxa due to specialized and peculiar type of leaf insertion, which makes leaves markedly reflexed along the postical margin. The leaf insertion is antically oblique with decurrence and transversely inserted on postical half.

The study is based on the authentic specimens obtained from NICH, Japan. Of the two specimens investigated, one was from Darjeeling (India) and the other was from East Nepal. Striking differences in the plants of both the locations were observed, which seem to be interesting environmental effect on the same species in both the regions. The plants of Darjeeling are small, 8 - 12mm long, 0.9 - 1.5mm wide, reddish brown in colour with stiff texture, leaves smaller 0.54 - 0.78mm long, 0.60 - 0.66mm broad and stem having similar structure and anatomy but cell size is slightly smaller than those of the plants from Nepal which were much larger, up to 50mm long, 1.09 - 1.95mm wide (with leaves), pale green to light brown in colour, smooth textured,

much larger leaf up to 1.29mm long, 1.32mm broad and the stem is also larger in diameter with large cells than those of the Darjeeling plants.

Anastrophyllum (Spruce.) Steph., Hedwigia 32: 140.1893.

Plants medium, small to very large, reddish brown to blackish brown; branching lateral intercalary, also from the axil of leaf. Stem rigid, ascending to erect, terete, orbicular to suborbicular in cross section, differentiated into 1-3 - layered, deeply pigmented, collenchymatous, thick-walled cortical cells and large, slightly pigmented medullary cells. Leaves succubous, distant to loosely imbricate forming cluster at the apex, alternate, loosely caespitose, strongly secund dorsally, concave to canaliculate, subtransversely inserted on the dorsal half and obliquely inserted on the ventral half upto stem midline, oblong-ovate, quadrate, sub - quadrate to rectangulate, shallowly to deeply 2-lobed to (1/16-) 1/10 - 1/2 (-2/3) of its length, lobes equal or subequal, blunt and divergent, broadly to narrowly triangulate, subparallel, asymmetric, acute to obtuse, sinus deep to shallow; dorsal margin usually smaller than ventral, both margins incurved; cells small to moderate, collenchymatous, unevenly thick-walled with simple, nodular and confluent trigones; apical cells small, polygonal, subisodiametric; median cells larger than apical cells with nearly confluent trigones; basal cells distinctly elongated with longitudinally confluent trigones (cell lumen small and irregular in shape). Cuticle nearly smooth, faintly to distinctly verrucose.

Asexual reproduction by means of 1-3 -celled elliptical or ovoid, angulate gemmae formed at the apices of the leaf at plant apex. Perianth large, highly emergent, deeply pluriplicate above the middle.

Type : Anastrophyllum donianum (Hook.) Steph. (*Jungermannia doniana* Hook.)

The discovery of the genus in India was made by Mitten (1861), who reported *Jungermannia piligera* Nees, *J. doniana* Hook. and *J. assimile* Mitt. from Sikkim, on the basis of specimens collected by J.D. Hooker in 1848. A fourth species, *Anastrophyllum alpinum* Steph., was probably also collected by Hooker and described by Stephani (1917) (see Schill & Long, 2003). Grolle (1964) reported *A. joergensenii* Schiffn. from Sikkim and reduced *A. alpinum* Steph. under *A. joergensenii*. Schill & Long (2003) however, doubted *J. piligera* as *A. bidens* (Reinw., Blume et Nees) Steph. Hattori (1966) reported *A. minutum* (Schreb. ex Cranz) R.M.Schust. as *Sphenolobus minutus* from Sikkim. Recently Daniels & al. (2012) reported *A. aristatum* (Herzog ex N. Kitag.) A.E.D. Daniels & al. from India and China.

Another species of the genus viz. *A. subacuta* Herzog (= *Cuspidatula subacuta* Herzog) is now treated as *Horikawayella subacutum* (Herzog.) S. Hatt. & Amak. under Solenostomataceae.

Buch (1933) divided *Lophozia-Sphenolobus* complex into eight genera including *Anastrophyllum* and *Sphenolobus*, differentiated mainly on the basis of leaf size and insertion pattern. Schuster (1951a) considered these characters insufficient for differentiation and synonymized *Sphenolobus* under *Anastrophyllum*. However, Müller (1954) resurrected *Sphenolobus* and differentiated it from *Anastrophyllum* in the presence of large size of plant, mode of leaf insertion, form of leaves, strongly thickened cell walls and elongated cells of stem, which was later accepted followed by Kitagawa (1966). In a recent revision of *Anastrophyllum*, Schill & Long (2003) treated *Sphenolobus* as synonym of *Anastrophyllum*. However, recent molecular studies (De Roo & al., 2007) have shown *Sphenolobus* as distinct from *Anastrophyllum* gene pool, as discussed earlier, but no morphological characters could be assigned to differentiate the two taxa. Molecular techniques are always helpful, provided they are supported by the morphological expression otherwise identification would never be possible. *Sphenolobus* is thus treated here under *Anastrophyllum*.

Key to the species of *Anastrophyllum* in India

1. Leaves deeply bilobed, up to or more than half of the leaf length 2
- 1a. Leaves shallowly bilobed, less than half of the leaf length 3
2. Leaf lobe apex with single row of 2-3 cells; female bract 1-4 lobed, margin irregularly serrate, sinuate and denticulate; perianth mouth ciliate and sparsely denticulate *A. bidens*
- 2a. Leaf lobe apex with single row of 5 or more cells; female bract 1-3-lobed, margin entire or wavy; perianth mouth ciliate but not denticulate *A. aristatum*

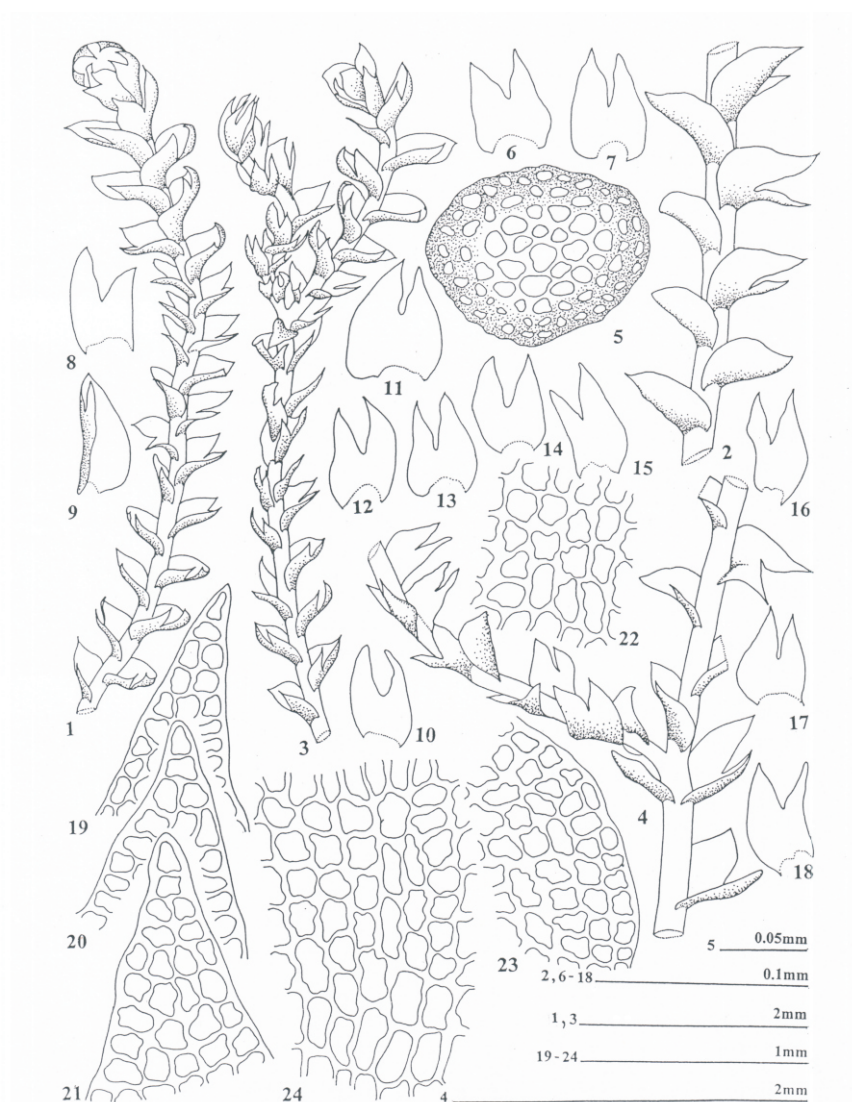


Fig. 4. *Anastrophyllum bidens* (Nees) Steph. 1. Plant, dorsal view. 2. Plant portion showing decurrence of ventral leaf lobe. 3. Plant with terminal branching. 4. Plant portion showing postical intercalary branching. 5. Stem, cross section. 6-18. Leaves. 19-21. Apical cells of leaf. 22. Median cells of leaf. 23. Marginal cells of leaf. 24. Basal cells of leaf (All figures drawn from NICH 311766).

- 3. Leaves triangulate ovate, elongated, radiating at shoot apex..... *A. donianum*
- 3a. Leaves ovate to orbicular-ovate, not radiating at apex 4
- 4. Leaf cells at the apex in irregular arrangement 5
- 4a. Leaf cells at the apex in regular concentric rows 6
- 5. Leaves are rounded boat shaped, lobes equal *A. alpinum*
- 5a. Leaves ovate to subquadrate, with unequal to subequal lobes *A. assimile*
- 6. Gemmae 1-3 celled, triangular and angulate *A. minutum*
- 6a. Gemmae strictly 2-celled, elliptical to spindle shaped with tapering ends *A. minutum* var. *himalayanum*

Anastrophyllum bidens (Reinw., Blume & Nees) Steph., Sp. Hepat. 2: 115. 1901. *Jungermannia bidens* Reinw., Blume & Nees, Nova. Acta. Phys.-Med. Acad. Caes. Leop.-Carol. Nat. Cur. 12: 208. 1824. **(Fig. 4)**

Plants small to medium, slender, upto 16mm long, 0.45 - 1.1mm wide (with leaves), blackish brown, reddish brown at apex, forming loosely caespitose mat on rock; branching lateral or postical intercalary reducing the ventral half of normal leaf; the leaf near branch emergence ovate to lanceolate. Stem brownish black, rigid,

terete, rounded to subrounded, 0.10 - 0.13mm wide, 8 - 10 cells wide across diameter; cells differentiated into 2-layered, small, thick-walled, rounded, deeply pigmented cortical cells, 3.8 - 7.6µm wide, moderately thick-walled; medullary cells rounded to subrounded, slightly pigmented, 7.6 - 15.2 × 11.4 - 15.2µm. Rhizoids frequently scattered on the ventral surface of the stem. Leaves contiguous to distant, alternate, succubous, secund, erect to vertically oriented towards axis, insertion transverse, concave, canaliculated, subovate, quadrate, subquadrate, to rectangulate, 0.30 - 0.42mm long, 0.27 - 0.33mm wide, slightly longer than wide, widest just above the base, bilobed for 2/3 - 3/5 of its total length, lobes unequal, narrowly triangulate, divergent; lobes with apiculate, acute to subacute apex, acute lobe ending into triangulate or setiform cell; dorsal lobe smaller, 0.09 - 0.18mm long, 0.06 - 0.15mm wide, 13-17 cells high, 9-11 cells wide, ventral lobe larger, 0.15 - 0.24mm long, 0.09 - 0.12mm wide, 15-20 cells high, 11-14 cells wide; leaf lamina symmetric to asymmetric with dorsal margin nearly of same length, sinus widely to narrowly acute, 0.15 - 0.21mm deep, 0.06 - 0.18mm wide; cells brownish, thick-walled with large, bulging trigones; apical cells subrounded, quadrate to subquadrate, 9 - 15 × 9 - 18µm; median cells quadrate, subquadrate to rectangulate, 5 - 21 × 9 - 15µm; basal cells elongated-rectangulate, 15 - 30 × 12 - 18µm. Cuticle verrucose. Gemmae and fertile plants not seen.

Habitat : On moist rocks and humus in mountainous areas, at higher altitude (Kitagawa, 1966), also grows along river margins, in disturbed or logged areas on mossy boulders, decaying stumps and logs (Schill & Long, 2003).

Type : Indonesia, Java “habitat in Iava insula frequens inter muscos ad terram. Leg. Blume.” (Iso : E).

Range : Australia, Bhutan, China, India, Indonesia, Japan, Sri Lanka, Thailand, Malaya, Nepal, Papua New Guinea, Philippines, Solomon Islands, Taiwan, (Kitagawa, 1966; Schill & Long, 2003).

Distribution : Sikkim.

Anastrophyllum bidens was first listed by Hattori (1971) and subsequently by Kitagawa (1975) and Parihar & al., (1994) from Eastern Himalaya. However, its first authentic report with a certain locality in India is credited to Schill & Long (2003), who described this species in great detail. In fact, they found the two samples from Sikkim, described as *Anastrophyllum piligerum*, proved as *A. bidens* and hence confirmed the presence of *A. bidens* in Indian territory. Another specimen from Sikkim, again described as *A. piligerum* by Mitten (1861) was also doubted as *A. bidens*.

Anastrophyllum bidens is rather different from all other Indian species of *Anastrophyllum* due to slender, rigid plants with deeply bilobed leaves (2/3 - 3/5 of their length), lobes narrowly triangulate, much longer than broad (dorsal lobe 13-17 cells high, 9-11 cells wide, ventral lobe 10-20 cells high, 11-14 cells wide) with apiculate or acute apex ending into single triangulate cell.

Mitten (1861) described *Anastrophyllum piligerum* (Nees) Spruce as *Jungermannia piligera* Nees. from Sikkim on the basis of collections made by J. D. Hooker and accordingly the species was listed from Himalaya by later workers (Chopra, 1943; Parihar, 1961-62, Parihar & al., 1994). Abeywickrama (1959) reported this species as single species of *Anastrophyllum* from Sri Lanka (Ceylon). Hattori (1966) reported this species as new to Himalayas. However, Schill and Long (2003) in their revisionary study of *Anastrophyllum* in Himalayan region doubted the specimen described by Mitten as *A. bidens*, although they could not see that specimen. However, the specimens from Sikkim, described by Hattori (1966) as *A. piligerum*, were available to Schill and Long and they treated them as *A. bidens*. As no authentic specimen from Indian territory was available to confirm the status of *A. piligerum* in India, hence treating here it as a doubtful record.

Anastrophyllum aristatum (Herzog ex N. Kitag.) A.E.D. Daniels & al., J. Bryol. 34(2): 148. 2012. *A. bidens* (Nees) Steph. var. *aristatum* Herzog ex N. Kitag., J. Hattori, Bot. Lab. 33 : 216. 1970.

Type : Indonesia, Borneo, Sarawak, Dulit Ridge, 1300m, on tree trunk, P.W. Richards 1908 (Holo : JE).

Range : Australia, China, India, Indonesia, Papua New Guinea. (Daniels & al., 2012).

Distribution : Tamil Nadu.

The species has recently been reported from India and China by Daniels & al., (2012).

Anastrophyllum donianum (Hook.) Steph., Brit. Jung. table 39. 1813.

Type : Scotland, Angus-shire, Clova. 1795, G. Donn. s.n. (BM) (Schill & Long, 2003).

Range : Bhutan, Canada, China, Czech Republic, Greece, India, Norway, Poland, Scotland, Tibet, United States of America (Schill & Long, 2003).

Distribution in India : Sikkim (Dzongri, Tsomgo lake) (Mitten, 1861; Schill & Long, 2003).

A. donianum was among the first three species of the genus described from India as *Jungermannia doniana* Hook. by Mitten (1861) from Sikkim on the basis of Hooker's collection in 1848. The plants are well represented in Sikkim as has been collected repeatedly since its original discovery. However, except Sikkim it has not been reported from anywhere else in the country. It is a quite distinct species due to its boat-shaped, elongated triangulate-ovate leaves. (for detail description, see Schill & Long, 2003).

Anastrophyllum alpinum Steph., Sp. Hepat. 6: 103. 1917.

Type : Syn : China (Delavay), Himalaya (Hooker). Lecto : India, Sikkim (J.D. Hooker) 3657 (G, lectotype selected by Grolle, 1964). (Schill & Long, 2003).

Range : India, Bhutan, China, Nepal, Scotland (Schill & Long, 2003 as *A. joergensenii*; Long & al., 2006).

Distribution : Sikkim, Uttarakhand (Chakrata) (Nath & al., 2002).

The species is well represented in India as confirmed through type and report by Nath & al., (2002, misidentified as *A. joergensenii*) from western Himalaya based on a collection made in 1976. The specimens were not available and report is based after Nath & al., (2002) and Long & al., (2006).

Grolle (1964) reported *A. joergensenii* from Sikkim and synonymized *Anastrophyllum alpinum* Steph. (from China and Sikkim) under *A. joergensenii*. It has been once again reported from Western Himalayas by Nath & al. (2002, misspelled as *A. jorgensenii*). Schill and Long (2003) also reported *A. joergensenii* from Sikkim on the basis of type of *A. alpinum*. However, Long & al., (2006) distinguished *A. joergensenii* from *A. alpinum* not only on the basis of molecular analysis but also supported the same by the differentiation in morphological characters. We agree with the findings of Long & al., (2006) and excluding *A. joergensenii* from Indian territory.

Anastrophyllum assimile (Mitt.) Steph., Hedwigia 32: 140. 1893. *Jungermannia assimilis* Mitt., J. Proc. Linn. Soc. Bot. 5: 93. 1861. **(Fig. 5)**

Plants small to medium, upto 19mm long, 0.63 - 1.1mm wide (with leaves), reddish to blackish brown, rigid, in scattered patches, loosely caespitose on rock; branching postical or lateral intercalary. Stem brownish-black, rigid, subterete, slightly arched at the apex, rounded to subrounded (in cross-section), 14-16 cells wide across the diameter; cells differentiated into 2-3 layers of brownish small cortical cells, 7.6 - 15.2 × 7.6 - 11.4µm, oblong, rounded to sub-rounded thick-walled, and pigmented; medullary cells large 11.4 - 26.6 × 7.6 - 19.0µm, subrounded, isodiametric, moderately thick-walled, non-pigmented. Rhizoids frequently scattered on the ventral surface of stem. Leaves contiguous to more or less imbricate, alternate, succubous, second, spreading horizontally to the stem, insertion transverse, dorsal half sub-transverse, ventral half slightly decurrent upto the stem midline, concave, canaliculate, subovate, quadrate to rectangulate, 1.1 - 1.9mm long and 0.51 - 1.6mm wide, longer than wide, widest just above the base, strictly bilobed to 1/3-1/2 of leaf length, lobes unequal, dorsal lobe smaller, 0.18 - 0.22mm long, 0.52 - 0.55mm wide, 18-20 cells high and 25-30 cells wide, folded over ventral one, broadly triangulate, divergent, apex subacute to obtuse; ventral lobe larger, apex obtuse to blunt, 0.15 - 0.20mm long, 0.63 - 0.97mm wide, 25-27 cells high 34-36 cells wide, sinus acute to descending subacute, 0.20 - 0.30mm deep, 0.45 - 0.52mm wide; leaf lamina asymmetric, dorsal margin smaller than ventral, entire, slightly arched inwards; cells minute, unevenly thick-walled, brownish with large, distinct confluent trigones; apical cells rounded-subrounded, quadrate to subquadrate, 12 - 18 × 9 - 15µm; median cells subquadrate to rectangulate, 12 - 21 × 12 - 15µm; basal cells elongated-rectangulate, 15 - 33 × 12 - 18µm (mid basal mainly vitta-like), lumen quadrate to subrounded. Cuticle smooth to slightly verrucose. Gemmae and fertile plants not

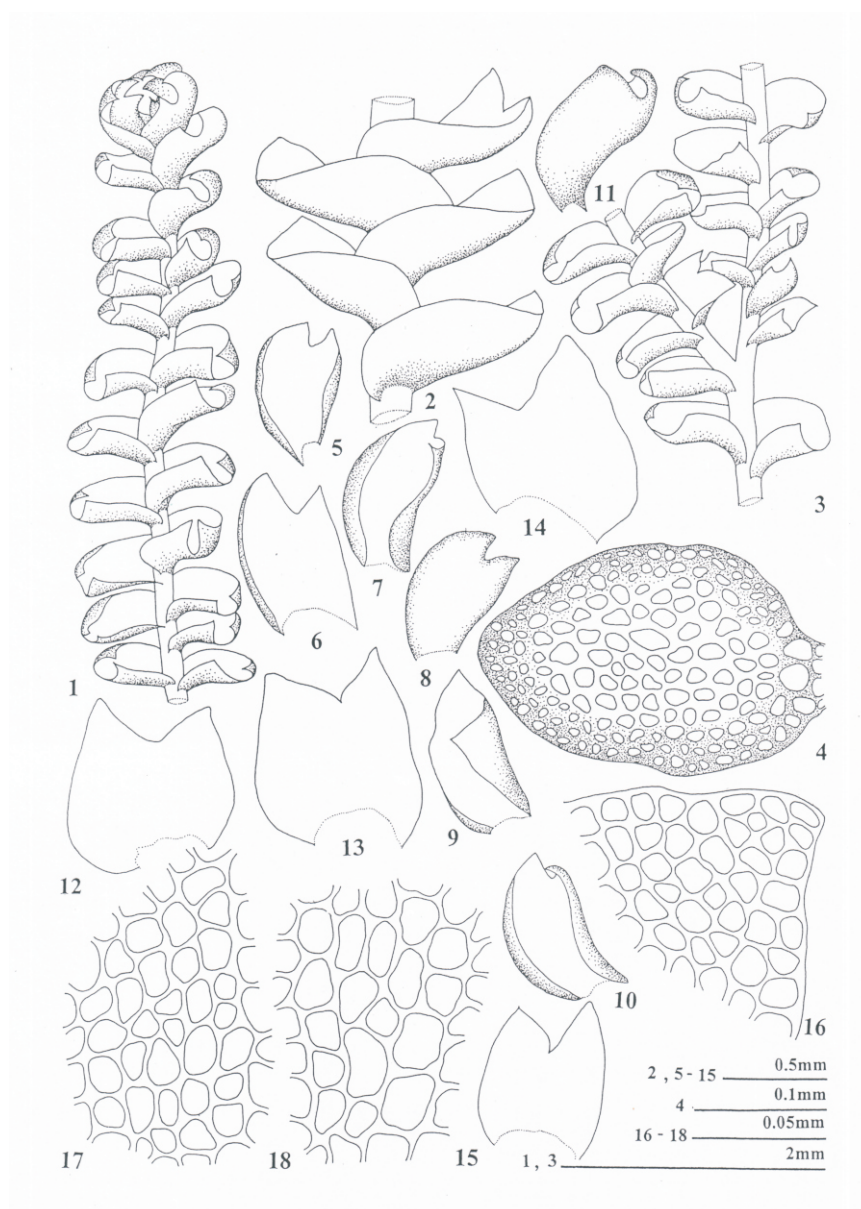


Fig. 5. *Anastrophyllum assimile* (Mitt.) Steph. **1.** Plant, dorsal view. **2.** Portion showing decurrence of ventral leaf lobe. **3.** Portion of plant showing branching. **4.** Stem, cross section. **5-11.** Folded leaves. **12-15.** Inflated leaves. **16.** Apical cells of leaf. **17.** Median cells of leaf. **18.** Basal cells of leaf. (All figures drawn from FH, type).

seen.

Habitat : On rocks at higher altitude.

Type : India, Sikkim, Lachen, alt. 10-11,000ft., J.D. Hooker 1321. (NY).

Range : Australia, Bhutan, Canada, China, Greenland, India, Indonesia, Italy, Japan, Korea, Nepal, Norway, Papua New Guinea, Switzerland (Kitagawa, 1966; Schill & Long, 2003)

Distribution : Sikkim (Lachen), West Bengal (Darjeeling, Sandakphu, Phalut).

Specimen examined : India, Sikkim, 7/1882, J.D. Hooker; 2 (FH) (Type of *J. assimile* Mitt!).

Anastrophyllum assimile, a very widely distributed species was first reported from India (Sikkim Himalaya) by Mitten (1861) as *Jungermannia assimile* on the basis of collections made by J.D. Hooker and Thompson. Furthur Chopra (1943), Parihar (1961-62) and Hattori (1966) listed this species from Sikkim Kitagawa (1975)

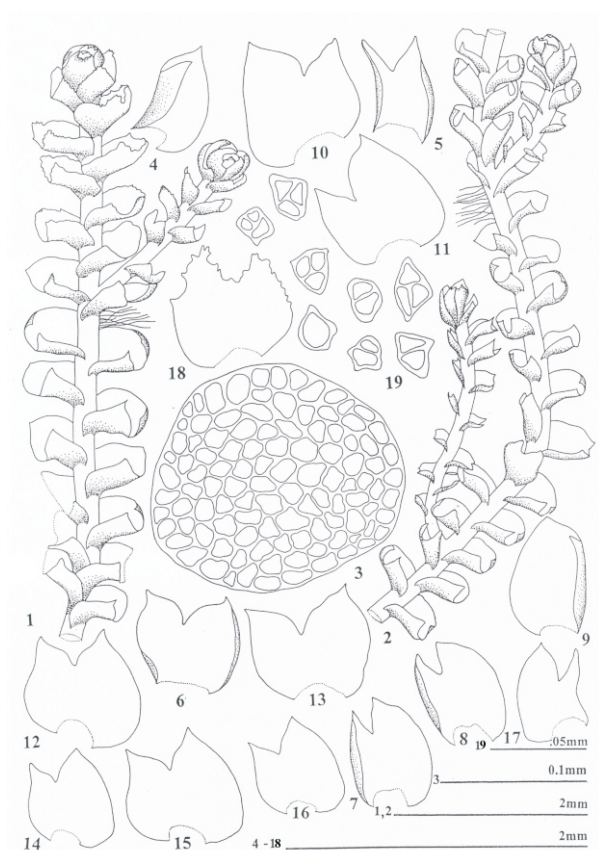


Fig. 6. *Anastrophyllum minutum* (Schreb. ex Cranz.) Schust. 1. Gemmiferous plant with intercalary branching (dorsal view). 2. Plant portion, with axillary branching. 3. Stem, cross section. 4-9. Folded leaves. 10-17. Inflated leaves. 18. Gemmiferous leaf. 19. Gemmae (Figures drawn from: 1,4-19 from LWU 11976/99; 2,3 from 12000/99).

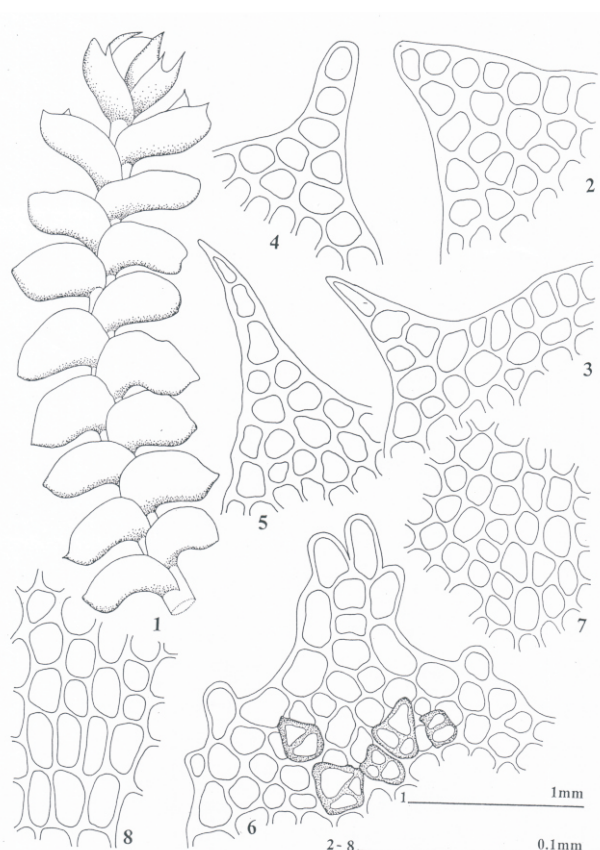


Fig. 7. *Anastrophyllum minutum* (Schreb. ex Cranz.) Schust. 1. Plant, ventral view. 2-5. Apical cells of leaf lobe. 6. Apical cells of leaf lobe, with developing gemmae and aggregated gemmae on the leaf surface. 7. Median cells of leaf. 8. Basal cells of leaf. (All figures drawn from LWU 11976/80)

from West Bengal (Darjeeling) in the Eastern Himalaya.

This species is distinct from others in colouration and absence of gemmae. According to Schuster (1969) it differs from all other species in its glossy texture when dry and it is more or less greyish or blackish brown. Müller (1954) considered *A. minutum* similar to *A. assimile* in appearance and asymmetric leaves with smaller antical lobe, $1/3 - 1/2$ of the leaf length, but it differs from the latter in having non-elongated basal leaf cells, equally thickened cell wall, acute to uniseriate (1-3-celled) lobe apex and reddish brown plants (see also Schuster, 1969).

This species is also confused with *A. michauxii* (F. Weber) H. Buch ex A. Evans in overall appearance, cell structure, lobes $1/3 - 1/2$ of the leaf length and obtuse lobe apex but reddish to pale brown plants, symmetric as well as squarrose leaf and frequent occurrence of gemmae in *A. michauxii* undoubtedly separate it from *A. assimile*.

Anastrophyllum minutum (Schreb.) Schust., Amer. Midl. Nat. 42(3): 576. 1949. *Jungermannia minuta* Schreb., Fortsetz. Hist. Grönland: 285. 1770. **(Figs. 6, 7)**

Plant small to large or medium, 10 - 25mm long, 0.60 - 0.81mm wide (with leaves), reddish brown to pale brown, branching ventral intercalary as well as axillary from the axil of normal leaf. Stem brown, rigid, terete, erect, procumbent, orbicular to elliptical, 0.16 - 0.18mm, 11-13 cells wide vertically, 0.30 - 0.22mm, 12-15 cells wide laterally across diameter, cells slightly differentiated into cortical and medullary cells; cortical cells rounded, subrounded, quadrate, 1-(-2)-layered, slightly thick walled, nearly subequal, $11.4 - 19.0 \times 11.4 - 15.2\mu\text{m}$; medullary cells thin walled, polygonal to subquadrate, slightly larger than cortical, $15.2 - 30.4 \times 11.4 - 22.8\mu\text{m}$. Rhizoids few and scattered on the ventral surface of the stem. Leaves distant to imbricate, alternate,

succubous, dorsally secund, horizontally oriented, insertion transverse on dorsal half and slightly decurrent on the ventral half upto stem midline, concave, canaliculate, quadrate-subquadrate to rectangulate, 0.42 - 0.66mm long, 0.39 - 0.66mm wide, as long as wide, widest above the base, bilobed; lobes unequal, divergent, 1/3-1/2 of the leaf length, broadly triangulate with acute to acuminate lobe apex (1-3-celled); dorsal lobe smaller, 0.12 - 0.18mm long, 0.12 - 0.24mm wide, 22-29 cells high, 24-32 cells wide; ventral lobe larger, (0.24) 0.30 - 0.33mm long, 0.21 - 0.33mm wide, 26-31 cells high, 32-40 cells wide, sinus descending acute, 0.15 - 0.24mm deep, 0.18 - 0.54mm wide, leaf disc asymmetrical with dorsal margin, smaller than ventral; cells minute, pale brown evenly thick walled, with confluent indistinct trigones; apical cells quadrate, subquadrate to polygonal, 12 - 24 × 15 - 24µm; median cells quadrate to subquadrate, 12 - 24 × 9 - 21µm; basal cells elongated, thick walled, 15 - 36 × 12 - 21µm, lumen of the cell quadrate to subrounded, cuticle with verrucose ornamentation. Gemmae present at the apices of apical leaf, formed from the leaf margin, 1-3-celled, ovoid and angulate, 18 - 33 × 12 - 24µm.

Habitat : Terrestrial, forming caespitose mats on soil enriched with humus and crevices of rocks.

Type : Greenland [Voucher for Dillenius, Hist. Musc.: 481. Lichenastrum no. 2 tab. 69, fig. 2. 1741] (Holo : OXF) (Schill & Long, 2003).

Range : Central, East and South Africa, Austria, Belgium, Bhutan, Britain, Bulgaria, China, Czech Republic, Denmark, Finland, France, Germany, Greenland, Hungary, Iceland, Indonesia, Ireland, Italy, Japan, Mexico, Netherlands, Nepal, Norway, India, Papua New Guinea, Poland, Portugal, Russia, Romania, Spain, Sweden, Switzerland, Ukraine, Venezuela, Yugoslavia (Schill and Long, 2003).

Distribution : Uttarakhand (Ghangharia), Sikkim (Dzongri).

Specimens examined : India, Uttarakhand, Ghangharia, c. 3400-3500m, on way to Hemkund, Sept. 26, 1999; Deepak Sharma 11976/99, 11977/99, 11980/99, 11990/99, 11991/99, 12000/99 (LWU).

Anastrophyllum minutum (Schreb. ex Cranz) R.M. Schust. was first reported from Sikkim in India by Hattori (1966). Schill & Long (2003) confirmed the presence of the species in Indian region.

Anastrophyllum minutum approaches *A. michauxii* in over all appearance and identical gemmiparous shoots. Both are also similar in slightly undifferentiated stem and 1-3-celled angulate gemmae, but *A. minutum* differs from *A. michauxii* in quadrate, subquadrate to rectangulate and transversely inserted dorsal half of the leaf (squarrose, ovate and slightly decurrent in *A. michauxii*), leaf lobe 1/3 - 1/2 of the leaf length (1/2 in the latter), lobe apex acute to acuminate (1-3-celled), (broadly acute to obtuse in the latter), cell wall with indistinct trigones (distinct trigones in the latter).

A. minutum is more or less similar to *A. assimile* also in appearance, asymmetric leaf lobe, 1/3 of the leaf length with dorsal lobe smaller than ventral, but can be easily distinguished in pale to reddish brown (blackish to reddish brown in the latter), only slightly differentiated stem (much differentiated in the latter), leaf apex 1-3-celled, acute to acuminate (subacute to obtuse in the latter) and angulate gemmae (absent in the latter).

Kitagawa (1966) pointed out that the Japanese and Himalayan plants of *A. minutum* diverge from the European - North American plants phenotypically in having often divergent and abruptly acute to acuminate leaf lobe; the more strongly thick walled marginal leaf cells and irregularly lobed and spinose dentate female bracts. Indian plants of *A. minutum* agree with the Japanese plants. According to Schuster (1969) however, The Japanese and Himalayan populations may represent new subspecies for the differences attributed by Kitagawa (1966).

***Anastrophyllum minutum* var. *himalayanum* S. Srivast., S.C. Srivast. & K.K. Rawat var. nov. (Figs. 8, 9)**

Plantae dissimilis Anastrophyllum minutum strictus bicellulatis, ellipticus, fusiformis gemmae.

Type : India, Uttarakhand, Chamoli, Ghangharia, May 22, 1980, S.C. Srivastava, D. Kumar & D.K. Singh 4325/80 (Holo : LWU).

Plants small to medium, 4 - 8mm long, 0.6 - 1.1mm wide (with leaves), reddish brown to pale brown, rigid in loosely caespitose scattered patches; branching frequent, terminal or lateral intercalary, the ventral half of the

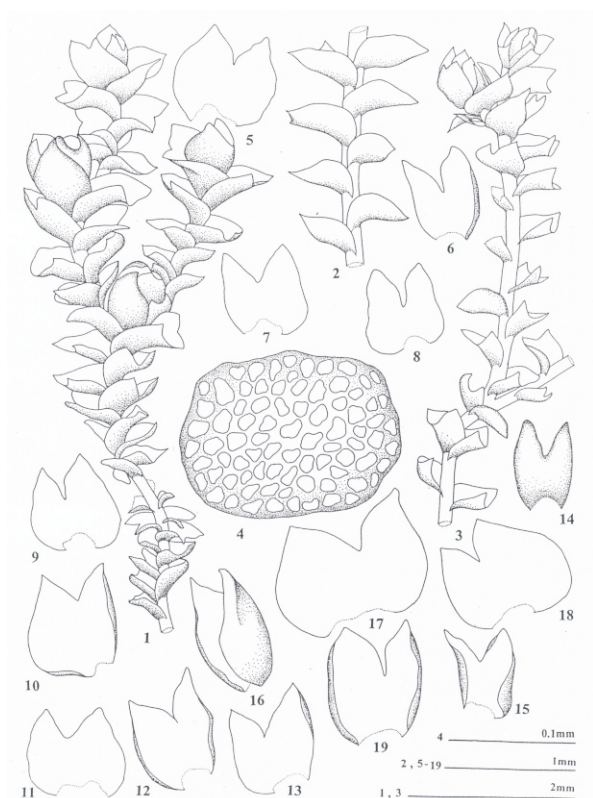


Fig. 8. *Anastrophyllum minutum* var. *himalayanum* S. Srivast., S.C. Srivast. & K.K. Rawat var. nov. 1. Plant, dorsal view showing terminal branching. 2. Plant portion, with lateral branching. 3. Stem, cross section. 4, 5, 7. Leaves. 6. Antically connate leaf near branching. 8-10. Antically connate leaves. 11-13. Apical cells of leaf. 14. Median cells of leaf. 15. Marginal dentition of leaf. 16. Basal cells of leaf. (All figures drawn from LWU 4171/80)

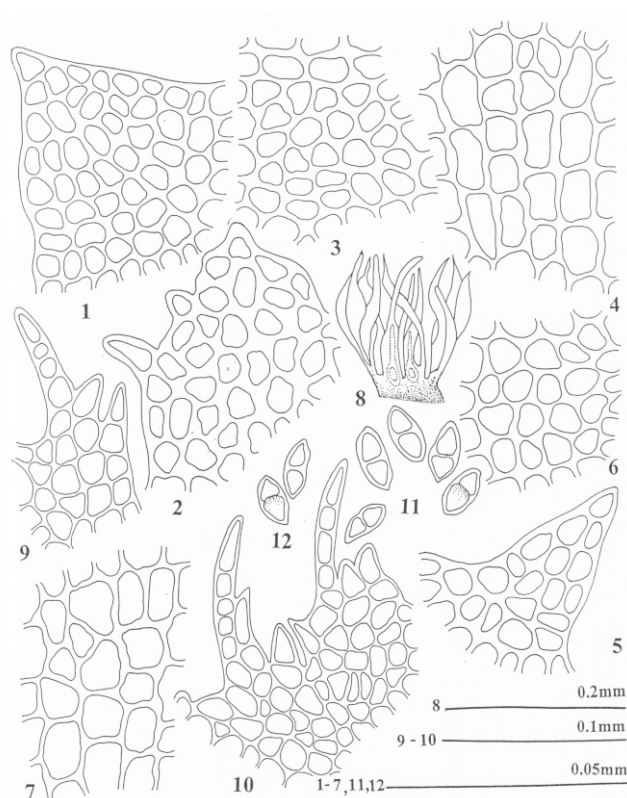


Fig. 9. *Anastrophyllum minutum* var. *himalayanum* S. Srivast., S.C. Srivast. & K.K. Rawat var. nov. 1. Apical cells of leaf. 2. Apical cells of leaf producing gemmae. 3. Median cells of leaf. 4. Basal cells of the leaf. 5. Apical cells of female bract. 6. Median cells of female bract. 7. Basal cells of female bract. 8. Developing perianth with archegonia (semidiagrammatic). 9-10. Cells of ciliated part of developing perianth. 11-12. Gemmae. (All figures drawn from LWU 4325/80)

normal leaf at branch emergence (near branch) reduced to half becoming lanceolate to ovate in shape, subfloral innovation much frequent. Stem brown, rigid, terete, orbicular to elliptical in outline in cross section, 0.09 - 0.1mm wide vertically, 0.15 - 0.17mm wide laterally, 6-8 cells wide vertically, 10-12 cells wide laterally, differentiated; cortical cells smaller, rounded to subrounded, oblong thick walled, pigmented, in 1-(-2) layers, $11.4 - 22.8 \times 11.4 - 19.0\mu\text{m}$; medullary cells relatively larger, subrounded, polygonal, oblong, moderately thick-walled, non pigmented, $11.4 - 26.6 \times 11.4 - 19.0\mu\text{m}$. Rhizoides frequent, scattered on the ventral surface of stem. Leaves distant imbricate to contiguous, alternate, succubous, secund, subhorizontally to vertically oriented, insertion transverse, slightly decurrent on the ventral half up to the stem midline, concave, canaliculate, broadly ovate, subquadrate to rectangulate, 0.51 - 0.66mm long, 0.48 - 0.60mm wide, nearly as long as wide and more so (leaf near the branch emergence unlobed, ovate to lanceolate), bilobed, lobes divergent $1/3 - 1/2$ of the leaf length; dorsal lobe slightly smaller and folded over ventral, 0.24 - 0.30mm long, 0.21 - 0.24mm wide, 21-30 cells high, 22-33 cells wide; ventral lobe 0.24 - 0.30mm long, 0.18 - 0.27mm wide, 26-38 cells high, 27-44 cells wide; leaf margins symmetric with dorsal and ventral margins nearly of the same length, spreading; cells minute, brownish, thick walled, with distinct and confluent trigones; apical cells rounded, subrounded, polygonal, quadrate to subquadrate, $12 - 21 \times 9 - 18\mu\text{m}$; median cells rounded to subrounded or quadrate to subquadrate, $12 - 21 \times 22 - 18\mu\text{m}$; basal cells elongated, quadrate to rectangulate, $18 - 30 \times 12 - 21\mu\text{m}$; lumen of cells rounded to squarrose. Gemmae present at the mergins of apical leaf lobe, strictly 2-celled, elliptical to spindle-shaped with tapering ends, $18 - 30 \times 9 - 15\mu\text{m}$. Cuticle prominently verrucose under SEM.

Dioicous? Male plants not seen. Female plants up to 8mm long, 1.1mm wide; gynoecia on main axis or branches, female bracts in one pair, closely imbricate, clustered at apex, broadly rectangulate, broader than long,

0.60 - 0.72mm long, 0.72 - 0.87mm wide, bilobed; lobes 1/3-1/2 of the bract length, lobe apex acute to subacute, sinus acute to subacute, broadly divergent, 0.30 - 0.39mm deep, 0.30 - 0.63mm wide, cells similar to the leaf cells, thick-walled with confluent trigones; apical cells rounded to subrounded, $15 - 21 \times 12 - 18\mu\text{m}$; median cells rounded, subrounded or quadrate, $15 - 31 \times 15 - 21\mu\text{m}$; basal cells elongated, subquadrate to rectangulate, $24 - 33 \times 15 - 24\mu\text{m}$. Perianth ciliated while young, enclosed within the surrounding female bracts. Sporophyte not seen.

Habitat : Terrestrial, on soil covered rocks, either in pure patches or commonly associated with *Blepharostoma trichophyllum*, *Solenostoma confirtissima*, *Tritomaria exsecta* and *Schistochilopsis incisa*.

Range : India (Endemic to Western Himalaya).

Distribution : Uttarakhand- Chamoli (Ghangharia, on way to Hemkund).

Anastrophyllum minutum var. *himalayanum* can be differentiated from typical *A. minutum* in having strictly 2-celled, always spindle-shaped gemmae, however, as compared to up to 4-celled, subspherical-cubical, irregularly angular, stellate or $\pm$ ovoid gemmae in the latter.

A. minutum var. *himalayanum* is also related to *A. hellerianum* in minute plants, bilobed leaves with descending sinus, leaf lobes 1/3-1/2 of the leaf length, leaves not strictly secund dorsally, obtuse to subacute leaf lobe apex, and indistinct confluent trigones. However, *A. hellerianum* can be easily separated in having radially symmetrical undifferentiated stem upto 7 cells across diameter, strictly 1-celled gemmae and faintly verrucose cuticle.

Lophozia (Dumort.) Dumort., Rec. d' Obs. 17. 1835.

Plants small to medium, slender to robust, yellowish to whitish or olive green, or even brownish to reddish brown; branching lateral-terminal, or intercalary with furcate terminal lateral branching. Stem prostrate to erect ascending, orbicular, elliptical to flattened in cross-section, with or without dorsiventral differentiation. Leaves alternate, succubous, obliquely inserted, imbricate to contiguous, vertically to subhorizontally oriented, rarely canaliculate, usually bilobed, sometime polymorphic, 2-3-lobed to (1/10) 1/8-1/2 of its total length, margin entire; leaf lobe broadly triangulate with acute, subacute to obtuse apex, sinus descending, rounded to lunate, obtuse, subacute to acute or V-shaped; cells with distinct to indistinct trigones. Underleaves absent to vestigial. Gemmae pale green to reddish brown, 1-4-celled, ovoid, elliptical to angulate.

Dioicous. Male inflorescence terminal or intercalary on main shoot; bracts in 2-12 pairs, similar to but smaller than leaves, imbricate, concave, saccate. Female inflorescence terminal, with subfloral innovations; bracts usually larger than leaves. Perianth well developed, free from bracts, cylindrical, terete, faintly plicate at apex, mouth entire or with small projecting cells.

Type : *Lophozia ventricosa* (Dicks.) Dumort.

Mitten (1861) for the first time recognized 3 species of *Lophozia* as *Jungermannia pluridentata* Mitt., *J. setosa* Mitt. and *J. ventricosa* Dicks from Sikkim. Later Chopra (1938) listed *L. turbinata* and *L. bidens* from Darjeeling and *L. bidentata* and *L. guttulata* from Kurseong. At the same time, Herzog (1939) listed *L. setosa* from Tsomgo lake in Sikkim. Chopra (1943) and later Parihar (1961-62) listed a total of 5 species viz. *L. alpestris*, *L. incisa* and *L. piacenzai* from Western Himalaya and *L. pluridentata* and *L. setosa* from Eastern Himalaya.

Hattori (1966) listed 4 species, *L. incisa* (Schrad.) Dumort., *L. longidens* Lindb., *L. setosa* (Mitt.) Steph., and *L. wenzelii* (Nees) Steph. from Eastern Himalaya with *L. longidens* and *L. wenzelii* for the first time from India. Most recently, Parihar & al., (1994) listed 9 species of *Lophozia* viz. *L. alpestris* (Scheich.) Evans, *L. handellii* Herz., *L. hatcherii* (Evans) Loeske, *L. incisa*, *L. longidens*, *L. piacenzai* Gola, *L. pluridentata*, *L. setosa* and *L. wenzelii* from India. However, recent studies have resulted in the change in taxonomic concept of the genus *Lophozia*. As such *L. alpestris* is now treated under *Leiocolea collaris* (Nees) Schljakov; *L. maybarae* (S. Hatt.) Kitag. is now *Leiocolea maybarae* (S. Hatt.) Furuki & Mizut., while *Lophozia hatcheri* is treated under *Barbilophozia hatcheri* (Evans) Loeske (see Excludenda). Thus, in present state of our knowledge only three species of *Lophozia* viz., *L. longidens*, *L. piacenzai* and *L. wenzelii* are known to occur in India. The present study

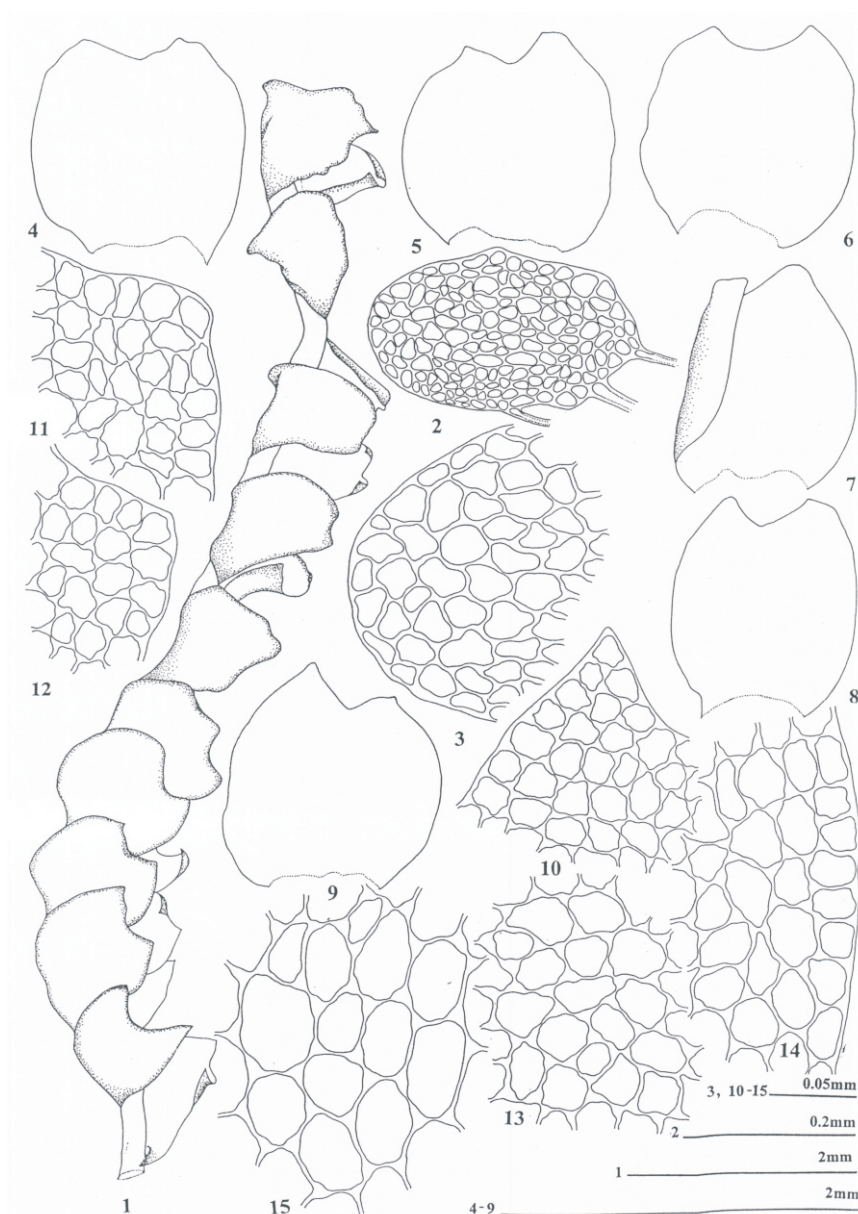


Fig. 10. *Lophozia wenzelii* (Nees) Steph. **1.** Plant, lateral view. **2.** Stem, cross section. **3.** Same, enlarged. **4-9.** Leaves. **10-12.** Apical cells of leaf. **13.** Median cells of leaf. **14.** Basal cells of leaf. (Figures drawn from FH 4506, 1488 and FH 4509 no. 183)

revealed hitherto two undescribed species from the country, viz. *L. udarii* sp. nov and *L. indica* sp. nov., which are described and illustrated alongwith *L. wenzelii*.

Key to the species of genus *Lophozia* in India

1. Leaves 2-lobed, with wide, shallow, rounded to lunate sinus. *L. wenzelii*
- 1a. Leaves polymorphic, 2-3-lobed, with narrow to wide, acute, subacute to obtuse sinus2
2. Leaves generally 2 (-3)-lobed, rectangulate; lobes 1/4 - 1/3 of the leaf length; cells with minute trigones; perianth mouth without dentition, apical marginal cells of the perianth, rectangulate, base thick or fleshy, 3-4 stratose *L. udarii*
- 2a. Leaves generally (2-) 4-lobed, obtrapezoidal; lobes 1/4 - 1/3 (1/2) of the leaf length; cells with distinct nodulose trigones; perianth mouth with few 1-2-celled dentitions, apical marginal cells of perianth quadrate to subquadrate, base not fleshy or massive, unistratose.....*L. indica*

Lophozia wenzelii (Nees) Steph. Bull. Boiss. ser. 2, 2: 135. 1902; Sp. Hepat. 2: 135. 1902. *Jungermannia wenzelii* Nees, Naturg. Eur. Leberm. 2: 58. 1836. **(Fig. 10)**

Plants medium, upto 20mm long, (0.66-) 0.75 - 1.05 (-1.2mm) wide with leaves, pale green to light brown, in dense patches or in tufts; branching sparse, furcate and terminal. Stem subterete, soft, pale green on dorsal surface, reddish brown on ventral side of stem, tinged with reddish brown at the apex, suborbicular to elliptical in cross section, 0.20 - 0.29mm, 14-16 cells wide laterally, 10-12 cells wide vertically across diameter, slightly dorsiventrally differentiated; dorsal cells larger, subrounded, polygonal, $22.8 - 34.2 \times 15.2 - 26.6\mu\text{m}$; ventral cells small, subrounded to subquadrate, $15.2 - 22.8 \times 11.4 - 15.2\mu\text{m}$. Rhizoids absent at the apex of the plant. Leaves contiguous to imbricate, alternate, succubous, obliquely inserted with no decurrence, subvertically to erect spreading, generally laterally compressed to one side, strongly concave, saucer-shaped, dorsally second, mainly towards the stem apex, broadly obovate to orbicular, quadrate to rectangulate, 0.90 - 0.96mm long, 0.72 - 0.90mm wide (widest near the base), shortly bilobed to 1/8-1/6(-1/3) of its length; lobes unequal to subequal, broadly triangulate. incurved; dorsal lobe 6-15 cells high, 15-28 cells wide, ventral lobe 7-12 cells high, 19-29 cells wide, apex obtuse to weakly acute, sinus wide, somewhat rounded, shallow to lunate, (0.6-) 0.12 - 0.18mm deep, 0.33 - 0.48mm wide; cells medium sized, thin-walled, trigonous; apical cells rounded, subrounded, polygonal, (15.2-) $19.0 - 30.4 \times 11.4 - 22.8\mu\text{m}$; median cells rounded to subrounded, $22.8 - 41.8 \times 22.8 - 30.4\mu\text{m}$; marginal cells distinct with single layer of small, quadrate to subquadrate cells, $15.2 - 30.4 \times 19.0 - 30.4\mu\text{m}$; basal cells large, polygonal to subquadrately elongated with distinct large trigones, (19.0-) $45.6 - 57.0 \times 22.8 - 38.0\mu\text{m}$; cuticle smooth. Gemmae and fertile plants not seen.

Habitat : On moist, sandy, muddy soil, rarely on humus.

Type : Germany: Riesengebirge Koppenplan, ca 1400m, V. Flotow 1824 (FH).

Range : Czech Republic, England, Germany, Greenland, Hungary, Iceland, India, Japan, Russia, Scotland, Taiwan, Unites States of America (Jung, 1910; Hattori, 1966; Frahm, 1987; Jóhannsson, 2003; Kucera & Vana, 2003).

Distribution : Sikkim (Dzongri).

Specimens examined : Japan, Mont. Hakkoda, Faurie 1488 (FH).

Schlajakov (1980) and Bakalin (2005b) proposed inclusion of *L. wenzelii* into sect. Sudeticae however, Vilnet & al., (2007) rejected the same, though imphasized that “*L. ventricosa*-*L. wenzelii* complex represented the most complicated and intricate complex”.

Lophozia wenzelii was first reported from India by Hattori (1966) from Eastern Himalaya, (Sikkim). Unfortunately specimens of this species were not available for study and therefore, the details provided in the description are based on the specimens obtained from Farlow Herbarium. The plants of *Lophozia wenzelii* are characteristically dense leaved with incurved leaf lobes having rather deeper and angular sinuses, stiff textured leaves, dorsal lobe vertically oriented (more or less ladder like), regular arrangement of strongly concave to saucer-like strongly incurved and very broad lobes, sinus very wide and never angulate in mature plants.

This species closely resembles *L. alpestris*, but differs in having leaves rather distantly arranged and tinged red at the apex and are flaccid, erectopatent, antically secund, concave and saucer-shaped as opposed to imbricate, concave to canaliculate leaves which are rotund to oblong rotund in *L. alpestris*. Further, the shortly incurved leaf-lobes which are broadest in middle, larger leaf cells with small but distinct trigones in *L. wenzelii* are distinctly different from those of *L. alpestris* which has leaf lobes not incurved and broadest below with relatively smaller, minutely trigonous leaf cells (see Macvicar, 1912).

L. wenzelii is often confused with *L. ventricosa*, but 4-9 oil-bodies per cells, concave leaves (often strongly saucer-like), small leaf-lobe, 1/8-1/6 of the leaf length with broad and shallow sinus separate the former from the latter, which has numerous oil-bodies per cell, plane and flat leaves, and leaf lobes 1/2 - 2/3 of the leaf length with deeper sinus (see Schuster, 1969).

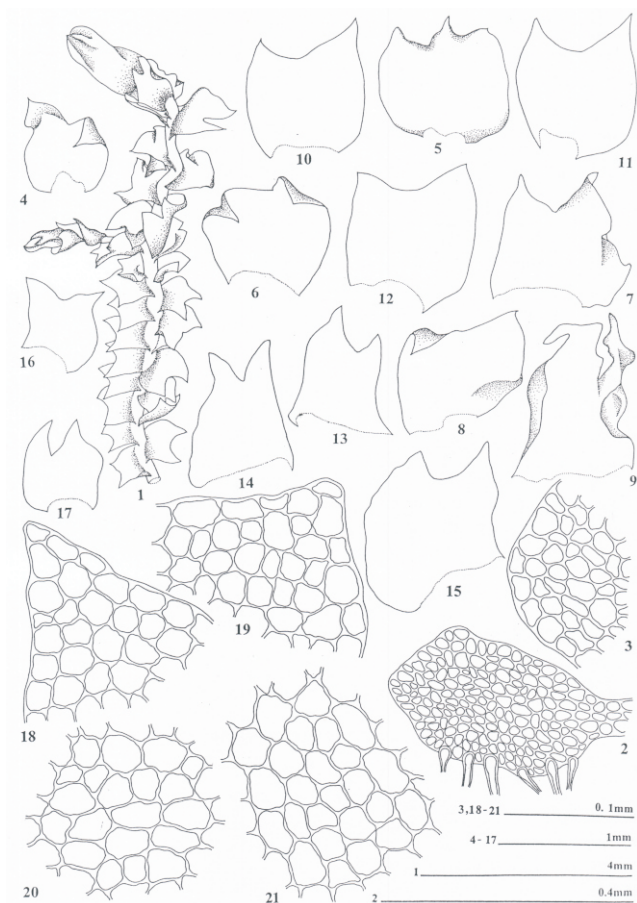


Fig. 11. *Lophozia udarii* S. Srivast., S.C. Srivast. & K.K. Rawat sp. nov. 1. Female plant, dorsal view. 2. Stem, cross section. 3. Stem cross section, enlarged. 4-9. Folded leaves. 10-17. Inflated leaves. 18, 19. Apical cells of leaves. 20. Median cells of leaves. 21. Basal cells of leaves. (All figures drawn from LWU 4337/80)

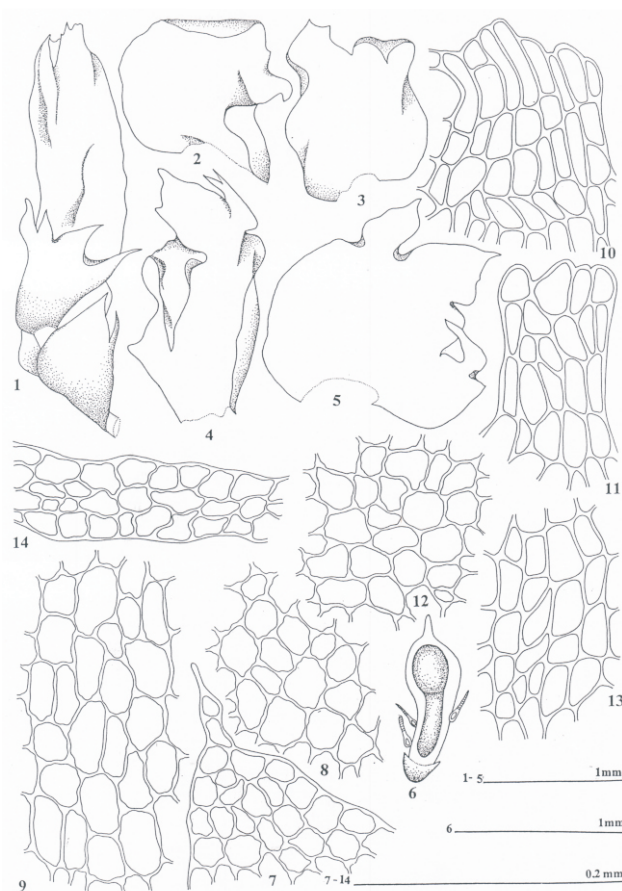


Fig. 12. *Lophozia udarii* S. Srivast., S.C. Srivast. & K.K. Rawat sp. nov. 1. Plant portion with perianth. 2-5. Female bracts. 6. Immature sporophyte with archegonia on the calyptra. 7. Apical cells of bract. 8. Median cells of bract. 9. Basal cells of bract. 10, 11. Apical cells of the perianth. (12) Median cells of perianth, (13) Basal cells of perianth, (14) T.S. of perianth base. (All figures drawn from LWU 4347/80)

***Lophozia udarii* S. Srivast, S.C. Srivast. & K.K. Rawat sp. nov.**

(Figs. 11, 12)

Plantae mediocris, ad 11mm longa, (0.75) 0.9 - 1.35mm lata, viridis vel hepaticus. Caulis ellipticus 17-19 cellulae lata lateralis, 11 - 13 cellulae lata verticalis, folia subimbricatus vel contiguus, obliquus inserta, quadrangularis vel rectangularis, ad $\frac{1}{4}$ - $\frac{1}{3}$ inciso, 2(-3) lobis. Cuticula grosse verrucosa. Perianthia longe exserta, cylindrica vel ovata, ore sine dentatus brevissime plicata, cellulae apicales hyaline & rectangularis, basales 3-4 stratosas.

Type : India, Uttarakhand, Ghanghariya, ca 3400 m, May 23, 1980, S.C. Srivastava, D. Kumar & D.K. Singh 4347/80 (Holo : LWU).

Plants medium, pale green to dull brown in caespitose patches; branching axillary, terminally furcate. Stem elliptical in cross section, 17-19 cells across diameter laterally, 11-13 cells across diameter vertically, dorsiventrally differentiated; dorsal cells larger, suborbicular to subquadrate, $15.2 - 26.6 (-34.2) \times 15.2 - 19.0 (-22.8) \mu\text{m}$; ventral cells smaller, orbicular to suborbicular, $11.4 - 15.2 (-19.0) \times 11.4 - 15.2 \mu\text{m}$. Rhizoids numerous on the ventral stem surface. Leaves subimbricate to distant, succubous, alternate, obliquely inserted, subvertically to horizontally spreading, polymorphic, quadrate, subquadrate, quadrate-ovate to oblong ovate, (0.45-) 0.54 - 0.75 (-0.93)mm long, (0.30-) 0.51 - 0.87mm wide, 2(-3)-lobed up to $\frac{1}{4}$ - $\frac{1}{3}$ of its length, broadly triangulate, (0.09-) 0.15 - 0.27 (-0.33)mm long, 0.15 - 0.39mm wide, lobe apex variable, ranging from acute (1-3-celled uniseriate), subacute to obtuse, sinus narrowly to broadly acute or rounded to lunate, 0.15 - 0.24mm deep, (0.06-) 0.24 - 0.54 (-0.60)mm wide; leaf margins rounded to straight; cells thin-walled with simple trigones;



Fig. 13. *Lophozia indica* S. Srivast., S.C. Srivast. & K.K. Rawat sp. nov. 1. Gemmiferous plant (G= Gemmae), dorsal view. 2. Plant portion with branching. 3. Stem, cross section. 4. Same, enlarged. 5-13. Leaves. 14. Gemmae (All figures drawn from LWU 4384/80)

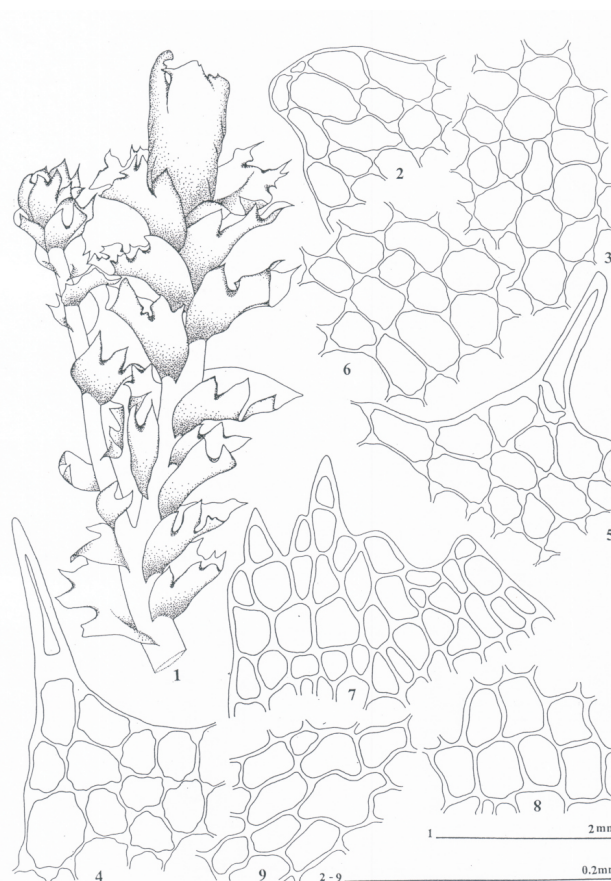


Fig. 14. *Lophozia indica* S. Srivast., S.C. Srivast. & K.K. Rawat sp. nov. 1. Plant with female inflorescence. 2. Apical cells of female bract. 3. Median cells of female bract. 4-5. Marginal dentition on the female bract. 6. Basal cells of female bract. 7. Apical cells of the perianth. 8. Median cells of the perianth. 9. Basal cells of perianth. (All figures drawn from LWU 4249/80)

apical cells rounded, subrounded to polygonal, $15.2 - 30.4 \times 15.2 - 34.2\mu\text{m}$; median cells suborbicular, polygonal to rectangulate, $19.0 - 38 \times 15.2 - 38\mu\text{m}$; basal cells suborbicular, polygonal to rectangulate, $19.0 - 38 \times 15.2 - 30.4\mu\text{m}$; cuticle faintly verrucose. Gemmae not seen.

Dioicous. Male plants not seen. Female plants upto 11.00mm long (0.75-) 0.9 - 1.35mm wide with leaves. Perianth fully exserted, covered with 1 pair of bracts at base. Bracts 2-4-lobed to 1/4-1/3 of their length, similar but larger than leaves, 1.2 - 1.4mm long, 1.05 - 1.4mm wide, concave, imbricate as long as wide; lobes broadly triangulate with acute (1-3-celled uniseriate) to subacute apex, sinus wide, obtuse at the base; cells thin walled with minute trigones; apical cells rounded, subrounded to subquadrate, $15.4 - 30.4 \times 15.4 - 26.6\mu\text{m}$; median cells subrounded, quadrate to subquadrate, $19.0 - 38.0 \times 15.2 - 26.6\mu\text{m}$; basal cells large, rectangularly elongated, $30.4 - 57.0 \times 26.6 - 30.4\mu\text{m}$. Perianth cylindrical, 1.4 - 1.8mm long, 0.45 - 0.54mm wide, faintly plicate, mouth without dentitions; apical cells near mouth thin-walled, hyaline, rectangularly much elongated, $26.6 - 68.4 \times 15.2 - 22.8\mu\text{m}$, without trigones; median cells irregularly subrounded to polygonal with distinct trigones, $15.2 - 45.6 \times 15.2 - 34.2\mu\text{m}$; basal cells subquadrate to rectangulate, $19.0 - 41.8 \times 15.2 - 22.8\mu\text{m}$; perianth base thick, 3 to 4 stratose with irregular rectangulate cells, $15.2 - 22.8 \times 19.0 - 34.2\mu\text{m}$. Sporophyte upto 1.17mm long, 0.36mm wide, with unfertilized archegonia on calyptra. Mature sporophyte not seen.

Habitat : Terrestrial, on soil and humus.

Range : India, probably endemic to western Himalaya.

Distribution : Uttarakhand (Ghangharia).

Specimens examined : (paratype) India: Uttarakhand, Hemkund, c. 3400m, Sept. 26, 1999, D. Sharma 11987/99 (LWU).

L. udarii is characteristically different from the rest of the species of the genus in having polymorphic leaves (quadrate-ovate to oblong-ovate), variable leaf lobes apex (acute, subacute to obtuse) and sinus (narrowly to broadly acute or rounded to lunate), mouth of the perianth without dentitions and base of perianth 3-4 stratoe .

This species also resembles *Leiocolea mayebarae* (Hatt.) Furuki and Mizut. in polymorphic leaves, acute to acuminate leaf lobes and faintly verrucose cuticle. However, it differs in relatively minute size of the plants, subterete to rounded stem, distantly arranged leaves and perianth mouth with projecting cells in *L. mayebarae*.

Lophozia indica S. Srivast, S.C. Srivast. & K.K. Rawat **sp. nov.**

(Figs. 13, 14)

Plantae mediocris, 6-8mm longa, (0.9) 1.44 - 2.07mm lata. Caulis late ellipticus, 14-16 cellulae lata lateralis & 8-10 cellulae lata verticalis, dorsiventralis differens. Folia caulina subimbricatis ad distans, aggregates ad apice subquadritatis vel obtrapizalis asymmetricis, 2-4 lobis, lobis lateralis generalis angustis terminus in triangulates dentatis. Cuticula grosse verrucosa. Gemmae 1-2 cellulae, flavovirens, globosa vel angulata. Perianthia longi exserta, cylindrical, ore breviter plicata cum 1-2 cellula minutus, dentatis.

Type : India, Uttarakhand, on way to Hemkund, ca 3300m, May, 23, 1980, S.C. Srivastava, D. Kumar & D.K. Singh 4249/80 (Holo : LWU).

Plants medium, blackish brown in dense patches, sparsely branched. Stem flattened, elliptical in cross section, 14-16 cells wide laterally, 8-10 cells wide vertically across diameter, dorsiventrally differentiated with flattened, irregularly rectangular to triangulate larger dorsal cells, $19.0 - 53.2 (-60.0) \times 15.2 - 34.2\mu\text{m}$; ventral cells small, subrounded, quadrate to subquadrate, $15.2 - 26.6 \times 11.4 - 19.0\mu\text{m}$. Rhizoids dense on ventral surface of stem. Leaves subimbricate to distant (clustered at apex), succubous, alternate, subtransversely inserted, subvertically to horizontally oriented, quadrate, subquadrate to obtrapezoidal, (0.48-) 0.54 - 0.75 (-0.90)mm long, (0.45-) 0.60 - 0.78 (-0.87)mm broad, asymmetric, dorsal margin small, ventral margin larger, 2-4 lobed to 1/4 - 1/3 (-1/2) of its length, lobes broadly triangulate, 0.12 - 0.36mm long, 0.15 - 0.60mm wide, lobe apex obtuse to subacute, lateral lobe generally reduced into narrow apex gradually ending into triangulate dentitions, sinus wide, obtusely rounded in 2-lobed leaves, narrow, acute to subacute in 3-4-lobed leaves, 0.06 - 0.36mm deep, 0.15 - 0.60mm wide; leaf cells thin-walled with distinct trigones; apical cells large, elongated, subrounded, polygonal, $22.8 - 45.6 (-57.0) \times 15.2 - 41.8\mu\text{m}$, apical lobe ending into single triangulate dentition, $34.2 - 152.0\mu\text{m}$ long, $15.2 - 22.8\mu\text{m}$ wide; median cells rounded, subrounded to polygonal, $15.2 - 38.0 \times 15.2 - 26.6\mu\text{m}$; basal cells polygonal to rectangularly elongated, $26.6 - 41.8 \times 15.2 - 30.4\mu\text{m}$, cuticle verrucose. Gemmae pale green, 1-2-celled, rounded, triangular to polygonal, $15.2 - 26.6 \times 11.4 - 19.0\mu\text{m}$.

Dioicous. Male plants not seen. Female plants 6-8mm long, (0.9-) 1.44 - 2.07mm wide with leaves; bracts concave, closely imbricate, in one pair, similar to leaves but larger, 3-4-lobed with dentitions on the lobes. Perianth exserted, cylindrical, weakly plicate, mouth with 1-2 celled minute dentition; cells thin walled; apical cells subrounded, quadrate to subquadrate, with triangulate dentitions, $19.0 - 26.6 \times 15.2 - 22.8\mu\text{m}$; median cells subquadrate to rectangular, $22.8 - 41.8 \times 22.8 - 30.4\mu\text{m}$; basal cells irregular, quadrate to rectangularly elongated, $30.4 - 49.4 \times 15.2 - 26.6\mu\text{m}$.

Habitat : Terrestrial, on soil and humus.

Range : India, probably endemic.

Distribution : Uttarakhand, on way to Hemkund from Ghangharia.

Specimens examined : India: Uttarakhand, on way to Hemkund, c. 3300m, May 23, 1980, S.C. Srivastava, D. Kumar and D.K. Singh 4384/80, 4385/80 (LWU).

L. indica is highly distinctive from the rest of the species of *Lophozia* in subtransverse to slightly oblique leaf insertion; polymorphic, 2-4-lobed leaves; apical part of perianth with quadrate to subquadrate cells and perianth mouth with 1-2-celled minute dentitions.

This species resembles *Schistochilopsis incisa* (Schrad.) Konstatn. in overall appearance, colour of the plant, more than 2-lobed leaves and elliptical stem (in a cross-section), however, the latter can be easily differentiated from *L. indica* in having spinate dentitions on leaf lobes, ciliate perianth apex with elongated and dentate apical cells as opposed to absence of spines and dentitions on leaf lobes, perianth apex with quadrate to subquadrate apical cells and few minute, 1-2-celled dentitions in *L. indica*.

Lophozia indica is close to *Lophozia udarii*, but it differs from the latter on the basis of number of leaf lobes (generally (2-) 4-lobed in *L. indica*, while 2 (-3) -lobed in *L. udarii*), leaf shape (obtrapezoidal in *L. indica*, while rectangulate in *L. udarii*), trigones (distinct nodulose trigones in *L. indica*, while minute in *L. udarii*) and perianth base (uniformly unistratose in *L. indica*, while thick or fleshy, 3-4 stratose towards base in *L. udarii*).

Tritomaria Schiffn. ex Loeske, Hedwigia 49: 13. 1909.

Plants pale to dark green or slightly brownish tinged, firm, rigid but flaccid when dry, largely caespitose, prostrate with ascending apices or suberect to erect in growth; branching less frequent, irregular, lateral intercalary or ventral intercalary replacing the ventral half of the lateral leaves. Stem slightly differentiated into usually smaller cortical cells and comparatively larger medullary cells. Leaves succubous, distant to closely imbricate towards apex, alternate, spreading to subvertically oriented, strongly incurved, falcate secund, transversely inserted up to the stem midline, typically asymmetrically lobed, margin entire, sinus open; cells small, thick-walled with small trigones. Underleaves completely absent. Gemmae reddish-brown, formed at the apices of plant, 1-2-celled, ovoid or elliptical in shape with tapering ends.

Androecia secondary-intercalary; bracts ventricose, antheridia with uni-or biseriate stalks. Perianth cylindrical-obovoid, deeply plicate above the middle, gradually contracted to ciliate mouth; female bract 3-4 lobed, as large as leaves, lobes entire or dentate; bracteole wanting or present. Capsule wall 3-5 stratose, the outermost cell-layers with nodular thickenings, the innermost with semi-annular bands.

Type : *Jungermannia exsecta* Schmid. ($\equiv$ *Tritomaria exsecta* (Schmid.) Schiffn.)

Loeske (1909) proposed the genus on the basis of *Jungermannia exsecta* Schmid. Kitagawa (1966), considering *Tritomaria* as a heterogenous taxon, proposed the division of the genus into two subgenera, subgen. *Tritomaria* Kitag. and subgen. *Trilophozia* R.M.Schust. According to him, *Tritomaria* was closely related to *Lophozia* and might have been derived from a *Lophozia* like ancestor. However, the most reliable feature to separate *Tritomaria* from *Lophozia* is the the asymmetrically 3-lobed leaves and its more transverse insertion. Schuster (1969) divided the genus *Tritomaria* into two subgenera, viz. subg. *Tritomaria* and *Tritomaria* subg. *Saccobasis* on account of transversely inserted sharply lobed leaves, strongly dentate perianth mouth in the former, and arched dorsal half insertion towards apex, blunt to rounded leaf lobe, truncate perianth with entire mouth in the latter. He (Schuster, 1969) further divided... further divided the subg. *Tritomaria* in 2 sections, sect. *Tritomaria* and sect. *Trilophozia* on the basis of the presence of abundant red brown gemmae, as wide as long leaves, single seriate antheridial stalk, 14-16 cells high stem, 3-4 stratose capsule wall in the former and occasional yellowish brown to yellowish, usually 3-5mm wide gemmae, 2-seriate antheridial stalk, 5-stratose capsule wall, 20-22 cells wide stem in the latter. Accordingly *T. exsecta* was placed under sect. *Tritomaria*. Crandall-Stotler & al., (2009) treated *Tritomaria* under family Scapaniaceae. Vána & al., (2013) however treated the genus *Tritomaria* under Lophoziaceae, which has been followed here.

In India, the genus is represented by two species, *T. exsecta* (Schmidt.) Schiffn. and *T. ferruginea* (Grolle) Vána. However only *T. exsecta* was available for study and the report of *T. ferruginea* is based after Long (2005). According to Vána & al., (2013) the only distinguishing character in *A. ferruginea* is the presence of Anomoclada-type branching which is not found in other species of the genus, including *T. exsecta*. *Tritomaria ferrugineus* (Grolle) Vána, Phytotaxa 81(1): 24. 2013 *Andrewsianthus ferrugineus* Grolle, *Ergebn. Forsch.*



Fig. 15. *Tritomaria exsecta* (Schr.) Loeske **1.** Plant, dorsal view. **2.** Plant portion showing ventral half leaf insertion. **3.** Plant portion showing branching. **4-11.** Folded leaves. **12-18.** Inflated leaves (All figures drawn from LWU 11980/99)

Untern. Nepal Himalaya 1(4): 275. 1966.

Type : Nepal, Vorhimalaya, westlich unter Rauje gegen Ringmo, 4000m, 1962, Poelt, Nr. H 200 (Holo : M!, Iso : JE!, F!, NICH) (Váňa & al., 2013).

Range : India, Nepal, Bhutan (Grolle, 1966; Pradhan & Joshi 2009, Long, 2005)

Distribution : : Sikkim

The species was reported by Long (2005) from Sikkim as *Andrewsianthus ferrugineus*. Váňa & al., (2013)

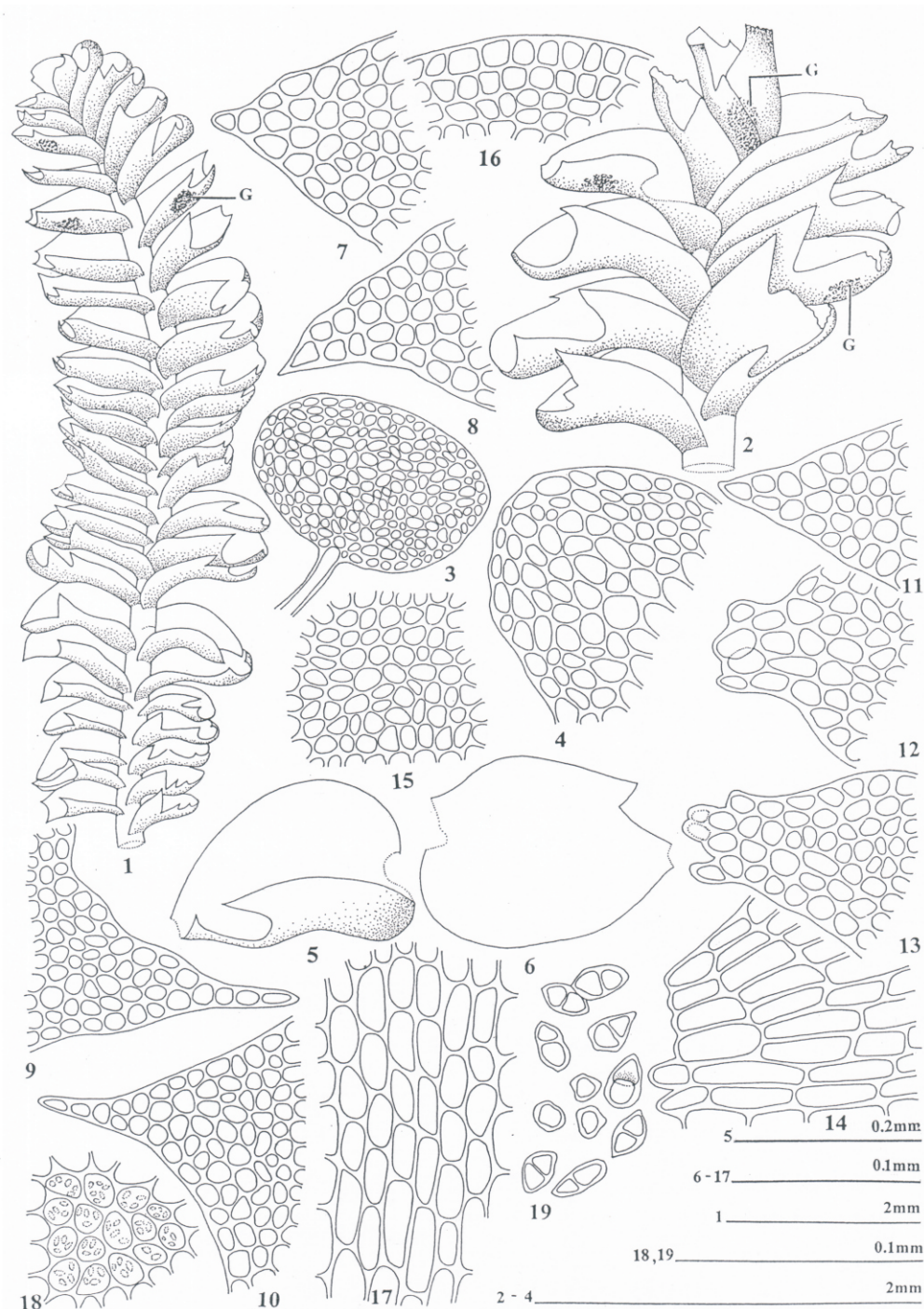


Fig. 16. *Tritomaria exsecta* (Schrad.) Loeske 1. Plant, dorsal view. 2. Plant portion showing gemmiferous apex and leaves with gemmae (G) accumulated on the surface. 3. Stem, cross section. 4. Same, enlarged portion. 5, 6. Leaves. 7, 8. Cells of postical leaf lobe. 9, 10. Cells of antical leaf lobe. 11-14. Cells showing development of gemmae from lobe apex. 15. Median cells of leaf. 16. Marginal cells of leaf. 17. Basal cells of leaf. 18. Median cells with oil bodies. 19. Gemmae (Figures drawn from: 1-17, 19 from LWU 11980/99; 18 from 15681/02)

transferred *A. ferrugineus* under the genus *Tritomaria*.

Tritomaria exsecta (Schmid.) Schiffn., Ber. Naturw. Ver. Innsbruck 31: 12. 1908. *Jungermannia exsecta* Schmid., Icones Pl. & Anal. 2: 241. 1797. *Sphenolobus exsectus* Steph., Sp. Hepat. 2: 170. 1902. *Sphenolobus striolatus* Horik., J. Sci. Hiroshima Univ., ser. B., Div. 2, Bot. 2: 157. 1934. **(Figs. 15, 16)**

Plant medium to robust, 4 to 14mm long, 3 to 5mm wide with leaves, pale to dark green, tinged with red at the

apex, firm and rigid but flaccid when dry, densely caespitose, decumbent, erect or ascending from a prostrate base, strongly acroscopically arched; branching irregular and less frequent, arising from the axil of normal leaves, ventral intercalary replacing the ventral half of the normal leaf. Stem rigid, green above, brown to nearly dark on ventral surface, robust, terete, elliptical to rarely subrounded in cross-section, $0.24 - 0.29 \times 0.13 - 0.17$ mm, 15-17 cells wide laterally, 12-14 cells wide vertically across diameter, cells differentiated, thin-walled, trigonous; cortical cells in single layer, slightly pigmented, small, quadrate to subquadrate, $14.4 - 19.0 \times 7.6 - 14.4$ μ m; medullary cells large, quadrate, subquadrate, irregularly rounded to angulate, $14.4 - 26.6 \times 14.4 - 19.0$ μ m, trigones small, triangular. Rhizoids scattered on the ventral surface of stem. Leaves contiguous to loosely imbricate, alternate, distant in younger plants, succubous, secund to spreading, horizontally attached to the stem, dorsal and ventral half transversely inserted up to stem midline, conspicuously concave canaliculate, ovate, subovate to subquadrate, (0.63-) 0.87 - 1.2 mm long, (0.57-) 0.72 - 0.90 mm wide, longer than wide, (2-)-3(-4)-lobed to (1/10-) 1/5 - 2/5 of the length; dorsal lobe short, arcuate, 12-34 cells long and 5-22 cells wide, 3 to 4-celled uniseriate at apex; the ventral larger lobe may further divide in 2(-3) unequal to subequal, acute to acuminate lobes, 10 to 28 cells long and 8-30 cells wide, lobes divergent; dorsal lobe with deep sinus; ventral lobes with shallow sinus; margins entire, arched and incurved, ventral margin much longer than dorsal; leaf cells minute, generally with small trigones, thick-walled with middle lamella visible mainly at apical portion; apical cells quadrate to subquadrate, rounded-slightly rectangulate, $7.6 - 19.0 \times 7.6 - 15.2$ μ m; median cells small, similar to apical cells, $11.4 - 19.0 \times 7.6 - 11.4$ μ m; basal marginal cells generally quadrate to rectangulate, $11.4 - 19.0 \times 11.4 - 15.2$ μ m; basal median cells elongated, rectangulate to subrectangulate with minute trigones, $22.8 - 45.6 \times 14.4 - 19.0$ μ m; oil-bodies (2-)3-6(-8) per cell, spherical to subspherical or elliptical, $1.9 - 5.7 \times 1.9 - 3.8$ μ m; cuticle verrucose under SEM. Underleaves absent.

Gemmae present generally on the tips of the upper most leaves, generally 2-lobed, red-rust in colour, ovoid or elliptical with tapering end, (1-)2-celled, $15 - 21 \times 12 - 15$ μ m. Gemmae producing apical cells of the leaves generally get elongated 2-3 times the normal cells, light in colour, rectangulate to subrectangulate, $19.0 - 57 \times 14.4 - 19.0$ μ m. After detachment gemmae accumulate on the leaf surface.

Habitat : Terrestrial and epiphytic, growing on soil covered rocks or, in soil filled crevices in rocks, compactly attached with the substratum and epiphytically on the bark of Fir and *Betula* at 1-1.5 m height above ground at the altitude between 3050 - 3700 m.

Type : Germany, Schrader s.n. (Iso : G!)

Range : East Africa, Austria, China, England, Finland, France, Germany, Hungary, India, Indonesia, Ireland, Italy, Japan, Korea, Madeira Isl. (Portugal), Mexico, Norway, Phillipines, Russia, Sri Lanka, Sweden, Switzerland, Taiwan (Hattori, 1966; Schuster, 1969; Vana, 1982; Gradstein and Vana, 1987; Piippo, 1990; Piippo & al., 1997; Srivastava, 2002).

Distribution : Uttarakhand (Valley of flower, Hemkund), Arunachal Pradesh (Tawang-Bomdir), Sikkim (Dzongri), West Bengal (Phalut).

Specimens examined : India: Uttarakhand, Ghangharia, c. 3048 m, May 22, 1980, S.C. Srivastava, D. Kumar and D.K. Singh 4202/80 (LWU). Uttarakhand, on way to Hemkund, c. 3300 - 3500 m, May 22-23, 1980, S.C. Srivastava, D. Kumar and D.K. Singh, 4241/80, 4276/80, 4279/80, 4335/80, 4347/80, 4385/80 (LWU). Uttarakhand, Ghangharia forest, c. 3058 m, Sept. 26, 1999, Deepak Sharma LWU 11975/99, 12023/99 (LWU). Uttarakhand, on way to Hemkund, c. 3400 - 3700 m, Sept. 26, 1999, Deepak Sharma 11976/99, 11977/99, 11978/99, 11980/99, 11987/99, 11990/99, 11991/99, 12003/99 (LWU). Uttarakhand, Ghangharia, on way to Valley of flowers; c. 3150 - 3300 m, Sept. 27, 1999, Deepak Sharma 12027/99, 12028/99, 12033/99, 12035/99, 12076/99, 12081/99, 12082/99, 12083/99, 12084/99 (LWU). Arunachal Pradesh, near Bomdir village, 11 km away from Tawang, c. 2900 m, April 27, 2002, K.K. Rawat and M.S. Azeem 15656/02, 15657/02, 15658/02, 15670/02, 15681/02, 15682/02 (LWU).

Tritomaria exsecta was first reported from India by Mitten (1861) as *Jungermannia exsecta* from Sikkim. Chopra (1943) and Parihar (1961-62) listed this species from Himalaya under *Sphenolobus exsectus*, a later synonym of *Tritomaria exsecta*. Grolle (1966) and Hattori (1966) listed this species as *Tritomaria exsecta* from Nepal and Sikkim Himalaya, respectively. The Indian population of the species are generally sterile.

The present investigation is based on the study of plants from various bryologically rich areas of Eastern as well as Western Himalaya. The plants show a wide range of vegetative characters and the Indian population is generally sterile.

The important characters by which the species can be recognized include the obliquely trilobed, concave, canaliculate and extremely asymmetrical form of leaves, with ventral leaf margins usually much longer than the dorsal margin and dorsal lobe thus appears as a tooth (2-4-celled uniseriate at the apex), the ventral lobes unequal to subequal and divergent with shallow sinus. The arrangement of leaves is also variable as some plants show contiguous to loosely imbricate arrangement while others generally have distant and alternate leaves at base and contiguous to loosely imbricate at apex. The leaf cells are small, rectangular to polygonal in shape and thick-walled. Basal cells are also much elongated in the middle giving vitta like appearance. The stem is elliptical to suborbicular in cross section with slight difference in the cortical and medullary cells. The gemmae are usually 2-celled, elliptical to ovoid in shape, generally present at the leaf lobe apices. The gemmiparous shoots appear red-rust in colour due to gemmae. The cells of the leaf lobe producing gemmae become enlarged, much elongated up to 2-3 times the normal leaf cells after the formation of gemmae. As such, the gemmae producing cells are distinctly different from rest of the cells.

Tritomaria exsecta approaches *Tritomaria exsectiformis* (Breide) Schiffn. due to extraordinarily similar appearance having 3-lobed, transversely inserted concave-canaliculate leaves, reddish brown mass of gemmae at the shoot apices and quite similar size of plants. However, the larger leaf cells and angular or pyramidal form of the large bulging trigones in *T. exsectiformis* (evenly thick-walled in *T. exsecta*) clearly distinguish *T. exsecta* from it (see also Schuster, 1969).

Another species, *Tritomaria scitula* is also allied to *T. exsecta* in trilobed leaves, reddish brown mass of gemmae at the leaf apices, but uniform lobes of the leaf in the former separate it from *T. exsecta* which has asymmetrical leaves (see also Schuster, 1969).

This species is also allied to *T. quinquedentata* in appearance, 3-lobed, spreading and slightly concave leaves of relatively larger size with short dorsal lobe and transverse insertion but broader than long and nearly constant absence of gemmae in *T. quinquedentata* remarkably distinguished it from *T. exsecta* (see also Schuster, 1953).

Schistochilopsis (Kitag.) Konstantinova, Arctoa 3: 125. 1994.

Plants prostrate to ascending, pale green to bright green and slightly brownish. Stem oval, soft, sparsely branching, undifferentiated internally; rhizoids sparse to common. Leaves succubous, inserted at various angles, distant to imbricate, spreading to appressed, flat to concave, divided by variously shaped sinus into 2-3(-4) lobes, lobes entire, cells collenchymatous or not, walls usually thin, sometime thickened; oil bodies 2-50 per cell; underleaves usually absent. Asexual reproduction by gemmae in masses at apices of shoot or on tips of specialized, attenuate branches. Sexual reproduction dioicous. Androeceia intercalary, 2-5 androus, antheridial stalk (1-)2-seriate. Gynoeceia terminal, female bracts in 1 pair. Perianth exerted 1/2-3/4 of its length, mainly cylindric, complicated at mouth, mouth dentate to ciliate and lobulated; perigynium entirely absent. Capsule oval, walls (3-)5-stratose, exterior walls with nodular thickenings, interior walls with annular thickenings, reddish brown. Elaters 2-spiral, reddish brown. Spores 10 - 16µm. Elaters 2-spiral, reddish brown. Spores 10 - 16µm. (based on Bakalin, 2011).

Type : *Schistochilopsis cornuta* (Kitag.) Konstant.

Konstantinova and Vasiljev (1994) proposed generic status for subgen. *Schistochilopsis* Kitag., alongwith other species, included *Lophozia incisa* (Schr.) Dumort. and *L. setosa* (Mitt.) Steph. as *Schistochilopsis incisa* (Kitag.) Konstant. and *S. setosa* (Mitt.) Konstant. Söderström & al., (2010) supported the treatment and retained

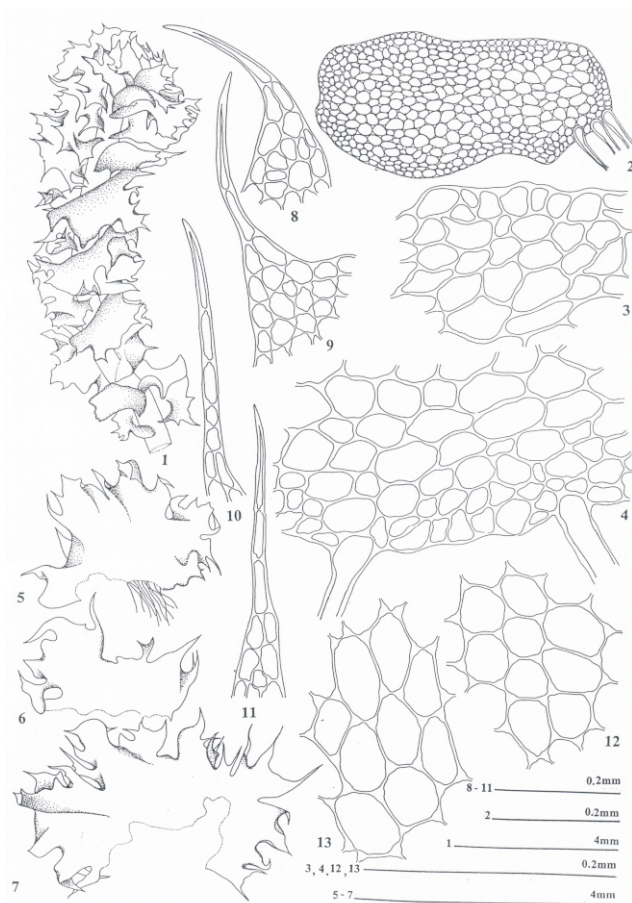


Fig. 17. *Schistochilopsis setosa* (Mitt.) Konstant. 1. Dorsal view of plant. 2. Stem, cross section. 3-4. Portion of same, magnified (dorsal and ventral cells respectively). 5-7. Leaves. 8-11. Marginal spines of leaf. 12. Median cells of leaves. 13. Basal cells of leaves (All figures drawn from NICH 311394)



Fig. 18. *Schistochilopsis setosa* (Mitt.) Konstant. 1. Plant portion with male inflorescence. 2. Plant portion with female inflorescence. 3. Male bract with antheridium. 4-6. Male bracts. 7. Antheridium. 8. Antheridial stalk. 9. Apical cells of male bracts. 10-12. Marginal spines of male bract. 13. Median cells of male bract. 14. Basal cells of bract. 15. Gemmae (All figures drawn from NICH 311394)

genus *Schistochilopsis* under paraphyletic family (incl. Lophoziaceae). The treatment of Konstantinova and Vasiljev (1994) is accepted here and hence, the presence of genus *Schistochilopsis* in India is confirmed with two species, *S. setosa* and *S. incisa*. In addition, another new variety of the latter is reported here from western Himalayan region as *S. incisa* var. *himalayana* var. nov.

Key to the species of the genus *Schistochilopsis* in India.

1. Plant very large, robust, upto 45mm long; stem upto 22 cells wide laterally, dorsiventrally differentiated; leaf margin with spinose dentitions with the dentitions setose to 2-5-celled uniseriate..... *S. setosa*
- 1a. Plants small to medium, upto 13mm long; stem 16-18 cells wide laterally, not differentiated; leaf margin with 1-celled, triangulate dentitions.....2
2. Leaf generally (2-)3-5-lobed, never antically connate, cells with distinct trigones; cuticle smooth; gemmae spindle-shaped *S. incisa*
- 2a. Leaf generally 2-3-lobed, seldom antically connate, cells with minute trigones; cuticle faintly verrucose; gemmae not seen *S. incisa* var. *himalayana* var. nov.

Schistochilopsis setosa (Mitt.) Konstant. *Arctoa* 3: 125. 1994. *Jungermannia setosa* Mitt., J. Proc. Linn. Soc. 5: 92. 1861. *Jungermannia pluridentata* Mitt., J. Proc. Linn. Soc. 5: 92. 1861. *Lophozia setosa* (Mitt.) Steph., Sp. Hepat. 2: 159. 1901. *Lophozia pluridentata* (Mitt.) Steph., Sp. Hepat. 6: 113. 1917. **(Figs. 17, 18)**

Plants very large, robust upto 45mm long, 1.92 (2.0) - 3.2 (3.6)mm wide with leaves, pale-green to brownish, sparsely branched. Stem subterete, rigid, pale green, flattened, more or less elliptical in outline in cross section, 19-27 cells wide laterally, 12-17 cells wide vertically, dorsiventrally differentiated with dorsal cells larger, quadrate, subquadrate, polygonal, $30.4 - 53.2 \times 22.8 - 41.8\mu\text{m}$; ventral cells small, subquadrate, rounded to polygonal, $15.2 - 30.4 \times 11.2 - 22.8\mu\text{m}$. Rhizoids dense on the ventral surface of stem. Leaves imbricate to contiguous, alternate, succubous, obliquely inserted with no decurrence, subvertically to horizontally oriented, very large, much broader than long, 1.32 - 2.0mm long, 2.4 - 2.8mm broad, with spines or dentitions along the entire margin, (3) 4-5-lobed; lobes unequal to subequal, ovate to broadly triangulate, dentitions 0.18 - 0.40mm long and 0.01 - 0.04mm wide, 11-29 in number, 1-celled setose to 2-5-celled uniseriate, sinus narrowly acute to subacute, 0.6 - 1.0mm deep; cells thin walled with large, distinct trigones; apical cells rounded, sub-rounded, polygonal, mostly elongated at the base of dentition, $31.5 - 67.5 \times 22.5 - 31.5\mu\text{m}$; median cells rounded, polygonal, $38.0 - 60.8 \times 22.8 - 41.8\mu\text{m}$; basal cells elongated, polygonal, $30.4 - 76.0 \times 19.0 - 39.2\mu\text{m}$, marginal dentitions much elongated; cells of marginal dentitions subquadrate to rectangulate, $83.0 - 133.0 \times 15.2 - 22.8\mu\text{m}$; cuticle smooth under SEM. Gemmae pale green, 2-4-celled, angulate, present at apices.

Dioicous. Male plants upto 45mm long, 3.2mm broad (0.19 - 0.20mm broad in the region of bracts), androecia both terminal and intercalary; bracts in 6-12 pairs, concave, closely imbricate, 3-5-lobed to 1/4 - 1/3 of the bract length, similar to leaves but smaller and with less dentitions, 1.2 - 1.5mm long, 1.44 - 2.4mm wide; cells thin-walled, trigonous; apical marginal cells without dentitions, sub-rounded, quadrate, sub-quadrate to polygonal, $24.0 - 54.0 \times 12.0 - 42.0\mu\text{m}$ with minute trigones; median cells sub-rounded to polygonal, $24.0 - 60.0 \times 30.0 - 45.0\mu\text{m}$ with distinct trigones; basal cells elongated, rectangulate with prominent trigones, $36.0 - 72.0 (87.0) \times 24.0 - 42.0\mu\text{m}$; antheridia 4-6 per bract; body sub-rounded to sub-globose upto 0.20mm long and 0.18mm wide; stalk biseriate, up to 1.1mm long, 0.02mm wide.

Habitat : On rocks.

Type : India, Sikkim, Yumthong, c. 12,000 ped., September 9, 1949, J. D. Hooker 1317 (Holo : & Iso : NY).

Range : Bhutan, China, India, Nepal (Srivastava, 2002).

Distribution : Sikkim (Lachen, Yumthong, Dzongri), West Bengal (Darjeeling, Sandakphu, Tonglu).

Specimens examined : India: Sikkim, Lachen, c. 10-11,000 ped., July 3, 1849, J. D. Hooker 1299 (Holotype & Isotype: NY, type of *J. pluridentata* Mitt.). Sikkim, c. 12,000 ped., J. D. Hooker (NY). Bhutan: Jongsang, c. 9-10,000 ped., Griffith. 868 (NY). Above Rydong Bhotan, c. 10,000 ped., Griffith (NY). Jongsang, c. 10,000, Griffith (NY). Summit of Yuto La, E of Tongsa, c. 3550m., June 8, 1979, D. G. Long No. 8265 (NY). Above Lami Gompa, Bumtang, c. 3100m., June 12, 1979, D. G. Long No. 8373 (NY). Nepal: East Nepal, in a coniferous forest above Topke Cola, c. 3650m, June 18, 1972, Z. Iwatsuki. no. 1253; 312159 (NICH). East Nepal, between Dor and Chauke, c. 2850m, June 7, 1972, Z. Iwatsuki. no. 496; 311394 (NICH).

Schistochilopsis setosa was first reported from India by Mitten (1861) as *Jungermannia setosa* from Sikkim Himalaya and subsequently listed by others (Herzog, 1939; Chopra, 1943; Parihar, 1961-62; Hattori, 1966; Grolle, 1966; Kitagawa, 1975). Later, Mizutani (1979) and Parihar & al., (1994) again listed this species from Eastern Himalaya and Nepal. However, this species has not been observed in recent collections available to us, suggesting the rare occurrence of the species in the area.

Schistochilopsis incisa (Schrad.) Konstant. Arctoa 3: 125. 1994. *Jungermannia incisa* Schrad., Syst. Samml. Krypt. Gewächse 2: 5. 1797. *Lophozia incisa* (Schrad.) Dumort., Rec. d'Obs., p. 17. 1835. **(Figs. 19, 20)**

Plants medium to large, up to 13mm long, 1.5 - 1.9 (-2.5)mm wide with leaves, blackish-brown, forming compact, often extensive, pure patches; branching furcate or often terminal. Stem prostrate or ascending, broad, fleshy, flattened, oblong-elliptical in cross-section, 16-18 cells wide across diameter laterally, 5-7 cells wide



Fig. 19. *Schistochilopsis incisa* (Schrad.) Konstant. 1. Plant dorsal view with perianth. 2. Stem, cross section. 3. Same, enlarged. 4-10. Leaves. 11. Apical cells of leaf. 12, 14. Marginal dentition of leaf. 13. Apical dentition of leaf. 15. Median cells of leaf. 16. Basal cells of leaf. (Figures drawn from: 1, 4-16 drawn from LWU 2084/99, 2, 3 from LWU 12035/99)

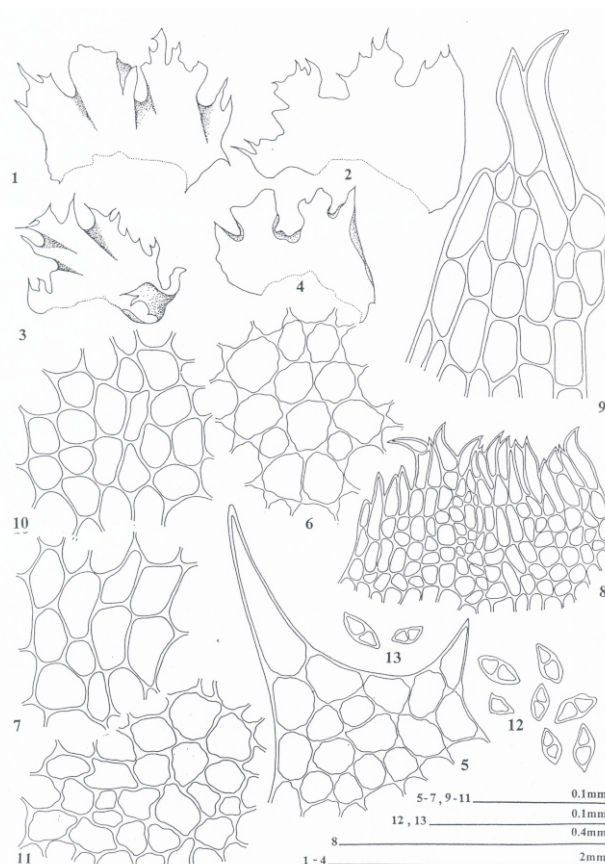


Fig. 20. *Schistochilopsis incisa* (Schrad.) Konstant. 1-4. Female bracts. 5. Apical cells of female bract with dentitions. 6. Median cells of female bract. 7. Basal cells of female bract. 8. Perianth cells at apex. 9. Same, enlarged. 10. Median cells of perianth. 11. Basal cells of perianth. 12, 13. Gemmae (All figures drawn from LWU 12084/99)

vertically, with no dorsiventral differentiation; cortical cells smaller, rounded to sub-rounded, or elliptical, $19.0 - 30.4 \times 11.4 - 19.0 \mu\text{m}$; medullary cells larger, flattened, oblong, elliptical, $30.4 - 49.4 \times 22.8 - 34.2 \mu\text{m}$. Rhizoids abundant, crowded on the ventral surface of stem. Leaves contiguous to imbricate at apex, generally distant in lower portion, alternate, succubous, obliquely inserted with slight decurrence dorsally, horizontally to sub-horizontally spreading, some leaves concave with dorsal half second over ventral, generally spreading, polymorphous, quadrate, subquadrate, roundly ovate, obtrapezoidal to obtrapezoidal, $0.60 - 0.75 \times 0.66 - 0.81 \text{mm}$, 2-5-lobed to $1/4 - 1/3 (-1/2)$ of its length; lobes unequal, narrowly to broadly triangulate, $0.15 - 0.30 \text{mm}$ long, $0.15 - 0.48 \text{mm}$ wide, with spinous marginal teeth; antical lobe generally ends into 1-celled spinous tooth; sinus narrowly acute to subacute, $0.15 - 0.30 \text{mm}$ deep, $0.18 - 0.36 (-0.45) \text{mm}$ wide; cells medium, thin-walled, trigonous; apical cells rounded, sub-rounded or polygonal, $15.2 - 34.2 \times 15.2 - 30.4 \mu\text{m}$, apical lobe ending cell triangulate and spinous, $76.0 - 95.0 \times 11.4 - 26.6 \mu\text{m}$; median cells rounded to sub-rounded or polygonal, $19.0 - 34.2 \times 22.8 - 38.0 \mu\text{m}$, with triangulate, rather short marginal dentitions, $60.0 - 83.6 \times 11.4 - 15.2 \mu\text{m}$; basal cells rounded to sub-rounded or slightly elongated, $22.8 - 41.8 \times 22.8 - 34.2 \mu\text{m}$; cuticle smooth. Gemmae present on the apices of the leaf, pale green, 1-2-celled, elliptical to triangulate.

Dioicous. Male plants not seen. Female plants $10 - 12 \text{mm}$ long, $1.5 - 1.9 (2.5) \text{mm}$ wide, perianth $1/2 - 2/3$ exserted; involucre bracts in one pair, similar to but larger than leaves, concave, erect, closely imbricate, $3-5$ -lobed to $1/4 - 1/3 (-1/2)$ of bract length, broadly obtrapezoidal to obtrapezoidal, $0.63 - 0.81 \text{mm}$ long, $0.90 - 1.2 \text{mm}$ wide; lobes with many, long dentitions; cells medium, thin-walled; apical cells rounded to subrounded or polygonal, with trigones, $15.2 - 38.0 \times 15.2 - 26.6 \mu\text{m}$; median cells rounded to subrounded or polygonal with distinct trigones, $26.6 -$

41.8 × 15.2 - 30.4µm, with long and triangulate marginal dentitions, 45.6 - 133.0 × 11.4-26.6µm; basal cell elongated-rectangulate without trigones, 34.2 - 53.2 × 15.2 - 22.8µm. Perianth cylindrical, obovoid, pluriplicate, mouth ciliate-dentate with 1-3-celled teeth; cell of dentation triangulate to quadrate, 76.0 -144.0 × 11.4 - 19.0µm; sub-apical cells elongated-rectangulate with minute acute trigones, (22.8-) 30.4 - 53.2 × 11.4 - 15.2µm; median cells sub-quadrate to rectangulate with or without minute trigones, 15.2 - 30.4 × 15.2 - 22.8µm; basal cells irregularly polygonal with distinct trigones, 22.8 - 30.4 × 19.0 - 30.4µm. Sporophytes not seen.

Habitat : Terrestrial, on soil covered rocks or humus, in crevices.

Type : Germany, Goettingen, Anon. - s.n. (Iso : G!).

Range : Central America, Bulgaria, Canada, Caucasus, China, Czech-republic, Denmark, England, Finland, France, Germany, India, Ireland, Japan, Korea, Mexico, Nepal, Norway, Poland, Russia, Slovakia, Sweden, Switzerland Taiwan, (Gradstien and Váňa, 1987; Piipoo, 1990; Piipoo & al., 1997; Srivastava, 2002).

Distribution : Jammu and Kashmir (Zanskar), Uttarakhand (Ghangharia, on way to Hemkund, and Valley of Flowers), Sikkim, West Bengal (Darjeeling, Phalut, Sandakphu).

Specimens examined : India: West Bengal, Darjeeling, Phalut - Sandakphu, c. 3200-3550m, June 6, 1960, H.H., H.K., G.M., M.T. and T.T. 201016 (NICH). Uttarakhand, on way to Hemkund, c. 3400m, May 23, 1980, S.C. Srivastava, D. Kumar and D.K. Singh 4279/80 (LWU). Uttarakhand, Ghangharia, on way to Hemkund, c. 3300-3700m, Sept. 26, 1999, Deepak Sharma, 11965/99, 11968/99, 11976/99, 11977/99, 11978/99, 11980/99, 11990/99, 12003/99 (LWU). Uttarakhand, Ghangharia, on way to Valley of Flowers, c. 3200-3250m, Sept. 27, 1999, Deepak Sharma 12033/99, 12035/99, 12040/99, 12042/99, 12080/99, 12081/99, 12082/99, 12083/99, 12084/99 (LWU). Bhutan: Between Ghijamachu and Tarumse La, W of Sangor, c. 3500m, June 13, 1979, D.G. Long 8429 (NY).

Schistochilopsis incisa was first described as *Lophozia incisa* from India by Kashyap (1932) from Western Himalaya (see also Chopra, 1943; Parihar, 1961-62; Parihar & al., 1994) and subsequently from Sikkim and West Bengal in the eastern Himalaya and Nepal (Grolle, 1966; Hattori, 1966; Kitagawa, 1975).

Schistochilopsis incisa has been variously treated by different workers earlier, e.g. under subgenus *Dilophozia* (Macvicar, 1912) and under subgenus *Massula* (Müller, 1954; Kitagawa, 1966) on the basis of deep green colour, flaccid texture of the plant, fleshy, flattened stem dorsiventrally not differentiated and by the large, thin-walled leaf cells with numerous oil-bodies. Later, Schuster (1969) treated it under section *Incisae* of the subgenus *Massula* on the basis of plants with bluish green colour, 2-5-lobed, asymmetric leaves, lobes usually sharply pointed (often apiculate) at apex, absence of underleaves and presence of greenish, angulate, 1-2-celled gemmae.

Schistochilopsis incisa seems to resemble *S. setosa* in having 3-4-lobed leaves with spinous dentitions but differs in relatively larger plants, high number of dentitions, which are 1-4 celled and are rectangularly elongated in *L. setosa*.

***Schistochilopsis incisa* var. *himalayana* S. Srivast., S.C. Srivast. & K.K. Rawat var. nov. (Fig. 21)**

Plantae mediocris vel robustes, 6-12mm longa & 0.76 - 0.96 (1.35)mm lata, Caulis phaeobrunea late ellipticus, 5 - 7 cellulae latis verticalis & 16 - 18 cellulae latis lateralis. Folia dimorpha, anticus conatus & simplex, imbricatus vel contigus ad apice, gradatim distans ad basi, mutuo lata quain longa, 2 - 3 lobis. Cuticula grosse verrucose.

Type : India, Ghanghariya, c. 3300m, May 22, 1980, S.C. Srivastava, D. Kumar & D.K. Singh 4171/80 (Holo : LWU).

Plants medium to large, 6 - 12mm long, 0.75 - 0.96 (-1.35)mm wide with leaves, blackish brown, forming dense caespitose patches; branching regular furcate and terminal. Stem prostrate to ascending, blackish-brown, thick, flattened to oblong-elliptical in outline in cross-section, 16-18 cells wide laterally, 5-7 cells wide

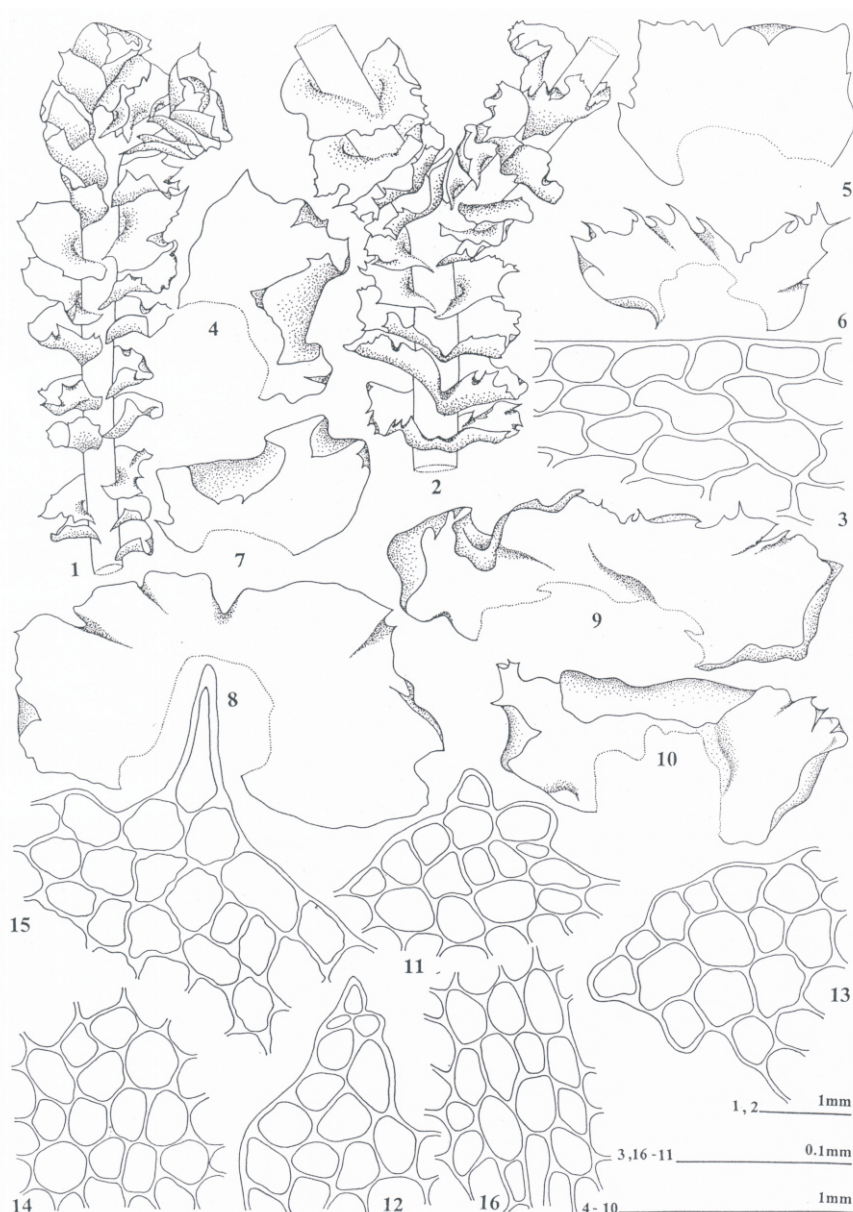


Fig. 21. *Schistochilopsis incisa* var. *himalayana* S. Srivast., S.C. Srivast. & K.K. Rawat var. nov. **1.** Plant dorsal view, with terminal branching. **2.** Plant portion with lateral branching. **3.** Stem, cross section, enlarged. **4-5, 7.** Leaves. **6.** Antically jointed leaf near branching. **8-10.** antically jointed leaves. **11-13.** Apical cells of leaf. **14.** Median cells of leaf. **15.** Marginal dentition of leaf. **16.** Basal cells of leaf. (All figures drawn from LWU 4171/80)

vertically, with no differentiation, cortical cells slightly smaller, sub-quadrate to rectangular, $26.6-41.8 \times 15.2-22.8\mu\text{m}$; medullary cells large, rectangular elongated, polygonal, $26.6-45.6 (-57.0) \times 19.0-30.4\mu\text{m}$. Rhizoids dense on ventral surface of the stem. Leaves, imbricate to contiguous in apical portion to generally distant below, alternate, subtransversely inserted upto stem mid-line, in some part dorsally connate, (mainly near branching in robust plants), 2-3-lobed to $1/4-1/3$ of its length, large, subquadrate to obtrhomboidal, $0.60-0.81\text{mm}$ long, $(0.90) 1.35-1.95\text{mm}$ broad, the part of leaf connation $(0.06-0.21-0.36\text{mm})$ wide; lobes broadly triangulate with 4-9 dentitions along the margins, $0.06-0.30\text{mm}$ long, $0.30-0.45\text{mm}$ wide, apex obtuse to subacute (with 1 triangulate cell at apex), sinus acute to obtusely wide, $0.15-0.24\text{mm}$ deep, $0.33-0.48\text{mm}$ wide; cells thin walled with minute trigones, apical cells sub-rounded, quadrate to sub-quadrate, $19.0-38.0 \times 19.0-30.4\mu\text{m}$; median

cells sub-rounded, quadrate to sub-quadrate, $19.0 - 26.6 \times 15.2 - 22.8 \mu\text{m}$ with the marginal dentitions on the lobe triangulate, upto $91.2 \mu\text{m}$ long and $11.4 - 19.0 \mu\text{m}$ wide; basal cells sub-quadrate to rectangularly elongated, $30.4 - 53.2 \times 15.2 - 22.8 \mu\text{m}$; cuticle faintly verrucose. Gemmae and fertile plants not seen.

Habitat : Terrestrial, on soil covered rock, on humus or on organic substrate.

Range : India (probably endemic).

Distribution : Uttarakhand (Ghangharia, Valley of Flowers).

Specimens examined (Paratypes) : India: Uttarakhand, Ghangharia, on way to Valley of Flower, c. 3300m, May 22, 1980, S.C. Srivastava, D. Kumar and D.K. Singh 4317/80 (LWU).

The new variety shows a very peculiar characteristic of dorsally connated leaf which is not exhibited by any other species of the genus. The variety can be differentiated from typical *S. incisa* in dorsally connated leaf near branching in robust plants (totally absent in *S. incisa*), leaf margin with few dentitions (dentitions frequent in *S. incisa*), and leaf cells without trigones (leaf cells with trigones in *S. incisa*).

The connation of the leaf is observed in majority of robust plants near branching but not in regular manner. The plant with connated leaves also show simple free leaves. Significantly the jointed leaves are not opposite but are alternate and the connation takes place in the alternately opposite leaves.

Tetralophozia (Schust.) Schljak., Novit. Syst. Plant. Non. Vasc. 13: 227. 1976.

Plants yellowish to reddish brown; branches rare, lateral intercalary and axillary. Stem erect to suberect with straight apex, rigid, firm, differentiated into 2(-3) rows of thick-walled cortical and collenchymatous medullary cells. Leaves subimbricate to contiguous, alternate, succubous, vertically to subvertically oriented with transverse insertion, symmetrically 4-lobed; lobes erect, ovate-triangulate to lanceolate, margin reflexed, lobes thus convex adaxially with 2-6, 1-celled dentitions, cilia upto 6-celled. Underleaves large, bifid; lobes much longer with deep sinus, base of the underleaves with few cilia or teeth; cells quadrate, subquadrate to polygonal, thick-walled, with indistinct confluent trigones. Gemmae not seen.

Dioicous. Male plants not seen. Female inflorescence terminal often with subfloral innovation. Bracts similar to but larger than leaves, the lobes gradually narrowed toward apex, with relatively less dentitions. Perianth 1/3-1/2 exerted, short, ovoid, mouth contracted, ciliate and dentate.

Type : *Jungermannia setiformis* Ehrh.

The species referable to the genus *Tetralophozia* in India were earlier reported as part of *Chandonanthus* Mitt. Herzog (1939) for the first time reported *C. setiformis* from Sikkim. Parihar (1961-62) also listed *C. setiformis* from Eastern Himalaya. Hattori (1966) listed another species, *C. filiformis* in place of *C. setiformis*. Hara (1971) listed only *C. filiformis* from Eastern Himalaya. Grolle (1966) and Mizutani (1979) reported *C. filiformis* from Nepal. Hattori (1966) remarked that *C. filiformis* does not occur in Eastern Himalaya, but *C. setiformis*, a closely allied European species occurs in this area. Both the species now belong to genus *Tetralophozia* (Urmi, 1983; Schuster, 2002) as *Tetralophozia filiformis* and *T. setiformis*. Konstantinova (2002) also did not mention distribution of *T. setiformis* in India. The available specimens confirmed the presence of *T. filiformis* in India which is described and illustrated here.

Tetralophozia filiformis (Steph.) Urmi, J. Bryol. 12: 394. 1983. *Chandonanthus filiformis* Steph., Sp. Hepat. 3: 644. 1909. **(Fig. 22)**

Plants medium to large, upto 18mm long, 0.36 - 0.90mm broad, yellowish to reddish brown, filiform; branching rare, lateral intercalary and axillary. Stem not arched, straight, erect to suberect, rigid, orbicular to suborbicular in cross-section, 0.17 - 0.22mm long, 0.13 - 0.15mm wide, 10-12 cells across diameter, differentiated, cortical cells in 2(-3) rows, small, $7.6 - 11.4 \times 3.8 - 7.6 \mu\text{m}$, thick-walled; medullary cells large, collenchymatous irregularly, suborbicular, polygonal, $11.4 - 19 \times 7.6 - 15.2 \mu\text{m}$. Rhizoids few, scattered over the ventral surface of the stem. Leaves subimbricate to contiguous, alternate, succubous, vertically to subvertically



Fig. 22. *Tetralophozia filiformis* (Steph.) Urmi 1. Plant, dorsal view. 2. Plant, ventral view. 3. same, enlarged. 4. Stem, cross section. 5-8. Leaves. 9-13. Underleaves. 14. Female bract. 15. Apical cells of leaf. 16. Median cells of leaf. 17. Basal cells of leaf. 18. Basal cilia of leaf. 19. Apical cells of underleaf. 20. Median cells of underleaf. 21. Basal cells of underleaf. 22. Apical cells of perianth. 23. Median cells of perianth. 24. Basal cells of perianth. (All figures drawn from NICH 201540).

oriented with transverse insertion, palmate, digitatus (fingered), (0.13-) 0.18 - 0.21mm long, 0.09 - 1.35mm wide, symmetrically 4-lobed; lobes equal to subequal, triangulate, ovate to lanceolate with incurved margin and acute to subacute apices, adaxially convex; leaf base with short, 1-celled dentitions to 2-6 celled uniseriate cilia; sinus 0.13 - 0.18mm deep, 0.9 - 0.15mm wide. Underleaf large, bifid with deep sinus, sinus 0.30 - 0.52mm deep, 0.15 - 0.34mm wide; lobes ovate-triangulate to lanceolate, with few cilia or teeth at the base, 0.31 - 0.6mm long, 0.27 - 0.30mm wide; leaf cells thick-walled with indistinct trigones; apical cells of the leaf quadrate to subquadrate, $11.4 - 19.0 \times 11.4 - 15.2\mu\text{m}$; median cells irregularly subquadrate to polygonal, $11.4 - 19.0 \times 11.4 - 19.0\mu\text{m}$; basal cells large, irregularly rectangulate with confluent trigones, (19.0-) $30.4 - 38 (-45.6) \times 11.4 -$

19.0µm; underleaf cells similar to but smaller than leaf cells; apical cells rounded to subquadrate, 7.6 - 11.4 × 7.6 - 11.4µm; median cells quadrate to subquadrate, 11.4 - 19.0 × 11.4 - 15.2µm; basal cells elongated-rectangulate, 19.0 - 38.0 × 11.4 - 19.0µm. Gemmae not seen.

Dioicous. Male plants not seen. Female inflorescence terminal with subfloral innovation; bracts similar to but larger than leaves with less dentitions, 0.60 - 0.75mm long, upto 0.66mm wide; perianth 1/3 - 1/2 exerted, ovoid, mouth contracted, ciliate and dentate, cilia long, 1-4 celled; apical cells of the perianth narrowly elongated, 19.0 - 38.0 × 11.4 - 15.2µm; median cells rectangular, 11.4 - 30.4 × 11.4 - 15.2µm; basal cells elongated-rectangulate, 19.0 - 30.4 (-38.0) × 11.4 - 15.2µm. Sporophyte not seen.

Habitat : Terrestrial

Type : China, Delavay (G!)

Range : China, India, Finland, Japan, Norway, Sweden (Hattori, 1966; Srivastava, 2002).

Distribution : Sikkim (Dzongri, Tsomgo lake), West Bengal (Darjeeling, Phalut).

Specimens examined : India: Sikkim, Dzongri, c. 4000m; May 22, 1960, H.H, H.K., G.M., M.T. and T.T. 201225 (NICH). West Bengal, Phalut, ca 3550m; May 11, 1960; H.H, H.K., G.M., M.T. and T.T. 201540, 201541 (NICH).

Tetralophozia filiformis was first reported from India as *Chandonanthus filiformis* from Tsomgo lake, Sikkim by Herzog (1939). Parihar (1961-62); Kachroo (1966) and Kitagawa (1975) also listed this taxon as *Chandonanthus filiformis* from Eastern Himalaya, while Grolle (1966) and Mizutani (1979) reported this species from Nepal.

Tetralophozia can be differentiated from *Chandonanthus* in having symmetrically 4-lobed leaves (2, 3-4 lobed, asymmetric leaves in *Chandonanthus*), transverse insertion of leaves (oblique insertion in *Chandonanthus*), perianth mouth contracted (rather wide open in *Chandonanthus*), and lateral intercalary branching (postical intercalary in *Chandonanthus*). The main difference in both the genera is in the structure of cells. The cells are thick walled and rounded with nearly guttulate lumen in the former while the cells are thin-walled with coarse and obvious, often confluent trigones in the latter (see Schuster, 1960).

Plicanthus R.M. Schust., Nova Hedwigia 74 : 484. 2002.

Plants in loose patches, yellowish to golden brown, medium to large. Stem rigid to stiff, procumbent to erect, simple to sparsely branched branches lateral intercalary; cortical cells in 2-4 layers. Leaves obliquely inserted, asymmetrically 3(-4)-lobed, margin dentate to ciliate, apices acuminate; cells thin walled with large, nodulose to confluent trigones; cuticle smooth to striate. Underleaves small. Paraphyllia may be present.

Dioicous. Gynoecia terminal; perianth long emergent, 5-6 plicate, mouth ciliate to spinose.

Type : *Chandonanthus squarrosus* (Hook.) Mitt.

The genus *Plicanthus* was also reported earlier from India as *Chandonanthus* Mitt., as Herzog (1939) for the first time reported its 2 species, *C. setiformis* (from Sikkim) and *C. birmensis* (from Darjeeling-Kalimpong). Parihar (1961-62) enumerated 3 species (*C. birmensis*, *C. hirtellus* and *C. setiformis*) of this genus from Eastern Himalaya. Hattori (1966, 1971, 1975) listed 3 species of this genus. Grolle (1966) reported one species, *C. filiformis* and Mizutani (1979) listed 3 species (*C. birmensis*, *C. filiformis* and *C. hirtellus*) from Nepal. Hattori (1966) remarked that *C. filiformis* does not occur in Eastern Himalaya, but *C. setiformis* a closely allied European species occurs in this area. Manju & al., (2008) listed *Chandonanthus birmensis* as *Plicanthus birmensis* in south India (Kerala). Out of the all, *C. birmensis* and *C. hirtellus* are now *Plicanthus birmensis* and *P. hirtellus* respectively (Schuster, 2002) and discussed here.

Schuster (1960) divided *Chandonanthus* into two subgenera, *Chandonanthus* subg. *Chandonanthus* and *Chandonanthus* subg. *Tetralophozia*, the former being tropical antipodal in distribution while the latter occurs in arctic and alpine region (see Schuster, 1969). These subgenera were later on elevated as distinct and independent

genera (Urmi, 1983). Currently *Chandonanthus* is represented in India by 2 validly recognized species, *C. hirtellus* and *C. birmensis*. The detailed description of both the species have been given by Udar and Kumar (1982) from Eastern Himalaya and Tiwari and Airi (1988) from Western Himalaya. Schuster (2002) while revising Chandonanthoideae segregated *Chandonanthus* into three elements. Genus *Tetralophozia* (Schust.) Schljakov, *Chandonanthus* s. str. (on basis of *C. squarrosus*) and *Plicanthus* Schust. According to him genus *Chandonanthus* s. str. is represented by single species *C. squarrosus* (Hook.) Mitt. and is purely Australasian element. He synonymized including others, *C. birmensis* and *C. hirtellus* (species reported in India) under genus *Plicanthus*.

Key to the species of *Plicanthus* in India

1. Plant reddish to greenish brown, leaf margin entire with few occasional teeth along the margin, underleaf with 1-2 marginal teeth at the base *P. birmensis*
2. Plant yellowish brown, leaf margin with many sharp marginal teeth and cilia, underleaf with numerous marginal teeth at the base *P. hirtellus*

Plicanthus birmensis R.M. Schust., Nova Hegwigia 74: 486. 2002. *Chandonanthus birmensis* Steph., Sp. Hepat. 3: 643. 1909. *Temnoma birmensis* (Steph.) Horik., Hikobia 1: 90. 1951.

For detail taxonomic description and illustration see Udar & Kumar (1982 as *Chandonanthus birmensis*).

Habitat : On rocks, humus or grows epiphytically.

Range : China, India, Indonesia, Japan, Madagascar, Myanmar, Russia, Taiwan, Thailand (Hattori, 1966; Lai & al., 2008; Konstantinova & al., 2009; Bakalin, 2010).

Distribution : Kerala, Uttarakhand (Almora, Binsar, Pindari, Ranikhet), West Bengal (Darjeeling, Victoria falls, Phalut, Sandakphu, Kurseong). (Udar and Kumar, 1982; Manju & al., 2008)

The plants of *P. birmensis* can be differentiated from those of *P. hirtellus* in the presence of few weakly developed teeth at the margins of leaf base and faintly developed verrucose cuticle in the former and several well developed teeth at leaf margin in the latter. The cuticle in *P. hirtellus* is reported to be papillately-striatedly verrucose (see Kitagawa, 1965 as *Chandonanthus hirtellus*). As the plants are already worked out in detail by Udar and Kumar (1982) and Tewari and Airi (1988), hence details are not being provided here.

Plicanthus hirtellus (F. Webber.) R.M. Schust., Nova Hegwigia 74: 492. 2002. *Chandonanthus hirtellus* F. Webber Mitt., Handb. New Zealand Fl. 2: 750. 1867.

Habitat : Grows either in pure population or in association with other liverworts in shady places.

Range : Africa, Australia, Canada, China, India, Indonesia, Japan, Polynesia, Sri Lanka, Taiwan, Thailand (Udar and Kumar, 1982; Piipoo & al., 1997; Lai & al., 2008)

Distribution : Meghalaya (Shillong), Sikkim (Nathula Pass, Dzongri), Uttaranchal (Almora, Chaubattia, Dhakuri, Loharkhet, Pithoragarh, Pindari, Ranikhet), West Bengal (Darjeeling, Yoksam, Sandakphu, Tonglu, Kurseong). (Hattori, 1966; Udar and Kumar, 1982)

Excluded Taxa

Sphenolobus longkyrdumii A.P. Singh and V. Nath = *Metahygrobiella albula* (Mitt.) Grolle syn. nov. (Cephaloziaceae)

Type : India, Meghalaya, east Khasi hills, Longkyrdum-Dawki road, 07.11.1998, V Nath & al. 206083B (Holo : LWG) (Singh & Nath, 2007)

Lophozia hatcheri (Evans) Steph., = *Barbilophozia hatcheri* (Evans) Loeske

Barbilophozia hatcheri (Evans) Steph. is reported from Himalaya by Stephani (1901) as *Lophozia hatcheri* but the exact locality of this species in India was not clearly mentioned. Unfortunately it has not been possible to collect this species from India.

Tetralophozia setiformis (Ehrh.) Schljakov.

Presence of this taxon in India is doubtful (see Konstantinova, 2002).

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भारत में लोफोजिएसी (हेपेटिसी) कुल की स्थिति

स्मिता श्रीवास्तव, एस. सी. श्रीवास्तव एवं के. के. रावत

सारांश

साम्प्रतिक अनुसंधान एवं भारतीय टैक्सा पर हमारे अपने अवलोकन के आलोक में भारत में लोफोजिएसी कुल की स्थिति का विवेचन किया गया है। आइसोपेकिस बूक, लोफोजिया (डुमोर्ट) डुमोर्ट, सिस्टोकिलोप्सिस (एन किटाग) कौस्टेंट, एनेस्ट्राप्टा (लिंडब) शिफिन, एनेस्ट्रोफायलम स्प्रूस शिफिन, ट्रिटोमेरिया शिफिन, टेट्रोलोफोजिया (आर एम शुष्ट) एवं प्लिकेंथस आर एम शुष्ट समेत आठ वंशों के अंतर्गत कुल १६ टैक्सा की पहचान की गई है। एनेस्ट्रोफाइलम माइनुटम प्रभेद हिमायेनम, लोफोजिया उदारी, लोफोजिया इंडिका एवं सिष्टोकिलोप्सिस इंसाइसा प्रभेद हिमालयाना प्रभेद नौव ये चार टैक्सा विज्ञान के लिए नये रूप में वर्णित हैं। स्फेनोलोबस लॉगकिर्कुमी ए. पी. सिंह एवं वी. नाथ को मेटाहायग्रोविएला एल्बुला (मिट) ग्राल (कुल संफेलोजिएसी मिग) के अंतर्गत पर्यायवाचक प्रस्तावित होने के कारण शामिल नहीं किया गया है।