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Recircumscription of *Lopholejeunea sikkimensis* (Lejeuneaceae: Marchantiophyta) and its varieties in India

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Abstract

The taxonomy of *Lopholejeunea sikkimensis* var. *tenuicostata*, *L. sikkimensis* var. *kumaunii* and *L. sikkimensis* var. *dentata* is evaluated. Based on study of numerous collections of *L. sikkimensis*, followed by comparison with the protologues of the varieties, we conclude that var. *tenuicostata* and var. *kumaunii* are not distinct from the typical variety. Hence both the varieties are placed here under synonymy of *L. sikkimensis*. *Lopholejeunea sikkimensis* var. *dentata*, however, is accepted as a distinct taxon. A detailed revised taxonomic description of *L. sikkimensis* is provided along with line drawing illustration and photographic plate for future identification and reference.

Key words: *Lopholejeunea,* variety, synonymy, taxonomic status

Introduction

Lopholejeunea (Spruce 1884: 119) Stephani (1890: 285) is a "Sprucean" genus of Lejeuneaceae with the highest diversity in Southeast Asia (Gradstein 1991; Zhu & Gradstein 2005). The genus was described initially as subgenus of *Lejeunea* Libert (1820: 372) and subsequently assigned to generic rank by Stephani (1890). Stephani described 74 species including 24 new species in his monumental work 'Species Hepaticarum' (Stephani 1912), from different parts of the world. After Stephani, the number of species under *Lopholejeunea* increased drastically as can be seen in the Index Hepaticarum (Gradstein & Zijlstra in Geissler & Bischler 1985) wherein 123 species are listed across the globe. In addition to these, nomenclatural changes were carried out in the framework of monographs and revisions (Thiers & Gradstein 1989; Gradstein 1991, 1994; Gradstein *et al.* 2002; Wigginton 2004; Zhu & Gradstein 2005; Haerida *et al.* 2010; Kornochalert *et al.* 2012; Wang *et al.* 2016) and new species were added (e.g. Mizutani & Piippo 1986; Tixier 1986; Thiers & Gradstein 1989; Gradstein & Hekking 1989; Piippo 1990; Awasthi *et al.* 2000; Sass-Gyarmati 2001, 2005, 2008; Singh 2002; Zhu & Gradstein 2004, 2005; Singh & Nath 2006; Dey & Singh 2011; Kushwaha *et al.* 2017). Currently, more than 50 accepted species (Sass-Gyarmati in Söderström *et al.* 2016) are accepted globally, mostly distributed in the tropical regions. However, this number may change as a result of future taxonomic revisions. The genus can be distinguished by its blackish green shoots, isodiametric leaf cells having homogenous oil-bodies, lobules with one tooth, unlobed underleaves, enlarged cortical cells and a toothed to laciniate, 2–5-keeled perianth without *Radula*-type innovations (Zhu & Gradstein 2005).

The earliest records of the genus *Lopholejeunea* in India came into light with the publication of William Mitten (Mitten 1861) who reported *Lejeunea applanata* (Reinwardt *et al.* 1825: 210) Nees von Esenbeck (1845: 314) (≡ *Lopholejeunea applanata* (Reinwardt *et al.* 1825: 210) Schiffner (1893: 129) from Sikkim and Khasi Hills, and *Lejeunea subfusca* (Nees von Esenbeck 1830: 36) Nees von Esenbeck & Montagne (1836: 61) (≡ *Lopholejeunea subfusca* (Nees von Esenbeck 1830: 36) Schiffner (1897: 593) from Khasi Hills and Madras (now in Tamil Nadu). Later, 9 species and 2 varieties were added, viz., *L. abortiva* (Mitten 1879: 399) Stephani (1912: 70) var. *abortiva*, *L. abortiva* var. *doliiformis* Awasthi *et al.* (2000: 41), *L. applanata*, *L. eulopha* (Taylor 1846: 391) Schiffner (1893: 129), *L. indica*

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Udar & Awasthi (1985‘1983’: 174), *L. javanica* (Nees von Esenbeck 1845: 320) Schiffner (1893: 129), *L. kashyapii* Awasthi *et al.* (2000: 48), *L. nicobarica* Stephani (1896: 111), *L. nigricans* (Lindenberg 1845: 316) Schiffner (1898: 293), *L. nilgiriensis* Awasthi *et al.* (2000: 51), *L. sikkimensis* var. *dentata* Awasthi *et al.* (2000: 56), *L. sikkimensis* Stephani (1912: 87) var. *sikkimensis*, and *L. subfusca* (Awasthi *et al.* 2000 and literature therein). Zhu & Gradstein (2005) in their revision of Asian *Lopholejeunea,* accepted only five species from India, *i.e. Lopholejeunea applanata*, *L. eulopha*, *L. nigricans*, *L. recurvata* Mizutani (1979: 369) and *L. subfusca*. The remaining taxa were placed in synonymy: *L. abortiva*, *L. abortiva* var. *doliiformis*, *L. javanica*, *L. kashyapii, L. sikkimensis* and *L. sikkimensis* var. *dentata* were synonymized under *L. nigricans*, *L. nicobarica* under *L. eulopha*, and *L. indica* and *L. nilgiriensis* under *L. subfusca.*

Singh *et al.* (2016) in a review of the taxonomic status of Indian *Lopholejeunea* disagreed with the synonymy proposed by Zhu and Gradstein (2005) and resurrected several species that were treated as phenotypes of *L. nigricans* by Zhu & Gradstein (2005). However, Singh *et al.* (2016) agreed with synonymy of *L. nicobarica* under *L. eulopha* and *L. nilgiriensis* under *L. subfusca*; in addition, they synonymized *L. nongstoinii* Singh & Nath (2006: 32) under *L. subfusca.* Singh *et al.* (2016) accepted 12 species and 3 varieties in India including several recently described and reported taxa i.e. *L. sikkimensis* var. *tenuicostata* Singh & Singh (2005: 189) (Singh & Singh 2005), *L. udarii* Dey & Singh (2011: 197) (Dey & Singh 2011), *L. soae* Zhu & Gradstein (2005: 69) (Singh & Singh 2016). More recently, *L. sikkimensis* var. *kumaunii* Kushwaha *et al*. (2017: 543) (Kushwaha *et al.* 2017) was described from India.

In the course of a revisionary study of the ptychanthoid genera of Lejeuneaceae in India, *Lopholejeunea sikkimensis*, a species resurrected from the synonymy of *L. nigricans* by Singh *et al.* (2016), was studied comprehensively. By comparing the varieties *L. sikkimensis* var. *dentata, L. sikkimensis* var. *kumaunii* and *L. sikkimensis* var. *tenuicostata* with the typical variety, the authors reached the conclusion that var. *tenuicostata* and var. *kumaunii* do not warrant separate status and fall within the range of variation of the typical variety. *Lopholejeunea sikkimensis* var. *dentata*, however, is a distinct taxon (Table 1). Unless otherwise mentioned, all the specimens are deposited in the Cryptogamic herbarium of the Botanical Survey of India, Eastern Regional Centre Shillong (ASSAM).

Taxonomic treatment

1a. *Lopholejeunea sikkimensis* Steph. var. **sikkimensis**, Sp. Hepat. 5: 87. 1912
(Figs. 1–3)

Awasthi *et al.*, Geophytology 29: 58. 2000; Singh & Nath, Hepat. Khasi & Jaintia Hills: East. Himal. 240. 2007; Singh & Ghosh, Bull. Bot. Surv. India 49: 161. 2007; Singh *et al.* in Mohamed *et al.* (eds.) Bryol. New Millenn. Kuala Lumpur, Univ. Malaya 124. 2008; Pradhan & Joshi, Bot. Orient. 6: 72. 2009; Kapoor *et al.*, Geophytology 38: 26. 2011; Barbhuiya & Singh, Archiv Bryol. 134: 5. 2012; Singh *et al.*, Liverw. Hornw. India, Annot. Checkl. 157. 2016

(=) *Lopholejeunea sikkimensis* var. *kumaunii* B.K.Kushwaha, S.N.Srivast., M.Rai & Prateek Srivast., Int. J. Life Sci. 5 (4): 544. 2017. Holotype: India, Uttarakhand, Pithoragarh, Munsyari, 2195 m, 06.10.2015, *S.N. Srivastava et al.* WHKP 0262 L/15 (DUTHIE) ***syn. nov.***

(=) *Lopholejeunea sikkimensis* var. *tenuicostata* Sushil K.Singh & D.K.Singh, Bull. Bot. Surv. India 47 (1): 189. 2005. Holotype: India, Himachal Pradesh, Kullu, Sainj Valley, on the way from Bah–Lapah, *c.* 1800 m, 26.05.2002, S.K.Singh 99594b (CAL !) ***syn. nov.***

Plants dark green to blackish green at maturity, blackish brown in herbarium specimen, closely apressed to the substrate; shoots 6.0–27 mm long, 0.7–1.4 mm wide, irregularly branched, branching mostly *Lejeunea*-type. Stem in section ellipsoid in outline, 85–170 × 68–120 µm, 5–8 cells across, well differentiated into cortex and medulla; cortical cells in layer of 11–16 cells, quadrate–subquadrate or pentagonal, 15.3–38.4 × 11.5–31 µm, thin or slightly thick-walled; medullary cells somewhat equal or slightly smaller than cortical cells 9–22, pentagonal–hexagonal or polygonal, 19–34 × 10–32.9 µm, slightly to moderately thick-walled with distinct triradiate trigones; ventral merophytes 3–4 cells wide. Rhizoids present at base near insertion of underleaves, somewhat hyaline. Leaves approximate to imbricate; lobes ovate, 0.60–0.82 × 0.49–0.58 mm, margin entire, apex rounded, sometimes incurved; marginal leaf cells towards apex quadrate–subquadrate or pentagonal or rarely subrectangular, 7–12.1 × 6.6–8.6 µm, median leaf cells subquadrate–hexagonal or occasionally polygonal, 13.7–28.2 × 10.8–14.4 µm, basal cells slightly elongated, hexagonal–polygonal, 13.9–28.7 × 11.1–14.6 µm; trigones small triradiate, intermediate thickenings often present; oil-bodies 12–14 per median cell, homogeneous, spherical–elliptical, 2.1–5.5 × 1.2–3.8 µm; leaf lobules saccate, 1/4–1/2 as long as leaf

lobe, 0.16–0.30 × 0.11–0.21 mm, free lateral margin 5–13-celled with a 1–2 cells long tooth, preapical tooth indistinct, lobule apex attached to leaf lobe by one cell; hyaline papillae near the tooth not observed; rudimentary stylus often present at leaf base inserting the stem. Underleaves remotely arranged at lower portion of shoot, imbricated towards apex, suborbicular–reniform, 0.41–0.52 × 0.31–0.42 mm, 2–4 times wider than the stem, margins entire, sometimes recurved, insertion line shallowly curved. Monoicous. Androecia usually intercalary; bracts imbricate, in 6–9 pairs, saccate; bract lobe ovate, 0.16–0.33 × 0.05–0.26 mm, margin entire, apex rounded; bract lobule almost as long as bract lobe, bearing 1 (-2) antheridium per bract; antheridium globose, 90–100 µm in diam. with c. 0.11 mm long stalk; bracteoles 6–9, almost identical in shape of underleaves, comparatively much smaller. Gynoecia terminal on main or short lateral branches, occasionally *Lejeunea*-type pseudo-innovations observed; bract usually in one pair, lobe ovate–obovate, 0.83–1.1 × 0.52–0.74 mm, margin entire to toothed, apex rounded, obtuse–subacute to apiculate; bract lobules iso- or heteromorphic, 1/4–1/2 to 3/4 of bract length, subtriangular–rectangular, 0.44–0.67 × 0.20–0.26 mm, margin entire to denticulate; bracteole suborbicular or obovate or very rarely cordate, covering 3/4th portion of perianth or occasionally covering the entire perianth, 0.7–1.2 × 0.9–1.1 mm, margin entire, apex rounded or shallowly depressed, often recurved. Perianth obovate, 0.8–1.1 × 0.45–0.75 mm, 5-keeled; keels smooth or denticulate–dentate; dentitions (1-) 3–6-celled long, 3–4 cells wide at base, surface between keels smooth or sometimes with small dentations; rostrum 1–3-cells long, occasionally with mamillated terminal cells. Seta hyaline, in transverse section orbicular, with 4 inner cells surrounded by 16 outer cells. Capsule light–dark brown, globose, 250–300 µm across diam., 4 valves, valves wall bistratose in upper half; outer wall upper portion have rectangular cells (marginal cells small) with nodular thickenings at tangential and radial walls; inner walls cells somewhat smaller with nodular thickenings and poses dark yellowish sheet like thickening with pitted or oblong area. Elaters linear, 140–190 µm long and 10–11 µm wide, with single spiral band. Spores subisodiametric, usually slightly elongated, subovate, 31–63 × 24–36 µm, exine granulose–verrucose, often with 2–4 rosettes on each face consist of 5–7 papillose teeth.

Habitat: The plants usually grow on bark of tree as an epiphyte either in pure population or in association with other bryophytes, at an elevation of 100–1800 m asl. Epiphyllous, terrestrial as well as lithophytic populations are also recorded of this species.

Distribution: INDIA: Assam (Barbhuiya & Singh 2012); Chhattisgarh (Kapoor *et al.* 2010); Jammu & Kashmir (Langer & Tanwir 2002); Karnataka & Kerala (Awasthi *et al.* 2000); Madhya Pradesh (Mizutani 1976; Lal & Parihar 1979; Singh & Kaul 2002); Manipur (U.S. Awasthi *et al.* 2000); Meghalaya (Mizutani 1976; Singh & Nath 2006); Sikkim (Stephani 1912; Chopra 1938; Zhu & Long 2003); Tamil Nadu (Awasthi *et al.* 2000); Uttarakhand (Mizutani 1976; present report); BHUTAN (Long & Grolle 1990); NEPAL (Pradhan & Joshi 2009).

Specimens examined: India, Eastern Himalaya, **Mizoram,** Mamit, Dampa Tiger Reserve, Teirei range, 23°42’21” N, 92°24’33.7” E, 597 m, 22.11.2011, *S.K.Singh et al.,* 123809A, 123810B; Teirei range, 23°42’6.2” N, 92°24’17.7” E, 650 m, 22.11.2011, *S.K.Singh et al.,* 123812A; Teirei range, 23°41’39” N, 92°24’29.4” E, 758 m, 22.11.2011, *S.K.Singh et al.,* 123834; Teirei range, 23°41’30” N, 92°24’42.6” E, 755 m, 22.11.2011, *S.K.Singh et al.,* 123839A; Teirei range, 23°41’6” N, 92°24’45” E, 740 m, 22.11.2011, *S.K.Singh et al.,* 123842B; Teirei range, Luhinar side, 23°40’46.4” N, 92°27’10.3” E, 265 m, 24.11.2011, *S.K.Singh et al.,* 123988A,123989C; Phuldungsei Range, 23°35’9.7” N, 92°26’42.7” E, 754 m, 26.11.2011, *S.K.Singh et al.,* 124044D; Phuldungsei Range, 23°39’0.4” N, 92°25’51.4” E, 868 m, 26.11.2011, *S.K. Singh et al.,* 124052A; Phuldungsei Range, 23°31’16.7” N, 92°25’11.5” E, 828 m, 26.11.2011, *S.K.Singh et al.,* 124057A; Phuldungsei Range, 23°29’57” N, 92°24’58.5” E, 873 m, 27.11.2011, *S.K.Singh et al.,* 124070C, 124071B; Phuldungsei Range, 23°29’59.1” N, 92°24’52.8” E, 832 m, 27.11.2011, *S.K.Singh et al*.,124073B, 124074; Phuldungsei Range, 23°30’1.9” N, 92°24’48” E, 798 m, 27.11.2011, *S.K.Singh et al.,*124078; Phuldungsei Range, 23°30’1.9” N, 92°24’51.8” E, 838 m, 27.11.2011, *S.K.Singh et al.,*124079; Phuldungsei Range, 23°30’1.9” N, 92°24’51.8”E, 838 m, 27.11.2011, *S.K.Singh et al.,*124080; Phuldungsei Range, 23°30’3.9” N, 92°24’59.1” E, 952 m, 27.11.2011, *S.K.Singh et al.,*124108A; Phuldungsei Range, 23°30’47.9” N, 92°25’11.6” E, 870 m, 27.11.2011, *S.K.Singh et al.,* 124128B; Phuldungsei Range, 23°30’53.4” N, 92°25’1.1” E, 944 m, 28.11.2011, *S.K.Singh et al.,* 124178B; Phuldungsei Range, 23°30’58.5” N, 92°25’8” E, 912 m, 28.11.2011, *S.K.Singh et al.,*124185; On way to North Marpara, 23°55’56” N, 92°25’25” E, 100 m, 29.11.2011, *S.K.Singh et al.,* 124195C, 124196B, 124197B, 124198B, 124199A; Lunglei, Tawipui, 22°41’58” N, 92°50’31” E, 885 m, 04.07.2008, *S.K.Singh et al.,*119961B, 119964; Bualte, 22°48’22” N, 92°48’40” E, 663 m, 04.07.2008, *S.K.Singh et al.,*119967B, 119969A; Near Lunglei, 22°50’02” N, 92°48’07” E, 1091 m, 04.07.2008, *S.K.Singh et al.,*119972; Hnathial to Liete, 22°54’35” N, 92°54’51” E, 640 m, 05.07.2008, *S.K.Singh et al.,*119998C, 120004B; Laisawral, 23°15’46.7” N, 92°28’17.9” E, 812 m, 29.11.2011, *S.K.Singh et al.,*124202; Thorang WLS, 23°14’40.8” N, 92°33’22.5” E, 896 m, 30.11.2011, *S.K.Singh et al.,*124208C; Thorang WLS, 23°14’42” N, 92°33’22” E, 905 m, 30.11.2011, *S.K.Singh et al.,*124212C; Thorang WLS, 23°14’46.3” N, 92°33’17.1” E, 960 m, 30.11.2011, *S.K.Singh et al.,*124218; Thorang WLS, 23°14’57.3” N, 92°33’48.8” E, 609

m, 30.11.2011, *S.K.Singh et al.,*124238B; Khawanglung WLS, 23°09’28.8’’ N, 92°54’09.1’’ E, 774 m, 04.12.2012, *S.K.Singh et al.,*127714A,127715A; Kolasib, Bukpui forest, 23°56’41” N, 92°45’47” E, 1081 m, 04.12.2010, *S.K.Singh et al.,* 120464C, 120465D, 120467A, 120471C; Bukpui forest, 24°04’42.7” N, 92°47’22” E, 930 m, 05.12.2010, *S.K.Singh et al.,* 120502C ; Aizawl, Tawi WLS, 23°33’46.5’’ N, 92°57’05.6’’ E, 1636 m, 06.12.2012, *S.K.Singh et al.,* 127822B; Champhai, Murlen National Park, 23°38’43’’ N, 93°17’32.6’’ E, 1580 m, 19.02.2009, *S.K.Singh et al*.,120047C; Murlen National Park, 23°38’32.7’’ N, 93°17’34’’ E, 1492 m, 19.02.2009, *S.K.Singh et al.,* 120089C; Murlen National Park, 23°38’59’’ N, 93°17’20.8’’ E, 1600 m, 20.02.2009, *S.K.Singh et al.,*120115D, 120116E; Murlen National Park, 23°38’35.1’’ N, 93°18’1.5’’ E, 1400 m, 20.02.2009, *S.K.Singh et al.,*120148C, 120152, 120166; Murlen National Park, 23°38’52.6’’ N, 93°17’26.7’’ E, 1300 m, 20.02.2009, *S.K.Singh et al.,*120206D, 120207D; Murlen National Park, 23°38’47.8’’ N, 93°17’32.3’’ E, 1500 m, 21.02.2009, *S.K.Singh et al.,*120251A; Champahai—Khazawl, 23°30’26’’ N, 93°12’40’’ E, 924 m, 24.02.2009, *S.K.Singh et al.,* 120439B; Saiha, Blue Mountain National Park Area, Sangau—Sentetfiang, 22°43’20’’ N, 93° 02’52’’ E, 1385 m, 25.06.2008, *S.K.Singh et al.,*119716E; Sentetfiang—Thaltlang, 22°42’27’’ N, 93°02’50’’ E, 1266 m, 25.06.2008, *S.K.Singh et al.,* 119731B, 119732A, 119733C, 119734A; Sentetfiang—Thaltlang, 22°42’17’’ N, 93°02’49’’ E, 1290 m, 25.06.2008, *S.K.Singh et al.,*119737B, 119741A; Sentetfiang—Thaltlang, 22°41’59’’ N, 93°02’55’’ E, 1400 m, 25.06.2008, *S.K.Singh et al.,*119754B, 119757D; Sentetfiang —Thaltlang, 22°41’55’’ N, 93°03’05’’ E, 1377 m, 25.06.2008, *S.K.Singh et al.,* 119760C; Thaltlang—Phawngpui Peak, 22°41’26’’ N, 93°03’24’’ E, 1431 m, 26.06.2008, *S.K.Singh et al*.,119776E; Blue Mountain National Park Area, Thaltlang—Phawngpui Peak, 22°41’26’’ N, 93°03’24’’ E, 1433 m, 26.06.2008, *S.K.Singh et al.,*119778B, Thaltlang—Phawngpui Peak, 22°41’26’’ N, 93°03’24’’ E, 1434 m, 26.06.2008, *S.K.Singh et al.,*119779A, 119780C; Thaltlang—Phawngpui Peak, 22°41’30’’ N, 93°03’10’’ E, 1609 m, 26.06.2008, *S.K.Singh et al.,*119783I; Thaltlang—Sangau, 22°41’26’’ N, 93°03’41’’ E, 1261 m, Corticolous, 26.06.2008, *S.K.Singh et al.,*119810B; Thaltlang—Sangau, 22°42’01’’N, 93°02’52’’E, 1352 m, 26.06.2008, *S.K.Singh et al.,*119831B; Thaltlang—Sangau, 22°42’07’’N, 93°02’51’’ E, 1320 m, 26.06.2008, *S.K.Singh et al.,*119843C; Sangau—Pangkhua, 22°44’21’’N, 93°03’50’’ E, 1250 m, 27.06.2008, *S.K.Singh et al.,*119851A; Sangau (towards S. Vanlaiphai), 22°45’18’’ N, 93°02’51’’ E, 1342 m, 29.06.2008, *S.K.Singh et al.,*119885C; Near Cheural, 22°41’44’’ N, 93°02’02’’ E, 1039 m, 01.07.2008, *S.K.Singh et al.,* 119903B; Near Bualpui, 22°34’32’’ N, 93°01’51’’ E, 1277 m, 01.07.2008, *S.K.Singh et al.,*119913B; on way from Vawmbuk to Blue Mountain Peak, 22°36’47.1’’ N, 93°03’24.8’’ E, 1715 m, 28.11.2012, *S.K.Singh et al.,*127514C; on way from Vawmbuk to Blue Mountain Peak, 22°36’51.7’’ N, 93°04’01’’ E, 1519 m, 28.11.2012, *S.K.Singh et al.,*127524D; Saiha Circuit House, 22°29’27’’ N, 92°59’17’’ E, 1180 m, 03.07.2008, *S.K.Singh et al.,* 119948; Saiha to Lungzarthum, 22°30’00’’ N, 92°01’11’’ E, 1615 m, 04.07.2008, *S.K.Singh et al.,*119953A. ***Tripura,*** North district, Jampui Hills, Thumlai dam side, 23°59′23.2″N, 92°16′23.4″E, *c.* 506 m, 20.10.2015, *Shashi Kumar,* TSLI-1016; *Manipur,* Tengnouspal district, Yangoupokpi Lokchao WLS, Laiching area, 24°16′45.4″N, 94°18′55.2″E, 308m, 13.07.2014, *Shashi Kumar,* TSLI-71; ***Assam,*** Cachar, Borail WLS, Kalain Range, *H.A. Barbhuiya,* 10.11.2011, 124416; Western Himalaya, **Uttarakhand,** Dehradun, 192 Kaulagarh Road, *c.* 600 m, 08.08.2023, *S.K.Singh & Priyanka* RLPI-1001; 21.08.2023, RLPI-1002, RLPI-1003, 04.09.2023, RLPI-4 (BSD).

Lopholejeunea sikkimensis var. *tenuicostata* S.K.Singh & D.K.Singh India, Himachal Pradesh, Great Himalayan National Park (Kullu), Sainj Valley, on way from Bah-Lapah, *c.* 1800 m, 26.05.2002, *S.K. Singh* 99594-b (Holotype: BSD!).

1b. *Lopholejeunea sikkimensis* var. ***dentata*** U.S.Awasthi, S.C.Srivast. & D.Sharma, Geophytology 29: 56. 2000. Holotype: India, Meghalaya, East Khasi Hills, Shillong, Elephant falls, *c.* 1600 m, 09.11.1979, *U.S. Awasthi & A Kumar,* 3939/79 (LWU)

The species is characterised by 5–10 mm long and 0.5–0.9 mm wide leafy shoots; stem 7–8 cells across diameter with 10–12 thick-walled cortical cells and 26–32 thin-walled medullary cells. The leaf lobules are 1/3–1/2 as long as lobe. Male bracts are arranged in 4 pairs terminally. The female bracts are ovate–obovate with dentate margin and acute apex. The perianth is 4-keeled with dentitions; dentitions (-2) 4–9-cells long, (2-) 3–4 cells wide at base (Awasthi *et al.* 2000 & our own observations).

Distribution: India [Meghalaya, Mizoram], endemic (Singh *et al.* 2016; Singh 2017).

Specimens examined: Mizoram, Mamit, Dampa Tiger Reserve, Teirei range, 23°40’51.8’’ N, 92°25’18’’ E, 817 m, 22.11.2011, *S.K.Singh et al.,* 123851B, 123852F.

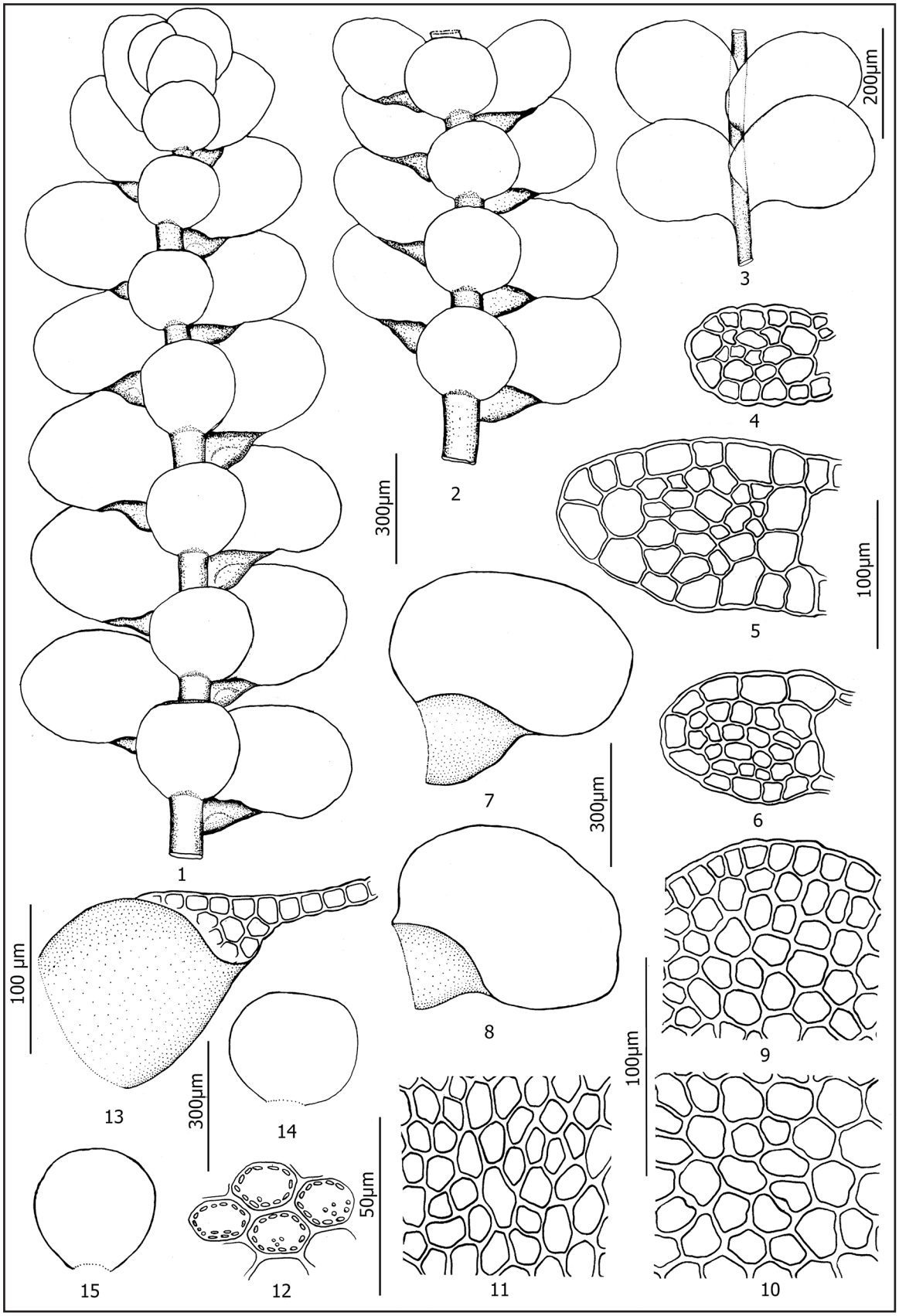

FIGURE 1. *Lopholejeunea sikkimensis* var. *sikkimensis*. 1,2. Portions of plant in ventral view. 3. A portion of plant in dorsal view. 4–6. Cross-sections of stem. 7, 8. Leaves. 9. Marginal leaf cells towards apex. 10. Median leaf cells. 11. Basal leaf cells. 12. Leaf cells with oil-bodies. 13. A leaf lobule. 14,15. Underleaves (Figs. 1–4, 6–15 drawn from Singh *et al.* RLPI-1003 and fig. 5 drawn from Singh *et al*. RLPI-1002 by Priyanka).

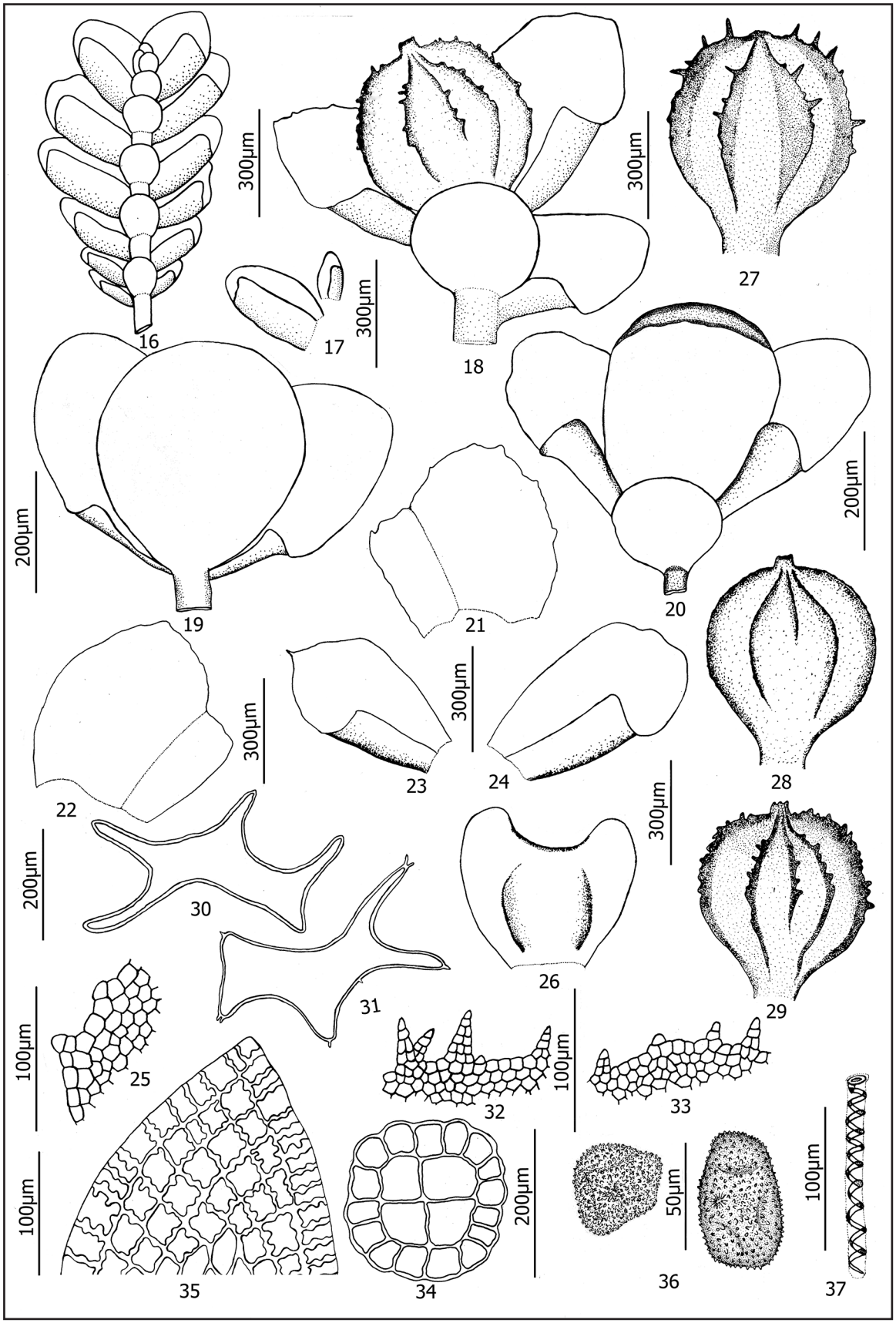

FIGURE 2. *Lopholejeunea sikkimensis* var. *sikkimensis*. 16. An androecial branch. 17. Male bracts. 18. Gynoecial branch with perianth. 19, 20. Two different female bract and bracteole. 21–24. Female bracts. 25. Female bract lobule free margin with teeth. 26. Female bracteole. 27–29. Three different kinds of perianth. 30,31. Cross-sections of perianth. 32,33. Dentitions on perianth keels. 34. Cross-section of seta. 35. Outer capsule wall. 36. Spores. 37. An elater (Figs. 16–27, 29, 31–32, 34–37 drawn from Singh *et al.* RLPI-1003; figs. 28, 30, 33 drawn from Singh *et al*. RLPI-1002 by Priyanka).

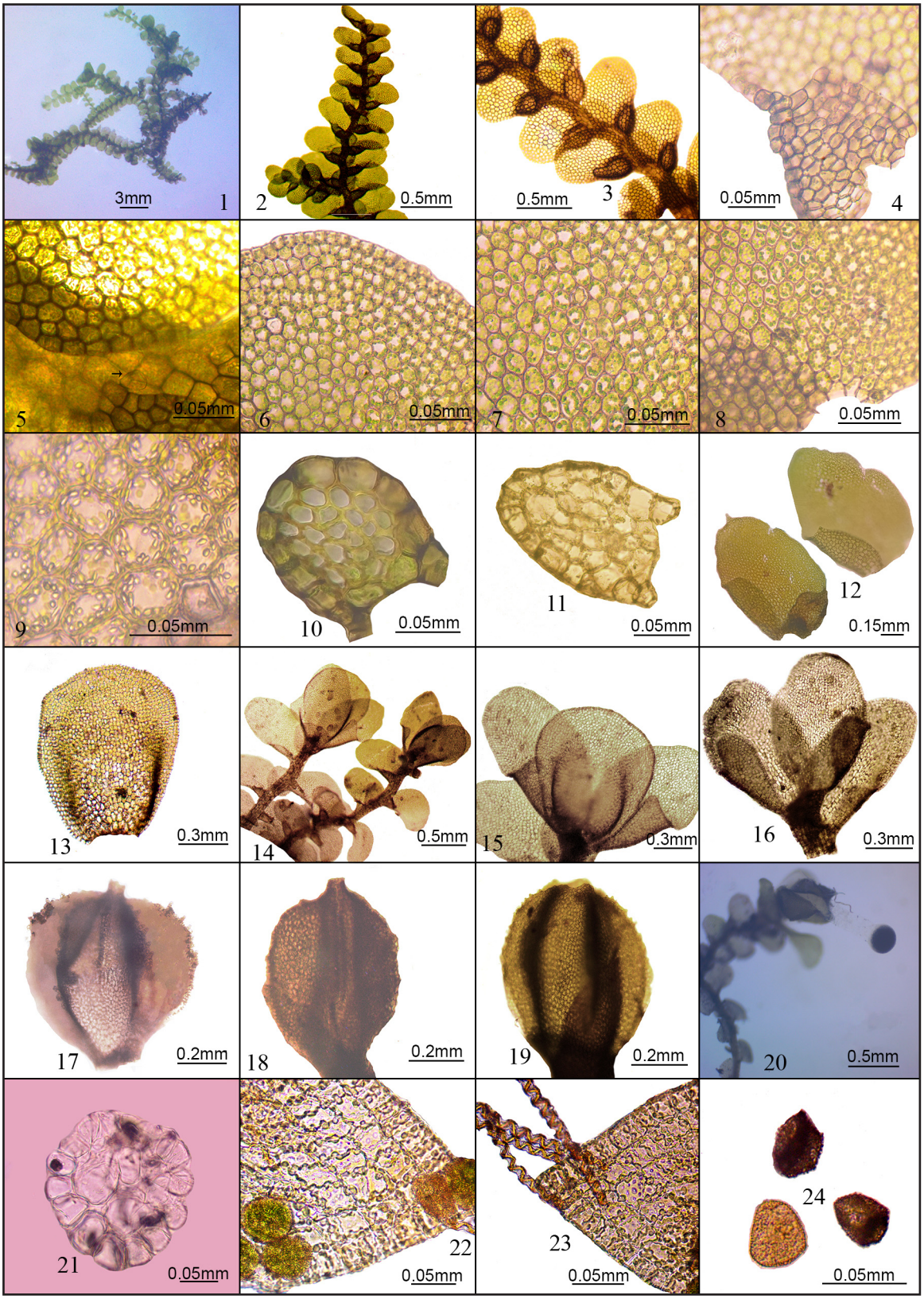

FIGURE 3. *Lopholejeunea sikkimensis* var. *sikkimensis*. 1. A plant with gynoecium. 2. A portion of plant in ventral view. 3. A portion of plant in dorsal view. 4. A portion of leaf showing lobule attachment (1-celled). 5. Rudimentary stylus at leaf base inserting the stem (arrow). 6. Marginal leaf cells towards apex. 7. Median leaf cells. 8. Basal leaf cells. 9. Leaf cells showing oil-bodies. 10,11. Cross-sections of stem. 12. Female bracts. 13. Bracteole. 14–16. Different shape and arrangement type of female bracts and bracteoles. 17–19. Entire to dentate perianths. 20. Gynoecial branch with mature sporophyte. 21. Cross-section of seta 22. The upper portion of inner capsule wall. 23. The upper portion of outer capsule wall. 24. Spores (Figs. 1–10, 12–14, 16–17, 20–24 photographed from Singh *et al.* RLPI-1003; figs. 11,15,18,19 photographed from Singh *et al.* RLPI-1002 by Priyanka &

Singh).

Discussion

The present study reveals that *Lopholejeunea sikkimensis* shows high plasticity in its morpho-taxonomic characters. While the typical form is chiefly characterized by its ovate leaf lobes with rounded apices; suborbicular–reniform underleaves; denticulate–dentate bracts and lobule; entire bracteole and 5-keeled dentate perianth (Mizutani 1976; Awasthi *et al.* 2000 and our own observations), we noticed variation in the size of leaf lobe and lobule, anatomy of the stem (delicate to firm), shape and size of the female bract and bracteole, presence and absence of dentations on the female bract and lobule, perianth symmetry, and keels with reduced to prominent dentition. The observed variations lead to the conclusion that the described varieties *L. sikkimensis var. tenuicostata* and *L. sikkimensis* var. *kumaunii* are synonyms whereas *L. sikkimensis* var. *dentata* is a distinct taxon, being characterized by a 4-keeled instead of 5-keeled perianth. A comparison of the varieties of *L. sikkimensis* is presented in Table 1.

TABLE 1. Comparison of the known varieties of *Lopholejeunea sikkimensis* Steph.

Serial No.	Characters	*L sikkimensis* var. *sikkimensis* (Awasthi *et al.* 2000 & our own observation).	*L. sikkimensis* var. *tenuicostata* (Singh & Singh 2005).	*L. sikkimensis* var. *kumaunii* (Kushwaha *et al.* 2017).	*L. sikkimensis* var. *dentata* (Awasthi *et al.* 2000).
1.	Leafy shoots	5–27 mm long, 0.7–1.4 mm wide.	5–9 mm long, 1.1–1.3 mm wide.	6–25 mm long, 0.4–1mm wide.	5–10 mm long, 0.5–0.9 mm wide.
2.	Stem	6–8 cells across; cortical cells 11–18, ± thick-walled, medullary cells in 9–22 (-32) vertical rows.	6 cells across; cortical cells 11–13, thick-walled, medullary cells in 13–17 vertical rows.	6 cells across; cortical cells 13–14, thick-walled; medullary cells in 14–16 vertical rows.	7–8 cells across; cortical cells 10–12, thick-walled; medullary cells in 26–32 vertical rows.
3.	Leaf lobule	saccate, 1/4–1/2 as lobe length.	saccate, c. 1/3 as long as lobe length.	saccate, 1/3 as long as lobe length.	saccate, 1/3–1/2 as long as lobe length.
4.	Male bract	intercalary, in 7–9 pairs.	intercalary, in 7–9 pairs.	not recorded.	terminal, in 4 pairs.
5.	Female bract	ovate–obovate with dentate to entire margin and rounded–subacute apex.	ovate–obovate, with dentate margin and often acute apex.	broadly ovate with entire to denticulate margin and obtuse apex.	ovate–obovate with dentate margin and acute apex.
6.	Female bracteole	suborbicular or obovate or rarely cordate, covering 3/4 to complete perianth.	almost orbicular, covering 3/4 portion of perianth.	suborbicular, covering complete perianth.	suborbicular, covering 3/4 portion of perianth.
7.	Perianth	5-keeled; keels denticulate–dentate or smooth; dentitions (1-) 3–6-cells long, 3–4 cells wide at base.	5-keeled; keels dentate; dentitions 3–6 cells long, 2–3 (-4) cells wide at base.	5-keeled, keels with rudimentary or small 1–2 cells long and wide at base.	4-keeled; keels dentate; dentitions (-2) 4–9-cells long, (2-) 3–4 cells wide at base.

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