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MORPHOTAXONOMY OF THREE RARE TERRICOLOUS TAXA OF JUNGERMANNIALES OCCURRING IN NILGIRI HILLS (WESTERN GHATS) INDIA

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Abstract

Nilgiri hills being a part of biodiversity hot spot, is a home of colossal life forms including bryophytes. Bryophytes have a great diversity in Nilgiri hills which includes both terricolous and corticolous forms. This study deals with morphotaxonomy of three extremely infrequent terricolous taxa of order Jungermanniales, viz., *Gottscheia schizopleura* (Spruce) Grolle, *Lethocolea javanica* (Schiffn.) Grolle and *Jackiella javanica* var. *cordifolia* Schiffn, occurring in Nilgiri hills. These taxa were located to a few restricted pockets and facing high risk of habitat loss which need urgent/immediate conservation management.

Key words: Bryophyta, Jungermanniales, Nilgiri hills, morphotaxonomy, habitat loss, conservation management

Introduction

Jungermanniales is the largest order in Hepaticae and comprises 82-85% of the total hepatic vegetation on earth, distributed equally in tropical and temperate parts of the world (Pradhan, 2014). Schuster (1984) classified Jungermanniales in 15 suborders of which 13 have been reported from India represented by 27 families, 97 (+ 3) genera and 520-600 species (Chopra, 1938a, 1938b, 1943; Kashyap, 1929, 1932; Parihar et al, 1994; Mitten, 1861; Stephani, 1917-1924; Udar, 1976; Srivastava, 1998; Sharma and Srivastava, 2003). In Nilgiri hills the class Hepaticae is represented by, 29 families and 55 genera with 164 species. Of these 90

species in 24 genera are epiphytic and remaining strictly terrestrial (Alam and Srivastava, 2012; Verma et al., 2013).

The terrestrial liverworts are more vulnerable to disappear than the corticolous forms due to habitat loss. Habitat loss is the major biotic threat to the terrestrial liverworts in India mainly due to rapid urbanization, industrialization, change in land use pattern, demand on forest products, etc. Beside these catastrophic activities and biological imparities are natural causes of decline in terrestrial liverwort diversity (Bhattacharyya, 2011).

As a result, several of the previously reported taxa in Nilgiri become extinct. It all happened due to rapid habitat loss (Alam, 2009; 2011; Alam et al., 2009; 2012).

In present study efforts have been made to provide morphotaxonomic account of three such terrestrial taxa which presume rare in their occurrence in Nilgiri. These three taxa are *Gottschelia schizopleura* (Spruce) Grolle, *Jackiella javanica* var. *cordiofolia* Schiffn., and *Lethocolea javanica* (Schiffn.) Mitt.

Materials and Methods

Study area

The blue mountain of Nilgiri is due to the predominant and verdant blue bloom of angiosperm – *Strobilanthus kunthianus* (Acanthaceae), is an ancient land mass that thrust upwards at the junction of two major mountain ranges near the southern end of India some 70 million years ago. Situated at 10°1'-11°45' N latitude, 76°-77°15' E longitude, and about 1200-2500 m altitude spread over an expanse of 2600 km² it forms the center of diversification in the India's oldest 'Biosphere Reserve', the Nilgiri Biosphere Reserve (NBR), of Tamil Nadu. Geographically the region is located between Moyar gap and Palghat gap which creates a natural barrier for the migration and diversification of taxa (Fig. 1). The geography and climate of the region make the area an important centre for diversification of the species. Recently few taxa reported new to the region (Alam, 2008).

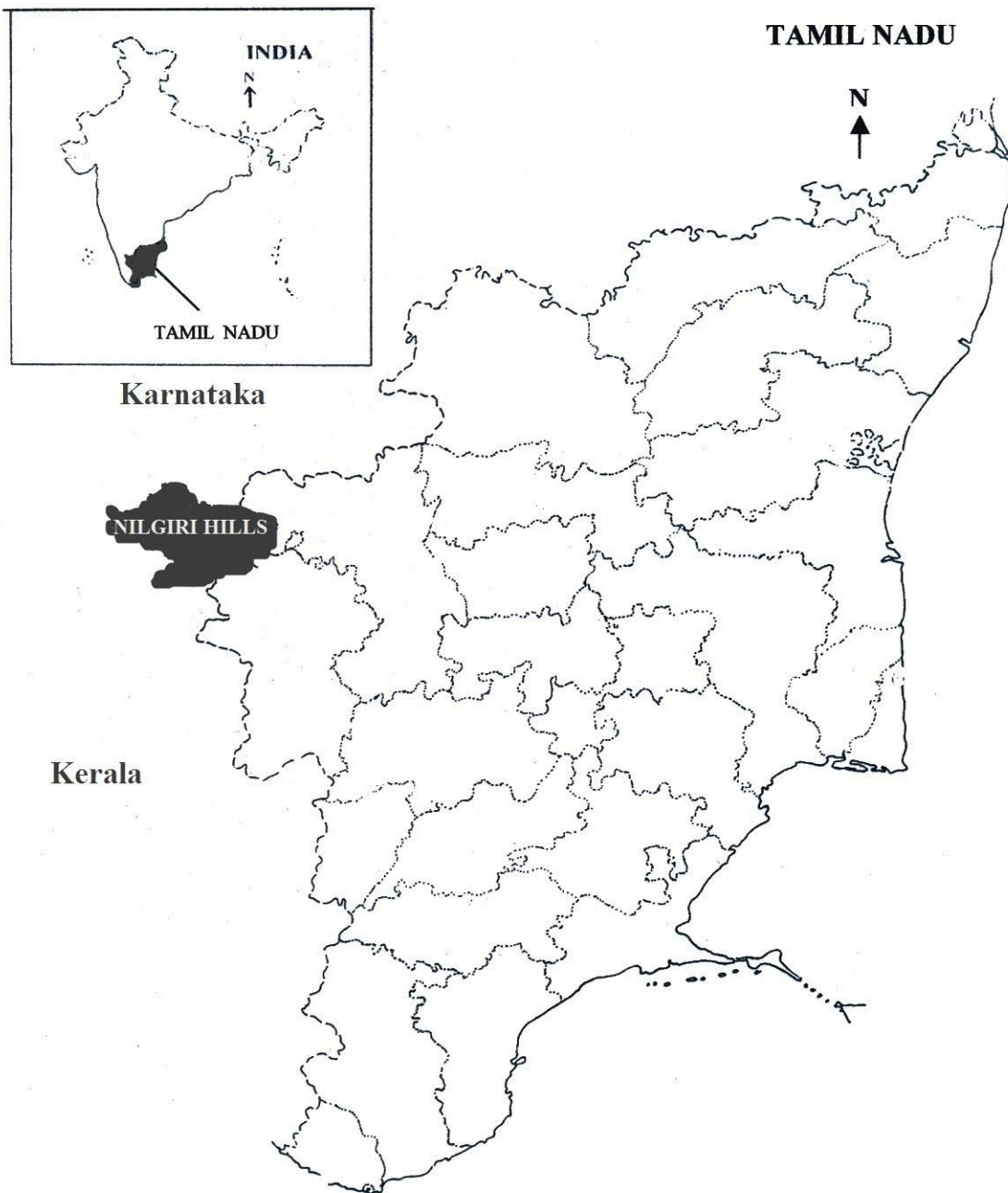


Figure 1. Map of Tamil Nadu showing study area

The present study was carried out from January 2001 to June 2009. Several collections were made during this period and on the basis of collection and field observations these three taxa are found to be very rare. Collections have been made according to standard field methods. The identification has been made by comparing type material and consulting relevant literature

(Udar and Kumar, 1981b; 1982; 1986). Nomenclature is updated following Brummitt and Powell (1992).

Observations

1. *Gottschelia schizopleura* (Spruce) Grolle

Gottschelia schizopleura (Spruce) Grolle. *Jour. Hatt. Bot. Lab.* 31: 16 (1968); Udar *et Kumar*, *J. Indian Bot. Soc.* 61: 250 (1982); -*Jungermannia schizopleura* Spruce, *Trans. Proc. Bot. Soc. Edinberg* 15: 577 (1885); -*Anastrophyllum cucullifolium* St., *Spec. Hepat.* 6: 104 (1917); - *Jamesoniella microphylla* (Nees) Schiffn., In Pande and Singh, *Bull. Bot. Soc. Univ. Saugar* 11: 1 (1959).

Plants robust, reddish, rigid, suberect, up to 30-35 mm long. Stem 112-176 μm in diameter, cortical region 2-3 cell layered thick, deep brown, cells 9.2-15.2 x 9.2-17.5 μm , thick walled, medullary cells hyaline, occasionally light yellow, 11.2-22.4 x 11.2-26.6 μm , thin walled, branches rare. Leaves contiguous, entire, succubus, ovate to oblong, 0.91-1.3 mm long, 0.76-0.89 mm broad, concave, more or less transversely inserted, interlocking dorsally, apex obtuse, margin incurved, marginal cells 19.2-30.4 x 15.2-26.4 μm , middle and basal cells 19.2-38.4 x 11.2-26.4 μm , thin to thick walled with prominent bulging to confluent trigones, more prominent in posterior part of the leaves, sometimes with intermediate nodular thickening in cell walls. Oil bodies not seen. Underleaves absent. Dioicous. Male inflorescence terminal becoming intercalary, male bracts similar to leaves; one antheridium per bract; antheridia globose, stalked. Female inflorescence terminal on main shoot, female bracts in 1 pair, comparatively larger than vegetative leaves, oblong, strongly concave, with entire, incurved margin, apex obtuse, occasionally retuse to bilobed, sometimes with abaxial fold on apex, bracteoles absent, perianth largely exserted, cylindrical. Perianth contracted and 5-plicate toward apex. Sporophyte immature (Fig. 2).

Type locality: Madagascar (Boswell) as *Jungermannia schizopleura* (Bonner, 1965).

Sexuality: Dioicous.

Ecology: Terricolous, grows on moist and shady soil surface.

Global distribution: Africa- E. Africa, Madagascar, Asia- China, Celebes, India, Indonesia (Borneo, Java, Sumatra) Malaysia (Malaya), Philippines, Sri Lanka (Ceylon), Norfolk Island, Papua New Guinea, West Iran.

Distribution in India: South India: Tamil Nadu- Nilgiri Hills [Ootacamund (Avalanche, Dodabetta, Governorsholai), Palni Hills: Shembaganur, Kodaikanal, Madura].

Specimens examined: South India: Tamil Nadu: Avalanche, ca. 2439 m, 02.01.1972 R. Udar and Party, det.: R. Udar and A. Kumar, 55 S /1972 (LWU). Palni Hills, ca. 2000 m, 07.10.2000, S. C. Srivastava and Party, 12337/2000 (LWU); Nilgiri Hills – Avalanche ca. 1950 m, 09.10.2000, S. C. Srivastava and Party, 12538-12543/2000, 12555/2000 (LWU); Ootacamund (Dodabetta), ca. 2400 m, 26.03.2001, P.K. Verma and Afroz Alam, 13474/2001, 13494/2001

(LWU); Ootacamund (Governorsholai), ca. 2200 m, 10.04.2002, P. K. Verma, Afroz Alam and N. Sahu, 15447/2002, 15466/2002, 15469/2002, 15491/2002 (LWU).

Characteristics of species:

1. Plants robust, reddish up to 35 mm long, 2. Leaves entire, ovate to oblong, 3. Female bracts oblong with entire margin; apical part of the perianth smooth.

Note: This species was instituted as *Jungermannia schizopleura* Spr. by Spruce (1884-85) and later described under the name of *Anastrophyllum cucullifolium* St. (Stephani, 1917), and as *Jamesoniella microphylla* (Nees) Schiffn. (Pande and Singh, 1959). Grolle (1968) described it as *Gottschelia schizopleura*.

2. *Lethocolea javanica* (Schiffn.) Grolle

Lethocolea javanica (Schiffn.) Grolle, *Bot. Mag. Tokyo* 78: 93 (1965);- *Symphymitra javanica* Schiffn. *Denkschr. Math. Nat. Class. Kais Akad. Wiss. Wien* 67: 193 (1898); Udar & Kumar, *Lindbergia* 12: 103.f.1-14 (1986).

Plants prostrate, up to 3.5- 5.0 mm long, green to brownish, stem 0.95 x 1.0 mm in diam., 8-10 cells across, cortical and medullary region indistinct, cells thin walled, 7.5-12.5 x 5.0-12.5µm. Rhizoids numerous, scattered on ventral surface of axis, simple, sinuate, hyaline. Leaves succubous, sub quadrate- ovate, entire, slightly oblong, 800-1200 x 760- 1040 µm, marginal cells recurved, slightly decurrent dorsally, 30.4-45.6 x 19.0-34.0 µm, median cells 34.2-49.7 x 30.4-57.0 µm, basal cells 45.6-91.2 x 26.6-49.4 µm in size, apex obtuse-rotundate, thin walled, without or with incipient trigones. Oil bodies not seen. Underleaves absent. Androecia not seen; gynoecia not seen. Marsupium terminal up to 3.68 mm long, cylindrical, pendent, rhizoidous, 5-7 cells thick, inner surface with numerous mucilaginous cells (Fig. 3).

Type Locality: Java (Udar and Kumar, 1986).

Ecology: Terrestrial, grows on moist soil and soil covered rocks along with *Jungermannia* sp., *Cephaloziella* sp., *Asterella* sp. and mosses.

Distribution in India: India: South India- Kerala (Mannar) and Tamil Nadu: Nilgiri hills (Mukhurthy) (Udar and Kumar, 1986), Coonoor (Aruvankadu, Droog), Gudulur (Cherambadi, Yellamalai, Wilson Plantation).

Global distribution: India and Java (Udar and Kumar, 1986).

Specimens examined:

India-South India : Tamil Nadu-Nilgiri Hills- Mukhurthy, ca. 2000m, 23.09.1983, R. Udar and Party, 5769/1983, 5770/1983(LWU); Ootacamund (Glenmorgan), ca. 1900 m, 01.12.2001, P. K. Verma and A. Alam, 14681/2001(LWU); Coonoor (Aruvankadu), ca. 1800m, 03.12.2001, P. K. Verma and A. Alam, 14802/2001, 14807/2001(LWU); Gudulur (Cherambadi), ca. 1200 m, 28.09.2002, P. K. Verma and A. Alam, 16088-90/2002(LWU); Gudulur (Yellamalai), ca. 1200m, 29.09.2002, P. K. Verma and A. Alam, 16148/2002(LWU); Gudulur Road (Wilson

Plantation), ca. 1600-1800m, 30.09.2002, P. K. Verma and A. Alam, 16156/2002(LWU); Coonoor (Droog), ca. 1800m, 05.10.2002, P. K. Verma and A. Alam, 16550/2002 (LWU).

Characteristics of species:

1. Plants prostrate, leaves succubous, sub quadrate- ovate, margin recurved, apex obtuse, rotundate, 2. Oil bodies 1(-2) in each leaf cell, 3. Underleaf absent, 4. Perianth absent; marsupium terminal, cylindrical pendent, rhizoidous, 5-6 cells thick, 5. Asexual reproduction by tuberous tip of marsupium or by discoid gemmae.

Note: This is the second time that this genus is being reported from India after its original discovery therefore, it can be consider as rare taxon in India.

3. *Jackiella javanica* var. *cordifolia* Schiffn.

Jackiella javanica var. *cordifolia* Schiffn., Denscher. *Mat.Nat. Cl. Kais Akad. Wiss. Wien* 70: 217 (1900); Udar et Ad. Kumar, *J. Indian Bot. Soc.* 60: 107.f. 1-36 (1981); - *Jackiella brunnea* (Horik.) Hatt., *Bull. Tokyo Sci. Mus.* 11: 48 (1944).

Plants prostrate to suberect, delicate, upto 2.0 to 3.0 cm long, light green, occasionally yellowish brown, with ascending shoot apices, in dense mat. Stem 114-201 μm in diameter upto 6-7 cells across, cortical region 1(-2) cell layered thick, cells thick walled; light to deep brown, isodiametric, 19.0-26.6 x 11.2-15.2 μm , medullary cells light brown to yellowish brown, thick to intercalary, small, ascending, light green. Leaves contiguous, somewhat distant, entire, succubous, ovate to cordate or sub quadrate to slightly oblong, usually longer than broad or as long as broad or occasionally broader than long, 0.68-0.75 mm long, 0.58-0.68 mm broad at middle, 0.54-0.68 mm long 0.64-0.63 mm broad at apex, light green to light brown, sub opposite, insertion oblique, apex obtuse, occasionally slightly retuse, margin entire (to wavy), not decurrent, marginal cells 19.2-26.6 x 19.2-27.0 μm , middle and basal cells 22.6-38.0 x 15.2-31.5 μm , wall thin, trigones prominently bulging, oil bodies not seen. Underleaves reduced, upto 4-5 cells long, 4-5 cells broad, 53.2-95.0 x 38.0-63.2 μm , bifid, lobes uniseriate, margin dentate, connate at base with leaves of one side, cell wall thin, trigones feebly developed. Rhizoids numerous on prostrate axis, particularly near the base of underleaves, with swollen tips harboring mycorrhiza. Asexual reproduction by 1-2 celled gemmae, arising from the marginal cells of the leaves. Dioicous. Fertile plants not seen (Fig. 4).

Type locality: Java.

Sexuality: Dioicous (Udar and Kumar, 1982).

Habitat: Grows on soil and rock surface in dense mats at moist places in association with *Jungermannia* sp., *Notoscyphus* sp. and *Pogonatum* sp.

Global distribution: India and Java (Udar and Kumar, 1982).

Distribution in India: South India: Karnataka - Abbi Fall in Mercara, Agumbe; Kerala - Lakkidi in Wynad; Tamil Nadu - Nilgiri Hills: Ootacamund (Dodabetta), Coonoor (Wellington), Gudalur (Yellamalai, Nellakota).

Specimens examined: India: south India- Tamil Nadu: Nilgiri hills- Coonoor (Wellington), ca. 1350 m, 31.12.1971, R. Udar and party, 375/1971 (LWU); Gudulur (Nellakota); ca. 1600 m; 04.04.2002; P. K. Verma and A. Alam; 14912/2002 (LWU); Gudulur (Yellamalai), ca. 1900 m, 29.09.2002, P. K. Verma and Afroz Alam, 16146/2002 (LWU).

Characteristics of species:

1. Plants prostrate to sub erect, with ascending apex or ascending branches, 2. leaves with or without curved margins, longer than broad, flat, hardly decurrent and comparatively smaller at the middle of axis, 3. Rhizoids numerous on prostrate axis, particularly near the base of underleaves, 4. Asexual reproduction by 1-2 celled gemmae.

Note: *Jackiella javanica* var. *cordifolia* was instituted by Schiffner (1900) from Java. After 2002, this species could not be collected in following explorations to Nilgiri hills hence considered rare.

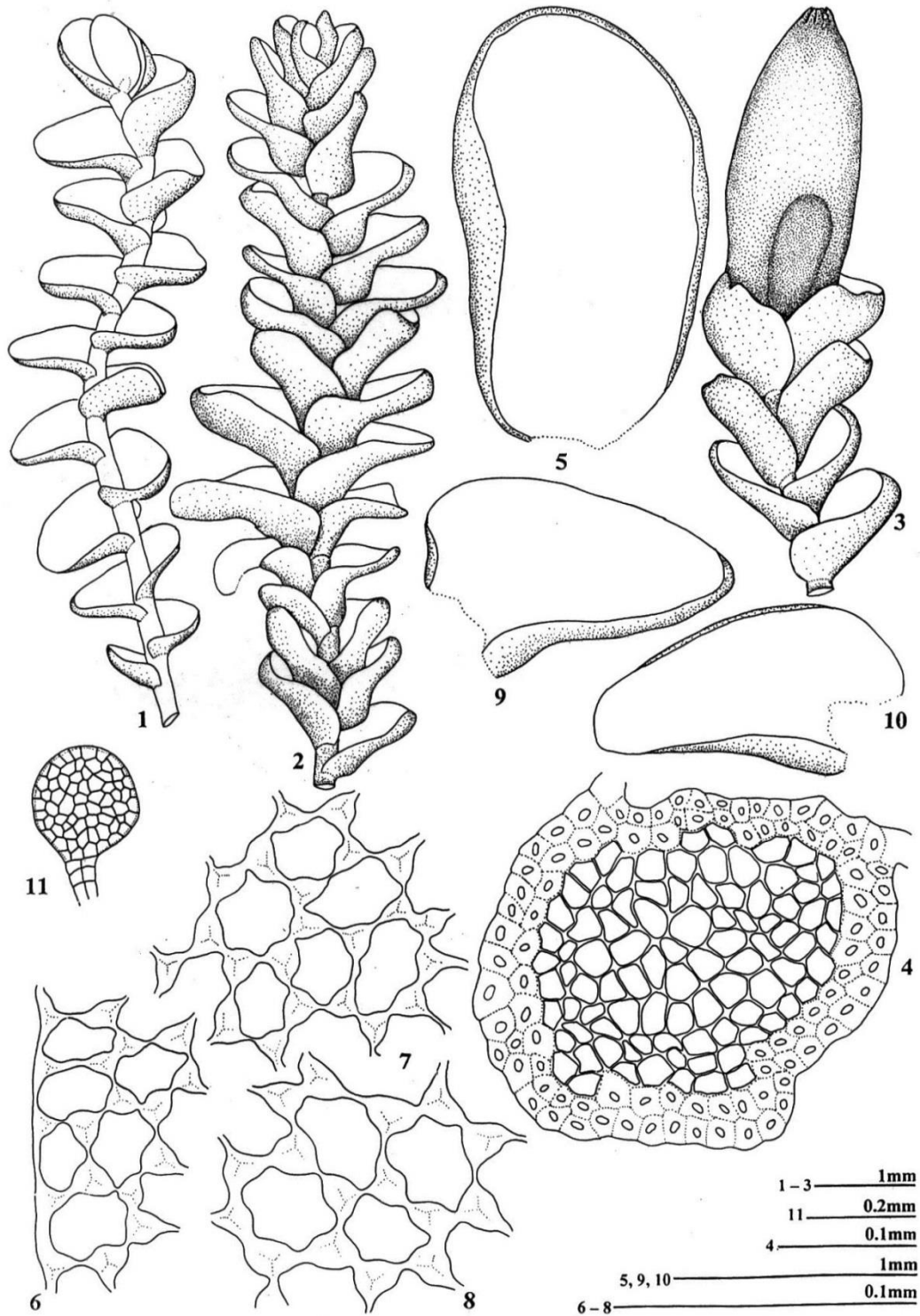


Figure 2. *Gottschelia schizopleura* (Spruce) Grolle: 1-11. 1. Habit of plant, 2. Male plant, 3. Female plant, 4. T. S. of axis, 5. A leaf, 6. Marginal cells of leaf, 7. Median cells of leaf, 8. Basal cells of leaf, 9-10. Male bracts, 11. Antheridium (Figures drawn from LWU-12555/2000).

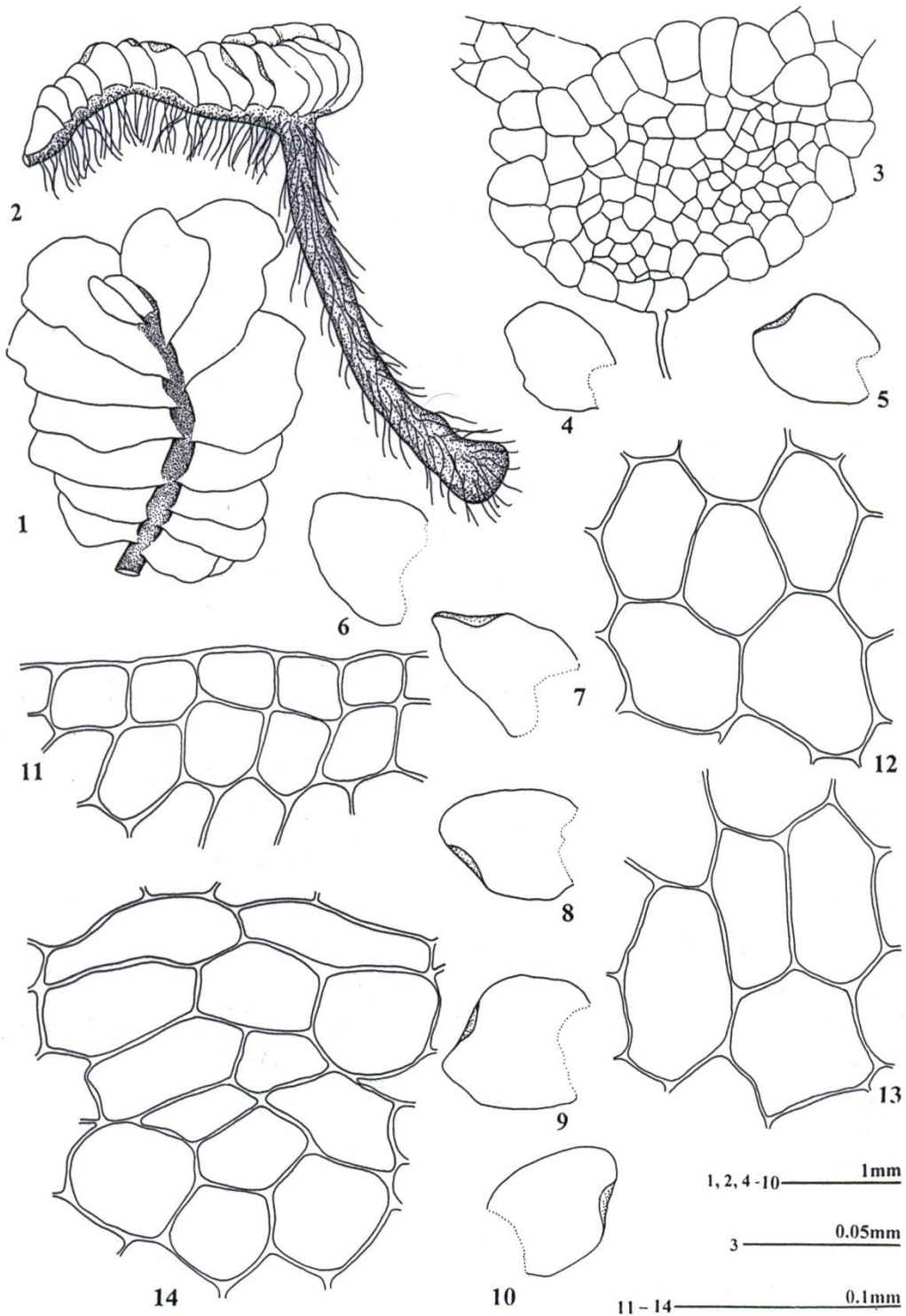


Figure 3. *Lethocolea javanica* (Schiffn.) Grolle: 1-14. 1. Plant in dorsal view, 2. Plant with marsupium (lateral view), 3. Cross section of axis, 4-10. Leaves, 11. Apical cells of leaf, 12. Median cells of leaf, 13. Basal cells of leaf, 14. T. S. of marsupium. (Figures drawn from LWU-14802/2001).

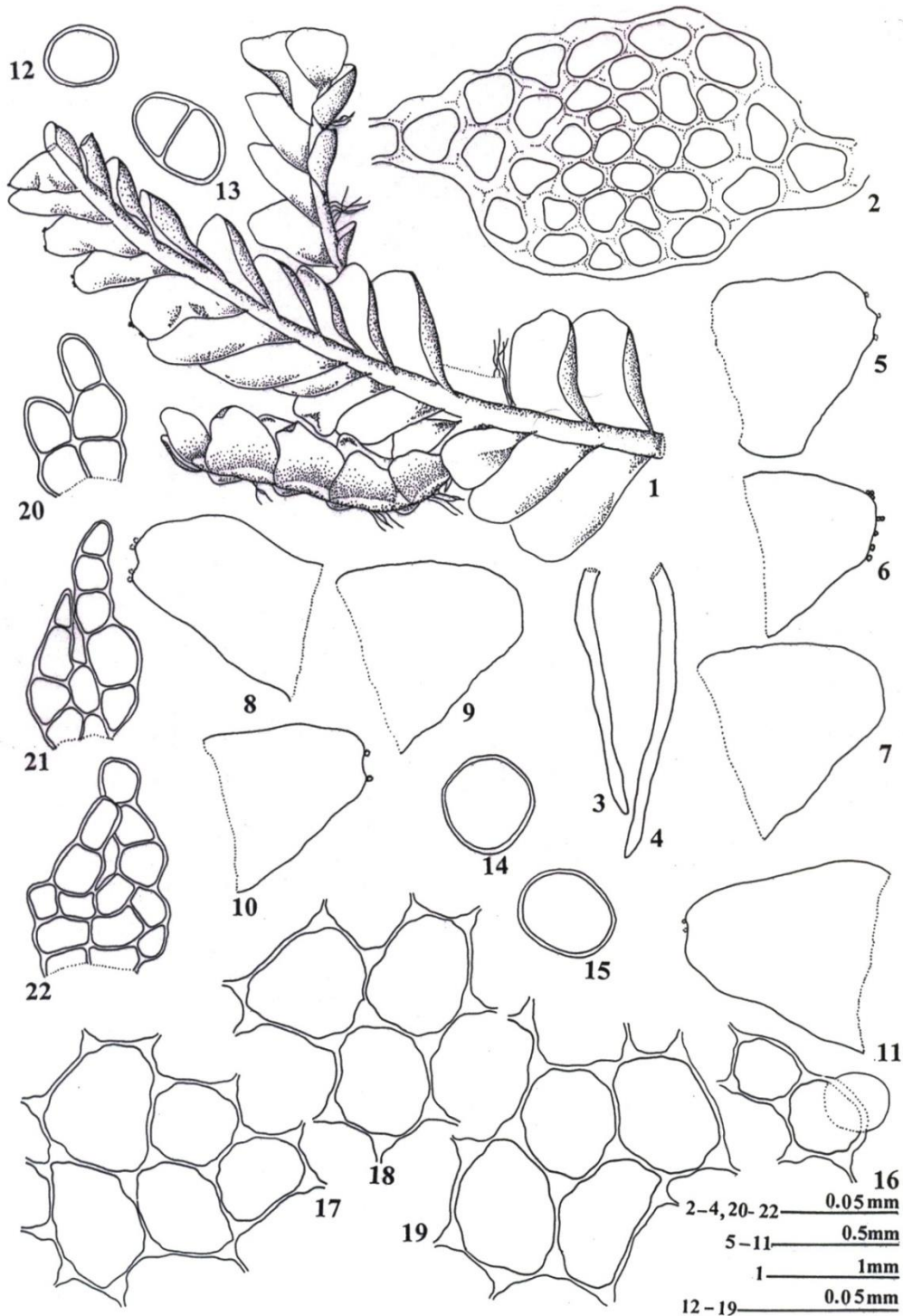


Figure 4. *Jackiella javanica* var. *cordifolia* Schiffn.: 1-22. 1. A plant (dorso-lateral view), 2. T. S. of axis, 3-4. Rhizoids, 5-11. Leaves with gemmae, 12-15. Gemmae, 16. Marginal cells with gemmae, 17. Apical cells of leaf, 18. Median cells of leaf, 19. Basal cells of leaf, 20-22. Underleaves (magnified) (Figures drawn from LWU-14912/2002).

Discussion

As far as the terricolous taxa are concerned, Nilgiri hills hosting 74 taxa distributed in 3 suborders, 21 families and 30 genera. The polymorphic order Jungermanniales is the most diversified with 14 genera and 30 species (Alam and Srivastava, 2012). In comparison to epiphytic forms terrestrial Jungermanniales always come under greater risk of extinction due to various biotic and natural activities mainly consequential in the form of habitat loss (Alam, 2009). In present study, taxa like *Gottschelia schizopleura*, *Jackiella javanica* var. *cordifolia* and *Lethocolea javanica* have been reported for the second time after their original discovery strengthen this fact, and revealed the uncongenial surroundings which do not seem supporting the growth and development of these species consequently they become confined only to particular ecological niche.

Conclusion

The infrequent occurrence of these three taxa explains that various factors contribute the loss of terricolous diversity of these liverworts such as habitat loss and fragmentation, pollution, introduction of exotic species, over exploitation, intensive agricultural and forestry. However, the main threat to diversity may be attributed to habitat destruction through expanding human population. Fragmentation of habitats results in destruction of complex ecological interaction among species resulting in ecological catastrophes. Natural disturbance and degradation are some of the usual causes of habitat destruction resulting excessive loss of habitat in a very short period. Therefore, some very serious attentions and efforts are required to save valuable gene pool for future.

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