

Taxonomic study on the genus *Bryum* Hedw. (Bryopsida: Bryaceae) in Garhwal Hills, Uttarakhand, India

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ABSTRACT

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A critical study on the genus *Bryum* Hedw. of Garhwal Hills, Uttarakhand revealed occurrence of five taxa, viz. *B. bessonii* Ren. & Card., *B. bicolor* Dicks., *B. pseudotriquetrum* (Hedw.) Schwaegr. var. *pallescens* (Schwaegr.) Dix., *B. pseudotriquetrum* (Hedw.) Schwaegr. var. *subrotundum* (Brid.) Gangulee and *B. uliginosum* (Brid.) B.S.G. for the first time. Out of five taxa identified in study area, *B. bessonii*, *B. bicolor* and *B. pseudotriquetrum* var. *subrotundum* occur at Mussoorie (between alt 1940 m - 2364 m), *B. pseudotriquetrum* var. *pallescens* at Chakrata (alt ca. 2865 m) and *B. uliginosum* at Chamoli (alt ca. 3510 m) and on way to Hemkund (alt ca. 3343 m). In the present contribution, a detailed morphotaxonomic account of the genus *Bryum*, a bryophyte from Garhwal Hills, is provided.

Key-words: Bryophyta, Moss (Musci), Bryaceae, *Bryum* Hedw., Garhwal Hills, Uttarakhand, India.

INTRODUCTION

The family Bryaceae is represented by about 12 genera, among these 10 genera occur in India (Nair et al. 2005) under two subfamilies Pohlioideae and Bryoideae. Genus *Bryum* Hedw., an acrocarpous moss belongs to family Bryaceae under order Eubryales and subfamily Bryoideae. The genus shows world-wide distribution with about 690 valid species. Lal (2005) reported 11 genera under this family with 33 species, 1 subspecies and 4 varieties of the genus *Bryum* distributed in various phytogeographical regions of India. Besides, a supplementary list of 13 other species of this genus with 1 subspecies and 3 varieties, has also been provided by him, which are endemic to south India only.

A perusal of the literature reveals that the West Himalayan zone is rich in terms of bryoflora. Ochi (1956) while working on the north-western Himalayan mosses reported *B. pallescens* from Mussoorie. Chopra (1960) worked on the mosses of Nainital and reported *Bryum andrei*, *B. argenteum*, *B. capillare*,

B. cellulare, *B. coronatum*, *B. inclinatum*, *B. nitens*, *B. pallescens*, *B. porphyroneuron*, *B. pseudopachythea* and *B. ramosum*. Vohra and Wadhwa (1964) collected mosses from Nilkanth and Chaukhamba peaks of Garhwal Hills and provided an enumeration including *B. argenteum*, *B. cellulare*, *B. duvalii* and *B. porphyroneuron* var. *erythrinum*. The notable work of Vohra (1969a, 1970) brought out a list of 10 species of *Bryum*, viz. *B. argenteum*, *B. argenteum* var. *lanatum*, *B. atrovirens*, *B. caespiticium*, *B. capillare*, *B. cellulare*, *B. coronatum*, *B. pseudoalpinum*, *B. truncorum* and *B. turbinatum* in his first report and 3 species, viz. *B. klinggraeffii*, *B. pallens* and *B. recurvulum* in the second report from Garhwal Hills. Robinson (1965) worked on the bryophytes of Kashmir and reported 60 species of bryophytes including *B. argenteum*, *B. caespiticium*, *B. capillare*, *B. pallens*, *B. pseudotriquetrum*, *B. turbinatum*, *B. turbinatum* var. *latifolium*. Vohra (1969b) while working with the mosses of Kashmir reported *B. alpinum*, *B. alpinum* var. *mildeanum*, *B.*

argenteum, *B. caespiticium*, *B. capillare*, *B. muehlenbeckii* ssp. *evanidinerve*, *B. schleicheri*, *B. teretiusculum* and *B. weigelli*. Later on Kaul and Singh (1972) enumerated 37 species of mosses from Kashmir including *B. argenteum*. Kumar and Negi (1977) worked on the mosses of Himachal Pradesh and reported *B. capillare* for the first time.

Bryum bessonii Ren. & Card. is mainly distributed in Madagascar and Nepal. In India species is distributed in south India only mainly in Palni Hills (Gangulee 1977) and Rivona and Zambaulim area of South Goa (Phatak et al. 2007) whereas Tewari and Pant (1994) reported this species from Nainital district of Kumaun Himalayas. *B. bicolor* Dicks. is a widely spread species and mainly distributed in Sikkim, Darjeeling (eastern Himalaya), Nainital (western Himalaya). Later on the species is also reported from Jaipur (Stern, 2000). It was long thought that this was a single species but with the interest that has developed in ruderal bryophytes over the last 20-30 years it becomes clear that it is a highly polymorphic species (Rilstone 1949, Warburg 1963, Wilczek & Demaret 1976, Smith & Whitehouse 1978). Redfearn et al. (1996) published an updated checklist of Chinese Mosses and Ignatov (2006) on the mosses of East Europe and North Asia synonymized *B. bicolor* Dicks. under *B. dichotomum* Hedw. Later on Spence (2007) worked on the mosses of family Bryaceae of North America and circumscribed a new genus, *Gemmabryum* and transferred the species *B. bicolor* Dicks. into *Gemmabryum bicolor* (Dickson) J. R. Spence, a newly circumscribed combination. Recently Spence (2010) provided a summary of Bryaceae genera and species for Bryophyte flora of North America and synonymized *B. bicolor* and *B. dichotomum* under the section *Gemmabryum* of newly circumscribed genus *Gemmabryum* but in the present study we treat the species as *Bryum bicolor* Dicks.

B. pseudotriquetrum (Hedw.) Schwaegr. var. *pallescens* (Schwaegr.) Dix. is cosmopolitan and mainly distributed in Darjeeling (eastern Himalaya) and Kashmir (western Himalaya) and globally distributed in Europe including Great Britain, Japan, Korea, Taiwan, Caucasus, Siberia, Tibet, North, Central and South Africa, North and South America and New

Zealand where as *B. pseudotriquetrum* (Hedw.) Schwaegr. var. *subrotundum* (Brid.) Gangulee in East Nepal, Europe, Greenland, North Africa, North America, Siberia, Tibet and in western Himalaya. *B. uliginosum* (Brid.) B.S.G shows its distribution mainly in Sikkim (eastern Himalaya) and Kashmir (western Himalaya) and also in Europe including Great Britain, Korea, North and South America and Manchuria (Gangulee 1977).

So far as the knowledge about bryoflora of Garhwal Hills is concerned, Vohra (1969a, 1970) provided a preliminary detail of mosses including genus *Bryum*. However, there is no record of the *B. bessonii*, *B. bicolor*, *B. pseudotriquetrum* var. *pallescens*, *B. pseudotriquetrum* var. *subrotundum* and *B. uliginosum* from Garhwal Hills. During the investigation of *Bryum*, plants of the above five taxa were collected from various parts of Garhwal Hills and are new records for bryoflora of Garhwal region.

MATERIAL

The observations are based on the specimens collected from Chamoli (ca. 3510 m), way to Hemkund (ca. 3343m), Deoban (ca. 2865m), Company Garden (ca. 1940 m) and Mussoorie (ca. 2130 and 2364 m) during the month of October 1964, 1976, 2005 and 2009 as well as in the month of April 2001 respectively (Text-figure 1). The voucher specimens have been deposited in the Bryophyte Herbarium of the National Botanical Research Institute, Lucknow (LWG).

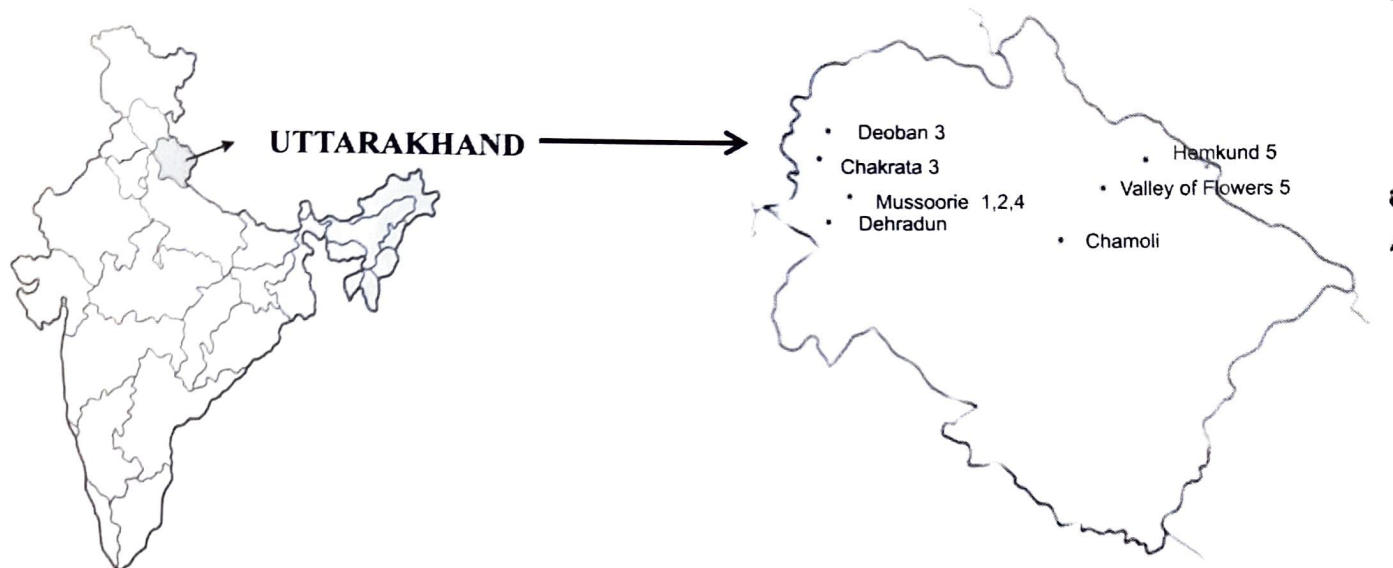
TAXONOMIC OBSERVATION

Bryum bessonii Ren. & Card.

(in Podr. Fl. Bryol. Madag. Suppl. 59, 1909)

Text-figure 2

Plants densely tufted, stems tending to be erect, reddish brown with subfloral innovations. Leaves imbricate, close, erect, more appressed to stem when dry, generally acuminate or cuspidate in a slender sharp point, lanceolate, reddish at apex, $\pm 3 \times 0.5$ mm, margin entire, strongly revolute from base to apex. Costa strong, slender, ending in a ± 0.2 mm long arista. Apical leaf cells thick-walled, rhomboid-hexagonal to narrowly rhomboid-hexagonal, 70-78 x 6-8 μm , basal leaf cells



Text-figure 1. Distribution of the genus *Bryum* Hedw. in Garhwal Hills, Uttarakhand, India. 1. *Bryum bessonii* Ren. & Card. 2. *Bryum bicolor* Dicks. 3. *Bryum pseudotriquetrum* (Hedw.) Schwaegr. var. *pallescens* (Schwaegr.) Dix. 4. *Bryum pseudotriquetrum* (Hedw.) Schwaegr. var. *subrotundum* (Brid.) Gangulee 5. *Bryum uliginosum* (Brid.) B. S. G.

reddish, sub-rectangular, 50-60 x 12-17 μm with some very short quadrate cells at extreme base. 1-2 rows of marginal cells in upper part of leaf are narrower but not forming clear distinct border. Sporophyte not seen.

Specimen examined: Garhwal Hills: Mussoorie: Company Garden (alt ca. 1940 m), 20.10.2005, Leg. V. Nath and Party, 228205 C (LWG).

***Bryum bicolor* Dicks.**
(in Pl. Crypt. Brit. F 4: 16, 1801)

Text-figure 3

Plants small, gregarious, up to 10 mm long, stem erect, green above reddish to dark brown below. Leaves numerous, close, imbricate, scarcely shrunken when dry, erect-erecto-patent when moist, crowded in comal tuft, ovate, acuminate, concave, $\pm 1 \times 0.3-0.4$ mm, margin more or less reflexed, entire, usually unbordered. Costa ending below apex, percurrent or in upper leaves shortly excurrent. Apical leaf cells rhomboid-hexagonal, 65-70 x 7-8 μm , basal leaf cells quadrate-rectangular, 44-50 x 6-8 μm . Marginal cells narrower but not forming clear distinct border. Upper leaves of shoots usually with greenish-reddish axillary gemmae, \pm triangular, multicellular. Yellowish-brown rhizoidal gemmae present. Seta apical, erect but bent at top, reddish, up to 20 mm long. Capsule purplish-red, horizontal-pendulous, ovoid with short neck,

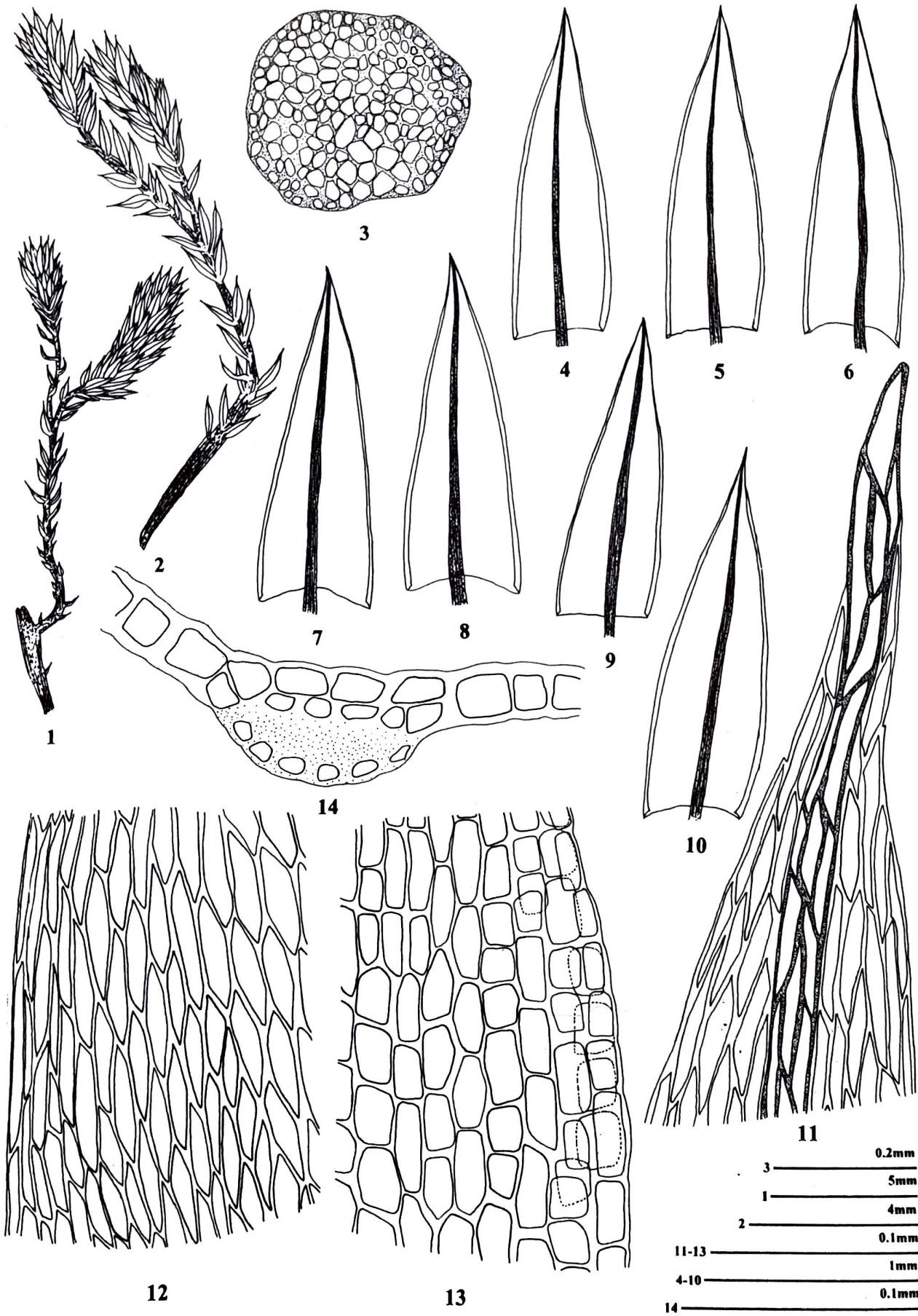
abruptly narrowed $\pm 2.5 \times 2$ mm. Exostome lanceolate, 500-550 x 70-75 μm with sharp, hyaline, papillose tips, endostome transparent yellow, fine papillose. Spores 8-11 μm in diameter.

Specimen examined: Garhwal Hills: Mussoorie (alt ca. 2130 m), 29.10.2009, Leg. V. Sahu, 251452 (LWG).

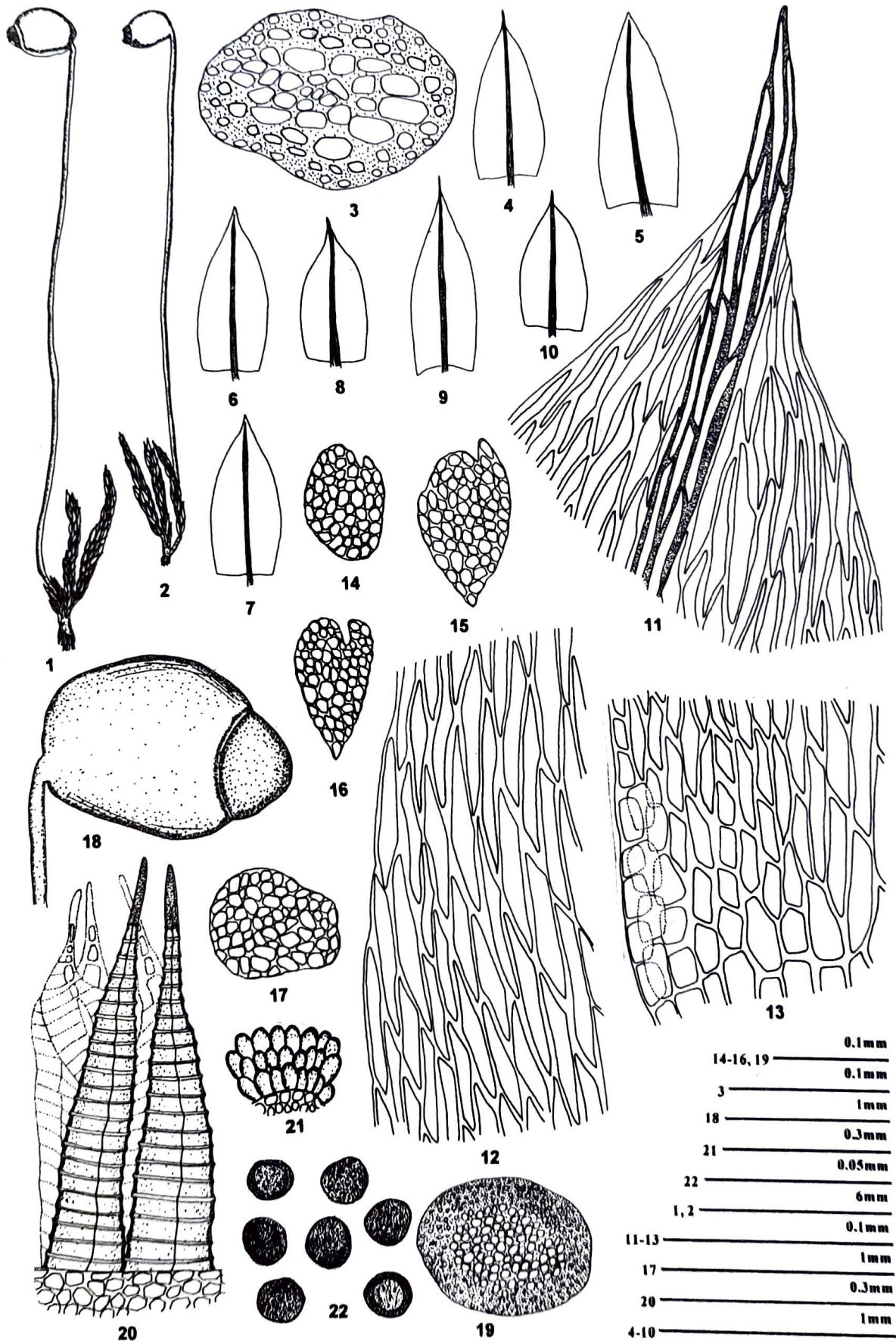
***Bryum pseudotriquetrum* (Hedw.) Schwaegr.**
var. *pallescens* (Schwaegr.) Dix.
(in Stud. Handb. Brit. Moss ed. 3: 364, 1924)

Text-figure 4

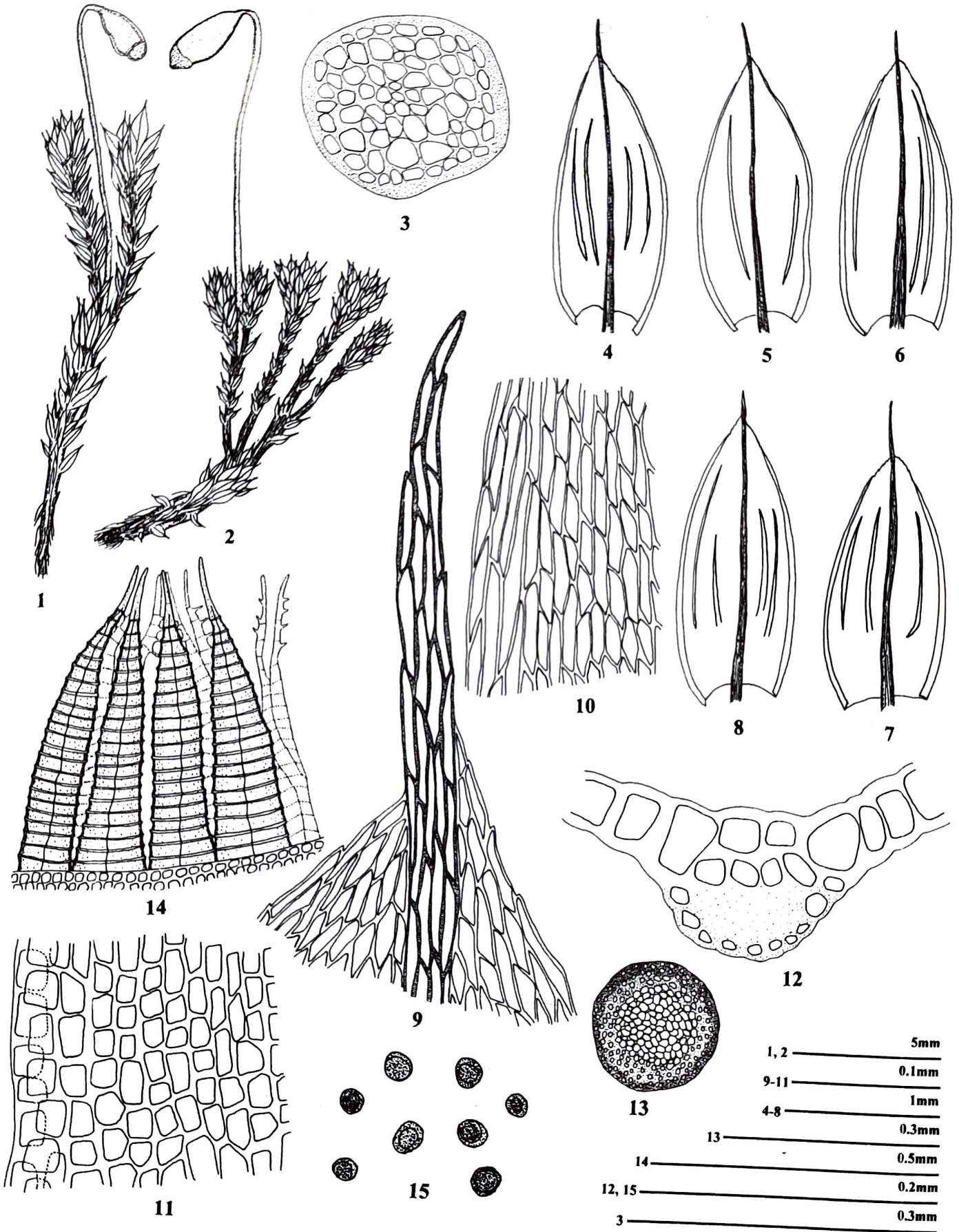
Plants large, robust, green to yellowish green above, reddish below, up to 18 mm long, stems erect, reddish with 2-3 subfloral innovations. Leaves spirally twisted when dry, erecto-patent when moist, reddish at base, ovate to lanceolate, long acuminate, $\pm 1.8 \times 0.83$ mm, margin recurved, entire except lightly denticulate towards apex, bordered. Costa reddish, excurrent in a short, denticulate, ± 0.23 mm long arista. Apical leaf cells hexagonal-rhomboid, 34.4-47.3(-51.6) x 8.6 μm , median leaf cells 43-60.2 x 8.6-10.75 μm , basal cells rectangular, 25.8-30.1(-34.4) x 19.4-21.5 μm . 2-3 rows of narrow elongated cells are present at margin, 73.1-77.4(-94.6) x 4.3 μm , forming a distinct yellow border. Seta apical, erect but arcuate at tip, up to ± 20 mm long. Capsule pale, inclined to



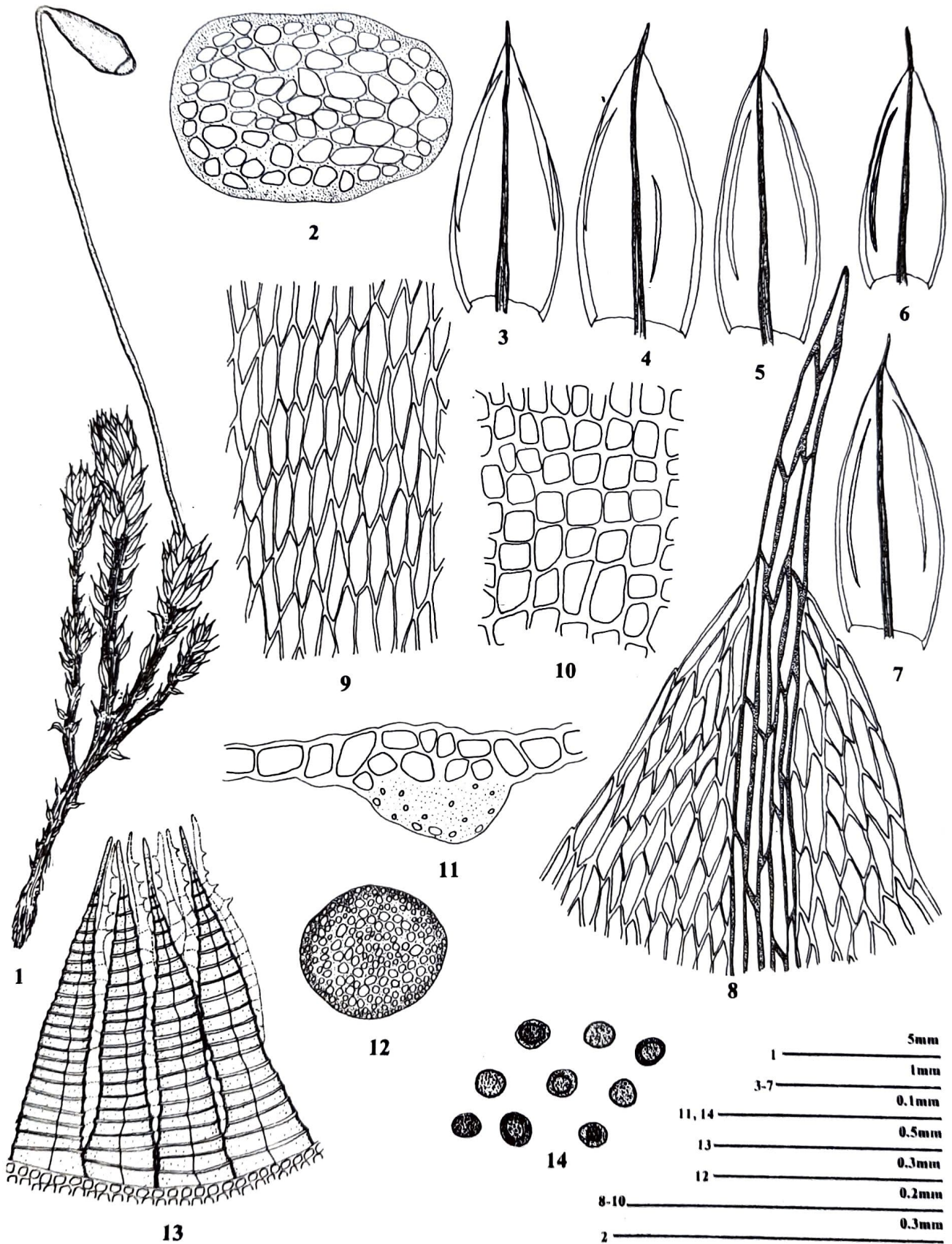
Text-figure 2. *Bryum bessonii* Ren. & Card. 1-2. Plants. 3. Cross-section of stem. 4-10. Leaves. 11. Apical laminal cells. 12. Middle laminal cells. 13. Basal laminal cells. 14. Cross-section of leaf.



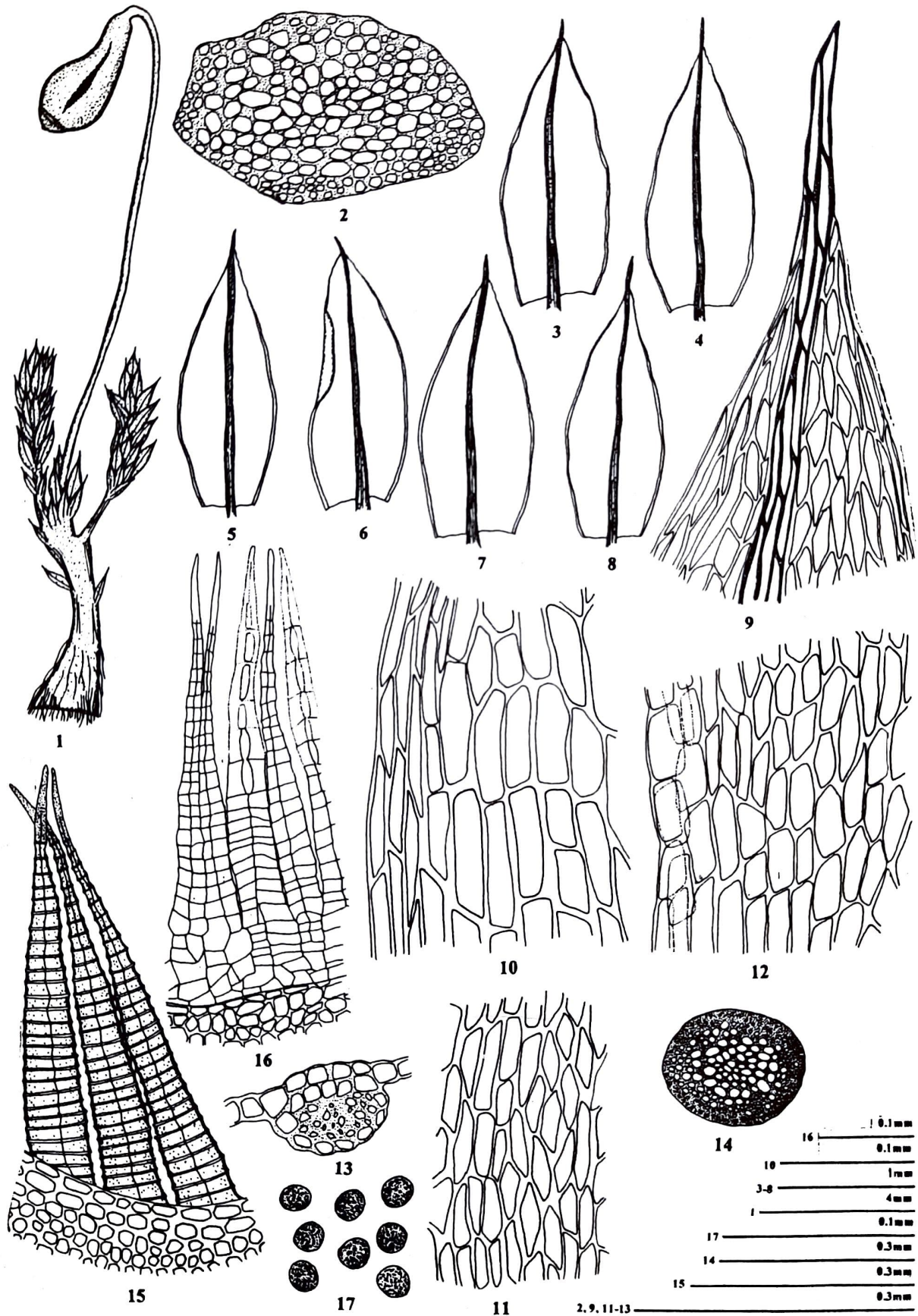
Text-figure 3. *Bryum bicolor* Dicks. 1-2. Plants. 3. Cross-section of stem. 4-10. Leaves. 11. Apical laminal cells. 12. Middle laminal cells. 13. Basal laminal cells. 14-16. Axillary gemmae. 17. Rhizoidal tuber. 18. Enlarged view of capsule. 19. Cross-section of seta. 20. Peristome teeth. 21. Annulus. 22. Spores.



Text-figure 4. *Bryum pseudotriquetrum* (Hedw.) Schwaegr. var. *pallescens* (Schwaegr.) Dix. 1-2. Plants. 3. Cross-section of stem. 4-8. Leaves. 9. Apical laminal cells. 10. Middle laminal cells. 11. Basal laminal cells. 12. Cross-section of leaf. 13. Cross-section of seta. 14. Peristome teeth. 15. Spores.



Text-figure 5. *Bryum pseudotriquetrum* (Hedw.) Schwaegr. var. *subrotundum* (Brid.) Gangulee. 1. Plant. 2. Cross-section of stem. 3-7. Leaves. 8. Apical laminal cells. 9. Middle laminal cells. 10. Basal laminal cells. 11. Cross-section of leaf. 12. Cross-section of seta. 13. Peristome teeth. 14. Spores.



Text-figure 6. *Bryum uliginosum* (Brid.) B.S.G.; 1. Plant. 2. Cross-section of stem. 3-8. Leaves. 9. Apical laminal cells. 10. Marginal laminal cells. 11. Middle laminal cells. 12. Basal laminal cells. 13. Cross-section of leaf. 14. Cross-section of seta. 15. Exostomial teeth. 16. Endostomial teeth. 17. Spores.

pendulous, ovate-clavate, ± 2 mm long and ± 1.5 mm in diameter. Exostome yellowish below, hyaline towards apex, endostome with well developed cilia. Spores yellowish green, 15-18 μm in diameter.

Specimen examined: Garhwal Hills: Dehra Dun: Chakrata: Janglat Chowki-Deoban (alt ca. 2865 m), 10.10.1976, Leg. S. Chandra, 202852 (LWG).

***Bryum pseudotriquetrum* (Hedw.) Schwaegr.**
var. *subrotundum* (Brid.) Gangulee
(in Mosses of eastern India and adjacent regions,
2: 994, 1977)

Text-figure 5

Plants large, robust, yellowish green above, reddish below. Stem erect, about 20 mm long with 2 or 3 subfloral innovations. Leaves somewhat distantly arranged below, in comal tuft above, oblong-lanceolate, $\pm 1.76 \times 0.8$ mm, tapering into an acute apex, base red, margin revolute, costa excurrent in a ± 0.18 mm long arista. Apical leaf cells hexagonal-rhomboid, 30-43(-56) \times 8.6-12.9 μm , median leaf cells 51.6-64.5(-73.1) \times 8.6-12.9(-17.2) μm , basal leaf cells rectangular, 25.8-34.4(-43) \times 17.2-25.8 μm , marginal cells are narrower, forming a distinct border, 51.6-55.9 \times 8.6-12.9 μm . Seta upto 25 mm long. Capsule pendulous, barrel-shaped, $\pm 4 \times 1.5$ μm , with distinct apophysis. Outer peristome yellowish below, hyaline towards apex, 642 \times 90 μm , spores yellowish green, 11-13 μm in diameter.

Specimens examined: Garhwal Hills: Dehra Dun: Mussoorie: Lal Tibba route (alt ca. 2364 m), 8.4.2001, Leg. V. Nath, A. K. Asthana and S. Sharma, 208803, 208807 (LWG).

***Bryum uliginosum* (Brid.) B.S.G.**
(in Bryol. Eur., 4: 88, 1839)

Text-figure 6

Plants usually olive-green to brownish, present in loose tufts, stems erect, ± 5 mm, often with subfloral innovations. Leaves erect, slightly twisted when dry, erecto-patent when moist, ovate-lanceolate to oblong-lanceolate, generally acuminate, $\pm 5 \times 0.6$ mm, margin recurved, entire except mild denticulation at tip, strongly bordered. Costa reddish-brown, excurrent in a ± 0.2 mm long arista. Apical leaf cells rhomboid-hexagonal, 65-70 \times 8-9 μm , basal leaf cells shortly rectangular,

50-55 \times 7-8 μm . 2-3 rows of marginal cells are narrower forming a clear distinct border. Seta apical, erect but arcuate at tip, up to 25 mm long. Capsule horizontal to pendulous, light brown, narrowly ellipsoid, neck distinct, abruptly or gradually tapering into seta, ± 4 mm long and ± 2 mm in diameter. Exostome linear lanceolate, yellowish-brown, 540-550 \times 60-70 μm , endostome hyaline with segments slightly shorter than outer teeth with short and rudimentary cilia. Spores rounded, 20-30 μm in diameter.

Specimens examined: Garhwal Hills: Valley of Flowers: Chamoli (alt ca. 3510 m), 20.10.1964, Leg. S. Chandra, 200812 C (LWG); on way to Hemkund (alt ca. 3343 m), 20.10.1964, Leg. S. Chandra, 200922 B (LWG).

DISCUSSION

The investigation of the altitudinal distribution of the *Bryum* species revealed that *B. bessonii* and *B. bicolor* occur at low altitudinal range ca. 1940 m and ca. 2130 m while *B. pseudotriquetrum* var. *pallescens* occur at ca. 2865 m and *B. pseudotriquetrum* var. *subrotundum* at ca. 2364 m whereas *B. uliginosum* is present in high altitudinal range between ca. 3343 m and ca. 3510 m. The robust, usually purplish-red, glossy metallic plant, stiff leaves with narrow cells make *B. bessonii* easy to recognize. It is closely related and similar to *B. alpinum*. However in *B. bessonii* leaves are densely covered with larger arista and very short quadrate cells at extreme base are present and on the basis of these characters these two species can be easily distinguished. Among the Indian species of *Bryum*, *B. bicolor* is confused with *B. dumense*, however the latter has larger bulbils, relatively narrower leaves with large excurrent costa and thin primordia, with a costa and appear distinctly leaf-like whereas in *B. bicolor* the leaves surrounding the gametangia may have excurrent costa and very concave leaves, the bulbils have thick, triangular primordia without costa and with little resemblance to leaves. *B. pseudotriquetrum* var. *pallescens* is usually easily recognized by the robust, glossy, often reddish-tinged plants with rigid leaves. Stunted form may be mistaken for *B. pallescens* but the latter differs in the usually short costa in comparison

to *B. pseudotriquetrum* var. *pallescens*, 3-3.5 mm, narrowly ellipsoid, inclined-pendulous capsule whereas in *B. pseudotriquetrum* var. *pallescens* capsule is inclined, ±pendulous, up to 5 mm long, ovate-clavate with a distinct tapering apophysis. The plant specimen is often confused with *B. pseudotriquetrum* var. *subrotundum* but the latter can be easily recognized by its large open, barrel shaped capsule with more distinct apophysis. The specimens show some minor variations in the size of plants, leaves and leaf cells which could be considered due to alteration in ecological conditions.

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