

HEPATICS AND ANTHOCEROTES (BRYOPHYTA) OF TAMIA AND PATALKOT VALLEY (DISTRICT CHHINDWARA), MADHYA PRADESH<sup>1</sup>A.K. ASTHANA<sup>2,3</sup> AND VIRENDRA NATH<sup>2,4</sup><sup>1</sup>Accepted October 2005<sup>2</sup>Bryology Laboratory, National Botanical Research Institute (Council of Scientific & Industrial Research), Lucknow 226 001, Uttar Pradesh, India.<sup>3</sup>Email: drakasthana@rediffmail.com<sup>4</sup>Email: drvirendranath2001@rediffmail.com

Observations and enumeration of liverworts and hornworts of Tamia hills and Patalkot valley have been made for the first time. Eighteen taxa belonging to orders Jungermanniales, Metzgeriales, Marchantiales and class Anthocerotae have been reported to occur in this valley. *Lophozia mayebarae* (Hatt.) N. Kitag. is reported for the first time from India, while *Jungermannia tenerrima* Steph. and *Phaeoceros kashyapii* Asthana *et* Sriv. are new additions to the central Indian Bryoflora. However, a remarkable absence of epiphytic liverworts in the entire region surveyed has been noticed. Characteristic features with illustrations of liverworts and hornworts have been provided.

**Key words:** Hepatics, Anthocerotes, Tamia, Patalkot, Madhya Pradesh

## INTRODUCTION

Floristic studies on Bryophytes in general, and liverworts and hornworts in particular, have received very little attention, and there is an urgent need to prepare regional floras of Bryophytes of India. However, some contributions have already been made by Pande and Srivastava (1952), Bapna (1958), Bapna and Vyas (1962), Hattori (1966, 1971), Kachroo (1969), Lal and Parihar (1979), Tewari and Pant (1994), Parihar *et al.* (1994), Bapna and Kachroo (2000). As far as floristic studies on Hepaticae of central India is concerned, Pande and Srivastava (1952), and Lal and Parihar (1979) have provided a list of Hepatics of Pachmarhi and Amarkantak respectively. Studies on Hepatics and Anthocerotes of Tamia hills and Patalkot valley have not received any attention; however, pteridophytic flora of this region was earlier provided by Vasudeva and Bir (1987), and Khare (1999).

Tamia hills (*ca* 1,000 m) and Patalkot valley (*ca* 400 m) are a part of the Satpura ranges. They are situated about 100 km south-east of Pachmarhi. The topography of Tamia exhibits deep ravines (Khuds) between the red sand stone hills made up of sedimentary rocks, composed mainly of red and yellow clay mixed with gravel. Frequent perennial streams flow in the deep ravines. The Patalkot valley is unique, giving an appearance of a piece of land that abruptly sank to a depth of 700 m; it is bordered by steep and straight hills, like a well. The valley is isolated with only 12 villages consisting of 265 families and about 1,614 individuals of the Bharia tribe. The entire region is spread over *ca* 79 sq. km.

The steep valley is endowed with dense forest cover, providing suitable conditions for the growth of Bryophytes, though only thalloid liverworts and mosses are dominant. A river, locally known as *Dudhi*, flows down the Valley near Rajakhoh, a hideout of a former king.

The region of Tamia hills and Patalkot valley is neither too hot nor too cold (temperature ranges from minimum 4 °C to 38 °C maximum) and remains pleasant throughout the year. There is not much variation in climate and altitude around Tamia region. The average annual rainfall in this region is about 200 cm. The suitable temperature, low light intensity, adequate soil moisture and presence of perennial streams, collectively provide favourable conditions for the luxuriant growth of liverworts. Some liverworts like *Dumortiera hirsuta* (Sw.) R. Bl. *et* Nees, *Pallavicinia lyellii* (Hook.) Gray and *Riccardia santapaui* Udar *et* Sriv. flourish under the dripping water on the side rocks of the deep ravines in Tamia. It is surprising to note that despite all favourable conditions, epiphytic liverworts are completely missing in these regions. This may be due to either unsuitable nature of forest vegetation (tree bark and leaves), or lack of specific conditions for epiphytic growth of liverworts.

## MATERIAL AND METHODS

Plant specimens collected from Tamia and Patalkot (Dist. Chhindwara, Madhya Pradesh) have been deposited in the Bryophyte Herbarium, National Botanical Research Institute, Lucknow (LWG). Morphological and anatomical studies were done by observing on Glycerine



mounted slides. Line drawing illustrations have been prepared using Camera Lucida.

## DESCRIPTIONS

### I *Jungermanniales* Limpr.

#### A. *Jungermanniaceae* Reichenb.

##### a. *Jungermannia* L.

1. *Jungermannia (Luridae) tenerima* Steph., Spec. Hepat. 6: 93, 1917. (Fig. 1, 1-5).

Plants medium to large, up to 10 mm long; light green. Stem simple, triangular in outline, 0.3 mm wide, 0.25 mm in diameter, 7-8 cells across, cortical cells slightly thick-walled. Rhizoids colourless. Leaves obliquely inserted, slightly decurrent dorsally in a single row spreading horizontally, ovate, 1 mm long and 1 mm wide, widest at base, obtuse at apex; marginal cells 36-48 x 28 µm, median cells 40-44 x 28-40 µm, basal cells 64-80 x 24-28 µm, cells thin-walled non-trigonus.

**Ecology and Distribution:** Plants grow on soil-covered rocks under moist conditions near Rajakhoh at Patalkot valley.

**Specimen Examined:** INDIA: Madhya Pradesh, Chhindwara, Patalkot valley, Rajakhoh (ca 400 m), 20.xii.1993. Leg. V. Nath & A.K. Asthana. 205725 (LWG). Det. V. Nath & A.K. Asthana.

#### B. *Lophoziaceae* Cavers

##### a. *Lophozia* (Dum.) Dum.

2. *Lophozia mayebarae* (Hatt.) N. Kitag., J. Hattori Bot. Lab. 29: 106, 1966. (Fig. 1, 6-12).

Basionym: *Cephalozia mayebarae* Hatt., J. Hattori Bot. Lab. 3: 37, 1948.

Plants very small, light brown, in loose tufts. Stem up to 5 mm long, 0.6 to 0.8 mm wide. Stem, 5-6 cells across in transverse section, formed of undifferentiated cells. Leaves distantly arranged, transverse to obliquely inserted, non-decurrent, quadrate to oblong-ovate 0.18-0.3 mm wide and upto 0.3 mm long, bilobed, sinus 1/6-1/3 the leaf length, lobes more or less unequal, sub-acute obtuse. Under leaves lacking, apical cells 15 x 12 µm, marginal cells 16-20 x 8-12 µm, median cells 28-32 x 12-24 µm, basal cells 40-48 x 20 µm cells thin-walled non-trigonus, hyaline or brown. Perianth not seen.

**Ecology and Distribution:** Plants grow over dead logs in shady habitat at Tamia.

**Specimen Examined:** INDIA: Madhya Pradesh, Chhindwara, Tamia (ca 1000 m), 10.x.1992. Leg. V. Nath & A.K. Asthana. 205497 (LWG). Det. V. Nath & A.K. Asthana.

### II *Metzgeriales* Schust. em. Schljak.

#### A. *Aneuraceae* Klinggr.

##### a. *Riccardia* S. Gray

3. *Riccardia santapau* Udar et Srivastava, Rev. Bryol. Lichenol. 39(1): 155-159, 1973. (Fig. 2, 1-2).

Thallus dark green, in dense and compact patches, robust usually 35-50 mm long, 1-1.75 mm wide; closely pinnately branched, branches opposite, margin entire, apices slightly broader. Rhizoids scarcely present. Main thallus axis is nearly biconvex in cross-section, 6-7 cells thick in the middle, 2-3 cells wide and ultimately unistratose at the margins, epidermal cells smaller and more or less rectangular in shape.

**Ecology and Distribution:** Grows luxuriantly in dense patches on rocks under dripping water at Tamia valley (near Chhota Mahadeo).

**Specimens Examined:** INDIA: Madhya Pradesh, Chhindwara, Tamia, on way to Chhota Mahadeo (ca 950 m), 10.x.1992, Leg. V. Nath & A.K. Asthana. 205498, 205509, 205510 (LWG). Det. V. Nath & A.K. Asthana; 19.xii.1993, Leg. V. Nath & A.K. Asthana. 205693, 205696, 205697, 205699, 205700 (LWG). Det. V. Nath & A.K. Asthana.

4. *Riccardia levieri* Schiffn., Osterr. Bot. Zeitschr. 49: 130, 1899. (Fig. 2, 3-4).

Thallus usually green, up to 30 mm long and 1.25 mm wide, irregularly or pinnately branched, branches more or less opposite, margin entire, apices broad and obtuse. Rhizoids usually present. Main axis of the thallus convex below and nearly concave or plain above in cross-section, about 6 cells thick in the middle, thallus wing multistratose, becoming thin towards margin, edges rounded or slightly acute, epidermal cells smaller than the inner cells.

**Ecology and Distribution:** Grows under extremely wet conditions on rocks under water stream at Tamia (on way to Chhota Mahadeo).

**Specimen Examined:** INDIA: Madhya Pradesh, Chhindwara, Tamia, on way to Chhota Mahadeo (ca 1000 m), 10.x.1992, Leg. V. Nath & A.K. Asthana. 205510 (LWG). Det. V. Nath & A.K. Asthana.

#### B. *Fossombroniaceae* Evans

##### a. *Fossombronia* Raddi

5. *Fossombronia wondraczekii* (Corda) Dum. Rec. d'observ. P. 11, 1835. (Fig. 2, 5-10).

Basionym: *Jungermannia wondraczekii* Corda in Sturm, Deutschl. Fl. Fasc. 2, Lfg. 19-20, 30, 1830.

Plants green or yellowish green. Stem 6 mm long with a tendency of dichotomous branching, slightly thickened towards apex, rhizoids hyaline to light yellow, densely distributed over ventral surface. Leaves succubous, densely arranged towards the apex, margin undulate, cells thin-walled,



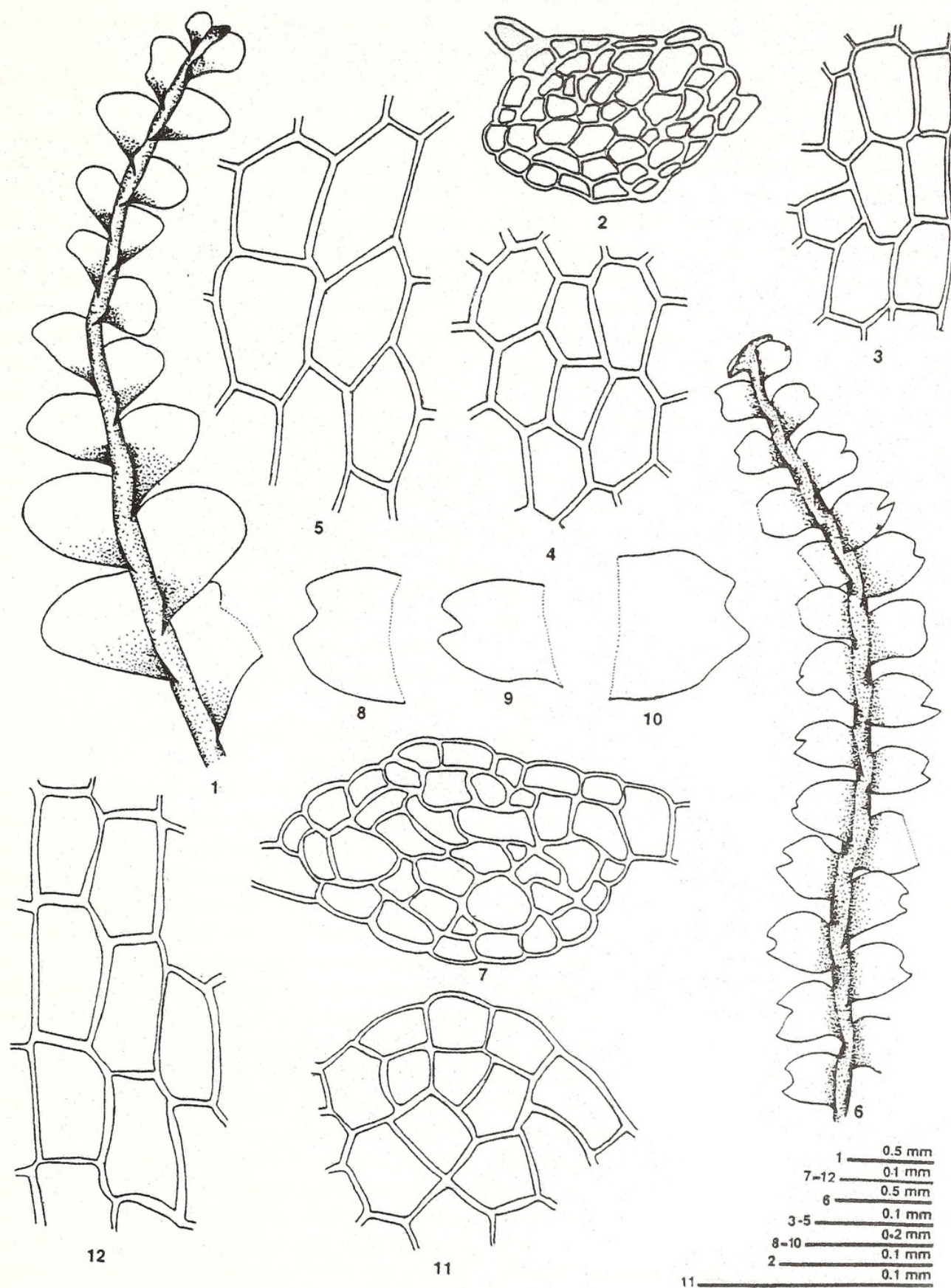


Fig. 1: 1-5: *Jungermannia tenerrima* Steph: 1. A portion of plant, 2. Cross section of stem, 3. Marginal cells of Leaf, 4. Median cells of Leaf, 5. Basal cells of Leaf; 6-12: *Lophozia mayebarae* (Hatt.) N. Kitag: 6. Dorsal view of plant, 7. Cross section of stem, 8-10. Leaves, 11. Apical cells Leaf, 12. Basal cells of Leaf



marginal cells 20-24 x 34-68 µm, median cells 34-42.5 x 85 µm and basal cells 42 x 153 µm. Monoecious. Antheridia not seen. Pseudoperianth campanulate or inverted bell-shaped with wavy margin. Seta elongated. Capsule spherical, blackish-brown and exserted, dehiscence irregular, capsule wall bistratose, cells of outer layer thin-walled without any thickening, cells of inner layer in surface view with incomplete thickening bands. Spores tetrahedral to spherical, 58 µm in diameter, dark brown distal face with prominent, parallel running lamellae, which sometimes form 1 or 2 reticulations in the middle, perispore prominent and well-developed at periphery, spines bold and pointed, proximal face devoid of lamellae, but with scattered papillae, triradiate mark faintly developed. Elaters 160 µm long, 20 µm broad, 2 (3-4) spirate, yellowish brown with obtuse end.

**Ecology and Distribution:** Grows on soil-covered rock near Rajakhoh in Patalkot valley.

**Specimen Examined:** INDIA: Madhya Pradesh, Chhindwara, Patalkot, near Rajakhoh (ca 400 m), 6.x.1992. Leg. V. Nath & A.K. Asthana. 205474 (LWG). Det. V. Nath & A.K. Asthana.

6. *Fossombronina kashyapii* Srivast. *et* Udar, Nova Hedwigia 26: 816 (1975). (Fig. 2, 11-16).

Plants small, green or dull-green. Stem 7-8 mm long, dichotomously branched, apical region often tuberous, ventral surface covered with hyaline rhizoids. Leaves simple, succubous, quadrate or sub-quadrate, obliquely inserted, arranged in two lateral rows, margins undulate, marginal cells 28 (-62.4) x 24 µm, median cells 60 (-163) x 28-43 µm. Dioecious. Antheridia not seen. Pseudoperianth campanulate, margin irregularly lobed. Capsule spherical, dark brown, dehiscence irregular, capsule wall bistratose, cells of outer layer thin-walled, without any thickening, inner layer cells in surface view with complete or incomplete thickening bands. Spores 52 µm in diameter, dark brown with thick lamellae, often forming reticulations in the middle region on distal face, usually 5 reticulations across the diameter with a range of 1-8 lamellae continuous usually forked at periphery, spines and perispore well-developed, proximal face devoid of lamellae, with some short and scattered low lamellae and faintly developed triradiate mark. Elater 160-258 µm long, usually trispirate.

**Ecology and Distribution:** Grows on rocks under moist and exposed conditions at Tamia.

**Specimen Examined:** INDIA: Madhya Pradesh, Chhindwara, Tamia (ca 1,000 m), 10.x.1992, Leg. V. Nath & A.K. Asthana. 205487 (LWG). Det. V. Nath & A.K. Asthana.

C. *Pallaviciniaceae* Migula *em.* Schust.

a. *Pallavacinia* S. Gray

7. *Pallavacinia lyellii* (Hook.) Gray. J. Bot. Brit. Foreign 3: 302, 1865. (Fig. 3, 1-6).

Basionym: *Jungermannia lyellii* Hook., Brit. Jung. Pl. 77, 1816.

Thallus prostrate, 70 mm long, 5 mm wide, light green, dichotomously branched at apex, margin entire. Rhizoids scarcely present. Thallus usually 11 cells high in the middle and has a prominent midrib, which gradually passes on both sides into a broad lamina, midrib more or less 0.5 mm broad with central conducting strand composed of thick-walled cells, cells usually 30 in number. Cup-shaped involucre having thick fringe of hairs at mouth. Perianth and sporophyte not seen.

**Ecology and Distribution:** Grows on soil-covered rocks under extremely moist conditions at Tamia, on way to Chhota Mahadeo.

**Specimens Examined:** INDIA: Madhya Pradesh, Chhindwara, Tamia, Chhota Mahadeo (ca 954-1000 m), 10.x.1992. Leg. V. Nath & A.K. Asthana. 205501, 205502, 205504, 205505, 205506, 205510, 205511 (LWG); 19.xii.1993, Leg. V. Nath & A.K. Asthana. 205682, 205702, 205703, 205704 (LWG). Det. V. Nath & A.K. Asthana.

### III. Marchantiales Limpr.

#### A. *Targioniaceae* Endl.

##### a. *Targionia* L.

8. *Targionia hypophylla* L. Spec. Plant. 1604, 1753. (Fig. 3, 12-16).

Plants yellowish green, thallus up to 10 mm long, 3 or rarely 4 mm broad, ventral surface purplish; scales purplish, delicate with or without appendage, pores nearly rounded. Dioecious, male plants not seen in our collection. Female thalli with dark, boat-shaped involucre around sporophyte near the apex on ventral surface. Spores dark brown-black, 60-68 µm in diameter, sporoderm minutely reticulate, forming a fine mesh all over, distal face with some larger reticulations, usually 4-5 across the diameter, proximal face with irregular folds or lamellae. Elaters usually 170-306 µm long with 2 or rarely 4 spiral thickening bands.

**Ecology and Distribution:** Plants grew over soil-covered rocks under exposed conditions at Patalkot valley, near Rajakhoh and at Tamia near Chhota Mahadeo.

**Specimens Examined:** INDIA: Madhya Pradesh, Chhindwara, Patalkot (ca 400 m), 6.x.1992. Leg. V. Nath & A.K. Asthana. 205472 (LWG) Det. V. Nath & A.K. Asthana; Tamia (ca 952 m), 11.x.1992. Leg. V. Nath & A.K. Asthana. 205526 (LWG). Det. V. Nath & A.K. Asthana.

##### b. *Cyathodium* Kunze

9. *Cyathodium cavernarum* Kunze in Lehm., Pugillus 6: 17,





Fig. 2: 1, 2. *Riccardia santapauli* Udar et Sriv.: 1. Plant, 2. Cross section of thallus; 3, 4. *Riccardia levieri* Schiff.: 3. Plant, 4. Cross section of thallus; 5-10: *Fossombronia wondraczekii* (Corda) Dum.: 5. Plant, 6. Apical marginal cells of thallus, 7. Inner lining layer of capsule, 8. Spore (distal face), 9. Spore (proximal face), 10. Elater with bispiral thickening bands. 11-16: *Fossombronia kashyapii* Sriv. et Udar.: 11. Plant, 12. Apical marginal cells of thallus, 13. Inner lining layer of capsule, 14. Spore (proximal face), 15. Spore (distal face), 16. Elater with trispiral thickening bands.



1834. (Fig. 3, 7-11).

Thalli yellowish green, small, delicate, 3-5 or rarely 8 mm long, 2-3 or rarely 4 mm wide, dichotomously branched at apex, repeated dichotomy results in a fan-shaped thallus, cavernous in nature, midrib not present. Monoecious. Antheridia not seen. Involucre present near the margin in the apical region of thallus, globose, non-hairy, cleaved into two lips, rim of involucre bordered with 2-3 rows of thick-walled cells. Capsule ovoid, dark brown. Spores blackish brown, 52-56  $\mu\text{m}$  in diameter, sporoderm spinose-baculate. Elaters up to 561  $\mu\text{m}$  long with bispiral thickening bands.

**Ecology and Distribution:** Plants grow on soil and soil-covered rocks in damp pockets at Tamia near Chhota Mahadeo.

**Specimens Examined:** INDIA: Madhya Pradesh, Chhindwara, Patalkot, near Rajakhoh (ca 953 m), 6.x.1992. Leg. V. Nath & A.K. Asthana 205469 (LWG); Tamia, Chhota Mahadeo, 11.x.1992. Leg. V. Nath & A.K. Asthana. 205518, 205527 (LWG). Det. V. Nath & A.K. Asthana.

#### B. *Aytoniaceae* Cavers

##### a. *Asterella* Beauv.

10. *Asterella wallichiana* (Lehm. et Lindb.) Grolle. J. Hattori Bot. Lab. 11: 8, 1954.

(Fig. 4, 1-4)

Basionym: *Fimbriaria wallichiana* in Lehm., Pugillus 4: 4, 1832.

Plants green, thallus up to 30 mm long, 3 mm broad, linear, dichotomously branched, dorsal surface nearly flat, margin wavy usually purple, apex notched; pores large, surrounded by 3 rings of 6 cells each; scales purplish, triangular with an acuminate appendage, sometimes unequally divided. Dioecious. Male plants not seen. Female receptacle terminal at apex, with 2-5 lobes, stalked, stalk 2 mm long, perianth nearly horizontal, membranous, beak-like, exerted. Spores dark brown, 63  $\mu\text{m}$  in diameter, sporoderm papillose with a predominantly lamellate pattern, sometimes with a tendency to form reticulations. Elaters yellow to light brown with 1-2 spiral thickening bands, up to 150  $\mu\text{m}$  long.

**Ecology and Distribution:** Plants grow over rocks and soil-covered rocks in exposed as well as shady places at Tamia, on way to Chota Mahadeo.

**Specimens Examined:** INDIA: Madhya Pradesh, Chhindwara, Tamia, Chota Mahadeo (ca 1,000 m), 10.x.1992. Leg. V. Nath & A.K. Asthana. 205489, 205519 (LWG); 19.xii.1993. Leg. V. Nath & A.K. Asthana. 205680, 205681 (LWG). Det. V. Nath & A.K. Asthana.

##### b. *Plagiochasma* Lehm. et Lindb.

11. *Plagiochasma appendiculatum* Lehm. et Lindb. Pugillus 4: 14, 1832. (Fig. 4, 12-15)

Thallus thick forming large patches, green to dark green up to 32 mm long and 6 mm wide, dichotomously divided; lobes obcordate, dorsal surface smooth with distinct pores, concave, margins undulate, slightly crenulate; ventral surface with purple tinge, scales in 1 row on each side of the midrib, purple, widely lunate in shape with a large appendage, constricted at base, obtuse, sometimes ovate with slightly acute apex, midrib gradually passing into the lamina and inconspicuous towards base. Male receptacles not seen. Female receptacles with very short stalks up to 4 lobed (in our specimens). Spores yellow, sporoderm lamellate - reticulate 68-80  $\mu\text{m}$  in diameter. Elaters yellowish-brown, 340-390  $\mu\text{m}$  long with bispiral thickening bands.

**Ecology and Distribution:** Plants grow on soil-covered rocks at Tamia, on way to Chota Mahadeo and at Patalkot.

**Specimens Examined:** INDIA: Madhya Pradesh, Chhindwara, Tamia, Chota Mahadeo (ca 950 m), 19.xii.1993. Leg. V. Nath & A.K. Asthana 205684, 205716, 205717 (LWG); Rajakhoh, Patalkot valley, Rajakhoh (ca 400 m), 20.xii.1993. Leg. V. Nath. & A.K. Asthana. 205731 (LWG). Det. V. Nath & A.K. Asthana.

12. *Plagiochasma intermedium* Lindbg. et Gott., Syn. Hep. 513, 1844. (Fig. 4, 5-11)

Thalli forming patches, green to dark green, 13-20 or rarely 25 mm long and 3-5 mm wide, sometimes slightly dichotomous; lobes strap-shaped with purple and thin margin, nearly entire or dentate, dorsal surface green with distinct pores. Ventral surface with purple tinge, scales purple, lunate appendaged, usually with 2 small appendages, oblong, constricted at base, entire with nearly acute apex. Midrib gradually passing into wings. Male receptacles not seen. Female receptacle with a very short stalk, dorsal in position, with 1-4 involucre. Spores brown-dark brown, lamellate, sometimes reticulate with a prominent wing, 60  $\mu\text{m}$  in diameter. Elaters yellowish, uniformly thickened without spiral bands, up to 390  $\mu\text{m}$  long.

**Ecology and Distribution:** Plants grow on soil-covered rocks at Patalkot and at Tamia in shady as well exposed conditions.

**Specimens Examined:** INDIA: Madhya Pradesh, Chhindwara, Patalkot valley, near Rajakhoh (ca 400 m), 6.x.1992. Leg. V. Nath & A.K. Asthana. 205470 (LWG); 20.xii.1993. Leg. V. Nath & A.K. Asthana. 205728 (LWG); Tamia, Chota Mahadeo (ca 950 m), 11.x.1992. Leg. V. Nath & A.K. Asthana. 205516, 205525 (LWG). Det. V. Nath & A.K. Asthana.

#### C. *Marchantiaceae* (Bisch.) Endl.

##### a. *Dumortiera* Nees.



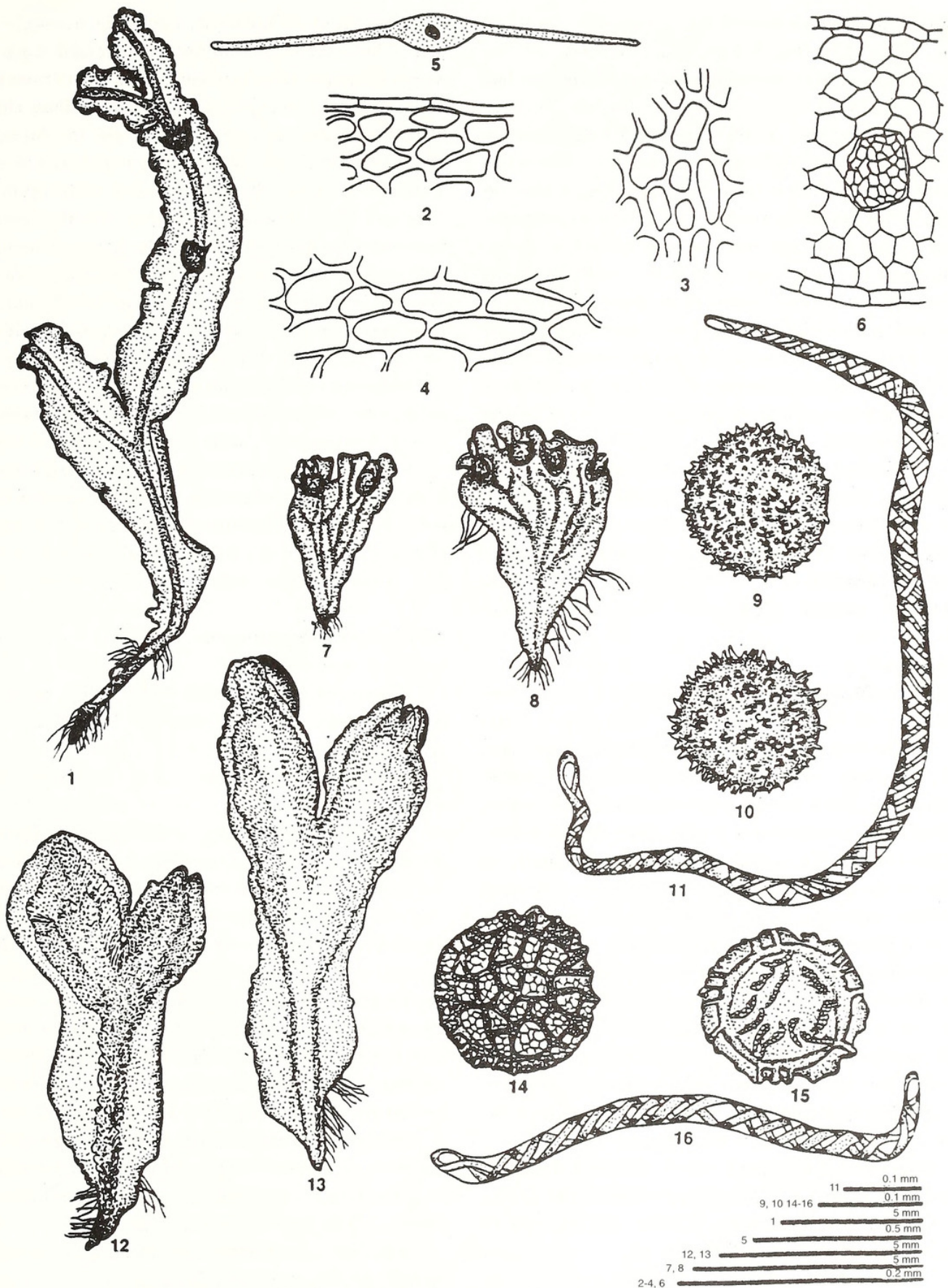


Fig. 3: 1-6: *Pallavicinia lyellii* (Hook.) Gray.: 1. Thallus with involucre, 2. Marginal cells of thallus, 3. Median cells of thallus, 4. Basal cells of thallus, 5. Cross section of thallus, 6. An enlarged portion of the same, 7-11: *Cyathodium cavernarum* Kunze: 7,8. Thalli, 9,10. Spores, 11. Elater with spiral thickening bands; 12-16: *Targionia hypophylla* L.: 12,13. Thalli with ventral involucre, 14. Spore (distal face), 15. Spore (proximal face), 16. Elater with bispiral thickening bands



13. *Dumortiera hirsuta* (Sw.) R. Bl. *et* Nees. Nov. Act. Leop. Carol. 7: 410, 1824. (Fig. 5, 1-4)

Basionym: *Marchantia hirsuta* Sw., Prodr. Fl. Ind. Occid. 145, 1788.

Plants dark green. Thalli in large overlapping patches. Thallus 40-50 mm (100 mm) long and 6-10 mm wide, repeatedly dichotomously branched, apex deeply cleaved, margin entire, undulate, translucent, midrib conspicuous. Dorsal surface with some papillate cells. Midrib prominent below, about 11 or more cells thick in the middle, gradually passing into the lamina formed of large cells. Dioecious, young female receptacles at apical articulation, sessile with bristles. Mature female receptacles with sporophyte not seen.

**Ecology and Distribution:** Plants grow luxuriantly in large patches on rocks under dripping water at Tamia, on way to Chota Mahadeo.

**Specimens Examined:** INDIA: Madhya Pradesh, Chhindwara, Tamia, on way to Chota Mahadeo (ca 1,000 m), 10.x.1992. Leg. V. Nath & A.K. Asthana. 205507, 205508, 205511, 205514, 205515 (LWG); 19.xii.1993. Leg. V. Nath & A.K. Asthana. 205701, 205714, 205715 (LWG). Det. V. Nath & A.K. Asthana.

#### b. *Marchantia* L.

14. *Marchantia linearis* Lehm. *et* Lindb. in Lehman, Nov. Stirp. Pug. 4: 8, 1832; Sp. Hep. 1: 187, 1900. (Fig. 5, 5-10)

Thallus thin, golden green in medium to large patches, 15-25 mm long, 2-3 mm wide, dichotomously branched, midrib narrow, black, margin entire, undulate. Pores scarce, small, up to 85 µm in diameter, bordered by 5-6 rings of cells. Thallus 14-20 cells thick in the middle, gradually or sometimes abruptly decreasing towards margins, sometimes one mucilage cavity present. Ventral surface brown, scale in 4 rows, two median rows with appendiculate scales having long decurrent base, appendages small hyaline or yellow, nearly cordate at base, apex acute with 1-2 apical cells, margin toothed usually with unicellular sharp teeth; laminal scales hyaline or purplish, orbicular, apex obtuse or rounded. Gemma cup at median region near apex, margin smooth.

**Ecology and Distribution:** Plants grow on moist soil under shady conditions near Chota Mahadeo at Tamia.

**Specimen Examined:** INDIA: Madhya Pradesh, Chhindwara, Tamia, Chota Mahadeo (ca 950 m), 19.xii.1993. Leg. V. Nath & A.K. Asthana. 205711, 205712, 205713 (LWG) Det. V. Nath & A.K. Asthana.

#### IV. Anthocerotae Endl.

A. *Anthocerotaceae* (Gray) Trev. em. Bharad.

a. *Anthoceros* (Micheli) L. em. Prosk.

15. *Anthoceros bharadwajii* Udar *et* Asthana, Proc. Indian

Natn. Sci. Acad. B51 (4): 484, 1985. (Fig. 6, 1-4).

Thalli fan-shaped to radially oriented, dark green, margin dissected, radially oriented thalli up to 9 mm (10 mm) wide, spongy in nature with prominent mucilage chambers clearly seen along the margin of the thalli. Involucre up to 3 mm long with a narrow mouth. Epidermal layer of capsule wall with 6-11 stomata / sq. mm, each stoma up to 65 µm long and up to 50 µm wide with reniform guard cells, surrounded by 6-7 more longer than broad epidermal cells with uniformly thickened radial walls. Spores brown or dark brown, 35-44 µm (55 µm) in diameter with spinulate to rather blunt projections forming reticuloid pattern, proximal face marked with distinct triradiate mark ending shortly before the periphery, bordered with unsculptured stripe on both the sides of ray, slightly arched. Pseudoelaters light brown, thin-walled, 120 µm long, usually 4 celled, sometimes branched.

**Ecology and Distribution:** Plants grow luxuriantly on soil-covered rocks under fairly moist conditions at Tamia.

**Specimen Examined:** INDIA: Madhya Pradesh, Chhindwara, Tamia (ca 1000 m), 10.x.1992. Leg. V. Nath & A.K. Asthana, 205488 (LWG). Det. A.K. Asthana & V. Nath.

#### B. *Phaeocerotaceae* Bharad.

a. *Phaeoceros* Prosk.

16. *Phaeoceros laevis* (Linn.) Prosk. subsp. *laevis* Prosk. Rapp. et Comm. 8. Congr. Intern. Bot. Paris 14-16: 69, 1954 (Fig. 6, 5-8)

Basionym: *Anthoceros laevis* Linn. Spec. Plant. 2: 1139, 1753.

Plants dioecious. Female thalli fan-shaped, light or dark green, branched, up to 11 mm long, 8-10 mm wide at apex, deeply lobed, margin entire-wavy, compact. Involucre cup-shaped cylindrical, 2 mm (-5 mm) long with wide mouth, compact, smooth, epidermal layer of capsule wall stomatiferous with 6-7 stomata/ sq. mm, each stoma 50-75 µm long and 40 µm wide with two reniform guard cells, surrounded by 5-6 more longer than broad narrow rectangular cells having uniformly thickened radial and end walls. Spores yellowish green, spherical or subspherical, 45 µm in diameter, sporoderm minutely papillate with a prominent equatorial crossitudo, proximal face with a distinct thin triradiate mark bordered by minute papillae along the rays, triradiate rays reaching to equatorial crossitudo. Pseudoelaters light brown to brown, 4 celled, 168 µm long, thin-walled.

**Ecology and Distribution:** Plants grow on rocks near streams at Chota Mahadeo, Tamia.

**Specimen Examined:** INDIA: Madhya Pradesh, Chhindwara, Tamia, Chota Mahadeo (ca 950 m), 19.xii.1993. Leg. V. Nath & A.K. Asthana. 205687 (LWG). Det. A.K. Asthana & V. Nath.



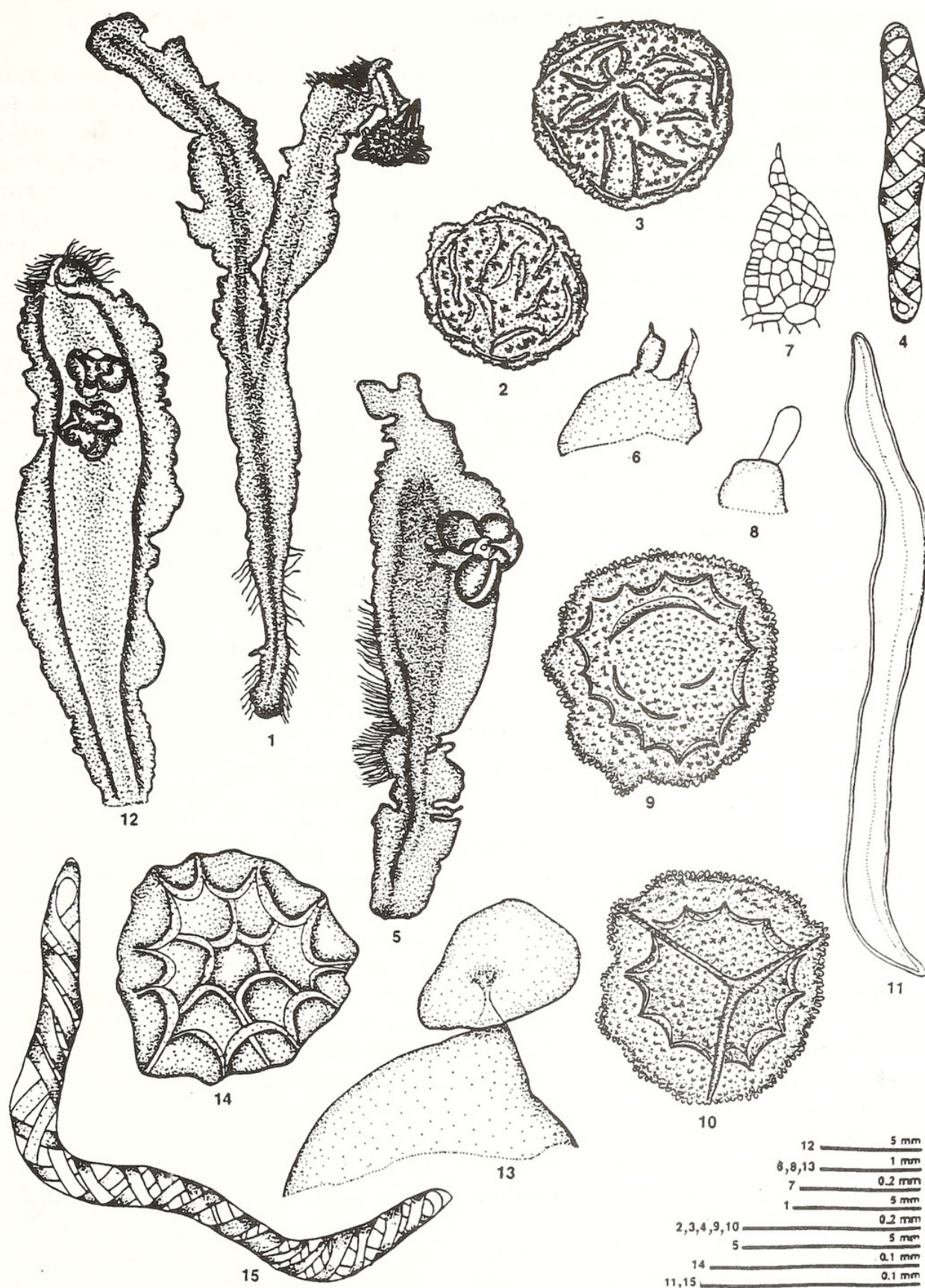


Fig. 4: 1-4: *Asterella wallichiana* (Lehm. et Lindb.) Grolle, 1. Thallus with female receptacle, 2, 3. Spores, 4. Elater with bispiral thickening bands; 5-11. *Plagiochasma intermedium* Ldbg. et Gott. 5. Thallus with female receptacle, 6. Ventral scale, 7, 8. An enlarged view of the same, 9. Spore (distal face), 10. Spore (proximal face), 11. Elater without thickening bands; 12-15: *Plagiochasma appendiculatum* L. et L. 12. Thallus with female receptacle, 13. Ventral scale, 14. Spore, 15. Elater with bispiral thickening bands



17. *Phaeoceros laevis* (Linn.) Prosk. subsp. *carolinianus* (Michx.) Prosk., Rapp. *et Comm.* 8. *Congr. Intern. Bot.*, Paris 14-16: 69, 1954. (Fig. 6, 9-11)

Basionym: *Anthoceros carolinianus* Michx., Fl. Bor. America 2: 280, 1803.

Plants monoecious. Thalli fan-shaped light or dark green, deeply lobed, usually 12 mm long and 10 mm wide with fanning apex and narrowing base, compact. Androecial chambers scattered irregular over the dorsal surface. Involucre cylindrical, 2-4 mm long, smooth, compact, narrow at mouth. Epidermal layer of capsule wall stomatiferous with 3-10 stomata/sq. mm, up to 80 µm long and 40 µm wide, with two reniform guard cells surrounded by usually 6 more longer than broad epidermal cells, cells with thickened radial and end walls. Spores yellowish green, 35 µm in diameter, sporoderm minutely papillate with a prominent equatorial crossitudo, proximal face with a distinct triradiate mark, triradiate rays thin and bordered with minute papillae all along its length, reaching up to equatorial crossitudo. Pseudoelaters yellowish brown, thin-walled, up to 150 µm long with irregular thickening bands.

**Ecology and Distribution:** Plants grow over soil-covered rocks under moist conditions near Chota Mahadeo.

**Specimen Examined:** INDIA: Madhya Pradesh, Chhindwara, Tamia, Chota Mahadeo (ca 950 m), 19.xii.1993. Leg. V. Nath & A.K. Asthana 205708 (LWG). Det. A.K. Asthana & V. Nath.

18. *Phaeoceros kashyapii* Asthana *et* Sriv. Bryophyt. Biblioth. Band 42: 129, 1991. (Fig. 6, 12-18)

Plants monoecious. Thalli light green, lobed up to 6 mm long and 2-4 mm wide, fanning above and narrow at base, compact. Involucre cylindrical, smooth, up to 3 mm long, compact. Epidermal layer of capsule wall stomatiferous, each stoma with 2 reniform guard cells, surrounded by 5-6 more longer than broad epidermal cells having thickened radial and end walls. Spores yellowish green, 37.5-40 µm in diameter, sporoderm with lamellate projections and a prominent equatorial crossitudo, proximal face with a prominent and thin triradiate mark reaching to the inner border of equatorial crossitudo. Pseudoelaters pale to light brown, thin-walled, smooth, 72-100 µm long.

**Ecology and Distribution:** Plants were collected from soil-covered rocks under moist conditions on way to Rajakhoh at Patalkot valley.

**Specimen Examined:** INDIA: Madhya Pradesh, Chhindwara, Patalkot, on way to Rajakhoh (ca 400 m), 6.x.1992. Leg. V. Nath and A.K. Asthana. 205475 (LWG). Det. A.K. Asthana & V. Nath.

## DISCUSSION

The investigation on the altitudinal distribution of liverwort and hornwort taxa growing at Tamia and Patalkot revealed that *Riccardia levieri*, *Fossombronia kashyapii*, *Lophozia mayebarae*, *Dumortiera hirsuta* and *Anthoceros bharadwajii* occur at higher altitude (ca 1,000 m), while *Riccardia santapau*, *Cyathodium cavernarum*, *Marchantia linearis*, *Phaeoceros laevis* subsp. *laevis* and subsp. *carolinianus* occur at ca 950 m. *Pallavicinia lyellii* grows between 954-1,000 m. Apart from this, the low altitude loving taxa like *Jungermannia* (Luridae) *tenerrima*, *Fossombronia wondraczekii*, *Targionia hypophylla* and *Phaeoceros kashyapii* grow at ca 400 m. The most adaptive taxa are *Plagiochasma appendiculatum* and *P. intermedium*, which grow at a range of 400-950 m.

*Lophozia mayebarae* (Hatt.) N. Kitag. was earlier described from Japan by Kitagawa (1966) and was considered endemic; the present study, however, revealed the occurrence of this taxon at Tamia (Chhindwara district), which is a new record for India, hence extending the range of distribution of this species from Japan to India. Indian specimens of the above taxon closely resemble Japanese plants in plant size, stem anatomy, leaf size and non-trigonus cells; but some variations, in apical leaf cells (30-40 µm), middle and basal cells (28-33 x 40-60 µm) have been observed, which may be due to different climatic conditions of the two geographically different locations.

*Phaeoceros kashyapii* Asthana *et* Sriv. was first described (Asthana and Srivastava 1991) from Deoban (Western Himalaya) at ca 3,300 m, but recent investigation showed the occurrence of this taxon at remarkably low altitude – ca 400 m – at Patalkot valley (Chhindwara district), which is a new addition to the central Indian bryoflora, and it shows the adaptability of this species to grow widely in various bryogeographical regions of India. A morphological variation in the specimens of Patalkot, as compared to the plants of Deoban, is that the thallus is smaller in size, in addition to variation in diameter of spore and elater's length. *Jungermannia* (Luridae) *tenerrima* is also a new addition to the central Indian bryoflora, as earlier it was known from western and eastern Himalaya only.

The present study revealed that *Targionia hypophylla*, *Cyathodium cavernarum*, *Plagiochasma intermedium* and *Plagiochasma appendiculatum* are common at both Tamia and Patalkot valley. This growth pattern exhibits the adaptability of these taxa to grow at lower, as well as at higher altitudes and in shady or exposed conditions as compared to other taxa. *Riccardia santapau* (Aneuraceae), *Pallavicinia*



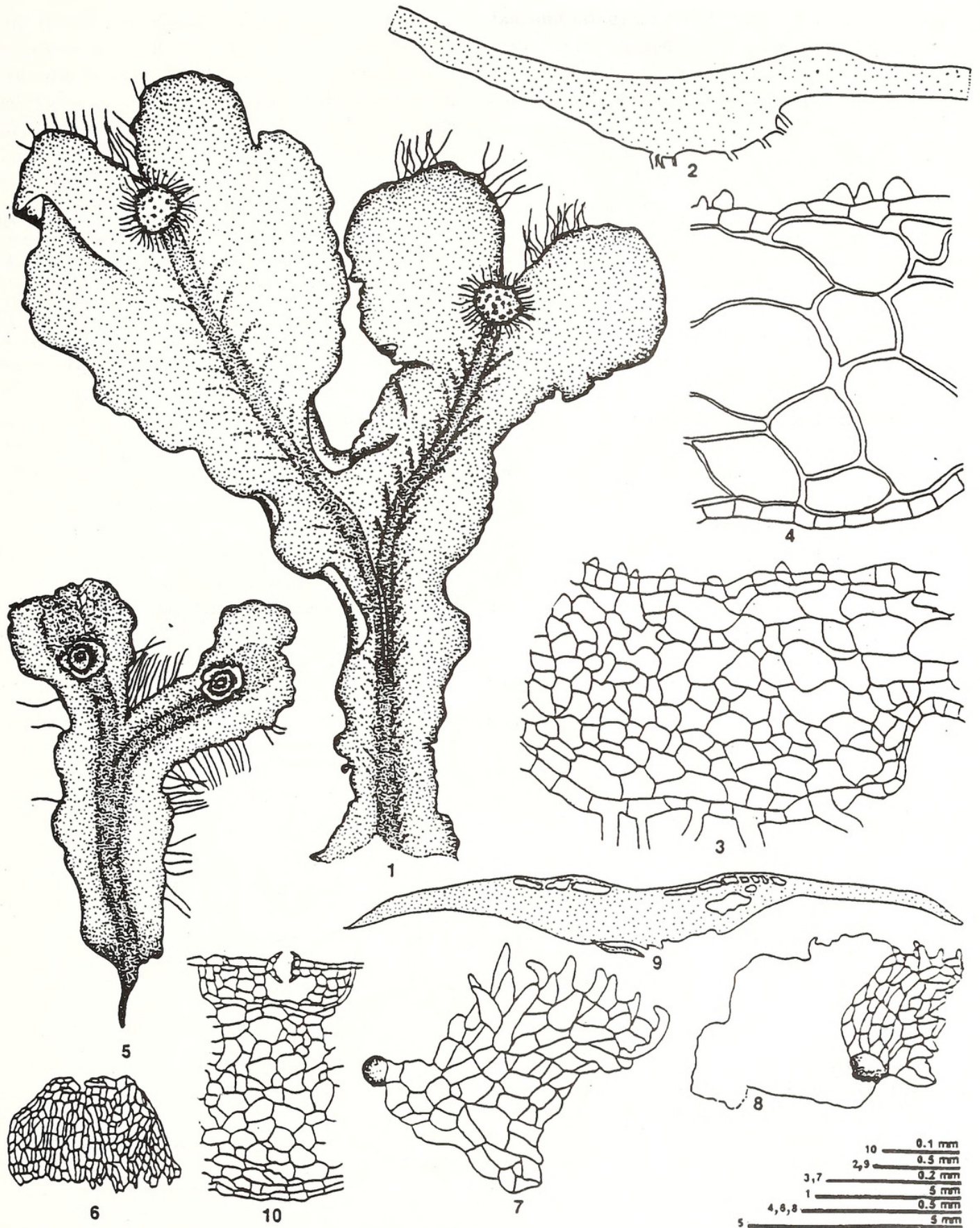


Fig. 5: 1-4: *Dumortiera hirsuta* (Sw.) R. Bl. et Nees: 1. Thallus with young female discs, 2. Cross section of thallus, 3, 4. An enlarged view of the same showing papillate cells; 5-10: *Marchantia linearis* Lehm. et Lindb.: 5. Thallus with gemma cups, 6. Laminal scale, 7. Appendage of the scale, 8. An appendaged scale, 9. Cross section of thallus, 10. An enlarged portion of the same



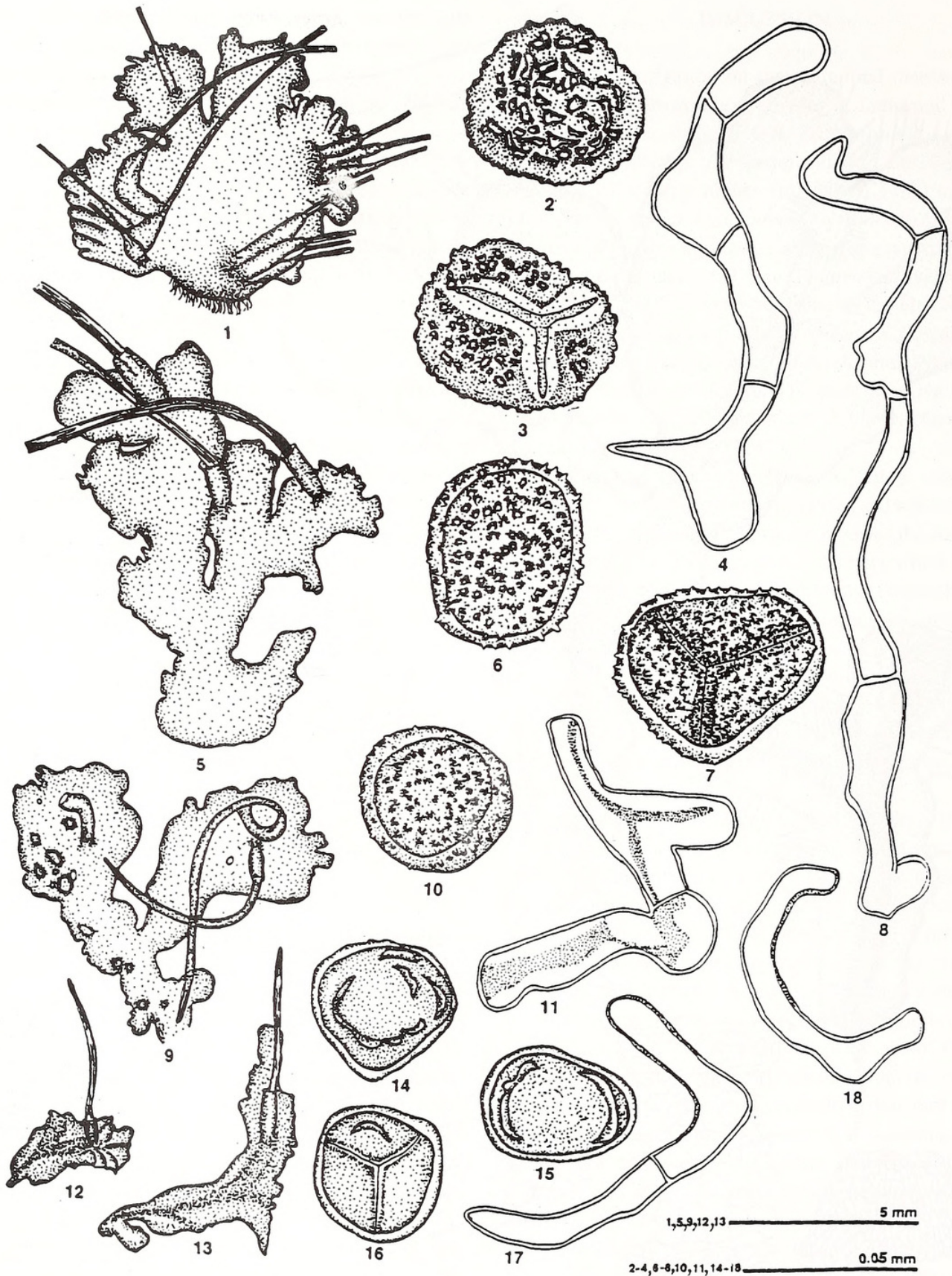


Fig. 6: 1-4: *Anthoceros bharadwajii* Udar et Asthana: 1. Thallus, 2. Spore (distal face), 3. Spore (proximal face), 4. Pseudoelater.  
 5-8: *Phaeoceros laevis* s. sp. *laevis* Prosk.: 5. Thallus, 6. Spore (distal face), 7. Spore (proximal face), 8. Pseudoelater.  
 9-11: *Phaeoceros laevis* s. sp. *carolinianus* (Michx.) Prosk.: 9. Monoecious thallus, 10. Spore, 11. Pseudoelater.  
 12-18: *Phaeoceros kashyapii* Asthana et Sriv.: 12, 13. Thalli, 14, 15. Spores (distal face), 16. Spore (proximal face),  
 17, 18. Pseudoelaters



*lyellii* (Pallaviciniaceae) and *Dumortiera hirsuta* (Marchantiaceae) respectively form the dominant liverwort vegetation at Tamia, while *Plagiochasma intermedium* and *Plagiochasma appendiculatum* exhibit dominance in the Patalkot valley.

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