

# BRYODIVERSITY OF DISTRICT BUDGAM (JAMMU AND KASHMIR) HAPLOLIPDEA I

Amarpreet Kour & Anju Rao & Sunita Kapila

Department of Botany, Panjab University, Chandigarh-160014

Received: October 01, 2018

Accepted: November 01, 2018

## ABSTRACT

Worldwide diversity of bryophytes is 18,500 species in nearly 1,050 genera. It is a matter of great concern that 102 species of bryophyta are listed in the IUCN world red list of 2014. In view of the threatening situation the study of the bryophytic flora of the unexplored area District Budgam (J&K) assumes greater importance. The present survey of the unexplored area till date has revealed the occurrence of 73 bryophyte species in various habitats. These species fall in 32 genera in 10 orders and 18 families. Among these, there are 23 haplolepidous species.

## Keywords:

## INTRODUCTION

Bryophytes are simple, small, green land plants; gametophyte thalloid or leafy, without vascular system, roots absent, attached to substratum by rhizoids; flowers and seeds absent, reproduction by means of spores; sporophyte permanently attached to the gametophyte. They are treated as subkingdom Bryobiotina and divided into three phyla namely, Bryophyta, Marchantiophyta and Anthocerotophyta (Crum, 2001; Shaw and Renzaglia, 2004; and Zander, 2006). Worldwide diversity of bryophytes is 18,500 species in nearly 1,050 genera (Oren *et al.*, 2007). 2489 taxa of bryophytes are recorded from India. Of these 1786 (in 355 genera), 675 (in 121 genera) and 25 (in 6 genera) species are of mosses, liverworts and hornworts respectively (Dandotiya *et al.* 2011). It is a matter of great concern that 102 species of bryophyta are listed in the IUCN world red list of 2014. In view of the threatening situation the study of the bryophytic flora of the unexplored area District Budgam (J&K) assumes greater importance.

## MATERIALS AND METHODS

In the present study, previously unexplored chosen areas of the district Budgam (Figure 1), in state Jammu and Kashmir were investigated to assess diversity of bryophytes. The materials were collected from different regions of district Budgam (J&K). The field data were recorded on the spot.

The systematic arrangement of the genera and families of mosses is after Buck and Goffinet (2000) and Goffinet and Buck (2004) and the systematic arrangement of the genera and families of liverworts is after the sequence of Crandall-Stotler *et al.* (2009).

## RESULTS AND DISCUSSION

*Schistidium apocarpum* (Hedw.) B.S.G. ssp. *gracile* (Roehl.) Meyl. Bull. Soc. Vaud. Sci. Nat. ser. 5, 41;100(1905).

### Plate 1

*Grimmia apocarpa* Hedw., var. *gracile* Roehl. Ann. Vet. Ges., 3(1): 97(1812).

*Grimmia stricta* Turn., Musc. Hib., 20: (1804).

*G. schleicheri* Spreng. Einl. Stud. Krypt. Grew.: 277(1804).

*G. apocarpa* Hedw., var. *schleicheri* (Spreng.) Brid. Sp. Musc., 1: 97(1806).

*G. gracilis* Schleich. ex Schwaegr. Sp. Musc. Suppl. 1(1): 98(1811).

*G. trichodon* Brid Bryol. Univ., 1:171(1826).

*Barbula albicuspis* Mitt., Musc. Ind. Or. :35(1859).

*Schistidium gracile* (Roehl.) Limpr., Laubm. Deutschl., 1:705(1889).

*Didymodon albicuspis* Mitt., Nat. Pfl., 1(3): 407(1902).

Monoecious or dioecious. Plants growing in loose tufts. Stem erect, usually branched, reddish brown, ± 3 cm long. Leaves erect when dry, erectopate when moist, crowded at apex, 2.9 mm long and 1mm wide, broadly ovate-lanceolate, leaf ending in a short spine, tip transparent, disintegrating early, margins denticulate, recurved just below the apex; costa prominent, deep brown, thick, ending before the apex, ± 65µ broad at base; upper laminal cells ± 50×10µ, quadrate, incrassate, mamillate, tumescent, opaque, basal laminal cells ±17×10µ, incrassate, rectangular, smooth near costa, marginal cells shorter, tumescent. Seta erect, ±1.7cm long; capsule dark red, ±1.2 mm long, exothecial cells usually quadrate, stomata present;

peristome erect, 16 in number, often twisted, red, densely papillose, usually perforated. Spores smooth, yellow,  $\pm 11 \mu$  in diameter.

Plants were found growing on rocks near the stream in shaded habitats. Capsules mature in late spring. A cosmopolitan species.

#### Specimen examined

**Budgam:** Khansahib, Beerwah; Collected from rock, where they were attached; Feb 2014, PAN 6122.

**Distribution:** Kashmir, Sikkim, Japan, Europe, Caucasus and North and Central America.

**Chromosome number:** n=13

- Plants about 1cm long, Leaves  $\pm 3$ mm long and  $\pm 1$ mm broad with long arista, apophysis indistinct.....*Grimmia ovalis*  
Plants 1.5cm long, Leaves  $\pm 1.5$  mm long and 0.7mm wide with short arista, apophysis distinct  
.....*Grimmia apophysata*

*Grimmia apophysata* Hamp. ex Gangulee, Nova Hedw., 12: 428 (1966).

Plate 2

*Grimmia apophysata* Hamp., Jaeg.,: Ber. S.Gall. Naturw. Ges. 1872-73:66(1874).

Dioecious. Plants branched, dark green to brown, growing in loose tufts. Stem slender, branched or unbranched,  $\pm 1.5$ cm long. Leaves crowded in upper parts, erect when dry, erectopatent when wet, folded,  $\pm 1.5$  mm long and 0.7mm wide, ovate-lanceolate, apex acute, ending into short transparent tip, lamina recurved at the base; costa brown,  $\pm 75 \mu$  broad at base, percurrent; upper laminal  $\pm 25 \times 14 \mu$ , quadrate, marginal cells  $\pm 17 \times 14 \mu$ , quadrate-rectangular, smooth, basal cells  $\pm 30 \times 14 \mu$ , rectangular. Seta apical, erect, brown,  $\pm 5.5$  mm long; capsule prominent, erect,  $\pm 1.75$ mm long and  $\pm 0.6$ mm broad; operculum conic-rostrate; a prominent short apophysis, peristome teeth 16, smooth or papillose, orange to dark red, entire, often perforate or cleft above; operculum convex conic, rostrate; calyptra mitrate or cucullate, smooth.

It is a distinct species characterised by short prominent apophysis and ovate-lanceolate leaf shape. Earlier, this species has been reported from Darjeeling and it is for the first time that it has been reported from Kashmir. It is endemic in these areas.

#### Specimen examined

**Budgam:**Charari Sharief; They were attached to rock and growing on a tree; Feb 2014. PAN 6124.

**Distribution:**Darjeeling and Kashmir.

**Chromosome number:** n=12

*Grimmia ovalis* (Hedw.) Lindb., Act. Soc. Sci. Fenn., 10: 75(1871)

Plate 3

*Dicranum ovale* Hedw., Sp. Musc.: 140(1801).

*Grimmia ovata*(Hedw.) Web. et Mohr., Nat. Reis. Schwed: 132(1804).

*Grimmia nigricans* Lam. Cand., Fl. France. 2: 459(1805).

*Trichostomum ovatum* (Hedw.) P. Beauv., Prodr.: 91(1805).

*Dicranum ovatum* (Hedw.) Sw. ex Brid., Sp. Musc., 1: 214(1806).

*Grimmia patens* Hornsch., Flora, 2 : 84(1819).

*Campylopus ovatus* (Hedw.) Brid., Mant. Musc.: 76(1819).

*C. ovalis* (hedw.) Wahlenb., Fl. Suec., 2: 748(1826).

*Grimmia commutata* Hueb., Musc. Germ., : 185(1833).

*G. neilgherriensis* C. Muell., (Corr.nilghirriensis Mitt. in Musc. Ind. Or.; 44, 1859) Bot. Zeit., 11: 62(1853).

*G. lurida* Wils., Kew J. Bot., 9:323(1857).

*G. neilgheerriensis* C. Muell., ex Kindb. Enum. Bryin. Exot.: 61(1888).

*G. hemipolia* Stirt., Ann. Scott. Nat. Hist., 11: 109(1902).

Dioecious. Plants simple, dark green to brown, growing in close tufts. Stem branched or unbranched, slender,  $\pm 1$ cm long. Leaves erect when dry, erecto-patent when moist, compact,  $\pm 3$ mm long and  $\pm 1$ mm broad, ovate, acute, concave, margins plane, leaves ending in transparent tip, arista covers  $1/4^{\text{th}}$  of total length, lower leaves lacking hyaline tip, perichaetial leaves erect, longer than normal leaves,  $\pm 4$ mm long, erect, ending into transparent tip; costa stout, percurrent,  $\pm 0.65 \mu$  broad at base; upper laminal cells  $\pm 13 \times 10 \mu$ , short, rounded-quadrate, median laminal cells  $\pm 20 \times 14 \mu$ , rounded, shorter, marginal cells  $\pm 42 \times 8 \mu$ , narrower, transparent, basal laminal cells near costa  $\pm 28 \times 7 \mu$ , rectangular. Seta erect, apical, brown,  $\pm 1.2$  cm long; capsule brown, smooth, erect,  $\pm 1$ mm long and  $\pm 0.5$ mm wide, apophysis indistinct; peristome single, teeth 16, smooth or papillose, orange to dark red, entire, often perforate or cleft above; operculum convex conic, rostrate; calyptra cucullate. Spores smooth, yellowish,  $\pm 12 \mu$  in diameter.

This species was found to occur on dry, exposed to partially shaded rocks of a hill and also growing on a tree.

**Specimen examined****Budgam:**Charari Sharief; They were attached to rock and growing on a tree; Feb 2014, PAN 6123.

Distribution:Western Himalayas, Kashmir, Central Asia, Western Tibet, South India, Ceylon China, Korea Japan, Europe, North Central South Africa, North Central South America and Australia.

**Chromosome number:** n=10**Campylopus fragilis** (Brid.) B.S.G., Bryol. Eur., 1:164(1847).**Plate 4**

Dioecious. Plants simple or branched, silky, yellow-green, growing in close tufts, whitish tomentose below. Stem erect, simple or dichotomously branched. Leaves erect when dry, erectopatent when moist, extending into a long canaliculate subula, margins inflexed except at base,  $\pm 8$  mm long,  $\pm 1$  mm broad, ovate-lanceolate, widest below, tapering at apex, apex serrulate; costa broad, covering two-third of leaf width, shortly excurrent, slightly serrate at tip, in transverse section showing very wide adaxial hyalocysts (easily recognizable in surface view of the costa), filling half of the width of the costa and abaxial substereids, slightly abaxially ridged; alar cells few, orange, distinct from costa, basal laminal cells  $\pm 60 \times 14 \mu$ , rectangular, yellow, thin-walled, hyaline, very distinctly differentiated from the distal thick-walled cells, upper laminal cells smaller,  $\pm 17 \times 8 \mu$ , rhomboid. Seta apical,  $\pm 1$  cm long, lightbrown; capsule  $\pm 0.8$  mm long and  $\pm 0.5$  mm wide, brown, elliptical, peristome teeth dicranate, papillose, calyptras cucullate. Spores, brown, warty,  $\pm 12 \mu$  in diameter.

Specialized fragile small branches (Serving as asexual reproductive units) facilitate easy determination and also spread of species. It is found in a few localities with lush green grasses.

**Specimen examined****Budgam:** Khansahib; Growing on moist soil; Sep 2014, PAN6125.

Distribution: Western Himalaya, Siberia, China, Africa and Europe.

Chromosome number: n= 12, 13

**KEY TO THE SPECIES OF GENUS OXYSTEGUS**

1. Leaves ovate.....*Oxystegus cylindricus* Leaves lanceolate to linear-lanceolate.....2
2. Leaves linear lanceolate, apex crenulated, basal laminal cells short,  $\pm 18.2 \times 11 \mu$ .....*Oxystegus khasianus* Leaves lanceolate to ligulate-lanceolate, basal laminal cells elongate,  $\pm 49 \times 12 \mu$  ..... *Oxystegus stenophyllus*

***Oxystegus cylindricus*** (Brid.) Hilp Beih. Bot. Centralbl., 50: (2) 620 (1933).**Plate 5***Oxystegus cylindricus* (Brid.) Hilp Beih. Bot. Centralbl., 50: (2) 620 (1933).*Weisia cylindrica* Bruch ex Brid. Bryol. Univ., 1: 806(1827).*Weisia tenuirostris* Hook. & Tayl. Musc. Brit. ed. 2: 83, Suppl. 3 (1827).*Didymodon tenuirostris* (Hook. & Tayl.) Wils in Hook.*Barbula longifolia* Griff. Cal. J. Nat. Hist., 2: 490(1842).*Didymodon longifolius* Griff. Cal. J. Nat. Hist., 2:510(1842).*Didymodon cylindricus* (Brid.) B. S.G. Bryol. Eur., 2: 139 (1846).*Didymodon calyptratus* Tayl. Lond. J. Bot., 7: 18(1848).*Trichostomum cylindricum* (Brid) C. Muell. syn., 1: 586(1849).*Tortula cylindrica* (Brid.) Mitt. Musc. Ind. Or.: 28(1859).*Tortula longifolia* (Griff.) Mitt. Musc. Ind. Or.: 28(1859).*Trichostomum tenuirostris* (Hook. & Tayl.) Lindb. Oefv. K. Vet. Ak. Foerh, 21: 225 (1864).*Mollia tenuirostris* (hook. & Tayl.) Lindb. Musci Scand., 21(1879).*Barbula leptotortuosa* C. Muell. N. Giorn. Bot. Ital. n.s., 5: 179(1898).*Barbula leptotortella* C Muell. Hedwigia, 38: 110(1899).*Trichostomum leptotortuosum* (C. Muell.) Broth. Nat. Pfl., 1(3): 394(1902).*Tortella cylindrica* (Brid) Loesk. Stud. Morph. Syst. Laubm.: 97(1910).*Trichostomum longifolium* (Griff.) Broth. Nat. Pfl., 1(3): 394(1902).*Oxystegus longifolius* (Griff.) Hilp. Beih. Bot. Centralb., 50(2): 667(1933).*Oxystegus leptotortella* (C. Muell.) Hilp. *ibid.* *Oxystegus leptotortuosum* (C. Muell.) Hilp. *ibid.*

Dioecious. Plants small to medium sized, yellowish green, growing in close tufts. Stem yellow, flexuose,  $\pm 3$  cm long. Leaves erect when dry, erectopatent when moist,  $\pm 4$  mm long and  $\pm 1$  mm wide, fragile, ovate, apex acute with short apiculus, margins flat, wavy at apex, smooth below, perichaetial leaves not differentiated;

costa brown, prominent, percurrent or excurrent; upper laminal cells rounded-quadrate,  $\pm 13 \times 10 \mu$ , incarassate, multipapillate, basal laminal cells rectangular, hyaline, thin walled,  $\pm 74 \times 12 \mu$ . Seta apical, yellowish, erect,  $\pm 1.2$  cm long; capsule  $\pm 3.5$  mm long and  $\pm 0.5$  mm wide, brown, cylindrical, straight; peristome teeth deep brown, usually not split, articulated, papillose; operculum rostellate, beaked. Spores pellucid, deep brown, finely papillose,  $\pm 11 \mu$  in diameter.

Plants were growing in mats. They were growing on moist soil and some were attached to wooden log near the water fall. For the first time, this species is reported from Kashmir. Earlier, it was reported from Western Himalaya (Tehri, Mussoorie, Chakrata and their surroundings) and Central India. This species is endemic to India.

#### Specimen examined

**Budgam:** Beerwah; Growing on moist soil and wood log; Feb 2013, **PAN 6126**.

**Distribution:** Western Himalaya (Tehri, Mussoorie, Chakrata and their surroundings), Kashmir, South India, Ceylon, Burma, Central Asia, China, Africa, Europe and America.

**Chromosome number**  $n=13, 13+m$

*Oxystegus khasianus* (Mitt.) Gangulee, Nova Hedwigia, 8: 149(1964).

**Plate 6**

*Tortula khasiana* Mitt. Musc. Ind. Or. 29(1859).

*Barbula khasiana* (Mitt.) Jaeg. Ber. S.Gall. Naturw. Ges. 1871-72: 415(1873).

*Trichostomum khasianum* (Mitt.) Broth. Nat. Pf., 1: 394(1902).

Dioecious. Plants small to medium sized, yellow brown, growing in lax, close tufts. Stem simple to branched, fragile,  $\pm 1$ cm long. Leaves spreading and curled when dry, erect when moist,  $\pm 3$ mm long and  $\pm 0.5$  mm broad, linear-lanceolate, canaliculate, concave base, apex acute, margins flat, crenulate; costa brown, prominent, covers one-third of leaf length, short excurrent; upper laminal cells short,  $\pm 8 \mu$  wide, chlorophyllose, rounded, highly papillose, basal laminal cells  $\pm 18.2 \times 11 \mu$ , rectangular, transparent.

Sporophyte not observed.

This species was found growing on moist soil near the water fall. The plants are were yellow to green in color and growing in mats. The present discovery is a new record for the area first time recorded from Kashmir. Earlier, it was reported from Eastern India (Khasia Hills). It is endemic in India.

#### Specimen examined

**Budgam:** Khansahib; Growing on moist soil; Feb 2013; **PAN 6127**.

**Distribution:** Eastern India (Khasia Hills).

**Chromosome number:**  $n=13$

*Oxystegus stenophyllus* (Mitt.) Gangulee, Nova Hedwigia, 12: 429(1966).

**Plate 7**

*Tortula stenophylla* Mitt. Musc. Ind. Or.: 28(1859).

*Barbula stenophylla* (Mitt.) Jaeg. Ber. S. Gall. Naturw. Ges., 1971-72: 415(1873).

*Trichostomum stenophyllum* (Mitt.) Broth. Nat. Pfl., 1: 394(1902).

Dioecious. Plants small to medium-sized, green, growing in close tufts. Stem erect, flexuose,  $\pm 1.5$ cm long. Leaves erect, narrowing to spreading, curled when dry,  $\pm 3$  mm long and  $\pm 0.5$ mm wide, concave, ovate, base sheathing, lanceolate, apex acute, margins flat, smooth and mildly serrate at apex; costa brown, percurrent; upper laminal cells comparatively smaller than basal laminal cells,  $\pm 17 \times 11 \mu$ , rectangular-rounded to quadrate, multipapillose, basal laminal cells  $\pm 49 \times 12 \mu$ , rectangular, smooth, hyaline, papillate; pericheatal leaves erect, longer than normal leaves,  $\pm 3.8$  mm long and  $\pm 0.5$ mm wide. Seta pale brown, apical, erect,  $\pm 1.5$  cm long; capsule erect,  $\pm 2.4$ mm long and  $\pm 0.4$ mm wide, slightly nodding, brown, erect; peristome teeth red-brown, irregularly divided, papillose, fragile; operculum conic rostrate, beaked. Spores yellow, pellucid,  $\pm 12 \mu$  in diameter.

Plants were growing on moist soil near the stream. Earlier it was not reported from the valley Kashmir. It is endemic in India.

#### Specimen examined

**Budgam:** Khansahib; Growing on moist soil; Feb 2013, **PAN 6128**.

**Distribution:** Western Himalayas and South India.

**Chromosome number:**  $n=13$

#### KEY TO THE SPECIES OF GENUS *HYOPHILA*

1. Leaf margins serrulate to denticulate in the upper portion only .....*Hyophila involuta* Leaf  
margins entire.....2
2. Leaves oblong to oblong-spathulate, leaf margins plane..... *Hyophila walkeri* Leaves  
spathulate, leaf margins inrolled.....3

3. Nerve percurrent, seta ±1mm long..... *Hyophila rosea* Nerve  
 excurrent, seta ±1.5cm long..... *Hyophila spathulata*  
***Hyophila involuta*** (Hook.) Jaeg., Natur. 1871-72: 356 (1873). **Plate 8**

*Gymnostomum involutum* Hook., Musc. Exot., 2: 154(1819).  
*G. tortula* Schwaegr., Sp. Musc. Suppl. 2:78, 175(1826).  
*G. cylindricum* Hook., Icon. Pl. Rar., 1:17(1836).  
*Barbula spathulata* Doz. & Molk., Ann. Sci. Nat. Bot. ser. 3, 2:300(1844).  
*Hyophila hookeri* Hamp., *ibid.* Ann. Sci. Nat. Bot. ser. 3, 2:300(1844)..  
*Pottia involuta* (Hook.) C.Muell., Syn., 1: 560(1849).  
*P. cylindrica* (Hook.) C.Muell., Syn., 1: 562(1849).  
*Desmatodon involutus* (Hook.) Mitt., Musc. Ind. Or.: 39(1959).  
*Pottia zollingeri* C. Muell., Bot. Zeit., 14: 419 (1856).  
*P. circinnata* C. Muell., Linn., 36:38(1869).  
*P. riparia* Aust., Musc. Appal., 112(1870).  
*Trichostomum bescherelli* Schimp., Besch, in Mem. Soc. Sc. Nat. Cherbourg, 16:477(1872).  
*Hyophila cylindrica* (Hook.) Jaeg., Ber. S. Gall. Naturw. Ges., 1871-72: 356(1873).  
*H. circinnata* (C. Muell.) Jaeg., Ber. S. Gall. Naturw. Ges., 1870-72: 357(1873).  
*H. bescherelli* (Schimp.) C.Muell., Flora, 58: 538(1875).  
*Trichostomum warnstorffii* Limpr., Laubm. Deutschl., 1:587(1888).  
*Leptodontium riparium* (Aust.) E. G. Britt., Bull. Torr.Bot. Club, 19:275(1892).  
*L. canadense* Kindb., Macoun. cat. Canad. Pl., 6:45(1892).  
*Hyophila micholitzii* Broth., Oefv. Finsk. Vet. Soc. Foerh., 35: 39(1893).  
*Didymodon riparias* (Aust.) Kindb., Eur. N. Am. Bryin., 2: 280(1897).  
*Hyophila stenocarpa* Ren. et Card., Bull. Soc. R. Bot. Belg., 38(1): 10(1900).  
*H. moutieri* Par. et Broth., Rev. Bryol., 28: 38(1901).  
*H. commutata* Broth., Nat. Pfl., 1(3): 403(1902).  
*H. riparia* (Aust.) Fleisch., Britt. Bryologist, 7:69(1904)  
*H. warnstorffii* (Limpr.) Fleisch., Musc. Fl. Buitenz., 1:330(1904).  
*H. dozy-molkenboeri* Fleisch., *ibid* p. 328.  
*H. tsunodae* Broth. ex Yas., Bot. Mag. Tokyo, 29:151(1915).  
*H. attenuata* Broth., Symb. Sin., 4: 37(1929).  
*H. subcylindrica* Broth., Bruehl, Rec. Bot. Surv. Ind., 13(1): 126(1931).  
*H. sinensi* Dix., Yang: Sc. Rep. Nat. Tsing Hua Univ. B. Biol., 2:117(1936).

Dioecious. Plants dark green, growing dense tufts on calcareous walls, small in size. Stem erect, ±1cm long, simple or branched, stem covered by red rhizoids, stem densely crowded at apex of stem. Leaves ±3mm long, ±1mm wide, erect when moist, curled circinately when dry, oblong-lingulate, carinate, the lower oblong part pale, apex broadly pointed, leaf rolled when dry, flat, wavy when moist, upper margins serrulate to denticulate; costa deep red-brown, plano-concave, percurrent, broader at base, perichaetial cells not much differentiated; upper laminal cells chlorophyllose, mamilllose, rounded-quadrate, ±8µ in diameter, basal laminal cells ±50× 20µ, rectangular, smooth, becoming smaller above. Seta apical, erect, red-brown, paler above, ±1 cm long; capsule cylindrical, ±0.7mm long and ±0.5mm broad, brown, erect or slightly curved, annulus of very thick-walled lenticular cells; peristome absent; operculum conical, rostrate; calyptra cucullate. Spores small, pellucid, finely papillose, ±10µ in diameter.

#### Specimen examined

**Budgam:** Budgam; Growing on moist soil on calcareous wall; Mar 2014, PAN 6129.

**Distribution:** Central India (Madhya Pradesh, Orissa) North-East India (Assam, Arunachal Pradesh, Bengal, Bihar, Darjeeling, Western Himalaya, Khasi hills), Kerala, Karnataka, Tamil Nadu, Gujarat, Sri Lanka, Nepal, China, Japan, Java, Korea, Philippines, Sumatra, Taiwan, New Guinea, Europe South and America.

**Chromosome number:** n = 7, 13, 13+m

***Hyophila rosea*** Williams, Bull. N. Y. Bot. Gard., 8: 341 (1914). **Plate 9**

Dioecious. Plants very small, green, growing densely. Stem simple, erect. Leaves crispate when dry, erect when moist, ±3mm long and ±0.65mm wide, leaves form rosette tufts, spathulate, carinate, apex acuminate, margins involute; costa brown, rough with papillae, percurrent, broader at base ±70µ wide; upper laminal cells chlorophyllose, multipapillose, hexagonal-rounded, ±9µ wide, basal laminal cells ±40× 20µ, rectangular, marginal laminal cells smaller, ±5µ in diameter, rounded. Perichaetial leaves not differentiated.

Seta apical, erect, light brown to yellow-green; capsule erect, brown, cylindrical,  $\pm 2.5$ mm long and  $\pm 0.3$ mm wide, peristome absent; operculum beaked. Spores small, pellucid, light brown,  $\pm 9\mu$  in diameter.

Plants were very small, growing in rosette form. The species is the first record from the area.

#### Specimen examined

**Budgam:** Budgam; Growing on a moist wall; Mar 2014, PAN 6130.

**Distribution:** North-Western Himalayas and South India.

**Chromosome number:** n=13

*Hyophila spathulata* (Harv.) Jaeg., Ber. S. Gall. Naturw. Ges., 1817-72: 353(1873).

Plate 10

*Gymnostomum spathulatum* Harv., Hook. Icon. Pl. Rar., 1: 17(1836).

*Pottia spathulata* (Harv.) C.Muell., Syn., 1: 559(1849).

*Desmatodon spathulatus* (Harv.) Mitt., Trans.Linn. Soc. Lond. Bot. Ser. 2, 3:160(1891).

Dioecious. Plants small to medium-sized, green to yellow, growing in close tufts. Stem erect,  $\pm 5$ mm long. Leaves erectopatent when moist, curled when dry,  $\pm 2.5$ mm long and  $\pm 0.5$  mm wide, spathulate, carinate, broad at the upper part, apex acute and pointed, margins inrolled, entire; costa prominent, red-brown, excurrent; upper laminal cells  $\pm 11\mu$  wide, chlorophyllose, thin walled, rounded-quadrate; basal leaf cells  $\pm 50 \times 11\mu$ , rectangular, thin walled, transparent; perichaetial leaves not differentiated. Seta apical, reddish brown,  $\pm 1.5$ cm long; capsule  $\pm 2$ mm long and  $\pm 0.4$ mm broad, cylindrical, tapering towards tip, peristome absent; operculum conical; calyptra cucullate. Spores brown, pellucid, spherical,  $\pm 10\mu$  in diameter.

#### Specimen examined

**Budgam:** Budgam; Growing on a moist wall and Wood log; Feb 2014,

PAN 6132.

**Distribution:** Western Himalayas, South India, Ceylon, China and Japan.

**Chromosome number:** n=13

*Hyophila walkeri* Broth., Rec. Bot. Surv. Ind., 1:317 (1899).

Plate 11

Dioecious. Plants very minute, growing very closely, yellow-green, growing on wooden logs, mostly on tree trunks. Stem  $\pm 1$ cm long, unbranched, green, with rosette of leaves, radiculose below. Leaves erect to erectopatent when moist, curled circinately when dry,  $\pm 2.5$ mm long,  $\pm 0.5$  mm wide, concave, oblong to oblong-spathulate, apex obtuse, margins smooth; costa prominent, brown, percurrent, smooth, broader at base,  $\pm 70\mu$  wide; upper laminal cells  $\pm 10\mu$  wide, chlorophyllose, irregularly quadrate to rounded, papillose, basal laminal cells rectangular  $\pm 40 \times 15\mu$ , hyaline, cover more than half of the length of leaf. Seta apical, erect, brown,  $\pm 4$ mm long; capsule erect, cylindrical, brown,  $\pm 1$ cm long and  $\pm 0.5$  mm broad; peristome absent; operculum conic-rostrate. Spores brown, smooth, spherical  $\pm 17\mu$  in diameter.

The minute plants were growing in patches on wood. Earlier, this species was reported from Central India. The present record from the area extends its range of distribution.

#### Specimen examined

**Budgam:** Budgam; Growing on a moist wall; Mar 2014, PAN 6131.

**Distribution:** Central India (Madhya Pradesh), Kashmir.

**Chromosome number:** Not known so far.

#### KEY TO THE SPECIES OF GENUS *BARBULA*

- |  |                            |  |                           |
|--|----------------------------|--|---------------------------|
| 1. Leaf margins crenulated .....                 | 2                          | Leaf margins smooth.....                         | 3                         |
| 2. Plants very long (9cm), costa percurrent..... | <i>Barbula asperifolia</i> | Plants short ( $\pm 2$ cm), costa excurrent..... | <i>Barbula constricta</i> |
| 3. Margins recurved through leaf length.....     | <i>Barbula vinealis</i>    | Margins not recurved.....                        | 4                         |
| 4. Seta $\pm 1.9$ cm long, .....                 | <i>Barbula cylindrica</i>  | Seta $\pm 7$ mm long long.....                   | <i>Barbula nigrescens</i> |

*Barbula asperifolia* Mitt., Musc. Ind. Or. 34(1859)

Plate 12

*Didymodon rufus* Lor. ex Rabenh., Bryoth. Eur. 13. 13:n. 621(1863).

*Tortula rufa* (Lor.) Braithw., J. Bot. 9:293(1871).

*Barbula rufa* (Lor.) Jur., Laubm. Fl. Oest. Ungarn. :113 (1882).

Dioecious. Plants robust, reddish green to brown-green, growing in close tufts. Stem branched, erect,  $\pm 9$ cm long. Leaves appressed to stem when dry, erecto-patent when moist, flexouse tip,  $\pm 2.5$ mm long and  $\pm 0.5$ mm broad, lanceolate to oblong, concave, non-decurrent, apex acute, margins crenulate, unbordered; costa

strong, prominent, red-brown, percurrent, papillose,  $\pm 70\mu$  broad at base; laminal cells unistratose, incrassate, upper laminal cells quadrate to hexagonal,  $\pm 11\mu$  diameter, highly papillose, median laminal cells quadrate to sub-rectangular; basal laminal cells rectangular-elongate,  $\pm 28 \times 11\mu$ , smooth, incrassate; alar cells absent; perichaetial bracts longer than stem leaves,  $\pm 3\text{mm}$  long and  $\pm 1\text{mm}$  broad.

Sporophyte not observed.

The plants were found growing in very close tufts, appearing like green balls on the soil. In the field, it look like *Grimmia*.

#### Specimen examined

**Budgam:** Budgam, Khansahib; Growing on a moist soil; Feb 2013, PAN 6133.

**Distribution:** Eastern India, Nepal, Iran, Caucasus, Turkey, China, Europe, N. Africa, Canada (British Columbia), U.S.A.

**Chromosome number:** Not known so far.

*Barbula constricta* Mitt., Musci Ind. Or.: 33(1859).

#### Plate 13

*Barbula schensiana* C. Muell., var. *longifolia* C. Muell., N. Giorn. Bot. Ital. n.s., 3:101(1896).

*Barbula altipes* C. Muell., *ibid*, 4:254(1897).

*Barbula magnifolia* C. Muell., *ibid*, 4:(1897).

Dioecious. Plants yellow-green to brownish, growing in close tufts. Stem brown, elongated, slender, branched,  $\pm 2\text{ cm}$  long. Leaves  $\pm 2.3\text{ mm}$  long and  $\pm 0.5\text{ mm}$  broad, erect, ovate-lanceolate, carinate, flexuose, crumpled when dry, margins recurved 2/3 of leaf at base, entire; costa prominent, brown, smooth on back, excurrent; upper laminal cells  $\pm 10\mu$ , irregularly quadrate, papillose, low papillae, basal laminal cells  $\pm 31 \times 9\mu$ , hyaline, rectangular; perichaetial leaves erect, longer than stem leaves,  $\pm 2.8\text{ mm}$  long and  $\pm 0.9\text{ mm}$  broad. Seta erect, slender, apical,  $\pm 1.6\text{ cm}$  long; capsule erect, brown, ellipitico-cylindrical,  $\pm 2.5\text{ mm}$  long,  $\pm 0.7\text{ mm}$  broad; peristome teeth filiform, papillose, spirally wound, brown; operculum brown, conic-rostrate. Spores spherical, yellow to brownish,  $\pm 10\mu$  in diameter, smooth.

#### Specimen examined

**Budgam:** Budgam, Charari Sharief; Growing on moist soil; Mar 2014, PAN 6134.

**Distribution:** India, China, Nepal, Pakistan, Myanmar, Indonesia, Philippines, Japan.

**Chromosome number:**  $n=7$

*Barbula cylindrica* (Tayl.) Schimp., var. *vinealis* (Brid) Lindb., Musci. Scand.: 32 (1879).

#### Plate 14

*Barbula schensiana* C. Muell., N. Giorn. Bot. Ital. n.s., 3:101(1896).

*Barbula ellipsithecica* C. Muell., *ibid*, 4: 258(1897).

*Barbula viridescens* Stirt. Ann. Scott. Nat. Hist., 58: 110(1906).

Dioecious. Plants mostly branched, olive-green, growing in close tufts. Stem erect, slender,  $\pm 3\text{ cm}$  long. Leaves erect when moist, erectopate to mildly crispate when dry, lanceolate,  $\pm 3\text{ mm}$  long,  $0.5\text{ mm}$  wide, apex acute, margins smooth, leaves crowded towards apex; costa light brown, wider at base,  $\pm 90\mu$ , percurrent or vanishing in tip; upper laminal cells chlorophyllose, irregularly quadrate,  $\pm 28 \times 11\mu$ , papillose and obscure, densely papillose towards the margin and also towards the upper lamina, marginal laminal cells  $\pm 60\mu$ , small, quadrate, basal laminal cells  $\pm 30 \times 12\mu$ , rectangular, papillose; perichaetial leaves erect, longer than stem leaves,  $\pm 3.6\text{ mm}$  long,  $0.5\text{ mm}$  wide. Seta apical, brown, usually curved,  $\pm 1.9\text{ cm}$  long; capsule  $\pm 3.8\text{ mm}$  long,  $\pm 0.7\text{ mm}$  broad, chestnut, brown, smooth, elliptico-cylindrical; peristome teeth brown, filiform, papillose and nodulose, twisted; operculum conical. Spores light brown, smooth, pellucid,  $\pm 12\mu$  in diameter.

This species was found growing on trunk of the *Platanus orientalis* in association of preceding species.

#### Specimen examined

**Budgam:** Budgam, Charari Sharief, Beerwah; Hanging from tree trunk; Mar 2014, PAN 6136.

**Distribution:** India, Nepal, China, Russia, Europe, and North America, Algeria.

**Chromosome number:**  $n = 13$

*Barbula nigrescens* Mitt., Musci Ind. Or. 36(1859).

#### Plate 15

Dioecious. Plants yellow-green, growing in close tufts, often branched. Stem  $2\text{ cm}$  long, dark brown, covered with erectopate leaves, laxer near base. Leaves erect when moist, erectopate when dry, closely appressed to the stem when dry, orange brown,  $\pm 1.7\text{ cm}$  long and  $\pm 0.9\text{ mm}$  wide, lanceolate, concave, sheathing at base, apex acute, margins smooth, reflexed from base to near tip; costa prominent, dark-red, vanishing below the tip; upper laminal cells  $\pm 25 \times 8\mu$ , thin walled, smooth, rectangular, basal laminal cells thin walled  $\pm 40 \times 10\mu$ , smooth, rectangular, laminal cells highly papillose; perichaetial leaves longer than normal leaves,  $\pm 2.3\text{ cm}$  long and  $\pm 1\text{ mm}$  wide. Seta orange-brown,  $\pm 7\text{ mm}$  long; capsule  $\pm 2.2\text{ mm}$  long,  $\pm 0.7\text{ mm}$  broad, erect,

reddish brown; peristome teeth filiform; operculum conic-rostrate. Spores pellucid, smooth,  $\pm 10 \mu$  in diameter.

Plants were found along the bank of stream. The substratum was sandy, often flooded by stream water.

#### Specimen examined

**Budgam:** Budgam, Charari Sharief, Chadoora; Growing on moist soil; Feb 2013, PAN 6137.

**Distribution:** Eastern and Western Himalayas, China and North America.

**Chromosome number:** Not known so far.

*Barbula vinealis* Brid, Bryol. 1: 830(1827).

**Plate 16**

*Barbula fallax* Hedw. var. *vinealis* (Brid.) Hueb., Musci. Germ.: 327(1833).

*Tortula fallax* (Hedw.) Schrad. var. *vinealis* (Brid) de Not., Mem. Acad. Torin., 40: 319 (1838).

*Tortula vinealis* (Brid) Spr., Lond. J. Bot., 4: 194(1845).

*Barbula artocarpa* Lesq., Trans. Am. Phil. Soc. n.s., 13:4(1865)

*Barbula cylindrica* (Tayl.) Schimp. s.sp. *vinealis* (Brid.) Dix., Stud. Handb. Brit. Moss.: 197(1869).

Dioecious. Plants dark green, branched, growing in close tufts. Stem erect, elongated, slender,  $\pm 3$  cm long. Leaves flexuose when dry, erect when moist,  $\pm 3$  mm long and  $\pm 0.5$  mm broad, lanceolate, carinate, apex acute, concave base, margins smooth, recurved throughout the length of leaf; costa light brown, stout, wider at base,  $90 \mu$ , percurrent; upper laminal cells  $\pm 11 \mu$  in diameter, chlorophyllose, quadrate, densely papillose, marginal cells shorter,  $\pm 7 \mu$ , basal laminal cells  $\pm 35 \times 11 \mu$ , rectangular, papillose; perichaetial leaves erect, longer than stem leaves,  $\pm 3.8$  mm long and  $\pm 0.7$  mm broad. Seta apical,  $\pm 1.5$  cm long, brown, curved; capsule chestnut, brown, smooth, elliptico-cylindrical,  $\pm 3.5$  mm long,  $\pm 0.7$  mm broad; peristome teeth brown, filiform, papillose nodulose; operculum conical. Spores light brown, pellucid, smooth,  $\pm 11 \mu$  in diameter.

Found on trunk of the *Platanus orientalis*.

#### Specimen examined

**Budgam:** Budgam, Khansahib; Hanging from tree trunk; Mar 2014, PAN 6135.

**Distribution:** India, China, Nepal, Russia, Europe and North America Algeria.

Cosmopolitan species.

**Chromosome number:**  $n=11$

#### KEY TO THE SPECIES OF GENUS SEMIBARBULA

1. Leaf apex acuminate, Spores upto  $11 \mu$  in diameter ..... *Semibarbula orientalis* Leaf apex  
blunt, Spores upto  $25 \mu$  in diameter ..... *Semibarbula ranuii*

*Semibarbula orientalis* (Weber) Wijk. & Marg., Taxon, 8: 75(1959).

**Plate 17**

*Trichostomum orientale* (Web. Arch. Syst. Nat., 1:129(1804).

*Dicranum orientale* (Web.) Mohr., Ann. Bot., 2: 546(1806).

*Trichostomum indicum* Schwaegr., Sp. Musc. Suppl.1(1):142 (1811).

*Tortula indica* Hook., M. Exot., 2: 135(1819).

*Barbula indica* (Hook.) Spreng., Steud. Nomencl. Bot., 2: 72(1824).

*Barbula orientalis* (Web.) Broth., Nat. Pfl., 1: 409(1902).

*Anoetangium nossibeum* Besch. Card. in Hist. Madag., 39: 215(1915).

*Semibarbula indica* (Hook.) Herz. ex Hilp., Bot Centralbl., 50(2):626(1933).

Dioecious. Plants yellow-green, growing in close tufts. Stem brown, unbranched,  $\pm 2$  cm long. Leaves lax, erectopatent when moist, curled when dry,  $\pm 1.5$  mm long and  $\pm 0.32$  mm broad, oblong to ovate, carinate, apex acuminate, margins flat; costa strong, light greenish yellow, percurrent or short excurrent,  $\pm 47 \mu$  wide; upper laminal cells chlorophyllose, multipapillose, obscure rounded, quadrate to quadrate-hexagonal,  $\pm 8 \mu$ , basal laminal cells large,  $\pm 42 \times 8 \mu$ , rectangular, hyaline; perichaetial leaves not differentiated. Seta apical, reddish,  $\pm 7$  mm long; capsule apical,  $\pm 1.7$  mm long and  $\pm 0.5$  mm in diameter, yellow-brown, pellucid; peristome teeth split into 32 short filamentous segments; operculum conic; calyptra cucullate. Spores spherical, smooth, brown,  $\pm 11 \mu$  in diameter.

Plants were found growing on moist and black soil near the bank of stream.

#### Specimen examined

**Budgam:** Charari Sharief; Growing on moist soil; Mar 2015, PAN 6138.

**Distribution:** South India (Kerala), North-East India (Darjeeling, Arunachal Pradesh, Bengal, Orissa), Pakistan, Sri Lanka, China, Nepal, New Guinea, Celebes, Taiwan, Madagascar, Malaysia, Siam and Central and Southern Africa.

**Chromosome number:**  $n=16$



*Semibarbula ranuii* Gangulee, Nova Hedwigia, 8:149(1964).

**Plate 18**

Dioecious, green, growing in close tufts; Stem brown, unbranched  $\pm 2$ cm long. Leaves erect when moist, erectopatent when dry, oblong-lanceolate,  $\pm 2$ mm long and  $\pm 0.4$  mm wide, carinate, apex blunt, margins usually flat; costa prominent,  $\pm 47\mu$  broad, excurrent; hyaline, papillose; upper laminal cells chlorophyllose, multipapillose, rounded-quadrate to rounded-hexagonal  $\pm 5-8\mu$ , basal laminal cells large, rectangular,  $\pm 42 \times 13\mu$ , hyaline with thin walls; perichaetial leaves not differentiated. Seta apical, yellow brown, erect,  $\pm 7$  mm long; capsule brown, erect, cylindrical,  $\pm 1.7$ mm long and  $\pm 0.5$  mm in diameter, exothelial cells thin-walled, irregularly hexagonal; peristome teeth split into 32 brown filiform teeth. Spores spherical, brown,  $\pm 25\mu$  in diameter, smooth.

The plants were growing near water spring. The soil was moist. Plants were growing in close tufts.

**Specimen examined**

**Budgam:** Beerwah; Growing on moist soil; Mar 2015, PAN 6139.

**Distribution:** Kashmir, Punjab, Rajasthan plains and Gangetic plains.

**Chromosome number:** Not known so far.

**KEY TO THE SPECIES OF GENUS HYDROGONIUM**

1. Leaves lanceolate, leaf apex rounded, upper laminal cells densely papillose.....

..... *Hydrogonium consanguineum*

Leaves ovate-oblong, leaf apex acute, upper laminal cells not papillose or scarcely so.....

..... *Hydrogonium gracilentum*

*Hydrogonium consanguineum* (Thw. et Mitt.) Hilp., Beih. Bot. Centrabl., 50(2): 626 (1933).

**Plate 19**

*Tortula consanguinea* Thw. et Mitt., J. Linn. Soc., 13: 300(1873).

*Barbula consanguinea* (Thw. et Mitt.) Jaeg., Ber. S. Gall. Naturw. Ges., 1877-78:409(1880).

*Barbula eroso-cuspis* C. Muell., Fleisch in Musci Fl. Buitenz., 1;308(1904).

Dioecious. Plants yellow green, slender, growing in dense tufts. Stem erect, yellow,  $\pm 2$  cm long, whole stem covered by erectopatent leaves, lower part of stem is covered by radicles. Leaves curled, carinate, lanceolate,  $\pm 2$  mm long and  $\pm 0.5$ mm wide, concave base, leaf apex rounded, mucronate, margins flat; costa prominent, covers one third of leaf length, pale yellow-brown, rough, excurrent; upper laminal cells  $\pm 6-8\mu$  in diameter, chlorophyllose, quadrate-hexagonal, densely multipapillose, basal laminal cells hyaline,  $\pm 42 \times 10\mu$ , pale walls, elongated rectangular; perichaetial leaves not differentiated. Seta apical, slender, erect,  $\pm 1.5$  cm long; capsule red-brown,  $\pm 1.5$ mm long and  $\pm 0.4$  mm in diameter, erect, ovate-cylindrical; peristome teeth red brown, filiform, papillose, twisted spirally; operculum conical, cucullate. Spores spherical, light greenish,  $\pm 14\mu$  in diameter.

This taxon was found growing near the bank of stream. Male plant were smaller, antheridia, orange, stalked, axillary, club shaped, filamentous paraphyses; female plants unbranched, larger than the male plant. Multicellular gemmae was a characteristic feature.

**Specimen examined**

**Budgam:** Beerwah; Growing on sandy soil near stream; Mar 2015, PAN 6140.

**Distribution:** Western Himalaya, Upper Gangetic Plains, West-Central-South India, Ceylon, Burma, Thailand, Vietnam, Malay, Singapur, Java, New Guinea, Philippines, Taiwan and China.

**Chromosome number:** n=13

*Hydrogonium gracilentum* (Mitt) Chen Hedw., 80: 237(1941).

**Plate 20**

*Barbula gracilenta* Mitt., Musc. Ind. Or.: (1859).

*Desmatodon latifolius* (Hedw.) Brid., Mant. Musc.: 86 (1819).

*Dicranum latifolium* Hedw., Sp. Musc.: 140(1801).

*Swarzia pilifera* Brid., J. Bot. 1800(2): 289(1801).

*Bryum piliferum* Dicks., Pl. Crypt. Brit., 4:10 (1801).

*Trichostomum piliferum* (Brid.) Sm., Fl. Brit., 3: 1245(1804) as var.

*Dicranum lanceolatum* Schleich., Brid., Mant. Musc.: 86(1819) nom. nud. synonym.

*Didymodon pilifer* Wahlenb., Fl. Suec., 2:755(1826) as var.

*D. apiculatus* Arnott., Mem. Soc. Linn. Paris, 5: 264(1827).

*Trichostomum hoppeanum* Schultz., Syll., 2 : 140(1828).

*Tortula latifolia* (Hedw.) Lindb., M. Scand.: 20 (1879).

*Barbula latifolia* (Hedw.) Kindb., Eur. N. Am. Bryin., 2: 252(1897).

Dioecious. Plants yellow-green, small plant, growing in close tufts. Stem unbranched,  $\pm 2$  cm long, erect, yellow. Leaves stiff,  $\pm 2.5$  mm long, erect when moist, erecto-patent when dry, ovate-oblong, concave, carinate, apex acute, denticulated at apex; costa excurrent modified into long awn, brown; upper laminal cells  $\pm 9\mu$  in diameter, chlorophyllose, hexagonal, multipapillose, papillae horse-shoe-shaped to ring-shaped papillae; basal laminal cells  $\pm 49 \times 13\mu$ , rectangular, hyaline, papillose. Seta apical, erect, brown, slender,  $\pm 1.5$  cm long; capsule apical,  $\pm 2$  mm long and  $\pm 0.5$  mm in diameter, erect, brown, cylindrical; peristome teeth brown, 32 in number; operculum conic-rostrate. Spores smooth, pellucid,  $\pm 11 \mu$  in diameter .

They were growing near the bank of stream. The soil was moist and sandy. They were yellow to green in color.

This species is exclusively found in North Western Himalaya and is endemic to this area.

#### Specimen examined

**Budgam:** Beerwah; Growing on sandy soil near stream; Mar 2015, PAN 6141.

**Distribution:** Western Himalaya and Kashmir.

**Chromosome number:**  $n=15 (14+m)$

#### KEY TO THE SPECIES OF GENUS *DESMATODON*

1. Leaf ovate-oblong, apex blunt, Gemmiferous..... *Desmatodon gemmascens* Leaf cucullate, apex acute, Not gemmiferous..... *Desmatodon latifolius*

*Desmatodon gemmascens* Chen, Hedwigia, 80: 297(1941).

Plate 21

*Didymodon gemmascens* Broth., Symb. Sin., 4: 48(1929).

*Didymodon (Erythrophyllum) saxicola* Broth. n. sp. in Herb.

*Desmatodon latifolius* (Hedw.) Brid., Mant. Musc.: 86 (1819).

*Dicranum latifolium* Hedw., Sp. Musc.: 140(1801).

*Swarzia pilifera* Brid., J. Bot. 1800(2): 289(1801).

*Bryum piliferum* Dicks., Pl. Crypt. Brit., 4: 10(1801).

*Trichostomum piliferum* (Brid.) Sm., Fl. Brit., 3: 1245(1804).

*T. latifolium* (Hedw.) Schwaegr., Sp. Musc. Suppl., 1(1): 145(1811).

*Dicranum lanceolatum* Schleich, Brid. Mant. Musc. 86(1819).

*Didymodon pilifer* Wahlenb. var. *spathulatus* Wahlenb., Fl. Suec., 2: 775(1826).

*D. apiculatus* Arnott. Mem. Soc. Linn. Paris. 5, :264(1827).

*Trichostomum hoppeanum* Shultz., Syll., 2: 140(1828).

*Tortula latifolia* (Hedw.) Lindb., M. Scand.: 20(1879).

*Barbula latifolia* (Hedw.) Kindb., Eur. N. Am. Bryin., 2: 252: (1897).

Dioecious. Gemmiferous, Plants yellow-green to reddish-green, small, growing in close tufts, branched at tip. Stem erect,  $\pm 1.5$  cm long, tomentum all over the stem. Leaves erect to erecto-patent when moist, crumpled and curled when dry,  $\pm 3$  mm long and  $\pm 0.6$  mm broad, ovate-oblong, concave, carinate, upper leaves long, base rectangular, apex blunt, margins smooth; costa excurrent, brown; upper laminal cells chlorophyllose, hexagonal  $\pm 15\mu$ , multipapillose, papillae horse-shoe shaped to ring-shaped, basal laminal cells rectangular,  $\pm 90 \times 20\mu$ , hyaline, papillose. Seta apical,  $\pm 1.5$  cm long, erect, brown; capsule  $\pm 1.5$  mm long and  $\pm 0.6$  mm broad, apical, erect, brown, cylindrical; operculum conic-rostrate, peristome teeth erect, lanceolate, with a low basal membrane, usually divided 2-3 times. Spores large, rounded, yellow or reddish brown, papillose,  $\pm 12 \mu$  in diameter.

Plants were very small and found growing on a piece of rock near the bank of the stream.

#### Specimen examined

**Budgam:** Budgam; Growing near bank of the stream; Feb 2013, PAN 6142.

**Distribution:** Western Himalaya and China. It is an Indo-Chinese species.

**Chromosome number:** Not known so far.

*Desmatodon latifolius* (Hedw.) Brid., Mant. Musc.: 86 (1819).

Plate 22

Dioecious. Non-gemmiferous, Plants yellow green, growing in close tufts, small. Stem very small, about  $\pm 3$  mm long, erect, often branched. Leaves erect when moist, erecto-patent when dry,  $\pm 1.7$  mm long, carinate, ligulate, cucullate, upper leaves longer, base rectangular, apex acute, margins involute; costa brown, broad at base,  $\pm 80\mu$ , excurrent; upper laminal cells  $\pm 9\mu$  in diameter, chlorophyllose, quadrate-hexagonal, densely papillose, basal laminal cells  $\pm 150 \times 20\mu$ , rectangular, thin walled, densely multipapillose with horseshoe or ring-shaped papillae, papillae obscure. Seta apical,  $\pm 1.4$  cm long, erect, brown; capsule apical,  $\pm 1.8$  mm long and  $\pm 0.5$  mm broad, erect, brown, cylindrical; peristome teeth brown, split into two papillose cures; operculum conic-rostrate, beak usually bend to one side. Spores yellow, papillose,  $\pm 11 \mu$  in diameter.

Plants were very small, found growing on a piece of rock along the bank of the stream.

### Specimen examined

**Budgam:** Budgam; Growing near bank of the stream; Feb 2013, PAN 6143.

**Distribution:** Western Himalaya (Garhwal, Kulu, Lahul) Kashmir, Caucasus, Central Asia, Altai, Kamchatka, China, Europe, North Africa and North America.

**Chromosome number:** n=26, 28

*Syntrichia princeps* (De Not.) Mitt., Musc. Ind.Or. :39(1859).

**Plate 23**

*Tortula princeps* DeNot. Mem. R. Acc. Sc.Torino, 40: 288(1838).

*Barbula princeps*(De Not.) C. Muell Syn., 1:636(1849).

*B. muelleri* B.S.G. Bryol. Eur., 2: 106(1849).

*Tortula muelleri* Hook. F. et Wils Fl. Antarct., 1: 103(1847).

Monoecious. Plants green to yellow, growing on rocks. Stem sturdy, green, dichotomously branched,  $\pm$  4cm long. Leaves erectopatient when moist, flexuous and appressed to stem when dry, oblong, elliptic, apex rounded, obtuse, slightly emarginated margins, margins revolute in the two-third of leaf; costa strong, brown,  $\pm$ 130  $\mu$  wide at base, excurrent, spinose, awn transparent; upper laminal cells  $\pm$ 15 $\mu$  wide, chlorophyllose, flattened, multipapillose, papillae +horse-shoe shaped, round, collenchymatous, marginal laminal cells  $\pm$ 130 $\times$ 11 $\mu$ , papillose, border cells rectangular, basal laminal cells  $\pm$ 140 $\times$ 15 $\mu$ , transparent, smooth, rectangular; perichaetial leaves not differentiated. Seta apical, erect,  $\pm$ 1.5cm long; capsule curved,  $\pm$ 5.6mm long, and  $\pm$  0.7mm in diameter, golden brown; peristome brown, papillose, spirally twisted; operculum conic-rostrate, brown. Spores brown, pellucid,  $\pm$ 10  $\mu$  in diameter.

Medium-sized, green to brown, plants growing on a piece of rock. The plants that were in direct influence of sunlight were red. The transparent awn and reddish tinge of the plants help easy recognition of this species.

### Specimen examined

**Budgam:** Budgam; Attached to the rock; Feb 2013, PAN 6144.

**Distribution:** Western Himalaya, Caucasus, Central Asia (Tajikistan), Australia, New Zealand, Europe, North Africa, N. C. & S. America and Oceania.

**Chromosome number:** n=12, 24+m, 28, 36+2m

### Discussion

Haplolepidous mosses are distributed among three families Pottiaceae, Dicranaceae and Grimmiaceae. Family Pottiaceae has evolved ecologically to exploit diverse habitats. The short and thickened leaf cells increase the surface area for water absorption and increased photosynthetic activity, the dense papillae in the cells check loss of water and provide protection from high insulation, the densely clothed stems and hair pointed leaves help in water conservation. All these features, singly or in combination found in the Pottiaceae and Grimmaceae, confer adaptive advantage to these families for colonization in exposed habitats.

It seems that the families, Pottiaceae and Grimmaceae, both haplolepidous, have evolved ecologically to exploit diverse habitats.



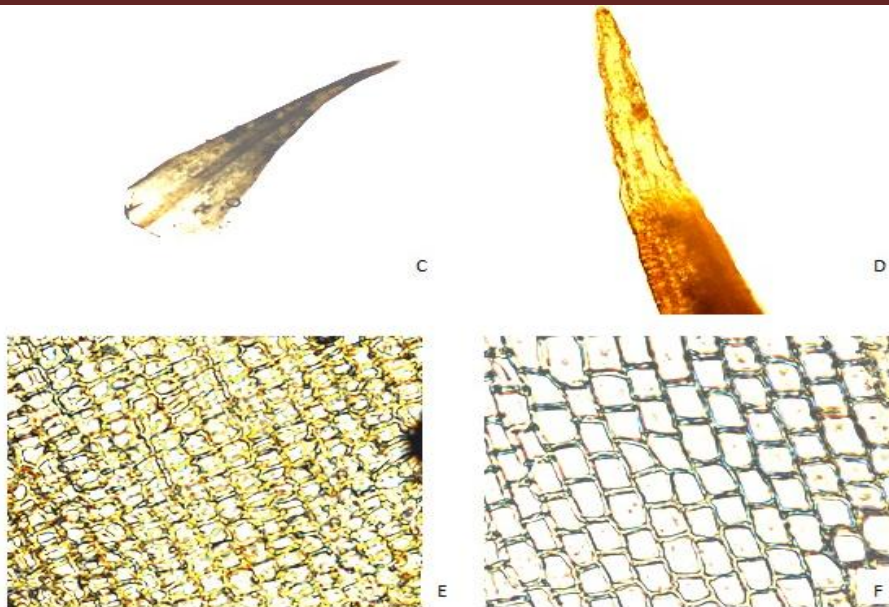
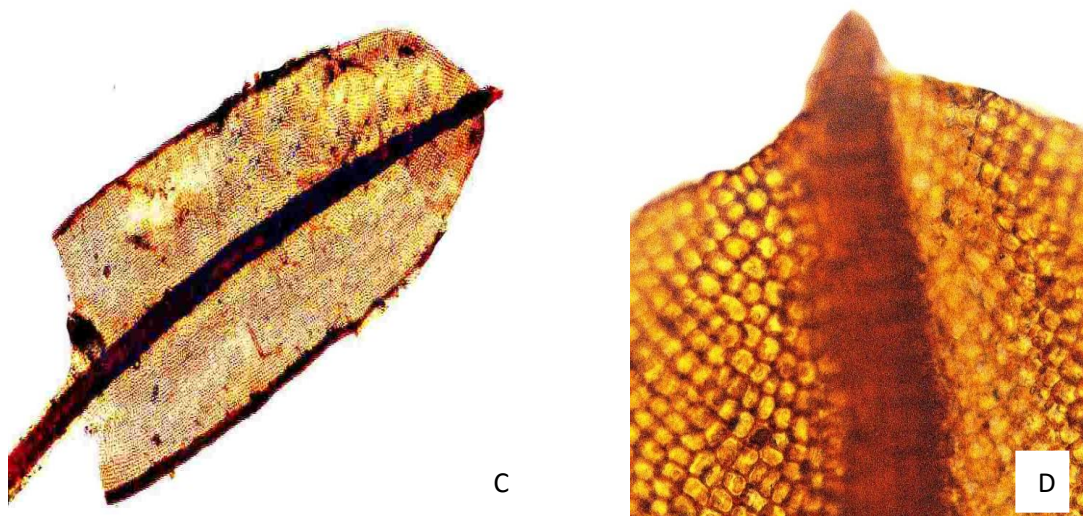
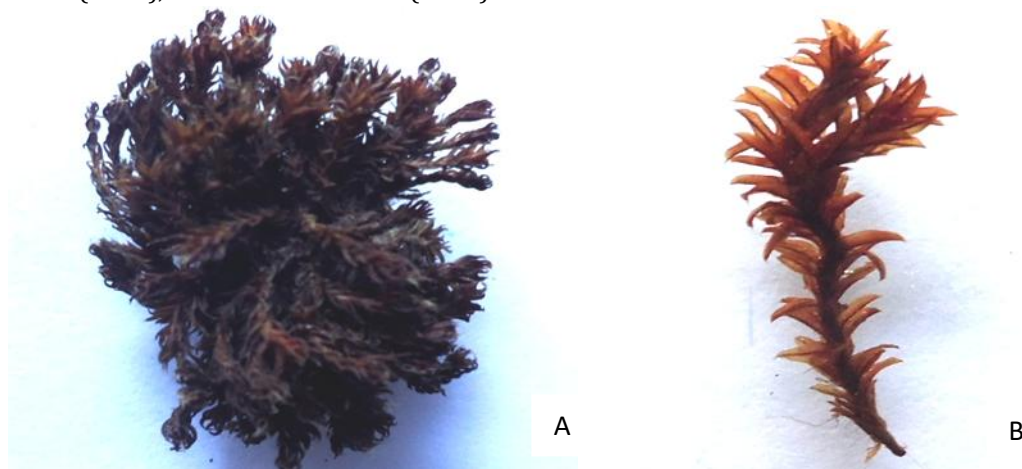


Plate 1: *Schistidium apocarpum* (Hedw.) B.S.G. ssp. *gracile* (Roehl.) Meyl. Bull. Soc. Vaud. Sci. Nat. ser. 5, 41;100(1905); A. Dry plant (1X), B. Wet plant (3X), C. Leaf (75X), D. Apical laminal cells (290X), E. Middle laminal cells (290X), F. Basal laminal cells (290X).



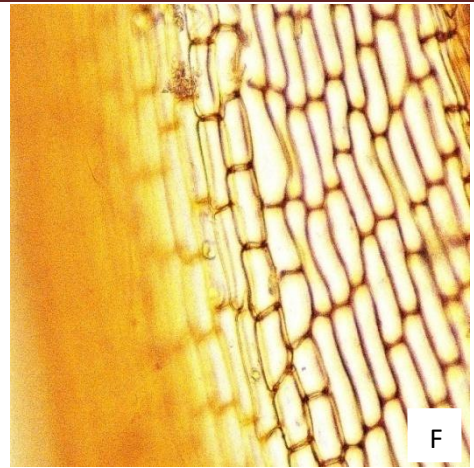
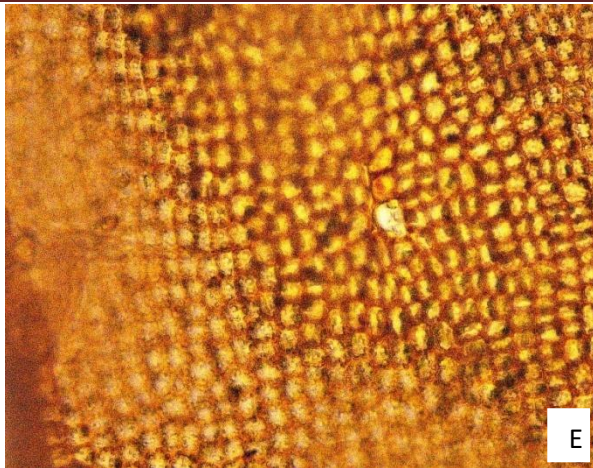
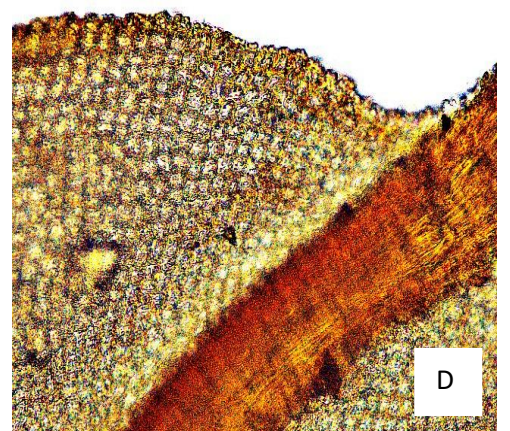


Plate 2: *Grimma apophysata* Hamp. ex Gangulee, Nova Hedwigia, 12: 428 (1966); A. Dry plant (1X), B. Wet plant (3X), C. Leaf (75X), D. Apical laminal cells (290X), E. Middle laminal cells (290X), F. Basal laminal cells (290X).



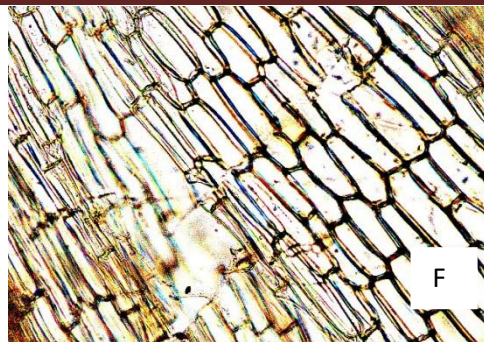
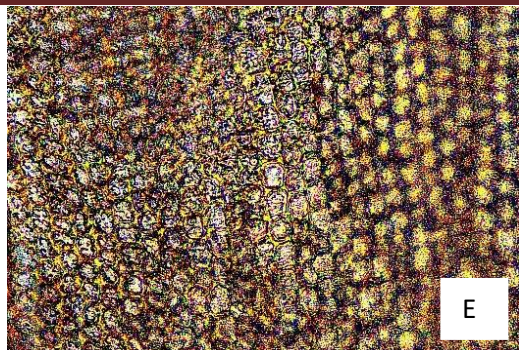


Plate 3: *Grimma ovalis* (Hedw.) Lindb. Act. Soc. Sci. Fenn., 10: 75(1871); A. Dry plant (1X), B. Wet plant (3X), C. Leaf (75X), D. Apical laminal cells (290X), E. Middle laminal cells (290X), F. Basal laminal cells (290X).

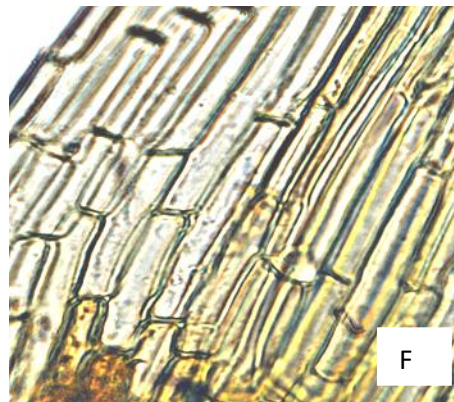
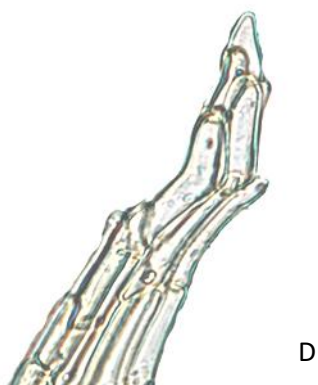
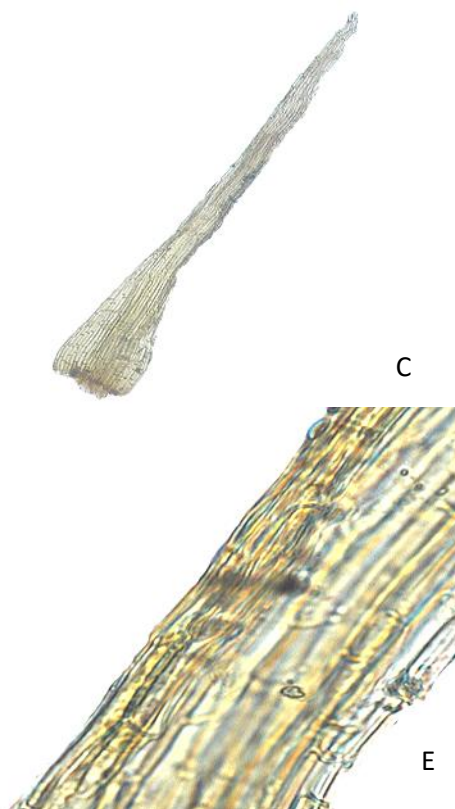
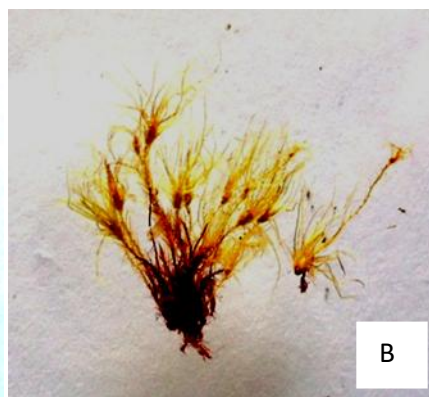


Plate 4: *Campylopus fragilis* (Brid.) B.S.G., Bryol. Eur., 1:164(1847); A. Dry plant (1X), B. Wet plant (3X), C. Leaf (75X), D. Apical laminal cells (290X), E. Middle laminal cells (290X), F. Basal laminal cells (290X).

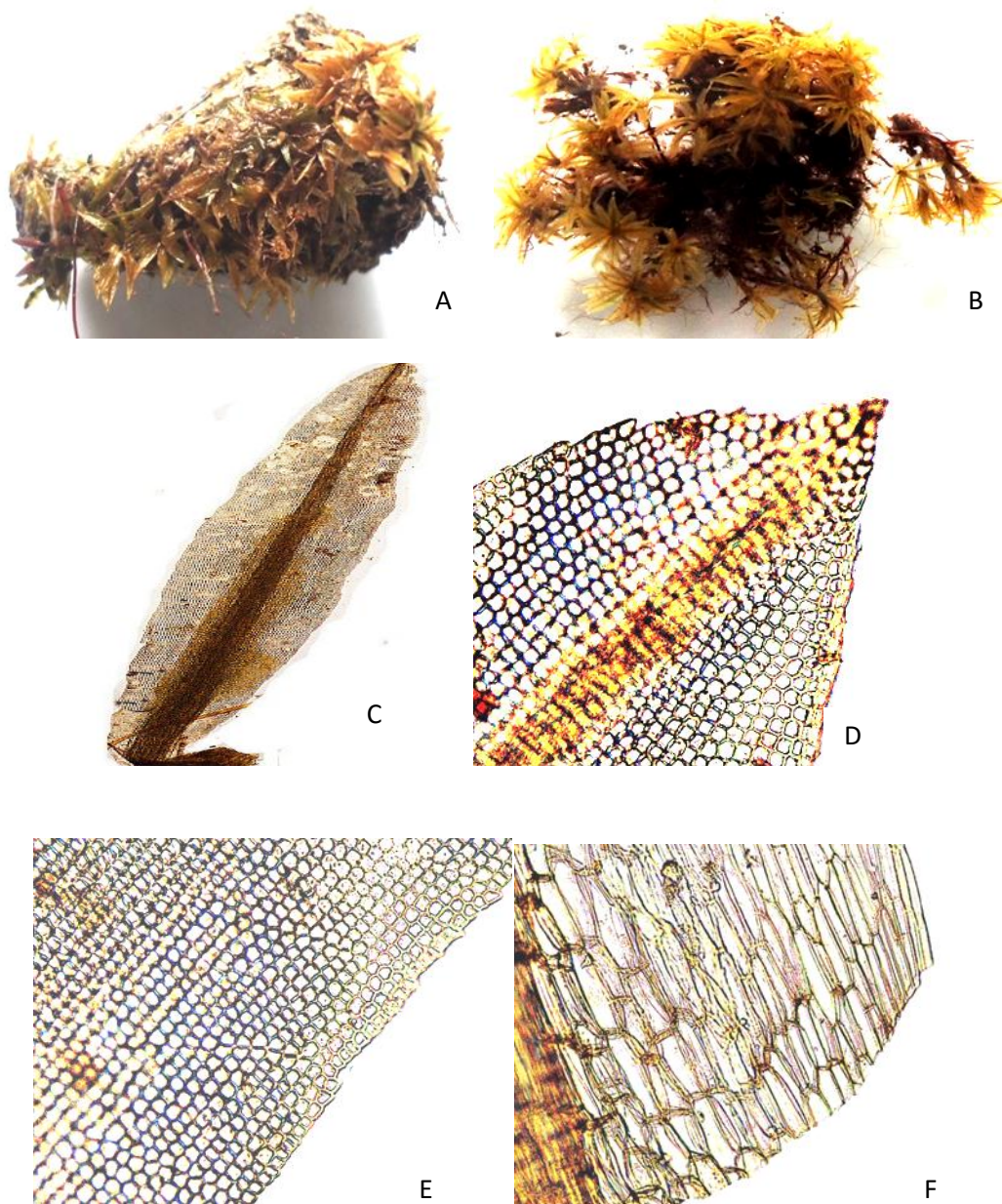
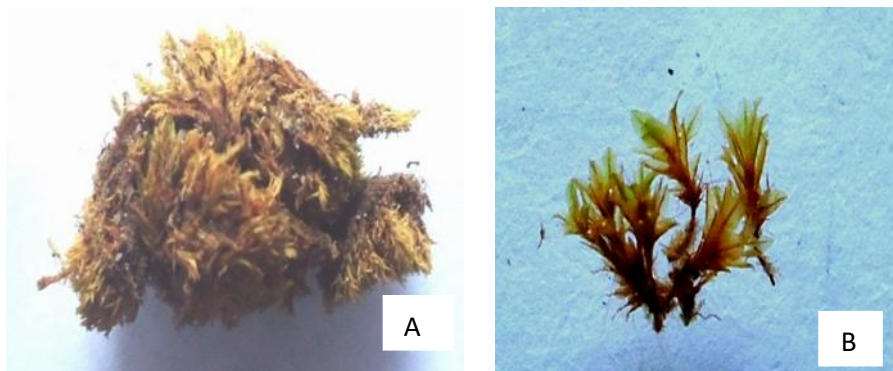


Plate 5: *Oxystegus cylindricus* (Brid.) Hilp Beih. Bot. Centralbl., 50: (2) 620 (1933); A. Dry plant (1X), B. Wet plant (3X), C. Leaf (75X), D. Apical laminal cells (290X), E. Middle laminal cells (290X), F. Basal laminal cells (290X).



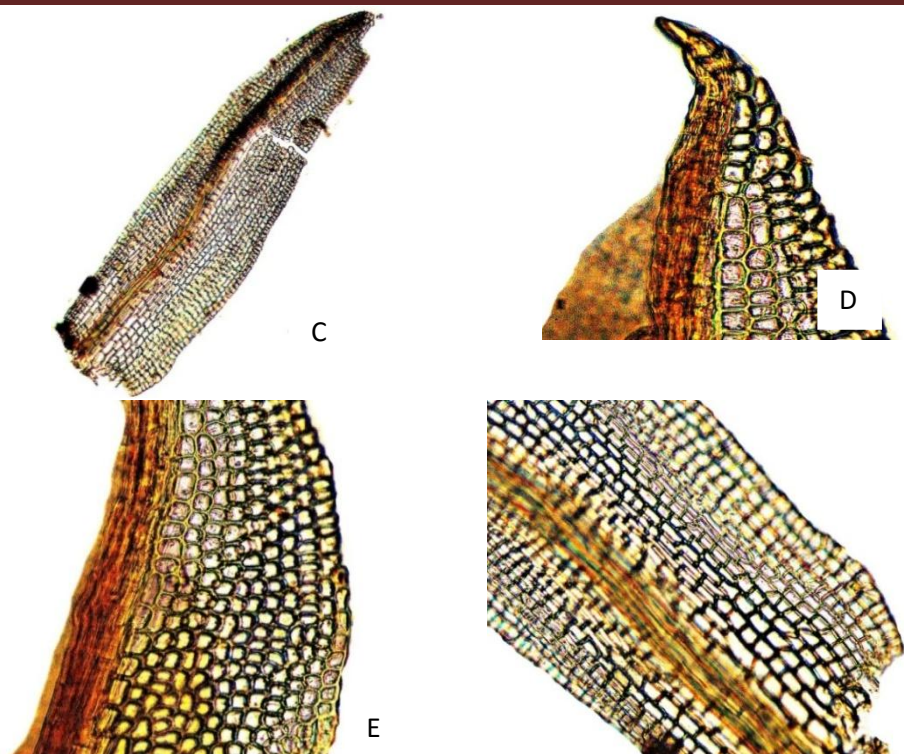
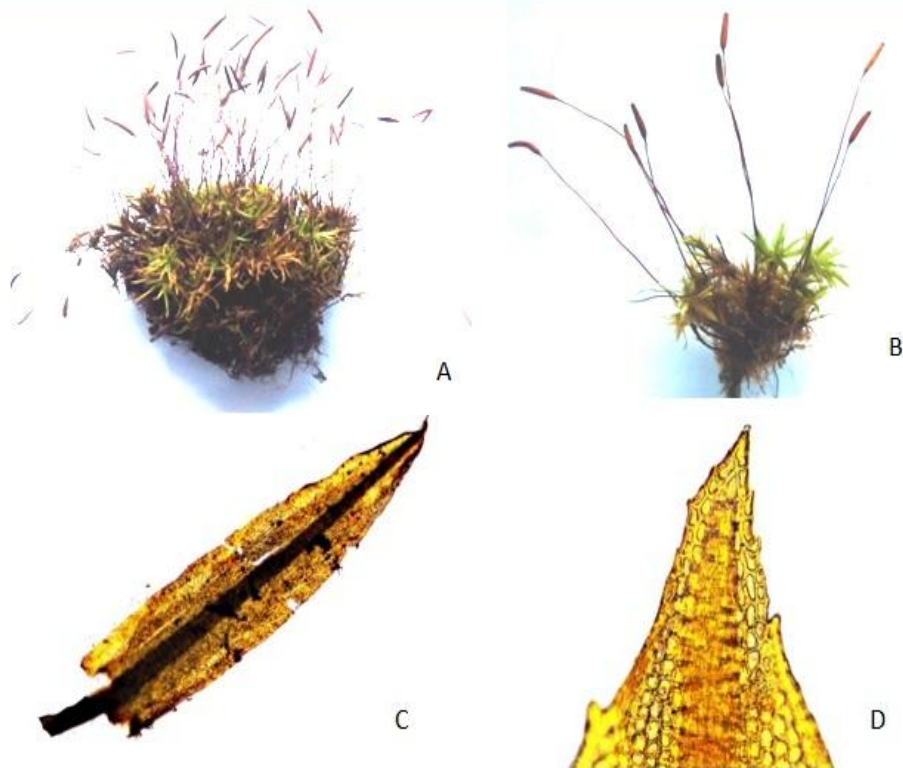


Plate 6: *Oxystegus khasianus* (Mitt.) Gangulee Nova Hedwigia, 8: 149(1964); A. Dry plant (1X), B. Wet plant (3X), C. Leaf (75X), D. Apical laminal cells (290X), E. Middle laminal cells (290X), F. Basal laminal cells (290X).





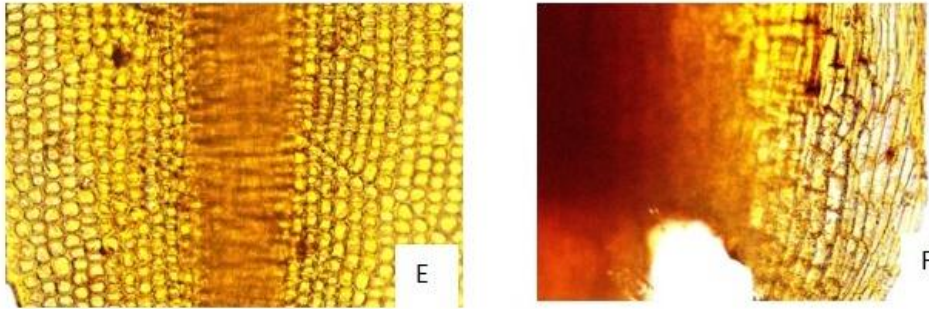


Plate 7: *Oxyetegus stenophyllus* (Mitt.) Gangulee, Nova Hedwigia, 12: 429(1966); A. Dry plant (1X), B. Wet plant (2X), C. Leaf (75X), D. Apical laminal cells (290X), E. Middle laminal cells (290X), F. Basal laminal cells (290X).

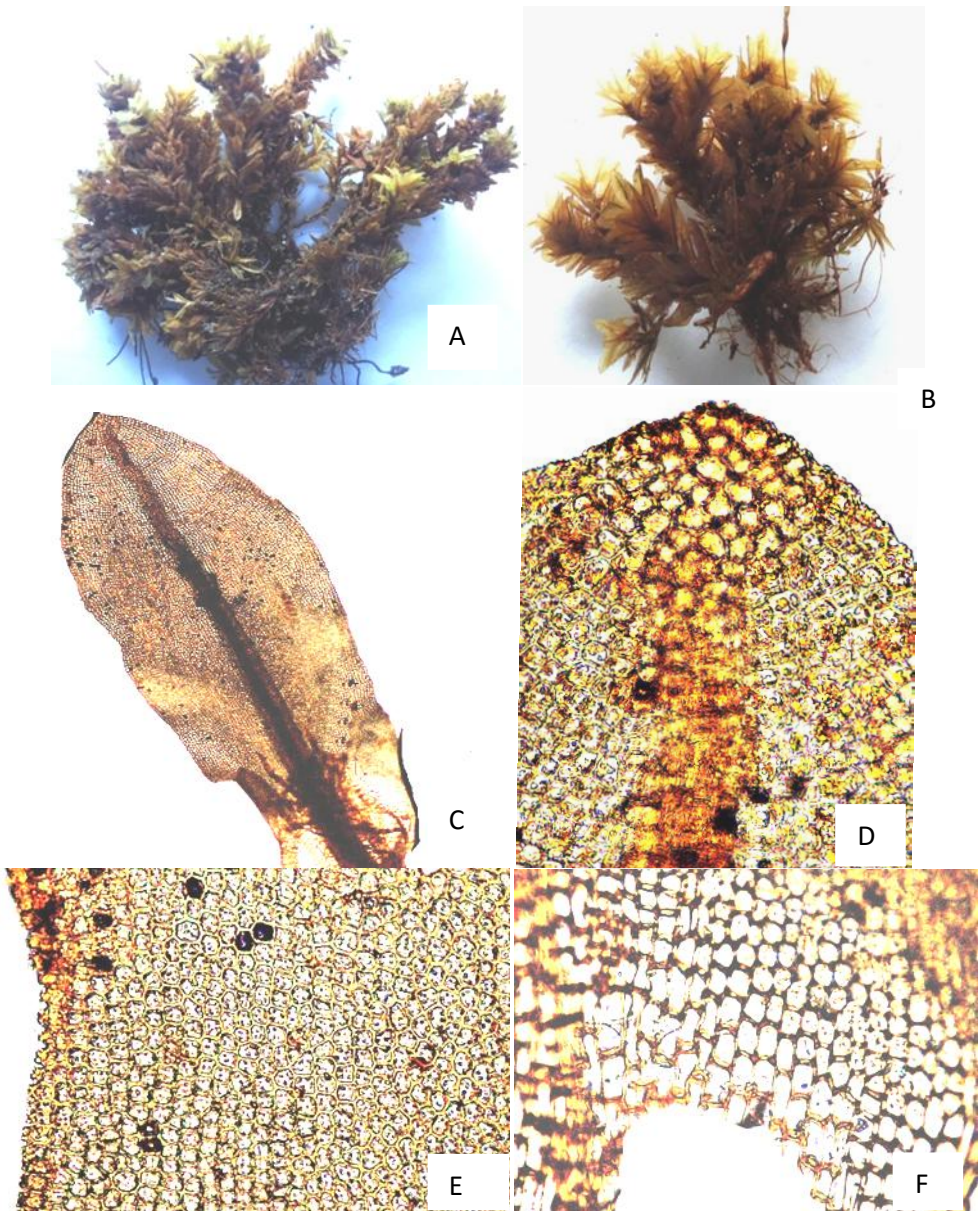


Plate 8: *Hyophila involuta* (Hook.) Jaeg., Natur. 1871-72: 356 (1873); A. Dry plant (3X), B. Wet plant (3X), C. Leaf (75X), D. Apical laminal cells (290X), E. Middle laminal cells (290X), F. Basal laminal cells (290X).

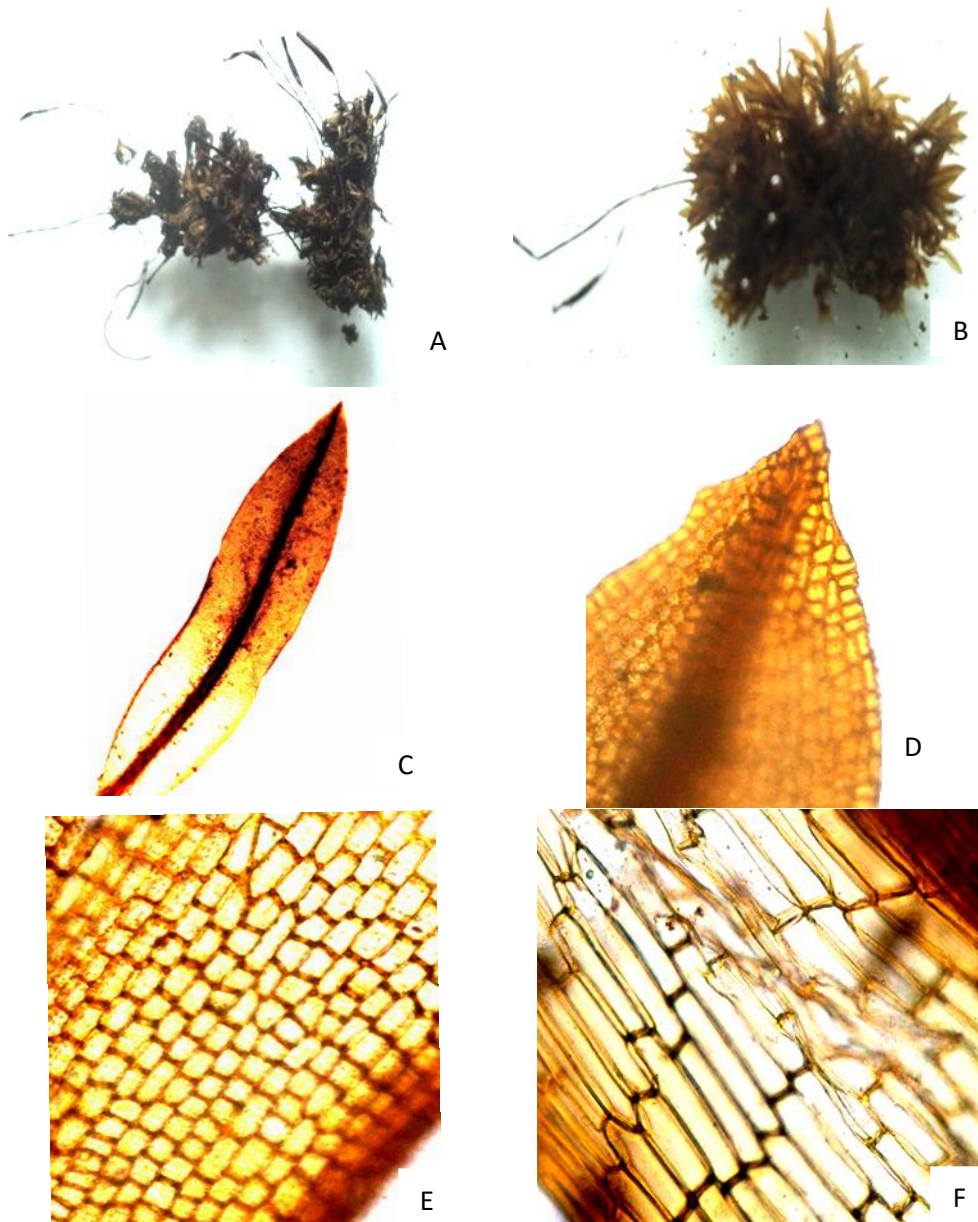
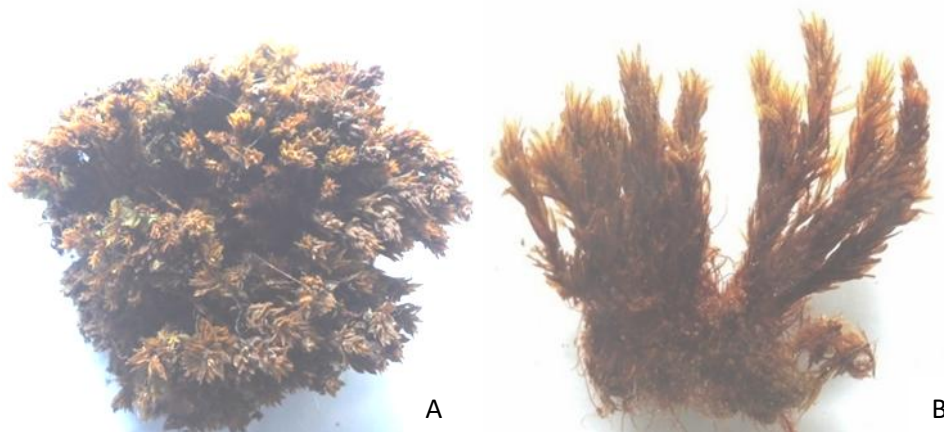


Plate 9: *Hyophila rosea* Williams, Bull. N. Y. Bot. Gard., 8: 341 (1914); A. Dry plant (2X), B. Wet plant (3X), C. Leaf (75X), D. Apical laminal cells (290X), E. Middle laminal cells (290X), F. Basal laminal cells (290X).



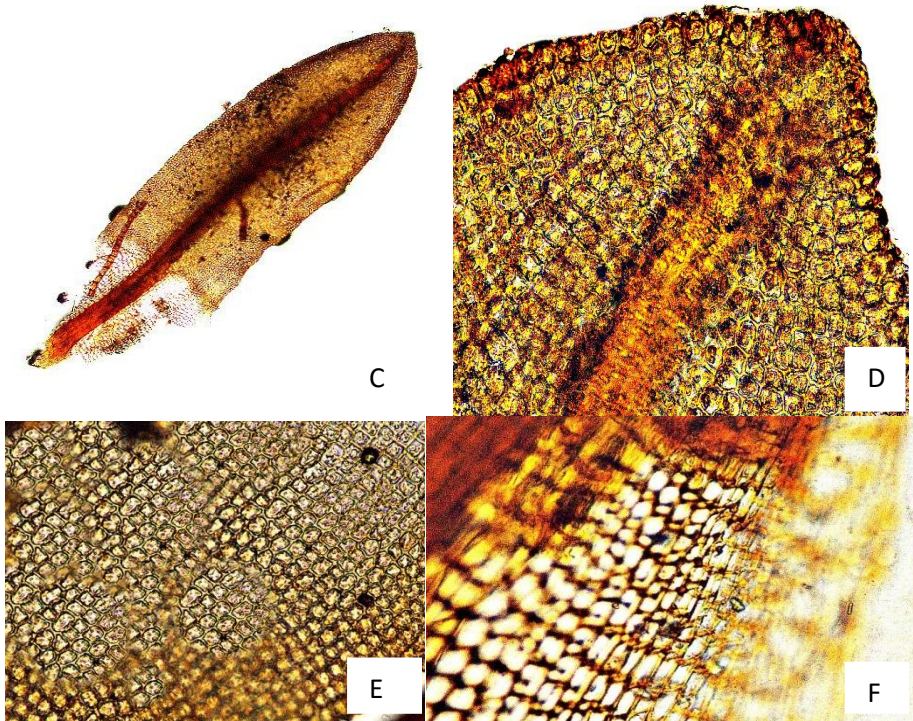
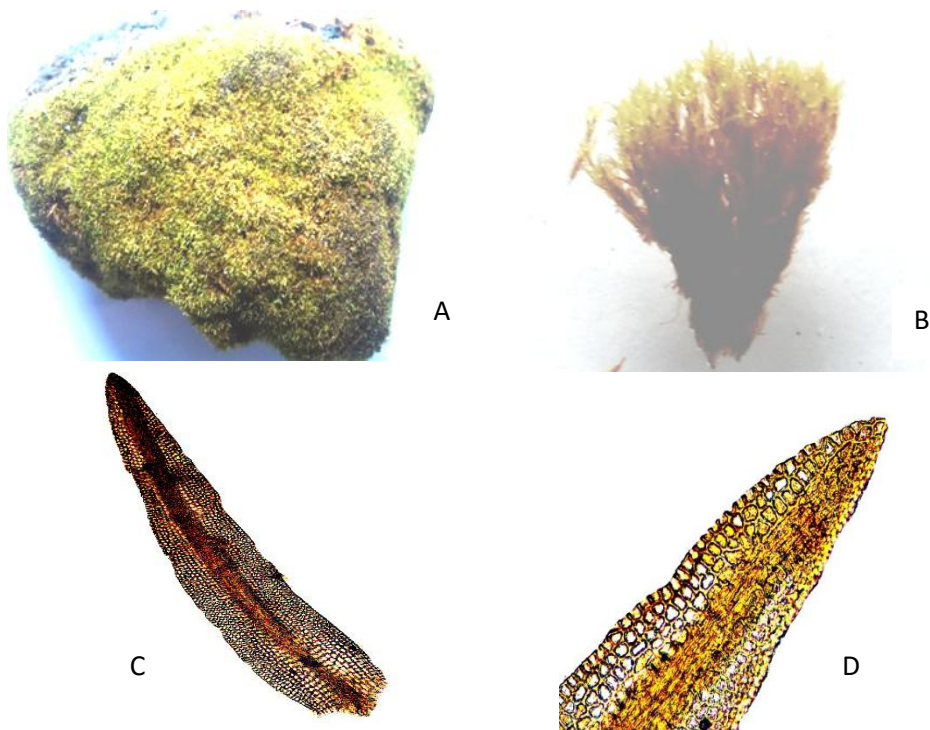


Plate 10: *Hyophila spathulata* (Harv) Jaeg., Ber. S. Gall. Naturw.Ges., 1817-72: 353(1873); A. Dry plant (1X), B. Wet plant (3X), C. Leaf (75X), D. Apical laminal cells (290X), E. Middle laminal cells (290X), F. Basal laminal cells (290X).



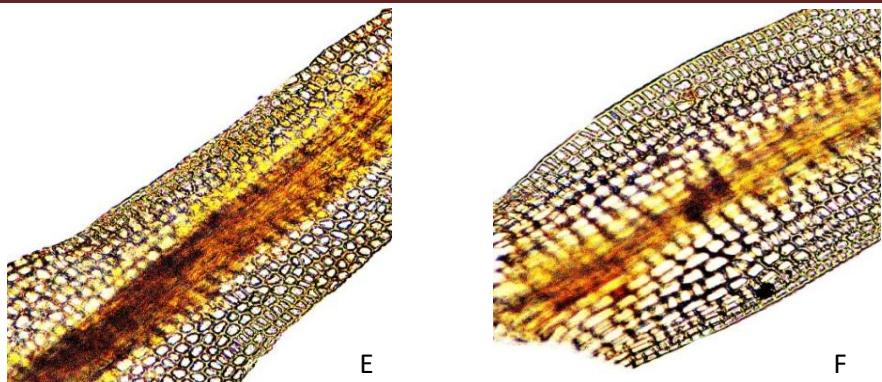


Plate 11: *Hyophila walkeri* Broth., Rec. Bot. Surv. Ind., 1:317 (1899); A. Dry plant (1X), B. Wet plant (5X), C. Leaf (75X), D. Apical laminal cells (290X), E. Middle laminal cells (290X), F. Basal laminal cells (290X).

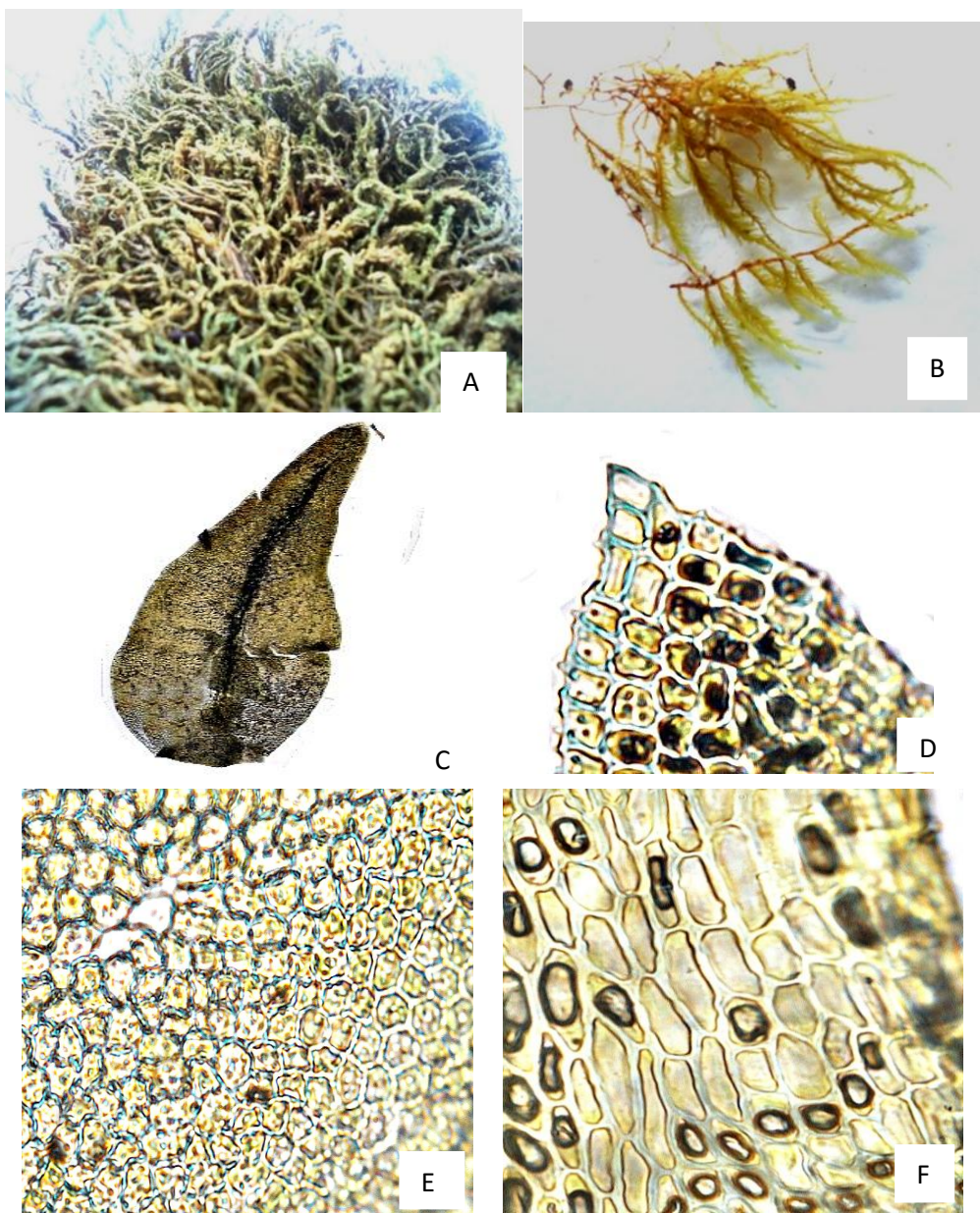


Plate 12: *Barbula asperifolia* Mitt. Musci Ind. Or. 36(1859); A. Dry plant (1X), B. Wet plant (4X), C. Leaf (75X), D. Apical laminal cells (290X), E. Middle laminal cells (290X), F. Basal laminal cells (290X).

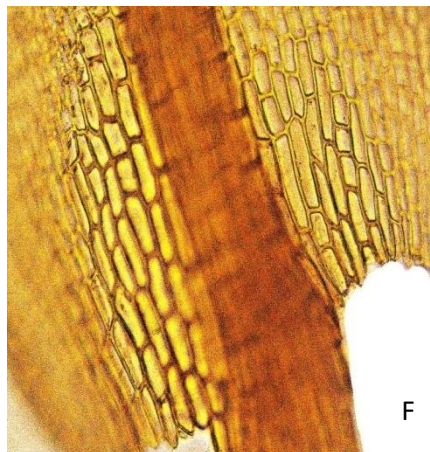
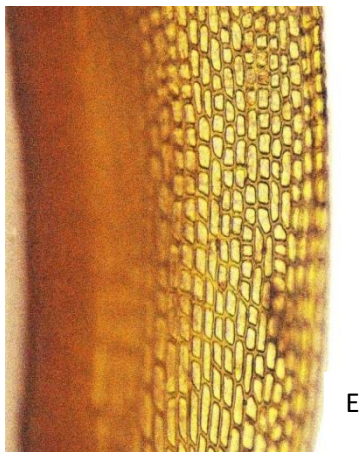
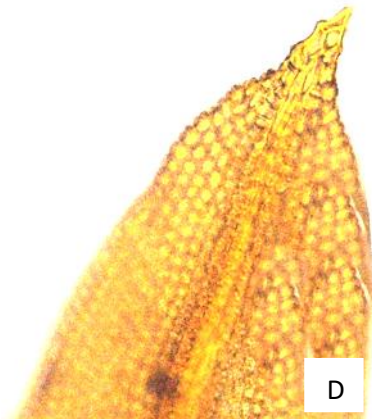
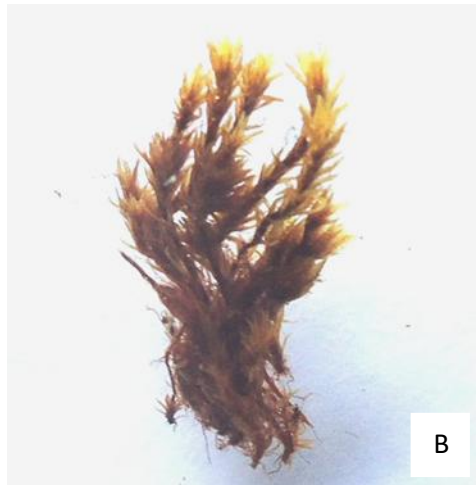


Plate 13: *Barbula constricta* Mitt., Musci Ind. Or.: 33(1859); A. Dry plant (3X), B. Wet plant (3X), C. Leaf (75X), D. Apical laminal cells (290X), E. Middle laminal cells (290X), F. Basal laminal cells (290X).

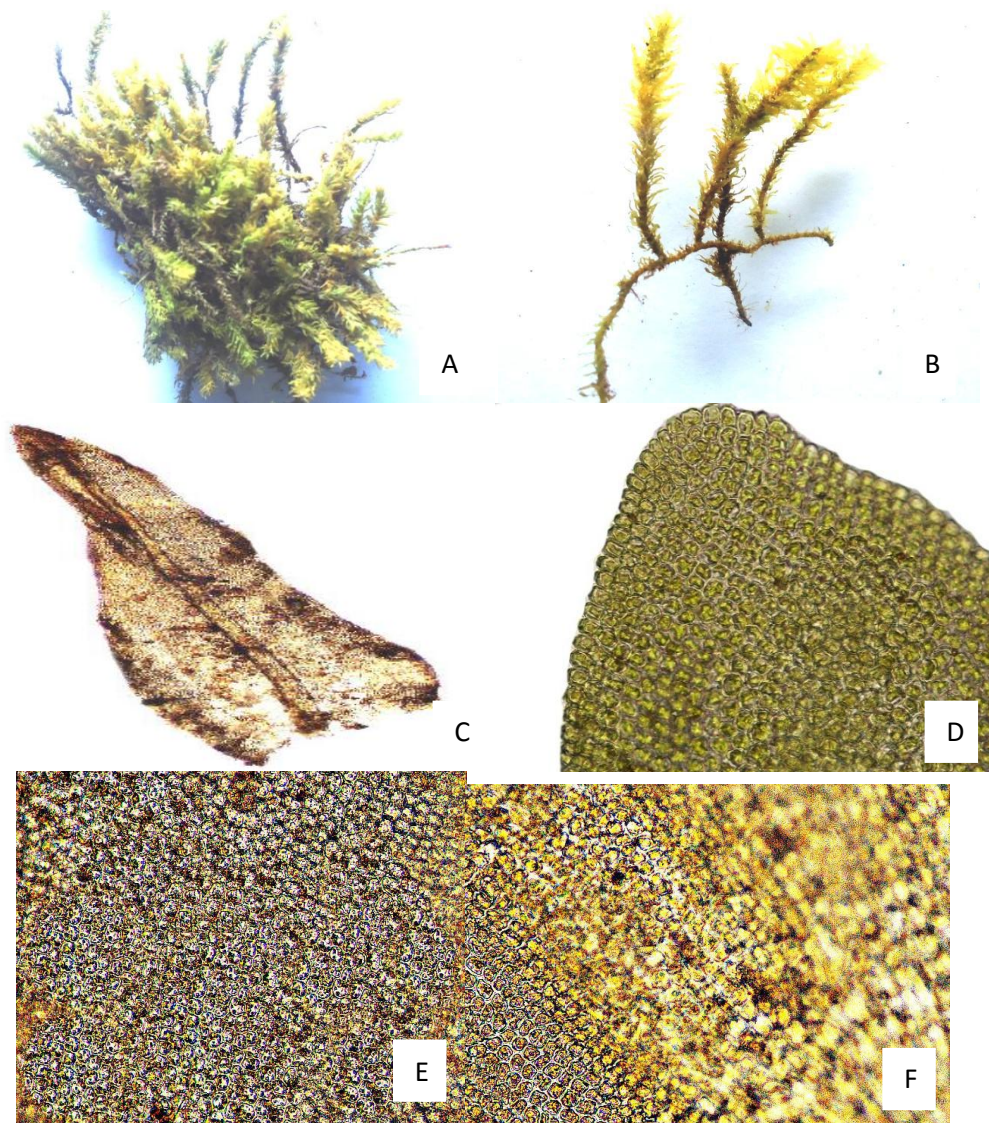
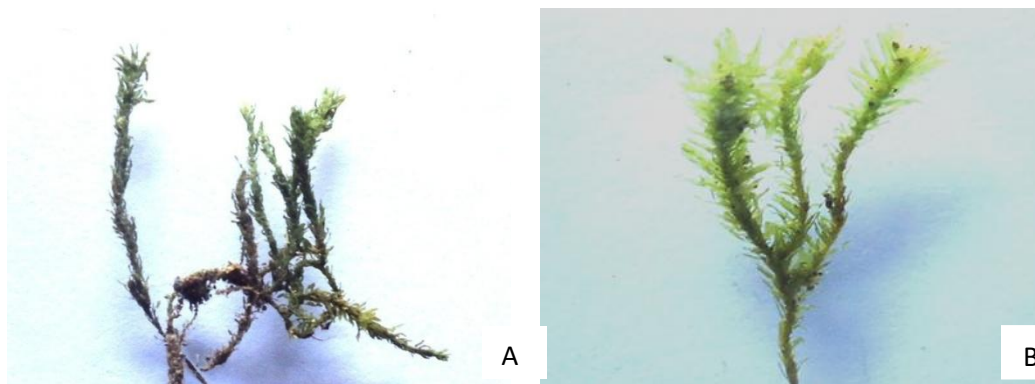


Plate 14: *Barbula cylindrica* (Tayl.) Schimp. var. *vinealis* (Brid) Lindb., Musci. Scand.: 32 (1879); A. Dry plant (2X), B. Wet plant (3X), C. Leaf (75X), D. Apical laminal cells (290X), E. Middle laminal cells (290X), F. Basal laminal cells (290X).



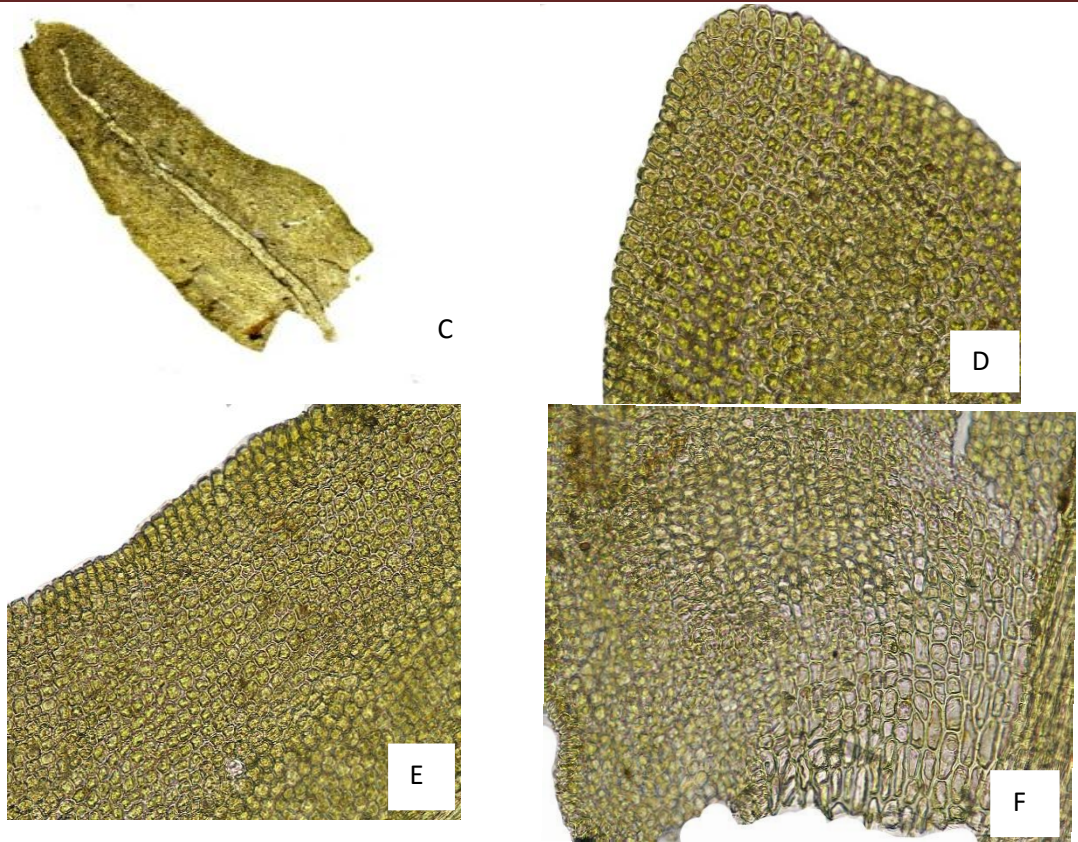
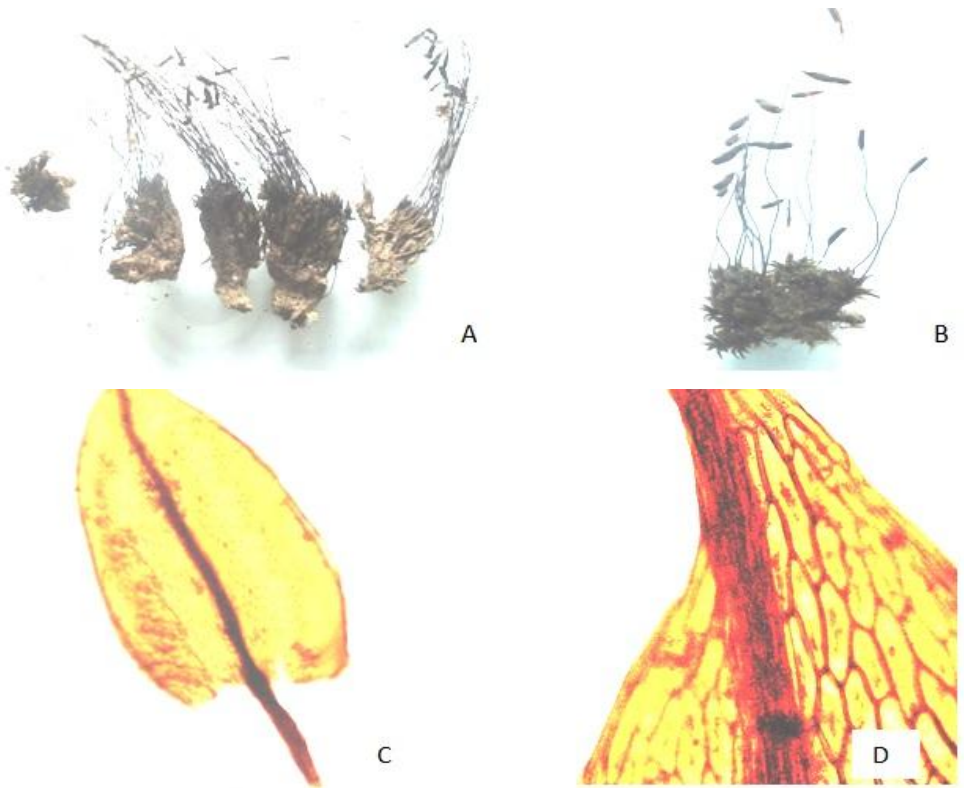


Plate 15: *Barbula nigrescens* Mitt. Musci Ind. Or. 36(1859); A. Dry plant (2X), B. Wet plant (3X), C. Leaf (75X), D. Apical laminal cells (290X), E. Middle laminal cells (290X), F. Basal laminal cells (290X).



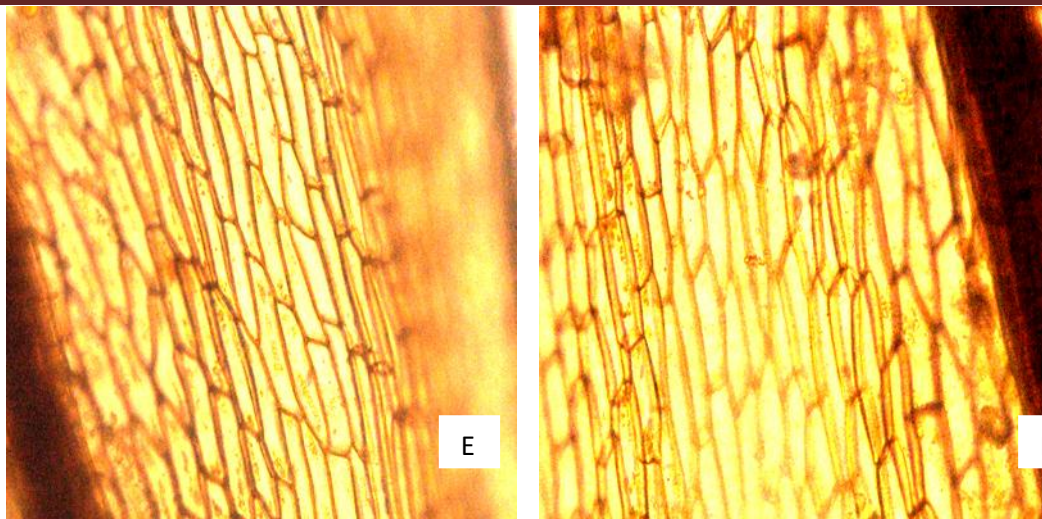
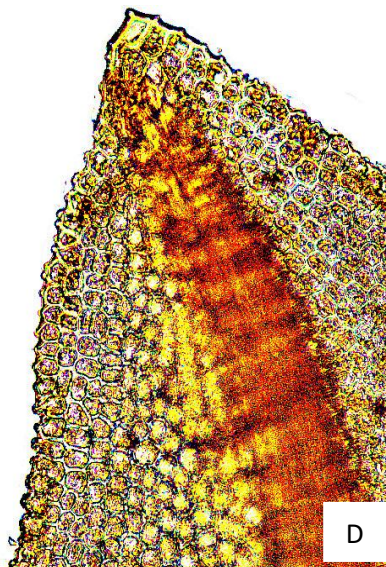
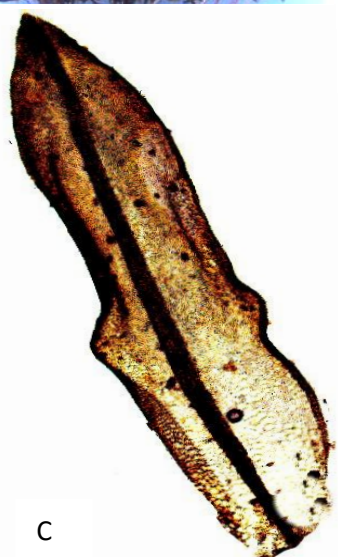


Plate 16: *Barbula vinealis* Brid Bryol. 1: 830(1827); A. Dry plant (3X), B. Wet plant (3X), C. Leaf (75X), D. Apical laminal cells (290X), E. Middle laminal cells (290X), F. Basal laminal cells (290X).





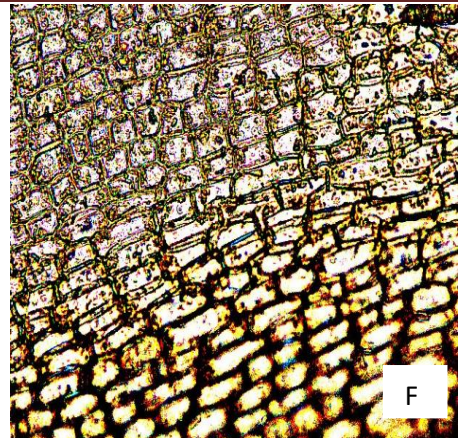
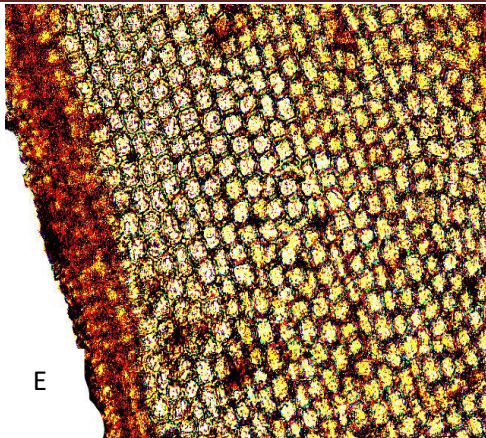


Plate 17: *Semibarbula orientalis* (Weber) Wijk. & Marg. Taxon, 8: 75 (1959); A. Dry plant (1X), B. Wet plant (3X), C. Leaf (75X), D. Apical laminal cells (290X), E. Middle laminal cells (290X), F. Basal laminal cells (290X).



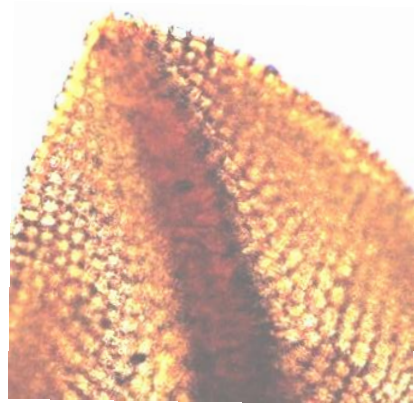
A



B



C



D

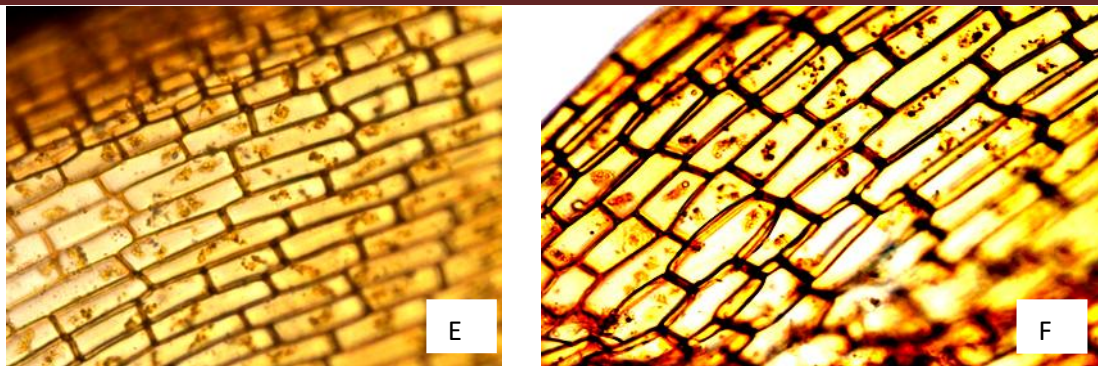


Plate 18: *Semibarbula ranuii* Gangulee NovaHedwigia, 8:149(1964); A. Dry plant (2X), B. Wet plant (2X), C. Leaf (75X), D. Apical laminal cells (290X), E. Middle laminal cells (290X), F. Basal laminal cells (290X).

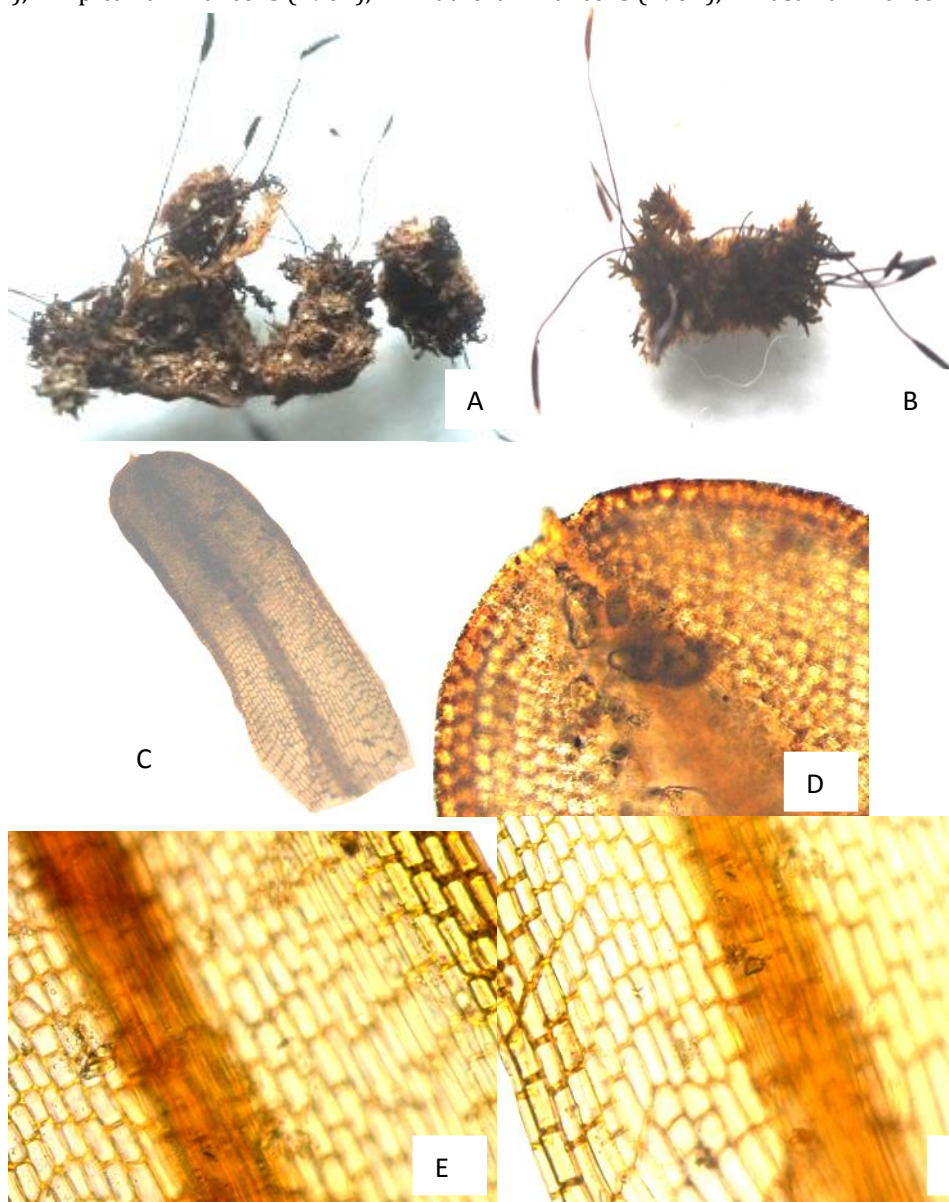
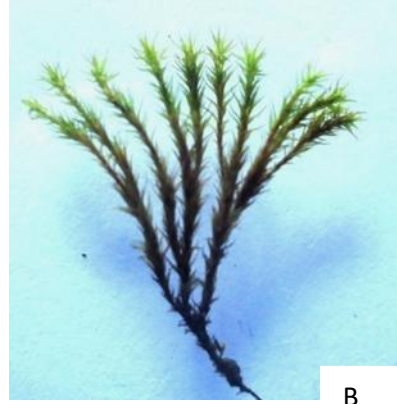


Plate 19 : *Hydrogonium consanguineum* (Thw. et Mitt.) Hilp., Beih . Bot. Centrabl., 50(2): 626 (1933); A. Dry plant (3X), B. Wet plant (3X), C. Leaf (75X), D. Apical laminal cells (290X), E. Middle laminal cells (290X), F. Basal laminal cells (290X).



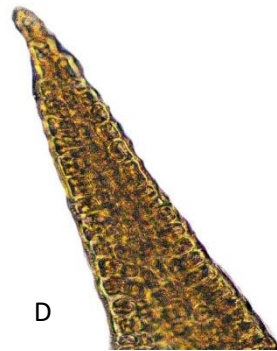
A



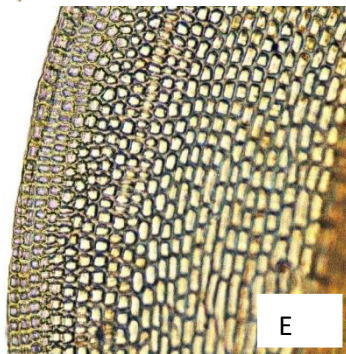
B



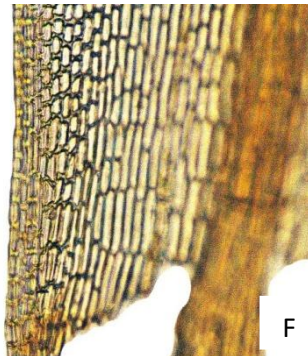
C



D



E



F

Plate 20: *Hydrogonium gracilentum* (Mitt) Chen Hedwigia, 80: 237(1941); A. Dry plant (3X), B. Wet plant (3X), C. Leaf (75X), D. Apical laminal cells (290X), E. Middle laminal cells (290X), F. Basal laminal cells (290X).



A



B

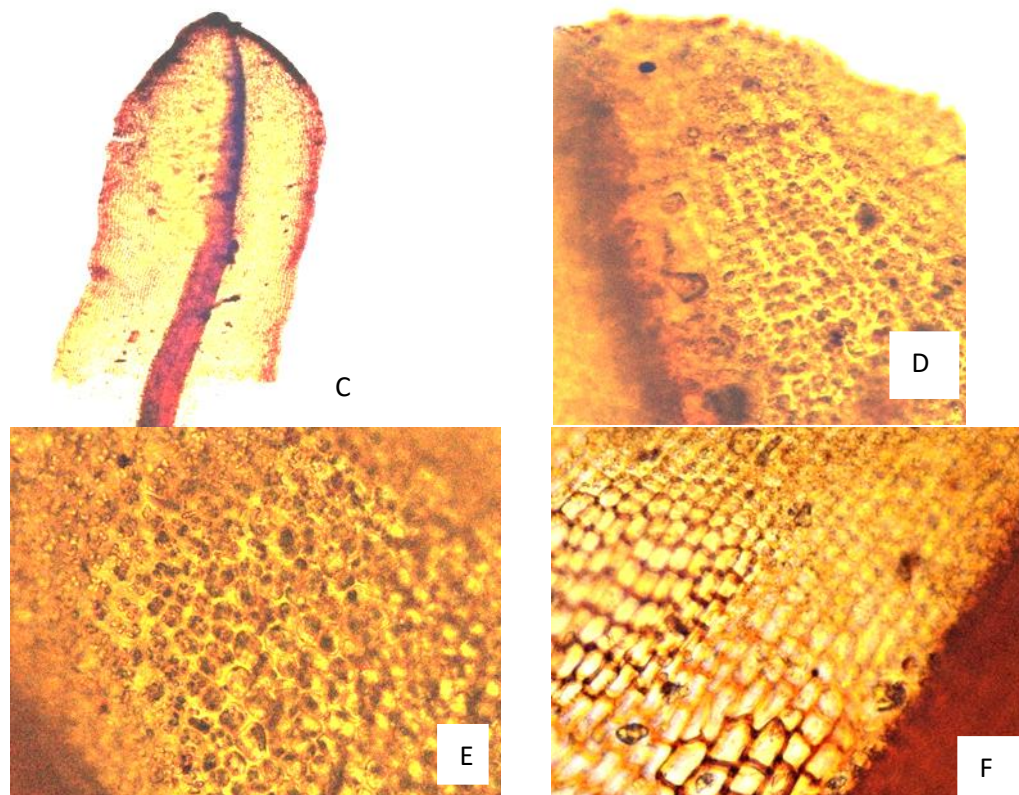
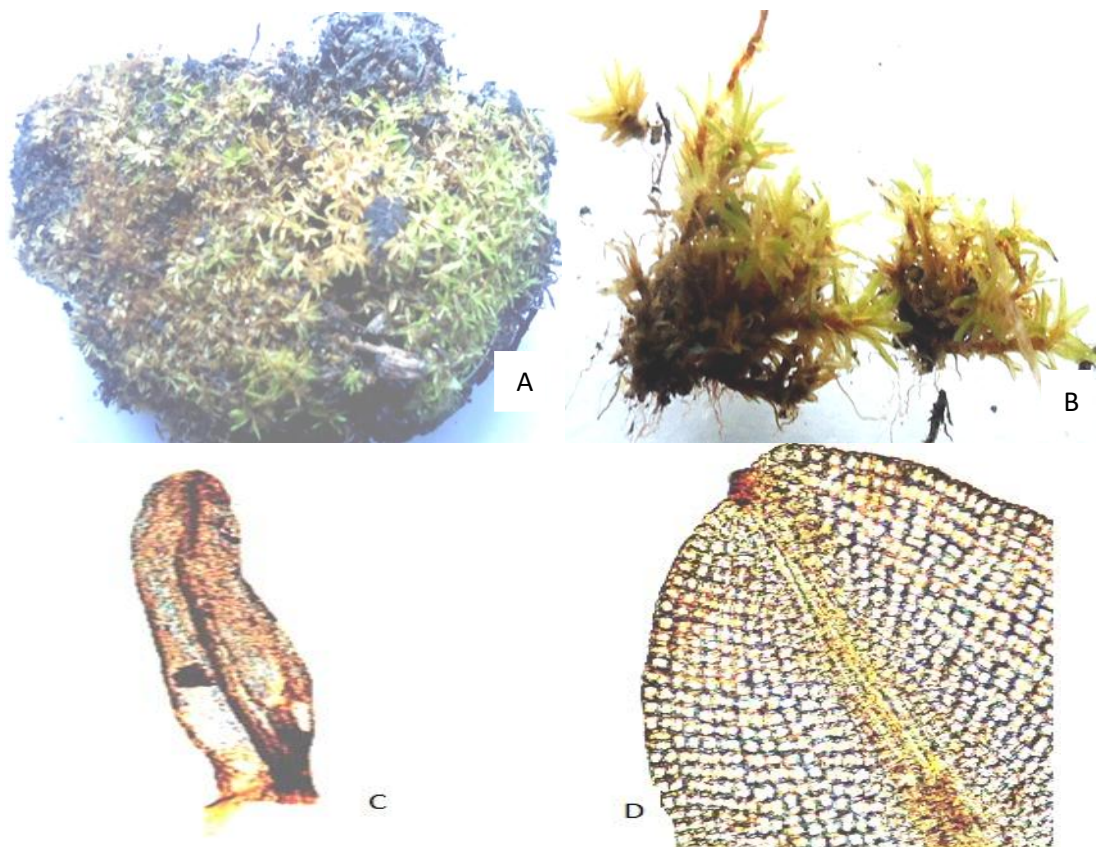


Plate 21: *Desmatodon gemmascens* Chen, Hedwigia, 80: 297(1941); A. Dry plant (3X), B. Wet plant (3X), C. Leaf (75X), D. Apical laminal cells (290X), E. Middle laminal cells (290X), F. Basal laminal cells (290X).



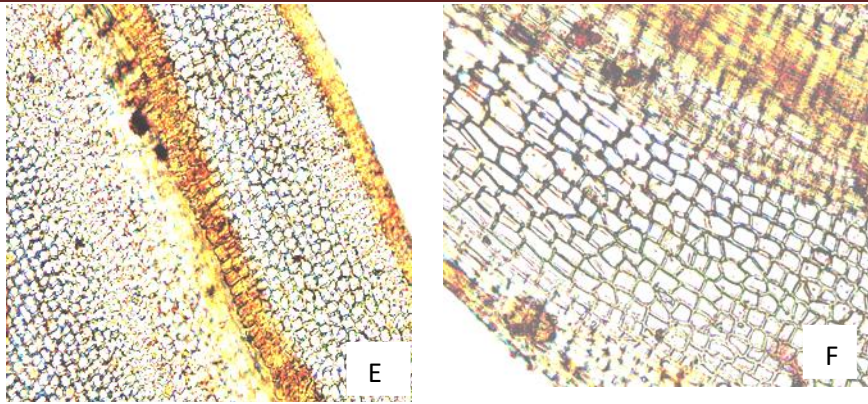


Plate 22: *Desmatodon latifolius* (Hedw.) Brid., Mant. Musc.: 86 (1819); A. Dry plant (1X), B. Wet plant (4X), C. Leaf (75X), D. Apical laminal cells (290X), E. Middle laminal cells (290X), F. Basal laminal cells (290X).

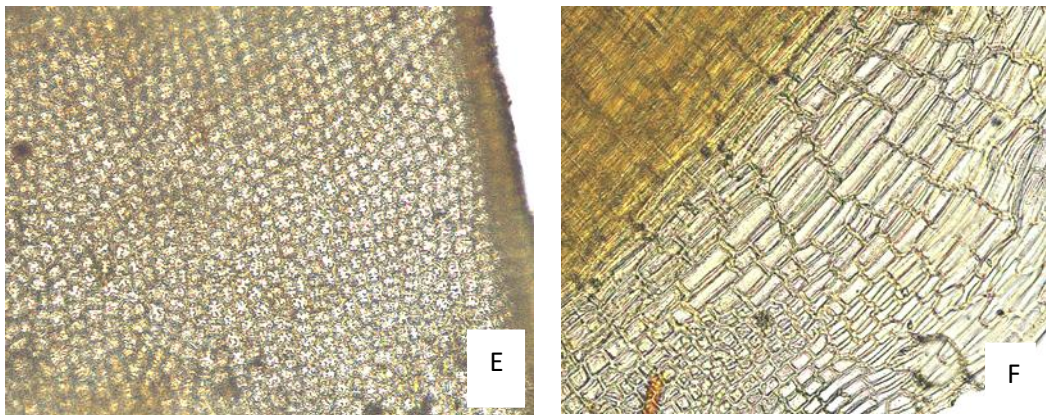
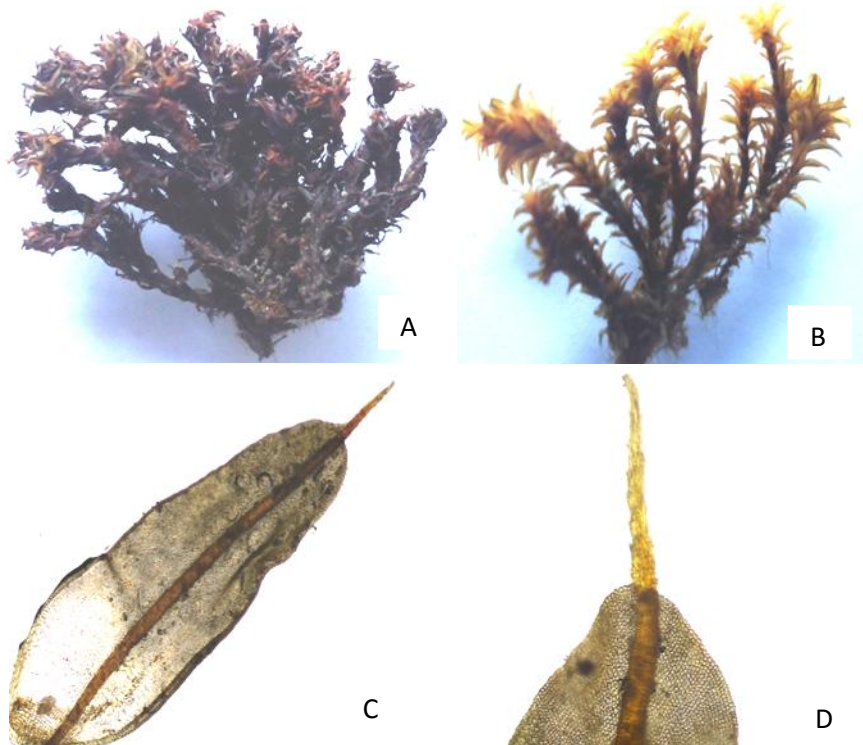


Plate 23: *Syntrichia princeps* (De Not.) Mitt. Musc. Ind. Or. : 39 (1859); A. Dry plant (3X), B. Wet plant (3X), C. Leaf (75X), D. Apical laminal cells (290X), E. Middle laminal cells (290X), F. Basal laminal cells (290X).

**References**

1. Buck WR, Goffinet B. Morphology and classification of mosses. In A.J. Shaw & B. Goffinet (eds.), *Bryophyte Biology*. Cambridge University Press. 2000; 71-119.
2. Crum HA. *Structural Diversity of Bryophytes*. The University of Michigan Herbarium, Ann Arbor, MI, 2001, pp. 379.
3. Dandotiya D, Govindaparyari H, Suman S, Uniyal PL. Checklist of the bryophytes of India. *Archive for Bryology*, 2011; 88: 1-126.
4. Goffinet B, Buck WR. Systematics of Bryophyta: from molecules to a revised classification. In: B. Goffinet, V. Hollowel & R. Magill (eds.), *Monographs in Systematic Botany from the Missouri Botanical Garden*, 2004; 205-239.
5. Oren M, Uyar G, Keceli T. The bryophyte flora of Erdec, Bandirrrma, Manyas district, (Balikesir, Turkey). *International Journal of Botany*, 2007; 3 (1):1-14.
6. Shaw J, Renzaglia K. Phylogeny and diversification of bryophytes. *American Journal of Botany*, 2004; 91: 1557-1581.
7. Zander RH. Initiation of search for fossil traits in the genome. *Bryological Times*, 2006; 119: 5-6.