

***Fissidens* Hedw. (*Fissidentaceae*, *Bryophyta*) from Kashmir with first record of *Fissidens bryoides* Hedw. from the state**

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ABSTRACT

Kour A. & Singh S.K. 2022. *Fissidens* Hedw. (*Fissidentaceae*, *Bryophyta*) from Kashmir with first record of *Fissidens bryoides* Hedw. from the state. *Geophytology* 51(1&2): 129–138.

Three species of *Fissidens* namely *Fissidens bryoides* Hedw., *Fissidens grandifrons* Brid. and *Fissidens taxifolius* Hedw. are described from union territory of Jammu and Kashmir, Western Himalaya of which *Fissidens bryoides* Hedw. is a new record from Jammu and Kashmir.

Keywords: *Fissidens*, *Fissidentaceae*, *Bryophyta*, Kashmir, Himalaya, India.

INTRODUCTION

Fissidens Hedw. is the largest genus among all moss genera in the world (Kwon 2021). It was established by Hedwig in 1801 and is derived from two Latin roots (fissus = cleft + dens = tooth), in reference to the peristome teeth that are divided for much of their length (Mehta et al. 2016). Genus *Fissidens* is characterized by sheathing or vaginant lamina, unicosate, distichous, complanate and haplolepidous peristome. It belongs to one of the largest, acrocarpous, haplolepidous family of mosses of the order *Dicranales*, *Fissidentaceae* Schimp. (Buck & Goffinet 2000). The species of the genus *Fissidens* occupy a wide range of habitats; most of them were recorded from humid ones at the tropics and subtropics (Beever 2014). *Fissidens* has complicated diversity as certain species have limited distributions while some

species like *F. bryoides* Hedw., *F. grandifrons* Bridel, and *F. curvatus* Hornsch. are broadly distributed or cosmopolitan (Bruggeman-Nannenga et al. 1994, Bruggeman-Nannenga & Pursell 1995, Pursell & Allen 2017). In Asia, the five varieties of *F. bryoides* var. *bryoides*, var. *lateralis*, var. *ramosissimus*, var. *esquirolii* and var. *schmidii*, were classified into *F. bryoides* complex (Li et al. 2001).

The genus *Fissidens* represented by 450 recognized species distributed worldwide (Pursell 2007) but has its greatest diversity in tropical and subtropical regions. It is majorly distributed in sub-Saharan Africa by 148 taxa (O’Shea 2006). Bruggeman-Nannenga (1982, 1985, 1989) studied section *Pachylomidium* of genus *Fissidens* from Europe, the Mediterranean and the Atlantic African islands. His study was further extended to the costa of same genus (Bruggeman-

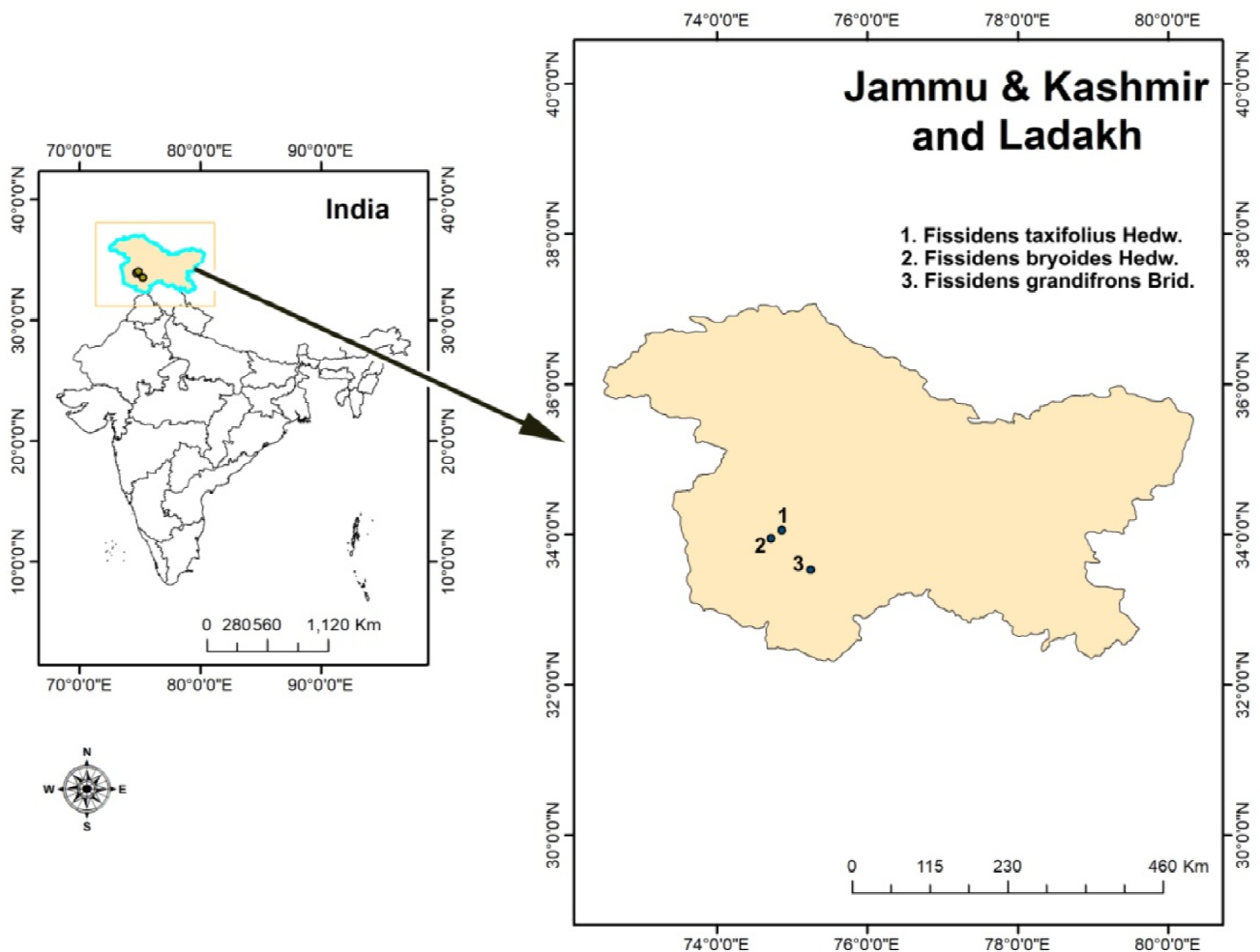


Figure 1. A. Map of India showing location of Jammu & Kashmir and Ladakh union territories, B. Showing localities in Jammu & Kashmir, from where plant specimens for the present study were collected. 1. Harwan, Srinagar District (*Fissidens taxifolius* Hedw.); 2. Kremshora, Budgam District (*Fissidens bryoides* Hedw.); 3. Verinag, Anantnag District (*Fissidens grandifrons* Brid.).

Nannenga 1990, 2017). Bruggeman-Nannenga and Berendsen (1990) studied peristome types found in the *Fissidentaceae* and their importance for the classifications. Bruggeman-Nannenga and Pursell (1995) and Bruggeman-Nannenga et al. (1994) studied African *Fissidens*. Churchill et al. (2000) documented 73 taxa of *Fissidens* from South America. Seppelt and Stone (2016) dealt 70 taxa of the genus from Australia. Ros et al. (2013) documented 41 taxa from

Mediterranean regions. Beever (1995) studied aquatic adaptations of *F. strictus* Hook.f. & Wils. and *F. berteroi* (Mont.) C. Muell, from New Zealand. Beever (2014) dealt 37 taxa of *Fissidens* from New Zealand and 27 taxa of *Fissidens* reported from North America (Pursell 2007). Allen (1980) studied peristome variations of 19 species in the genus *Fissidens* via SEM. Pursell (1982, 1990, 1994a, b, 2007) worked on American *Fissidens* and published a series of papers.



Figure 2. *Fissidens bryoides* Hedw. A. Habit. B–D. A portion of plant. E–F. Leaves. G. Apical leaf cells. H. Capsule along with seta. I. Cross section of seta. J. Spores. K. peristome teeth. L. Cross section of stem. M. Cross section of leaf. N, P, R. Middle cells and limbidium. O, Q. Basal cells and limbidium.

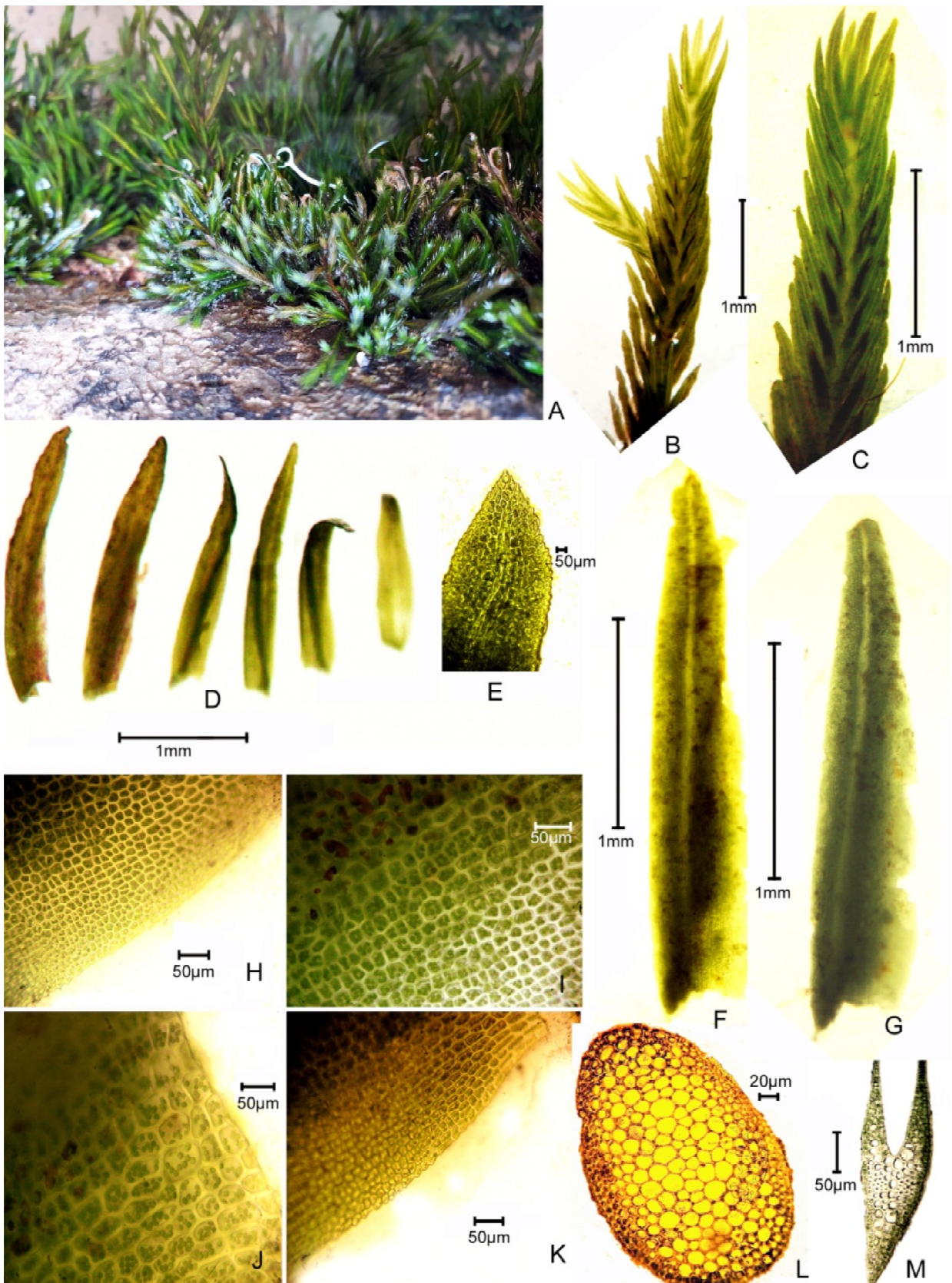


Figure 2

Pursell and Bruggeman-Nannenga (2004) did a revision of the infrageneric taxa of *Fissidens*. Pursell and Allen (2017) studied *Fissidens* of Delaware and adjacent areas of Evansia. Ignatov et al. 2006 enlisted 28 taxa from East Europe and North Asia. Iwatsuki and Mohamed (1987) did a pioneer work in genus *Fissidens* in Peninsular Malaysia and Singapore. Li (1985) did a revision of the Chinese species of *Fissidens*. Li et al. (2001) recorded 58 taxa from China. Iwatsuki (1969), Iwatsuki and Suzuki (1982, 2002) did a marvelous work on Japanese *Fissidens*. Ishihara and Iwatsuki (1992) did infrageneric classification of the genus *Fissidens*. Suzuki (2015, 2017) recorded 51 taxa of *Fissidens* from Japan. Tan and Meng-Shyan (2002) worked on taxonomy, phytogeography and conservation of the *Fissidens* of Singapore. Kwon (2021) documented 38 taxa of *Fissidens* from Korea. Yoon and Sun (2010) and Yoon et al. (2015a, b) recorded some new *Fissidens* to the moss flora of South Korea. Pradhan and Joshi (2006) reported 42 species and 7 varieties of *Fissidens* from Nepal. Gangulee (1969–80) recorded 51 taxon of *Fissidens* from Eastern India. In India the genus is represented by 62 taxa, which are distributed in Eastern Himalaya (33 spp.), Western Himalaya (25 spp.), South India (26 spp.), Central India (14 spp.), Meghalaya (13 spp.) and Gangetic plains (11 spp.) (Lal 2005).

While exploring the bryophyte, the first author collected the samples of bryophyte from alpine regions of Jammu and Kashmir in November 2021, that includes three species of Genus *Fissidens*. After a careful examination of morphological and anatomical characters of these specimens, their identities are ascertained as *Fissidens bryoides* Hedw., *Fissidens grandifrons* Brid. and *Fissidens taxifolius* Hedw. *F. grandifrons* and *F. taxifolius* were already reported from the area but were poorly documented. *Fissidens bryoides* is reported for the first time from Union territory of Jammu

and Kashmir (Figure 1). The studied specimens are deposited in Cryptogamic Herbarium of Botanical Survey of India, Northern Regional Centre, Dehradun (BSD).

TAXONOMIC TREATMENT

1. *Fissidens bryoides* Hedw.

Sp. Musc.: 153. 1801.

Figure 2

Gangulee, Mosses E. India 469. 1972. *F. synoicous* Sull., Musci. Hep. U.S. East Mississippi River Add. Corr., 103. 1856; *F. gymnadrus* Buse Mild. Hedwigia 8: 55. 1869; *F. taiwanensis* Herz. Et Nog., J. Hattori Bot. Lab. 14: 57. 1955.

Description: Plant green, gregarious, 0.6–2.0 cm long and 0.4 mm wide. Usually branched and ranching terminal. Leaves 7–17 pairs, measuring 1.4–2 mm long and 0.3–0.6 mm wide, crumpled when dry, oblong-lanceolate, tip acuminate measuring $57 \times 38 \mu\text{m}$. Dorsal lamina usually narrowing down to a short decurrent base, Sheathing lamini covering half of leaf length. Apical part symmetrical, narrower than basal part. Costa solid, $19\text{--}24.7 \mu\text{m}$ wide. Stem rounded, $195 \times 253 \mu\text{m}$ in diameter, central cells large measuring $11.4\text{--}13.3 \mu\text{m}$ and peripheral cells small measuring $3.8\text{--}5.7 \mu\text{m}$. Limbidium yellowish, cartilaginous, elongated, all around leaf. Limbidium at tip one rowed, which may change to some shorter cells at the extreme tip giving rise to faint denticulation and finally joining the nerve end. On dorsal lamina the limbidium is one rowed at tip, 2–rowed at base. On sheathing lamini the limbidium is about 4 rowed at base and 2 rowed at apex. Light yellow-brown costa percurrent or slightly excurrent. Leaf cells smooth, transparent, chlorophyllose with rounded chloroplastids, rounded-hexagonal. Apical cells sub-quadrate, rounded, hexagonal, elongated at the tip $3.8\text{--}7.6 \times 5.7\text{--}9.5 \mu\text{m}$; middle cells quadrate-hexagonal $5.7\text{--}7.6 \times 7.6\text{--}11.4 \mu\text{m}$; basal cells quadrate to rectangular



Figure 3. *Fissidens grandifrons* Brid. **A.** Habit. **B–C.** A portion of plant. **D.** A portion of plant in dorsal view. **E.** Apical leaf cells. **F–G.** Leaves. **H.** Middle leaf cells. **I.** Cells near the costa at base of leaf. **J.** Basal leaf cells. **K.** Marginal leaf cells. **L.** Cross section of stem. **M.** Cross section of leaf.

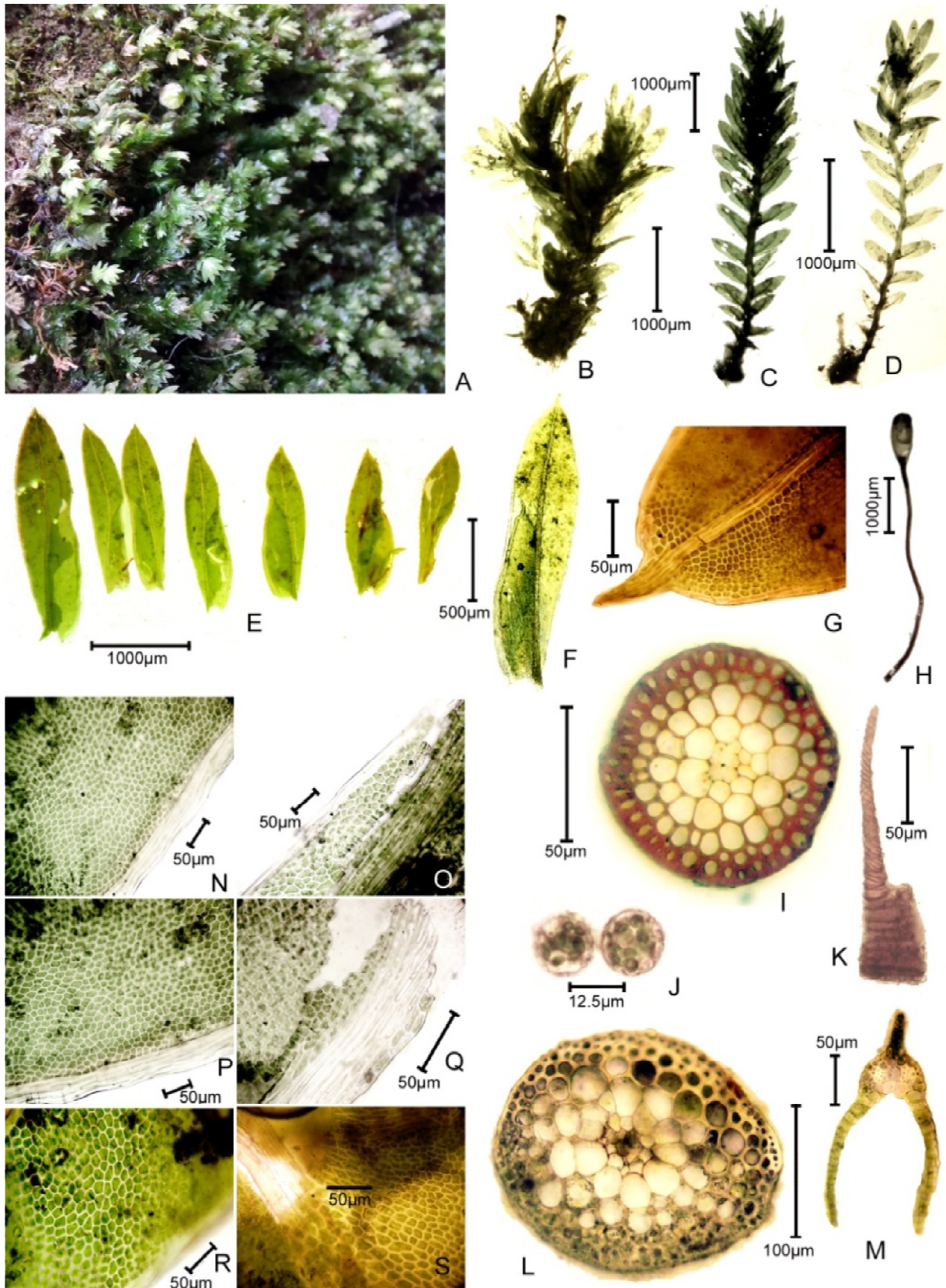


Figure 3

7.6–11.4 × 13.3–19 µm and cells near costa at 9.5–19 × 11.4–47.5 µm. Sporophyte: Single or two reddish setae arising from the tip 0.6 mm long, capsule not globose, 38–79.8 µm, operculum oblong rostrate. Peristome teeth 190 µm long with spiral thickening. Spores 9.5 µm in diameter.

Habitat: Growing in association with *Marchantia paleacea* Bertol., near a spring, where water was dripping all time.

Distribution: India: (Jammu and Kashmir – present record), Himachal Pradesh, Uttarakhand, S. India, China, Nepal, Europe, Japan, Taiwan, Malaya, Java, Philippines, Sri Lanka, Russia, North America, South America, Europe and Africa (Gangulee 1969–80; Churchill et al. 2000, O’Shea 2006, Pradhan & Joshi 2006, Ignatov et al. 2006, Pursell 2007, Ros et al. 2013).

Specimen examined: India: Jammu and Kashmir, District Budgam (Kremshora) 9.11.2021, Amarpreet Kour G-23 (BSD).

2. *Fissidens grandifrons* Brid.

Muscol. Recent. Suppl. 1: 170. 1806.

Figure 3

Gangulee, Mosses E. India, 564, 1972. *Skitophyllum strictum* Index Bryol. ed. 2, 4: 255. 1905. *F. diversiretis* Broth. Symb. Sin., 4: 11 1929. *F. grandifrons* Brid. var. *planicaulis* (Besch.) Nog. J. Hattori Bot. Lab. 7: 68. 1952.

Description: Plant rigid, semi erect or hanging, branched, shoots 5–10 cm long, 3–5 cm wide. more stiff when dry with little change in the leaves and making the axis of the plant very prominent. Stem without central strand but with highly thickened epidermal and hypodermal layers. Leaves numerous crowded, sometimes overlapping, stiff, ovate-lanceolate, with dentate margin and without border, narrowly obtuse to acuminate at tip measuring. Leaves 2–4 mm long and

0.4–0.8 mm wide. Sheathing lamini almost 2/3 the leaf length long. Leaf one layered only at margin, more layered at costa. Limbidium absent. Costa broad, ending one or two cell below the usually blunt apex, 19–32.3 µm wide. Dorsal lamina base slowly rounded to meet costa base. Sheathing lamini equal with acute tips. Stem oblong, 300 × 500 µm, Stem differentiated into central and peripheral regions. In centre cells are large 19.5–23.4 × 23.4–42.9 µm. At periphery cells are small, rounded to oval measuring 11.7–27.3 in diameter. Leaf cells quadrate, sub-quadrate or pentagonal-hexagonal, smooth, thick walled. Apical leaf cells pentagonal, oval, rounded, quadrate 7.6–7.6 × 7.6–15.2 µm; marginal cells quadrate, triangular or irregular 3.8–5.7 × 7.6–20.9 µm (at base); middle cells quadrate to sub-quadrate or pentagonal hexagonal, 7.6–15.2 × 5.7–7.6 µm; basal leaf cells rectangular, oval, quadrate, larger near costa 15.2–19 × 24.7–30.4 µm. Sporophyte not seen.

Habitat: Growing under water of Jhelum River.

Distribution: India: (Jammu and Kashmir – present record), Himachal Pradesh, Uttarakhand, S. India; China, Nepal, Japan, Taiwan, Malaysia, Java, Philippines, Sri Lanka, Russia, North America, South America, Europe and Africa (Gangulee 1969–80; Churchill et al. 2000, O’Shea 2006, Pradhan & Joshi 2006, Ignatov et al. 2006, Pursell 2007, Ros et al. 2013).

Specimen examined: India: Jammu and Kashmir, District Anantnag (Verinag) 14.11.2021, Amarpreet Kour G-26 (BSD).

3. *Fissidens taxifolius* Hedw.

Sp. Musc.: 155. 1801

Figure 4

Gangulee, Mosses E. India 544. 1972. *F. nipponensis* Sak., Bot. Mag. Tokyo 47: 743. 1933. *F. okinawaensis* Bartr., Bryologist 50: 160. 1947. *F.*



Figure 4. *Fissidens taxifolius* Hedw. A. Habit. B–D, G. A portion of plant. E–F. Leaves. H. Leaf tip. I. Apical cells. J. Cross section of seta. K. Capsule along with seta. L. Spores. M. Peristome teeth. N. Cross section of stem. O. Middle leaf cells. P–Q, S. Basal leaf cells. R. Middle leaf cells near costa. T. Marginal leaf cells.

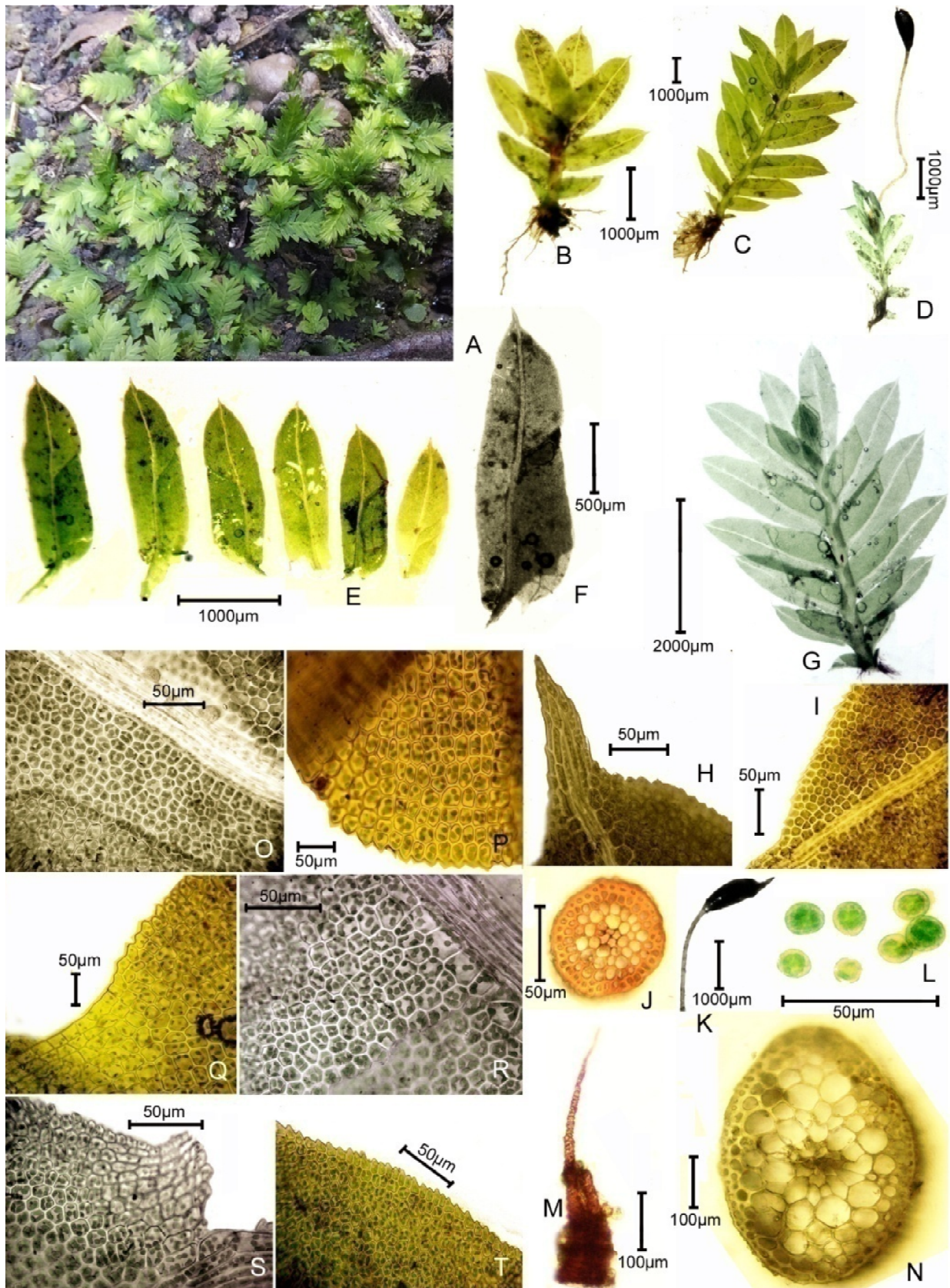


Figure 4

pallidulus Hamp. ex Gangulee, Bull. Bot. Soc. Bengal 11: 82. 1957.

Description: Plant yellow green to dark green, semi sturdy, shoots 0.4–1 cm long and 3 mm wide. Leaves 3 to 12 pairs, measuring 800–2060 μm long 340–600 μm wide, not much crumpled but curled circinate at the top of shoot when dry; oblong-lingulate, broadly acuminate, margin dentate. Leaf tip 76–114 μm . Dorsal lamina at base usually meeting stem at point of leaf attachment but undulating at base sometimes decurrent, usually not narrowing much before reaching base. Sheathing lamina covering half of the leaf length. Limbidium absent, Marginal layer of cells slightly irregular but usually differentiated and serrulated up to leaf base. margin shows a yellowish gleam, specially near apex. Stem rounded measuring, 195 \times 273 μm . Centre cells 5.7 μm in diameter and medullary 20.9 \times 26.6 μm . Costa of deep color, 46.8 μm wide at base short excurrent, tip ending in an apiculus measuring 76–114 μm . Leaf cells irregularly quadrate-hexagonal, transparent, chlorophyllose. Apical cells quadrate to sub-quadrate 7.6–9.5 \times 11.4–15.2 μm , marginal leaf cells quadrate to sub-quadrate 5.7–13.3 \times 9.5–15.2 μm ; middle leaf cell rounded, quadrate to sub-quadrate, pentagonal-hexagonal 7.6–9.5 \times 11.4–15.2 μm ; basal cells quadrate to sub-quadrate, pentagonal-hexagonal 7.6–15.2 \times 19–28.5 μm ; cells near costa at mid of leaf are comparatively larger 9.5–13.3 \times 15.2–19 μm ; lower laminal cells near costa are also large 38 \times 13.3 μm . Sporophyte on short lateral branch growing from the base of stem. Seta orange 1.2 cm long and 79.8 μm diameter long in dia. Capsule brown, horizontal, urn shaped 800–840 μm long, 360 μm wide; peristome teeth dicranate, 253.5 μm long. Spores 9.5 \times 11.4 μm .

Habitat: Growing just above water canal and besides natural water spring. It was growing in isolated patches in moist and shaded place which was covered with fallen leaves.

Distribution: India: (Jammu and Kashmir – present record), Himachal Pradesh, Uttarakhand, S. India, China, Nepal, Europe, Japan, Malaysia, Java, Philippines, Sri Lanka, Russia, Taiwan, North America,

South America, Europe and Africa (Gangulee 1969–80, Churchill et al. 2000, O’Shea 2006, Pradhan & Joshi 2006, Ignatov et al. 2006, Pursell 2007, Ros et al. 2013).

Specimen examined: India: Jammu and Kashmir, District Srinagar (Harwan) 4.11.2021, Amarpreet Kour G-19 (BSD).

DISCUSSION

Fissidens bryoides, *F. grandifrons* and *F. taxifolius*, related with subgenus *Fissidens* of the genus *Fissidens*, show close affinity with each other. *F. grandifrons* distinctly differs from *F. taxifolius* and *F. bryoides* for being robust plant. *F. grandifrons* further differs from *F. taxifolius* in having much wider leafy shoots, numerous leaves, in leaf size which is much bigger, blunt leaf apex, Sheathing lamina which covers 2/3rd of leaf, stem oblong, 300 \times 500 μm and thick leaf cells. Further, *F. bryoides* differs from *F. taxifolius*, in case of more leaf pair, presence of limbidium all around leaf and less acuminate leaf apex. Furthermore, *F. bryoides* differs from *F. grandifrons* in plant size, leaf no. leaf measurement, limbidium, leaf margin, leaf apex, sheathing lamina, stem and leaf cells. In *F. bryoides*, plant is small in size, 0.6–2.0 cm long and 0.4 mm wide, 7–17 pairs of leaves, leaf 1.4–2 mm long and 0.3–0.6 mm wide, limbidium all around leaf, smooth leaf margin, leaf apex acuminate 57 \times 38 μm , Sheathing lamina covering half of leaf length, stem round 195–253 μm in diameter, leaf cells thin walled. In *F. grandifrons*, plant is robust, numerous leaves measuring 2–4 mm long and 0.4–0.8 mm wide, limbidium absent, dentate margin, blunt apex, Sheathing lamina 2/3 the leaf length, stem oblong 300 \times 500 μm and leaf cells thick walled.

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