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A study on genus *Fissidens* Hedw. in Meghalaya (North-Eastern Hills), India

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ABSTRACT: During the recent study on the mosses of Meghalaya (North-Eastern Hills), six species of *Fissidens* have been identified from Shillong viz., *Fissidens anomalous* Mont., *F. elongatus* Mitt., *F. gardneri* Mitt., *F. obscurus* Mitt., *F. pellucidus* Hornsch.and *F. pulchellus* Mitt. Among these *Fissidens gardneri* and *Fissidens pellucidus* are new additions to eastern Himalaya, while *Fissidens pulchellus* Mitt. is new to Meghalaya. The present paper provides the detailed taxonomic account of the *F. gardneri*, *F. pellucidus* and *F. pulchellus* Mitt. and taxonomic notes on other species of genus occurring in Meghalaya.

KEY WORDS: Bryophyta, *Fissidens*, India, North-Eastern Hills.

INTRODUCTION

Meghalaya is a state of diverse climate and topography, with rainiest places of the world, Cherrapunji and Mawsynram. These ecological factors favour extreme speciation and luxuriant growth of floristic elements, enriching the bryophyte diversity in this region. The area comprises of East Khasi Hills, West Khasi Hills, Jaintia Hills, East Garo Hills, West Garo Hills and Ribhoi districts covering about 22,429 sq-km-between 24°58'–26°8'N –latitude and 89°47'–92°50'E longitudes with the altitude ranging from 182–1950 m. (Fig. 1)

The family Fisssidentaceae is one of the largest families of haplolepidous acrocarpous mosses, established by Hedwig J. (1801). Various workers like Cardot (1907), Iwatsuki (1969), Chopra (1974), Gangulee (1969–80), Allen (1980), Iwatsuki and Suzuki (1982a), Pursell (1982), Li (1985), Pursell (1990), Kattel and Adhikari (1992), Ishihara and Iwatsuki (1992), Pradhan (2000), Li and Iwatsuki (2001), Pursell and Bruggeman-Nannenga (2004), Pradhan and Joshi (2007), Pursell (2007), Bruggman-Nannenga and Theo Arts (2010), Nathet *et al.* (2011) studied the genus in different parts of the world from time to time. As far as systematic treatment of the family is concerned Brotherus (1901, 1924) included four genera viz., *Simplicidens* Hertz., *Moenkemeyera* C. Muell., *Fissidentella* Cardot., and *Fissidens* Hedw. in the family. However, Pursell and Bruggeman-Nannenga (2004) have reclassified Fissidentaceae, with a single genus, *Fissidens* in the family with four subgenera viz., Aloma C. Muell, *Fissidens* Hedw., *Octodiceras* (Brid.) Broth. and *Pachyfissidens* (C.Muell.) Kindb. About 450 species of genus *Fissidens* are known worldwide (Pursell, 2007), whereas 62 taxa are known from India (Lal, 2005), out of which 33 species are distributed in eastern Himalaya, 25 in western Himalaya, 26 in South India, 14 in central India and 11 species in the Gangetic plains. So far as the diversity of genus in Meghalaya is concerned only 13 species are known from this region in the present state of our knowledge. The genus *Fissidens* can be distinguished on the basis of a set of characters comprising unicostate distinctive leaves, invariably distichous and complanate, with characteristic sheathing or vaginant lamina in most cases and presence of haplolepidous peristome.

TAXONOMIC TREATMENTS

Key to the species of genus *Fissidens* Hedw.in Meghalaya

1a. Leaves with limbidium ..... ***F. bryoides***
1b. Leaves elimbate 2
2a. Leaf margin differentiated 3
2b. Leaf margin undifferentiated 4
3a. Leaf margin one cell rowed ……..……..... ***F. jungermannioides***
3b. Leaf margin multi-cell rowed with lighter colour border 5
4a. Leaf margin 3-4 cell rowed and irregularly toothed..... ***F. nobilis***
4b. Leaf margin bordered by a light colour band of 1–3 rows of thick walled cells ..... ***F. anomalus***
5a. Plants up to 10 mm in size 6
5b. Plants 10–80 mm in size 7
6a. Plants 2–6 mm in size 12
6b. Plants 10 mm in size ..... ***F. pulchellus***
7a. Leaf cells incrassate ..... ***F. elongatus***
7b. Leaf cells smooth 8
8a. Leaf margin serrulate up to leaf base..... ***F. taxifolius***
8b. Leaf margin crenulate to dentate at apex only…..... 9
9a. Costa ending nearly seven cells below apex..... ***F. obscurus***
9b. Costa ending just below apex 10
10a. Sheathing lamina open or unequal ..... ***F. polypodioides***
10b. Sheathing lamina closed or equal..... 11
11a. Leaf circinately coiled at top when dry ..... ***F. crispulus***
11b. Leaf not circinately coiled at top when dry ..... ***F. dubius***
12a. Leaf cells unipapillate..... ***F. pellucidus***
12b. Leaf cells pluripapillate..... ***F. gardneri***

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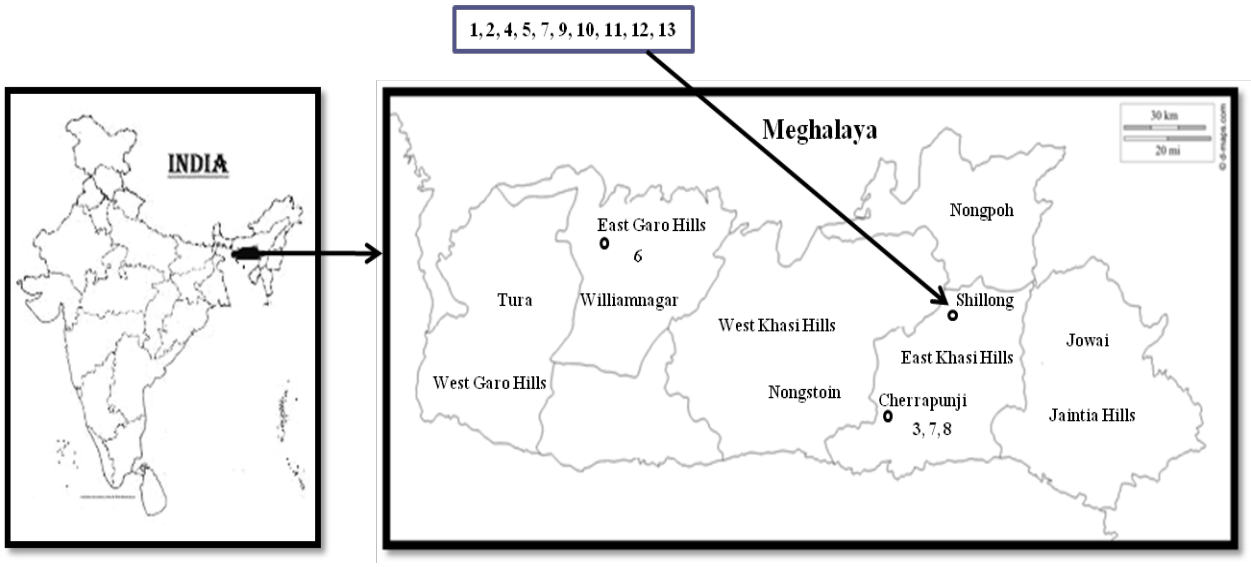


Fig 1. Map showing the collection sites in Meghalaya, India. 1. *F. bryoides* Hedw. 2. *F. crispulus* Griff. 3. *F. elongatus* Mitt. 4. *F. nobilis* Griff. 5. *F. jungermannioides* Griff.6. *F. dubius* P. Beauv. 7. *F. anomalus* Mont.8. *F. obscurus* Mitt. 9. *F. gardneri* Mitt. 10. *F. pellucidus* Hornsch.11. *F. pulchellus* Mitt. 12. *F. polypodioides* Hedw. 13. *F. taxifolius* Hedw.

Fissidens anomalous Mont. - Ann. Sci. Nat. Bot. ser.2, 17: 252, 1842. Fig. 2

This species is distributed in Shillong (Cherrapunji) at an altitude of 4700ft. It grows epiphytically and is characterized by short decurrent, vaginant lamina ½ of the length of dorsal lamina, closed, costa excurrent, sometimes ending below apex, margin near leaf apex denticulate, crenulate to serrulate throughout, bordered by a lighter colored band of 1–3 rows of thick walled cells.

Specimen examined: **INDIA**: Eastern Himalaya, Shillong, Cherrapunji (ca. 4700ft alt.) epiphytic - Apr. 7, 1965, leg. S. Chandra, 201093-A (LWG).

Range of Distribution: Eastern Himalaya (Meghalaya, Sikkim, West Bengal), South India (Tamil Nadu), western Himalaya (Himachal Pradesh); Burma, Ceylon, Java, Thailand, Philippines,Vietnam, Yunnan.

Fissidens bryoides Hedw. Sp. Musc. Frond.153: 1801.

This is a common species of genus *Fissidens* which is distributed in eastern Himalaya, South India and western Himalaya. This species is characterized by plants up to 7mm with 4–6 pairs of leaves, leaves oblong lanceolate with dorsal lamina wedge shaped at base, costa percurrent or ending below apex, sheathing lamina unequal, open, limbidium with one celled row at tip and 2–3 - cells rowed at base of leaf.

Range of Distribution: Eastern Himalaya (Meghalaya), South India (western Ghats), western Himalaya (Himachal Pradesh, Uttarakhand); Caucasus, Ceylon, China, Europe, Japan, Java, Malay, North and South America.

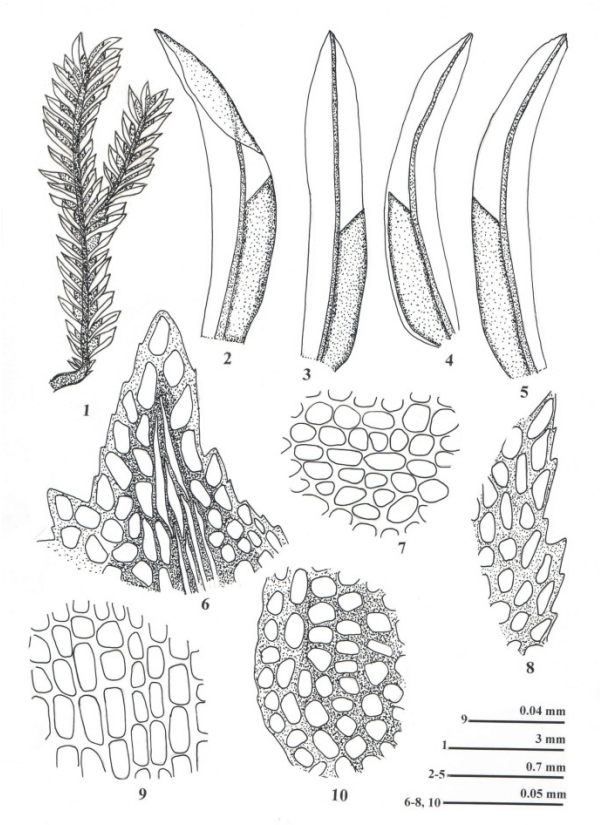


Fig. 2. *Fissidens anomalous* Mont.1: Plant. 2-5: Leaves. 6: Apical cells of leaf. 7: Middle cells of leaf. 8: Marginal cells of leaf. 9: Basal cells of sheathing lamina. 10: Basal marginal cells of dorsal lamina. (drawn from LWG 201093A)

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Fissidens crispulus Brid. Muscol. Recent. Suppl. 4: 187. 1819[1818].

This wide ranging species was earlier known as *Fissidens sylvaticus* Griff. (Gangulee 1969–80). It is a highly variable species and is characterized by small to medium sized plants (2–20 mm), about 5–32 pairs of leaves, leaf - with costa ending below apex, sometimes percurrent, excurrent, or shortly mucronate. Leaf margin slightly denticulate or crenulate, sheathing lamina equal, closed, leaf cells somewhat obscure.

Range of Distribution: Eastern Himalaya (Assam, Meghalaya, W. Bengal), Gangetic plains (Bihar, Orissa), South India (Tamil Nadu), western Himalaya (Uttarakhand); Algeria, Borneo, Burma, Celebs, Central Africa, Hong Kong, Japan, Java, Madagascar, New Guinea, New zealand, Philippines, Thailand, Vietnam.

Fissidens dubius P. Beauv. Prodr. Aetheogam. 57. 1805.

This species was earlier treated as *F. cristatus* Wilson & Smith (Gangulee 1969–80). The species can be easily identified by medium sized Plants up to 25mm. Leaf usually rolled when dry, sheathing lamina usually equal, closed, tumescent and obscure leaf cells with 3–4 marginal rows of obscure incrassate cells; margin of sheathing lamina deeper brown.

Range of Distribution: Eastern Himalaya (Meghalaya), South India (Tamil Nadu), Western Himalaya (Uttarakhand, Jammu & Kashmir); Caucasus, Ceylon, East Nepal, Europe, Japan, Java, Korea, North Africa, North America, Sakhalin.

Fissidens elongatus Mitt. J. Proc. Linn. Soc., Bot. Suppl. 2:139 1859. Fig. 3

This species is endemic to Meghalaya in India. Plant is terrestrial and can be found at an altitude of 915m. This taxon can be identified by its large size of plant about 80 mm with curled and crumpled leaves. Margin of leaves slightly toothed at apex, cells are quite incrassate and crenulated at base, costa percurrent, presence of large size patch of cells near costa, sheathing lamina unequal, open. This specimen is examined from Shillong (Cherrapunji), at an altitude of 914.4m on soil.

Specimen examined: **INDIA**: eastern Himalaya, Shillong, Cherrapunji, ca 3000ft alt., - on soil, - Apr. 7, 1965, leg. S. Chandra, 201136 (LWG).

Fissidens gardneri Mitt., J. Linn. Soc. Bot. 12: 593. 1869. Fig. 4

Plants small, green, brownish when old 2–4 mm long, rhizoids smooth, leaves in - 6–9 pairs, 0.4 – 0.6 × 0.1mm, oblong, apex obtuse to rounded, base of dorsal lamina narrow, vaginant lamina 0.4 × 0.5 mm, costa ending four to five cells below apex; leaf cells quadrate to rounded, multipapillose, apical cells of leaf 6 × 6 µm, few cells at base slightly become narrow, 6 × 0.3 µm,

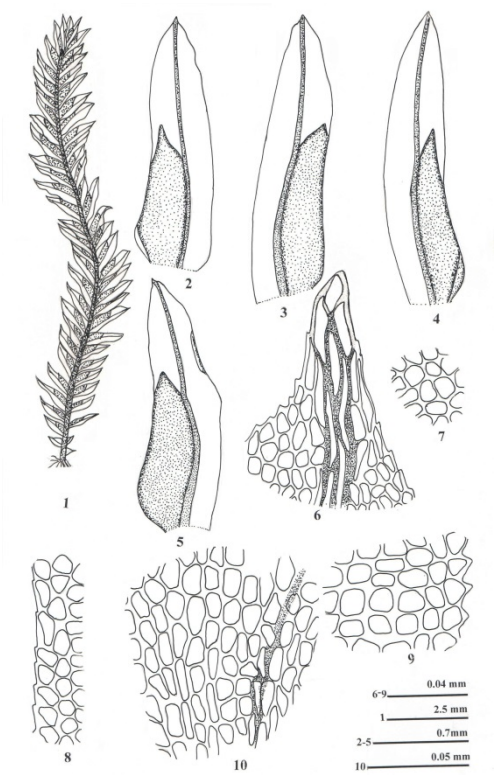


Fig. 3.*Fissidens elongatus* Mitt.1: Plant. 2-5: Leaves. 6: Apical cells of leaf. 7: Middle cells of leaf. 8: Marginal cells of leaf. 9. Marginal cells of dorsal lamina. 10: Basal juxtacostal cells. (drawn from LWG 201136).

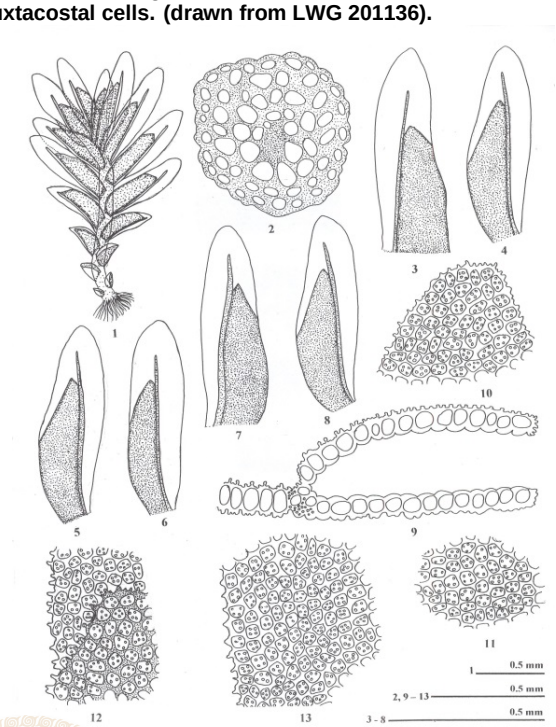


Fig. 4. *Fissidens gardneri* Mitt.1: Plant. 2: Cross section of stem. 3–8: Leaves. 9: Cross section of leaf. 10: Apical cells of leaf. 11: Middle cells of leaf. 12: Cells of sheathing lamina. 13: Cells of dorsal lamina. (drawn from LWG 251539B).

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margin crenulated by projection of cells, no differentiated border even on upper leaves, B/L = ± 25/100, S/L= ±66.6/100. Limbidium absent. Sporophytes not seen.

Specimen examined: **INDIA**: Eastern Himalaya, Meghalaya, Shillong, Lum Nehru Park, Umiam, ca 3500ft alt., epiphytic, Oct. 23, 2010, V. Sahu & V. Awasthi 251539B (LWG).

Range of Distribution: Eastern Himalaya (Meghalaya), South India (Kerala).

Fissidens jungermannioides Griff. Calcutta J. Nat. Hist. 2: 504. 1842.

This species is known from India and China and in India it is endemic to Meghalaya. It is characterized by plants up to 3mm with 22 pairs of leaves, open sheathing lamina, unequal, costa shortly excurrent but sometimes vanishes below apex, leaf cells quadrate, hexagonal, incrassate, obscure.

Range of Distribution: Eastern Himalaya (Meghalaya); China.

Fissidens nobilis Griff. Calcutta J. Nat. Hist. 2: 505. 1842.

The species is characterized by plants up to 80mm in size with up to 36 pairs of leaves, sheathing lamina unequal, open, margin irregularly toothed at apex. Leaf margin 3–4 layered thick which looks darker except at base, leaf cells incrassate.

Range of Distribution: Eastern Himalaya (Darjeeling, Manipur, Meghalaya, Nagaland), western Himalaya (Uttarakhand); Borneo, Burma, Celebs, Ceylon, East China, Fiji, Hong Kong, Japan, Java, Malay, New Guinea, Sumatra, Taiwan, Thailand, Vietnam, Yunnan.

Fissidens obscurus Mitt., J. Proc. Linn. Soc., Bot. Suppl. 2: 138, 1859.Fig. 5

The taxon is characterized by dorsal lamina narrowing down at base, decurrent. Leaf cells irregularly rounded, quadrate, hexagonal. Margin of apex crenulate, entire below, leaf tip obtuse, sheathing lamina usually unequal, open; basal cells of sheathing lamina are longer.

Specimen examined: **INDIA**: Eastern Himalaya, Shillong, Cherrapunji (ca 4700ft alt.) epiphytic Apr. 7, 1965, leg. S. Chandra, 201095-A (LWG).

Range of Distribution: Central-India (Gujarat), eastern Himalaya (Meghalaya), western Himalaya; China, Japan, Nepal.

Fissidens pellucidus Hornsch., Linnaea.15: 146, 1841. Fig. 6

Plants small, reddish brown, 5–6 mm, leaves in 6–7 pairs, upper leaves larger than lower ones, lanceolate, apex acute- acuminate, wide at middle with sheathing lamina about 0.43 mm long, unequal, open, dorsal lamina narrow at base. B/L = ± 24.6/100, S/L =± 50/100. Costa percurrent or short excurrent. Cells of lamina irregular, quadrate- hexagonal, unipapillose with central position, about 10–11µm wide, larger at sheathing lamina base about 14–15µm. Limbidium

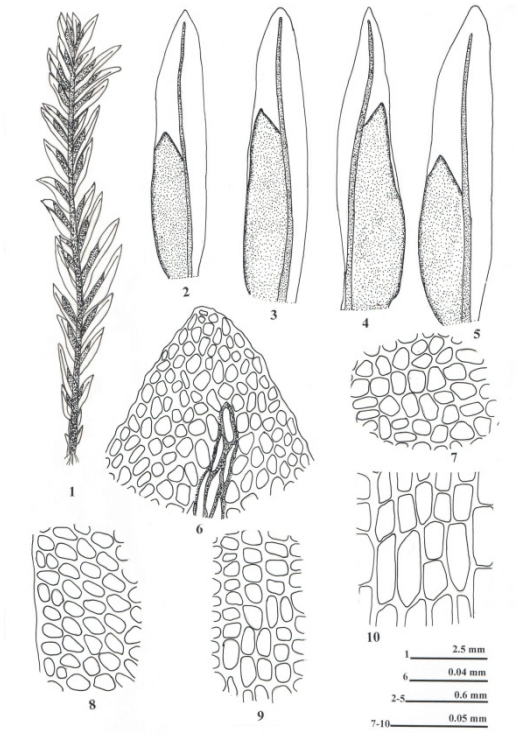


Fig. 5. *Fissidens obscurus* Mitt.1: Plant. 2-5: Leaves. 6: Apical cells of leaf. 7: Middle cells of leaf. 8: Marginal cells of leaf. 9: Basal cells of dorsal lamina. 10: Basal cells of sheathing lamina. (drawn from LWG 201095A).

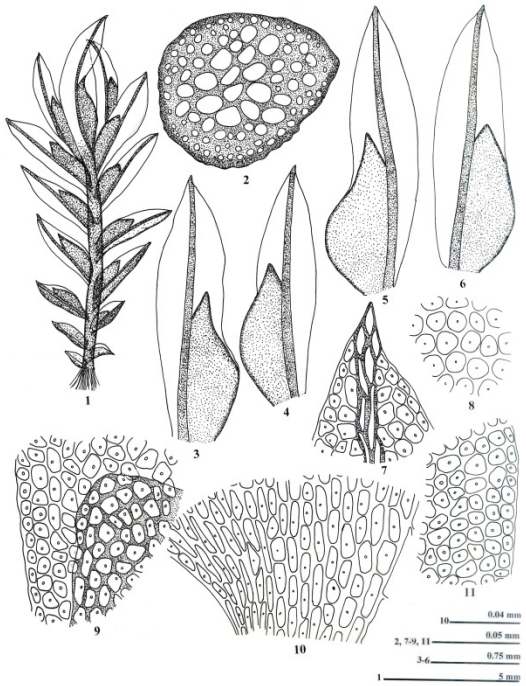


Fig 6. *Fissidens pellucidus* Hornsch.1: Plant. 2: Cross section of stem. 3–6: Leaves. 7: Apical cells of leaf. 8: Middle cells of leaf. 9: A portion of dorsal lamina & sheathing lamina. 10: Basal cells of sheathing lamina. 11:Basal cells of dorsal lamina. (drawn from LWG 252540).

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absent, several rows of elongated cells at extreme margin of base. Sporophyte not seen.

Specimen examined: **INDIA**: Eastern Himalaya, Shillong, Umiam, Lum Nehru Park ca 3500ft alt., on soil, Nov. 23, 2010, S. Chandra, 252540 (LWG).

Range of Distribution: Eastern Himalaya (Meghalaya), South India (Maharashtra, Kerala).

Fissidens polypodioides Hedw. Sp. Musc. Frond. 154. 1801.

This species was earlier described as *Fissidens areolatus* Griff. but latter treated as synonym under *Fissidens polypodioides*. This taxon is characterized by medium sized plant with obstuse leaf tip, costa vanishing below leaf apex, cells are highly obscure by tumescence specially at tip, leaf margin usually denticulate.

Range of Distribution: Eastern Himalaya (Meghalaya), central India (Gujarat) and western Himalaya; East Nepal.

Fissidens pulchellus Mitt., J. Linn. Soc., Bot., Suppl. 2: 140. 1859. Fig. 7

Plants about 10mm long; leaves in up to 20 pairs, oblong lanceolate, denticulate, 1–1.3 mm long, 0.2 mm wide, sheathing lamina unequal, open, dorsal lamina sometimes rounded at base, costa excurrent in a short apiculus or percurrent. B/L = ± 25.5 / 100, S/L = ± 52.6/100. Lamina cells quadrate- hexagonal, 9 - 10 µm with papillae on each cell. At extreme base cells are about 20 µm, margin denticulate. Sporophyte not seen.

Specimen examined: **INDIA**: Eastern Himalaya, Meghalaya, near Shillong peak, ca 6000ft alt. on soil, Oct. 27, 2010, *V. Sahu & V. Awasthi 252338B* (LWG).

Range of Distribution: Central India (Madhya pradesh), eastern Himalaya (Arunachal Pradesh, Meghalaya, West Bengal,), South India (Kerala, Tamil Nadu); East Nepal.

Fissidens taxifolius Hedw. Sp. Musc. Frond. 155. Pl. 39. F. 1–5. 1801.

This is a widely distributed species and commonly found in eastern Himalaya and western Himalaya . It can be identified by plants up to 20mm in size, leaves with short excurrent costa ending in a short apiculus, margin of leaf irregular at apex and crenulate at base, sheathing lamina unequal, open, leaf cells tumescent, quadrate to hexagonal.

Range of Distribution: Eastern Himalaya (Meghalaya, W. Bengal), western Himalaya (Himachal Pradesh, Jammu & Kashmir, Uttarakhand,); West Nepal, Canary Is., Caucasus, Central Asia, Japan, Korea, Maderia, North Africa, North, Central & South America, Persia, Ryukus, Sakhalin.

DISCUSSION

As far as habitat preference of the species of *Fissidens* in Meghalaya is concerned, most of them are terrestrial except two viz., *F. anomalous* and *F. obscurus* which are epiphytic. The most commonly growing species in the area are *F. pulchellus* and *F. pellucidus*. The plants of the latter species are smaller, about 5 mm long, recorded at the elevation of 1020 m. *Fissidens pellucidus* which was earlier described as *F. laxus* Sull. & Lesq. (Li 1985) is closely allied to *Fissidens guangdongensis* Z. Iwat. & Z. H. Li, but the former is different from latter in the presence of short excurrent to percurrent costa ceasing 6–9 cells below apex in latter species. *F. obscurus* shows resemblance with *Fissidens involutus* Wilson ex Mitt. and *F. polypodioides* Hedw. but differs from latter two taxa in having obstuse to obstusely acute leaf apex, with the costa ending several cells below the leaf apex. Another species *F. anomalous* has strong resemblance with *F. dubius* P. Beauv. (=*F cristatus* Wilson & Mitt.) although they differ in their leaf shape, which is narrowly lanceolate in *F. anomalous* with a 1–3 cells wide light coloured border, while it is linear lanceolate in *F.dubius* with 3-4 rows of cells forming the border. Among the other species of Meghalaya, *F. polypodioides* was earlier described as *F. areolatus* Griffith (Gangulee, 1969–80).

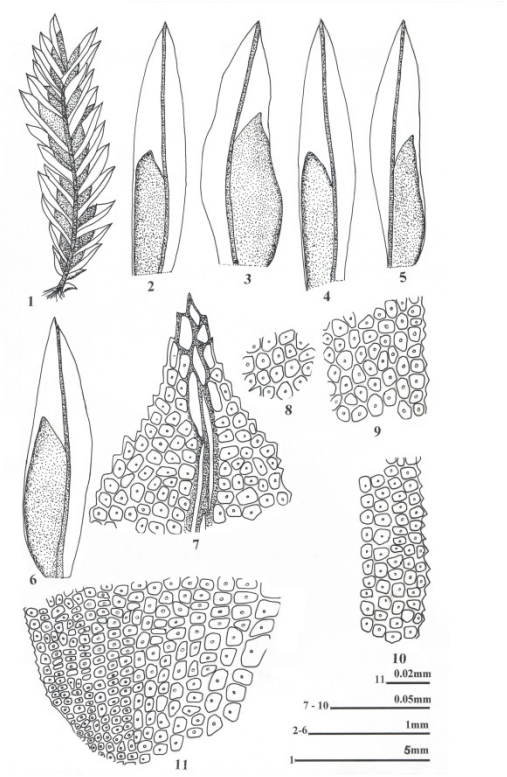


Fig.7. *Fissidens pulchellus* Mitt.1: Plant. 2-6: Leaves. 7: Apical cells of leaf. 8: Median cells of leaf. 9: Marginal cells of leaf. 10: Marginal cells of dorsal lamina. 11: Basal cells. (drawn from LWG252338B).

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Fissidens mittenii Par. is now considered under *F. pellucidus* Hornsch. (Moss Flora of China, 2001). Diversity of above 13 species (known from Meghalaya) in different Bryogeographical regions of India is presented in Table 1. Among these *F. bryoides* Hedw., which is common and widely distributed species, occurs in western Himalaya, Gangetic plains and South India, while *F. taxifolius* Hedw. and *F. obscurus* are common to western Himalaya and central India.

Table 1.Distributional relationship of the species of *Fissidens* occurring in Meghalaya with other bryo-geographical regions of India.(EH= Eastern Himalaya, GP= Gangetic Plains, WH= Western Himalaya, CI= Central India, SI= South India)

Species Name	EH	WH	CI	GP	SI
Fissidens bryoides	+	+	–	+	+
Fissidens crispulus	+	–	+	–	–
Fissidens taxifolius	+	+	+	–	–
Fissidens nobilis	+	+	–	–	–
Fissidens jungermannioides	+	–	–	–	–
Fissidens dubius	+	–	–	–	+
Fissidens anomalus	+	+	–	–	+
Fissidens obscurus	+	+	+	–	–
Fissidens polypodioides	+	–	+	–	–
Fissidens elongatus	+	–	–	–	–
Fissidens gardneri	+	–	–	–	+
Fissidens pellucidus	+	–	–	–	+
Fissidens pulchellus	+	–	+	–	–

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