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

Ashish K. Asthana* and Ankita Srivastava
Bryology Laboratory, CSIR-National Botanical Research Institute, Lucknow – 226 001, India.
*Corresponding author: drakaasthana@rediffmail.com

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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 anomalus 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 and Ribhori 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 Fissidentaceae 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 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), Nath 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. broyoides  
1b. Leaves eliminate .......................................................... 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 ....................................................... 10
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. polypodioide  
10b. Sheathing lamina closed or equal .................................. 11
11a. Leaf circinately coiled at top when dry .................... F. crisipalus
11b. Leaf not circinately coiled at top when dry ................. F. dubius
12a. Leaf cells unipapillate .................................................. F. pellucidus
12b. Leaf cells pluripapillate ............................................. F. gardneri

**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.


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


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)
**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.


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 incressate 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 incressate 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.


**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,
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.


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


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.


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.


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).
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).


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 obtuse 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.


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, Uttarakhind); 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. anomalus* 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 obustue to obstusely acute leaf apex, with the costa ending several cells below the leaf apex. Another species *F. anomalus* 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. anomalus* 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).

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**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).
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)

<table>
<thead>
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<th>Species Name</th>
<th>EH</th>
<th>WH</th>
<th>CI</th>
<th>GP</th>
<th>SI</th>
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<tbody>
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<td>Fissidens bryoides</td>
<td>+</td>
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<tr>
<td>Fissidens taxifolius</td>
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<tr>
<td>Fissidens nobilis</td>
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<tr>
<td>Fissidens jungkennioiides</td>
<td>+</td>
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<tr>
<td>Fissidens dubius</td>
<td>+</td>
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<tr>
<td>Fissidens anomalous</td>
<td>+</td>
<td>+</td>
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<tr>
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<tr>
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<td>+</td>
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<tr>
<td>Fissidens pulchellus</td>
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LITERATURE CITED


