NOTE

Genus *Fissidens* Hedw. (Fissidentaceae, Bryopsida) at Pachmarhi Biosphere Reserve (Madhya Pradesh), India

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ABSTRACT: Studies on the moss flora of Pachmarhi Biosphere Reserve (PBR), Madhya Pradesh, India, have revealed the occurrence of six taxa of the genus *Fissidens* Hedw., namely *F. asperisetus* var. *andamanensis* Gangulee, *F. ceylonensis* Doz. et Molk., *F. crispulus* var. *crispulus* Brid., *F. involutus* Wils. ex Mitt., *F. pulchellus* Mitt., *F. taxifolius* Hedw., belonging to the family Fissidentaceae (Bryopsida), distributed in 8 localities of the region. Among these, *F. asperisetus* var. *andamanensis* Gangulee is new to central Indian bryogeographical region while *F. ceylonensis* and *F. involutus* are new to PBR. The species scatter at various localities of the PBR, mostly terrestrial, but with a single epiphytic species of *F. taxifolius.*

KEY WORDS: Moss, Fissidentaceae, Pachmarhi Biosphere Reserve, central India.

INTRODUCTION

The mosses of central India have received considerable attention in the recent years by providing enumerations and accounts of the moss flora (Bapna, 1975; Deora and Chaudhary, 1996, Chaudhary and Deora, 2001; Chaudhary and Sharma, 2002; Nath and Gupta, 2007, 2008; Nath et al., 2005, 2007, 2008). However, the mosses of the Pachmarhi Biosphere Reserve (PBR) have not been described previously to an extent that can satisfy the want of a researcher. PBR lies in Madhya Pradesh, India, covering three civil districts of Chhindwara, Betul and Hoshangabad, casing an area of 4987.38 square km (Fig. 1). The region has been declared as a Biosphere Reserve since 1999 under UNESCO's Man & Biosphere (MAB) Programme and also a part of the 'Project Tiger' since 2000. Nearly 57 species of liverworts, 3 species of anthocerotes and 47 species of mosses have been reported from here so far (Singh and Kaul 2002), however, any detailed account of the bryoflora is still not available.

Fissidentaceae is a moss family that can be very aptly 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. The peristome is haplolepidous. Initially, the family was divided into four genera by Brotherus (1901, 1924) viz. *Simplicidens* Hertz., *Moenkemeyera* C. Muell., *Fissidentella* Cardot., and *Fissidens* Hedw. The genus *Fissidens*, is the most important and abundant amongst these. Recently, Pursell and Bruggeman – Nannenga (2004) have rearranged Fissidentaceae to include a single genus, *Fissidens*, which is further divided into four subgenera, *Aloma*, *Fissidens*, *Octodiceras,* and *Pachyfissidens*,on the basis of new taxonomically useful characters i.e., peristome type, costa type, and number of layers of exothecial cells.

Fissidens Hedw. is highly variable in the terms of gametophytic characters, which may be explained by the infrageneric classification followed by some workers in the past. From the very first classification onwards, there have been quite a few refinements including changes taking place at different levels. Various workers classified specimens on the basis of peristomial as well as gametophytic characters, as the characters of peristome alone were not sufficient to account for the proper taxonomy of the family. A complex taxonomic pattern has led the workers to take manifold approach towards the identification and naming of species under the genus. Numerous workers have tried to assign status to the taxa and dispense proper synonyms to them. Noteworthy contributions in this regard are those of Bruggeman – Nannenga and Berendsen (1990), Bruggeman – Nannenga and Roose (1990, 1990a), Stone (1991), Bruggeman – Nannenga and Iwatsuki (1994), Bruggeman – Nannenga and Pursell (1995) and Bruggeman – Nannenga (1997). Studies on Asiatic taxa of Fissidentaceae have been carried out by several workers (Iwatsuki, 1967, 1969, 1980; Pursell, 1982; Iwatsuki and Suzuki, 1982, 1996, 2005; Iwatsuki and Inoue, 1984; Pursell *et* al., 1992; Iwatsuki *et* al., 1998; Zhang *et* al., 1998; Pradhan and Joshi 2006) and in the Indian context studies have been performed by Norkett (1969), Gangulee (1969-1972), Ellis (1992), Dabhade (1998), Chaudhary and Deora (2001), Daniels and Daniel (2003), Nair *et* al. (2005), Lal (2005, 2007), Madhusoodnan *et al*. (2007) and

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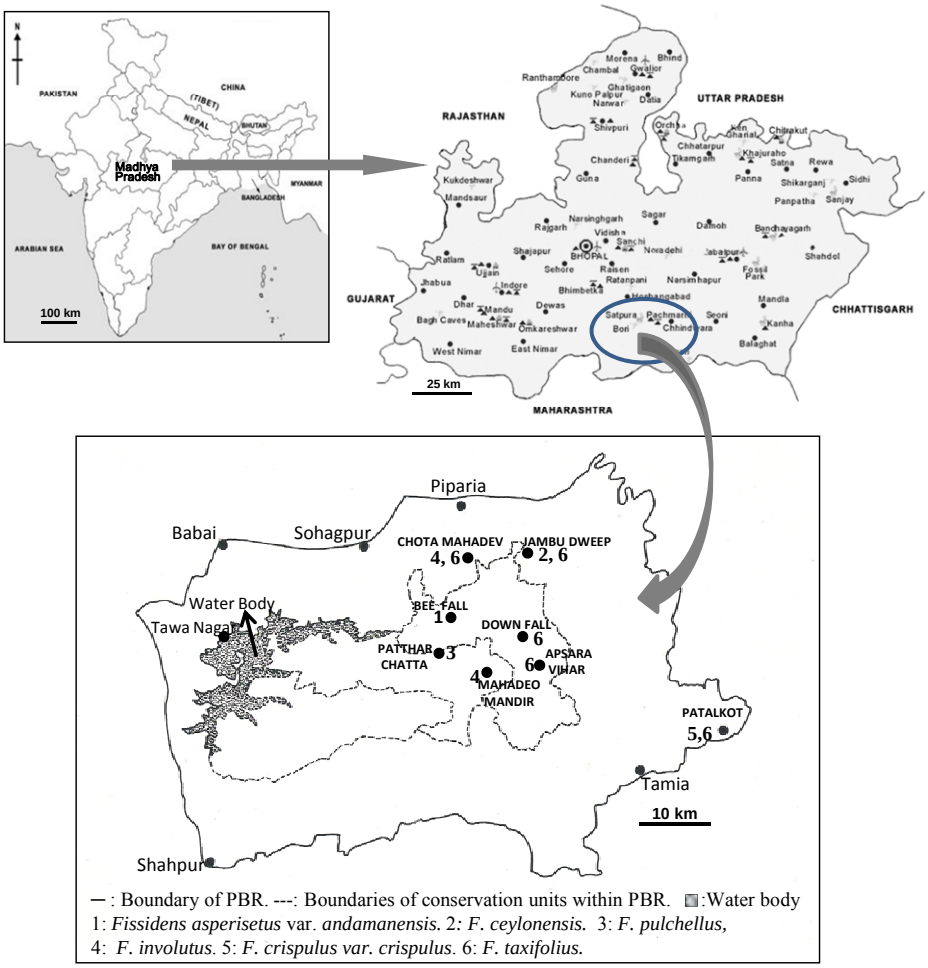


Fig. 1. Map of the Pachmarhi Biosphere Reserve (PBR)and the collection sites of this study.

Vashishta (2007) etc. *Fissidens* Hedw. has been assigned nearly 900 species by Wijk *et* al. (1962) which is about 826 throughout the world according to some workers. Pursell (1982) has given the opinion that the number of species is bound to get reduced due to synonymy.

In the present study, six taxa of *Fissidens* viz. *F. asperisetus* var. *andamanensis* Gangulee, *F. ceylonensis* Doz. et Molk., *F. crispulus* var. *crispulus* Brid., *F. involutus* Wils. ex Mitt., *F. pulchellus* Mitt., *F. taxifolius* Hedw. have been undertaken, which have been encountered from PBR. Although, Singh and Kaul (2002) have mentioned two species, *F. sylvaticus* var. *zippelianus* (Doz. et Molk.) and *F. subpulchellus* Norkett., from the region, but a detailed description has not been provided. The present study provides an account of the members of Fissidentaceae present at the Biosphere Reserve. There have been some changes and additions to the existing knowledge. Iwatsuki (1980) suggested that about 10 species from Asia are needed to be reduced to synonym. Hence the status of some species taken up by the Indian workers has been revised in accordance with the latest works (O' Shea, 2002 and e-journal: Moss Flora of China, 2007). For example, *F. sylvaticus* var. *zippelianus* has been reduced as synonym of *F. crispulus* var. *crispulus, F. sylvaticus* to that of *F. taxifolius* and *F. subpulchellus* to that of *F. pulchellus* respectively. The Authors have followed the classification provided by Vitt (1984).

MATERIALS AND METHODS

The specimens were collected during the years 1992, 1993 and 2006 respectively from 8 localities of PBR covering an altitudinal range of 400 to 1100 meters. The specimens were collected from terrestrial habitats such as rocks, soil covered rocks, wet rocks etc. and from tree bark as well and have been deposited in the Bryophyte herbarium, NBRI, Lucknow (LWG), India. The area covered under PBR and the major sites of plant collection has been shown in the Map (Fig. 1). The material was studied in detail and the taxonomic observations were recorded to perform the identification.

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TAXONOMIC TREATMENTS

Key to the species of *Fissidens* at PBR

1. Plants with incomplete semilimbidium ……..…..…… 2
1. Plants without semilimbidium ……..…… 3
2. Plants larger in size, with more than 20 leaf pairs, leaf tip broader, marginal leaf cells lighter in colour at times ……..... ……. 1. *F. asperisetus var. andamanensis*
2. Plants smaller in size, with 8 to 12 leaf pairs, leaf tip acute, marginal leaf cells of same colour ……..…….… 2. *F. ceylonensis*
3. Plants with less than 14 leaf pairs, leaves mostly equally broad from base till near the tip ……..……...…. 3. *F. pulchellus*
3. Plants with 14 or more leaf pairs, leaves broader at base, narrower upwards …… 4
4. Leaf margin crenulated due to cell projections, dorsal leaf lamina rounded at base, costa ending below (3-4 cells below) tip ……..…… 4. *F. involutus*
4. Leaf margin slightly irregular due to cell projections, costa ending just below tip or slightly extended forming a mucronate apex ……..... 5
5. Dorsal lamina gradually tapering to base and ending at leaf insertion ……...……. 5. *F. crispulus var. crispulus*
5. Dorsal lamina undulating at base, not narrowing much before reaching base ……...……..…… 6. *F. taxifolius*

OBSERVATIONS

1. ***Fissidens asperisetus* var. *andamanensis*** Gangulee in Mosses of Eastern India and Adjacent Regions 1: 507, 1972. Figs 2: 1-13

Plants terrestrial, yellowish green, upto 14 mm long with 26 leaf pairs. Leaves oblong, ligulate with somewhat broader tip more or less1.93 × 0.43 mm in size; with sheathing lamina upto 1.12 mm long (B/L = approx. 22/100, S/L = 57.8/100), mostly unequal (open). Leaf margin shows slight crenulations attributed to the projecting marginal cells; cells with 1-2 papillae, more or less 6 µm in upper and middle region. Costa ending just below tip. Semilimbidium covers nearly half of the leaf length, vanishing afterwards. Archegonial clusters of 8-10 archegonia is present on apical portion of lateral shoots, deep red in colour. Perichaetial leaves more slender than vegetative leaves. Sporophyte not seen.

Ecology and distribution: On wet rock, on the way to Bee Fall, 818 m, growing in association with *Phaeoceros laevis* subsp. *laevis* Prosk. and *Bryum paradoxum* var. *reflexifolium* Ochi (Ochi).

Range of distribution: Celebs, Java, India: central India (PBR), south India (Kerala), Andaman & Nicobar Islands, Philippines, Sri Lanka.

Specimens examined: India, Madhya Pradesh, Pachmarhi: near Bee Fall, alt. ca 818 m, 30.11.2006, growing on wet rock, leg. *V. Sahu & V. Awasthi. 227666C* (LWG).

2. ***Fissidens ceylonensis*** Dozy & Molk., Annls Sci. nat. Bot. Ser. 3, 2: 304, 1844. Figs 3: 1-13

Plants terrestrial, yellowish green, up to 6.5 mm in length, 1.5 mm in width; with 12 leaf pairs, slightly overlapping. Leaves oblong, more or less 0.75 × 0.24 mm in size, sheathing lamina slightly unequal, 0.36-0.05 mm (B/L = 31/100 to 35/100, S/L = 53/100 to 65/100). Costa brownish-orange, percurrent, ending just below the tip. Sheathing lamina usually unequal (open), limbidium in the specimen poorly developed or reduced to 2-3 cells, composed of linear to sublinear cells, the outermost row gives rise to crenulated cells, giving the limbidium an intramarginal appearance.

Ecology and distribution: On rocks, near Jambu Dweep, 900 m, growing in association with *Hypohila involuta* (Hook.) Jaeg. and *Phaeoceros laevis* subsp. *laevis* Prosk.

Range of Distribution: Australia, Borneo, Greece, Fiji Islands, India: western Himalaya, Gangetic Plains, central India (PBR), south India (Tamilnadu: Nilgiri, Palni, Trivandrum), Indonesia, Java, Malayasia, Meluccas, Nepal, Papua New Guinea, New Zealand, Philippines, Singapore, Sri Lanka, Sumatra, Thailand, Vietnam.

Specimens examined: India, Madhya Pradesh, Pachmarhi, On way to Jambu Dweep, alt. ca 900m, 17.12.1993, on rocks, leg. *V. Nath & A. K. Asthana, 205595C* (LWG).

3. ***Fissidens pulchellus*** Mitt., J. Linn. Soc. Bot. Suppl. 1: 140. 1859. Figs 4: 10-19

Fissidens subpulchellus Norkett in Gangulee, Mosses of Eastern India and Adjacent Regions 1. 521. 1971.

Plants terrestrial, dull brownish - green, upto 8 mm long with about 8-10 pairs of leaves. Leaves are oblong-ligulate, more or less 1.7 × 0.30 mm in size. Sheathing lamina usually unequal (open), rarely closed; (B/L = approx. 20.3/100, S/L = 59/100). Costa bright orange, percurrent, ending below tip. Leaf cells rounded-hexagonal, more or less 8 × 6 µm in size at midleaf region. Dorsal leaf lamina decurrent, ending much near the nerve base. Sporophyte not seen.

Ecology and distribution: near water stream on soil covered rocks, Patthar Chatta, 1000 m.

Range of distribution: India: eastern Himalaya (Burkill, Abor Hills, Darjeeling) M.P. (Amarkantak, PBR), Nepal.

Specimens examined: India, Madhya Pradesh, Pachmarhi: Patthar Chatta, alt. ca 1000 m, 18.12.1993, near water stream in valley, leg. *V. Nath & A.K. Asthana, 205650* (LWG); On rock, leg. *V. Nath & A.K. Asthana, 205661*(LWG).

4. ***Fissidens involutus*** Wils. ex Mitt. in Musc. Ind. Or.: 138, 1859. Figs 4: 1-9

Plants terrestrial, dull green, up to 12 mm in length, most frequently 14 leaf pairs seen. Leaves apiculate with acute apex, more or less 1.8 × 0.35 mm in size, sheathing lamina mostly equal (closed), may be unequal

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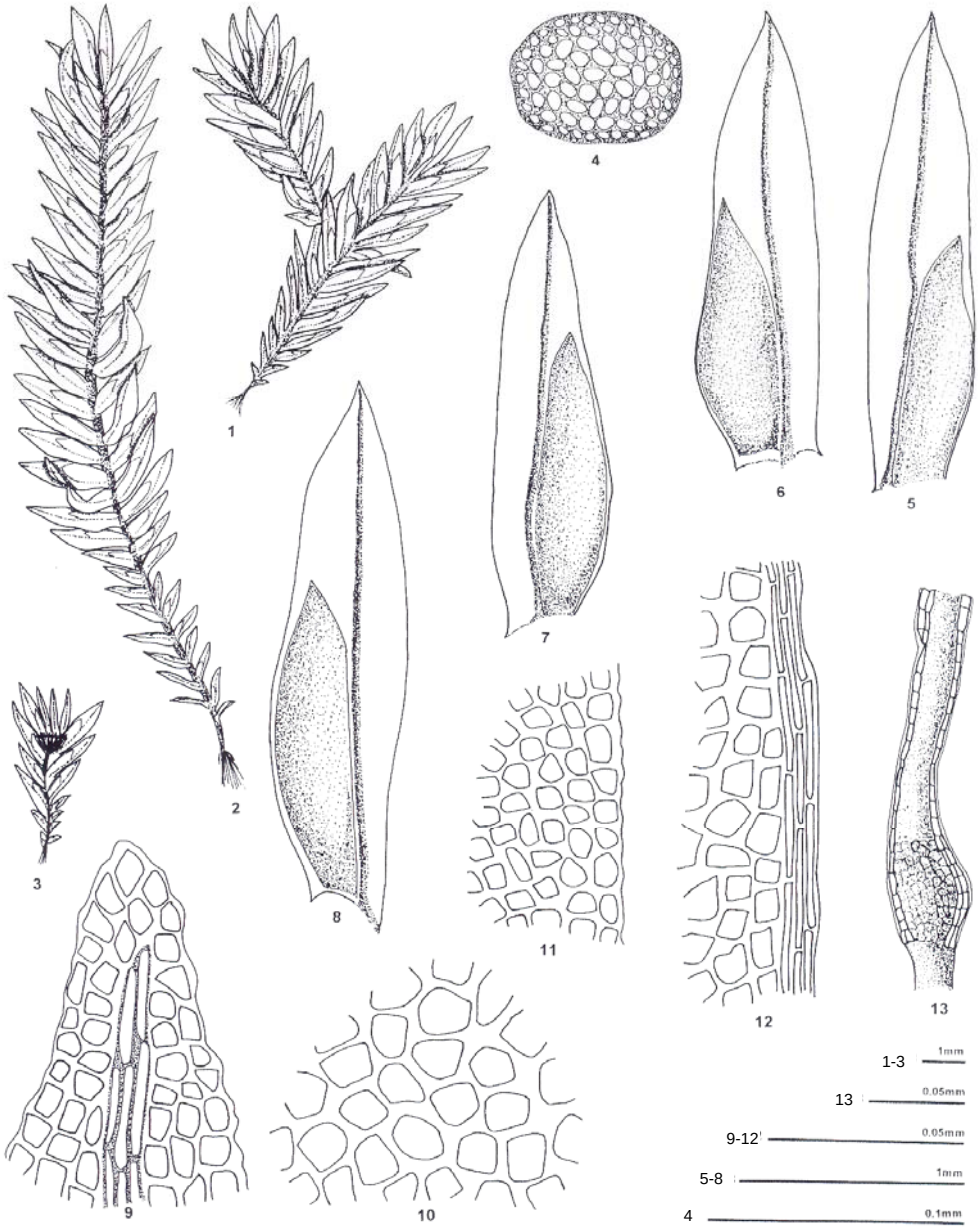


Fig. 2. ***Fissidens asperisetus var. andamanensis*** **Gangulee. (LWG.227666-C). 1, 2: Plants. 3: Plant with archegonial cluster. 4: T.S. of axis. 5 – 8: Leaves. 9: Apical leaf cells. 10: Middle leaf cells. 11: Basal leaf cells. 12: Cells of sheathing lamina. 13: Single enlarged archegonia.**

(open) at times (B/L = approx. 20/100, S/L = approx. 60/100). Leaf margin slightly projecting and dentate owing to protruding cell margins. Costa ending 2-3 cells below the apex, dull light brown to light orange in colour. Leaf cells rounded - hexagonal, upper leaf cells more or less 9 × 10 µm in size. Dorsal lamina slowly rounded at the base. Sporophyte not seen.

Ecology and distribution: On wet rocks, Mahadeo Mandir, Chota Mahadev, 885-1006 m.

Range of distribution: Chile, China, Chhota Nagpur, India: Darjeeling (Sikkim), western Himalaya, M.P. (Amarkantak, Bastar, PBR), Nepal, Myanmar, Papua New Guinea, Thailand, Vietnam.

Specimens examined: India, Madhya Pradesh, Pachmarhi: Mahadeo Mandir, alt. ca 1005.84 m, 28.11.2006, on rock; leg. *V. Nath & A.K. Asthana, 227612* (LWG); Chota Mahadev Mandir, alt. ca 855 m, on wet rock; leg. *V. Nath & A.K. Asthana, 227641* (LWG).

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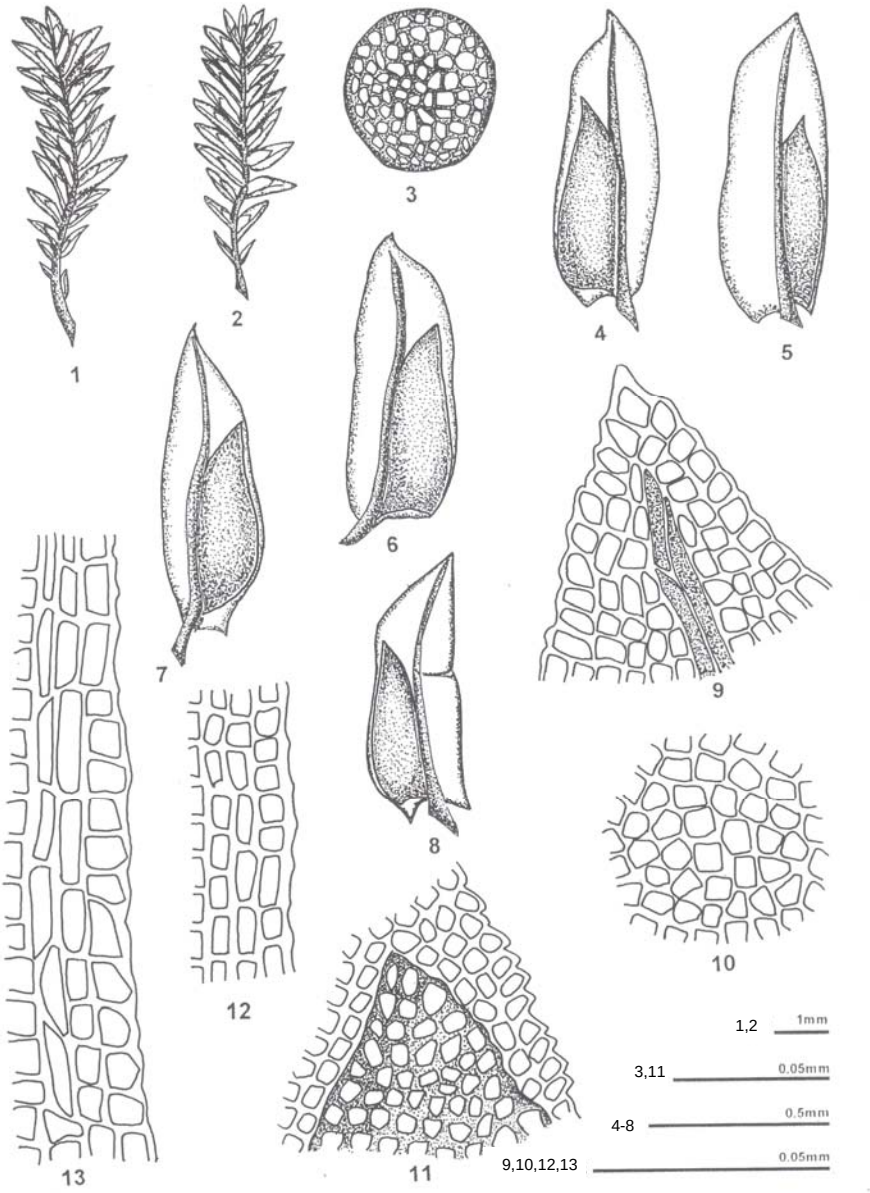


Fig. 3. *Fissidens ceylonensis* Dozy & Molk. (LWG 205595-C). 1, 2: Plants. 3: T.S. of axis. 4-8: Leaves. 9: Apical leaf cells. 10: Middle leaf cells. 11: Portion of the leaf showing unequal (open) leaf lamina. 12: Basal leaf cells. 13: Cells of sheathing lamina.

5. ***Fissidens crispulus* var. *crispulus*** Brid., Musc. Rec. Suppl. 4:187, 1819. Fig 5: 9-17

Fissidens sylvaticus var. *zippelianus* (Dozy & Molk.) Gangulee, Mosses of Eastern India and Adjacent Regions 1: 537. 1972.

Plants terrestrial, small, up to 12 mm long with usually 14 leaf pairs. Leaves oblong, ligulate ranging from 1.2-1.8 mm in length and more or less 0.04 mm in breadth with sheathing lamina equal (closed) (B/L = approx.16/100, S/L = 57.4/100); costa dull greenish brown, ending just below the tip; Leaf margin slightly crenulated due to projection of cells; Leaf cells rounded-hexagonal, 8-12 × 8 µm in size; chlorophyllose, slightly obscure. Sporophyte not seen.

Ecology and distribution: On soil, Rajakhoh (Patalkot), 400 m.

Range of distribution: Australia, Brunei, Cameroon, central African Republic, China, Fiji Islands, India: western Himalaya, Gangetic Plains, central India

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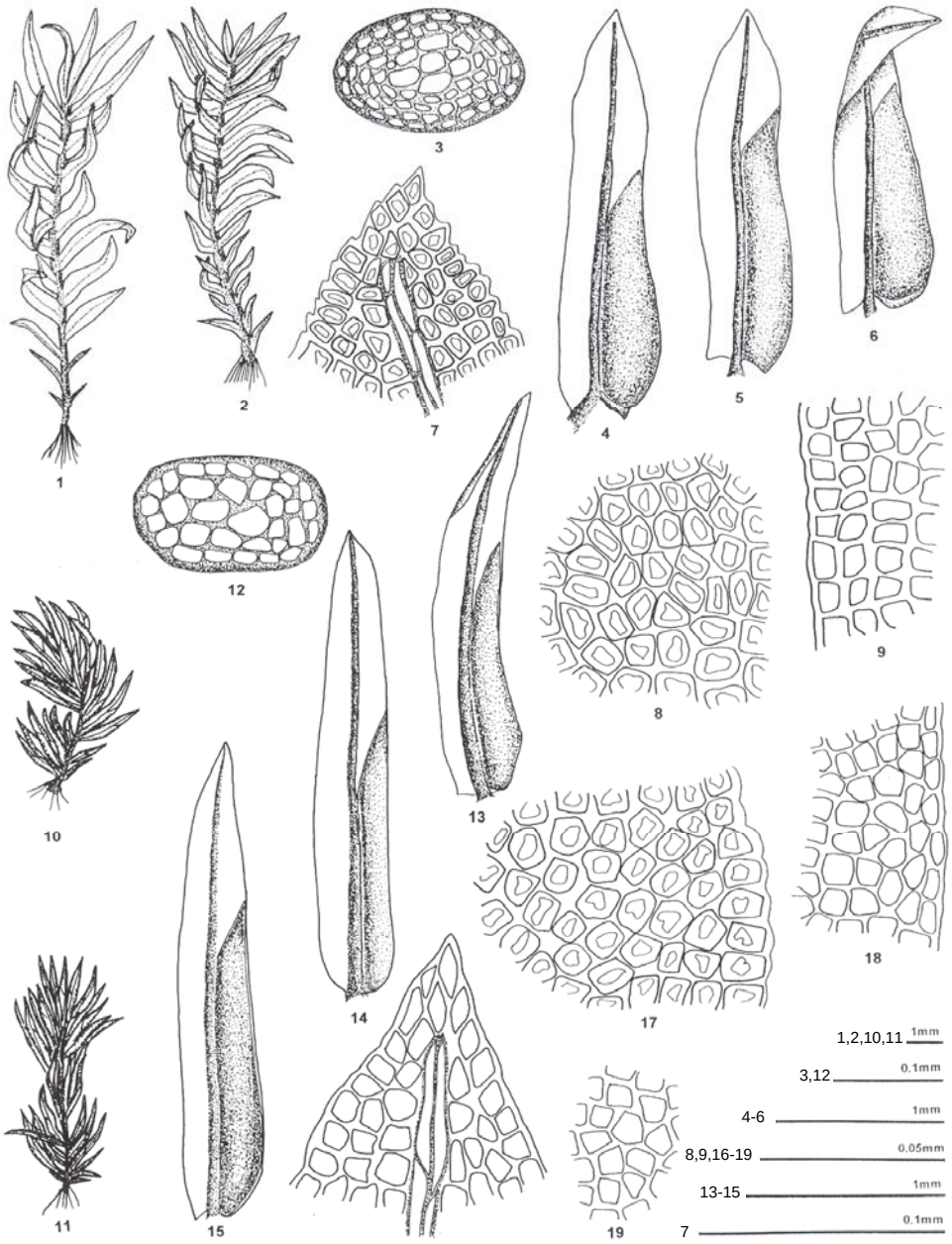


Fig. 4. 1-9: *Fissidens involutus* Wils. ex Mitt. (LWG 227641). 1, 2: Plants. 3: T.S. of axis, 4-6: Leaves. 7: apical leaf cells, 8: Middle leaf cells. 9: basal leaf cells. 10-19: *F. pulchellus* Mitt. (LWG 205650). 10, 11: Plants. 12: T.S. of axis. 13–15: Leaves. 16. Apical leaf cells. 17. Middle leaf cells. 18: Basal leaf cells. 19: Cells of sheathing lamina.

(PBR), south India (western ghats), Indonesia, Malaysia, Mauritius, Mayotte, Niger, Papua New Guinea, Philippines, Sri lanka, Sudan, Taiwan, Thailand.

Specimens examined: India, Madhya Pradesh, Pachmarhi. Rajakhoh, Patalkot, alt. ca 400 m, 06.10.1992, on soil, leg. *V. Nath & A.K. Asthana, 205465* (LWG).

6. ***Fissidens taxifolius*** Hedw. in Sp. Musc. : 155, 1801. Figs 5: 1-8

Fissidens sylvaticus Griff. in Cal. J. Nat. Hist., 2: 507, 1842.

Plants both terrestrial and epiphytic, yellowish green, up to 10 mm long with an average 16 pairs of leaves (leaf pairs ranging from 14-18). Leaves oblong, ligulate, more or less 1.5 × 0.314 mm with unequal (open) sheathing lamina (B/L = approx. 21/100, S/L = approx. 66/100). Costa deep coloured, may be deep orange at base, lighter above, reaching upto the tip which may form slightly mucronate or end just below

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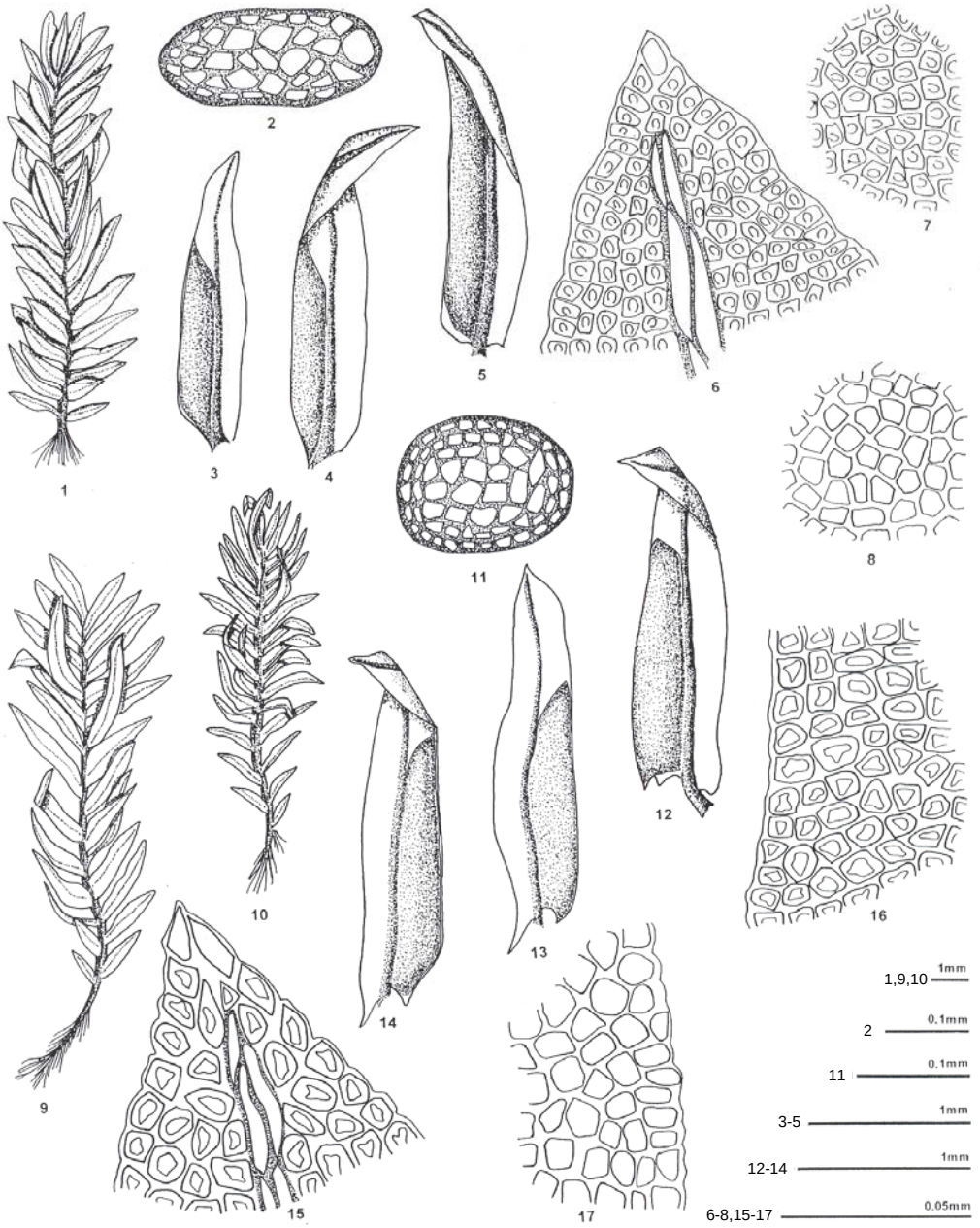


Fig. 5. 1-8: *Fissidens taxifolius* Hedw. (LWG 227692-A). 1: Plant. 2: T.S. of axis. 3–5. Leaves. 6: Apical leaf cells. 7: Middle leaf cells. 8: Basal leaf cells. 9-17: *F. crispulus* var. *crispulus* Brid. (LWG 205465). 9, 10: Plants. 11: T. S. of axis. 12–14: Leaves. 15: Apical leaf cells. 16: Middle leaf cells. 17: Basal leaf cells.

tip. Marginal leaf cells irregular, upper and middle cells quadrate- hexagonal, up to 4.3 µm wide in the middle leaf region, getting larger towards the costa. Dorsal lamina base undulating. Sporophyte not seen.

Ecology and distribution: On soil covered rocks, wet rocks and epiphytic, Downfall, on way to Jambu Dweep, Rajakhoh (Patalkot), Chota Mahadev, on way to Apsara Vihar, 400-1065 m, growing in association with *Phaeoceros laevis* subsp. *laevis* Prosk.

Range of distribution: Algeria, Armenia, Austria, Bermuda, Brazil, Burma, Canada, Chad, Cuba, Durussalam, Denmark, Dominican Republic, Egypt, France, Germany, Guatemala, Haiti Islands, Honduras, India: western Himalaya, eastern Himalaya (Darjeeling, Khasia Hills, Upper Assam), Gangetic Plains (Chhota Nagpur, West Bengal, Bihar), central India (Amarkantak, PBR), south India (Goa), Andaman & Nicobar Islands, Ireland, Japan, Mexico, Netherlands,

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Table 1. Distribution of the taxa undertaken for study in different bryogeographical zones of India.

BRYOGEORAPHICAL ZONES / PLANT NAME	WESTERN HIMALAYA	EASTERN HIMALAYA	PUNJAB & WEST RAJASTHAN PLAINS	GANGETIC PLAINS	CENTRAL INDIA	WESTERN GHATS	EASTERN GHATS	ANDAMAN & NICOBAR ISLANDS
Fissidens viz. *F. asperisetus* var. *andamanensis* Gangulee	−	−	−	−	©	+	−	+
F. ceylonensis Doz. et Molk.	+	+	−	+	⊕	+	−	−
F. pulchellus Mitt.	−	+	−	−	+	+	−	−
F. involutus Wils. ex Mitt.	+	+	+	+	⊕	−	−	−
F. crispulus var. *crispulus* Brid.	+	−	−	+	+	+	−	−
F. taxifolius Hedw.	+	+	−	+	+	+	−	+

⊕ : Recorded first time in the present study from PBR.

© : Recorded first time in the present study from central India.

New Zealand, Norway, Papua New Guinea, Poland, Portugal, Russia, Spain, Sweden, Switzerland, Taiwan, Thailand, Turkey, United Kingdom, United States of America.

Specimens examined: India, Madhya Pradesh, Pachmarhi: Downfall, alt. ca 1056 m, 17.12.1993, on moist rock, leg. *V. Nath & A.K. Asthana, 205545* (LWG); On the way to Jambu Dweep, alt. ca 900 m, 17.12.1993, on rock, leg. *V. Nath & A.K. Asthana, 205595B* (LWG); Rajakhoh, Patalkot, alt. ca 400 m, 20.12.1993, on rock; leg. *V. Nath & A.K. Asthana, 205735* (LWG); Downfall, alt. ca 884 m, 28.11.2006, on soil covered rock, leg. *V. Sahu & V. Awasthi, 227605B* (LWG); On way to Chota Mahadev, alt. ca 853.5 m, 29.11.2006, on soil covered rock, leg.*V. Sahu & V. Awasthi, 227627* (LWG); On the way to Apsara Vihar, alt. ca 731 m, 01.12.2006, epiphytic, leg. *V. Sahu & V. Awasthi, 227692A* (LWG).

DISCUSSION

Fissidens indeed is a difficult genus when one tries to undertake identification, as even under a single species, there are considerable variations at times. Gangulee (1969 - 1972) has delegated the occurrence of two species with very close characters viz. *F. taxifolius* and *F. sylvaticus* respectively, and they may only be differed by their occurrence at different altitudes. But later, workers have made the latter a synonym of *F. taxifolius*. Here, in the present work, all specimens which were either related closely to *F. sylvaticus* or F. *taxifolius* described by Gangulee (1969 - 1972) have been put under *F. taxifolius*. Further, the specimens in the present study described as *F. pulchellus* show a smooth leaf margin and papillose cells, and such characters are similar to *F. subpulchellus* as described by Gangulee, although Gangulee has taken peristome as the main attribute for distinction between these two species. However, the sporophyte is absent in our collection. In consequence, the synonymy given in the Moss Flora of China (Anonymous, 2007) has been adopted.

Among the other species, *F. asperisetus* var. *andamanensis* has been so far reported in India from southern India and Andaman and Nicobar Islands only. It can be noted as a new record from central India. Further, *F. ceylonensis*, *F. involutus* and *F. taxifolius* are among the widely distributed species of the genus in India. Table 1 shows the distribution of the members taken up here for study among the 8 bryogeographical zones of India. The members are distributed at PBR from 400 to 1000 meters across 8 localities. They are mostly terrestrial, with a single epiphytic specimen of *F. taxifolius*. In terms of abundance, *F. taxifolius* shows more abundance since it was collected from 5 out of 8 localities.

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印度潘恰瑪生物保留區之鳳尾苔屬植物

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摘要：研究印度潘恰瑪生物保留區之苔類植物相，總共發現六種鳳尾苔屬植物分布於本區之八個地點。包括 *Fissidens asperisetus* var. *andamanensis* Gangulee、*F. ceylonensis* Doz. et Molk.、*F. crispulus* var. *crispulus* Brid.、*F. involutus* Wils. ex Mitt.、*F. pulchellus* Mitt. 及 *F. taxifolius* Hedw. 。其中 *F. asperisetus* var. *andamanensis* Gangulee 是印度中部苔蘚植物地理區之新紀錄種，而 *F. ceylonensis* 和 *F. involutus* 這兩種則是本區之新紀錄種。這六種除 *F. taxifolius* 為附生，其餘都是土生。

關鍵詞：苔類、鳳尾苔科、潘恰瑪生物保留區，中印度。

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