

Six species of *Fissidens* Hedw. (Fissidentaceae; Dicranales; Bryopsida), additions to Bryoflora of Andhra Pradesh

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Abstract-Six species of *Fissidens* Hedw., viz., *F. bilaspurense* Gangulee, *F. elongatus* Mitt., *F. laxitextus* Broth. ex Gangulee, *F. polysetulus* Mull. Hall. ex Nork. & Gangulee and *F. subpalmatus* Mull. Hall. and *Fissidens titalyanus* Mull. Hall. are collected from different localities in Andhra Pradesh are being reported as new distributional records to the state, of which *Fissidens bilaspurense* Gangulee, *F. elongatus* Mitt., *F. laxitextus* Broth. ex Gangulee, are recorded first time from Southern Peninsular India, India.

Keywords-Bryoflora of Andhra Pradesh, *Fissidens* of India

I. INTRODUCTION

Fissidens Hedw. Belonging to the family Fissidentaceae Schimp. comprises 729 species [1], [2]. In India, *Fissidens* is represented by 89 taxa belonging to 77 species [3], [4], [5], [6], [7]. In Southern Peninsular India, the genus is represented by 73 taxa belonging to 61 species, two subspecies and eight varieties [3], [4], [7], [8], [9], [10], [11], [12], [13]. We reported 26 species [8], [14], [15] of *Fissidens* prior to the present study. With the current report, now Andhra Pradesh is harboring 32 species of *Fissidens*.

The southern peninsular India covers five Indian states namely: Andhra Pradesh, Karnataka, Kerala, Tamil Nadu and Telangana. It represents 19.31% of total geographical area of India, bordered by Bay of Bengal in the east, Arabian sea in the west, Indian Ocean in the south and Vindhya and Satpura ranges in the north. The area covers the two important bio-geographically significant areas, Eastern Ghats and Western Ghats. Andhra Pradesh is the seventh largest state in Indian union and extended over about 162, 970 sq. km and lies between 12° 37' and 19° 25' NL and 76° 45' and 84° 72' EL. The state comprises 13 districts, four of them constitute Rayalaseema region and nine, coastal Andhra Pradesh. Total recorded forest area of the state is 37,258 Sq. Km. (22.86% of geographical area) with about 17.88 percentage of forest cover (FSI, 2019). The state cover major portion of Eastern Ghats hill ranges, and has varied vegetation types, with nearly more than 180 waterfalls (seasonal and perennial) and an altitudinal range from Mean Sea Level to 1680m above MSL.

Part of our explorations of bryophytes in Andhra Pradesh, we could collect some curious acrocarpus moss plant specimens from various localities of Eastern Ghats Forest tracks in different districts of Andhra Pradesh. After critical

microscopic examination these specimens were identified belonging to genus *Fissidens* Hedw. and taxa viz., *F. bilaspurense* Gangulee, *F. elongatus* Mitt., *F. laxitextus* Broth. ex Gangulee, *F. polysetulus* Mull. Hall. ex Nork. & Gangulee and *F. subpalmatus* Mull. Hall. and *Fissidens titalyanus* Mull. Hall. Published literature [3], [4], [6], [7], [8], [9], [10], [11], [13] revealed that these species are nowhere located in Andhra Pradesh till date and thus form new distributional records to the state of Andhra Pradesh. *Fissidens bilaspurense* Gangulee, *F. elongatus* Mitt., *F. laxitextus* Broth. Ex Gangulee are being reported additions to bryoflora of Southern Peninsular India.

II. MATERIALS AND METHODS

Extensive bryophyte explorations were conducted covering diversified habitats in the state of Andhra Pradesh during 2016 to 2020. The corticolous plant material was collected by using sharp edged knife and terrestrial specimens were scraped by using manually bent and sharpened flat spoon. The collected specimens were placed in zip lock polythene cover with labeled field number and field observations were recorded and photographs were taken by using Nikon D3300. Collected materials were air dried and preserved in brown paper packets (12 × 18 cm) with detailed label (10 × 17cm). Critical examination of the specimens was done by using temporary slides and plant parts were separated by using micro forceps (Varin) VR-15 curved, VR-11 straight with fine sharp edges. Slides were observed under light microscope (Olympus CH20i), stereo microscope (Olympus SZ61) and micro measurements were taken by using ocular micro meter (ERMA). Photographs were taken by using Moto g3 turbo equipped with 13 MP camera. Different dimensions were measured and identification of the specimens by using standard floras. Descriptions, Habitat and ecology, Voucher specimens' information,

field photographs, microscopic photographs were provided for the species. Voucher specimens are deposited in Sri Krishnadevaraya University Herbarium (SKU) Ananthapuramu. Abbreviated names used for the collectors are: AS (Ananthaneni Sreenath) and BR (Boyina Ravi Prasad Rao).

III. RESULTS

Systematic Treatment:

Fissidens bilaspurens Gangulee Bull. Bot. Soc. Bengal 11: 66. f. 5 1957; Mosses of E. India 1(2): 491. 1971.(Plate. 1).

Plants aquatic and lignicolous, small up to 4.5 mm high and about 2.5 mm with leaves, light green to yellowish green. Leaves up to 6 pairs (about 1.7 leaves per mm of stem), which are freely arranged on stem, oblong, $1 - 1.3 \times 0.2 - 0.3$ mm broad with semi sheathing lamina; semi sheathing lamina $\frac{1}{2}$ of the leaf or more than $\frac{1}{2}$ of the leaf length, $6 - 7 \times 0.16 - 0.18$ mm, limbidium 4 cells broad at base to middle, dorsal lamina base decurrent on the stem. Costa percurrent to excurrent, one cell protruding at tip. Leaf cells rounded-quadrate-hexagonal, apical, middle and basal cells these all cells almost same in size, $5 - 8 \mu\text{m}$ diagonally. Sporophyte present on apical portion of the plant. Capsules are not seen.

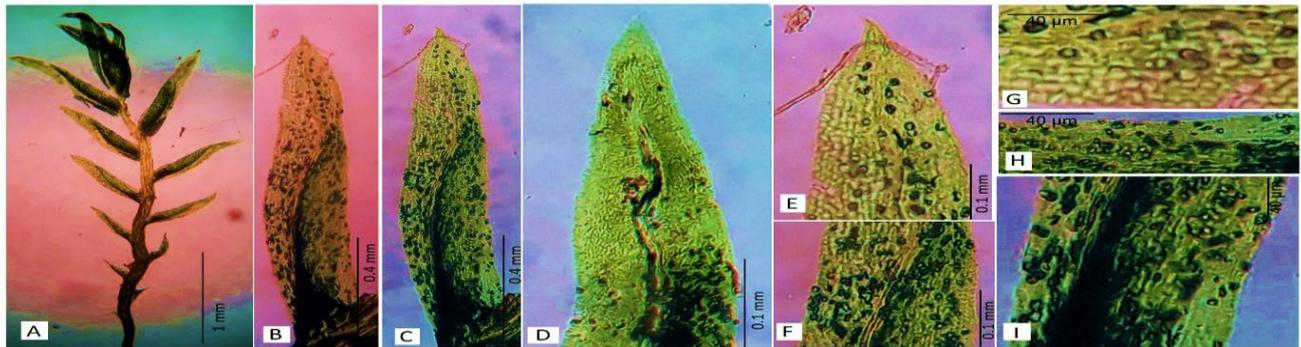


Plate. 1

Habitat and Ecology: Found on sandy rocks near waterfalls and moist places in dense forests, commonly associated with *Taxiphyllum taximerium* and *Hypnum macrogynum* (Hypnaceae).

Specimens Examined: India, Andhra Pradesh, Chittoor district, Sheshachalam hills, Talakona waterfall, 15, November, 2016, 51695 B SKU, BR & AS.

Distribution: Endemic to India (Madhya Pradesh, West Bengal, Central India-Gangetic Plains).

Fissidens elongatus Mitt. J. Proc. Linn. Soc., Bot., Suppl. 2: 139 1859; Mosses of E. India 1(2): 561 - 562. 1971. (Plate. 2).

Plants near floating or sprinkling water, lignicolous or bark substratum, up to 6 cm by proliferation, and up to 2.5 mm wide with leaves, light to dark green. many leaves (about 2.5 leaves per mm of stem), lanceolate, $1.9 - 2.2 \times 0.25 - 0.28$ mm broad, sheathing lamina below $\frac{1}{2}$ of the leaf length $0.6 - 0.8 \times 0.11 - 0.13$ mm, leaf limbidium absent, dorsal lamina narrowing towards stem and ending on the stem, margin slightly dentate at apex. Leaf cells rounded slightly below and hexagonal near at apex to $20 \mu\text{m}$ and to $26 \mu\text{m}$ near at costa. Costa percurrent light brown, Sporophytes not seen.

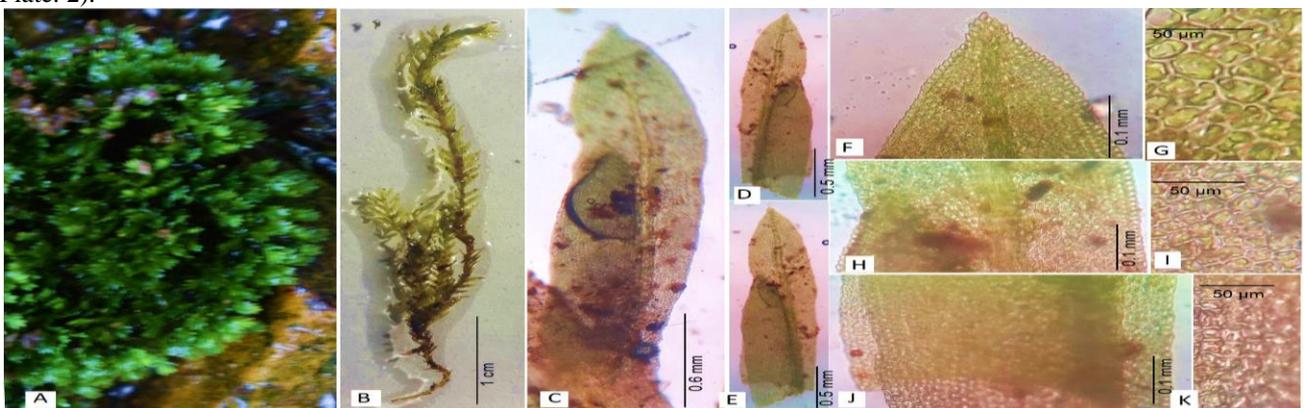


Plate. 2

Habitat and Ecology: Found on rocks near waterfalls, in shady places of dense forests, associated with *Riccardia*

multifida (Annuraceae) and *Bartamiadula* sp. (Bartramiaceae).

Distribution: World: India: Meghalaya, (Kashia Hills).

Specimens Examined: India, Andhra Pradesh, Nallamalais, Kurnool District, Near Srisailam, Paladara Panchadara, 24 September 2017, 53566 SKU BR & AS.

Fissidens laxitextus Broth. ex Gangulee. Nova Hedwigia 8: 144. Pl. 3 1964; Mosses of E. India 1(2): 529 - 531. 1971. (Plate. 3 A-J).

Plants terricolous, up to 6 mm high and 1.7 mm broad with leaves, light green to yellowish green, 8 pairs of leaves on sterile shoots (about 3 leaves per mm of stem) fertile plants 3.7 mm high, up to 7 pairs of leaves (about 2 leaves per mm

of stem). Leaves oblong-lingulate, 1.1 - 1.3 × 0.2 - 0.3 mm broad, semi sheathing lamina more than ½ of the leaf length and more than ½ of the leaf width 0.5 - 0.7 × 0.11 - 0.13 mm. dorsal lamina ending on the stem. Costa percurrent to ending 2 cells below the apex. Leaf cells quadrate to irregularly hexagonal with clear thin walls, apical, middle and basal cells up to 14 µm and some slightly more elongated up to 17 µm near at costa base. Sporophyte present on apical portion of the plant. Seta up to 2 mm long, capsule 0.6 mm long and 0.34 mm broad (diagonally) spores light yellowish brown and up to 18 µm.



Plate. 3

Habitat and Ecology: Found in soil cuttings near water fall areas, associated with *Wissia* sp. and other pottiaceae members.

Specimens Examined: India, Andhra Pradesh, Prakasam district, Nallamalais, Palanka waterfall, 27 October 2017, 53655 B SKU, BR & AS; East Godavari district, Amruthadara waterfall, 22 November 2018, 55806 B SKU, BR & AS; Ananthapuramu district, Gundumala fort, 10 August 2019, 55861 A, 55864 A & 55866 C.

Distribution: World: Nepal and **India:** West Bengal (Darjeeling).

Fissidens polysetulus Mull. Hall. ex Nork. & Gangulee. Mosses E. India 2: 525. f. 248 1971. (Plate. 3 K-V).

Plants terricolous and lignicolous, small up to 4 mm and 2.2 mm broad with leaves, yellowish green to brownish green. Leaves up to 9 pairs (about 2.6 leaves per mm of stem), oblong-lingulate, 1.8 - 2 × 0.35 - 0.37 mm, with semi sheathing lamina, semi sheathing lamina more than ½ of the leaf length, 0.9 - 1.1 × 0.16 - 0.19 mm, limbidium absent, dorsal lamina ending on the stem near at costa. Costa shortly excurrent. Leaf cells rounded to hexagonal, apical middle cells up to 6 µm, in perichaetial leaves up to

12 µm, mamilllose or slightly obscure at some places and basal cell slightly larger up to 8 µm and in perichaetial leaves up to 28 µm. sporophyte present on apical portion of the plant, seta up to 4 mm long and capsules not seen clearly.

Habitat and Ecology: Found on moist soil and rock near water areas of interior forest and hill slopes, found associated with *Weisia* sp. (Pottiaceae) and sometimes found as a mono dominant plant.

Specimens Examined: India, Andhra Pradesh, Chittoor district, Sadasiva kona, 24 February 2017, 53327 SKU, BR & AS; Prakasam district, Nallamalais, Peddachama base camp, near watch tower, 23 September 2017, 53607 SKU, BR & AS; Ananthapuramu district, Kundurpi, Kundurpamma konda, 05 November 2017, 53719 SKU, BR & AS; Chittoor district, Seshachalam, Tirumala hills, near Sreevaripadalu, 14 November 2017, 53783 B, 53784 B SKU, BR & AS; Tirumala gardens, 15 November 2017, 53801 C SKU, BR & AS.

Distribution: World: India: Sikkim, West Bengal (Dargeeling) and Tamil Nadu (Western Ghats).

Fissidens subpalmatus Mull. Hall. Linnaea 37: 164 1872; Gungulee, Mosses of E. India and adjacent regions. 1(2): 466 – 467. 1971. (Plate. 4).

Plants terricolous and lignicolous, small up to 7 mm high and 2.8 mm long with leaves, green to dark green, leaves up to 15 pairs, about 3 leaves per mm of stem, leaves curled when dry, oblong–lingulate, narrowly acuminate, 1.1 - 1.3 × 0.18 - 0.25 mm broad. Semi sheathing lamina below ½ of the leaf length, 0.4 - 0.5 - 0.08 - 0.1 mm. dorsal lamina

base ending on the stem. Limbidium present on entire leaf, simple 1 row and 2 to 3 rows on sheathing lamina. Costa excurrent. Leaf cells smooth, rounded to hexagonal, apical, middle cells up to 15 µm diagonally, basal cells elongated up to 27 µm and some cells slightly elongated at near costa base up to 30 µm. Sporophyte present on apical portion of the plant, seta up to 4.5 mm. capsule up to 0.45 mm long and 0.26 mm wide in diameter, yellowish brown. Spores round, 12.8 - 16.5 µm.



Plate. 4

Habitat and Ecology: Found on moist soil or rocks near waterfalls, found associated with *Thuidium* sp. (Thuidiaceae).

Specimens Examined: India, Andhra Pradesh, Prakasam district, Nallamalais, Gundlabrahmeswaram Wild Life Sanctuary, Rollapenta waterfall, 24 September 2017, 53626 A SKU, BR & AS.

Distribution: **World:** East Nepal and **India:** North Bihar, West Bengal (Bolpur and Kharagpur), Southern west Bengal (Parganas), Maharashtra (Bombay) and Tamil Nadu.

Fissidens titalyanus Mull. Hall. Linnaea, 37: 165 1872; *Fissidens crenulatus* var. *titalyanus* (C. Muell.) Gangulee, Gungulee, Mosses of E. India and adjacent regions 1(2): 506 - 507. 1971. (Plate. 5).

Plants terricolous, small up to 6 mm high and up to 2 mm wide with leaves, greenish white to reddish brown or light green. Leaves up to 10 pairs (about 3 leaves per mm of stem), oblong lingulate, 0.9 - 1.3 × 0.24 - 0.26 mm broad, semi sheathing lamina below ½ of the leaf length to ½ of the leaf length, 0.4 - 0.6 × 0.11 - 0.12 mm broad, semi limbidium arranged in 1 to 4 rows at base, limbidium covers more than ½ of the sheathing lamina, dorsal lamina narrowing and decurrent on the nerve. Costa excurrent, leaf cells rounded to hexagonal, cells 6 - 9 µm diagonally, more elongated up to 16 µm at the base of semi sheathing lamina, near costa and up to 25 µm in perichaetial leaves. Sporophyte present on apical portion of the plant, costa 3 to 5.6 mm long and capsule to 0.7 mm long and up to 0.3 mm wide (diameter), brown. Spores pellucid up to 15 µm.

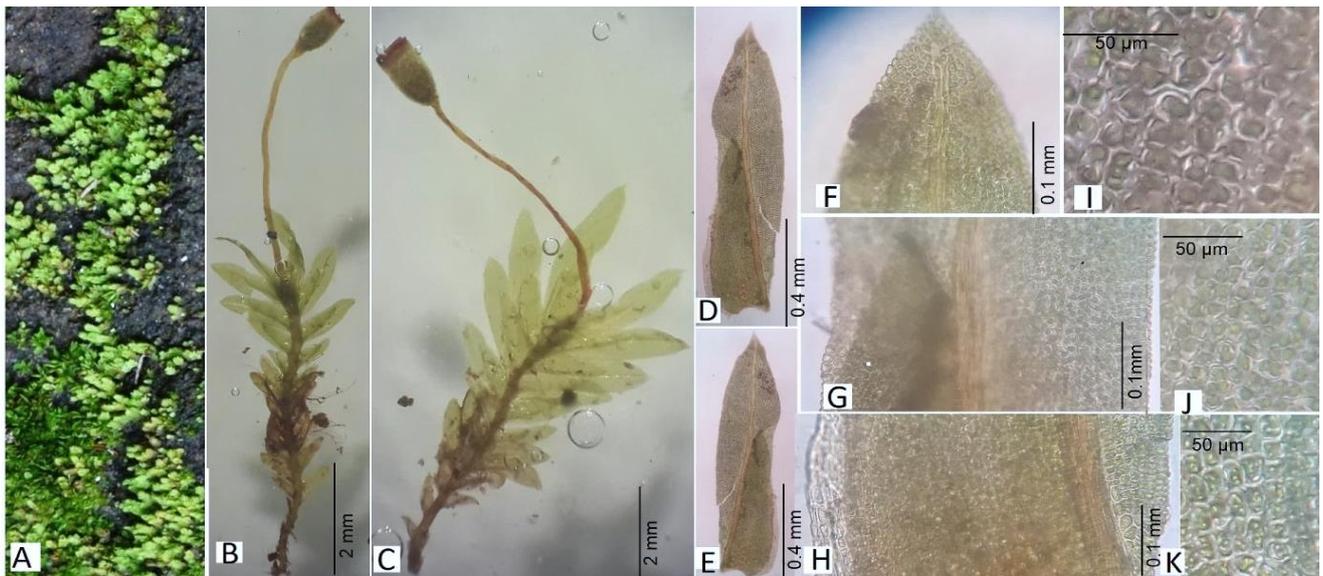


Plate. 5

Habitat and Ecology: Found on moist soil in shady places of interior forests, associated with Pottiaceae and Aytoniaceae members.

Specimens Examined: India, Andhra Pradesh, Chittoor district, Horsley hills, 16 September 2016, 51642, SKU, BR & AS; Prakasam District, Nallamalais, Gundlabrahmeswaram Wild Life Sanctuary, Anjanajuni Borakalu, 04 August 2017, 53542 A, SKU BR & AS.

Distribution: World: East Nepal and **India:** West Bengal (Jhargram), South Bengal (Parganas), Odisha (Ganjam) and Tamil Nadu (Eastern Ghats and Western Ghats).

IV. CONCLUSIONS

The present study is based on primary data collected from the collections from field and is a part of a comprehensive baseline taxonomic database for bryophytes of Andhra Pradesh executed during 2015-2021. With the six records of *Fissidens* reported in the present study, Andhra Pradesh has now a rich diversity of *Fissidens*, i.e., 32 species.

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Legend of plates:

Plate.1: *Fissidens bilaspurens* Gangulee. A. Single plant, B & C. Leaves, D. Leaf apex with protruding costa, E. Leaf apical cells, F. Leaf middle cells, G. Elongated leaf apical cells, H. Elongated leaf middle cells and I. Leaf basal cells.

Plate. 2: *Fissidens elongatus* Mitt. A. Plant natural habit, B. Single plant, C. Leaf arrangement of on stem, D & E. Leaves, F. Leaf apical cells, G. Elongated view of leaf apical cells, H. Leaf middle cells, I. Elongated view of leaf middle cells, J. Leaf basal cells and K. Elongated view of leaf basal cells.

Plate. 3: A-J. *Fissidens laxitextus* Broth. ex Gangulee. A. Plant natural habit, B & C. Single plants, D & E. Leaves, F. Leaf apical cells, G. Elongated view of leaf apical cells, H. Leaf middle cells, I. Leaf basal cells and J. Elongated view of leaf basal cells. K-V. *Fissidens polysetulus* Mull. Hal. ex Nork. & Gangulee. K. Plant natural habit, L. Plant natural habit with sporophyte, M. Single plant with sporophyte, N & O. Leaves, P. Leaf apical cells, Q. Elongated view of leaf apical cells, R. Leaf middle cells, S. Elongated view of leaf middle cells, T. Leaf basal cells, U. Elongated view of leaf basal cells and V. Elongated view of vaginate lamina cells.

Plate. 4: *Fissidens subpalmatus* Mull. Hall. A. Single plant with sporophyte, B & C. Leaves, D. Leaf apical cells, E. Elongated view of leaf apical cells, F. Leaf middle cells, G. Elongated view of leaf middle cells, H. Leaf basal cells and I. Elongated view of leaf basal cells.

Plate. 5: *Fissidens titalyanus* Mull. Hall. A. Plant natural Habit, B & C. Single plans with sporophyte, D & E. Leaves, F. Leaf apical cells, G. Elongated view of leaf apical cells, H. Leaf middle cells, I. Elongated view of leaf middle cells, J. Leaf basal cells and K. Elongated view of leaf basal cells.

AUTHORS PROFILE

Dr. Ananthaneni Sreenath

Completed his Masters in Botany in 2015. He executed his PhD work on 'bryophytes of Andhra Pradesh' and awarded in 2021 from the Department of Botany, Sri Krishnadevaraya University, Ananthapuramu and studied extensively the Bryophytes of Andhra Pradesh. He reported over 180 new bryophyte species records to the state and published 24 research articles in national and international journals.



Prof. B. Ravi Prasad Rao

Currently, Professor of Botany, Head & Chairman BOS of Botany, Sri Krishnadevaraya University, Ananthapuramu. He published 189 research articles in international and national journals and 17 books. Twenty five students awarded PhD under his guidance. He executed 15 major research projects till date. He is the recipient of Best Teacher Award in 2015 from the Govt. of Andhra Pradesh. He was the member, Species Survival Commission, IUCN during 2009-2015.

