



Research Article

Morphotaxonomical studies on some mosses of Indian Thar desert

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Abstract: Studies on the mosses of hot and arid Indian Thar Desert revealed the occurrence of five moss species viz. *Tortula muralis* Hedw., *Gymnostomiella veroncosa* (Hook.) Fleisch., *Hyophila involuta* (Hook.) Jaeger., *Semibarbula orientalis* (Web.) Wijk. & Marg. and *Fissidens flaccidus* Mitt. Among these taxa *Fissidens flaccidus* Mitt. is a new record for Rajasthan and it distinguishes from its allies in having leaves with complete limbidium and percurrent costa, ending far below apex. The present work deals with a morphotaxonomic studies of these taxa along with the adaptive strategies to survive in severe xeric environmental conditions of Thar Desert. This is the first consolidated record of bryophytes from Indian Thar Desert.

Keywords: Adaptive strategies, Indian Thar Desert, Morphotaxonomy, mosses.

Introduction

The Indian Thar Desert is the biggest desert in India, lies between 24° to 28° N latitude and 68° to 71° E longitude. More than 60 per cent of the desert lies in the state of Rajasthan. It extends into southern portion of Haryana and Punjab states and northern Gujarat. Climate of the Thar Desert stays extreme during two halves of the year. Summer prevails for a longer duration than other seasons. Strong winds and dust storm activities are common feature. The area is characterized by low relative humidity and scanty precipitation. Contrary to believe, deserts are devoid of life, the area of this region is rich in biodiversity, due to comparatively satisfactory rainfall during last five to ten years. Biodiversity richness is due to variation in geographical conditions and diversified habitat. The kinds of plants that live here need to be superbly adapted to live in arid zone.

Bryophytes are the non-vascular cryptogams, represents the second largest group of green plants after angiosperms. Bryophytes are shade and moist loving plants and are rarely in competition with higher plants, thus successfully exploited many habitats (Anderson, 1980). Bryophytes plays an important role in ecosystem function, being the first colonizers of variety of habitat (Alam *et al*, 2011) and perhaps prepare these areas suitable for later plants by trapping moisture and windblown organic debris. Some of them are effective soil binders and help in and erosion control dune stabilization.

Mosses are the largest group among the three lineages of Bryophytes. Mosses differs from the vascular plants by virtue of their smaller size, non-

vascularity and poikilohydric (Proctor *et al*, 2007) nature of leafy shoots. In addition, they produce spores for reproduction instead of seeds and have rhizoids instead of true roots. The study on the Desert flora has been focused on the vascular plants for long. But the knowledge of desert bryophytes is so fragmentary and only few studies undertaken on bryophytes (Bansal and Nath, 2014; Choyal and Sharma, 2011). Although good contribution has been made by Deora and Chaudhary (1997, 2000) towards the mosses of Rajasthan but no attempt has been done to the study of bryophytes of Indian Thar Desert, therefore present study was undertaken to provide the morphotaxonomic account of the mosses along with ecological conditions and many fascinating strategies employed by mosses surviving in such extreme habitats.

Material and Methods

The present study was based on freshly collected plant materials, collected during the period of year 2015 to 2017, particularly in the rainy season from different localities of different parts of Indian Thar Desert. The plant materials were collected carefully with the help of sharp edge knife. The collected material were brought to laboratory in polythene bags and washed thoroughly in fresh water and then preserved in 10 per cent FAA solution for further investigations. The FAA preserved specimen then soaked in 2 per cent KOH solution for 2-3 hours for tissue clearance and then temporary slides were prepared in 10 per cent aqueous glycerin. The whole plant measurements were taken with the help of graph paper, for dissected plant part and anatomical studies, measurements were taken with the help of ocular micrometer. Photographs were

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taken with the microscope attached with Nikon FX-35 A Japan camera. The remaining material were air dried at room temperature. After drying the specimens were kept in brown paper envelopes. All the crucial data were noted down including serial number, locality, date of collection, substrate etc. and were deposited in the Herbarium of Department of Botany, Jai Narain Vyas University, Jodhpur (Raj.) for further study. Various relevant literatures were consulted for identification work (Chaudhary and Deora, 1993; Dabhade, 1998)

Results

Morphotaxonomic description

1. *Tortula* Hedw.

Plants small and erect. Leaves densely arranged, oblong-lanceolate, apex obtuse, margin recurved, costa strong excurrent with long arista.

Tortula muralis Hedw. Spec. Musc., 123. 1801.

Morphotaxonomical description: Plants small, acrocarpous, darkish green, 2-4 mm long. Stem erect. Leaves densely arranged, spreading and erect when moist, curled and twisted when dry, spatulate, 1.4 mm long; apex obtuse, margin recurved; costa strong, thick, brown, excurrent with arista; apical and middle cells- papillose, quadrate to rounded-quadrate, 8 μ m long, 10 μ m broad; basal cells, 13 μ m long, 10 μ m broad, elongated and quadrate rectangular. Plants sterile.

Habitat: Plants are saxicolous, in association with *Riccia* species and *Semibarbula orientalis*, under boulder overhangs.

Xerophytic parameter: Long arista, recurved margins and papillose cells in leaves.

Locality: Aarna jharna-Jodhpur(Rajasthan).

Range: India, Pakistan, China, Japan, Central Asia, Caucasus, Europe, North America, Canary Islands, Turkey, Africa.

2. *Gymnostomiella* Fleisch.

Small, delicate plants. Stem filiform and radiculose below with comal tufts of leaves above. Laminal cells quadrate to hexagonal with papillose margin, leaf basal cells rectangular, hyaline with smooth and entire margin. Costa percurrent. Capsule red brown, erect, ovoid. Peristome absent.

Gymnostomiella veronicosa (Hook.) Fleisch., Musc. F1. Buitenzorg, 1:310, 1904.

Morphotaxonomical description: Plants small, velvety, in dense tufts, 6- 9 mm long. Stem filiform, radiculose at base, leaves crowded at apex forming comal tuft. Leaves spreading, concave, oblong-spathulate, 0.3- 1mm long; apex rounded; margin entire below and papillose above; Costa faint, percurrent, reach half of leaf length; upper and middle laminal cells quadrate to hexagonal, 13 μ m long, 15.6 μ m wide; basal cells hyaline, elongated-rectangular, 46 μ m long, 15 μ m wide. Seta erect, 5mm high; capsule reddish brown, ovoid 1-1.2mm long, 0.3mm in diameter; spores yellowish brown,

papillose 10-12 μ m in diameter. Multicellular gammae in terminal rosette.

Xerophytic parameter: Papillose cells in stem and leaves cell. Terminal gammae as a perennating bodies.

Habitat: Saxicolous, on calcareous rocks and on limy and concrete brick walls of temples.

Locality: Mandalnath temple, Mandore; Rao Jodha Desert Rock Park, Jodhpur (Rajasthan)

Range: India, China, East Nepal, Java, Philippines, New Guinea, Singapore, Korea, Japan, Formosa.

3. *Hyophila* Bridel.

Plants erect, dense, dark greenish, radiculose. Leaves crowded, oblong lanceolate, spatulate, margins with denticulations at apex, costa strong and percurrent.

Hyophila involuta (Hook.) Jaeger., Ber. S. Gall. Naturw. Ges. 1871-72:356, 1873.

Morphotaxonomical description: Plants in dense, dark greenish, upto 2-4 mm. Stem erect, radiculose below, upper leaves in rosettes. Leaves erect, spreading, upto 0.8-1.4 mm, lingulate to spatulate with denticulate apex; costa strong, percurrent (ending below apex), reddish below; upper and middle cells rounded to quadrate, mamillate, 8-10 μ m long, 5-8 μ m broad; basal cells rectangular, elongated, hyaline, 26-36 μ m long, 10 μ m broad. Seta 7 mm high. Capsule reddish brown, 2mm long, 0.5mm in diameter; peristome absent; spores brown, 10-12 μ m in diameter.

Xerophytic parameter: Presence of multipapilosity and hyaline cells.

Habitat: Growing on hardscape, on walls of temples near stream sides, moist house foundations or cement walls.

Locality: Rojda-Pali; Khajuwala-Bikaner (Rajasthan).

Range: Cosmopolitan.

4. *Semibarbula* Herz.

Plants tufted. Stem erect. Leaf carinate, obtuse at tip, lanceolate from broad base; costa percurrent, ending in short apiculus; laminal cells quadrate and densely papillose, basal cells elongated; peristome not completing one spiral turn.

Semibarbula orientalis (Web.) Wijk. & Marg.

Morphotaxonomical description: Plants green, in dense tufts, upto 1 cm long. Leaves crisped when dry and erecto-patent when moist; spirally arranged, forming comal tuft at apex; oblong to lanceolate, upto 1.2mm long; apex obtuse with apiculus; margin papillose; costa strong, percurrent; upper cells small, quadrate to hexagonal, 13 to 15.6 μ m long, 10 μ m wide, coarsely papillose; middle cells quadrate to polygonal, 15 to 18 μ m long, 10.4 μ m wide; basal cells elongated, rectangular, hyaline, 18 to 26 μ m long, 13 μ m wide. Multicellular terminal gammae present. Plants sterile.

Xerophytic parameter: Comal tufts of leaves at distal part, densely papillose cells of leaves and

hyaline basal cells. Presence of aerial gammae in axil of leaves as perennating bodies.

Habitat: Saxicolous, near stream sides where it gets sufficient moisture and partial shade, in association with *Riccia* species.

Locality: Bhim bhadak, Kayalana road, Arna jharna-Jodhpur(Rajasthan).

Range: India, Burma, Java, Sri Lanka, Malaysia, Pakistan, China, Africa, Taiwan, Philippines, New Guinea, Nepal.

5. *Fissidens* Hedw.

Plants erect, light green. Leaves distichous, oblong-lanceolate, characterized with vaginant lamina which may be equal or unequal, limbidium may be complete or incomplete.

Fissidens flaccidus Mitt., Trans. Linn. Soc. London 23: 56. 6 f. 18. 1860.

Morphotaxonomical description: Plants very small, 3-5mm long, delicate, light greenish, axillary nodules not differentiated, central strand lacking. Leaves in 5-7 pairs, oblong-lanceolate, acute at apex, 0.6-1.8mm long, margin entire; limbidium complete, 2-4 rows of linear elongated cells, single row at tip, indistinct toward the base of dorsal laminae and 2-5 rows at vaginant laminae; vaginant laminae unistratose, reaching half the leaf length; costa percurrent or ending far below the apex; laminal cells compactly arranged, rhombic to elliptic ovate, 21 µm long, 13 µm wide at dorsal and apical laminae, while basal cells elongated, rectangular to sub-rectangular, 28 µm long, 18.2 µm wide . Gemmae and sporophyte not found.

Xerophytic parameter: Sheathing or vaginant laminae.

Habitat: On rocks, in association with *Semibarbula orientalis*, *Tortula muralis* and *Riccia* species.

Locality: Aarna jharna-Jodhpur (Rajasthan).

Range: India, Nepal, China, Japan, Sri Lanka, Vietnam, Myanmar, Indonesia, New Guinea, Philippines, Americas, Australia, Africa, Brazil, Mexico, Siberia.

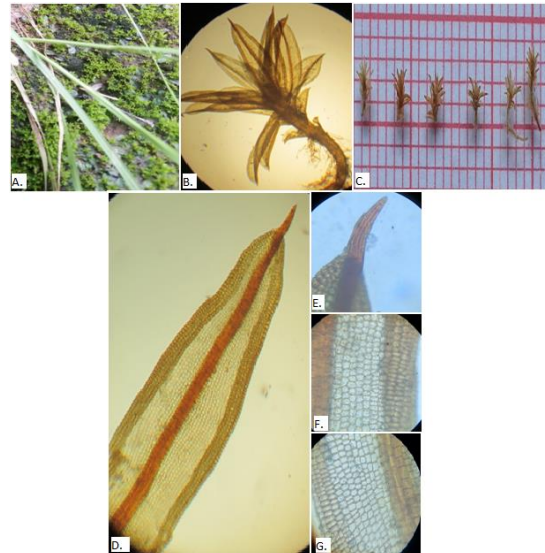


Figure 1. *Tortula muralis* Hedw. A-Field photograph. B, C-Plant. D-Leaf. E-Cells from upper part of leaf. F-Cells from middle part of leaf. G-Cells from basal part of leaf.

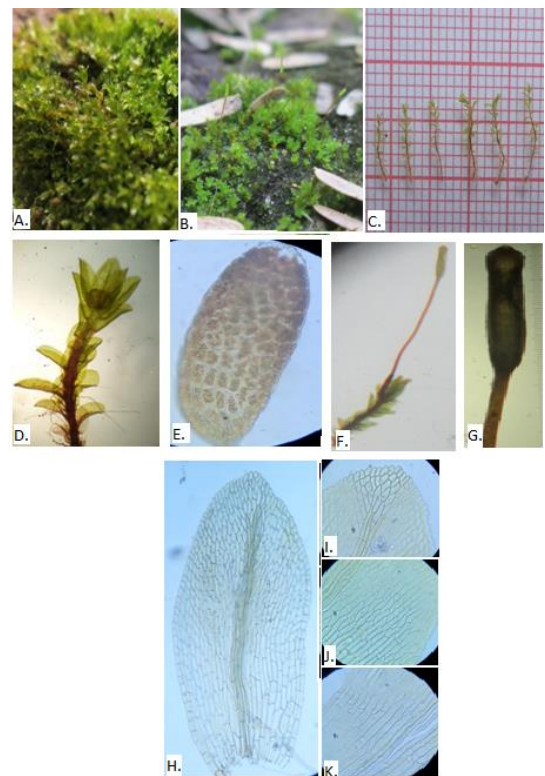


Figure 2. *Gymnostomiella veronicosa* (Hook.) Fleisch. A, B-Field photograph. C-Plant. D-Plant with terminal gemmae. E- gemma. F-Plant with capsule. G-Capsule. H- Leaf. I- Cells from upper part of leaf. J- Cells from middle part of leaf. K- Cells from basal part of leaf.



Figure 3. *Hyophila involuta* (Hook.) Jaeger. A-Field photograph. B, C-Plant. D-Plant with sporophyte. E-Spores. F-Leaf. G-Cells from upper part of leaf. H-Cells from middle part of leaf. I- Cells from basal part of leaf

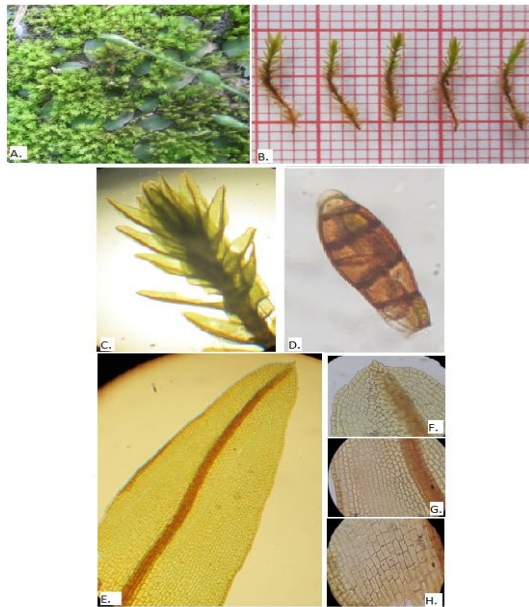


Figure 4. *Semibarbula orientalis* (Web.) Wijk. & Marg. A-Field photograph. B, C-Plant. D-Multicellular terminal gemma. E- Leaf. F-Cells from upper part of leaf. G-Cells from middle part of leaf. H-Cells from basal part of leaf.

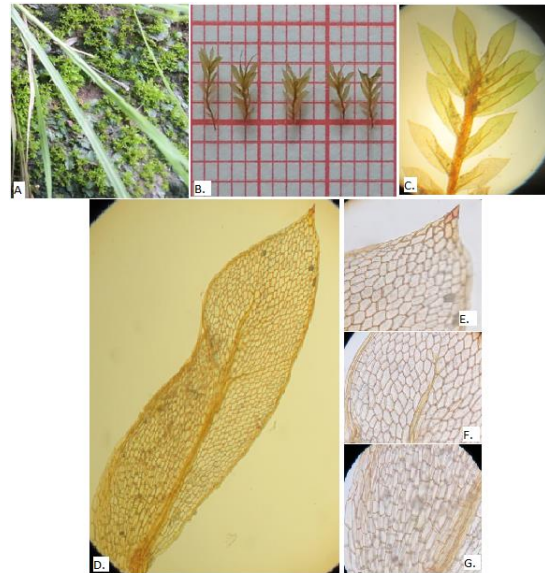


Figure 5. *Fissidens flaccidus* Mitt. A-Field photograph. B, C-Plant. D-Leaf. E-Cells from upper part of leaf. F-Cells from middle part of leaf. G-Cells from basal part of leaf.

Discussion

Thar Desert covers the western part of Rajasthan. This area is the hottest and driest region on the Indian subcontinent. Due to low rainfall and high temperatures the vegetation is very poor and majority of represented by xeric forms. The region is practically devoid of moss vegetation and are found to be near water sources during the rainy season, in the more protected microhabitats such as base of grass tussocks, under boulder overhangs, in rock crevices etc.

During rainfall, there will be runoff from the boulder which moisten the soil around the base and hence provides the suitable habitat for mosses to flourish. The xeric plants inhabiting here, like *Prosopis juliflora* and *Euphorbia caducifolia* (Danda thor) provides the shade and holds the water for long and make it available to mosses.

Additionally, mosses inhabiting the Thar, adopted to extreme environment and possesses various adaptive features, summarized as “Xeropottioid life syndromes” (Kurschner, 2004). Anatomically, these mosses possess papillose and hyaline cells. These cells result in the shrinkage of lamina with inward rolling of leaves under unfavourable conditions, whenever the precipitation is available these cells accelerates the water uptake and the leaves become erect. Sheathing base of leaves, peculiarly in *Fissidens flaccidus*, reduces the evaporating surface and forms a small reservoir between sheathing portion and stem. Similarly, revolute leaves or recurved margins in *Tortula muralis* reduces the evaporating surface (Watson, 1914); the outgrowth of leaf and costa increases the photosynthetic surface of leaves.

Mosses reported here grows in dense carpets or small patches. In such dense colonies water is lost more slowly than the sparse growth. During drought the metabolic activity of the plant may be ceases to a extent that it appears to be dead, when moistened it quickly revives and continues its normal function (Watson, 1914). The cells from the plants of drier habitat are smaller in size, compared to mesic and humid environment. Deora and Guhil (2014) reported that bryophytes perennate in adverse climatic condition by the formation of gemmae, tubers, meristematic rolling of apical apices and some other vegetative parts of the plants. Above discussed exhibiting strategies are not true xerophytic, instead these features enable the plant to live under less moist conditions.

Conclusion

Present study revealed the presence of five moss species in the unexplored area of Indian Thar Desert. Papilosity and hyaline cells were the prominent adaptive characters for the retention of water under xeric conditions among the taxa studied. *Fissidens flaccidus* Mitt., with complete limbidium and costa ending far below apex, is new record to the Rajasthan mosses. Vaginant lamina of *Fissidens flaccidus* and revolute leaves of *Tortula muralis* reduces the evaporating surface and helps to cope up with drier environmental conditions. This is the first record of mosses found in the Indian Thar Desert.

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