Bryophyte diversity in Terai regions of Uttar Pradesh, India with some new additions to the state

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INTRODUCTION

Uttar Pradesh (U.P.) can be divided into three topographical zones (i) The sub Himalayan Terai region in the North (ii) The Gangetic Plain in the centre (iii) The Vindhya Hills and plateau in the South. In the state average temperature ranges from 0°C to 46 °C and average annual rainfall is around 65 to 70 cm (https://en.wikipedia.org/wiki/Climate_of_Uttar_Pradesh). A total of 9.26% of the state's geographic area is under forest/tree cover in U.P. Thus area is not much favourable for the growth of bryophytes. Various workers from time to time made an attempt to provide consolidated account of bryophytes of Uttar Pradesh (Ahmad 1942, Pande & Ahmad 1944, Pande et al. 1954, Sahai 1962, Sahai & Sinha 1972, Srivastava 1964, Sinha et al. 1990, Singh & Kumar 2003, Singh et al. 2005, Lal 2007, Nath et al. 2010, Kumar & Kazmi 2004, 2006). Singh (2013) has listed 27 species of liverworts, 3 species of hornworts and 24 species of mosses from Uttar Pradesh. During the course of bryological exploration in that region, the authors come across some interesting taxa of bryophytes. In the present study, an attempt has been made to provide an enumeration of bryophytes of this area with ecology and distribution, range in India and abroad along with details of specimens examined.

MATERIALS AND METHODS

Plant exploration trip has been undertaken to Lakhimpur, Pilibhit and their neighbouring areas in Uttar Pradesh. Bryophyte plant samples has been collected from Gola forest, Salempur Forest Division, Malani Range, Lalapur, near forest nursery, Lakhimpur-Kheri and Pilibhit Tiger Reserve, Barahi range. Collected specimens have been deposited in Herbarium, CSIR-National Botanical Research Institute, Lucknow (LWG).

RESULTS AND DISCUSSION

During the present investigation on the bryophytes of Pilibhit Tiger Reserve and its neighbouring areas (Lakhimpur-Kheri, Gola, Shahjahanpur) about 30 taxa has been identified and enumerated. It includes an account of 22 species belonging to 17 genera of 11 Families of Mosses, 6 species belonging to 3 genera of 3 families of Liverworts and 2 species belonging to 1 genus of 1 family of Hornworts. During the study one Hornwort, *Notothylas kashyapii* D.K. Singh from Gangetic plains; and 8 mosses, *Dicranella macrosora* Gangulee, *Entodontaopsis tavoyense* (Hook. ex Harv.) W.R. Buck & R.R. Ireland, *Trachyphyllum inflexum* (Harv.) Gepp., *Weissia controversa* Hedw., *Fissidens crenulatus* Mitt., *Fissidens flaccidus* Mitt. and *Fissidens zollingeri* Mont. are reported from Uttar Pradesh for the first time.
It has been observed that terricolous forms are dominant than epiphytic ones and out of 30 taxa investigated from the area, mosses viz., Barbula indica, Philonotis mollis, Fissidens zollingeri and Hyophila nymaniana were more frequent in occurrence. Among liverworts Riccia billardieri and Cyathodium cavernarum have been frequently found in the area. Among the mosses, family Pottiaceae seems to be more dominant in the region with 5 taxa and Genus Fissidens has maximum number (5) of species. As far as the liverworts are concerned, family Ricciaceae exhibits maximum number of 4 species.

Enumeration

Liverworts

Family - Aytoniaceae

1. Plagiochasma appendiculatum Lehm. et Lindenb; Pag. IV. 14 (1832). (Fig. 1A)

Habitat: On stony wall, soil; Altitude- 452–536 ft.
Distribution: Central India (Amarkantak, Pachmarhi), Eastern Himalaya (Assam, Darjeeling, Sikkim), Gangetic Plains (Uttar Pradesh), Punjab and West Rajasthan plain, South India (Maharashtra, Munmar, Tamil Nadu), Western Himalaya (Corbett National Park, Dhanoli, Himachal Pradesh- GHNP, Kangra, Kullu, Simla, Nainital, Mussoorie, Ranikhet); Afghanistan, Africa, China, Myanmar, Nepal, Pakistan, Philippines, Vietnam.


Family - Cyathodiaceae

2. Cyathodium cavernarum Kunze in Lehm., Pugillus 6: 17 (1834) M ont. in Ramon de la Sagra, Hist. de Cuba; Crypt. 491, tab. 19, Syn. Hepat. 577 (1846). (Fig. 1B)

Habitat: On stony wall, soil; Altitude- 452–600 ft.
Distribution: Central India (Gujarat, Madhya Pradesh), Eastern Himalaya (Darjeeling, Khasi Jaintia Hills, Shillong), Gangetic Plains (Uttar Pradesh – Bareilly, Lucknow), South India (Mumbai, Elephanta caves, Khandala, Mahabaleshwar, Malabar Hills, Panchagani, Pratabgarh), Western Himalaya (Dehradun, Gumkhal, Karn Prayag, Mussoorie, Salkuli); Africa, America, Myanmar, Java.


Family - Ricciaceae

3. Riccia billardieri Mont. et Nees in Gottsche, Lindenberg & Nees, Syn. Hepat. 4: 602. (Fig. 1C)

Habitat: On soil; Altitude- 485–547 ft.
Distribution: Central India (Gujarat, Jharkhand, Madhya Pradesh, Rajasthan), Eastern Himalaya (Assam, Manipur, Sikkim), Gangetic Plains (Uttar Pradesh, West Bengal), South India (Andaman, Karnataka, Kerala, Maharashtra, Tamil Nadu), Western Himalaya (Himachal Pradesh, Uttarakhand); Australia, Bangladesh, Indonesia, Nepal, Philippines, Sri Lanka, Thailand.


4. Riccia gangetica Ahmad Ahmad ex L.Söderstr., A. Hagborg et von Konrat, Phytotaxa 65: 57 (2012). (Fig. 1D)

Habitat: On soil; Altitude- 530–600 ft.
Distribution: Central India (Gujarat, Madhya Pradesh, Rajasthan), Eastern Himalaya (Meghalaya), Gangetic Plains (Uttar Pradesh, West Bengal), Western Himalaya (Himachal Pradesh, Uttarakhand); South India (Kerala, Maharashtra, Tamil Nadu); Australia, Bangladesh, Indonesia.

Figure 1. A, Plagiochasma appendiculatum; B, Cyathodium cavernarum; C, Riccia billardieri; D, Riccia gangetica; E, Riccia discolor; F, Riccia stricta; G, Notothylas indica; H–I, Archidium birmannicum; J–K, Philonotis mollis.
5. **Riccia discolor** Lehm. et Lindenberg. in Lehmann, Nov. Stirp. Pug. 4: 1. (1832). ([Fig. 1E](#))  
**Habitat:** On soil; Altitude- 600 ft.  
**Distribution:** Central India (Chattishgarh, Gujarat, Madhya Pradesh, Punjab, Rajasthan) Eastern Himalaya (Assam, Sikkim, Meghalaya), Gangetic Plains (Uttarakhnd, Uttar Pradesh, West Bengal), Western Himalaya (Himachal Pradesh, Jammu & Kashmir), South India (Karnataka, Kerala, Maharashtra, Tamil Nadu); Africa, Australia, Bangladesh, Myanmar, Nepal, Pakistan, Sri Lanka.  

6. **Riccia stricta** (Gottsche, Lindenb. & Nees) Perold, Bothalia 20: 197 (1990). ([Fig. 1F](#))  
**Habitat:** On soil; Altitude- 480 ft.  
**Distribution:** Central India (Madhya Pradesh), Eastern Himalaya (Sikkim), South India (Kerala, Tamil Nadu), Gangetic Plains (West Bengal); Africa.  

Family - Archidiaceae

7. **Archidium birmannicum** Mitt. ex Dix. in J. Ind. Bot., 2: 175 (1921). ([Fig. 1H, I](#))  
**Habitat:** On stony wall, soil; Altitude- 485 – 600 ft.  
**Distribution:** Eastern Himalaya (Assam), Gangetic Plains (West Bengal Plains-Ramnagar, Hooghly), South India (Nilgiri and Palni Hills); Myanmar, Nepal.  

Family - Bartramiaceae

8. **Philonotis mollis** (Dozy & Molk.) Mitt. in Musci Ind. Or.: 60 (1859). ([Fig. 1J, K](#))  
**Habitat:** On soil; Altitude- 497–600 ft.  
**Distribution:** Eastern Himalaya (Sikkim), South India (Coorg, Kanara, Andaman Is.), Bhutan, Borneo, Celebes, Japan, Java, Madagascar, Philippines, Sri Lanka, Sumatra, Taiwan, Tonkin.  
**New record to Uttar Pradesh.**

Family - Dicranaceae

9. **Dicranella macrospora** Gangulee in Nov. Hedwigia, 8: 145 (1964). ([Fig. 2A](#))  
**Habitat:** On soil; Altitude- 497 ft.  
**Distribution:** Assam, Uttar Pradesh (Lakhimpur Kheri).  

Family - Ditrichaceae

10. **Ceratodon purpureus** (Hedw.) Brid. in Bryol. Univ., 1: 480 (1826). ([Fig. 2D](#))  
**Habitat:** On soil; Altitude- 547 ft.  
**Distribution:** Eastern Himalaya (Assam, Darjeeling), Gangetic plains (Raebareli), South India, Western Himalaya (Kashmir); Antarctic, Australia, Brazil, China, Chili, East Nepal, Europe, Japan, Java, Madagascar, New Zealand, North America (including Green Land, Alaska) North, Central and South Africa, Oceania, Siberia, Sri Lanka, Tajikistan, Thailand.

Figure 2. A, Dicranella macrospora; B–C, Erpodium mangiferae; D, Ceratodon purpureus; E, Fissidens bryoides; F, Fissidens crenulatus; G, Fissidens flaccidus; H–I, Fissidens involutus; J–K, Fissidens zollingeri; L, Physcomitrium eurystomum.
Family - Erpodiaceae

11. Erpodium mangiferae C. Müell in Linnaea 37: 178. (1873). (Fig. 2B, C)

Habitat: Epiphytic; Altitude: 452 ft.

Distribution: Central India (Gujarat), Eastern Himalaya (Assam), Gangetic plains (U.P.-Allahabad, Saharanpur; W. Bengal-Kolkata, Hooghly), Western Himalaya (Uttarakhand), South India (W. Ghats of Karnataka, Maharashtra and Tamil Nadu); Bangladesh, Nepal.


Family - Fissidentaceae

12. Fissidens bryoides Hedw. in Sp. Musc.: 153 (1801). (Fig. 2E)

Habitat: On soil; Altitude: 536 ft.

Distribution: Eastern Himalaya (Khasi Hills), Gangetic Plains (Lower Bengal); South India (Coonoor, Nilgiri Hills, Western Ghats), Western Himalaya (Nainital, Ranikhet, Simla), Africa, Caucasus, China, East Nepal, Europe, Japan, Java and Philippines, Malay, N. & S. America, Sri Lanka, Siberia, Taiwan.


13. Fissidens crenulatus Mitt. in Musc. Ind. Or.: 140 (1859). (Fig. 2F)

Habitat: On soil; Altitude: 418–568 ft.

Distribution: Gangetic Plains (Orissa), South India; East Nepal, Upper Burma.


14. Fissidens flaccidus Mitt. in Transactions of the Linnean Society of London 23: 56. 6 f. 18 (1860). (Fig. 2G)

Fissidens splachnobryoides Broth. in Schum. et Lauterb in Fl. Deutsch Schutzgeb. Südsee 81 (1900).

Habitat: On soil; Altitude: 418–568 ft.

Distribution: Central India (Pachmarhi), Gangetic Plains (Lower Bengal), South India (Bombay, Khandala), Western Himalaya (Kalka); Africa, Brazil, Borneo, Burma, China, Japan, Java, Nepal, New Guinea, Philippines, Sri Lanka, Vietnam.


15. Fissidens involutus Wilson ex Mitt. in J. Proc. Linn. Soc. Botany, Supplement 2: 138. 1859. (Fig. 2H, I)

Habitat: On soil; Altitude: 536 ft.

Distribution: Central India (Bastar, Chhotanagpur), Eastern Himalaya (Darjeeling, Sikkim), Gangetic Plains (Saharanpur), South India (Bombay, Khandala), Western Himalaya; Borneo, Burma, China, Nepal, Thailand, Vietnam.


16. Fissidens zollingeri Mont. in Ann. Sci. Nat. ser.3, 4: 114 (1845). (Fig. 2J, K)

Fissidens xiphoideus Fleisch. in Hedwigia 38: 125 (1899).

Habitat: On soil; Altitude: 418 ft.

Distribution: Central India (Pachmarhi), Gangetic Plains (Lower Bengal plains), South India (Bombay, Khandala, Western Ghats, Kanara, Andamani Is.), Western Himalaya (Nainital, Simla); widely distributed in Southwest Asia and Oceania, Borneo, Burma, China, Fiji, Indonesia, Nepal, Thailand, New Guinea, New


Family - Funariaceae

17. Physcomitrium eurystomum Sendtn. in Denkschr. Bayer Bot. Ges. Regensb., 3: 142 (1841). (Fig. 2L)

Habitat: On soil; Altitude- 418 ft.

Distribution: Gangetic plains (Lower Bengal, Hooghly, Allahabad); Central and South Africa, China, France, North Vietnam, Taiwan.


18. Entosthodon wichurae M. Fleisch. in Musci Fl. Buitenz., 2: 481 (1904). (Fig. 3C)

Habitat: On soil; Altitude- 536 – 600 ft.

Distribution: Eastern Himalaya (Meghalaya- Khasi and Jaintia Hills), Western Himalaya (Ranikhet); Burma, Java, Sri Lanka.


Family - Pottiaceae


Habitat: On soil, stony wall; Altitude- 353 – 547 ft.

Distribution: Widely distributed plain area in the country and up to 1000 m in the Himalayas; Nepal, Southeast Asia, Japan, South Africa, New Guinea.


20. Gymnostomum calcareum Nees et Hornsch., Bryol. Germ., 1: 153 10f.15 (1823); Gangulee, Moss. E. Ind., 3: 641 (1972). (Fig. 3D)

Habitat: On soil, Altitude- 547 ft.

Distribution: Eastern Himalaya, Western Himalaya (Uttarakhand-Mussoorie, Corbett National Park); Africa, Australia, China, Europe, Japan, New Zealand, North Central and South America.


Habitat: On soil, Altitude- 353 ft.
Figure 3. A–B, Barbula indica; C, Entosthodon wichurae; D, Gymnostomum calcareum; E, Hyophila spathulata; F–G, Hyophila nymaniana; H, Weissia controversa; I, Splachnobryum obtusum; J, Trachyphyllum inflatum; K–L, Entodontopsis tavoyense.
Distribution: Central India (Madhya Pradesh, Jharkhand, Orissa), Eastern Himalaya (Assam, Arunachal Pradesh, Meghalaya West Bengal), South India (Tamil Nadu), Western Himalaya (Himachal Pradesh, Kashmir, Uttarakhand); Bhutan, China, East Nepal, Japan, Java, Malaya, Moluca, Myanmar, New Guinea, Philippines, Oceania.


Habitat: On soil, stony wall; Altitude- 452–600 ft.

Distribution: Central India (Gujarat), Eastern Himalaya (Meghalaya), Gangetic Plain (Allahabad), Western Himalaya (Uttarakhand, Corbett National Park), South India (Karnataka, Kerala, Tamil Nadu); Nepal, Philippines.


Habitat: On soil; Altitude- 418–480 ft.

Distribution: Gangetic Plain (Allahabad, Delhi), Western Himalaya (Uttarakhand) South India (Tamil Nadu); China, Japan, East and West Nepal, Myanmar, Sri Lanka.


Habitat: On soil; Altitude- 480 ft.

Distribution: Western Himalaya (Kashmir, Uttarakhand), South India (Tamil Nadu); Australia, China, Europe, Japan, New Zealand, North Central and South America, Pakistan, Sri Lanka, West Indies.


**Family - Splachnaceae**


Habitat: On rock, stony wall; Altitude- 485 ft.

Distribution: Gangetic plains (Gangetic Southern Bengal, Howrah, Hooghly, Kolkata, Delhi, Allahabad, Orissa), Western Himalayas (Tehrī), South India (Western Ghats); Java, Africa, America, Australasia, Burma, Europe, Indonesia, Macaronesia, Philippines, Papua New Guinea. Thailand.


**Family - Thuidiaceae**


Habitat: Epiphytic; Altitude- 547 ft.

Distribution: Central India (Madhya Pradesh-Amakantak), Eastern Himalaya (Darjeeling, Khasi Hills, Sikkim), Gangetic plains (Orissa), South India (Palni Hills, Kanara), Western Himalaya (Valley of Flowers, Corbett...
Figure 4. *Notothylas kashyapii*: A–C, Thalli; D, Sporophytes in the apical region; E, Lamellae present on involucres; F, Capsule wall; G, chloroplast; H–I, Spores.
National Park); Australia, Bangladesh, Burma, Central Vietnam, China, Cambodia, Java, Madagascar, Moluccas, Nepal, New Caledonia, Philippines, Thailand.


Family - Stereophylaceae


(Fig. 3K, L)

*Sematophyllum tavoyense* (Hook.) Jaeg.

Habitat: Epiphytic; Altitude: 547 ft.

Distribution: Gangetic plain (Bihar), Western Himalaya (Dehradun, Corbett National Park); South India (Kerala); Bangladesh, East Nepal, Moulmein, Penang, Tavoy.


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Family - Notothylaceae

28. *Notothylas indica* Kash. in Kashyap and Dutt in Proc. Lahore Phill. Soc. 4: 49-56 (1925); Asthana & Srivastava in Bryophyt. Biblioth. 42:94 (1991). (Fig. 1G)

Habitat: On soil; Altitude: 485 ft.

Distribution: Gangetic plain (Lucknow, Allahabad), Central India (Pachmarhi, Tikamgarh), South India (Mumbai, Nagpur), Western Himalaya (Dehradun, Mussoorie); Pakistan (Parachhinar), Myanmar (Yangong).


Habitat: On soil; Altitude: 418–600 ft.

Distribution: Western Himalaya (Uttarakhand-Dehradun).


New record to Uttar Pradesh.

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