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ASSESSMENT OF LIVERWORT AND HORNWORT FLORA OF NILGIRI HILLS, WESTERN GHATS (INDIA)

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Abstract. Bryophytes are an important part of the flora of the Nilgiri Hills of Western Ghats, a biodiversity hotspot. This paper gives an updated catalogue of the Hepaticae of the Nilgiri Hills. The list includes all available records, based on the authors' collections and those in LWU and other renowned herbaria. The catalogue of liverworts indicates their substrate and occurrence, and includes several records new for the Nilgiri bryoflora as well as for Western Ghats. The list of Hepaticae contains 29 families, 55 genera and 164 taxa. The list of Anthocerotae comprises 2 families, 3 genera and 5 taxa belonging to almost all life form types.

Key words: Western Ghats, biodiversity hotspot, Tamil Nadu, Bryophyta, Hepaticae, Anthocerotae

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INTRODUCTION

The Nilgiri Hills of Tamil Nadu are a part of the Nilgiri Biosphere Reserve (NBR), recognized under the Man and Biosphere (MAB) Program of UNESCO. These hills (junction of Eastern Ghats and Western Ghats) are formed by north-south hill ranges rising from the coastal plains of peninsular India, with a few isolated peaks such as Dodabetta Peak (2667 m) and Mukuruti Peak (2554 m). The Nilgiris lie between 10°01′ to 11°47′ latitude north and 76°12′ to 77°15′ longitude east, covering *ca* 2549 km^2. The area receives the south-east and northwest monsoons, making for very rich bryoflora, especially that of epiphytes. Tropical montane evergreen forest, known as *shola* forest, occurs at higher elevations of the Western Ghats and its associated hill range in southern India. It is discontinuous and patchy, usually restricted to sheltered valleys, hollows and depressions, and surrounded by grasslands. Some of the main forest types in the area are wet evergreen forest, sub-tropical hill forest, montane wet temperate forests, mixed deciduous, montane evergreen (shola grassland) (see also Champion & Seth 1968; Hockings 1989; Mohandass & Davidar 2009).

For south India there are several provincial liverwort floras, including monumental works on liverworts by Montagne (1842) and Gottsche *et al*. (1845–1847). Many species are given in revisions of Indian *Cheilolejeunea* (Asthana *et al*. 1995), Indian Metzgeriaceae (Srivastava & Udar 1975a), Indian *Brachioelejeunea* (Awasthi & Srivastava 1988), Indian Fossombroniaceae (Srivastava & Udar 1975b), Indian Anueraceae (Srivastava & Udar 1976); Indian hornworts (Asthana & Srivastava 1991), Indian *Cololejunea* (Asthana & Srivastava 2003), Indian Lepidoziineae (Sharma & Srivastava 1993), Indian Geocalycaceae (Srivastava & Srivastava 2002), Indian *Lopholejeunea* (Awasthi *et al*. 2000) and a global revision of *Cyathodium* (Srivastava & Dixit 1996). There are recent papers on different aspects of the bryophytes of southern India (Srivastava *et al*. 1989; Srivastava & Sharma 2000;

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Srivastava *et al*. 2002; Srivastava & Verma 2004a, b; Nair *et al*. 2005; Srivastava *et al*. 2006a, b; Alam *et al*. 2007, 2011; Nair & Madhusoodanan 2007; Verma & Srivastava 2007, 2008a, b, 2010, 2011a, b, c, d; Madhusoodanan *et al*. 2007; Pócs *et al*. 2007; Nair *et al*. 2008, 2009a, b, 2012a, b; Daniels 2010; Verma 2010; Alam & Srivastava 2011; Verma *et al*. 2011; Alam 2012).

The Nilgiri Hills of Tamil Nadu host a valuable gene pool and significant bryodiversity. Preliminary reports on the liverworts of the area appeared in the middle of the 19th century, based largely on collections made by Europeans. Montagne's (1842) pioneer work on bryophytes of the Nilgiri Hills mentioned some hepatics, followed by Gottsche *et al*. (1845–1847) and later by Mitten (1861) who provided the first documentation of the liverworts of the Nilgiri Hills and described 20 species. Most of his names have been replaced due to changes in their systematic position. Chopra (1938) also listed several liverworts from the area. To extend our knowledge of the bryophytes of the Nilgiri Hills, we made an exhaustive survey of the entire area, collected and identified representative specimens, and made a detailed analysis of their diversity in the area on the basis of fresh collections and a critical survey of earlier reports and collections available in the Lucknow University Hepatic Herbarium (LWU) or overseas herbaria including NY, G, FH, NICH, STR and JE. The survey produced some noteworthy developments in the systematics of the bryophytes of remote localities in the Nilgiri Hills.

Material and methods

We collected and studied nearly 7000 herbarium specimens (mainly Hepaticae and Anthocerotae). They are preserved in the Bryophyte Herbarium, University of Lucknow (LWU). As different species grow in different seasons, generally we collected samples in summer and winter every year from 2000 to 2008 in the Nilgiri Hills, also making ecological observation in the field. At the same time we studied herbarium accessions collected by earlier workers. We identified and authenticated several taxa from type/authentic specimens obtained on loan from different International herbaria (FH, G, JE, NICH, NY, STR) and exsiccatae (*Hepaticae Selectae et Criticae* edited by Fr. Verdoorn; *Hepaticae Japonicae* edited by S. Hattori). The treatment of taxa mainly follows Schuster (1984), Inoue (1984), Gradstein *et al*. (2002), So (2003), Engel and Merrill (2004), Zhu and Gradstein (2005) and Fuselier *et al*. (2011).

Results and discussion

This work presents 169 taxa belonging to 58 genera and 31 families of Hepaticae and Anthocerotae. Seventy-five of the 169 taxa are reported here as obligate epiphytes, mostly members of the Plagiochilaceae, Porellaceae, Frullaniaceae, Lejeuneaceae, Radulaceae and Metzgeriaceae. The liverwort flora of the Nilgiri Hills consists of two phylogenetically related classes: Jungermanniidae and Marchantiidae. The Jungermanniidae include 43 genera and 151 species under 9 suborders and 23 families, of both thallose and leafy organization, belonging to Metzgeriales (with 5 genera and 13 species) and Jungermanniales (a highly diversified group with 38 genera and 143 species). The class Marchantiidae includes 12 genera and 28 species under 2 suborders and 8 families in the area, while class Anthocerotophyta includes 3 genera and 5 species under 2 families (Tables 1 & 2, Figs 1–18).

During this study we discovered 8 liverwort taxa new for the Nilgiri Hills and published them elsewhere: *Cololejeunea nilgiriensis* S. C. Srivast. & G. Asthana (from Avalanche; Asthana & Srivastava 2003), *Taxilejeunea nilgiriensis* P. K. Verma & S. C. Srivast. [from Kotagiri (Kengarai); Verma & Srivastava 2008a, b], *Lejeunea srivastavae* P. K. Verma & K. K. Rawat (from Ootacamund; Verma & Rawat 2013), *Microlejeunea udarii* P. K. Verma & S. C. Srivast. (from Pykara; Verma & Srivastava 2011a, b, c, d), *Telaranea indica* (S. C. Srivast. & P. K. Verma) A. E. D. Daniel & P. Daniel (from Governorsholai, as *Arachniopsis indica* S. C. Srivast. & P. K. Verma; Srivastava & Verma 2004b), *Gongylanthus indicus* S. C. Srivast. & P. K. Verma (from Naduvattam and Yellamalai; Srivastava & Verma 2004c), *Metzgeria coorgense* S. C. Srivast. & Sm. Srivast. [from Ootacamund and Mercara (Karnataka); Srivastava & Srivastava 2002], and *Solenostoma nilgiriensis* (A. Alam,

Table 1. Genera and families of Hepaticae and Anthocerotae in the Nilgiri Hills.

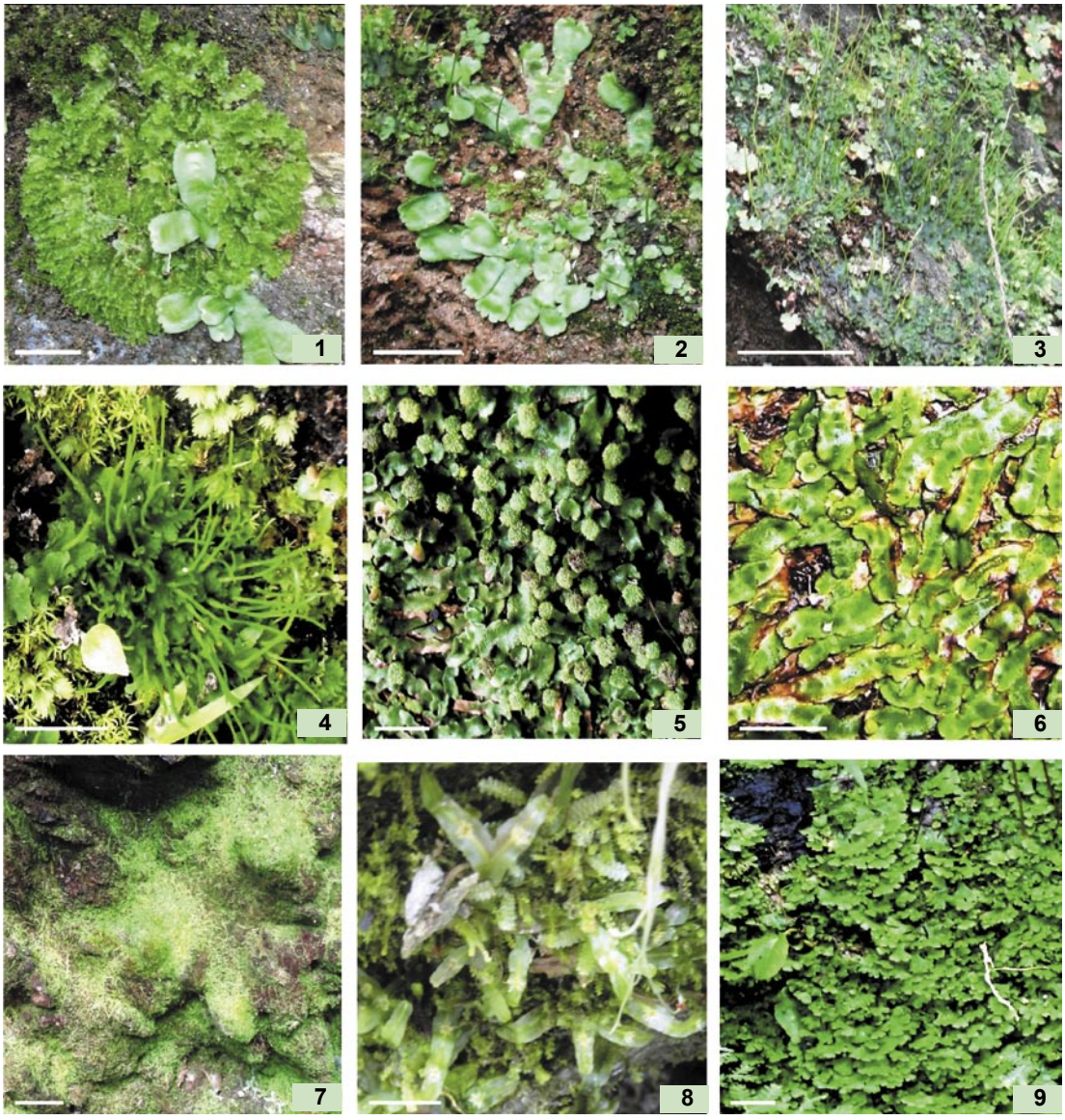
Phylum / Class	Families	Genera	Species
Marchantiophyta / Hepaticae	29	55	164
Anthocerotophyta / Anthocerotae	2	3	5
Total	31	58	169

Ad. Kumar & S. C. Srivast.) Vaňa & D. G. Long [from Ootacamund (Theetkul), as *Jungermannia nilgiriensis* A. Alam, Ad. Kumar & S. C. Srivast.; Alam *et al*. 2007].

ECOLOGICAL OBSERVATIONS

In terms of habitat preference, the liverworts and hornworts of Nilgiri can be grouped as terrestrial or epiphytic. Apart from soil-covered rocky slopes and dense broadleaved forests, the Nilgiri Hills also have a number of waterfalls, providing favorable climate and topography for a variety of terrestrial bryophytes, the predominant form. Springs, ponds, streams, pools, falls, seeps and dripping water create extremely wet conditions, as found at Laws Falls, Pykara Waterfalls, St. Catherine Waterfall and Kalahatti Waterfall, which support the growth of taxa such as *Dumortiera hirsuta*, *Pallavicinia lyellii*, *Riccia fluitans*, *Riccardia levieri*, *Phaeoceros* spp. and *Anthoceros* spp. The steep slopes and rocks of the entire region favor saxicolous vegetation such as *Asterella wallichiana*, *A. khasiana*, *Exormotheca ceylonensis*, *Targionia* spp., *Plagiochasma* spp. and *Reboulia hemisphaerica*. Some leafy liverworts including *Jungermannia lanceolata*, *J. tetragona*, *J. truncata*, *Notoscyphus lutescens*., *Cephaloziella* sp., *Cephalozia* sp, *Lophocolea* spp., *Heteroscyphus argutus*, *H. perfoliatus*, *Lethocolea javanica*, *Plagiochila acuta*, *P. indica* and *Porella acutifolia* are found in grassland or on soil-covered rocks. Some terricolous taxa grow as small turfs (*Jungermannia* sp., *Hebertus* spp., *Gottschelia schizopleura*) and mats (*Lunularia cruciata*, *Marchantia* sp., *Pallavicinia lyellii*).

The epiphytic bryophytes of Nilgiri Hills are significant in terms of number but also phytosociology. They are found mostly where the conditions are humid. The entire region of Dodabetta, Pykara and Mukuruthy National Park receives *ca* 1200 mm precipitation annually. The epiphytic liverworts of the area form corticolous and epiphyllous communities. The bark characteristics of the phorophyte – bark pH (always slightly acidic), bark texture (smooth, rough), exposure to the physical environment, tree age – play an important role for corticolous communities. As a habitat for epiphytic liverworts, a tree can be broadly divided into three regions: the base (up to 50 cm above soil level), characterized by the growth of species of *Lophocolea*, *Heteroschyphus*, *Plicanthus*, *Lejeunea discreta*; the trunk region with large primary limbs, which host liverworts such as *Ptychanthus*, *Radula*, *Lopholejeunea*, *Porella*, *Plagiochila* and *Frullania*; and twigs and small secondary branches with leaves, providing substrate for liverworts such as *Metzgeria* spp., *Lejeunea* spp., *Frullania tamarisci*, *Plagiochila* spp. and *Cheilolejeunea* spp. The epiphyllous forms are most typical and require more relative humidity. Here they are restricted to the leaves of young trees. Different life forms of epiphytic liverworts were recorded in the Nilgiri Hills: short turfs (*Lejeunea* spp), pendants (*Frullania tamarisci*, *Ptychanthus striatus*), wefts (*Bazzania tridens*), mats (*Radula* spp., *Leucolejeunea* sp.), fans (*Porella perrottetiana*) and dendroid forms (e.g., *Plagiochila fruticosa*). The liverwort diversity of the Nilgiri Hills is also affected by the altitudinal gradient, as some characteristics of the taxa may be governed by environmental factors. In the lower Nilgiri foothills the representation of terrestrial liverworts is at maximum; the absence of epiphytic liverworts in lower areas may be attributed to the drier conditions there: lower humidity, moisture and dew. With increasing altitude the temperature drops and relative humidity rises, enhancing the growth of epiphytic liverworts.



Figs 1–9. 1 – *Fossambronia wondraczekii* (Corda) Dumort., 2 – *Plagichasma rupestre* (G. Forst.) Steph., 3 – *Anthoceros subtilis* Steph., 4 – *Pheoceros laevis* (L.) Prosk. subsp. *laevis*, 5 – *Asterella khasiana* (Griff.) Grolle, 6 – *Asterella wallichiana* (Lehm.) Grolle, 7 – *Lophocolea bidentata* (L.) Dumort., 8 – *Pallavicinia lyellii* (Hook.) Gray, 9 – *Cyathodium cavernarum* Kunze. Scale bars: 1 = 1 cm, 2 = 4 cm, 3, 5, 6 & 8 = 3 cm, 4 & 9 = 2 cm.

Human activities and population pressures coupled with the developing tourism industry in the area have changed the natural vegetation, posing a serious threat to the survival of a number of the region's floristic elements. The influx of tourists indirectly affects the environment. Ooty, a major tourist destination, attracts great numbers of tourists the year round. Any environmental impact in major urban areas at higher elevations such as Ooty, Coonoor and Kotagiri can affect sites at lower locations (Daniels 1992). Many hotels and other tourism facilities have been constructed. Continuous traffic

Figs 10–18. 10 – *Targionia hypophylla* L., 11 – *Marchantia paleacea* Bertol., 12 – *Dumortiera hirsuta* (Sw.) Nees, 13 – *Cephaloziella kiaerii* (Austin) S. W. Arnell, 14 – *Bazzania tridens* (Reinw., Blume & Nees) Trev., 15 – *Frullania tamarisci* subsp. *obscura* (Verd.) S. Hatt., 16 – *Plagiochila indica* Mitt. *ex* Steph., 17 – *Ptychanthus striatus* (Lehm. & Lindenb.) Nees, 18 – *Solenostoma strictum* (Schiffner) Vaňa, Hentschel & J. Heinrichs, Scale bars: 11 = 4 cm, 12 = 3 cm, 13 = 1 cm, 14, 16 & 18 = 2 cm, 15 & 17 = 5 cm.

has produced heavy automobile pollution in the area. Grazing is also taking its toll in areas like Masinagudi, which is a livestock hub with an almost 1:1 ratio of cattle to humans (Daniels 1996). Free grazing in such areas poses a constant threat to surface flora. The slopes of the Nilgiri forests are being cleared for agriculture, destroying forest patches and consequently the epiphytic flora, and also increasing the threat of landslides, which are more common now than earlier.

Observations during field survey work in the area in recent years have revealed the absence of

Table 2. Enumeration of liverwort and hornwort taxa of Nilgiri Hill, (Tamil Nadu), Western Ghats. C – corticolous, E – epiphyllous, T – terricolous.

Family & Genus	Species	Substrate
	MARCHANTIOPYTA Stotler & Crand.-Stotl. METZGERIALES R. M. Schust. *emend*. Schljak.	
Fossombroniaceae Hazsl.		
Fossombronia Raddi	1. ***F. cristula*** Aust.	T
	2. ***F. himalayensis*** Kash.	T
	3. ***F. pusilla*** (L.) Dumort.	T
	4. ***F. wondraczekii*** (Corda) Dumort.	T
Pallaviciniaceae Migula *emend*. R. M. Schust.		
Pallavicinia S. F. Gray	5. ***P. lyellii*** (Hook.) S. F. Gray	T
Metzgeriaceae H. Klinggr.		
Metzgeria Raddi	6. ***M. pubescens*** (Schrank) Raddi	C
	7. ***M. furcata*** (L.) Dumort.	C
	8. ***M. indica*** Udar & S. C. Srivast.	C, T
	9. ***M. consanguinea*** Schiffn.	C
	10. ***M. pandei*** S. C. Srivast. & Udar	C
	11. ***M. coorgense*** S. C. Srivast. & Sm. Srivast.	C
Aneuraceae H. Klinggr.		
Aneura Dumort.	12. ***A. pellioides*** (Horik.) Inoue	T
Riccardia S. F. Gray	13. ***R. levieri*** Schiffner	T
	JUNGERMANNIALES H. Klinggr	
Herbertaceae Mull.Frib. *ex* Fulford & Hatcher		
Herbertus S. F. Gray	14. ***H. nilgerriensis*** (Steph.) H. A. Mill.	T
	15. ***H. pinnatus*** (Steph.) H. A. Mill.	T
Lophoziaceae Cavers		
Plicanthus R. M. Schust.	16. ***P. hirtellus*** (F. Weber) R. M. Schust.	C
Gottschelia Grolle	17.***G. schizopleura*** (Spruce) Grolle	T
Jungermanniaceae Rchb.		
Jungermannia L.	18. ***J. appressifolia*** Mitt.	T
	19. ***J. lanceolata*** L.	T
	20. ***J. pfleidereri*** Amakawa & Vána	T
	21. ***J. pyriflora*** Steph.	T
Solenostoma Mitt.	22. ***S. strictum*** (Schiffner) Váňa, Hentschel & J. Heinrichs	T
	23. ***S. tetragonum*** (Lindenb.) R. M. Schust. *ex* Váňa & D. G. Long	T
	24. ***S. truncatum*** (Nees) R. M.Schust. *ex* Váňa & D. G. Long	T
	25. ***S. nilgiriensis*** (A. Alam, Ad. Kumar & S. C. Srivast.) Vaňa & D. G. Long	T
Notoscyphus Mitt.	26. ***N. darjeelingensis*** Udar & Ad. Kumar	T
	27. ***N. pandei*** Udar & Ad. Kumar	T
	28. ***N. paroicus*** Schiffner	T
Scapaniaceae Migula		
Diplophyllum Dumort.	29. ***D. nanum*** Herzog	T

Table 2. *Continued*.

Family & Genus	Species	Substrate
Arnelliaceae Nakai		
Gongylanthus Nees	30. ***G. indicus*** S. C. Srivast. & P. K. Verma	T
Geocalycaceae Klinggr.		
Lophocolea (Dumort.) Dumort.	31. ***L. bidentata*** (L.) Dumort.	T, C
	32. ***L. heterophylla*** (Schrad.) Dumort.	T, C
	33.***L. minor*** Nees	T
	34. ***L. muricata*** (Lehm.) Nees	T, C
Heteroscyphus Schiffn.	35. ***H. argutus*** (Nees) Schiffner	T, C
	36. ***H. perfoliatus*** (Mont.) Schiffner	T, C
	37. ***H. orbiculatus*** A. Srivast. & S. C. Srivast.	T, C
Plagiochilaceae Müll. Frib. & Herzog		
Plagiochila (Dumort.) Dumort.	38. ***P. acuta*** Steph.	T, C
	39. ***P. beddomei*** Steph.	C
	40. ***P. celebica*** Schiffn.	T, C
	41. ***P. duthiana*** Steph.	T, C
	42. ***P. elegans*** Mitt.	C
	43. ***P. flexuosa*** Mitt.	C
	44. ***P. fruticosa*** Mitt.	C
	45. ***P. ghatiensis*** Steph.	C
	46. ***P. gracilis*** Lindenb. & Gottsche	C
	47. ***P. indica*** Mitt. *ex* Steph.	T, C
	48. ***P. junghuhniana*** Sande Lac	T, C
	49. ***P. peradenyensis*** Schiffn.	C
	50. ***P. sciophila*** Nees	C
	51. ***P. semidecurrens*** (Lehm. & Lindenb.) Lehm. & Lindenb.	C
	52. ***P. sisparensis*** Steph.	C
	53. ***P. subtropica*** Steph.	C
Acrobolbaceae Hodgs.		
Lethocolea Mitt.	54. ***L. javanica*** (Schiffn.) Grolle	T
Chonecoleaceae R. M. Schust. *ex* Grolle		
Chonecolea Mitt.	55. ***C. schusteri*** Udar & Ad. Kumar	T
Lepidoziaceae Limpr.		
Bazzania S.F. Gray	56. ***B. oshimensis*** (Steph.) Horik.	T, C
	57. ***B. tridens*** (Reinw., Blume & Nees) Trev.	T, C
Telaranea Spruce *ex* Schiffn.	58. ***T. indica*** (S. C. Srivast. & P. K. Verma) A. E. D. Daniel & P. Daniel	T
Calypogieaceae (K. Müll.) Arnell		
Calypogeia Raddi	59. ***C. arguta*** Nees &Mont. *ex* Nees	T
	60. ***C. azurea*** Stotler & Crotz.	T, C
	61. ***C. lunata*** Mitt.	T
Cephaloziaceae Migula		
Cephalozia (Dumort.) Dumort.	62. ***C. siamensis*** N. Kitag.	T
	63. ***C. willisana*** Steph.	T

Table 2. *Continued*.

Family & Genus	Species	Substrate
Cephalloziallaceae Douin		
Cephaloziella (Spruce) Schiffn.	64. ***C. kiaerii*** (Austin) S. W. Arnell	T
Jackiellaceae R. M. Schust.		
Jackiella Schiffn.	65. ***J. javanica*** var. ***cardiocarpa*** Schiffn.	T
Porellaceae Cavers		
Porella L.	66. ***P. acutifolia*** (Lehm. & Lindenb.) Trevis.	T, C
	67. ***P. caespitans*** var. ***setigera*** (Steph.) S. Hatt.	C
	68. ***P. campylophylla*** (Lehm. & Lindenb.) Trevis.	T, C
	69. ***P. campylophylla*** var. ***ligulifera*** Tayl.	C
	70. ***P. chinensis*** (Steph.) S. Hatt.	C
	71. ***P. madagascariensis*** (Nees & Mont.) Trevis.	C
	72. ***P. plumosa*** (Mitt.) Inoue	C
	73. ***P. perrottetiana*** (Mont.) Trevis.	T, C
Frullaniaceae Lorch		
Frullania Raddi	74. ***F. hampeana*** var. ***acutiloba*** (Mitt.) S. Hatt.	C
	75. ***F. arecae*** (Spreng.) Gottsche	C
	76. ***F. alstonii*** var. ***pfleidereri*** S. Hatt.	C
	77. ***F. campanulata*** Sande Lac.	C
	78. ***F. ericoides*** (Nees *ex* Mart.) Mont.	T, C
	79. ***F. grandistipula*** Steph.	C
	80. ***F. inflexa*** Mitt.	C
	81. ***F. muscicola*** Steph.	C
	82. ***F. neurota*** Taylor	T, C
	83. ***F. riojaneirensis*** (Raddi) Spruce	C
	84. ***F. tamarisci*** subsp. ***obscura*** (Verd.) S. Hatt.	T, C
Lejeuneaceae Cavers		
Mastigolejeunea (Spruce) Schiffn	85. ***M. humilis*** (Gottsche) Schiffner	C
Lopholejeunea (Spruce) Schiffn.	86. ***L. indica*** Udar & U. S. Awasthi	C
	87. ***L. subfusca*** (Nees) Schiffner	T, C
Schiffneriolejeunea Verd.	88. ***S. indica*** (Steph.) Udar & U.S. Awasthi	C
	89. ***S. polycarpa*** (Nees) Gradst.	C
Archilejeunea (Spruce) Schiffn.	90. ***A. apiculifolia*** Steph.	C
	91. ***A. planiuscula*** (Mitt.) Steph.	C
	92. ***A. minutiloba*** Udar & U. S. Awasthi	C
Spruceanthus Verd.	93. ***S. semirepandus*** (Nees) Verd.	T, C
Acanthocoleus R. M. Schust.	94. ***A. yoshinaganus*** (S. Hatt.) Kruijt	C
Frullanoides Raddi	95. ***F. tristis*** (Steph.) Slageren	C
Ptychanthus Nees	96. ***P. striatus*** (Lehm. & Lindenb.) Nees	T, C
Drepanolejeunea (Spruce) Schiffn.	97. ***D. angustifolia*** Grolle	C
	98. ***D. ternatensis*** (Gottsche) Steph.	C
	99. ***D. ternatensis*** var. ***lancispina*** Herz.	C
	100. ***D. yunnanensis*** (P. C. Chen) Grolle & R. L. Zhu	C, E
Leptolejeunea (Spruce) Schiffn.	101. ***L. foliicola*** (Horik.) R. M. Schust.	C
Metalejeunea Grolle	102. ***Metalejeunea cucullata*** (Reinw., Blume & Nees) Grolle	E

Table 2. *Continued*.

Family & Genus	Species	Substrate
Microlejeunea (Spruce) Jack. & Seph.	103. ***M. punctiformis*** (Taylor) Spruce	C, E
	104. ***M. udarii*** P. K. Verma & S. C. Srivast.	C
	105. ***M. ulicina*** (Taylor) A. Evans	C
Lejeunea Libert.	106. ***L. brittoniae*** A. Evans	C
	107. ***L. caespitosa*** Lindenb.	C
	108. ***L. cocoes*** Mitt.	C
	109. ***L. discreta*** Lindenb.	T, C
	110. ***L. flava*** (Sw.) Nees	T, C
	111. ***L. srivastavae*** P. K.Verma & K. K. Rawat	C
	112. ***L. neelgherriana*** Gottsche	C
	113. ***L. perrottetii*** Steph.	C
	114. ***L. stevensiana*** (Steph.) Mizut.	C
	115. ***L. tuberculosa*** Steph.	C
	116. ***L. wightii*** Lindenb.	T, C
	117. ***L. aloba*** Sande Lac.	C
	118. ***L. subolivacea*** Mizut.	C
Cheilolejeunea (Spruce) Schiffn.	119. ***C. trapezia*** (Nees) R. M. Schust.	T, C
	120. ***C. laeviscula*** (Mitt.) Steph.	C
	121. ***C. serpentina*** (Mitt.) Mizut.	C
	122. ***C. udarii*** G. Asthana, S. C. Srivast. & A. K. Asthana	C
	123. ***C. xanthocarpa*** (Lehm. & Lindenb.) I. Malombe.	C
Taxilejeunea (Spruce) Schiffn.	124. ***T. eckloniana*** (Agarwal) P. K. Verma & S. C. Srivast.	C
	125. ***T. nilgiriensis*** Verma & S. C. Srivast.	C
	126. ***T. tenerrima*** Steph.	C
Cololejeunea (Spruce) Schiffn.	127. ***C. appressa*** (A. Evans) Benedix	C, E
	128. ***C. cardiocarpa*** (Mont.) Steph.	C, E
	129. ***C. latilobula*** (Herz.) Tixier	C, E
	130. ***C. minutissima*** (Smith) Schiffn.	C, E
	131. ***C. pseudofloccosa*** (Horik.) Benedix	C, E
	133. ***C. nilgiriensis*** G. Asthana & S. C. Srivast.	C
	134. ***C. udarii*** G. Asthana, S. C. Srivast. & A. K. Asthana	C, E
Radulaceae (Dumort.) K.Mull.		
Radula Dumort.	135. ***R. madagascariensis*** Gottsche	C
	136. ***R. nilgiriensis*** Udar & Dh. Kumar	C
	137. ***R. onraedtii*** K. Yamada	C
	138. ***R. perrottetii*** Gottsche *ex* Steph.	C
	139. ***R tabularis*** Steph.	C
MARCHANTIALES Limpr.		
Cleveaceae Cavers		
Athalamia Falc.	140. ***A. pusilla*** (Steph.) Kash.	T
Aytoniaceae Cavers		
Reboulia Raddi	141. ***R. hemisphaerica*** (L.) Raddi	T
Mannia Corda	142. ***M. foreaui*** Udar &V. Chandra	T

Table 2. *Continued*.

Family & Genus	Species	Substrate
Plagiochasma Lehm. & Lindenb.	143. ***P. cordatum*** Lehm. & Lindenb.	T
	144. ***P. pterospermum*** C. Massal.	T
	145. ***P. rupestre*** (G. Forst.) Steph.	T
Asterella P. Beauv.	146. ***A. khasiana*** (Griff.) Grolle	T
	147. ***A. wallichiana*** (Lehm.) Grolle	T
Lunulariaceae H. Klinggr.		
Lunularia Adans.	148. ***L. cruciata*** (L.) Dumort. *ex* Lindb.	T
Exormothecaceae Müll. Frib. *ex* Grolle		
Exormotheca Mitt.	149. ***E. ceylonensis*** Meijer	T
Marchantiaceae (Bisch.) Endl.		
Marchantia March.	150. ***M. kashyapii*** Udar & Shaheen	T
	151. ***M. paleacea*** Bertol.	T
	152. ***M. palmata*** Reinw., Blume & Nees	T
Dumortieraceae D. G. Long		
Dumortiera Nees	153. ***D. hirsuta*** (Sw.) Nees	T
Targioniaceae Endl.		
Targionia L.	154. ***T. lorbeeriana*** K. Müll.	T
	155. ***T. hypophylla*** L.	T
Cyathodiaceae Stotler & Crand.-Stotl		
Cyathodium Kunze	156. ***C. cavernarum*** Kunze	T
Ricciaceae Rchb.		
Riccia L.	157. ***R. crozalsii*** Levier	T
	158. ***R. crystallina*** L.	T
	159. ***R. stricta*** (Gottsche *et al*.) Perold	T
	160. ***R. gangetica*** Ahmad	T
	161. ***R. grollei*** Udar	T
	162. ***R. melanospora*** Kash.	T
	163. ***R. plana*** Tayl.	T
	164. ***R. warnstrofii*** Limpr.	T
ANTHOCEROTOPHYTA Stotl. & Crand.-Stotl.		
Anthocerotaceae Dumort. Corr. Trevis emend. Hässel		
Anthoceros L.	165. ***A. angustus*** Steph.	T
	166. ***A. subtilis*** Steph.	T
Notothyladaceae (Milde) Müll.		
Notothylas Sull. *ex* A. Gray	169. ***N. indica*** Kash.	T
Pheoceros Prosk.	167. ***P. laevis*** (L.) Prosk. subsp. ***laevis***	T
	168. ***P. laevis*** subsp. ***carolinianus*** (Michx.) Prosk.	T

some taxa earlier reported in recent collections: e.g., *Acrolejeunea pycnoclada* (Taylor) Schiffn., *Archilejeunea apiculifolia* Steph., *Archilejeunea minutiloba* Udar & U. S. Awasthi, *Asterella leptophylla* (Mont.) Grolle, *Athalamia pusilla* (Steph.) Kashyap, *Chonocolea schusterii* Udar & Ad. Kumar, *Mannia forauei* Udar & V. Chandra, *Radula javanica* Gott., *Riccia melanospora* Kash., *Riccia warnstorfii*

Limpr., *Schistochila aligera* (Nees & Blume) Jack & Steph., *S. glaucescens* (Hook.) A. Evans and *S. philippinensis* (Mont.) Jack & Steph., which have not been re-collected since their original discovery in the area. A number of other taxa [e.g., *Cheilolejeunea udarii*, *Cololejeunea nilgiriensis*, *Exermotheca ceylonensis* Meijer, *Plagiochila gracilis* Lindenb. *Plagiochila sisparensis* Steph., *Reboulia hemisphaerica* (L.) Raddi] are near extinction in the area due to their very low frequency of occurrence and habitat change.

Some endemic taxa, for example *Metzgeria nilgiriensis*, *Plagiochila sisparensis*, *Radula nilgiriensis*, *Taxilejeunea nilgiriensis*, *Microlejeunea udarii*, *Gongylanthus indicus*, *Telaranea indica*, *Chonocolea schusterii*, *Lejeunea perrottetii*, *Herbertus nilgiriensis*, *Cheilolejeunea udarii* and *Archilejeunea minutiloba*, face the maximum risk of extinction because they have so few localities. Some taxa which are known from other countries but whose distribution within India is restricted to the Nilgiri Hills (e.g., *Lethocolea javanica*, *Plagiochila beddomei*, *Gottschelia schizopleura*, *Plagiochila junghuhniana*) are also threatened.

Bryophytes, though the second-largest group of terrestrial plants, have received much less attention than vascular plants in conservation and protection planning. Some liverwort species urgently require protection and conservation to save them from extinction. Habitat destruction eliminates bryophytes earlier than many other phanerogams because they are more sensitive to environmental change. The study area, Nilgiri, is filled with lush green vegetation. Tropical evergreen trees occur at high frequency and density, providing an excellent environment for growth of bryophytes; they may serve in *in situ* conservation of these plants. Changes in the habit, growth rate and growth pattern of a particular species can be monitored over a period of several years and the data thus collected can be used to predict the growth potential of bryophytes during climatic change in the area. Some rare bryophyte species may be grown in a natural conservatory such as the Government Botanical Garden at Ootacamund and Sims Park at Coonoor.

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