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Checklist of mosses (Bryopsida) from Pachamalai Hills of Eastern Ghats, Tamil Nadu, India

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Abstract
Pachamalai Hills, situated on the Southern Eastern Ghats of Tamil Nadu, was relatively unexplored as far as moss flora (Bryopsida) is concerned. Considering the need for an enumeration and distribution of mosses in Pachamalai Hills, field visits were carried out from 2013 to 2016 covering all the seasons. The compilation includes 68 species belonging to 42 genera and 21 families. The dominant families with the maximum number of species are Pottiaceae (15), Hypnaceae (9) and Fissidentaceae (9). The genus *Fissidens* is the dominant one with 8 species. It is interesting to note that 14 moss species of Pachamalai hills belonging to 11 families are newly added to the moss flora of Tamil Nadu.

Keywords: bryophyta, Eastern Ghats, floral checklists, mosses, Pachamalai Hills

Introduction
Floristic studies are the primary means which helps to understand the plant diversity of an area and are important in the management plans for conservation. Floral checklists are invaluable resources which serve a range of functions for research and biodiversity-related activities. The objective of a national checklist should be to coordinate, consolidate and disseminate basic taxonomic and species information that is commonly required by a range of users [1]. In terms of species richness, bryophytes form the largest group of land plants after angiosperms nearly 23, 000 species [2]. Amongst these mosses are a highly evolved group of bryophytes with nearly 17,000 species. In India, mosses are almost widely distributed in all forest regions. The checklist of the bryophytes of India [3] reports a total number of 2,489 taxa of bryophytes recorded from India, comprising 1,786 species in 355 genera of mosses, 675 species in 121 genera of liverworts and 25 species in six genera of hornworts. In spite of the richness of moss flora in the country, there is a dearth of researchers in bryologists and in the amount of work done on their taxonomy owing to inexplicable reasons [4]. However during the early 19th century, Bryophytes in India began to receive attention and a significant contribution has been made in the recent past. Checklists for mosses are seldom available for many ecologically important areas in India when compared to that of vascular plants. The studies on mosses from different localities in various parts of the world as well as in India have been reviewed. In the recent past, various states of India like Gujarat, Madhya Pradesh, Chattisgarh, Jharkhand, Karnataka, Kerala, Tamil Nadu and Andhra Pradesh have published their moss checklist [5]. The checklist of the bryophytes of Tamil Nadu, India published by Daniels [6] included 712 taxa of bryophytes from Tamil Nadu, India, comprising 211 taxa in 56 genera and 32 families of liverworts, 8 taxa in 4 genera and 2 families of hornworts, and 493 taxa in 189 genera and 44 families of mosses. The checklist was prepared from the intensive field works done by the author himself and the previous records available. However mountain ranges of Eastern Ghats were not covered completely for the floristic studies of Bryophytes. Pachamalai Hills which is situated at the southern parts of Eastern Ghats covers is a rich source of biodiversity. A checklist of mosses in Boda Hills of Eastern Ghats was published [7]. Other notable works include the moss flora study by many researchers [8, 9, 10 & 11]. The biodiversity and ecosystem functioning Pachamalai Hills has been studied [12]. An ethnomedicinal survey of threatened plants of Pachamalai Hills was carried out [13]. The ethno veterinary usage of medicinal plants in Pachamalai Hills was studied [14]. However this area has not been explored for the diversity of mosses. Therefore, the primary goal of this research was to make an enumeration and distribution of species of moss flora to increase knowledge of moss diversity in the Pachamalai Hills area. Hence a field study was carried out systematically to enumerate the mosses of present study area.

Topography of the study area
The Eastern Ghats is a long stretch of hills covering various states of South India *viz*., Odisha, Andhra Pradesh, Tamil Nadu and some parts of Karnataka. In Tamil Nadu it is spreading over three Districts - Perambalur, Salem and Tiruchirappalli. The Pachamalai Hills is geographically situated between 78° 31' E and 11° 28' N to 78° 20' E and 11° 10' N, occupying an area of about 14,122 km^2 (Figure. 1). The climate is tropical with temperature ranging between 25 to 30°C and a minimum temperature range of 12 to 18°C with an annual rainfall of 800- 900 mm in the altitude of 1015 MSL. The vegetation has mixed forests of deciduous and evergreen trees and shrubs.

Material and Methods
Field visits were carried out for three years from 2013 covering pre monsoon, monsoon and post monsoon seasons. Plants were gently scraped out from the substrates with the

help of sharp edged knife and spatula. The collected materials were washed gently to remove the soil and debris adhering to them. Finally the collected parts were carefully pressed out without damaging the fragile plant parts. The materials were collected in the polythene bags and the herbaria were prepared by air drying the materials at room temperature after removing the excess of water from the plants with high water content using blotting papers. The dried specimens were stored in brown paper packs of dimensions 5" × 4". The packets were labeled with the necessary information and they were stored and kept away from insects. Observations were made after the materials were soaked in water for about 10 to 15 minutes to retain turgidity. The plants were identified with the help of Gangulee's '*Mosses of Eastern India and Adjacent Regions*' [15], *Bryophytes of Wayanad in Western Ghats* [16] and other authentic publications. All moss taxa included in the list were checked against the database and Checklist of the bryophytes of Tamil Nadu, India [6] was referred for current acceptable nomenclature. Final authentication was done by comparing with specimens available at Rapinat Herbarium (RHT), St. Joseph's College (Autonomous), Tiruchirapalli, Tamil Nadu, India. The taxon was arranged by following the classification of Goffinet [17].

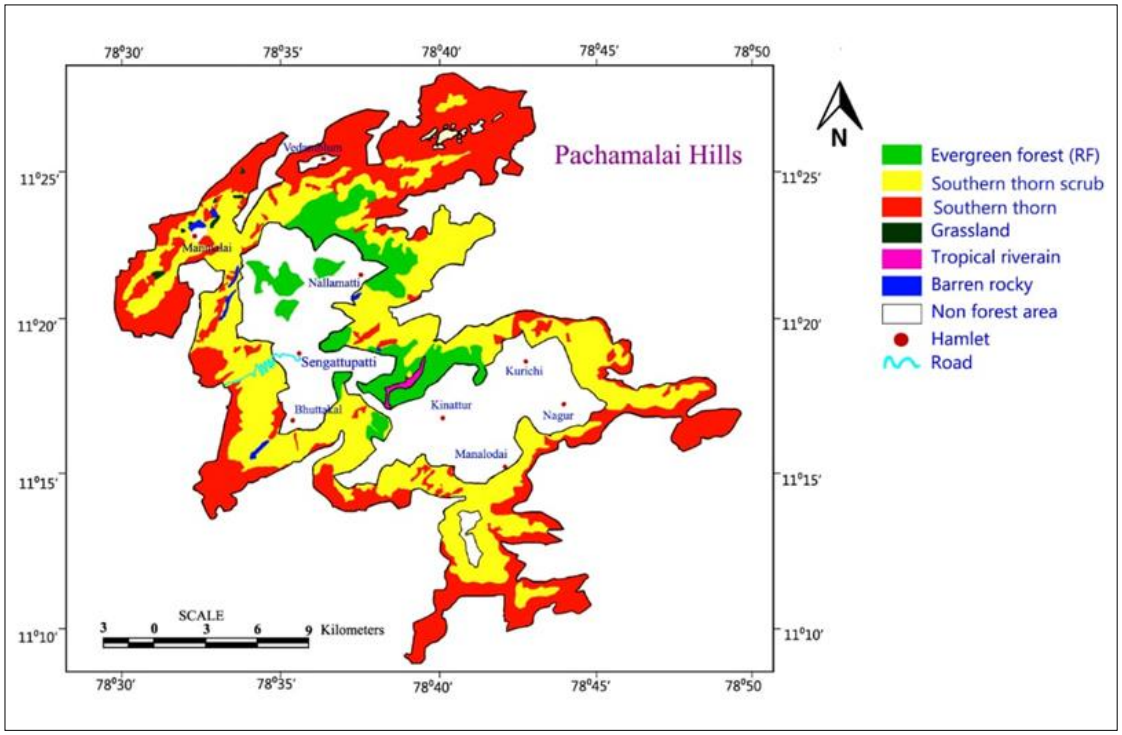

Fig 1: Location map of Pachamalai Hills

Result and Discussion

The study has revealed the occurrence of a total number of 68 species, 42 genera belonging to 21 families (Table – 1). It is interesting to note that 14 moss species of Pachamalai hills belonging to 11 families are newly added to the moss flora of Tamil Nadu. The family Pottiaceae is the most diversified one among other families. 13 species of mosses belonging to pottiaceae was reported in the Pachamalai Hills [18]. The genus *Fissidens* is the most common one having 8 species. Other genera with more number of species are *Hyophila*, *Barbula*, *Trichostomum*, *Brachymenium*, *Entodontopsis* and *Sematophyllum*. The second most predominant family is Hypnaceae (7 genera and 9 species). Of these 68 species, 10 species have been previously reported from Palni Hills [19] and 18 species from Nilgiri hills [20]. In the present investigation 38 moss species have been reported as acrocarpous. According to a study, acrocarpous mosses have been considered more drought tolerant than pleurocarpous [21].

Table 1: Checklist of mosses in Pachamalai Hills, Tamil Nadu.

S. No.	Family	Name of the species
1	Polytrichaceae	*Pogonatum cirratum* (Sw.) Brid. *Polytrichum patulum* Harv.
2	Fissidentaceae	*Fissidens asperisetus* Sande Lac.
		Fissidens biformis Mitt.
		Fissidens bryoides Hedw.
		Fissidens crenulatus Mitt.
		Fissidens ceylonensis Dozy & Molk.
		Fissidens diversifolius Mitt.
		Fissidens orishae Gangulee
		Fissidens ranuii Gangulee
3	Dicranaceae	*Campylopus flexuosus* (Hedw.) Brid. *Campylopus schmidii* (C. Müll.) Jaeg.

4	Calymperaceae	*Calymperes moluccense* Schwaegr.
5	Pottiaceae	*Barbula fuscescens* Wall. ex Müll. Hal.,
		Barbula indica (Hook.) Spreng.
		Barbula tenuirostris Brid.
		Hymenostomum edentulum(Mitt.) Besch.
		Hymenostylium recurvirostrum (Hedw.) Dixon
		Hyophila involuta (Hook.) A. Jaeger
		Hyophila kurziana Gangulee
		Hyophila rosea R.S. Williams
		Oxystegus cylindrothecus (Mitt.) Gangulee
		Pseudosymblepharis angustata (Mitt.) Hilp.
		Semibarbula ranuii Gangulee
		Tortella tortuosa (Hedw.) Limpr.
		Trichostomum brachydontium Bruch
		Trichostomum criotum R.H. Zander
		Trichostomum tenuirostre (Hook. & Taylor) Lindb.
6	Bryaceae	*Brachymenium indicum* (Dozy & Molk.) Bosch & Sande Lac.
		Brachymenium leptophyllum (Bruch & Schimp. ex Müll. Hal.) Bruch & Schimp. ex A. Jaeger
		Brachymenium sikkimense Renauld & Cardot
		Bryum argenteum Hedw.
		Bryum medianum Mitt.
		Ptychostomum capillare (Hedw.) D. T. Holyoak & N. Pedersen
7	Bartramiaceae	*Philonotis hastata* (Duby) Wijk & Margad.
		Philonotis thwaitesii Mitt.,
8	Orthotrichaceae	*Schlotheimia grevilleana* Mitt.
9	Racopilaceae	*Racopilum cuspidigerum* (Schwagr.) Ångstrom
10	Hookeriaceae	*Distichophyllum cirratum* var. *elmeri* (Broth.) P.J. Lin & B.C. Tan
11	Amblystegiaceae	*Campylophyllum halleri* (Hedwig) M. Fleischer
12	Thuidiaceae	*Haplocladium angustifolium* (Hampe & Müll. Hal.) Broth.
		Thuidium cymbifolium (Dozy & Molk.) Dozy & Molk.
13	Regmatodontaceae	*Regmatodon declinatus* (Hook.) Brid.
14	Stereophyllaceae	*Entodontopsis anceps* (Bosch. & Lac.) Buck & Ireland
		Entodontopsis nitens (Mitt.) W.R. Buck & Ireland
		Entodontopsis wightii (Mitt.) W.R. Buck & Ireland
		Stereophyllum radiculosum (Hook.) Mitt.
		Stereophyllum tavoyense (Hook. ex Harv.) A. Jaeger
15	Brachytheciaceae	*Rhynchostegiella scabriseta* (Schwägr.) Broth.
16	Meteoriaceae	*Aerobryidium filamentosum* (Hook.) M. Fleisch.
		Floribundaria setschwanica Broth.
		Meteorium buchananii (Brid.) Broth.
17	Hypnaceae	*Ctenidium lychnites* (Mitt.) Broth.
		Ectropothecium ramuligerum Dixon
		Hypnum macrogynum Besch.
		Hypnum subimponens Lesq.
		Isopterygium albescens (Hook.) A. Jaeger,
		Isopterygium longitheca (Mitt.) A. Jaeger
		Isotheciopsis comes (Griff.) Nog.
		Pseudotaxiphyllum elegans (Brid.) Z. Iwats.
		Vesicularia succosa (Mitt.) Broth.
18	Pterigynandraceae	*Trachyphyllum inflexum* (Harv.) A. Gepp
19	Entodontaceae	*Erythrodontium julaceum* (Hook. ex Schwagr.) Paris
20	Sematophyllaceae	*Sematophyllum humile* (Mitt.) Broth.
		Sematophyllum phoeniceum (Mull. Hal.) M. Fleisch.
		Sematophyllum subpinnatum (Brid.) E. Britton
21	Neckeraceae	*Himantocladium cyclophyllum* (Mull. Hal.) M. Fleisch.
		Himantocladium plumula (Nees) M. Fleisch.

Species New To Tamil Nadu

Polytrichaceae

1. *Pogonatum cirratum* (Sw.) Brid., Bryol. Univ. 2: 110. 1827.

Pogonatum flexicaule Mitt., J. Proc. Linn. Soc., Bot., Suppl., 2: 152. 1859.

Specimen examined: Karuvankadu, CCSH 1893, 09.04.2016.

Habitat & Distribution: Rupicolous. India: East Nepal and Darjeeling.

Wider distribution: Thailand, Laos, China, Malay, Sumatra, Molucca, Java, Borneo, Celebes, Amboina, New Guinea, Oceania and South Africa.

Fissidentaceae

2. *Fissidens orishae* Gangulee, Nova Hedwigia 8: 140. pl. 1. 1964.

Specimen examined: Periya pakkalam, CCSH 1458, 06.07.2013; CCSH 1470, 13.07.2013; Kokkuvarai, CCSH 1498, 10.08.2013; Ponavarai, CCSH 1530, 08.02.2014;

Periya mangalam, CCSH 1630, 28.08.2014; Nagur, CCSH 1676, CCSH 1677, 10.01.2015; Karuvankadu, CCSH 1852, 31.01.2016.

Habitat & Distribution: Terricolous and rupicolous. India: Odisha, West Bengal and Gangetic Plains.
Wider distribution: India only.

3. *Fissidens ranuii* Gangulee, Nova Hedwigia 8: 141. pl. 2. 1964.
Specimen examined: Periya pakkalam, CCSH 1470, 13.07.2013; Ponavarai, CCSH 1522, 08.02.2014; Periyamangalam, CCSH 1639, 12.09.2014; Cinnamangalam, CCSH 1669, 13.12.2014
Habitat & Distribution: Terricolous and rupicolous. India: Karnataka, Kerala.
Wider distribution: India only.

Calymperaceae
4. *Calymperes moluccense* Schwaegr., Sp. Musc. Frond., Suppl. 1. 2: 334. 1816.
Calymperes cucullatum P.J. Lin, Acta Phytotax. Sin. 17 (1): 96. 1979.
Specimen examined: Periya shola, CCSH 1768, 05.09.2015.
Habitat & Distribution: Corticolous. India: South Andaman.
Wider distribution: Sri Lanka, China, Malaysia, Australia and Oceania.

Pottiaceae
5. *Barbula fuscescens* Wall. ex Müll. Hal., Syn. Musc. Frond., 1: 613. 1849.
Barbula flavescens Brid., Bryol. Univ., 1: 831. 1827.
Specimen examined: Nagur, CCSH 1678, CCSH 1681, 10.01.2015.
Habitat & Distribution: Rupicolous. India: Nepal, Western Himalaya, Dehradun, Mussoorie and Bilaspur.
Wider distribution: Bhutan.

Hookeriaceae
6. *Distichophyllum cirratum* var. *elmeri* (Broth.) P.J. Lin & B.C. Tan, Harvard Pap. Bot. 7: 36. 1995.
Distichophyllum sinuosulum Dixon, J. Siam Soc., Nat. Hist. Suppl. 10 (1): 15. 1935.
Specimen examined: Kokkuvarai, CCSH 1502, 21.12.2013.
Habitat & Distribution: Rupicolous. India: Western Himalaya and East Nepal.
Wider distribution: Borneo, Thailand, Mainland China, Malaya Peninsula, Philippines and Taiwan.

Amblystegiaceae
7. *Campylophyllum halleri* (Hedwig) M. Fleischer, Nova Guinea. 12: 123. 1914.
Campylium halleri (Sw. ex Hedw.) Lindb., Musci Scand. 38. 1879.
Specimen examined: Karuvankadu, CCSH 1899, 09.04.2016.

Habitat & Distribution: Rupicolous. India: East Nepal, Darjeeling and Sikkim.

Wider distribution: Kumaon, China, Caucasus, Newfoundland, Labrador, Columbia, Europe, Asia, North America, Mexico, North Estonia and Guatemala.

Thuidiaceae
8. *Haplocladium angustifolium* (Hampe & Müll. Hal.) Broth. Nat. Pflanzenfam. 229 (I,3): 1008
Bryohaplocladium angustifolium (Hampe & Müll. Hal.) R. Watan. & Z. Iwats., J. Jap. Bot. 56: 259. 1981.
Specimen examined: Kokkuvarai, CCSH 1491, 10.08.2013; Ponavarai, CCSH 1526, 08.02.2014.
Habitat & Distribution: Terricolous. India: East Nepal, Sikkim, Bhutan, Khasi Hills, Himachal Pradesh, Mussoorrie, Naga Hills.
Wider distribution: Burma, Korea, Vietnam, China, Japan, Taiwan, Central & South Africa, Mexico, Jamaica, Italy, Switzerland and Siberia.

Regmatodontaceae
9. *Regmatodon declinatus* (Hook.) Brid., Bryol. Univ., 2: 204. 1827.
Regmatodon declinatus var. *minor* Broth., Symb. Sin., 4: 94. 1929.
Specimen examined: Top sengattupatti, CCSH 1732, 26.07.2015.
Habitat & Distribution: Rupicolous. India: Himalayas and Kerala.
Wider distribution: Malaysia, Philippines and Indonesia.

Stereophyllaceae
10. *Entodontopsis anceps* (Bosch. & Lac.) Buck & Ireland, Nova Hedwigia 41: 103. 1985.
Stereophyllum anceps (Bosch & Sande Lac.) Broth., Nat. Pflanzenfam. I (3): 898. 1907.
Specimen examined: Ponavarai, CCSH 1542, CCSH 1543, 08.02.2014; CCSH 1584, CCSH 1586, 15.03.2014; Periyamangalam, CCSH 1638, 12.09.2014; Nagur, CCSH 1689, CCSH 1693, CCSH 1695, CCSH 1697, 25.04.2015; Top Sengattupatti, CCSH 1710, CCSH 1718, 06.06.2015; CCSH 1739, 26.07.2015; Karuvankadu, CCSH 1839, 31.01.2016.
Habitat & Distribution: Terricolous, rupicolous, lignicolous and corticolous. India: Kerala, Karnataka, Maharashtra, Assam, Madhya Pradesh, Himachal Pradesh, Punjab, Central Nepal, Eastern Himalayas and Gujarat.
Wider distribution: Kanara, Bangladesh, China, Ceylon, Cochin, Indonesia, Java, Philippines, Thailand and Vietnam.

Brachytheciaceae
11. *Rhynchostegiella scabriseta* (Schwägr.) Broth., Nat. Pflanzenfam., I(3): 1161. 1909.
Eurhynchium scabrisetum (Schwägr.) Paris, Index Bryol., 447. 1896.
Specimen examined: Kannimar solai, CCSH 2103, 26.11.2016.
Habitat & Distribution: Corticolous. India: Sikkim, Western Himalaya and Assam.
Wider distribution: India only.

Hypnaceae
12. *Ectropothecium ramuligerum* Dixon, J. Bombay Nat. Hist. Soc. 39: 793. 1937.
Specimen examined: Periyapakkalam, CCSH 1462, 06.07.2013; Nalamatti, CCSH 1594, 16.05.2014; Top Sengattupatti, CCSH 1733, 26.07.2015; Karuvankadu, CCSH 1898, 09.04.2016.
Habitat & Distribution: Rupicolous. India: Assam and Arunachal Pradesh.

Wider distribution: India only.

13. ***13. Hypnum macrogynum*** **Besch., Ann. Sci. Nat., Bot., sér. 7, 15: 91. 1892.**

Hypnum aduncoides (Brid.) Müll. Hal., Syn. Musc. Frond., 2: 295. 1851.

Specimen examined: Kannimar solai, CCSH 2128, 10.12.2016.

Habitat & Distribution: Corticolous. India: Himalayas and Kerala.

Wider distribution: Iran, Eastern Nepal, Myanmar, South China, South Africa and Taiwan.

14. ***Vesicularia succosa*** (Mitt.) Broth., Nat. Pflanzenfam. I (3): 1094. 1908.

Stereodon succosus Mitt., J. Proc. Linn. Soc, Bot. l (Suppl.): 101. 1859.

Specimen examined: Puttur, CCSH 1822, 26.12.2015.

Habitat & Distribution: Rupicolous. India: Sikkim, Arunachal, Eastern Himalaya, Central India and Western Ghats of Kerala, Karnataka and Nepal.

Wider distribution: Japan and Sri Lanka.

Summary and Conclusion

Eastern Ghats is a biodiversity rich area. Pachamalai Hills, a part of Eastern Ghats, is an ecologically important place for diversity of different species. These hills have been explored for the presence of moss flora. The present investigation has revealed the occurrence of a total number of 68 species, 42 genera belonging to 21 families. The family Pottiaceae is the most diversified one with 9 genera. The genus *Fissidens* is the most common one having 8 species. Other genera with more number of species are *Hyophila*, *Barbula*, *Trichostomum*, *Brachymenium*, *Entodontopsis* and *Sematophyllum*. The second most predominant family is Hypnaceae (7 genera and 9 species). Of the 68 species investigated during the present study, 38 are acrocarpous and 30 species are pleurocarpous mosses. The habitat preferences of the mosses differ. It is observed that 41 species of mosses are seen in rupicolous type of habitat, 37 in terricolous type and 29 in corticolous type. The study shows that Pachamalai Hills is an ecologically important place for diversity of mosses. The people living in and around Pachamalai Hills are mostly depending on the forests for their livelihood and the increasing area of cultivation has led to the habitat loss for moss flora. Considering their importance in various aspects of ecosystem functioning, special efforts are needed to conserve the diversity of mosses, since they are highly sensitive to changes in the natural habitat.

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