EAST AFRICAN BRYOPHYTES XXX. NEW LIVERWORT AND HORNWORT RECORDS.

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New East African liverwort records
Comoros, Kenya, Tanzania, Madagascar, Réunion

Abstract. *Records of 45 liverwort and one hornwort species new to or very rare in East African countries. Among them the occurrence of* Leptolejeunea subrotundifolia *is new to Africa*, Anthoceros punctatus, Cephaloziella antheli-oides, Diplasiolejeunea cobrensis, Marsupella sparsifolia,Tritomaria camerunen-sis *and* Plagiochila rodriguezii *are new to tropical East Africa while* Cephalozi-ella tenuissima, C. transvaalensis, Chiloscyphus muhavurensis, Cololejeunea inflectens, C. magillii, C. peponiformis, Diplasiolejeunea hamata, D. rudolphia-na, Harpalejeunea filicuspis, Lopholejeunea sphaerophora *and* Syzygiella col-orata, *to the bryoflora of Madagascar. Finally* Cephalozia connivens *var.* fissa, Solenostoma onraedtii, Plagiochila incerta, P. repanda, P. stricta, Colura dusenii *and* Diplasiolejeunea kraussiana *are new to the flora of Comoro Islands.* The new combination of *Drepanolejeunea pentadactyla* var. *dactylophoroides* is also presented.

INTRODUCTION

During the past 45 years many scattered records from East African countries including the western Indian Ocean Islands have accumulated. In this paper we communicate Cephaloziaceae, Cephaloziellaceae, Gym-nomitriaceae, Adelanthaceae, Lophocoleaceae Solenostomataceae, Geo-calycaceae and Lophoziaceae identified by J. Váňa and Anthocerotaceae,

Frullaniaceae, Geocalycaceae, Plagiochilaceae and Lejeuneaceae identified by T. Pócs, if not otherwise stated. Only records that are new to a country or island, or very rare according to the checklists by Wigginton (2009), Ah Peng et al. (2012) and by Marline (2012) are included and annotated here.

ENUMERATION OF SPECIES

Cephaloziaceae

Cephalozia connivens (Dicks.) Lindb. ssp. ***fissa*** Váňa

COMOROS: Ndzouani Island, cloud forest on the SE summit ridge of Mt. N'Tingui, 1590 m, on decaying wood. Coll. *Pócs & Magill 9274/J,* 7 Aug. 1992 (EGR). – Distrib.: Very widespread in tropical Africa, and may occur in Australia too (Váňa 1988), new to the Comoro Islands.

Odontoschisma jishibae (Steph.) L. Söderstr. & Váňa

Syn.: *Iwatsukia jishibae* (Steph.) N. Kitag. (Váňa et al., 2013).

TANZANIA: Kilimanjaro Mts. Uru W forest section on the S slope, at 1980–2200 m alt. On *Ocotea usambarensis* bark in montane rainforest with *Ocotea, Podocarpus* and *Afrocrania.* Coll. *Pócs & Shayo 90015/AS,* 25. Jan. 1990 (EGR). – Distrib.: Palaeotropic species widely distributed in Asia and in the Indian Ocean islands (Grolle 1995, Pócs 1995), scattered in mainland Africa (Bioko, Malawi, Wigginton 2009), new to Tanzania.

Cephaloziellaceae

Cephaloziella anthelioides S.W. Arnell

TANZANIA: Mt. Kilimanjaro, montane evergreen forest along Machame Route at 2000-2200 m, on soil. Coll. *Pócs 6975/O,* 4 & 9. Apr. 1984 (EGR, PRC).– Distrib.: New to continental East Africa, previously only known from South Africa and Réunion island (Wigginton 2009).

Cephaloziella tenusissima (Lehm. et Lindenb.) Steph.

MADAGASCAR: Prov. Toamasina, Between Adrovoranto and Ambila-Lemaitso, ericaceous heath on white sand between Panganales canal and Indian Ocean coast, 10 m, on peaty soil. Coll.: *Pócs & Szabó 9886/E,* 24. Aug. 1998 (EGR, TAN). – Distrib.: Hitherto known only from South Africa and Leshoto (Wigginton 2009).

Cephaloziella transvaalensis S. Arnell

MADAGASCAR: Réserve Forestière Andasibe (Périnet) 100 km E of Antananarivo. Logged submontane rainforest S and W of the railway station, at 910-940 m, on earth banks and roadcut surface. Coll. *Pócs 90105/N,* 16-17 March 1990 (EGR, PRC); COMOROS: Ndzouani Island, Col de Moya, 650–770 m, on roadcut surface. Coll. *Pócs 9165/E,* 23 March 1991 (EGR, PRC); Ndzouani Island, Mt. Pomouni E of M'rijou village, 500 m, on the soil of ylang-ylang plantation. Coll. *Pócs 9281/D,*14 Aug. 1992 (EGR, PRC)– Distrib.: New to Madagascar and the Comoros, known from South and East Africa and the Mascarene Islands (Wigginton 2009).

Cephaloziella umtaliensis S.W. Arnell

TANZANIA: Mt. Kilimanjaro, along Umbwe Route, Podocarpus-*Erica arborea* forest and ericaceous heath at 2850-3450 m alt. On lava rocks. Coll. *Pócs 89235/AP, 89236/W and AF*, 24-28 Nov. 1989 (EGR, PRC). Mt. Kilimanjaro, NE slope of Mawenzi WSW of Tareka village, in Nesikiria River gorge at 2600-2700 m alt. On dry volcanic *clliff* with *Senecio johnstonii* and *Lobelia deckenii.* Coll. *Pócs 90023/AP,* 31. Jan. 1990 (EGR, PRC); Morogoro Region, S Uluguru Mts., Lukwangule Plateau above Mgeta Falls, at 2350-2450 m alt. On soil of secondary *Panicum lukwangulense* grassland scattered with *Agauria salicifolia* trees. Coll. *Pócs, Ochyra & Bednarek-Ochyra 88111/V.* 8-9 June 1988 (EGR, PRC).– Distrib.: New to Tanzania, known from Mt. Cameroon, Uganda, South-east Africa and Réunion (Wigginton 2009).

Cylindrocolea abyssinica (Gola) Váňa

TANZANIA: Mt. Meru, S slope, Sokoine University Training Forest, along road to Laikinoi, at 1950 m alt. On soil of *Grevillea* plantation. Coll. *Pócs 88292/C,* 13. Dec. 1988 (EGR, PRC). – Distrib.: Widespread in tropical Africa, new to Tanzania (Wigginton 2009).

Gymnomitriaceae

Marsupella sparsifolia (Lindb.) Dumort.

KENYA: Mt. Kenya, Naro Moru Track, on exposed rocks at 3750 m alttitude. Coll. *Chuah-Petiot, Nm 1004,* 27. Jan. 2003 (EGR). – Distrib.: Bipolar, Arctic-Alpine species occurring in N America, Europe, Macaronesia, Caucasus, South Africa, Australia, New Zealand and the Subantarc-

tic Islands (according to Váňa et al.2010, the species was erroneously reported before from tropical East Africa).

Gymnomitrion subintegrum (S.W. Arnell) Váňa

Syn.: *Marsupella subintegra* S. Arnell. (Váňa et al. 2010)

TANZANIA: Mt. Kilimanjaro, Machame Route, *Erica arborea* heath and subalpine streamside vegetation at 2960–3800 m, on lava rocks and on bare soil. Coll. *Pócs 6979/E,6981/D,* 5-7. Apr. 1984; *S. Pócs et al. 87175/T,* 22-23. June 1987 (EGR, PRC); Mt. Meru, SW slope of summit area at 3300–3400 m, on irrigated lava rocks. Coll. *Pócs 8687/AX, 8687/BB,* 15. June 1986 (EGR, PRC). – Distrib.: Altimontane species inTropical Africa, India, Malesia, Papuasia, Amsterdam I., new to Tanzania (Wigginton 2009, Váňa et al., 2010,Váňa et al. 2012).

Adelanthaceae

Syzygiella colorata (Lehm.) K. Feldberg, Váňa, Henschel et J. Heinrichs

Syn.: *Jamesoniella colorata* (Lehm.) Schiffn. (Feldberg et al. 2010).

MADAGASCAR: Prov. Antsiranana, Réserve Integrale Nationale de Marojezy. Tussock grassland on the main summit at 1900–2130 m alt. On granitic cliff. Coll. *Pócs, Randrianasolo, Magill & LaFarge-England 90117/C,* 28. March 1990 (EGR, MO, TANA). – Distrib.: A southern temperate species distributed in South America, the Subantarctic islands, southern Australia, New Zealand, and South Africa (Grolle 1975, map in Engel 1990). New to Madagascar.

Lophocoleaceae

Chiloscyphus muhavurensis S.W. Arnell

MADAGASCAR: Prov. Antsiranana, Réserve Integrale National de Marojezy, in subalpine bush below the summit at 2050 m, on soil. *Pócs, Magill & LaFarge-England 90116/R,* 28 March 1990 (EGR, TAN). – Distrib.: An Afroalpine species hitherto only known from the high mountains of Kenya, Tanzania and Uganda (Wigginton & Grolle 1996), new to Madagascar. May be conspecific with the widespread and very variable Neotropical *Lophocolea trapezoidea* Montagne = *Chiloscyphus breutelii* (Gott.) Engl & Schust. (Gradstein et al. 1984).

Solenostomataceae

Solenostoma onraedtii (Váňa) Váňa, Hentschel et J. Heinrichs

COMOROS: In a remnant of lowland rainforest at Lingoni Falls, 200 m, on wet cliff. Coll. *Pócs & Magill 9282/U,* 15 Aug. 1992 (EGR). Distrib.– Known from Madagascar and Réunion (Váňa 1974) only, new to the Comoro Islands.

Geocalycaceae

Notoscyphus lutescens (Lehm. et Lindenb.) Mitt.

TANZANIA: Nguru Mountains, Dikurura Valley 3 km W of Mhonda, on seeping cliff at 9 00 m. Coll. *Pócs 8910/B,* 27 March 1989 (EGR). – Distrib.: Palaeotropical species widespread in tropical Africa (Wigginton 2009) but unknown from Tanzania.

Lophoziaceae

Tritomaria exsectiformis Breidl. ssp. ***camerunensis*** S.W. Arnell ex Váňa

TANZANIA: Mt. Kilimanjaro, S slope of Kibo, 3900–4000 m, on irrigated rocks of Karanga Valley. Coll. *Pócs 6992/Q,* 4. March 1985 (EGR, PRC); SW face of Kibo summit at 4100 m alt. Dripping, S facing cliff at the head of Barranco Valley. Coll. *Pócs 89240/B,* 26. Nov. 1989 (EGR, PRC).– Distrib.: Previously known only from Mt. Cameroon in West Africa (Arnell 1958, Váňa 1982).

Plagiochilaceae

Plagiochila drepanophylla Sande Lacoste

TANZANIA: North Pare Mts., Kindoroko Forest reserve W of Ndorwe village, montane rainforest at 1860–2100 m, on bark. Coll. *Pócs 90072/AD,* 4 May 1990 (EGR); Uluguru Mts., elfin forest on the crest of Lupanga peak at 2100–2140 m, on bark. Coll. *Pócs 86108/*A, 7 July 1986 (EGR). – Distrib.: Madagascar, Réunion (Grolle 1995). In continental Africa it was previously only known from the Usambara mountains in Tanzania (Jones 1981, Pócs 1985).

Plagiochila fusifera Taylor

SEYCHELLES: Mahé Island, Morne Seychellois Nat. Park, Congo Rouge, montane rainforest, 500–720 m, on rocks and bark. Coll.: *Pócs 9318/AJ and 9319/K,* 8 Aug. 1993; Morne Blanc, mossy cloud forest,

590–670 m, on ground. Coll.: *Pócs 9323/J and 9362/M,* 12 and 4 Sept. 1993 (EGR); Trois Frères ridge, montane mossy forest, 740–770 m, on bark and rocks. Coll.: *Pócs 9342/A and B,* 22 Aug. 1993 (EGR). COMOROS: Ngazidja Island, N slope of Karthala volcano, montane rainforest at 700–770 m, on bark. Coll. *Pócs 9150/AW,* 16 March 1991 (EGR); Ndzouani Iland, Col du Moya, degraded rainforest at 740–760 m, on rocks. Coll. *Pócs, Magill & Rupf 9278/B and W,* 12 Aug. 1992. – Distrib.: Widespread in the mountains of continental Africa (Jones 1962, Wigginton 2009) but new to the East African islands.

Plagiochila heterostipa Steph.

TANZANIA: Nguru Mts. in Turiani District. Submontane rainforest in Duale Valley at 600–900 m alt. On twigs. Coll. *Pócs & Schlieben 6435/G,* 19. Aug. 1971 (EGR).– Distrib.: Widespread in tropical Africa, new to Tanzania (Jones 1962).

Plagiochila incerta Gottsche

COMORES: Ngazidja Island.W slope of Mt. Karthala along the path from Boboni sawmill to "Convalescence" at 1150–1600 m alt. On bark in mossy cloud forest. Coll. *Pócs, Magill & Rupf 9268/AA,* 1-3 Aug. 1992 (EGR). – Distrib.: Endemic in western Indian Ocean Islands, known from Madagascar, Mauritius and Réunion (Grolle 1995), new to the Comores.

Plagiochila pectinata Willd. ex Lindenb.

TANZANIA: West Usambara Mts., Shume Nature Forest Reserve, montane evergreen forest, on bark. Coll. *Pócs 88306/A,* 19 Dec. 1988 (EGR). – Distrib.: Widespread in tropical African mountains, (Wigginton 2009), new to Tanzania.

Plagiochila punctata (Nees) Steph.

RÉUNION: Col de Bébour, rocky heath at 1450 m, on volcanic cliff. Coll.: *Pócs 00114/P,* 22 June 2000 (EGR). – Distrib.: Widespread in the Neotropics, scattered in the Canary Islands and on the Atlantic coast of Europe, previously known by the illegitime name *Plagiochila subalpina* from tropical Africa Steph. from: Bioko, Zaire, Tanzania, Uganda, Comoros and Madagascar (Jones 1962, Vanden Berghen 1981) and synonymized by Heinrichs et al. (2005). New to Réunion Island.

Plagiochila repanda (Schwaegr.) Lindenb.

TANZANIA: Uluguru Mts., Bondwa peak, elfin forest at 1950–2000 m alt. On mossy ground. Coll. *Pócs & Gibbon 6052/AV,* 12. Oct. 1969 (EGR), det. E.W. Jones; Uluguru Mts., Kinole, 900–1000 m. On wet rock in submontane rainforest. Coll. *Pócs & Harris 6166/F,* 30. Apr. 1970 (EGR); COMOROS: Forêt du Moya, montane rainforest, 1070 m, on bark. Coll.: *Pócs & Magill 9276/AJ,* 11 Aug. 1992 (EGR). – Distrib.: Widespread in Indian Ocean islands (Vanden Berghen 1981), scattered in mainland Africa (Kenya, Malawi, Wigginton 2009), new to Tanzania and the Comoros.

Plagiochila rodriguezii Steph.

TANZANIA: East Usambara Mts., Amani, behind "Forest Houses" at 920 m alt. On twigs in submontane rainforest. Coll. *Jones & Pócs 6377/G,* 10. Jan. 1971 (EGR, Hb. E.W. Jones), det. E.W. Jones; Uluguru Mts., N slope of Bondwa peak at 1500 m alt. On well lit, recently felled tree. Coll. *Jones 2057, Pócs 6305/D* 13. Dec. 1970 (EGR, Hb. E.W. Jones), det. E.W. Jones; Southern Highlands, Mufindi District. On planted *Cupressus lusitanica* trees near Mufindi village. Coll. *Jones 2075, Pócs 6320/L,* 16. Dec. 1970 (EGR, Hb. E.W. Jones), det. E.W. Jones – Distrib.: Hitherto only known from the western Indian Ocean islands: Comores, Madagascar, Réunion, ? Rodrigues Isls. (Vanden Berghen 1981, Grolle 1995, Müller & Pócs 2002), new to mainland Africa.

Plagiochila stricta Lindenb.

COMORES: Ngazidja Island. Elfin forest around "Convalescence" on W slopes of Karthala volcano caldera rim at 1600–1850 m alt. On ericaceous bark. Coll. *Pócs, Magill & Rupf 9269/B,* 1-3 Aug. 1992 (EGR).– .Distrib.: Widespread in tropical America and quite recently discovered at single location only E of Antananarivo in Madagascar (Lindner et al. 2004, Gradstein 2013). Therefore its occurrence on Comoro Islands has great significance and suggests it might also occur on other East African islands.

Frullaniaceae

Frullania gabonensis Vanden Berghen

SEYCHELLES: Mahé Island, Congo Rouge, mossy elfin forest, 640–720 m, on *Plagiochila.* Coll.: *Pócs 9319/K,* 8 Aug. 1993. – Distrib.:

Cameroun, Gabon, Madagascar (Vanden Berghen 1976, Wigginton & Grolle 1996), new to the Seychelles.

Lejeuneaceae

Cololejeunea inflectens (Mitt.) Benedix

MADAGASCAR: Prov. Toamasina, Coastal dune forest 1 km W of Antanambe, at 5 m, on bark. Coll.: *Pócs & Szabó 9875/AY,* 12 Aug. 1998 (EGR, TAN). – Distrib.: A widespread Indomalesian–Pacific species reaching Africa at the Indian Ocean islands only. Known to the Comoros and the Seychelles, new to Madagascar.

Cololejeunea magillii Pócs

MADAGASCAR: Prov. Antsiranana, Réserve Integrale National de Marojezy, very humid rainforest N of Andampibe Falls, 800–900 m, epiphyllous. Coll. *Pócs, Magill & LaFarge-England 90113/EJ,* 24 and 29 March,1990 (EGR, TAN). – Distrib.: Known from its type locality in the Comoros from Mayotte Island only, new to Madagascar (Pócs 1993).

Cololejeunea peponiformis Mizut.

MADAGASCAR: Prov. Antsiranana, Réserve Integrale Nationale de Marojezy. Montane rainforest on ridge N of Andampibe Falls, at 780–1050 m, on decaying wood. Coll.: *Pócs 90113/CX,* 24-29 March 1990 (EGR, TANA). – Distrib.: Comoro, Seychelles, Réunion, Malaysia: Sabah, new to Madagascar (Tixier 1985, Wigginton 2009).

Colura berghenii Ast

TANZANIA: Nguru Mountains, elfin forest on summit above Spirit Lake near Mhonda, at 2260 m, on *Erica* twigs. Coll. *Pócs & Orbán 89168/AE,* 1 June 1989 (EGR). – Distrib.: Known from Mt. Kilimanjaro and Mt. Rungwe in Tanzania, from Rwanda and from Ethiopia: Bale Mts only. (Jovet-Ast 1954, Tixier 1995, Bizot & Pócs 1979, Pócs 1990, Fischer 2013).

Colura calyptrifolia (Hook.) Dum.

KENYA: Taita Hills, NW slope of Yale summit above Lushangani village, remnants of montane rainforest, 1650–1780 m, epiphyllous. Coll. *Pócs & Malombe 04039/BG,* 31 March 2004 (EGR). – Distrib.: Southern

temperate species, penetrating into tropical, subtropical mountains and atlantic Europe (Gradstein et al. 1984, map 43), new to Kenya.

Colura dusenii (Steph.) Steph.

COMOROS: Ngazidja Island, W slope of Karthala volcano around "Convalescence" at 1730 m, on bark. Coll. *Pócs & Magill 9269/BF,* (EGR). – Distrib.: Scattered in mainland Africa, new to the East African Islands.

Colura saroltae Pócs

KENYA: Taita Hills, Vuria top, elfin forest at 2200 m, on *Erica* and other twigs. Coll. *Pócs Chuah-Petiot & Malombe 04042/AO,* 1 Apr. 2004 (EGR); TANZANIA: West Usambara Mountains: Sagara Ridge, on twigs in ericaceous heath at 1900–1920 m. Coll. *Pócs and staff of the Botany Department of Helsinki University, 88080/G*, 21 May 1988 (EGR, H); Nguru Mts., elfin forests W of Spirit Lake above Mhonda Mission, 2100-2250 m, on twigs. Coll. *Pócs & Orbán 89165/X, 89168/AD and 89173/D,* 2 June 1989 (EGR). – Distrib.: Known from Mt. Kilimanjaro and Mt. Rungwe in Tanzania and from Rwanda only (Jones & Pócs 1987, Pócs 1994, Fischer 2013), new to Kenya.

Colura usambarica E.W. Jones

TANZANIA: S-Pare Mts., Ranji Plateau at 1900–2000 m, ericaceous heath, on *Erica* bark. – Coll. *Pócs and Helsinki University students, 89250/P,* 4. Dec. 1989 (EGR). – Distrib.: Previously known from Usambara Mts. in Tanzania, from Mulanje Mts. in Malawi and from Taita Hills in Kenya only (Jones & Pócs 1987, Wigginton 2009).

Diplasiolejeunea cobrensis Gottsche ex Steph.

TANZANIA: Mafia Island, *Rhizophora* mangrove near Utende village, N of the lodge, on bark, 2 m. Coll. *Pócs & Krog* 89210/H, 11 Aug. 1989 (EGR). Disrib.: Pantropical, although very scattered and rare. In Africa known to Ghana, Sierra-Leone and Madagascar only (Wigginton 2009), new to Tanzania.

Diplasiolejeunea hamata Tixier

MADAGASCAR: Prov. Fianarantsoa, Ranomafana Nat. Park, S side ridge of Mt. Namatoana, 1.6 km E of Ambatovaku Avaratra village, montane rainforest, 1250 m, epiphyllous. Coll. *Pócs & Tuba 04130/CA,* 31

July 2004 (EGR, TAN). Previously known from its type near Vohiparara in the same province only (Tixier 1979).

Diplasiolejeunea kraussiana (Lindenb.) Steph.

COMORES: Ngazidja (Grande Comore) Island. On 15 year old lava flow above Singani village at 150–300 m alt. Epiphyllous on shrubs. Coll. *Pócs 9461/J,* 26. July 1994 (EGR). – Distrib.: Scattered throughout tropical Africa, new to the Comores (Wigginton 2009).

Diplasiolejeunea rudolphiana Steph.

MADAGASCAR: Prov. Toamasina, Mananara Nord Biosphere Reserve, 1 km W of Antanambe village, at 5 m alt. Coastal dune forest with rich moss layer, on twigs. Coll. *Pócs & Szabó 9875/AT, 9875 BA,* 13. Aug. 1998 (EGR, Hb. Schäfer-Verwimp); Coastal dune forest 5 km SSW of Ambila-Lemaitso, 6-8 m alt., on *Pandanus* stem. Coll.: *Pócs & Szabó 9881/AH,* 19 Aug. 1998 (EGR, TAN). – Pantropical species, common in the Americas and rare in Asia: Sri Lanka, China: Hainan (Zhu & So 2001) and in Africa, where it was known only from Mauritius (Tixier & Guého 1997). New to Madagascar.

Diplasiolejeunea villaumei Steph.

KENYA: Taita Hills, Vuria top, elfin forest at 2200 m, on *Erica* and other twigs. Coll. *Pócs Chuah-Petiot & Malombe 04042/AP,* 1 Apr. 2004 (EGR); MAURITIUS: Mondrain Nat. Reserve at the W edge of the lava plateau, SW of Vacoas, at 480–550 m alt. Ramicolous in degraded montane rainforest. Coll. *Pócs & Florins 00131/M,* 29. June 2000; RÉUNION: Col de Bébour, rocky heath at 1450 m, on volcanic cliff. Coll.: *Pócs 00114/E,* 22 June 2000 (EGR). – Distrib.: Madagascar, Malawi, Tanzania (Wigginton 2009), new to Kenya and the Mascarene archipelago.

Drepanolejeunea cultrella (Mitt.) Steph.

RÉUNION: Réserve Naturelle Mare Longue NW of St. Philippe, 200-250 m, on bark. Coll.: *Pócs 9505/B,* 27 Febr. 1995 (EGR). – Distrib.: Widespread in tropical Africa, new to Réunion.

Drepanolejeunea pentadactyla (Mont.) Steph. var. ***pentadactyla***

RÉUNION: Cirque de Cilaos, forêt Mare à Joseph, E from "le Bloc", montane forest, 1370 m, on decaying wood. Coll.: *Kis 9638/CP,* 10-13

July 1966 (EGR); Between 'le Bloc" and the Plateau du Petit Matarum, 1350–1930 m, montane rainforest, on bark. Coll.: *Vojtkó 9639/DC,* 10-13 July 1996. – Distrib.: The species is widespread in tropical Asia. In Africa, previously known as *Drepanolejeunea cambouena* Steph. from the Eastern Arc mountains of Tanzania, Comores, Seychelles, Madagascar and Mauritius (Wigginton 2009, synonymised by Pócs 2011), new to Réunion.

Drepanolejeunea pentadactyla (Mont.) Steph. var. ***dactylophoroides*** (Herz.) Pócs **comb. nov.** (See figs 1–2).

Basionym: *Drepanolejeunea micholitzii* Steph. var. *dactylophoroides* Herzog 1930, *Annales Bryologici* 7: 79.

MADAGASCAR: Prov. Toamasina, Mt. Maromizaha S of Andasibe-Mantadia Nat. Park, montane rainforest at 1200 m, on *Pandanus* leaf. Coll.: *Pócs 9890/CC,* 26 Aug. 1998 (EGR). – Distrib.: variety known from tropical Asia: Indonesia, Cambodia, Malaysia only (Herzog 1930, Rzhu & So 2001). The variety is distinct by its many acute and long lobe teeth similar to those of ***Drepanolejeunea dactylophora*** (Nees et al.) Schiffn. which also occurs in Madagascar (Tananarive, Manjakandriana, Lake Mantasoa, 1400 m. Coll.: Tixier (11340), 1978 (G 142407 ex Hb. Tixier 024048), identified by him as *Drepanolejeunea cambouena* Steph. (Pócs 2011:184, not enumerated in Marline et al. 2012). But *D. dactylophora* differs from *D. pentadactyla* by the recurved lobe teeth and toothed perianth wings.

Harpalejeunea filicuspis (Nees) Mizut.

MADAGASCAR: Prov.Toamasina, Coastal dune forest 1 km W of Antanambe, at 5 m, on bark. Coll.: *Pócs & Szabó 9875/AB,* 12 Aug. 1998 (EGR); Ericaceous heath on coastal dunes, 2-3 km N of Andovoranto, on *Erica* twigs. Coll.: *Pócs & Szabó 9882/G,* 22 Aug. 1998 (EGR) . – Distrib.: It has Indomalesian–Pacific distribution, reaching Africa only at the East African islands in Indian Ocean.

Lejeunea obtusata Gottsche

KENYA: Taita Hills, Vuria top, elfin forest at 2200 m, on *bark*. Coll. *Pócs, Chuah-Petiot & Malombe 04042/Z,* 1 Apr. 2004 (EGR). – Distrib.: Sierra Leone, Ghana, Uganda, Tanzania, Madagascar, Mauritius (Jones 1989), new to Kenya.

Lejeunea setacea Steph.

TANZANIA: Tanga Region, Tongwe Hill SSW of Muheza. On rocks in shady semi-evergreen forest at 400 m alt. Coll. *Pócs & Kornaś 6517/P,* 9. Feb. 1972 (EGR, DSM), det. E.W. Jones. – Distrib. Widespread in tropical Africa, new to Tanzania (Jones 1969).

Lejeunea villaumei (Steph.) Grolle

MAURITIUS: Mt. Cocotte, degraded elfin forest near the summit, 770 m, on bark. Coll.: *Pócs, D. Florens & Probst 9665/AJ,* 1 Aug. 1966 (EGR). Scattered throughout Subsaharan Africa (Wigginton 2009), new to Mauritius.

Leptolejeunea subrotundifolia Herz. (See figs 3–6).

MADAGASCAR: Prov. Toamasina, Coastal dune forest 1 km W of Antanambe, at 5 m, mostly on bark of twigs, one specimen epiphyllous. Coll.: *Pócs & Szabó 9875/AZ,* 12 Aug. 1998 (EGR). – Distrib.: Known only from two localities in Indonesia: West Borneo (Herzog 1942) and from southern Thailand (Pócs & Chantanaorrapint 2014), new to Africa. A species that is probably more widespread but has avoided attention due to is small size. It typically occurs on bark, is seldom epiphyllus, unlike the majority of *Leptolejeunea* species.

Lopholejeunea sphaerophora (Lehm. et Lindenb.) Steph.

MADAGASCAR: Prov. Fianarantsoa, Montane rainforest near a small waterfall along Fianarantsoa–Ambatolaky road, 1015 m, on twigs. Coll.: *Orbán & Vojtkó 9466/AA,* 27 Sept. 1994 (EGR), det.: *A. Sass-Gyarmati*; Degraded montane rainforest of Mt. Ambatokirijy, S of Andasibe Forest Reserve, at 950–1000 m, on bark. Coll.: *Pócs 9488/AA,* 3 Oct. 1994 (EGR), det.: *A. Sass-Gyarmati.* – Distrib.: Previously known from two localities in Mauritius and by a dubious sterile specimen from Tanzania, Usambara Mts. (Thiers 1983, Vanden Berghen 1984). New to Madagascar.

Anthocerotaceae

Anthoceros punctatus L.

TANZANIA: Uluguru Mts. Abandoned cultivation in the W valley of Mt. Lupanga, above Kileka village, at 1280 m alt., on open ground. *Pócs & van Zanten 86111/*A, 17 July 1986 (EGR). – A widespread cosmopolite

species previously known to western and central tropical Africa and Socotra only, new to East Africa. (Wigginton 2009).

DISCUSSION

It was expected that the very rich Madagascar bryoflora and the lesser known Comoro Islands furnish novelties. We are sure that their further exploration will yield much more. An interesting feature of the bryoflora of the East African Indian Ocean islands, along with their relatively high proportion of endemics, is the presence of tropical Asian (mostly Indomalesian-Pacific) elements, which reach the westernmost limit of their distribution here and do not penetrate (or very rare) in continental Africa. Such elements are according to Pócs (1976, 1992) and Gradstein (2013) and according to the present paper:

Allisoniella nigra (Rodway) R.M. Schust.
Archilejeunea planiuscula (Mitt.) Steph.
Cheilolejeunea ventricosa (Schiffn.) X.-L. He
Cololejeunea hasskarliana (Lehm. et Lindenb.) Schiffn.
Cololejeunea inflectens (Mitt.) Benedix
Cololejeunea peponiformis Mizut.
Cololejeunea raduliloba Steph.
Colura pluridentata Ast
Denotarisia linguifolia (De Not.) Grolle
Drepanolejeunea dactylophora (Nees et al.) Schiffn.
Frullania repandistipula Sande Lac. (also in Tanzania)
Harpalejeunea filicuspis (Steph.) Mizut.
Heteroscyphus splendens (Lehm. et Lindenb.) Grolle (also in Tanzania)
Lejeunea alata Gottsche (also in Tanzania)
Lepidolejeunea bidentula (Steph.) R.M. Schust.
Leptolejeune subdentata Schiffn. ex Herzog
Leptolejeunea subrotundifolia Herzog
Leptolejeunea vitrea (Nees) Schiffn.
Porella madagascariensis (Nees et Mont.) Trevis
Schiffneriolejeunea tumida (Nees) Gradst.
Wiesnerella denudata (Mitt.) Steph.

These 21 species amount to nearly one third of all Afro-Asian (Palaeotropical) liverwort species enumerated by Gradstein (2013). Most of these occur in more than one island and a few occur sporadically even on the Precambrian crystalline arc mountains of Tanzania. Some are restricted to one island only. The Seychelles are especially prominent from this point of view, as was already noted by Grolle (1978) and Pócs (1992). They are the oldest among the Indian Ocean islands as remnants of a former subcontinent which now is sunk and exists in the form of Seychelles bank. This subcontinent has been close to Indian Plate during the Cretaceous and could be easier accessed by the diasporas (spores or gemmae or other plant fragments) of Indian origin through the air currents, than the rest of the islands (Pócs 1997). In our contribution most elements of this distribution type occur at the eastern coast of Madagascar, usually in dune forests or heath.

ACKNOWLEDGEMENTS

Thanks are due to all institutions, agencies and foundations providing financial help and logistics for the many study trips and expeditions during the past 45 years. The first author expresses his gratitude toward all co-collectors and companions helping his collecting work, as Halina Bednarek-Ochyra (KRAM), Min S. Chuah-Petiot (NAI), Danielle Florins (MAU), David Gibbon (SUA), Eustace W. Jones (OXF), Gabriella Kis (EGR), Hildur Krog (O), Jan Kornaś (KRA), Catherine LaFarge-England (ALTA), Itambo Malombe (EA), Patrick Syola Mwanjabe (Sokoine University, Morogoro), Ryszard Ochyra (KRAM), David J. Mabberley (OXF), Robert M. Magill (MO), Armand Randrianasolo (TAN, MO), Zoltán Tuba (Gödöllő University), Andrea Sass-Gyarmati (EGR), Dominique Strasberg (REU), András Szabó (EGR), András Vojtkó (EGR), Bernard Otto van Zanten (GRO) and last but not least to his wife, Sarolta (Saci) Pócs (EGR) and to their children.

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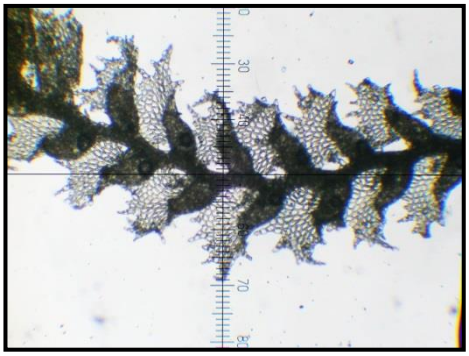
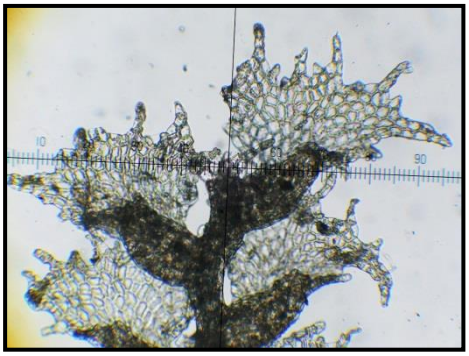
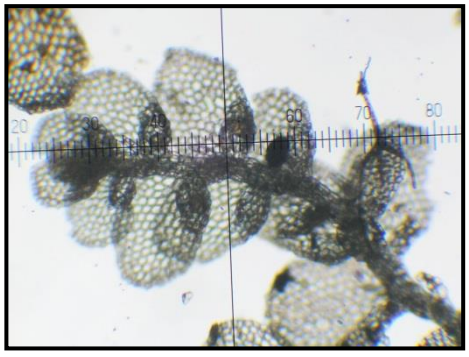


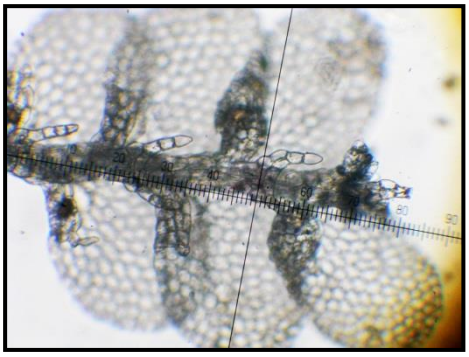
1. *Drepanolejeunea pentadactyla* (Mont.) Steph. var. *dactylophoroides* (Herz.) Pócs, habit



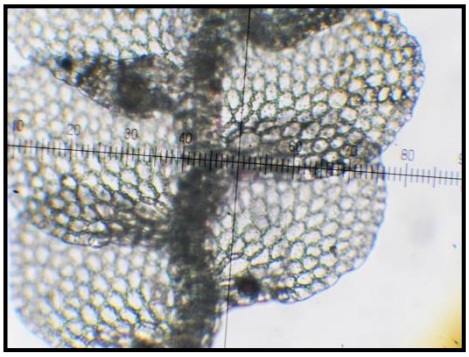
2. Same species, leaves. From *Kis 9638/CP.* (Scale in fig. 1. by 25 µm, in fig. 2. by 8 µm)



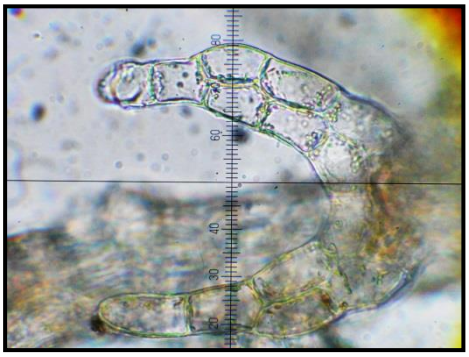
3. Leptolejeunea subrotundifolia Herzog, habit (scale by 25 µm), *Pócs & Szabó 9875/AZ*



4. Same species, ventral view (scale by 8 µm).



5. Same species, dorsal view, with ocelli (scale 25 µm)



6. Same species, underleaf (scale by 2 µm).

REDISCOVERY OF *PLAGIOCHILION MAYEBARAE* S. HATT. FROM NAGALAND, INDIA

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Keywords: *Plagiochilion mayebarae*, Plagiochilaceae, rediscovery, Hepaticae, Nagaland

Abstract: *Plagiochilion mayebarae* S. Hatt. has been described along with mature sporophytes for the first time from Nagaland state. This taxon has been previously reported from Sikkim Himalaya (Inoue, 1964). Therefore, the present investigation shows the extension of distributional range from Sikkim to Nagaland state (rediscovered after a gap of 49 years). Hand drawing illustrations have been provided for its identification.

Introduction

Plagiochilion S. Hatt. belonging to the family Plagiochilaceae was segregated from the genus *Plagiochila* by Hattori (1947). The genus *Plagiochilion* S. Hatt, was later accepted by Inoue (1958) and Schuster (1959). In India, the genus *Plagiochilion* is poorly understood and so far no intensive work has been done on this taxon. The genus *Plagiochilion* are distinct from the genus *Plagiochila* in having opposite and connate leaves, rhizoids are fasciculate and restricted to near the postical of leaves, and the branching of stem is predominantly intercalary and postical (Inoue, 1964). Inoue (1964) has described the species *P. mayebarae* S. Hatt. and reported the occurrence of the taxa from Sikkim Himalaya from Kurseong, Nagkli, Singalelak, Jongli and Senchal. Therefore, the present investigation on the genus *Plagiochilion* sporophytes have been described for the first time and the occurrence of the genus *Plagiochilion* is an un-

known hitherto to the North East Indian Sub-Himalayan region. The occurrence of this taxon shows the extension of distributional range of genus *Plagiochilion* to North East India sub-Himalayan region in general and Nagaland state in particular. Detailed hand drawing illustrations have been provided for its easy identification.

Materials and Methods

The fresh specimens were collected from their natural localities from Kohima district of Nagaland. The morphological characters were studied under Leica digital Stereo-zoom. The anatomical studies of leaves and stems were studies under Leica digital Microscope. The hand sections of stems, leaves, spores and elaters were mounted in 30% aqueous solution of glycerin and observed under the Leica digital Microscope. The photomicrographs and photomacrographs were taken under Leica digital Microscope (DM1000) and Leica stereo-zoom (S6D) respectively. The preserved specimens were deposited in the Department of Botany, Nagaland University, Hqs: Lumami.

Taxonomic Observation

Plagiochilion mayebarae S. Hatt. J. Hattori Bot. Lab. 3: 39. 1950.

Plants medium, light green to dull green, brownish green, in dry herbarium blackish brown, 30-45 mm long, 2-3.5 mm wide including leaves, slightly to closely appressed to the stem; branched, branching of postical intercalary, stolons frequent. Stem reddish brown, cross section circular-oval, 2.5 x 3.5 mm in diameter, 12-15 cells across, 3 thick brownish cortical cells, medullary cells thin walled. Rhizoids in fascicules at the base of the leaves. Leaves slightly imbricate to contiguous, distant, opposite, slightly connate at base, orbicular, ovate, 1.2-1.4 mm long, 1-.2 mm wide, not decurrent, margin entire or minutely dentate, 3-5 teeth at leaf apex, 2-4 cells long, 3-4 cells wide at base; leaf cells thin or thick walled, apical cells thick walled, 10-20 μm long, 6-15 μm, trigone minute; median cells 17-34 μm long, 15-23 μm wide, thin wall, trigonous; basal cells 22-36 μm long, 15-27 μm wide, thin walled, trigonous, nodulose, and intermediate thickening present. Underleaves absent. Male plant not seen. Female inflorescence terminal on main stem or on short lateral branched, bracts one pair, oblong-ovate, 1.3-1.8 mm long and 1.2-1.8 mm wide; apex irregular-

ly dentate, tooth 2-4 (-6) cells long, 2-4 cells wide; basal cells trigonous, nodulose, 24-55 μm long, 15-27 μm wide, rectangular; median and apical cells like the lateral leaf cells. Perianth campanulate, 1.6 x 2.5 mm in diameter, mouth irregularly dentate, truncate; spores brownish red, small, circular, spherical, 16 x 18 μm in diameter, globose, granulate, papilate; elaters 131-220 μm long, 7-10 μm in diameter, bi-spiral.

Ecology and Distribution: The plants grow on the bark (epiphytic) in association with *Plagiochila corticola*, *Plagiochila semidecurrens, Lejeunea* sp., and Mosses.

Range: Japan, China, Formosa, India.

Specimen examined: Nagaland: Khuzama: 16.11.2009, KE 10155, Kazhuhrii Eshuo; Khonoma: 19.03.2011, KE 10423, Kazhuhrii Eshuo.

Discussion

Plagiochilion mayebarae S. Hatt. is somewhat variable in regards to the walls of its leaf cells (Inoue, 1960). *P. mayebarae* is closely allied to *P. braunianus* and earlier workers had erroneously reported as *Plagiochila brauniana* from Sikkim-Himalaya, China, and Formosa. However, *P. braunianus* can easily be distinguished from *P. mayebarae* in having reniform leaves, always entire, large trigones, nodulose trigones along leaf margin cells and cylindrical perianth whereas *P. mayebarae* have orbicular and non-decurrent leaves, margin with 1-6 small teeth or sometime entire, minute trigones and thick walled at leaf apex and margin, campanulate perianth. The diameter of the leaf cells especially the median and basal have larger size as described by Inoue and this is considered to be due to ecological variation by the present authors.

Acknowledgement

Authors are thankful to the University Grants Commission, Government of India, New Delhi for the financial help to the Department of Botany, Nagaland University, Lumami, under SAP (DRS-II) and Rajiv Gandhi National Fellowship (RGNF) for ST/SC, UGC for awarding JRF. Thanks are indebted to Prof. Tamás Pócs, Department of Botany, Eszterhazy College, Hungary for critically reading the manuscript and suggestions. Thanks are due to Dr. D.K. Singh, Additional Director, BSI, Kolkata; Dr. D. Singh, CNH-Kolkata for generously giving literature and help-

ing during the studies. Authors are also grateful to Mr. Soyhunlo Sebu and Mr. S. Majumdar for their valuable help.

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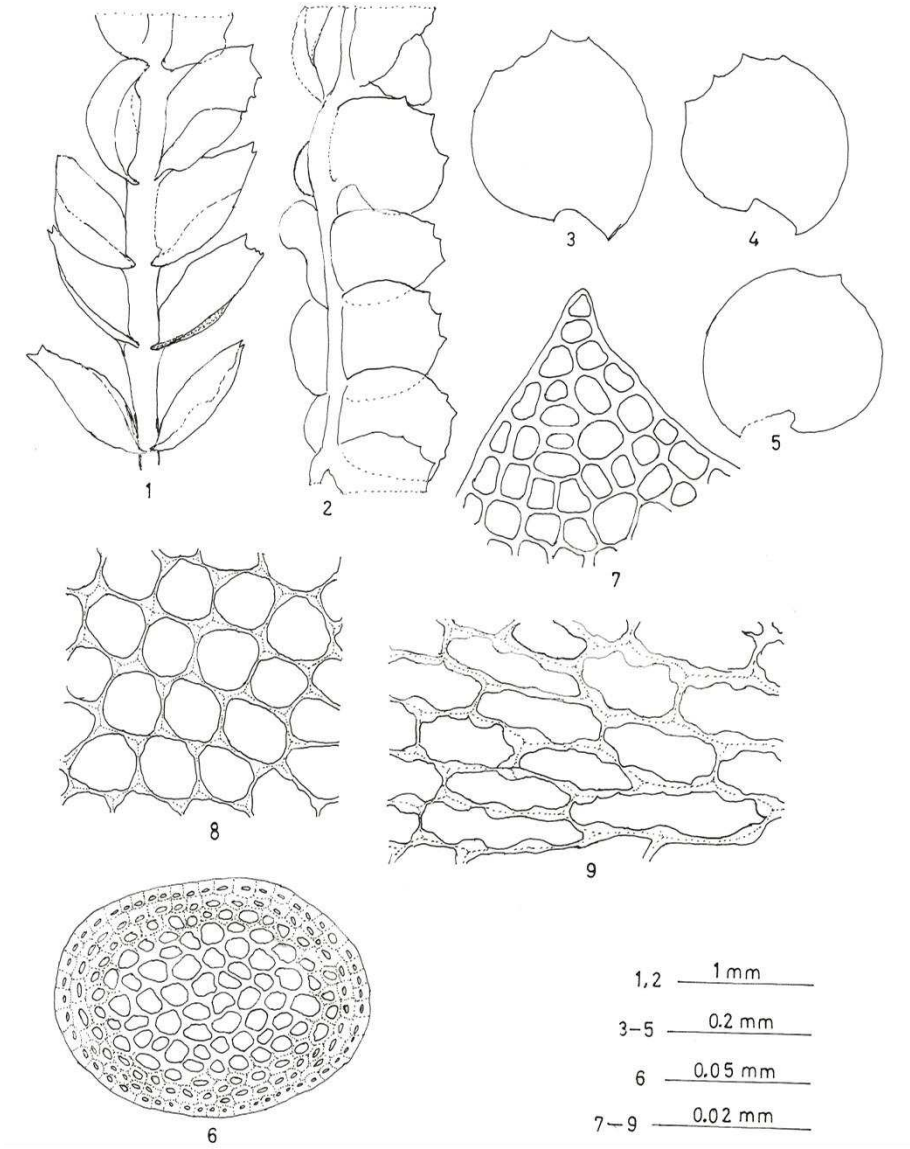


Plate 1. *Plagiochilion mayebarae S. Hatt*., Figs. 1-9.
Figs. 1. A portion of plant in ventral view; 2. A portion of plant in lateral view; 3-5. Leaves; 6. Cross section of the stem; 7. Leaf apical cells; 8. Leaf median cells; 9. Leaf basal cells.

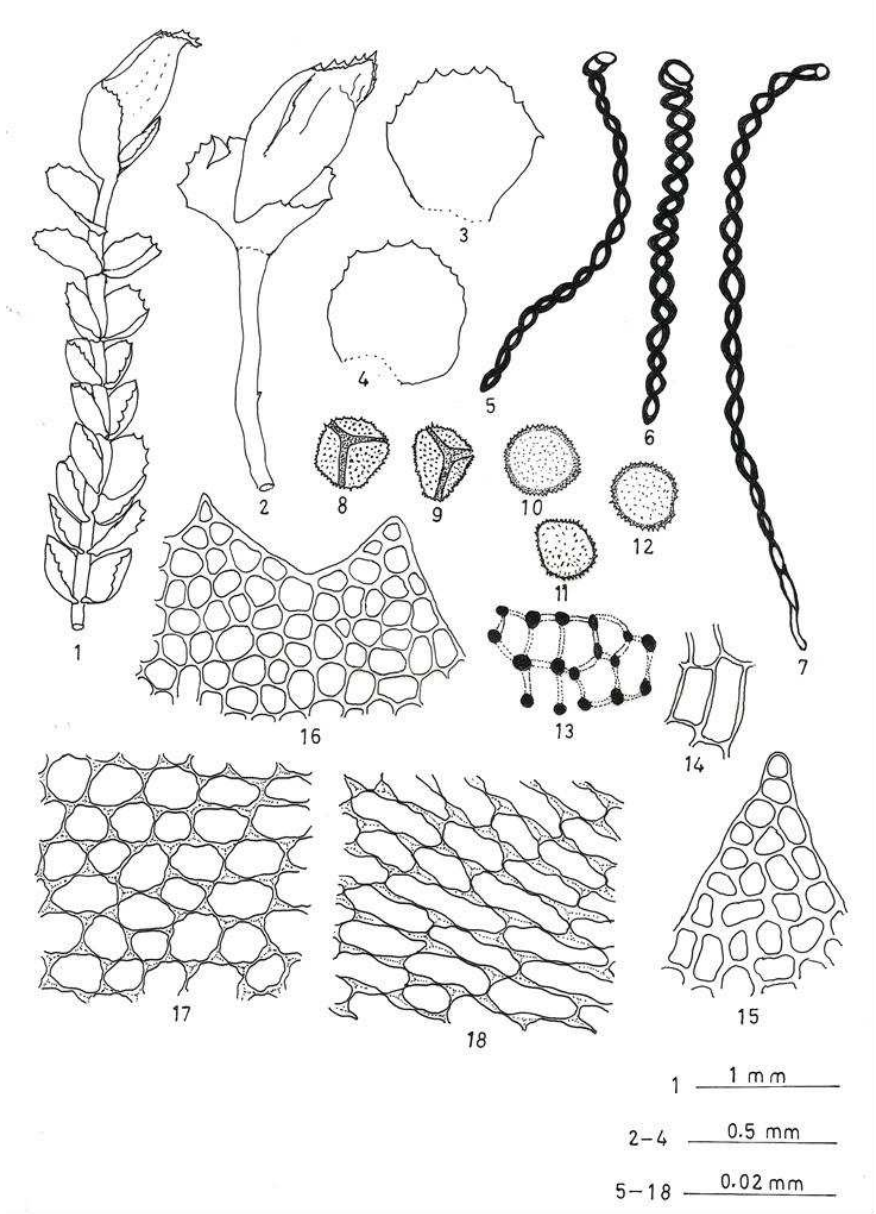
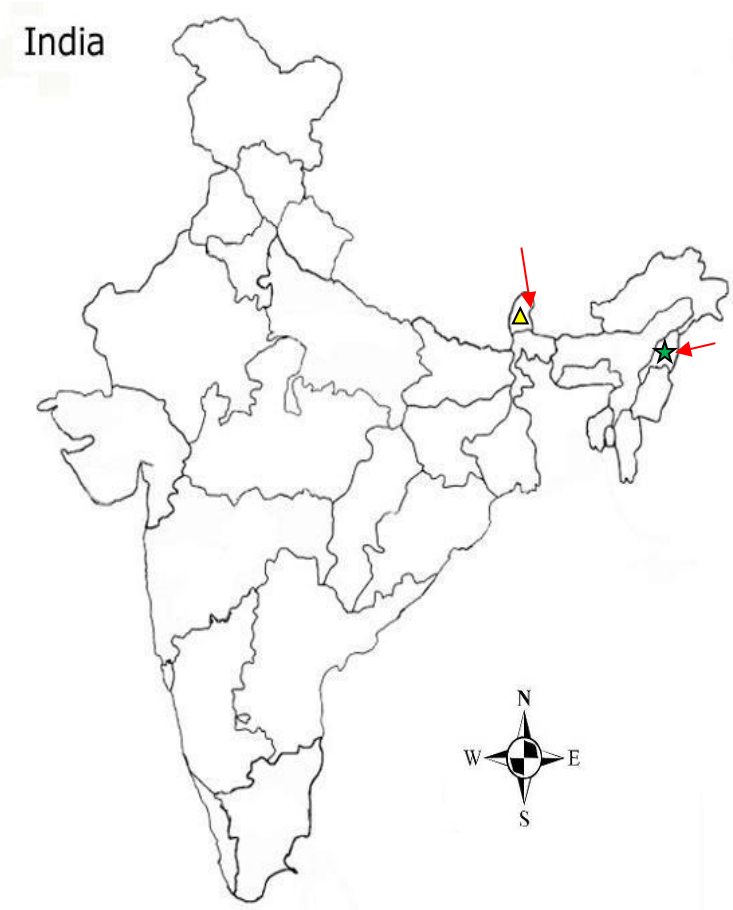


Plate 2. *Plagiochilion mayebarae* S. Hatt., Figs. 1-18.
Figs. 1-2. A female plants showing perianth; 3-4. Female bracts; 5-7. Elaters; 8-12. Spores, 8-9. Spores in proximal view, 10-121. Spores on distal view; 13. Inner wall of sporangium thickenings; 14. Outer wall layer of sporangium; 15-16. Female bract apical cells; 17. Female bract median cells; 18. Female bract basal cells.



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Map I: Showing the distribution of ***Plagiochilion mayebarae*** S. Hatt. in India

= Shows the distribution of ***P. mayebarae*** S. Hatt. from Sikkim, India.

= Shows the distribution of ***P. mayebarae*** S. Hatt. from Nagaland [Khuzama; Khonoma] India.

EFFECTS OF EXPERIMENTAL INCREASE OF TEMPERATURE AND DROUGHT ON HEATHLAND VEGETATION

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Increase of temperature and drought on heathland vegetation

Key words: environmental change, heathland vegetation, climatic manipulation

Abstract. Effects of simulated environmental changes on heathland vegetation were investigated in Oldebroek, the Netherlands. As response to strong disturbance, decrease of the presence/coverage of lichen species was observed; bryophytes have shown various reactions. In the drought plots the normally predominant species are decreasing, while others reach their maximum coverage here.

Introduction

Global changes in the climate are a potential threat to biodiversity and may cause irreversible effects (Kappelle *et al.* 1999). As identified by the European Environmental Agency (Anonymous 2004) the lack of studies on the effects of global climatic change on species diversity is one of the areas needing greater attention of researchers.

INCREASE is an EU-funded infrastructure of six large-scale climate change experiments designed to study climate change effects on shrub

lands. The experiments combine two different "space for time" substitution approaches to study climate effects on ecosystems: observational studies (performing along a precipitation and temperature gradient in Europe) and manipulative experiments. The research involves non-intrusive technologies for realistic climate manipulations (temperature and drought manipulations) and non-destructive sampling methodologies and by synthesis of long data records.

The few studies that exist on how bryophyte and lichen species richness or diversity is affected by temperature enhancement show diverse results, from no changes to decreases in abundance of bryophytes, and from decreases to increases in abundance of lichens (Jonasson 1992; Molau & Alatalo 1998; Press *et al.* 1998; Jägerbrand *et al.* 2006). Thus, so far, the response pattern of brophyte and lichen richness/diversity to global change has not been clearly defined.

The aim of this work was to give a full checklist of bryophytes of the investigated plots and to investigate whether species richness and species composition of the bryophyte assemblage are affected by temperature and drought.

Materials and methods

Site description

The Dutch experimental site Oldebroek (52°24'N; 5°55'E) is located at the Artillary Practice Ground (ASK) of the Dutch Army near the towns of 't Harde and Oldebroek, province of Gelderland, the Netherlands (Fig. 1). The site is part of a large heathland area called Oldebroekse heide. Climate is temperate and humid, with yearly rainfall 1072 mm, and annual average temperature 10.1°C. The heathland vegetation found here is dominated by *Calluna vulgaris*, *Deschampsia flexuosa* and *Molinia caerulea* with some scattered *Betula pendula* and *Pinus sylvestris* trees and bushes of *Juniperus communis.* The plots are mainly covered with *Calluna vulgaris* of a maximum height of 75 cm.

The heathland is managed by regular vegetation cutting back, or more drastically by sod-cutting to prevent grass encroachment by removing nutrients. The soil is a well drained, sandy to loamy sand podzol, with a groundwater class of VII. In the Duch system class VII means that groundwater level is always lower than 1.8 m soil depth. The site is located at an elevation of 25 m above sea level and is almost flat (slope 2%).

Remarkably high N leaching was observed at the heath with 18 and 6.4 kg N ha^{-1} $year^{-1}$ of NO_3-N and NH_4-N leached from the control plots, respectively, indicating that this site is nitrogen saturated. Increased soil temperature of 0.5-1.0°C in the warmed plots almost doubled the concentrations and losses of $N0_3$-N and DON (dissolved organic nitrogen) at this site (Kopittke *et al.* 2012). However, NO_3 leaching and the effect of warming have decreased during the last years (Schmidt *et al.* 2004). Due to the high N deposition, the growth of biota is limited only by phosphorous (Van Meeteren *et al.* 2007). Finally, it is supposed that climate change affects the overall water holding capacity of the soil, leading to decreased moisture contents even in winter (Sowerby *et al.* 2008).

CLIMATIC MANIPULATION

At Oldebroek there were a total of 9 plots of 20 m^2 each that have been under climatic manipulation since 1998. There were 3 replicated plots of each treatment; 3 control plots, 3 night time warming plots and 3 repeated summer drought plots. In the warming plots a reflective curtains was drawn across the plots at night thus preventing loss of infrared radiation, leading to an increase in mean daily temperature in the topsoil of 0.5 to 1.0 ºC. The curtains were controlled by a light sensor. In case of rain during the night, the curtains were withdrawn so the water balance was kept intact. Drought plots were protected from rain by a rain cover for 2-3 months during every growing season since 1999. A rain sensor controlled the curtains to ensure that they only cover the plots during rain events. At the end of summer 2009, 2 m^2 of the vegetation of all plots was cut and all the cut vegetation removed, allowing investigation on the interaction between climate change and manipulation.

SAMPLING METHOD

Bryophytes were inventoried in October, 2011. It was done with a minimum disturbance of the plots and only selected species were collected for ulterior determination. In every plot 5 quadrates of 20 × 20 cm were chosen randomly and coverage of bryophyte species was estimated within these quadrates. Total number of sampling quadrates were 45 (15 control, 15 temperature and 15 drought quadrates).

Nomenclature follows Catalogue of Life (http://www.catalogueoflife.org).

Results

Allover 19 species: 7 vascular plants, 1 alga, 1 lichen and 10 bryophytes were observed in the investigated plots (Table 1). The dominancy of *Hypnum cupressiforme* and *Calluna vulgaris* was observed in each plot, both of them showed significantly decreased coverage in the drought plots.

Six bryophyte species were in the control plots, five in temperature plots and eight in the drought plots. Four species are present only in the control plots, three only in the temperature plots and one only in the drought plots. *Dicranum scoparium* is present in all three types of plots, reaching its highest coverage at the temperature plots. *Pohlia nutans* reaches its highest coverage in drought plots and is present in less proportion in the other two plots. *Polytrichum juniperinum*, also reaching its highest coverage in drought plots, is missing from temperature plots and present only in 2% in the control plots. *Cladonia* sp. lichen species is equally present in control (11%) and temperature plots (10%) but completely missing at drought plots.

Analysing flora elements and strategy of bryophytes we found that most of the species (8) are cosmopolitans, five of them are perennials and other five are colonists. Most of the species found have wide ecological amplitude concerning the water and temperature requirements (Table 2).

Percentage of colonist species is significantly higher in drought plots (Fig. 2).

Discussion

It was observed that climatic manipulation modifies the composition of both the bryophyte and vascular plant flora.

Concerning vascular flora: the dominant vascular plant species is *Calluna vulgaris*; a gradual decrease of its coverage can be detected in the temperature and drought plots. Besides *Calluna vulgaris*, other vascular plants are represented here by *Nardus stricta* which usually occurs on poor acidic sandy, peaty soils and is strongly calcifuge. *Molinia caerulea* grows best in acidic soils and can live under extreme conditions. The replacement of ericaceous dwarf shrubs by grasses such as *M. caerulea* is a major threat to heathland conservation (Mobaied *et al.* 2012). Both of them could be observed only in the control plots. *Rumex acetosella* is

often one of the first species to appear in disturbed areas, especially if the soil is acidic; it is widely considered to be a noxious weed. In the warmed plots it has a cover of 10%, reaching its highest coverage of 28% in the drought plots, whereas it was missing in the control plots. Other plants present on the experimental site are: *Juniperus communis, Prunus serotina* and *Carex pilulifera,* all are present only in the temperature plots. Large-scale geographical investigations are important because *Prunus serotina* (originally, native to North America) is an invasive species in north-western Europe (Reinhart *et al.* 2005). A single shoot of *Carex pilulifera* occured in one of the warmed plots. This species has a wide distribution in Europe (Jermy *et al.* 2007); it typically inhabits soils with a pH of 4.5–6.0.

Concerning cryptogams*:* dominant moss species is *Hypnum cupressiforme* which has a great coverage in control and temperature plots and significantly decreases (by 10%) in drought plots. *Hypnum cupressiforme* is an extremely polymorphic species, reflected in the more than 60 varieties that have been described. Recently Frahm (2009) has described the infraspecific taxa of this group. This species has wide ecological amplitude as well as a cosmopolitan world distribution (Table 2.) and is found in all climatic regions. Two phenotypes of *H. cupressiforme* occurred here: one adapted to shade, with slender shoots and darker olive green in shadow – always under *Calluna* shrubs and one more robust, yellow-green observed in more light exposed places (between *Calluna* shrubs). In a single quadrate where the vegetation was cut in 2009 (which means a strong disturbance) *Hypnum* disappeared and instead of it a jelly layer with green algae (*Aphanothece* sp.) appeared. Embedded in this algae layer *Polytrichum juniperinum* and *Cladonia* sp. lichen could be detected. *Polytrichum juniperinum*, being a xerophyte species (Table 2), also reaches its highest coverage in drought plots (14%) and missing from temperature plots, present only in 2% in the control plots. According to Smith (1978) *P. juniperinum* commonly grows on well drained acidic soil on heaths, moorland and rocks. *Cladonia* lichen species is equally present almost in the same proportion in control and temperature plots but completely missing at drought plots. *Campylopus introflexus* is well represented in drought plots (2%) but also found in control plots (0,66%). It is an invasive moss species in Europe and it has wide ecological tolerance (Table 2). It is widespread in the Southern hemisphere and it was first discovered outside its native range in 1941 in Great Britain (Richards, 1963). In the Netherlands it was discovered in 1963 (Barkman & Mabelis

1968) and as a result of rapid spread, Greven (1992) reported more than 200 records. Bernth (1998) showed that this species has a significant negative effect on the germination of seeds of *Calluna vulgaris* in the field. *Dicranum scoparium* is a moss species considered to be indifferent to soil pH and it is a characteristic, constant species in *Callunetum* and can be found in all three types of plots. Remarkable was the high cover (59%) of *Dicranum scoparium* in the warmed plots compared to the control plots (24%), although it is a moderately hygrophyte, mesophyte species according to Dierßen (2001) (Table 2). Gimingham (1961) described *Calluna* communities in Northern Europe, including reports of *Dicranum scoparium* in heath associations throughout Scandinavia, Germany, Denmark and the Netherlands. *Ceratodon purpureus* occurring at the drought plots is considered to be a coloniser of disturbed sites. This species is most abundant on exposed sandy soils but tolerates a wide range of soils and it is a considerably xerophyte species (Table 2). *Dicranella heteromalla* also occurred only in the drought plots. It is common and sometimes abundant except on calcareous substrate (Smith 1978). *Pohlia nutans* reaches its highest coverage in drought plots (11%) and is present in less proportion (3, respectively 5%) in the other two plots. This species is common on heaths, tolerates mineral-rich habitats and occurs at industrial sites especially those with heavy-metal pollution (Smith 1978) and it has a wide ecological tolerance (Table 2). *Polytrichum longisetum* is present only in the temperature plots (4%), although it has a wide ecological tolerance concerning the temperature requirement, but moderately hygrophyte (Table 2). This moss species grows on acidic, well drained soil on heaths and moorlands (Smith 1978). The liverwort species *Lophozia ventricosa,* common in many acidic places (Landwehr 1980), was found in the temperature and drought plots, missing from the control plots; although this species has a moderately hygrophyte character and requires a somewhat colder temperature range (Table 2). *Cephaloziella hampeana* was found in one of the control plots forming a small patch and covering 4%. This species usually grows on acidic or neutral substrates (Smith 1990) and it requires a little bit colder temperature range, but it has wide ecological tolerance concerning the water requirement (Table 2).

Conclusions

The main findings of this study are:

1. The dominant vascular (*Calluna vulgaris*) and bryophyte (*Hypnum cupressiforme*) species reach their highest coverage in the control plots and show significantly lower coverage in temperature and drought plots due to climatic manipulations.

2. Occurrence of colonist species (*Ceratodon purpureus)* and species adapted to disturbed areas (*Rumex acetosella* and *Prunus serotina*) were observed only in temperature and drought plots, while *Cladonia* sp. lichen is missing from the manipulated plots.

3. There is a strong increase in the percentage of colonist and stress tolerant perennial species (e .g. *Ceratodon purpureus, Dicranella heteromalla, Polytrichum juniperinum, P. longisetum*) in the drought plots.

It is also concluded that to get a more complete picture about the bryophyte assemblages of the investigated plots, more sampling work is needed to take into account the yearly climatic differences and natural fluctuation in the species composition.

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Table 1. Average coverage (expressed as percentage) of species in the three plots of the control, warming and drought treatments.

Species	Control	Warming	Drought
Calluna vulgaris L.	96	91	84
Carex pilulifera L.	0	0.26	0
Juniperus communis L.	0	0.50	0
Molinia caerulea (L.) Moench	0.50	0	0
Nardus stricta L.	0.50	0	0
Prunus serotina Ehrh.	0	0.26	0
Rumex acetosella L.	0	10	28
Aphanothece sp.	0.80	0	0
Cladonia sp.	11	10	0
Campylopus introflexus Brid.	0.66	0	2
Cephaloziella hampeana (Nees) Schiffn.	0.26	0	0
Ceratodon purpureus Brid.	0	0	1.85
Dicranum scoparium Hedw.	24	59	16
Dicranella heteromalla (Hedw.) Schimp.	0	0	0.50
Hypnum cupressiforme L.	90	91	80
Lophozia ventricosa (Dicks.) Dum.	0	0.93	0.20
Pohlia nutans (Hedw.) Lindb.	3	5	11
Polytrichum juniperinum Hedw.	2	0	14
Polytrichum longisetum Sw. *ex* Brid.	0	4	0

Table 2. Bryophyte species and their distribution, strategy type, water and temperature requirement according to Dierßen (2001)

Species name	Flora element	Strategy	Humidity	Heat balance
Campylopus introflexus (Hedw.) Brid.	disj cosmopol	perennial, dominant	moderately hygrophyt – considerably xerophyt	mesotherm – moderately thermophyt
Cephaloziella hampeana (Nees) Schiffn.	circpol+Macar	colonists	moderately hygrophyt – considerably xerophyt	moderately cryophyt – mesotherm
Ceratodon purpureus (Hedw.) Brid.	cosmopol	colonists	mesophyt – considerably xerophyt	considerably cryophyt – considerably thermophyt
Dicranum scoparium Hedw.	cosmopol	competitive perennials	moderately hygrophyt – mesophyt	considerably cryophyt – considerably thermophyt
Dicranella heteromalla (Hedw.) Schimp.	cosmopol	colonists	mesophyt	mesotherm – moderately thermophyt
Hypnum cupressiforme Hedw.	cosmopol	perennials, stress tolerant	mesophyt – moderately xerophyt	tempindiff
Lophozia ventricosa (Dicks.) Dum.	circpol	pioneer colonists	moderately hygrophyt – mesophyt	considerably cryophyt – mesotherm
Pohlia nutans (Hedw.) Lindb.	cosmopol	pioneer colonists	moderately hygrophyt – moderately xerophyt	considerably cryophyt – moderately thermophyt
Polytrichum juniperinum Hedw.	cosmopol	competitive and stress tolerant perennials	moderately – considerably xerophyt	considerably cryophyt – considerably thermophyt
Polytrichum longisetum Sw. *ex* Brid.	nearly cosmopol	competitive and stress tolerant perennials	moderately hygrophyt	considerably cryophyt – moderately thermophyt

Fig. 1. Location of the experimental site (NL – the Netherlands, BE – Belgium, GE – Germany)

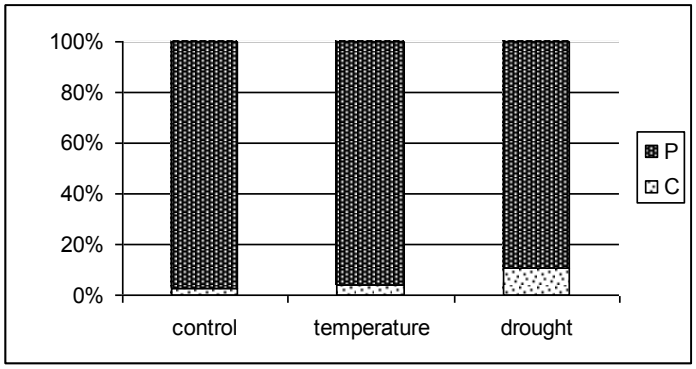

Fig. 2. Percentage of two life strategies (P – perennials, C - colonists) in different plot categories calculated on the basis of species coverages

A SYNOPSIS OF THE FAMILY POTTIACEAE (BRYOPHYTA) OF KERALA, INDIA

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Keywrds: Bryophyta, Kerala, New Record, Pottiaceae, *Pottia bryoides*

Abstract: The Potttiaceae are one of the dominant acrocarpic moss family of India with 26 genera and 130 species. The present paper is a synopsis of the family Pottiaceae in Kerala State. Here we report 18 species distributed among 13 genera such as *Anoectangium aestivum, A. bicolor, Barbula tenuirostris, B. indica, Hyophila involuta, H. nymaniana, Hymenostylium recurvirostrum, Hymenostomum edentulum, Indopottia zanderii, Oxystegus cylindricus, Pottia bryoides, Scopelophila cataractae, S. ligulata, Syntrichia fragilis, T. muralis, Tortella tortuosa, Trichostomum wayanadense* and *T. crispulum.* Among these one species *viz., Pottia bryoides* is a new record for India. *Scopelophila ligulata* is widely known as "copper moss" but this species was not recorded yet from Peninsular India. This report is then new to Peninsular India. Two species *viz; Barbula tenuirostris* Brid. and *Syntrichia fragilis* (Tayl.) Ochyra. are new records for Kerala and *Indopottia zanderii* is endemic to Western Ghats.

Introduction

Pottiaceae is one of the largest families of the acrocarpic Indian mosses. It is a highly diversified family inhabiting all climatic zones from plains to the higher altitudes. The collection of members of Pottiaceae were began with the work of Griffith (1842), who travelled widely in Assam and adjacent regions and described 4 species of Pottiaceae. In Eastern

India and adjacent regions, the family Pottiaceae are distributed with 73 species among 24 genera (Gangulee, 1969-1980). Vohra *et al.* (1982) described 14 species under 10 genera from Silent Valley National Park of Kerala. In Central India, the family Pottiaceae are represented by 8 species (Nath, *et al*., 2011). In Nair *et al.* in 2005 Pottiaceae are represented by 10 species under nine genera from Wayanad district in Western Ghats. Among the 10 species, *Trichostomum wayanadense* is reported as new and it was endemic to Western Ghats. A checklist of bryophyte taxa reported from Kerala have been represented by Manju *et al.* in 2008. This list reports 17 taxa of Pottiaceae members to Kerala.

In India the Pottiaceae are represented by 5 subfamilies; Eucladoideae including 4 genera *viz*; *Anoectangium, Molendoa, Gymnostomum, Hymenostylium;* Trichostomoideae including 5 genera *viz; Oxystegus, Tortella, Scopelophila, Hymenostomum, Trichostomum;* Barbuloideae including 8 genera *viz; Hyophila, Barbula, Gheebia, Bellibarbula, Semibarbula, Prionidium, Bryoerythrophyllum, Didymodon;* Pottioideae including 4 genera *viz; Indopottia, Merceya, Weisiopsis and Desmatodon* and Leptodontoideae inclunding *Leptodontium* (Aziz & Vohra, 2008). In Kerala Pottiaceae is represented with 13 genera *viz; Scopelophila, Pottia, Anoectangium, Oxystegus, Hyophila, Barbula, Semibarbula, Syntrichia, Hymenostomum, Tortula, Hymenostylium, Tortella, Trichostomum* and *Indopottia* and by 19 species. Among these *Pottia bryoides (*Dicks.) Mitt. is a new record for India, which is collected from New Amarambalam Reserve Forest of Nilambur area. *Scopelophila ligulata* (Spruce) Spruce is widely known as "copper moss" in America. In India this species is misidentified as *Merceya ligulata, Scopelophila duthiei* and *Scopelophila simlaensis* which were collected from North- East India. Hence, the present report is a new record for Peninsular India. Two species *viz. Barbula tenuirostris* Brid. and *Syntrichia fragilis* (Tayl.) Ochyra. are new records for Kerala. *Oxystegus cylindricus* (Bruch. *ex* Brid.) Hilp. and *Hyophila involuta* (Hook.) A.Jaeger are widely distributed in high and low altitudes areas of Kerala. *Trichostomum wayanadense* Nair *et al.* (2005) is an endemic species of Western Ghats and *Indopottia zanderii* Daniels *et al*. (2010) is an endemic genus of Kerala. *Anoectangium bicolor* Renauld & Cardot, is found only in Western Himalayas and Kerala. *Hyophila involuta* is recorded from all districts.

The family Pottiaceae is well recognized by haplolepidous, papillose, filamentous peristome which may be erect or in some cases spirally twisted and also by quadrate papillose laminar cells (Aziz & Vohra, 2008).

They are characterized by small to large, robust to slender in dense compact to loose tufts, rarely calcicolous, green, yellowish green to yellowish-brown above, dark brown to blackish-brown below. Stem erect, sometimes procumbent or decumbent, brownish, reddish-brown to blackish brown, radiculous below, simple to branched, branches mostly sympodial. Leaves when dry crisped to curled, erect to appressed with hooked and incurved apices, when moist erect to erect spreading, densely arranged on the stem, forming a sort of rosette, linear-lanceolate to lanceolate, spathulate, obovate and ligulate.

The present study reports 18 species distributed among 13 genera in Kerala. For each species representative specimens with the following data are included as far as possible; brief description, locality, habitat, altitude, collectors name, collection number and range of the species. The following acronyms are used – MCN (Manju C. Nair), VV (Vidya, V.), KPR (K.P. Rajesh), PVM (P.V. Madhusoodanan), SEK (Shaji E.K.), WLS (Wildlife Sanctuary)

Taxonomic Observations

Key to the species of *Anoectangium*

1a. Costa excurrent, stem loosely covered with leaves, light greenish *A. aestivum*

1b. Costa percurrent, stem densely covered with leaves, yellowish green *A. bicolor*

Anoectangium aestivum (Hedw.) Mitt., J. Linn. Soc. Bot. 12: 175. 1869.

Plants yellowish green, occur as dense tufts, dark brown at base, stem erect, 9 mm-1.1 cm long, margin serrate, costa prominent ends where the leaf tip ends, slightly excurrent tip, 0.57-0.60 mm long, 0.09-.012 mm wide; leaf tip cells are thickly packed, papillose, hexagonal 7.5 μm; leaf middle cells are thickly packed, papillose, hexagonal; leaf basal are papillose, hexagonal, loosely packed, 10 x 3.5 μm; cells at costal region elongated, rectangular, papillose, loosely arranged; cells at marginal region small hexagonal, papillose, arranged thickly (Fig. 1 A-F).

Habitat & Distribution: On rocks and on earth banks. Distributed in India (Kerala) China, Japan, Philippines, New Zealand, Europe and North and South America.

Specimen examined : India, Kerala, Munnar (1200 m) *MCN 87276* (CALI).

Anoectangium bicolor Renauld & Cardot, Bull. Soc. Bot. Belgium 14(1): 19. 1905.

Plants yellowish-green, seen in dense tufts, stem branched, 0.6-1 cm long, densely covered with leaves, leaf lanceolate, yellowish-green above, reddish brown below, 2-4 mm long, 0.21-0.23mm wide; costa strong, percurrent, margin serrated, apex acute, cells upto 1.2 x 0.3 μm, basal cells rectangular, smooth, 40 x 8 μm, shorter and slightly papillose near margin (Fig. 1. G-J).

Habitat & Distribution: On earth banks in Tea estate. This species is recorded only from the Western Himalayas and Kerala only.

Specimen examined: India, Kerala, Wayanad, Chembra estate (1060m) *MCN 120239* (CALI).

Key to the species of *Barbula*

1a. Leaves ovate to spathulate, costa light yellow, leaf tip cells irregularly shaped *B. indica*

1b. Leaves lanceolate, costa light greenish, leaf tip cells hexagonal *B. tenuirostris*

Barbula indica (Hook.) Spreng., Syst. Veg. 2: 72. 1824.

Syn.: Semibarbula orientalis (F.Weber) Wilk & Margad., Taxon 8(2): 75. 1959.

Plants pale greenish, seen in dense tufts, stem branched, 0.9-1.3 cm long; leaves ovate–spathulate with serrated margin, 0.1-0.2 mm long and 0.26-0.28 mm wide, slightly excurrent midrib, costa strong, light greenish; leaf tip cells irregularly shaped, thickly arranged, papillose 5-8 μm; leaf middle cells round, thickly packed, papillose; leaf basal cells are polygonal cells, thickly packed, smooth, 25 x 10 μm; leaf cells at costal region are small rectangular, smooth, thickly arranged; leaf cells at margin are elongated rectangular cell, smooth, hyaline, thickly arranged (Fig. 2. A-I; Fig. 12 A&B).

Habitat & Distribution: It is found almost everywhere, on roadsides, earth banks, rock crevices, moist bricks, rotten logs and on concrete walls in moist deciduous forests. . Found on soil along with *Cheilolejeunea, Cyathodium and Lopholejunea subfusca*. In India this species is distributed only in Kerala, South India (Kerala), North east India (Darjeeling, Arunachal Pradesh, Bengal, Orissa),

Sri Lanka, China, Japan, Korea, Nepal, New Guinea, Pakistan, Myanmar,Celebes, Taiwan, Malaysia, Siam, Papua New Guinea, Philippines, Colombia, Mexico, Africa and America, rare in Europe. **Specimen examined**: Kasaragod, Parappa (30 m) *KPR 87007* (CALI) Kerala, Kozhikode, Peruvannamuzhi, (50m), Deepa 4725 (ZGC, CALI); VV 938 (ZGC); Wayanad, Kurichiad Range (858 m) MCN 84653, Tholpetty range (860 m) MCN 84591, Begur (850 m) MCN 84586 (CALI).

Barbula tenuirostris Brid., Bryol. Univ. 1: 826. 1827.

Plant yellowish green, seen in dense tufts, branched, 6-8 mm long, leaves lanceolate, 1-2 mm long, 0.14-0.16 mm wide, light greenish, costa brownish, prominent, excurrent, margin wavy; leaf tip cells thickly arranged, hexagonal cells, papillose 7-8 μm; leaf middle cells thickly arranged, papillose, hexagonal cells; leaf basal cells thickly arranged, rectangular, papillose, 11-35 x 5-11 μm; cells at costal region elongated, loosely arranged, rectangular; smooth cells at marginal region rectangular, not elongated, loosely arranged, smooth (Fig. 2. J-R).

Habitat & Distribution: On earth banks. A widely distributed species in India (Western Himalaya, Plains of Uttarpradesh, Madhya Pradesh, Bihar, West-Bengal Plains, Darjeeling, Arunachal Pradesh, Tamil Nadu), East Nepal, Sri Lanka, Myanmar, China, Japan, Thailand, Vietnam, Malaysia, Java, Singapore, New Guinea, Philippines, Taiwan.

Specimen/s examined: Malappuram, Vazhayur (20 m) *Ganga 106414* (CALI); *VV 926* (ZGC).

Note: The present collection is a new record for Kerala.

Key to the species of *Hyophila*

1a. Costa percurrent, leaves lingulate to spathulate, leaf base wider *H. involuta*

1b. Costa excurrent, leaves ovate to lanceolate, leaf base narrow *H. nymaniana*

Hyophila involuta (Hook.) A. Jaeger, Ber. Senckenberg. Naturf. Ges. 1871-72: 356. 1873.

Plants yellowish green, erect, simple or branched, 4-6 mm long, upper leaves spreading in rosettes, leaves erect spreading, ligulate to

spathulate; upto 2 mm long, 0.22-0.33 mm wide; costa prominent, strong, ends at the leaf tip. Leaf marginal cell serrated at the tip, apex broadly pointed, wider at base. Leaf tip cells small, hexagonal, papillose cells, 6-10 μm; middle cells thickly packed, small, hexagonal with papillose cells; basal cells elongated and smooth, colourless; leaf cell near costa region large and elongated; leaf cell marginal region densely arranged and elongated with papillose cells. Sporophyte on main stem, 1-1.5 cm long, seta long, 7-10 mm; capsule cylindrical, 1-2 mm long (Fig. 3. A-N; Fig. 12 D&E).

Habitat & Distribution: It is seen in a variety of habitats such as on soil, rocks, logs, crevices of rocks, walls etc. from low to high altitudes. It is also found on termite mount. It is a widely distributed species from lower to high altitudes. Africa, Asia [China, India: Andaman and Nicobar Islands; central India (Achanakmar – Amarkantak Biosphere Reserve, Gujarat, Mt. Abu, PBR); eastern Himalaya (Arunachal Pradesh, Assam, Darjeeling, Meghalaya, W Bengal, Sikkim); Punjab and west Rajasthan Plains (Rajasthan); Gangetic plains (Bengal Plains, Jharkhand, Uttar Pradesh); S India (Karnataka, Tamil Nadu, Kerala); western Himalaya (Himachal Pradesh, Uttarakhand), Indonesia, Japan, Jordan, Malaysia, Mali, Oman, Philippines, Sri Lanka, Taiwan, Thailand], Europe, North America, Oceania, South America. A widely distributes species on earth.

Specimen/s examined: India, Kerala, Calicut, Mananjira, (msl) *MCN 76073*, Naduvannur, Malappuram (30 m), *Ganga 106360* (ZGC); C.U. Campus, Malappuram (40 m) *SEK 99242*; Chelari, Malappuram (40 m) *PVM 106352*, Ozhuvathadam, Idukki (1300 m) *Shaji 120587*, Thattekkad, Kottayam (msl) *KPR 106488*, Thalassery (150 m) *PVM 84697a*, Ambalappara, Kannur (1100 m) *KPR 99785*, Kumarakam (msl) *KPR 120386*, Aralam WLS, Kannur (250 m) *KPR 106684*, Hairpin area, Wayanad (700 m) *MCN 80084*, Soochippara, Wayand (760 m) *MCN 87080*, Sulthan Bathery, Wayanad (929 m) *MCN 84362*, MG University Campus, Kottayam (40m) *KPR 120381*, Sabarimala, Pathanamthitta (600 m) *SEK 120683* (CALI); Kozhikode, Arts College Campus, (sea level) *VV 921*; ZGC Campus (40 m) *VV 941* (ZGC), Kakkavayal (100 m) *VV 924* (ZGC); Malappuram, University Campus (40 m) *VV 925*; Olavanna (sea level) *VV 937*; ZGC Campus (40 m) *VV 938* (ZGC); Ernakulam, Kombara (sea level) *VV 923,924* (ZGC).

Note: This is a widely distributed species on the earth. The misidentification of several species into various names have synonimised by various authors.

Hyophila nymaniana (M.Fleisch.) Menzel, Willdenowia 22: 198. 1992.

Plant yellowish green, simple, seen in dense tufts, 1.3-1.6 cm long; leaves ovate-lanceolate, narrower base, margin wavy; strong costa, brownish, excurrent tip, leaf 2-8 mm long, 0.74-0.77 mm wide; leaf tip cells are thickly arranged, hexagonal papillose; leaf middle cells thickly arranged, papillose, hexagonal 5-8 μm; leaf basal cells elongated, rectangular, papillose; 20 x 10 μm; at the excurrent tip 7 cells are present, leaf cell at costal region elongated, rectangular; leaf cell at the margin small, thickly packed, hexagonal, papillose; sporophyte 1.7-1.8 cm long, seta long, 1.5-1.6 cm, capsule 2-3 mm long; spores light brownish, round, thin walled, 4 μm in diameter (Fig. 4. A-J; Fig. 12 F).

Habitat & Distribution: On earth cuttings and cement walls in moist deciduous forests and in homestead areas. Africa, Asia [China, India: central India (Orissa, Achanakmar – Amarkantak Biosphere Reserve, Gujarat, PBR); Gangetic plains (Uttar Pradesh, Orissa); S India (Kerala, Wayanad, Idukki; Tamil Nadu: Palni Hills; Karnataka); Western Himalaya (Uttarakhand), Indonesia, Philippines, Thailand], North America.

Specimens examined: Pathanamthitta, Sabarimala (600 m) SEK 120683; Wayanad, Kurichiad range (858 m) MCN 84550, Dottapalam (816 m) MCN 84528b (CALI).

Hymenostomum edentulum (Mitt.) Besch., Bull. Soc. Bot. Fr. 34: 95. 1887.

Plant yellowish green, forming dense mats on soil; stem simple or branched, branches erect, 2-5 mm long, densely covered with leaves, leaves lanceolate, apex narrow pointed, upto 2 mm long, margin serrated, costa prominent, excurrent; cell at base yellowish, smooth, upto 10 x 20 μm near costa, shorter towards margin, upper cells rounded, papillose, upto 9 μm wide, densely papillose; at the excurrent portion 8 cells are present; sporophyte upto 4 mm long, seta erect, upto 3 mm long, capsule erect, upto 1 mm long (Fig. 12 C).

Habitat & Distribution: On earth banks. This is an Indo-Pacific species found distributed in South India (Nilgiri hills, Palni hills, Madras,

Chembra hills), Andaman & Nicobar Islands, Sri Lanka, China, North Vietnam, Taiwan, Java, Philippines and New Caledonia.

Specimen examined: India, Kerala, Chinnar WLS, Palaputty (1500 m) *MCN 87288* (CALI).

Hymenostylium recurvirostrum (Hedw.) Dixon, Rev. Bryol. Lichenol. 6: 96. 1933.

Plants yellowish green, seen in dense tufts, up to 3 mm long, leaves curled when dry, linear lanceolate, base broad, leaf 2 mm long, 0.24-0.26 mm wide, margin wavy, apex acute, costa prominent, strong, ends before leaf tip, cells at the tip of the leaf thickly arranged, papillose, rounded; cells at the middle of leaf loosely arranged, papillose, rounded, 6-8 µm; leaf basal cells rectangular, elongated, smooth, loosely arranged; leaf cell at the costal region elongated rectangular cells, smooth, 40 x 15-20 µm leaf cell present at marginal region hexagonal, smooth, 20 x 10-30 µm; seta long, erect, 6-8 mm. Capsule erect, dark brown 1 mm, spores long, globose, dark brownish, 5-7 µm in diameter (Fig. 5 A-H).

Habitat & Distribution: On rocky patches in semi-evergreen forests. It is distributed in Kerala, North-east India (Western Himalaya, Kashmir, Kumaon, Khasi hills, Kangra, Ladakh, Mussoorie, Sikkim), Temperate Eurasia, Myanmar, New Zealand, New Guinea, Philippines, Pakistan and Western Tibet. **Specimen examined**: Wayanad, Soochippara (767 m) *MCN 87084* (CALI).

Oxystegus cylindricus (Bruch. ex Brid.) Hilp., Beih. Bot. Centralbl. 50: 620. 1933.

Plants yellowish green, in loose tuffs; stem dark, slender, 6-8 mm long, leaves fragile, spreading, elongate, lanceolate, 2-3 mm long, 0.37-0.47 mm wide, yellowish, costa prominent, ends before tip, margin smooth, leaf base broad; cells at tip slightly elongated, rounded, papillose, middle cells small, hexagonal papillose, small intercellular spaces, basal cells elongated, smooth, rectangular 20-25 x 4-6 µm; leaf cell at the costal region large, elongated, not papillose; basal marginal cells densely arranged, rectangular, smooth; sporophyte 7-10 mm, seta long, 5-6 mm, capsule 2-3 mm long, spores rounded ca. 1.1 µm, in diameter, light brownish (Fig. 5. I-T; Fig. 12 G).

Habitat: On small rocky patches in semi-evergreen forests and grassland.

Distribution: Temperate Eurasia. This species is common at high altitudes. It is distributed in Kerala, North-east India (Darjeeling, Naga hills, Khasi hills, Sikkim), Nepal.

Specimen/s examined: Kannur, Aralam WLS, Ambalappara (1450 m) *KPR 99764*; Soochippara (760 m) *MCN 87091*, Manikkunnumala, Near MSSRF (960 m) *MCN 120299* (CALI).

Pottia bryoides (Dicks.) Mitt., Ann. Mag. Nat. Hist., ser. 2, 8: 311. 1851.

Plant light yellowish, seen in dense tufts, 3-5 mm long, branching simple; leaf lingulate-lanceolate, margin entire, costa prominent, excurrent, apex hair pointed, upto 1.4 mm long, 46-48 µm wide, leaf tip cells quadrangular, papillose, arranged with intercellular spaces, 8-9 x 4-5 µm, leaf middle cells rectangular, papillose, thick walled, 10-13 x 6-9 µm, leaf basal cells rectangular, transparent, smooth, 16-20 x 6-9 µm. Sporophyte at the tip of gametophyte, seta short, 4-6 mm long, capsule globose, erect, spores numerous (Fig. 6 A-G; Fig. 12 H).

Habitat: On earth banks.

Distribution: India (Kerala); Southern Europe, Kazakhstan, United States (Arizona, Colorado).

Specimen Examined: Malappuram, Nilambur, New Amarambalam Reserve Forest (1100 m) *KPR 109007* (CALI).

Note: Earlier only one species of *Pottia* was known from India *viz., Pottia watsonii* R.S.Chopra, collected from Palni hills. The present collection of *Pottia bryoides* is the first record of the species from India and the genus is the first addition to Kerala.

Key to the species of *Scopelophila*

1a. Plants up to 1 mm long, leaves lanceolate, cells near costa hexagonal with slightly large intercellular spaces
S. cataractae

1b. Plant 3-4 mm long, leaves cauline, cells near costa elongated without intercellular spaces
S. ligulata

Scopelophila cataractae (Mitt.) Broth., Engl. & Prantl, Nat. Pflanzenfam 1(3): 436. 1902.

Plants yellowish green, seen in loose tufts, up to 1 mm long, about 5-6 leaves in a single plant, leaves lanceolate, margin entire, costa narrow, percurrent, leaf 0.7-0.8 mm long, 0.11-0.14 mm wide, acute to short-acuminate, smooth; lower leaves smaller; leaf tip cells hexagonal, papillose; leaf middle cells hexagonal, thickly packed, not papillose; leaf basal cells hexagonal, with inter cellular spaces, smooth; 10 x 5 μm; upper cells 3-5 μm diagonally; cells near costa hexagonal with slightly large intercellular spaces, smooth; marginal cells rectangular, smooth. Sporophyte not observed (Fig. 13 A).

Habitat: Seen in sandy soil near riverine areas, mostly in mineral rich areas in semi-evergreen forests.

Specimen examined: India, Kerala, Wayanad, Chandanathode (900 m) *MCN 80112* (CALI).

Distribution: It is widely distributed in the warmer parts of all continents as North, Central & South America, Africa, Asia through to China and probably introduced to atlantic Europe. In India, it is distributed in North India (Nainital, Kumaon Himalaya), Kerala (Wayanad).

Scopelophila ligulata (Spruce) Spruce, J. Bot. 19: 14. 1881.

Plant small, yellowish green, with sparse brown rhizoids, 3-4 mm long, leaves cauline, 2-3 mm long, 62-64 μm wide, costa percurrent, brownish black proximally, possibly associated with iron in the soil; margins usually bordered by thick-walled cells; apex obtuse to acute; leaf tip cells and middle cells small, hexagonal, thickly packed, upto 3 μm in diameter, papillose, leaf basal cells elongated rectangular, often extending beyond mid leaf, smooth, 16-19 x 2-3 μm;, cells near costa elongated without intercellular spaces, costa with 1 layer of parenchymatous cells adaxial to the stereid band, distal lamina cells isodiametric (Fig. 8 A-F).

Habitat: On sandy soil and rock near river.

Distribution: Almost cosmopolitan species. India (Western Himalayas, Darjeeling as *Merceya ligulata*, China, Nepal, Japan, Costa Rica, Japan, Mexico, Papua New Guinea, Philippines, United States, Guatemala, Ecaudor, Boliwia, Europe in the Alps and Pyrenees, Taiwan, Thailand.

Specimen examined: Malappuram, Nilambur, New Amarambalam Reserve Forest (1200 m) *KPR 109006* (CALI, ZGC).

Note: This is a widely known "copper moss" in America (Shaw & Anderson, 1988). In India this species is misidentified as *Merceya ligulata*, *Scopelophila duthiei* and *Scopelophila simlaensis* (Bruehl, 1932). The present report is a new record for Peninsular India.

Syntrichia fragilis (Tayl.) Ochyra., Fragm. Florist. Geobot. 37: 212. 1992.

Syn.: *Tortula schmidii* (C.Mueller) Borth., Nat. Pflanzenfam. 1(3): 434. 1902.

Plants dark brownish, occur in dense tufts, stem erect, 2.5-3 cm long, lower portion covered with dark brownish rhizoids, leaf dark brownish, costa prominent, excurrent, margin entire, 4-5 mm long, 0.7-0.8 mm wide, leaf tip cells thickly arranged, hexagonal, papillose, 8-11 µm; leaf middle cells thickly arranged, hexagonal, papillose; leaf basal cells elongated quadrangular cells, smooth, 41-70 x 14 µm; cells at the costal region are large elongated cells, smooth; cells at the margin are small elongated, not papillose (Fig. 9 A-G; Fig. 13 C).

Habitat: On rocky patches.

Specimen examined: India, Kerala, Parambikulam Tiger Reserve (1400 m) *MCN 106726* (CALI); Kozhikode, Vilangad – Nadapuram (40 m) *MCN 99674* (CALI)..

Distribution: India (Tamil Nadu, Karnataka, Kerala), China, Central & Western Asia, all over Africa, rare in Europe, sothern part of North America, Bolivia, Chile, Columbia and Argentina.

Note: The present collections are new records for Kerala.

Key to the species of *Trichostomum*

1a. Costa excurrent, leaf margin slightly wavy, leaves crowded
T. wayanadense

1b. Costa percurrent, leaf margin smooth, leaves loosely arranged
T. crispulum

Trichostomum crispulum Bruch., Flora 12: 395. 4. 1829.

Plants yellowish green, seen in dense tufts, brown at the base, 1.2-1.5 cm long, pale yellowish, slightly rolled at the tip, lanceolate, midrib prominent, ends before the tip, margin entire, 1-2 mm long,

0.2-0.3 mm wide, leaf tip cells thickly arranged, polygonal, papillose 6-8 μm; leaf middle cells thickly packed, polygonal, papillose; leaf basal cells elongated, with large intercellular spaces, smooth, 24-26 x 11-13 μm; cells near costal-region elongated, with large intercellular spaces, smooth, hyaline, cells at marginal region elongated with intercellular spaces, not papillose (Fig. 10 A-I).

Trichostomum wayanadense Manju, Rajesh & Madhus. Bryo. Wayanad. W. Ghats. 119-2005.

Plants yellowish green, seen in dense tufts, 5-7 mm long; leaves crowded, narrow, lanceolate, margin slightly wavy; costa strong, slightly excurrent, 0.19-0.3 mm long, 0.47-0.59 mm wide; base of leaf achlorophyllous, cells at upper part irregularly rounded to hexagonal, papillose, chlorophyllose, up to 10-12 x 7-10 μm; middle cells are quadrate thickly packed, papillose; basal cells elongated, rectangular, smooth, 43-48 x 10-15 μm, leaf base slightly bulged; cells near costa broad and elongate, 62-68 x 20-25 μm; marginal cells elongate (Fig. 10 J-N; Fig. 13 E).

Habitat: On logs in moist deciduous forest.

Specimen examined: India, Kerala, Wayanad, Ponkuzhi (903 m) MCN 84373 (CALI).

Distribution: Endemic to Western Ghats.

Note: Nair *et al*. (2005) described this species from Wayanad district as new to science.

Tortula muralis Hedw., Sp. Musc. Frond. 123. 1801.

Plants yellowish green, small, stem erect, brownish, 3-5 cm long; leaf lanceolate, 2-3 mm long, 0.3-0.4 mm wide, light green coloured; costa prominent, yellowish brown, costa extended beyond the leaf tip, margin entire, margin yellowish brown; cells at the leaf tip are small, rounded, papillose, 6-8 μm, cells at the leaf middle are round, thickly arranged, papillose; leaf basal cells elongated, quadrate, smooth, 27-32 x 8-11 μm; cells at costal region large, elongate, smooth, hyaline; basal cells at marginal region small, elongated, smooth; sporophyte 1-1.6 cm long, seta long, 0.7-1.3 cm long, capsule brownish-red, 3-4 mm long; spore light brownish, double layered, rounded, 3-4 μm in diameter (Fig. 11 A-I; Fig. 13 D).

Habitat: On rocks.

Specimen examined: India, Kerala, Palakkad, Parambikulam (1400 m) *MCN 106722* (CALI).

Distribution: India, Kerala (Palakkad; Parambikulam Tiger Reserve), North-east India (Sikkim, Garhwal, Kulu), central Asia, Caucasus, Europe and North America.

Note: Manju & Rajesh (2011) reported this species as new record for Peninsular India.

Tortella tortuosa (Hedw.) Limpr., Laubm. Deutschl., 1: 604. 1888.

Plant yellowish green in colour, seen in dense tufts, stem erect, 6-8 mm long; leaves curved, laneolate, narrow, broad at base, light brown costa, prominent, excurrent, at the excurrent portion 9 cell are present, leaf margin crenulate at apex, leaf upto 5 mm long, 0.28-0.42 mm wide, leaf tip cells are rounded to quadrate, upto 8 μm, thickly packed, papillose cells; basal cells elongate, rectangular, 45-54 x 6-8 μm, thin walled, hyaline (Fig. 8 G-K).

Habitat: On tree trunk.

Specimen examined: Trivandrum, Chemunji (814 m) *Stephen Sequria 106316 a* (CALI).

Distribution : India (Kerala, Tami Nadu, Kashmir, Uttarakhand), East Nepal, China, Japan, North America, Europe, Caucasus, Algeria, Morocco, Iran.

Indopottia zanderi A.E.D. Daniels, R.D.A. Raja & P. Daniel, J. Bryol. (2010) 32: 216-219.

Plants forming mats, not glossy, golden brown to brown. Stems decumbent, simple, rarely branched, 5–15 mm long, with scale leaves and rhizoids in lower side. Leaves dense, without much change when dry, obovate or lingulate, 1–2 x 0.3–0.5 mm, characteristically folded at apex; margins plane without border, flat, entire, often undulate, irregularly toothed at apex; costa ending a little below apex. Laminal cells weakly convex on both surfaces, epapillate, irregularly rounded-quadrate above, 8–16 x 6–12 mm, irregularly elongate-rectangular below, 48–92 x 8–32 mm; Sexual condition autoicous. Perigonia terminal, bud-like. Perichaetia terminal, similar to vegetative leaves, 2.5–3.0 x 0.5–0.8 mm. Sporophytes terminal, in pairs, rarely single. Setae short, 0.3–0.7 mm long. Capsules mostly declinate, dark brown; theca 0.8–1.2 x 0.3– 0.5 mm, ovoid, operculum long-rostrate, 0.9–1.1 mm long, peristome absent, spores globose, 30–36 mm, papillose, dark orange-brown.

Habitat: Lignicolous, in association with *Syrrhopodon spiculosus* Hook. & Grev. and corticolous, in moist evergreen forests, 980–1070 m.
Distribution: W. Ghats, Kerala, Silent Valley National Park.
Note: Description based on the original author.

Discussion

Pottiaceae is an acrocarpic moss family widely distributed in almost all the microhabitats and ranges from low to high altitude areas. They are well adapted to varying climatic conditions. Within the eight bryogeographical zones of the country the Pottiaceae is the most abundant family. In Western Ghats the dominant genera are *Anoectangium, Barbula* and *Hyophila*. The central Indian region is dominated by genera like *Weissia*, *Barbula*, *Hyophila* and *Anoectangium,* about 22 species of Pottiaceae have been reported to occur from the various localities there (Chaudhary et al. 2006, Chaudhary and Sharma 2007, Nath and Gupta 2007, 2008, Aziz and Vohra 2008, Nath and Bansal 2009). Among the different taxa the most widely distributed species are *Barbula indica*, *Hyophila nymaniana* and *Hyophila involuta,* which are found in all the bryogeographical zones of India. The frequency of occurrence of Pottiaceae members are wider than other acrocarpic moss families such as Fissidentaceae, Bryaceae and Dicranaceae. The genus *Hyophila* Brid. has emerged as the most frequent one among the 14 genera investigated during present study.

From Kerala 18 species of Pottiaceae members are described among 13 genera such as *Anoectangium aestivum, A. bicolor, Barbula tenuirostris, B. indica, Hyophila involuta, H. nymaniana, Hymenostylium recurvirostrum, Hymenostomum edentulum, Indopottia zanderii, Oxystegus cylindricus, Pottia bryoides, Syntrichia fragilis, Scopelophila cataractae, S. ligulata, T. muralis, Tortella tortuosa, Trichostomum wayanadense* and *T. crispulum.* Among these one species *viz., Pottia bryoides* is a new record for India. *Scopelophila cataractae* and *Scopelophila ligulata* are widely known as "copper moss" in Northern Indian region, but *S. ligulata* is not recorded from Peninsular India. This report forms a new record of occurrence to Peninsular India. Two species *viz; Barbula tenuirostris* Brid. and *Syntrichia fragilis* (Tayl.) Ochyra. are new records for Kerala and *Indopottia zanderii* which is described here based on the original description is an endemic to genus to Western Ghats.

Acknowledgements

The authors are grateful to the Kerala State Council for Science Technology & Environment (KSCSTE), Thiruvananthapuram for financial assistance. We are thankful to the staff members of the Kerala Forest Department for extending support during our field study. The authors sincerely acknowledge the support provided by the authorities of the Zamorin's Guruvayurappan College, Calicut and Malabar Botanical Garden, Olavanna, Calicut.

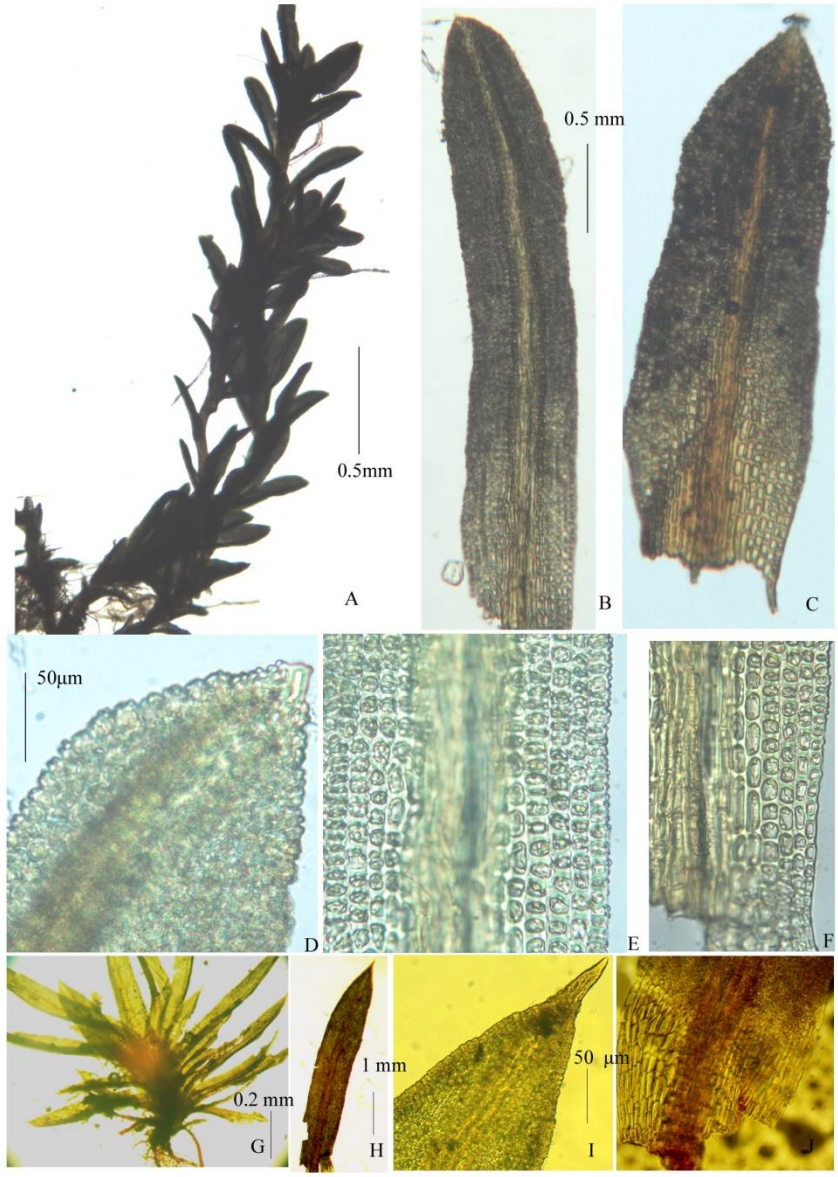

Fig. 1 A-F. Anoectangium aestivum A. Dry habit, B&C. Leaf, D. Leaf tip cells, E. Leaf middle cells, F. Leaf basal cells ; G-J. Anoectangium bicolor, G. Habit, H. Leaf, I. Leaf tip, J. Leaf base (B&C, D&F, I&J same size)

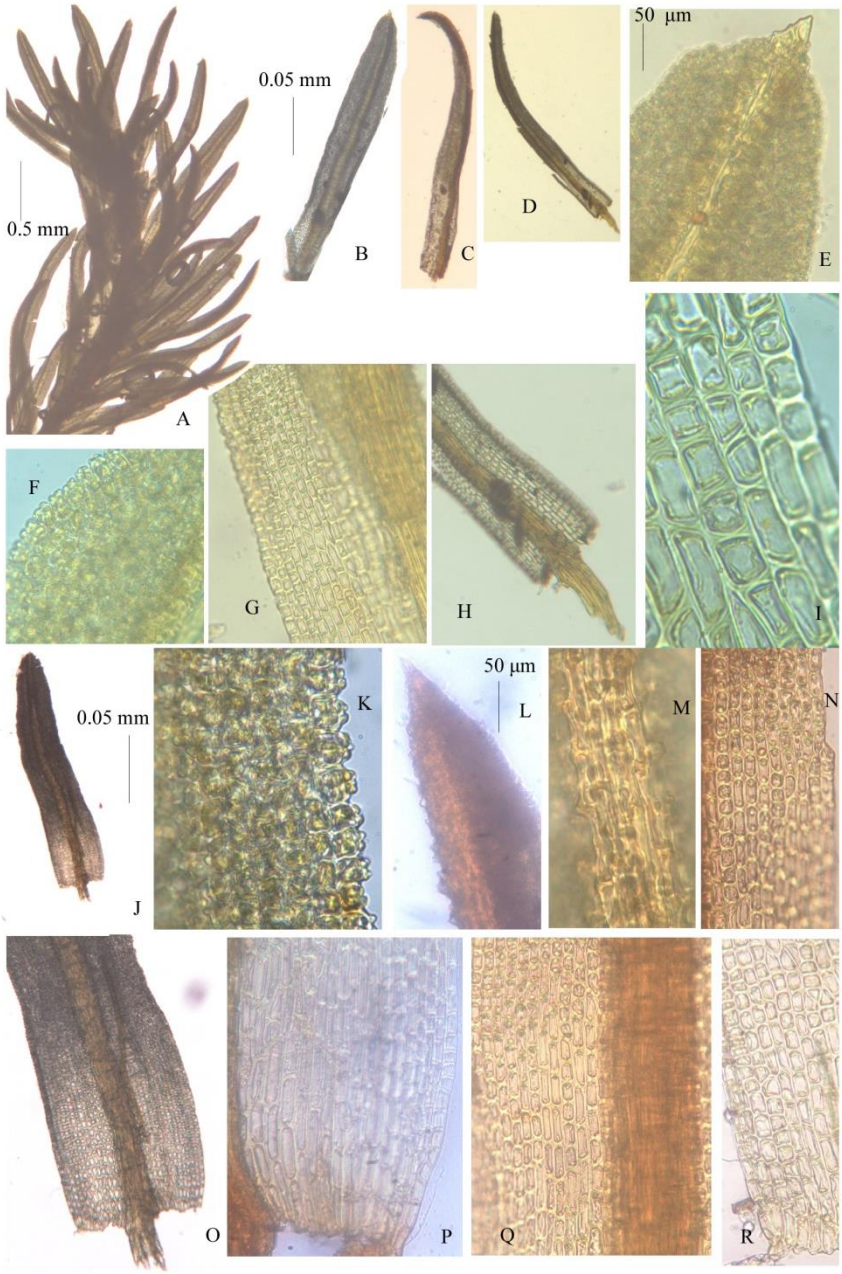

Fig. 2 A-I. Barbula indica, A. Habit, B-D. Leaf, E. Leaf tip, F. Leaf tip marginal cells, G. Leaf middle cells, H. Leaf base, I. Leaf basal cells; J-R. Barbula tenuirostris, J. Leaf, K. Leaf tip marginal cells, L. Leaf tip, M. Costa, N. Middle marginal cells, O. Leaf base, P-R. Basal cells (B-D, E-I, K-R same size)

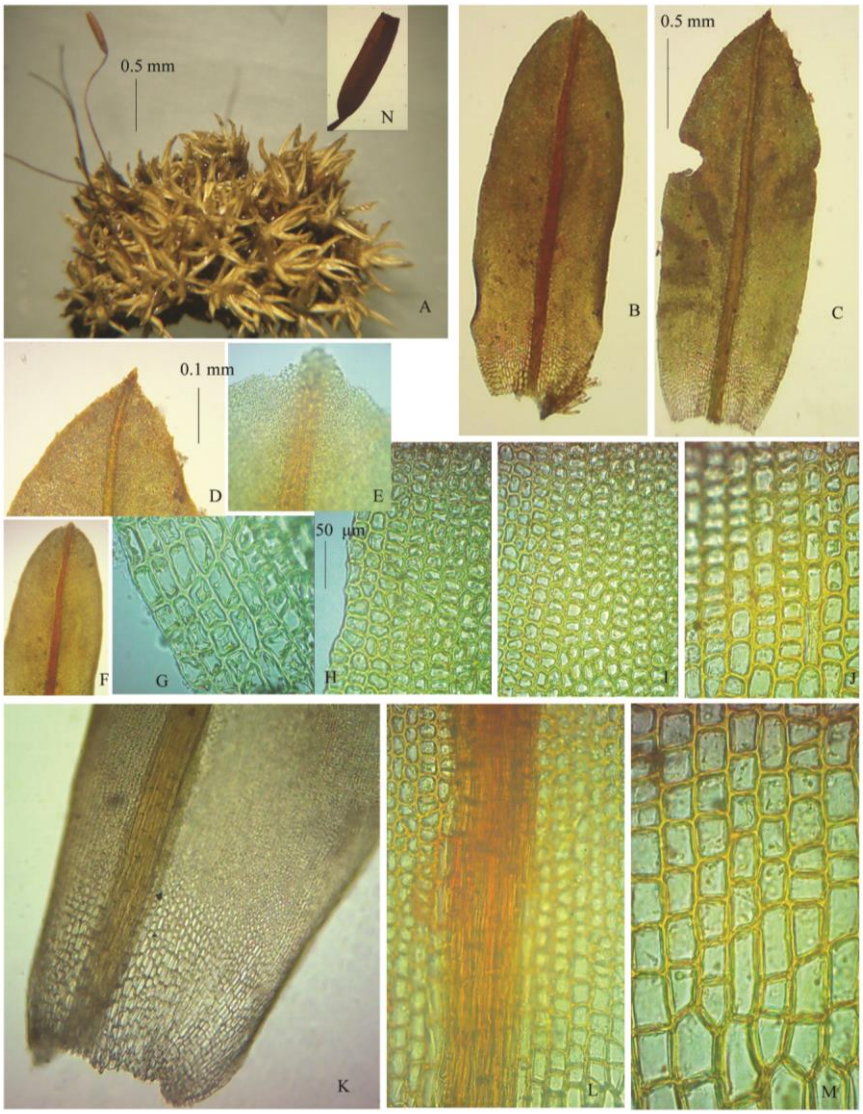

Fig. 3 A-N. Hyophila involuta, A. Dry habit, B&C Leaf, D-F. Leaf tip, G&H. Marginal cells, I. Leaf tip cells, J. Above basal cells, K. Basal region, L. Cells near costa, M. Basal cells, N. Capsule (B-C, D-F, G-M same size)

Fig. 4. A-J. Hyophila nymaniana, A7B. Leaf, C. Leaf tip, D. Leaf base, E&F. Leaf tip cells, G. Middle marginal cells, H-J. Basal marginal cells (A-D & E-J same size)

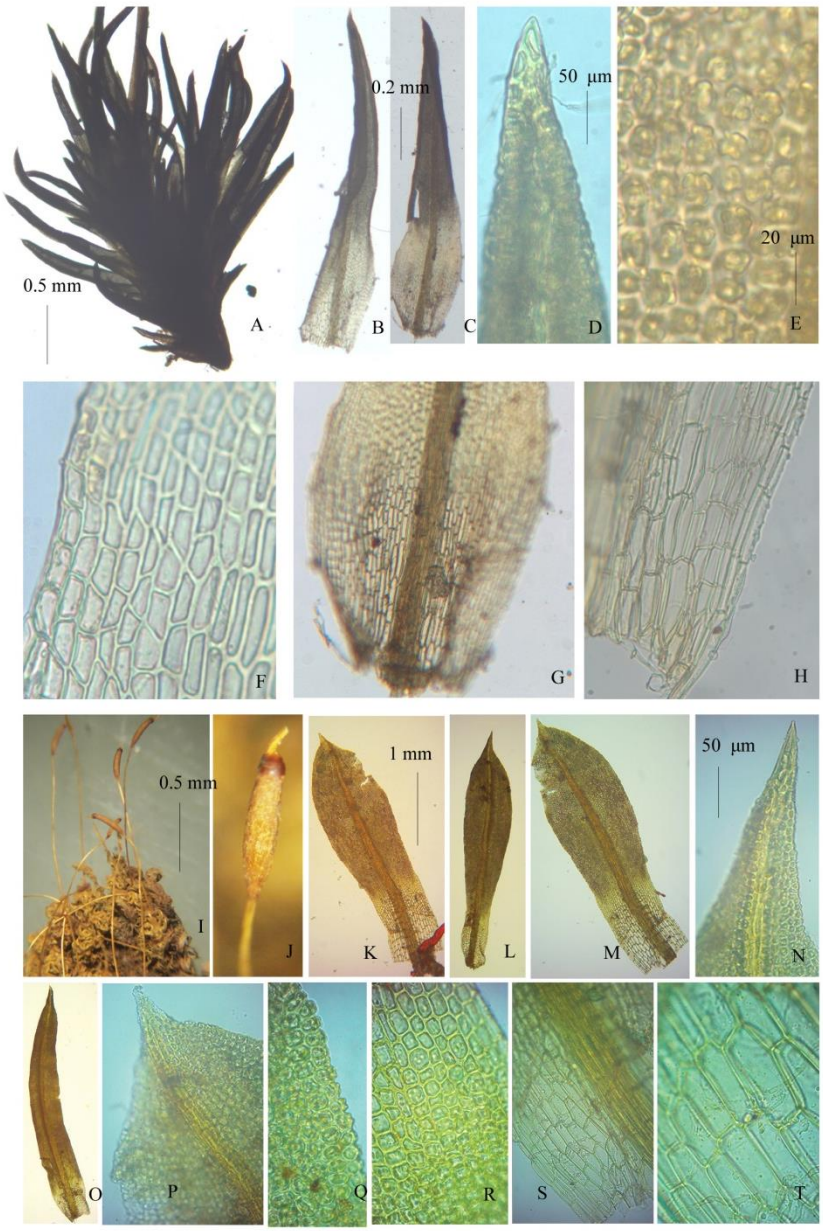

Fig. 5 A-H. Hymenostylium recurvirostre, A. Habit, B&C. Leaves, D. Leaf tip, E. Leaf tip cells, F. Leaf basal marginal cells, G. Basal leaf portion, H. Leaf basal cells; I-T. Oxystegus cylindricus, I. Habit, J. Capsule, K-M,O. Leaves, N,P. Leaf tip, Q. Leaf margin at tip, R. Middle leaf cells, S&T. Basal cells (B-D, E-H,K-M&O, N,P-T same size)

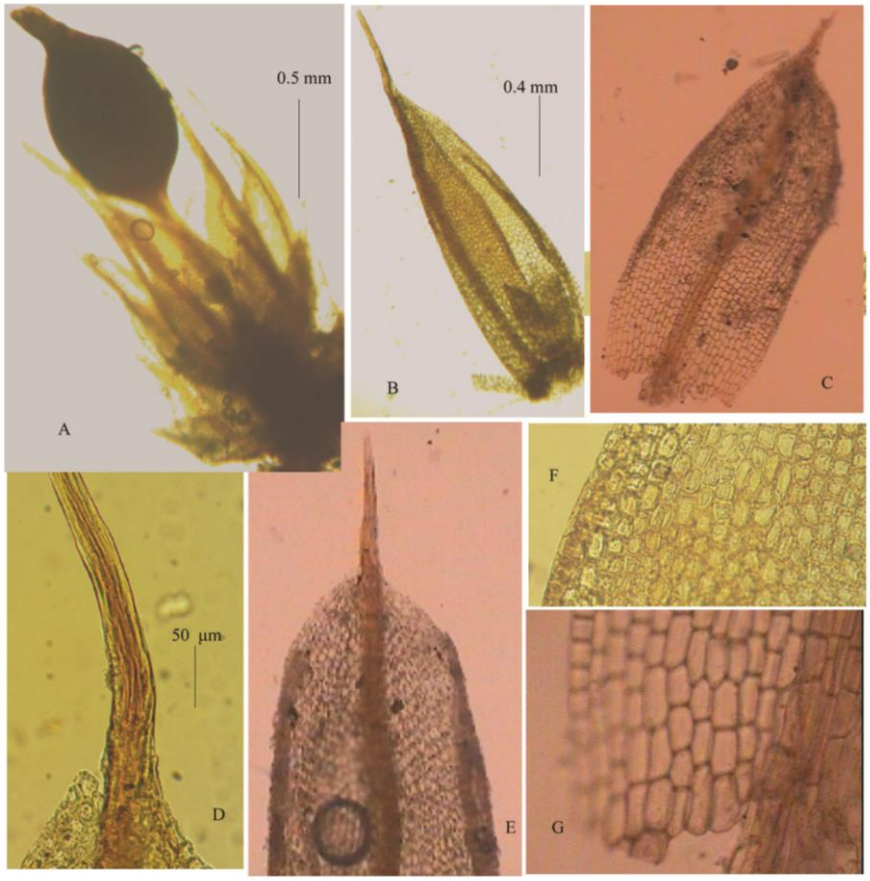

Fig. 6 A-G. Pottia bryoides, A. Habit with capsule, B&C. Leaves, D. Excurrent costa, E. Leaf tip, F. Marginal cells, G. Basal cells (D-G same size)

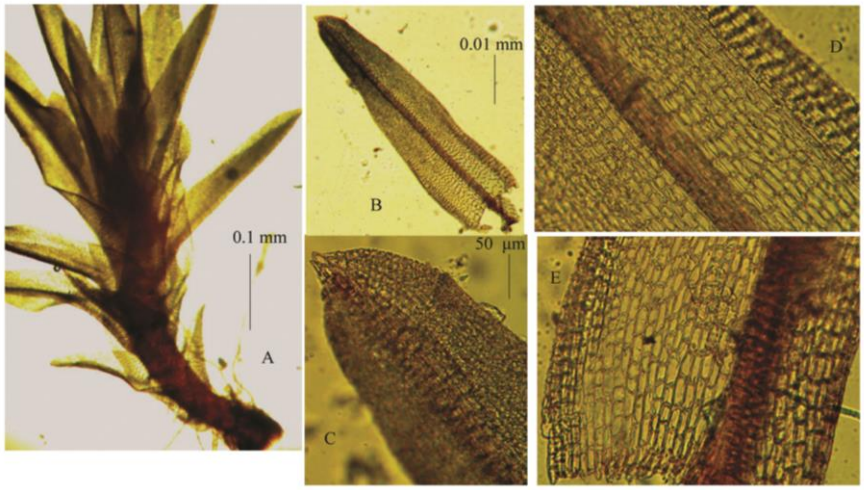

Fig. 7. A-E. Semibarbula orientalis, A-Habit, B. Leaf, C. Leaf tip cells, D. Leaf middle cells, E. Leaf basal cells (C-E same size).

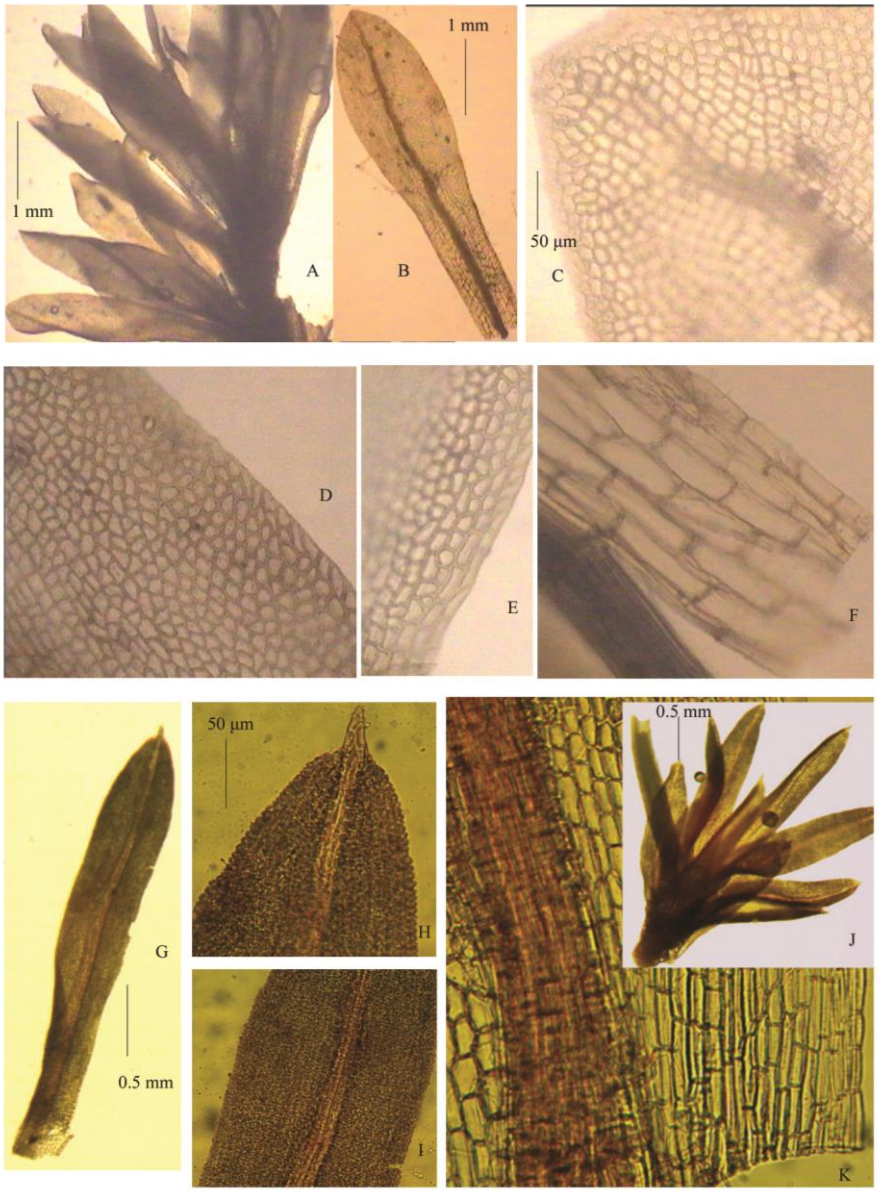

Fig. 8. A-F. Scopelophila ligulata, A. Habit, B. Leaf, C. Leaf tip, D. Leaf marginal cells at tip, E. Leaf margin above base, F. Leaf basal cells; G-K. Tortella tortuosa, G. Leaf, H. Leaf tip, I. Leaf middle cells, J. Habit, K. Leaf basal cells (C-F, H-I, K same size).

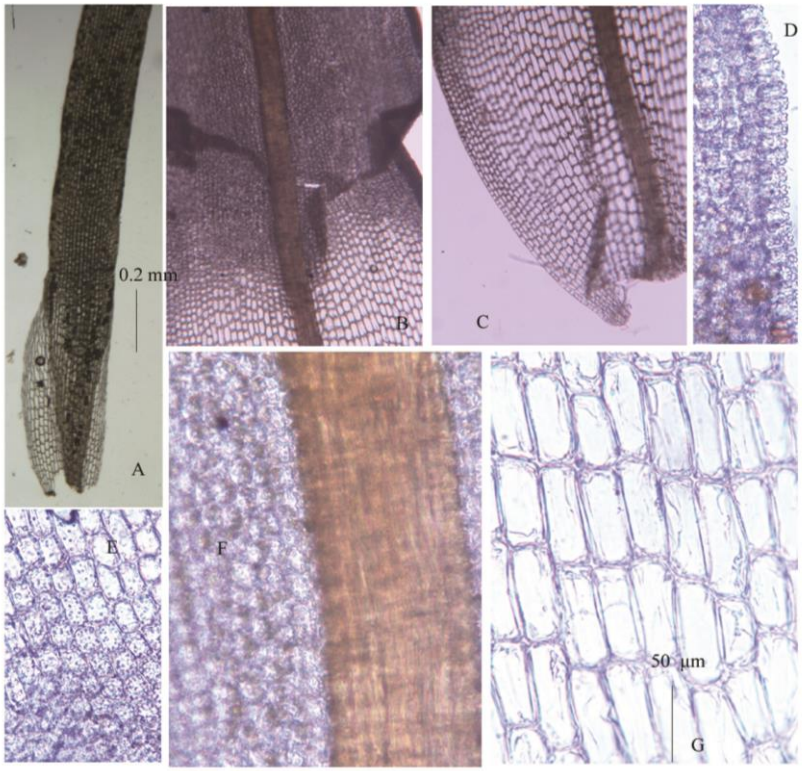

Fig. 9. A-G. Syntrichia fragilis, A. Leaf base, B. Leaf middle portion, C. Leaf base cells enlarged, D. Leaf tip marginal cells, E. Leaf cells at middle, F. Cells near costa, G. Basal cells (A-C, D-G same size)

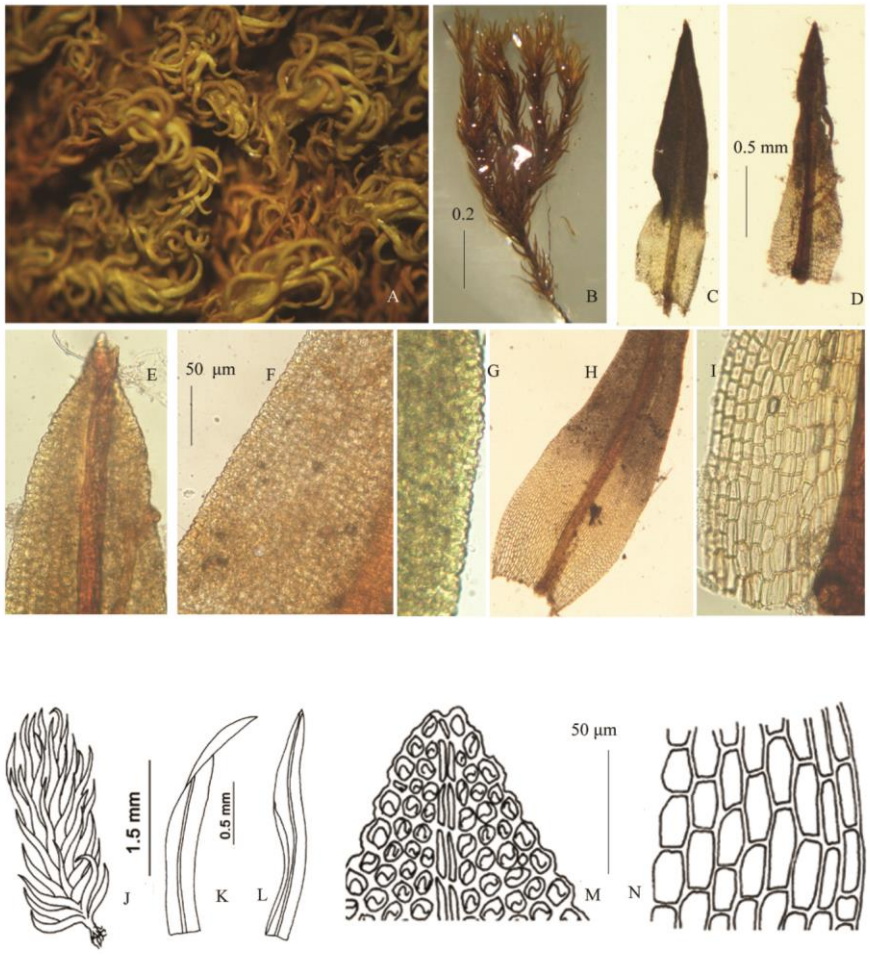

Fig. 10. A-I. Trichostomum crispulum, A. Dry habit, B. Wet habit, C&D. Leaves, E. Leaf tip, F. Leaf marginal cells, G. Leaf margin enlarged, H. Leaf base, I. Leaf basal cells enlarged; J-N. Trichostomum wayanadense, J. Habit, K&L. Leaves, M. Leaf tip, N. Leaf basal cells (A-B, C-D, E-I, M&N same size)

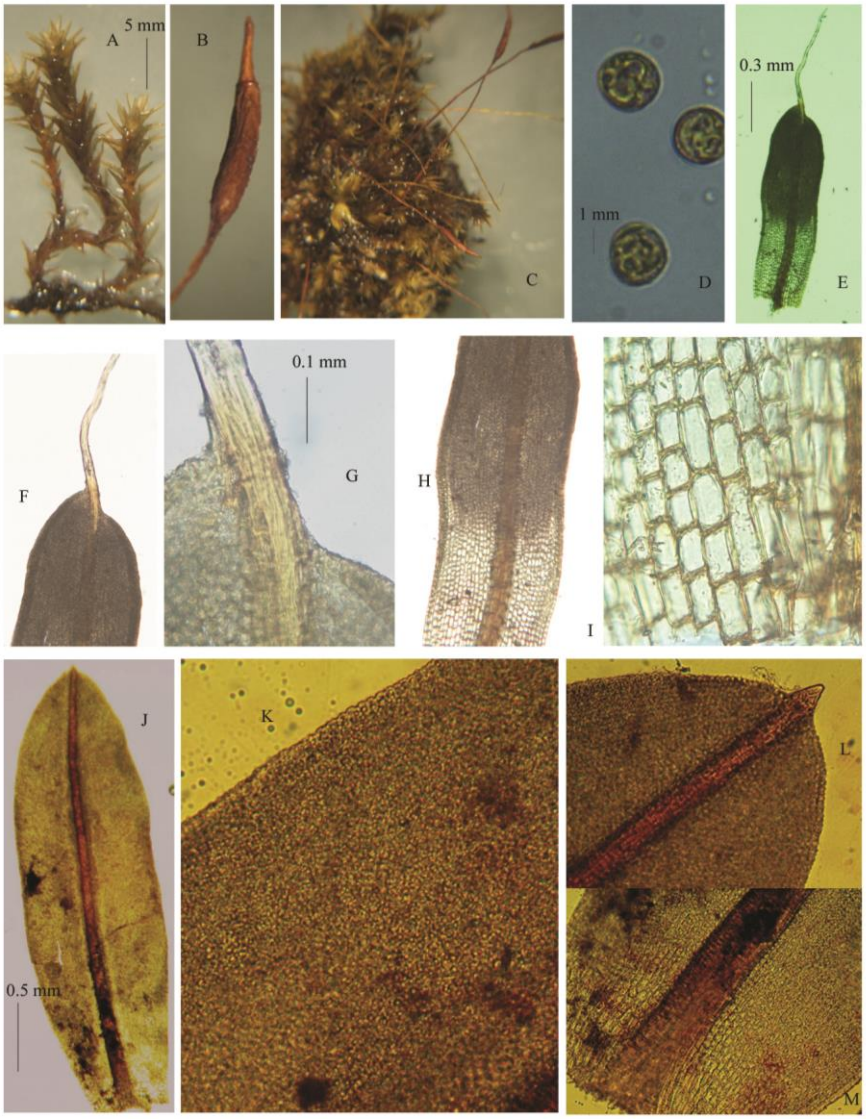

Fig. 11. A-I. Tortula muralis, A. Habit, B. Capsule, C. Dry habit, D. Spores, E. Leaf, F. Leaf tip with long costa, G. Leaf tip cells, H. Leaf base, I. Leaf basal cells; J-M. Tortula schmidtii, J. Leaf, K. Marginal cells, L. Leaf tip cells, M. Leaf basal cells (A-C, E-F, G-I,J-M same size)

Fig. 12. A. Barbula indica, B. Barbula indica habit with sporophyte, C. Hymenostomum edentulum, D. Hyophila involuta, E. Capsule enlarged, F. Hyophila nymaniana, G. Oxystegus cylindricus, H. Pottia bryoides

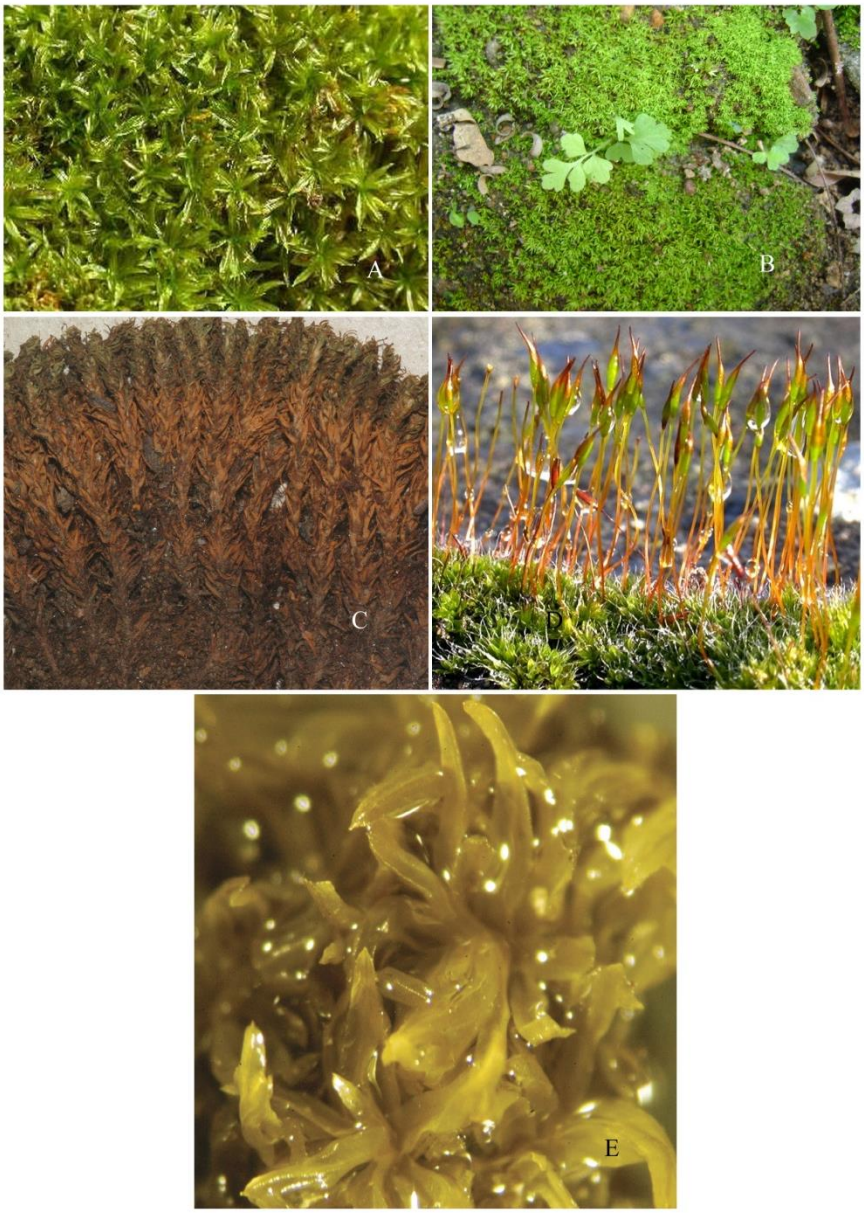

Fig. 13. A. Scopelophila cataractae, B. Semibarbula orientalis, C. Syntrichia fragilis, D. Tortula muralis, E. Trichostomum wayanadense

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CONTRIBUTION TO THE BRYOPHYTE FLORA OF INDIA: SILENT VALLEY NATIONAL PARK IN THE WESTERN GHATS, INDIA

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Key words: Bryophytes, Silent Valley National Park, Kerala, India, Western Ghats.

Abstract: The bryophyte flora of the Silent Valley National Park is catalogued. The catalogue consists of 148 taxa (109 mosses, 36 liverworts, 3 hornworts), of which nine species *viz*., *Chrysocladium flammeum* (Mitt.) M.Fleisch., *Gymnostomum calcareum* Nees & Hornsch., *Glossadelphus bilobatus* (Dix.) Broth., *Hypnum flaccens* Besch., *Notoscyphus paroicus* Schiffn., *Macromitrium turgidum Dix.*, *Calyptothecium pinnatum* Nog., *Brotherella amblystegia* (Mitt.) Broth. and *Wijkia deflexifolia* (Ren. & Card.) Crum. are newly reported for Peninsular India. Another four species *viz*., *Lejeunea cavifolia* (Ehrh.) Lindb., *Radula obscura* Mitt., *Radula meyeri* Steph. and *Barbella turgida* Nog. are new record of occurrence for Kerala State. *Trichostelium stigmosum (Manju et al., 2012) and Aerobryopsis wallichii* (Brid.) Fleisch. (Prajitha et al., in press), has been reported as new records for India from Silent Valley.

Introduction

The Silent Valley National Park, also known as *Sairandhri Vanam,* located in the Nilgiri Hills of Palakkad District in Kerala state, is one of the

most popular protected areas in India. It raised as a legend of conservation and environmental protection movement in India and elsewhere. It forms the part of the Nilgiri Sub-Cluster of Western Ghats World Heritage Site designated by UNESCO. The National Park spreads over an area of 91 km^2 forms the major part of the Nilgiri International Biosphere Reserve.

The area in this National park was historically explored in 1847 by the botanist Robert Wight. The Park is one of the last undisturbed tracts of the South Western Ghats montane rain forests and tropical moist evergreen forest in India. Contiguous with the proposed Karimpuzha National Park (225 km²) to the north and Mukurthi National Park (78.46 km²) to the north-east, it is the core of the Nilgiri Biosphere Reserve.

It rises abruptly to the Nilgiri Plateau in the north and overlooks the plains of Mannarkkad in the South forming the core area of Nilgiri Biosphere Reserve. Silent Valley perhaps, is one among the most magnificent gifts of nature to mankind. The mean annual temperature is 20.2°C. The hottest months are April and May when the mean temperature is 23 °C and the coolest months are January and February when the mean temperature is 18^{o} C.

The great diversity in ecological factors and high range of altitudinal variation have been responsible for the very rich and diverse vegetation of the area. It belongs to the Indo-Malayan eco-region (Olson *et al.,* 2001) and the major vegetation types include North Western Ghats montane rain forests (IM0135) (Tropical wet evergreen forests), North Western Ghats moist deciduous forests (IM0134) (Tropical Moist deciduous forests (300-800 m)), South Western Ghats montane rain forests (IM0151) (Subtropical montane forest (1400-1868) and grass lands. These grass lands of the higher altitudes are seen over the crest of the Silent Valley National Park and at the Poochipara area. The soil is very shallow and vegetation comes after the monsoon. There is a clear demarcation of vegetation types based on the altitudinal range.

Manoharan (1999) edited a book on the Silent Valley Whispers of Reason, which contains 38 articles on various aspects of Silent Valley such as on the historical and managerial evolution of Silent Valley National Park as well as on its biodiversity. The first major attempt to document the bryophyte diversity of the area has been made by Vohra *et al.* (1982). Later some other authors such as Asthana and Srivastava (1986), Srivastava & Sharma (2000) reported the occurrence of some more species. Daniels *et al.* (2010) reported a new endemic genus, *Indopottia* with

the species *I. zanderii*. Manju *et al.* (2012) reported the occurrence of *Trichostelium stigmosum* from Silent Valley as a new record for India. However, a comprehensive account on the bryophyte diversity of this area is still lacking, which is attempted here. This paper tries to present a detailed account on the bryophyte diversity, mainly based on the recent collections, and also incorporating earlier accounts. Some of the taxa reported earlier such as by Vohra *et al.* (1982) were now sunk into the synonymy, and which are mentioned under respective species.

Enumeration of species

The specimens were collected by Manju C.N. (MCN), Rajilesh, V.K. (RVK), Anoop, K.P. (AKP) and Hareesh (HA) between 2001-2011 and were identified and confirmed by Manju C.N. (first author), L.T. Ellis of Britisch Natural History Museum (BM) during 2001-2012. The specimens are deposited in the Calicut University Herbarium (CALI) and the Malabar Botanical Garden (MBG). Each species is listed with author citation followed by the observations on the substrate/s on which it was found growing in the study area, the locality, altitude, the collector's name, collection number, and with comments on the distribution of species; (species not found in Tropicos is given the sign !),. Microphotographs of new records of species were provided.

List of Species

Marchantiophyta
Aytoniaceae

Asterella leptophylla (Mont.) Pande,- This is an Indian endemic species. (Based on Srivastava and Sharma, 2000).

Marchantiaceae

Dumortiera hirsuta (Sw.) Nees- On rocky patch near streams were water drips regularly. Silent Valley National Park (1500 m), RVK & *al.* 5026, 5525, 5526 *(MBG).* This is widely distributed in the high altitude areas of the Western Ghats. It has wide distribution in Southern India (Tamil Nadu, Kerala, Karnataka), Northern India (Simla, Mussoorie, Kumaon, Pachmahri), Nepal, Japan, Brazil, Mexico, Jamaica, North &

South America, Europe, New Zealand, Hawaii and Africa. (Srivastava and Sharma, 2000 also collected this species).

Targioniaceae

Cyathodium cavernarum Kunze- On moist soil, rocks and on concrete walls. Silent Valley National Park (1000 m), RVK & al. 5480 (MBG). This is a widely distributed species from low to high altitude areas. (Srivastava and Sharma, 2000 also reported this species)

Targionia hypophylla L.- On rocky patch. Silent Valley National Park (1600 m), RVK & al. 5406 (MBG). Distributed in India (Kerala, Tamil Nadu) China, Australia, Europe, Ireland, Madagscar, Mexico, New Zealand, South Africa and South America. (Srivastava and Sharma, 2000 also reported this species).

Targionia indica Udar & Gupta,- On rocky patch and crevices of rocks. This is an Indian endemic species. (Based on Srivastava and Sharma, 2000).

Pallaviciniaceae

Pallavicinia indica Schiffn.- On land cuttings and on soil covered rocks; Silent Valley National Park (1500 m), *RVK & al.* 5532 *(MBG). It* is distributed in India (Eastern Himalayas, Meghalaya, Khasi hills, Kerala), Nepal, Java, Sumatra and Tahiti. Manju and Rajesh (2011) reported this species from Parambikulam Tiger Reserve as new record of occurrence to the Peninsular India.

Pallavicinia lyellii Schiffin., on base of tree trunks and on rhizome of ferns near stream. Silent Valley National Park (1200-1500m), *RVK & al.* 5529, 5528, 5339*,* 5398a (MBG). It is distributed in Southern India (Kerala, Karnataka), North-east India (Assam, Gauhati, Shillong, Pachmahri), Sri Lanka, Europe, Jamaica, Cuba, Brazil, Java, Singapore, Philippines, Japan (Ryukyu), Moluccas, New Zealand, Africa and America.

Fossombroniaceae

Fossombronia cristula Austin- On land cuttings, and on moist rocks near stream. Silent Valley National Park (1600 m). RVK & al. 5402 (MBG). It is distributed in India (Kerala), Japan and America. (Srivastava and Sharma, 2000 also reported this species).

Fossombronia indica Steph.- On moist soil in association with other bryophytes. This is an Indian endemic species. (based on Srivastava and Sharma, 2000)

Calypogiaceae

Calypogia khasiana Singh et Nath, On bark, Siruvani (1200 m) *RVK & al.* 5527, 5370b (MBG). It is distributed in India (Eastern Himalaya, Meghalaya, Kerala).

Geocalycaceae

Heteroscyphus argutus (Nees) Schiffn.- On land cuttings and on roots of higher plants near streams. Silent Valley National Park (1200 – 2000 m) *RVK & al.* 5390*b,* 5533b, 5359a, 5349, 5503, 5345 *(MBG)*. A widely distributed species in India in the high altitude areas of Kerala, Tamil Nadu & Karnataka and North-eastern India (Darjeeling, West Himalaya, Pachmahri, Assam, Sikkim, Manipur, Meghalaya). distribution extends to Borneo, Brazil, Myanmar, China, Java, Japan, New Guinea, New Zealand, Philippines, Sumatra and Taiwan.

Lophocolea minor Nees- On land cuttings where water drips regularly, Silent valley tower area (1200 – 2000 m) *RVK & al.* 5350 (MBG). Distributed in India (Eastern Himalayas, Meghalaya, East khasi Hills, Mawphlong forest), Europe, America, Asia, China, Nepal, Japan, Siberia and Korea.

Aneuraceae

Riccardia tenuicostata Schiffn.- On moist rocks. Silent Valley National Park (1200 – 1500m) *RVK & al.* 5533a, 5353 *(MBG). Widely* distributed species in Kerala, Tamil Nadu, Darjeeling, Eastern Himalaya and Western Himalayas in India and distribution extends to Singapore and Java.

Riccardia levieri Schiffn.- On moist soil and on rocks. Silent Valley National Park (1500 m) RVK & al. 5404 (MBG). Distributed in India (Kerala, Tamil Nadu, Western and Eastern Himalayas), Bhutan. (Srivastava and Sharma, 2000 also reported this species)**.**

Riccardia multifida (L.) Gray.- On rocky patch and on land cuttings near stream. Distributed in India (Kerala, Tamil Nadu, Western and Eastern Himalayas), Sri Lanka, Japan, Taiwan, Australia, Ireland, Scotland and Netherlands. (based on Srivastava and Sharma, 2000)**.**

Cephaloziellaceae

Cephaloziella kiaerii (Austin) Arnell.- On moist soil along with other liverworts. Silent Valley National Park (1500m) *RVK & al.* 5401 *(MBG). Distributed in India (Kerala, Tamil Nadu, Western Himalayas), Sri Lanka, China, Java, Malaysia, New Caledonia, Taiwan and Africa.* (Srivastava and Sharma (2000) also reported this species).

Plagiochilaceae

Plagiochila devexa Steph., On tree trunk, Silent Valley (1200-2000m) *RVK & al.* 5341 (MBG). It is distributed in North-eastern India (Sikkim, Himalaya), South India (Kerala), China, Bhutan, Nepal and Sri Lanka.

Jungermanniaceae

Notoscyphus paroicus Schiffn.- On rocks, Silent Valley (1200-2000 m) *RVK & al.* 5381, 5390a, 5392 (MBG). It is distributed in India (Eastern Himalaya, Meghalaya), Java, Japan, Vietnam, Luzon, Sumatra and Banca. The present collection is a new record for the Peninsular India (Plate 3 H-Q).

Jungermannia tetragona Lindenb.- On moist soil and on land cuttings. A widely distributed species in high altitude areas. (based on Srivastava and Sharma, 2000).

Jungermannia truncata Nees, Terrestrial on moist soil. Distributed in India, Borneo, Myanmar, Sri Lanka, China, Taiwan, Java, Korea, Malaysia, New Guinea, Philippines, Indonesia and Thailand. (based on Srivastava and Sharma, 2000).

Jubulaceae

Frullania acutiloba Mitt.- On bark. It is distributed in India and Sri Lanka. (based on Srivastava **and Sharma, 2000).**

Frullania tamarisci (L.) Dumort. subsp. *obscura* (Verd.) S.Hatt., On bark. Silent Valley (1450 m) *MCN 70080 (CALI).* It is a widely distributed species in Southern India (Kerala, Tamil Nadu), Northern India (Himalaya), Sri Lanka, Malaysia, China, Taiwan, Korea, Japan and Europe.

Lejeuneaceae

Archilejeunea apiculifolia *Steph., Epiphytic. Endemic to India. (based on Srivastava and Sharma, 2000).*

Dicranolejeunea gilva Steph., Epiphytic. Distributed in India and Nepal (based on Srivastava and Sharma, 2000).

Lejeunea cavifolia (Ehrh.) Lindb., Grows on soil covered rock, Silent Valley (1200–2000 m) *RVK & al.* 5359b (MBG). It is distributed in India (Tamil Nadu, Uttar Pradesh, Sikkim Himalaya, Assam-Shillong), Nepal, China, Siberia, Caucasus, Europe and United States. The present collection is a new record for Kerala State (Plate 4. A-E).

Lejeunea flava (Sw.) Nees- Epiphytic and also terrestrial, Silent Valley (1200–2000m), *RVK & al.* 5399b (MBG). It is distributed in India (Eastern Himalayas, Meghalaya, Kerala), China, Taiwan, Philippines, Thailand, Nepal and Sri Lanka. Widespread Pantropical species. *Srivastava and Sharma (2000) also reported this species.*

Lopholejeunea abortiva (Mitt.) Steph., Epiphytic. *(based on Srivastava and Sharma, 2000).*

Lopholejeunea javanica (Nees) Schiffn.- On rocky soil and boulders. This species is distributed in India, java, Japan and Philippines. *(based on Srivastava and Sharma, 2000).*

Lopholejeunea sikkimensis Steph.- *Epiphytic. Distributed in India and Nepal. (based on Srivastava and Sharma, 2000).*

Lopholejeunea subfusca (Nees) Steph.- Epiphytic, Silent Valley (1200–2000 m), RVK & al. 5375b (MBG). Widely distributed species. Srivastava and Sharma (2000) also reported this species.

Microlejeunea ulicina A.Evans, Epiphytic. Distributed in India, Japan and North America. (based on Srivastava and Sharma, 2000).

!*Taxilejeunea indica A. Agarwal,* Epiphytic. Indian endemic species (based on Srivastava and Sharma, 2000).

Radulaceae

Radula obscura Mitt.- on bark of trees, Silent Valley (1200–2000m), *RVK & al.* 5399a (MBG). It is distributed in India (Eastern Himalayas, Meghalaya), China, Taiwan, Philippines, Thailand, Nepal and Sri Lanka. The present collection is a new record for Kerala (Plate 4. F-H).

Radula meyeri Steph.- On rocky patch, Silent Valley (1200–2000 m), *RVK & al.* 5375 (MBG). It is distributed in India (Eastern Himalayas,

Meghalaya), China, Taiwan, Philippines, Thailand, Nepal and Sri Lanka. The present collection is a new record for Kerala (Plate 4. I-K).

Radula kurzii Steph.- On rocky patch. (based on Srivastava & Sharma, 2000).

Radula pandei Udar & Kumar, On rocky patch and on bark. (based on Srivastava & Sharma, 2000).

Anthocerotophyta

Anthocerotaceae

Anthoceros crispulus (Mont.) Douin,- On land cuttings near stream. Silent Valley National Park (1500-1600 m) RVK. & al. 5407 (MBG). Distributed in India (Kerala, Tamil Nadu, Western & Eastern Himalayas), Sri Lanka, Japan, Korea, Malaysia, Europe and United States of America. (Srivastava and Sharma, 2000 also collected this species).

Folioceros udarii Asthana & Srivastava,- Terrestrial. This is an Indian endemic species. (Based on Asthana and Srivastava, 1986; and Srivastava and Sharma, 2000).

Phaeoceros laevis (L.) Prosk. subsp. laevis Prosk.- Terrestrial. Distributed in India (Kerala, Tamil Nadu, Western Himalayas) North America and Britian. (Based on Srivastava and Sharma, 2000).

Bryophyta

Polytrichaceae

Atrichum pallidum Renauld & Cardot- On land cuttings. Silent Valley National Park (1300-1600 m) RVK & al. 5409 (MBG). This species is distributed in India (Kerala, Darjeeling, Khasia, Western Hiamalaya), Nepal and Tibet. Vohra *et al.* 1982 reported this species as *Atrichum aculeatum* (Card. & Vard.) Broth.

Pogonatum microstomum (Schwaegr.) Brid.- On land cuttings. Silent Valley (1200-1500 m), *RVK & al.* 5334a (MBG). This species has wide distribution in the Western Ghats. It is a South-east Asiatic species reported from Southern India (Kerala, Tamil Nadu, Karnataka), North-eastern India (Darjeeling, Western Himalaya, Meghalaya, Sikkim), Sri Lanka, Bhutan, Taiwan, Nepal, Philippines, Setchwan, Vietnam and Yunnan. (Vohra *et al. 1982* also reported this species).

Pogonatum hexagonum Mitt.= *P. patulum* (Harv.) Mitt.- On earth bank. (based on Vohra, et. al., 1982).

Diphysciaceae

Diphyscium involutum Mitt., on rocky patch, Silent Valley (1300-1500m), *RVK & al.* 5330 (MBG). It is distributed in India (Khasia Hills, Palni Hills) Sri Lanka and the Philippines.

Dicranaceae

Campylopus flexuosus (Hedw.) Brid.- On rocks and soil, Silent Valley (1250 m), *RVK & al.* 5334, 5342 (MBG). This is a cosmopolitan species mostly occurring in high altitude areas. It has been reported earlier from Southern India (Kerala; Eravikulam National Park), North India (Western Himalaya), China, East Nepal, Algeria, Abyssinia, Madagascar, New Zealand, Oceania and Siberia.

Campylopus involutus (C.Mueller) A.Jaeger. On rocky patches. Silent Valley (1200m), *RVK & al.* 5517a, (MBG). An Indo-Malesian species distributed in North India (Darjeeling), Southern India (Tamil Nadu: Nilgiri hills; Kerala: present collection). Vohra *et al* (1982) reported this species as *Campylopus erythrognaphalus* (C.Mueller) A.Jaeger.

Campylopus schmidii (C.Mueller) A.Jaeger- on tree trunks. (based on Vohra *et al.* 1982).

Dicranella divaricata (Mitt.)A.Jaeger- on earth bank. (based on Vohra *et al.* 1982).

Leucoloma taylorii (Schwaegr.) Mitt., On bark, Silent Valley (1250m), *RVK & al.* 5517, 5346, 5341, 5358a, 5386, 5393, 5394, (MBG). It is a South–east Asiatic species distributed in India (Kerala), Nepal, Malaya and Myanmar.

Calymperaceae

Calymperes lonchophyllum Schwaegr.- Epiphytic. Silent Valley National Park (1300 m) RVK & al. (MBG). A widely distributed pantropical species (Vohra *et al.* 1982 also reported this species).

Calymperes tortelloides Broth. & Dix.- on tree trunks (based on Vohra *et al.* 1982).

Syrrhopodon gardneri (Hook.) Schwaegr., On bark, Silent Valley (1500 m), *RVK & al.* 5393a (MBG). Pantropical species. India (Northwestern Himalayas, West Bengal, Khasia hills), Sri Lanka, Bhutan, Bor-

neo, Indonesia, Nepal, Philippines, Sumatra and Vietnam. (Vohra *et al.* 1982 also reported this species).

Leucobryaceae

Leucobryum mittenii Besch.-On logs, Silent Valley (1200–1500 m), *RVK & al.* 5502, 5516, 5521 (MBG). It is distributed in India (Khasia Hills, Kerala) and Japan.

Leucobryum nilghiriense Müll. Hal.-On tree trunk, Silent Valley (1200–1500m), *RVK & al.* 5329 (MBG). It is distributed in India (Darjeeling, Tamil Nadu, Kerala), East Nepal, Bhutan, Khasia Hills, Sri Lanka, Myanmar, Thailand, Vietnam, Sumatra, Java, Borneo, Celebes, Philippines, China, Korea, Japan and Fiji.

Fissidentaceae

Fissidens asperisetus Sande-Lac.-On earth bank, Silent valley (1200-1500m) *RVK & al.* 5524 (MBG). It is distributed in South India (Tamil Nadu, Kerala), Andaman Island, Sri Lanka, Celebes, Java and Philippines. (Vohra *et al.* 1982 also reported this species).

Fissidens crispulus Brid.- On soil, rocks and bases of tree trunks, Silent valley (1200-1500 m) *RVK & al.* 5360,5372 (MBG). A widely distributed species in India (Noth–east, Kerala, Tamil Nadu), China, Malaysia, Madagascar and Cameron. Vohra *et al.* (1982) reported this species as *Fissidens sylvaticus* Griff.

Fissidens firmus Mitt.- on submerged rocks. *(based on* Vohra *et al.* 1982).

Fissidens virens Thwait. ex Mitt., On earth bank near stream, Silent Valley (1500 m) *RVK & al.* 5360 (MBG). Asiatic mainland species distributed in North-eastern India (Assam, West Bengal), South India (Kerala) Nepal and Vietnam. *(*Vohra *et al.* 1982 also reported this species).

Pottiaceae

Gymnostomum calcareum Nees & Hornsch., On rocks, Silent valley (1200 m); *RVK & al.* 5366 (MBG). It is distributed in India (Eastern Himalaya, Western Himalaya), Western Tibet, Europe, Caucasus, Siberia, Tajikistan, China, Japan, N.&S. Africa, Australia, New Zealand, N.&S. America and Oceania. The present collection is a new record for Peninsular India (Plate 1 G-L).

Hyophila involuta (Hook.) A. Jaeger, seen on wide variety of habitats such as on rocks, soil, bark, etc. Silent Valley (1200-1500m), *RVK & al.* 5343, 5366a (MBG). It is a widely distributed species. *(*Vohra *et al.* 1982 also reported this species).

Hyophila mollifolia Dix. & Vard.- on rocks. *(based on* Vohra *et al.* 1982).

Hyophila nymaniana (M.Fleisch.) Menzel, On rocky patch. Silent Valley (1500 m) *RVK & al.* 5375a. This is an Indo-Pacific species distributed in Peninsular India (Kerala, Tamil Nadu, Gujarat), North-east India (Western Himalaya, Orissa) and Philippines. Vohra *et al.* (1982) reported this species as *Hyophila comosa*.

Hymenostylium recurvirostre (Hedw.) Dixon, on rocks, Silent valley (1500 m), *RVK & al.* 5375 (MBG). it is distributed in South India (Kerala), north-east India (Western Himalaya, Kashmir, Kumaon, Khasi Hills, Kangra, Ladakh, Mussorrie, Sikkim), Afganistan, China, Japan, Korea, Myanmar, New Zealand, New Guinea, Philippines, Pakistan and Western Tibet.

Indopottia zanderi A.E.D. Daniels, R.D.A. Raja & P. Daniel- Lignicolous, in association with *Syrrhopodon spiculosus.* Endemic to Silent Valley National Park in Kerala (980–1070 m). *(based on Daniels et al., 2010).*

Pseudosymblepharis indica Dix. & Vard. = *P. bombayensis* (C.Mueller) P.Sollman, On tree trunks and rocks. *(based on* Vohra *et al.* 1982).

Barbula indica (Hook.) Spreng., Syst. Veg. 2: 72. 1824.
On rocks. (based on Vohra *et al.* 1982).

Funariaceae

Funaria hygrometrica Hedw., on rocks and on earth bank, Silent Valley (1600 m), *RVK & al.* 5344b (MBG). A cosmopolitan species. (Vohra *et al.* 1982, also reported this species).

Bryaceae

Anomobryum auratum (Mitt.) A.Jaeger, on moist rocks and soil, Silent Valley (1200–1500 m) 5343a, 5347a (MBG). It is distributed in South India (Kerala: Eravikulam National Park; Karnataka: Mahabaleswar; Tamil Nadu), North–east India (Darjeeling, Western Himalayas, Kashmir, Meghalaya, Naga Hills, Sikkim), Sri Lanka, China, Bhutan,

Nepal, Korea, Japan, Philippines, Tanzania, Kenya and Madagascar. (Vohra *et al.* 1982 also reported this species).

Brachymenium nepalense Hook., on bark, Silent Valley (1300) *RVK & al.* 5347c (MBG). *B. nepalense* is an Afro-Asiatic species distributed in South India (Kerala, Karnataka, Tamil Nadu), North-east India (Simla, Kumaon, Garhwal), Sri Lanka, Thailand, Sumatra, Java, Borneo, Celebes, New Guinea, Myanmar, China, Taiwan, Indonesia, Japan, Philippines and Africa. (Vohra *et al.* 1982 also reported this species).

Bryum apalodictyoides Müll. Hal.- On wet soil. (based on Vohra *et al.* 1982).

Bryum coronatum Schwaegr.- On concrete walls. (based on Vohra *et al.* 1982).

Bryum capillare Hedw., On rocky patch, Silent Valley (1200–1500 m) 5352 (MBG). It is a cosmopolitan species found distributed in South India (Tamil Nadu: Palni hills, Kerala), North India (Western Himalaya, Kashmir), China, Thailand, Vietnam, Taiwan, Korea, Jappan, Siberia, Central Asia, Europe, North and Central Africa, North and South America, Australia and New Zealand.

Bryum cellulare Hook., On earth bank, Silent Valley (1200–1500 m) 5519, 5338, 5344a, 5383 (MBG). This is distributed widely in North India (Western Himalayas, Kerala) Myanmar, China, Japan, Sumatra, Java, Philippines, Taiwan, Europe, North and Central Africa and Australia.

Bryum curyphyllum Dix. & P.Vard.- On soil near stream. (based on Vohra *et al.* 1982).

Bryum rugosum Müll. Hal.- = *Brachymenium pendulum* Mont.- On submerged rocks. (based on Vohra *et al.* 1982).

Bryum vellei Card. & P. Vard. var. *robustum* Dix. & Vard. = *B. billardierei* var. *billardierei* Schwaegr. (based on Vohra *et al.* 1982).

Bryum wightii Mitt.-On rocky patch, Silent Valley (1300-1500m) 5383 (MBG). It is distributed in Eastern India, South India (Mahabaleswar, Nilgiri, Palni), Sri Lanka, East Nepal.

Pohlia flexuosa (Hook.) Mitt.- On earth bank. *(based on* Vohra *et al.* 1982*).*

Bartramiaceae

Bartramidula dispersa Card. & Vard.= *Philonotis dispersa* (Cardot & P. de la Varde) D.G. Griffin & W.R. Buck.- On earth bank. (based on Vohra *et al.* 1982).

Philonotis anisoclada Card. & Vard.= *P. falcata* - On earth bank. (based on Vohra *et al.* 1982).

Philonotis hastata (Duby) Wijk. & Marg., on soil and rocky patches, Silent Valley (1200–1500 m) 5366a (MBG). It is a pantropical species earlier reported from South India (Kerala, tamil Nadu, Karnataka) North–East Inda (Calcutta, Assam, Sikkim), Sri Lanka, Borneo, Bolivia, Java, Thailand, Celebes, Philippines, Japan, Taiwan, Chile, Oceanic island, Peru, Venezuela, Africa, South America and Australia. (Vohra *et al.* 1982 reported this species as *Philonotis heterophylla* Mitt.).

Philonotis mollis (Dozy & Molk.) Mitt., On rocky patch, Silent Valley (1500 m) 5352 a (MBG). Distributed in South India (Karnataka, Kerala), Central India (Rajasthan), Andaman Islands, Sri Lanka, Borneo, Java, Indonesia, Japan, Madagascar, Philippines, Sumatra and Vietnam. (Vohra *et al.* 1982 also reported this species).

Philonotis thwaitesii Mitt., on soil cuttings and moist rocks, Silent Valley (1200–1500 m) 5519b, 5343b (MBG). Distributed in South India (Kerala, Tamil Nadu; Palni hills), North India (Western Himalaya), Sri Lanka, China, Borneo, Bolivia, Colombia, Japan, Korea, New Guinea and Taiwan.

Orthotrichaceae

Macromitrium calimperidium Mitt.- Epiphytic. (Based on Vohra *et al.* 1982).

Macromitrium moorcrofti (Hook & Grev.) Schwaegr., On bark, Silent Valley (1200–1500 m) 5347b (MBG). It was earlier reported from South India (Karnataka: Coorg, Kerala), North–East India (Western Himalaya, Khasi hills, Sikkim, Darjeeling) Andaman and Nicobar Islands, China, Nepal, Myanmar, Bhutan and Bangladesh.

Macromitrium perrottetii Müll. Hal.- Epiphytic. (Based on Vohra *et al.* 1982).

Macromitrium sulcatum (Hook.) Brid., on bark, Silent Valley (1200–1500 m) 5365 (MBG). It is widely distributed in South India (Kerala, Maharashtra, Tamil Nadu), Sri Lanka, Nepal, Borneo, Kampuchea, Madagascar, Malaysia, Myanmar, Philippines, Thailand and Vietnam.

Macromitrium turgidum Dix., on bark, Silent Valley (1200–1500 m) 5364 (MBG). It is distributed in India (Naga Hills, Arunachal) and Thailand. The present collection is a new record for Peninsular India (Plate 2 H-L).

Myuriaceae

Myurium rufescens (Reinw. *et* Hornsch.) Fleisch., on bark, Silent Valley (1350 m) *RVK & al.* 5384 (MBG). It is distributed in India (Darjeeling, Khasia Hills), Sri Lanka, Myanmar, Thailand, Sumatra, Java, Malacca, Celebes, Borneo, New Guinea, Philippines, China, Jappan, Australia and New Caledonia.

Racopilaceae

Racopilum cuspidigerum (Schwaegr.) Angstr., earth bank and on soil covered rocks; Silent Valley National Park (1500 m) *RVK & al. 5532a (MBG).* Distributed in South India (Tamil Nadu, Kerala), Myanmar, Thailand, Philippines, Vietnam, Borneo, Indonesia, Malaysia and Papua New Guinea.

Racopilum schmidii (Müll. Hal.) A.Jaeger- On earth bank. (Based on Vohra *et al.* 1982).

Trachypodaceae

Diaphanadon blandus (Harv.) Renauld & Cardot., on bark, Silent Valley (1350 m) 5361 (MBG). It is distributed in South India (Kerala,Karnataka Tamil Nadu), North-east India (Mussoorie, Simla, Kumaon, West Bengal, Sikkim, Assam, Dargeeling), Sri Lanka, Nepal, Bhutan, Borneo, Ceram, Halmahera, Indonesia, Myanmar, Taiwan, Sumatra and Yunnan.

Trachypus bicolor Reinw. & Hornsch., On bark, Silent Valley (1250m) *RVK & al.* 5346a (MBG). Widely distributed species in high altitude areas. (Vohra *et al.* 1982 also reported this species).

Trachypodopsis crispatula (Hook.) Fleisch.- On tree trunks and rocks. (based on Vohra *et al.* 1982).

Pterobryacceae

Pterobryopsis orientalis (Müll. Hal.) M.Fleisch.- On bark, Silent Valley (1200 -1500 m) 5515b (MBG) It is a south -cost Asiatic species found distributed in South India (Kerala, Tamil Nadu), North – East India (Mussoorie, Kumaon, Darjeeling, Sikkim, Naga hills), Myanmar, Thailand, North Vietnam and Yunnan.

Pterobryopsis schmidii (Müll. Hal.) Fleisch.- Epiphytic. (based on Vohra *et al.* 1982).

Pterobryopsis tumida (Dicks. Ex Hook.) Dixon- Epiphytic. (based on Vohra *et al.* 1982).

Symphysodontella involuta (Mitt) Fleisch., on bark, Silent valley (1200-1500m) 5508 (MBG). It is distributed in Eastern India and Arunachal. (Vohra *et al.*1982 also reported this species).

Meteoriaceae

Aerobryopsis longissima (Dozy & Molk.) M.Fleisch., hanging from the branches of trees, Silent Valley (1200–1500 m) 5341 (MBG). It is distributed in South India (Tamil Nadu, Karnataka, Kerala), Eastern India (Sikkim), Sri Lanka, China, Caroline Islands, Indian Archipelago, Madagascar, Malaysia, New Guinea, Philippines, Pacific Ocean Island, Sumatra, Taiwan, Vietnam, Australia and Yunnan (Vohra *et al.* 1982 also reported this species).

Aerobryopsis wallichii (Brid.) Fleisch., On branches, Silent Valley (1200–1500 m) RVK & al. 5337 (MBG). Distributed in East Nepal and Sri Lanka. Gangullee (1971) commented that this species is endemic in these areas. The present collection from Silent Valley NP extends its distribution and it is a new record for India. (Prajitha *et al.* in press).

Aerobryum speciosum Dozy & Molk., on base of tree trunk, Silent Valley (1200–1500 m) 5396 (MBG). An east and South east Asiatic species earlier reported from South India (Western Ghats of Tamil Nadu, Kerala), North – Eastern India (Darjeeling, Arunachal Pradesh, Khasi hills, Manipur, Meghalaya, Sikkim), Sri Lanka, Bhutan, Celebes, China, Taiwan, Indonesia, Japan, Philippines, New Guinea and Vietnam.

Aerobryidium filamentosum (Hook.) Fleisch.-On tree trunks. Silent Valley National Park (1500 m) RVK & al. 5410 (MBG). A South east Asiatic species distributed in India (Kerala, Tamil Nadu, Coorg, Western & Eastern Hiamalayas, Darjeeling), Nepal, Bhutan, Sri Lanka, Myanmar, Thailand, Vietnam, Sumatra, Java, Borneo, Celebes and Philippines. (Vohra *et al.*1982 also reported this species).

Barbella convolvens (Mitt.) Broth.- On branches of trees. (based on Vohra *et al.* 1982).

Barbella turgida Nog., on tree trunk, Silent Valley (1200–1500 m) 5336 (MBG). It is distributed in India (Western Himalaya, Tamil Nadu), East Nepal. The present collection is a new record for Kerala (Plate 4. L-P).

Barbella flagellifera (Card.) Nog.- On branches of trees. (based on Vohra *et al.* 1982).

Chrysocladium flammeum (Mitt.) M. Fleisch.- On bark, Silent Valley (1200–1500 m) 5515a (MBG). It is distributed in Eastern India, Sikkim, Darjeeling, East Nepal. The present collection is a new record for Peninsular India (Plate 1 A-F).

Cryptopapillaria chrysoclada (Müll. Hal.) A.Jaeger- On tree trunks. (based on Vohra *et al.*1982).

Cryptopapillaria feae (M.Fleisch.) M.Menzel – On tree trunks (based on Vohra *et al.* 1982)

C. Mueller et Fleisch.- on tree trunks. (based on Vohra *et al.*1982)

Cryptopapillaria fuscescens (Hook.) A. Jaeger- On tree trunks and on logs, Silent Valley (1200-1500m) 5523 (MBG). It is a widely distributed in species in high altitude areas of South India (Kerala, Goa, Karnataka, Tamil Nadu), North–East India (Kumaon Himalaya, West Bengal, Arunachal Pradesh, Manipur, Meghalaya, Sikkim), Sri Lanka, Bhutan, Indonesia, Indian Aruchipelago, Myanmar, Nepal, Philippines, Thailand, Vietnam and Yunnan. (Vohra *et al.* 1982 also reported this species).

Floribudaria floribuda (Doz. & Molk.) Fleisch.- on branches, Silent Valley (1200–1500m), 5376 (MBG). It is distributed in India (Sikkim, Darjeeling, Bhutan, Arunachal, Assam, Khasia Hills, Manipur) and East Nepal. (Vohra *et al.* 1982 also reported this species)

Floribundaria sparsa (Mitt.) Broth.- On branches, Silent Valley (1200–1500 m), 5358b (MBG). It is distributed in India (Sikkim, Darjeeling, Khasia Hills), East Nepal, Bhutan, Thailand, Java and Taiwan.

Floribundaria walkerii (Renauld & Cardot) Broth., on branches and on rocky patch, Silent Valley (1200m). 5395 (MBG). It is an Indian endemic species distributed in Eastern Himalayas, West Bengal and Kerala. (Vohra *et al.* 1982 also reported this species).

Meteoriopsis reclinata (Müll. Hal.) M.Fleisch., on tree trunks and on branches, Silent Valley (1200–1500m) 5377 (MBG). It was earlier recorded from South India (Tamil Nadu, Karnataka, Kerala), North–east India (Mussoorie, Kumaon, Bihar, Meghalaya, Sikkim), Sri Lanka, China, Japan, Indonesia, Malacca, Myanmar, Thailand, Laos, Celebes, Nepal, New Guinea, Sumatra and Australia.

Meteoriopsis squarrosa (Hook) M.Fleisch., on bark and on small branches, Silent Valley (1200–1500m) 5514 (MBG). It is distributed in South India (Tamil Nadu, Karnataka, Kerala), North–east India (Sikkim, Darjeeling, Himalaya, Arunachal Pradesh, Khasi hills, Manipur), Sri

Lanka, Nepal, Bhutan, Myanmar, Thailand, Vietnam, Sumatra, Java, New Guinea, Philippines, Taiwan and Yunnan. (Vohra *et al.* 1982 also reported this species)

Papillaria crocea (Hamp.) A.Jaeger, on bark, Silent valley (1250m) *RVK & al.* 5397a (MBG). Distributed in *South India (Tamil Nadu, Kerala), Sri Lanka, China, Japan, New Zealand and Australia.*

Pseudobarbella compressiramea (Ren.& Card.) Nog.- On branches, Silent Valley (1450 m) 5522, 5385 (MBG). It was earlier recorded from Eastern India (Sikkim, Darjeeling and Naga Hills) and East Nepal.

Neckeraceae

Calyptothecium pinnatum Nog., hanging from bark and branches, Silent Valley (1250 m) 5379 (MBG). An east Asiatic species distributed in Eastern India (Sikkim, Darjeeling, Khasia Hills), Eastern Nepal, Taiwan and Myanmar, Taiwan. The present collection is a new record for Peninsular India (Plate 2 A-G).

Cryptoleptodon flexuosus (Harv.) Ren. & Card. – On tree trunks. (based on Vohra *et al.* 1982).

Handeliobryum setschwanicum Broth. = *H. sikkimense* (Paris) Ochyra.- On tree trunks and on rocks. (Based on Vohra *et al.* 1982).

Himantocladium rugulosum (Mitt.) Fleisch. = *H. cyclophyllum* (C.Mueller) Fleisch.- On tree trunks. (based on Vohra *et al.* 1982).

Himantocladium plumula (Nees) M.Fleisch., base of tree trunk, Silent Valley (1400 m) *RVK & al.* 5535 (MBG). An Indo–Pacific species found distributed in North–east India (Arunachal Pradesh, Assam, Khasi hills), Bangladesh, China, Taiwan, Japan, Sumatra, Indonesia, Borneo, Philippines, New Caledonia, New Guinea, Australia and Pacific Ocean Islands.

Homaliodendron flabellatum (Sm.) M.Fleisch., on tree trunks and on rocks, Silent Valley (1200–1500m) *RVK & al.* 5378 (MBG). It was earlier reported from South India (Kerala, Tamil Nadu: Nilgiri hills, Madurai, Thirunelveli, Kanyakumari, Karnataka). North – East India (West Bengal, Sikkim, Darjeeling, Arunachal Pradesh, Meghalaya), Sri Lanka, Java, Borneo, Philippines, Japan, Pacific Ocean Island Sumatra, Tailand and Australia. *et al.* (1982) also reported this species.

Pinnatella foreauana Ther. & Vard.- On tree trunks. (Based on Vohra *et al.*1982).

Leskeaceae

Rhegmatodon orthostegium Mont.- Epiphytic. (Based on Vohra *et al.* 1982).

Thuidiaceae

Claopodium assurgens (Sull. & Lesq.) Card.- On tree trunks. (Based on Vohra *et al.* 1982).

Claopodium nervosum (Harv.) Feisch. = *C. prionophyllum* (Müll. Hal.) Broth. On wet rock. (Based on Vohra *et al.* 1982)

Haplocladium vestitum Dix. et Vard. = *Haplocladium microphyllum* subsp. *virginianum* (Brid.) Reimers – On tree trunks. (Based on Vohra *et al.* 1982).

Thuidium pristocalyx (Müll. Hal.) A.Jaeger., on rocks near stream, Silent Valley (1200–1500 m) 5534, 5357 (MBG). It is distributed in India (Eastern Himalayas, Kerala) Thailand, Vietnam, Indonesia, Malaysia and Philippines. Vohra *et al.* (1982) reported this species as *Thuidium glaucinum* (Mitt.) Bosch & Sande Lac

Thuidium cymbifolium (Dozy & Molk.) Dozy & Molk., on rocks, Silent valley (1200-1500m) *RVK & al.* 5373 (MBG). A widely distributed very common species in the tropics at high altitude areas. (Vohra *et al.* 1982 also reported this species).

Plagiotheciaceae

Stereophyllum tavoyense (Hook.) A.Jaeger = *Entodontopsis tavoyensis* (Hook. Ex Harv.) W.R. Buck & Ireland. On tree trunks. (based on Vohra *et al.*, 1982).

Brachytheciaceae

Eurhynchium swartzii (Thurn.) Curnow., on rocky patch, Silent Valley (1300–1500m), 5370a (MBG). It is distributed in East India, East Nepal, Darjeeling, Sri Lanka, China, Japan, Siberia, Kurdistan, Caucasus, Europe, Azores, Algeria, Central and South Africa, Canada and United States of America.

Sematophyllaceae

Brotherella amblystegia (Mitt.) Broth., on bark, Silent Valley (1200–1500 m) *RVK & al.* 5400a (MBG). It is distributed in Eastern India (Dar-

jeeling, Arunachal Pradesh, Naga Hills). The present collection is a new record for Peninsular India (Plate 2 M-Q).

Clastobryum patentifolium Dix. & Vard.- On tree trunks. (Based on Vohra *et al.*1982).

Chionostomum rostratum (Griff.) Müll. Hal., on bark, Silent Valley (1200–1400 m) *RVK & al.* 5335, 5391 (MBG). It is distributed in Eastern India (Darjeeling, Khasia Hills, Coorg), Sri Lanka, Thaliland, North & South Vietnam, Philippines and Taiwan.

Glossadelphus bilobatus (Dix.) Broth.- On wet rocks, Silent Valley (1200–1500 m) *RVK & al.* 5526, 5339b (MBG). It is distributed in Eastern India (Naga Hills), Sri Lanka and Moluccas. The present collection is a new record for Peninsular India (Plate 1 M-R).

Sematophyllum phoeniceum (Müll. Hal.) M. Fleisch.- On logs, Silent valley (1400m), 5346b (MBG). It is distributed in Eastern India, South India, Andaman Island, Thailand, Vietnam, South China and Bangladesh.

Taxiphyllum taxirameum (Mitt.) M.Fleisch.- On logs. Silent valley (1400m), 5346b (MBG). Widely distributed in the tropics including North-east India (Mussoorie, Simla, Nainital, Ranikhet, Almora, Sikkim, Abor, Assam, Khasi hills), Southern India (Tamil Nadu, Kerala), Sri Lanka, Nepal, Bhutan, Indonesia, Japan, Myanmar, New Guinea, Philippines, Sumatra, Taiwan and Vietnam. (Vohra *et al.*, 1982 also reported this species).

Trichosteleum stissophyllum (Hamp.) A.Jaeger = *Papillidiopsis stissophylla* (Hampe & C.Mueller) B.C. Tan & Y.Jia- On tree trunks. (based on Vohra *et al.*, 1982).

Trichosteleum stigmosum Mitt., on bark, Silent Valley (1300–1500 m) *RVK & al.* 5332, 5333 (MBG). Manju *et al.* (2012) recorded this species as new record for India.

Wijkia deflexifolia (Ren. & Card.) Crum., on bark, Silent Valley (1500 m) *RVK & al.* 5520 (MBG). It is distributed in Eastern India, Darjeeling and Bhutan. The present collection is a new record for Peninsular India (Plate 3 A-G).

Entodontaceae

Entodon obtusatus Card. & Vard.= *Entodon obtusatus* Broth.- On tree trunks. (based on Vohra *et al.* 1982)

Entodon perplicatus Ther. & Vard. = !*Campylopodium perplicatum* - On tree trunks (based on Vohra *et al.* 1982).

Hypnaceae

Bryosedgwickia kirtikarii (Bel.) Mitt.= *Platygyriella kirtikarii* (Cardot & Dixon) W.R. Buck- On **tree trunks. (based on Vohra *et al.* 1982)**

Ectropothecium cyperoides (Hook.) A. Jaeger- On submerged stones. (based on Vohra *et al.* 1982).

Ectropothecium drepanocladioides Broth. & Vard.- On tree trunks. (based on Vohra *et al.*1982).

Hypnum macrogynum Besch., on rocky patch and on roots of higher plants, Silent Valley (1200m) *RVK & al.* 5369 (MBG). It is distributed in Eastern India, East Nepal, Myanmar, South China and Taiwan.

Hypnum flaccens Besch.- on roots of higher plants, Silent Valley (1400 m) *RVK & al.* 5388 (MBG).It is distributed in India (Easty Nepal), Sikkim, Bhutan . The present collection is a new record for Peninsular India (Plate 1 S-X).

Vesicularia vesicularis (Schwaegr.) Broth.- On rocks, Silent Valley (1350–1500 m) *RVK & al.* 5348 (MBG). It is distributed in North–east India (Western Himalaya, West Bengal, Arunachal Pradesh), South India (Kerala), China, Thailand, Vietnam, Sumatra, Java, Borneo, Philippines, Australia and Oceania.

Vesicularia reticulata (Dozy & Molk.) Broth. - on rocks, Silent valley (1500 m) *RVK & al.* 5373 (MBG). Distributed in India (Sikkim, Arunachal, Assam, Naga hills, Kerala) Sumatra, Java, Celebes, Philippines, Japan, Oceania and New Zealand. Vohra *et al.* (1982) reported this species from Silent Valley NP.

Conclusion

A preliminary report of the bryophytes of Silent Valley National Park is presented here. The catalogue consists of 148 taxa including 109 mosses, 36 liverworts and 3 hornworts. Of these nine species *viz*., *Chrysocladium flammeum* (Mitt.) M. Fleisch., *Gymnostomum calcareum* Nees & Hornsch., *Glossadelphus bilobatus* (Dix.) Broth., *Hypnum flaccens* Besch., *Macromitrium turgidum Dix.*, *Calyptothecium pinnatum* Nog., *Brotherella amblystegia* (Mitt.) Broth., *Notoscyphus paroicus* Schiffn. and *Wijkia deflexifolia* (Ren. & Card.) Crum. are newly reported for Peninsular India. Another four species *viz*., *Lejeunea cavifolia* (Ehrh.) Lindb., *Radula obscura* Mitt., *Radula meyeri* Steph. and *Barbella turgida* Nog. are new record of occurrence for Kerala State. *Trichostelium stigmosum*

(Manju et al., 2012) and Aerobryopsis wallichii (Brid.) Fleisch. (Prajitha *et al*., in press), has been reported as new records for India from Silent Valley.

Vohra *et al.* (1982) reported a preliminary checklist of mosses of Silent Valley National Park. They reported 70 species of mosses from the area, but in the present collection, we could locate only 28 species, reported by Vohra *et al.* (1982). Among these 70 species 21 were synonymised under different names. Vohra (1981) reported *Pogonatum hexagonum* an endemic moss to India from Silent Valley, which is now synonymised under *P. patulum* (Harv.) Mitt. Srivastava and Sharma (2000) also reported 24 species of Liverworts and three species of hornworts from Silent Valley National Park. In the present collection we could locate eight species of liverworts and one species of hornwort reported by Srivastava and Sharma (2000). Asthana and Srivastava (1986) described a new *Folioceros species, as F. udarii Asthana & Srivastava* from Silent Valley. Recently a new genus *viz*., *Indopottia* along with its species *I. zanderii* has been described from Silent Valley (Daniels *et al.*, 2010). Hence in a preliminary survey we could report 148 species of bryophytes from the area. Explorations of smaller areas are often found very effective in biodiversity documentation, especially when searching cryptogrammic groups such as bryophytes. This report also suggest to study the area more in detail.

Acknowledgements

The authors are thankful to the Kerala State Council for Science Technology & Environment (KSCSTE), Thiruvananthapuram for the financial assistance. We are thankful to the staff members of the Kerala Forest Department for extending support during the field study. The authors acknowledge Mr. Anoop, K.P. and Mr. Hareesh. K.T. for their help in the field for collection of specimens. First author sincerely acknowledges the support provided by the authorities of the Zamorin's Guruvayurappan College, Calicut.

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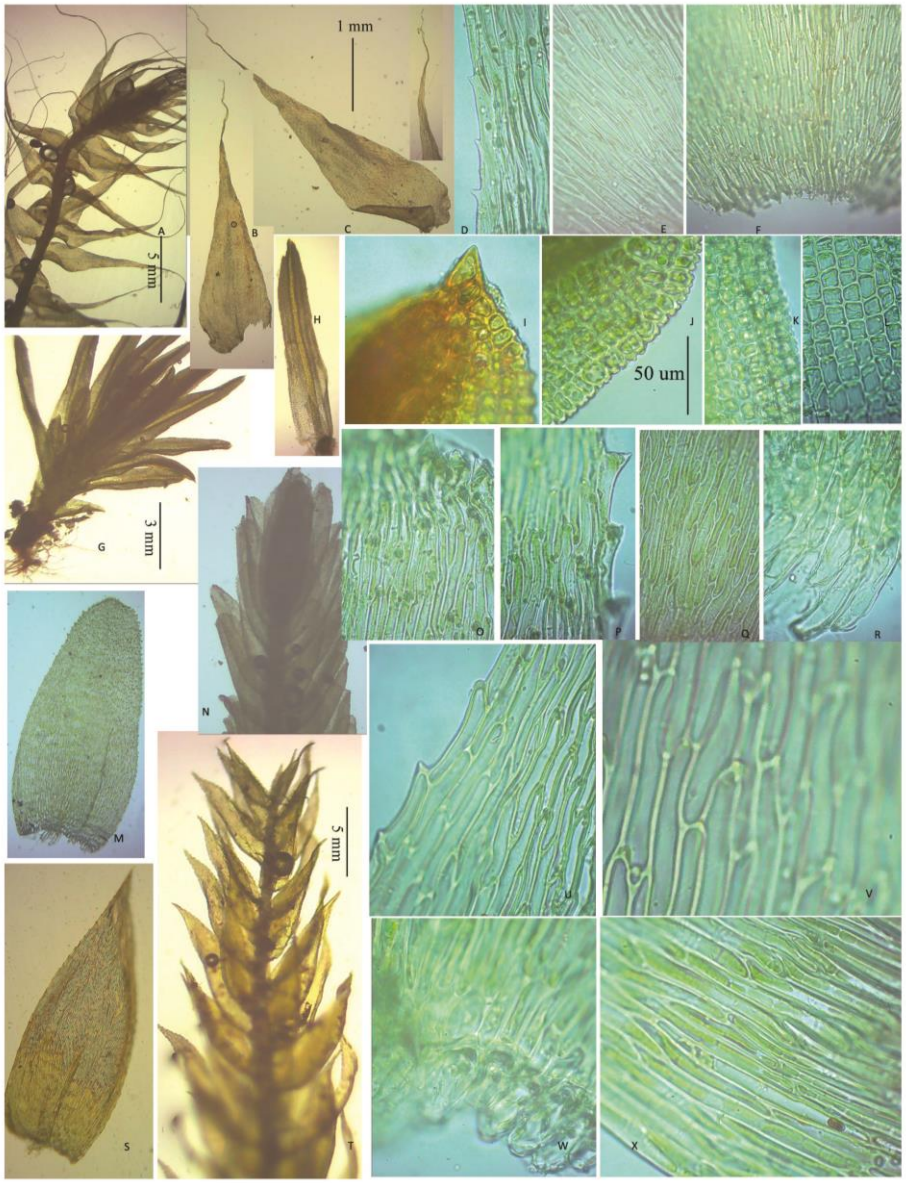

Plate 1. A-F; *Chrysocladium flammeum*, A. branch, B&C. Leaf, D.Leaf tip, E. Leaf middle cells, F. Leaf basal cells; G-L ; *Gymnostomum calcareum* , G. Habit, H. Leaf, I. Leaf tip, J&K. Leaf marginal cells, L. Leaf basal cells; M-R; *Glossadelphus bilobatus*, M. Leaf, N. Branch, O. Leaf tip, P. Leaf marginal cells, Q. Leaf middle cells, R. Leaf basal cells; S-X; *Hypnum flaccens*, S. Leaf, T. Branch, U. Leaf mrginal cells, V&X. middle cells, W. basal cells (B,C,D,H,M,S same length; all cells same length as J)

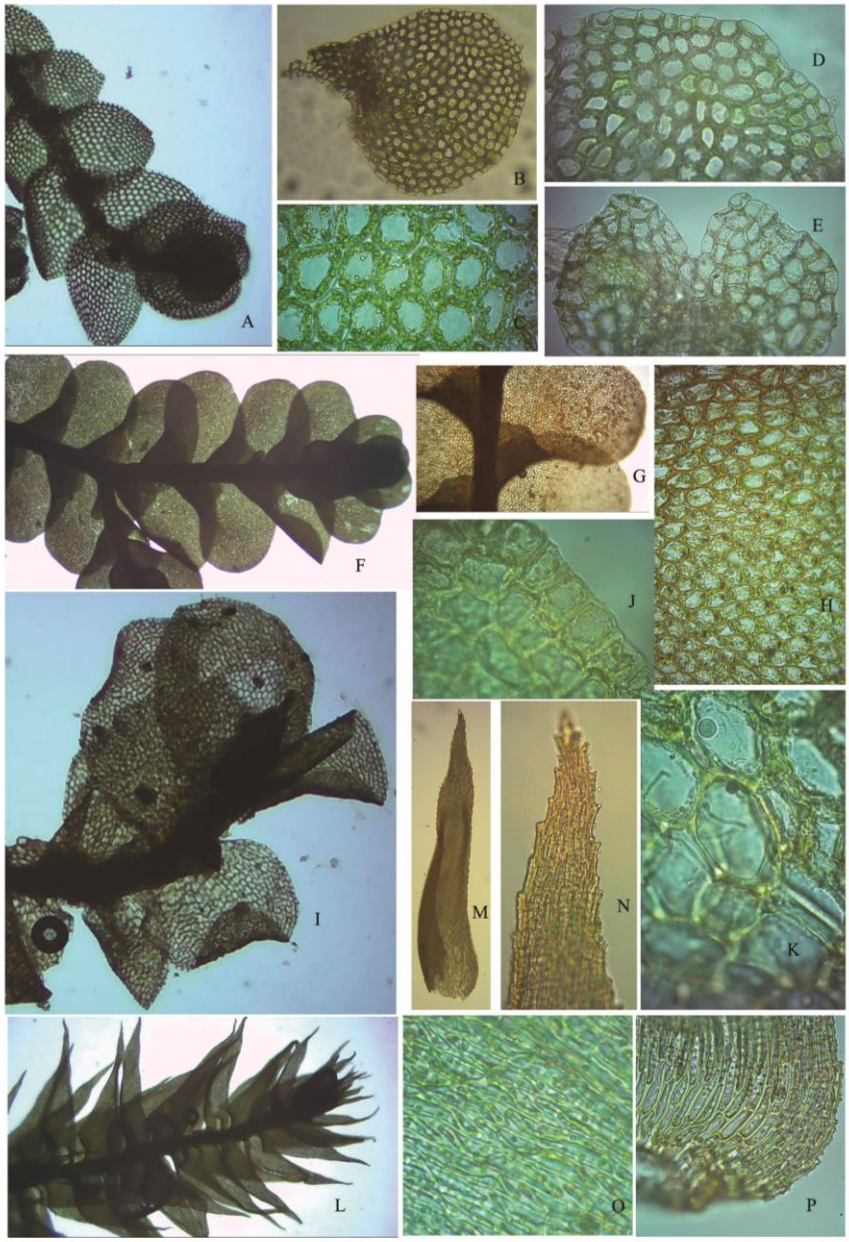

Plate 4. A-E; *Lejeunea cavifolia* , A. Branch, B. Leaf, C. Basal cells, D. Marginal cells, E. Underleaf; F-H; *Radula obscura*, F. Branch, G. Branch showing the leaf lobule, H. Leaf cells; I-K. *Radula meyeri*, I. Branch, J. Leaf marginal cells, K. Basal cells; L-P. *Barbella turgida* , L. Branch, M. Leaf, N. Leaf tip cells, O. Middle cells, P. Basal cells

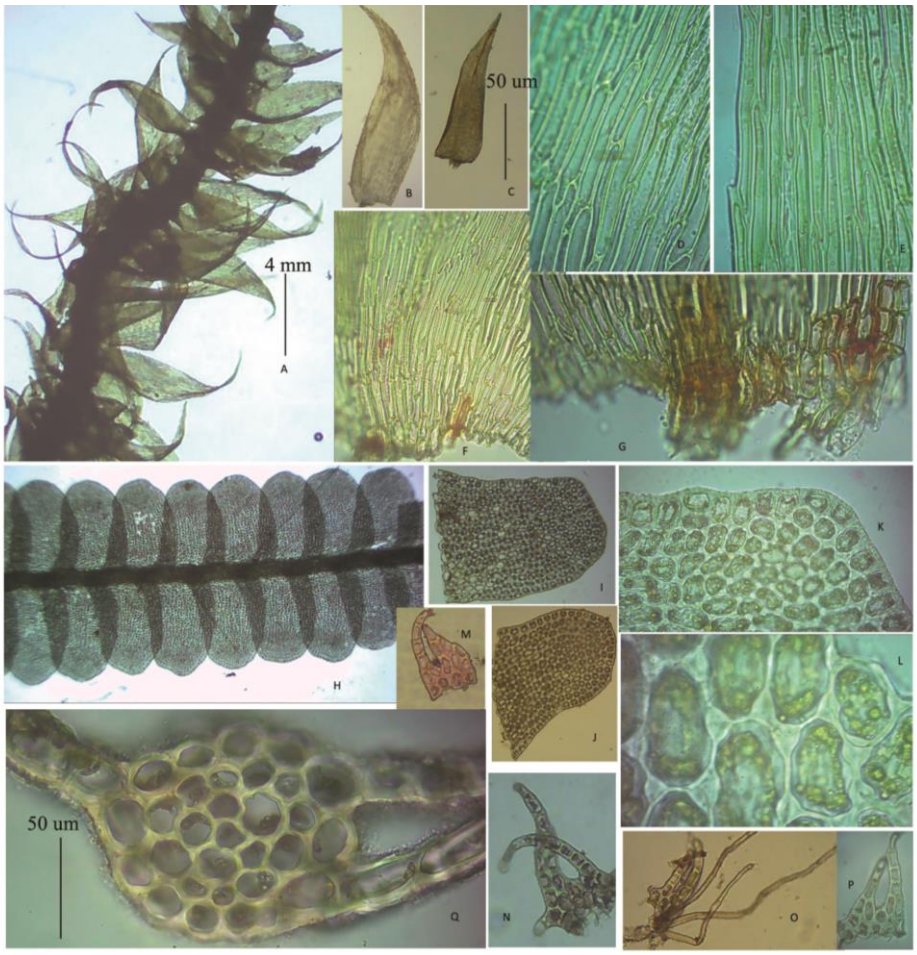

Plate 3. A-G. *Wijkia deflexifolia,* A. Branch, B&C. Leaves, D&E. Leaf middle & marginal cells, F&G. Basal cells; H-Q; *Notoscyphus paroicus*, H. Branch, I&J. Leaves, K. Leaf margin, L. Basal cells, M-P, Underleaves, Q- C.S. of stem (A&H same length; B,C,I,J, same length; all cells same length as G)

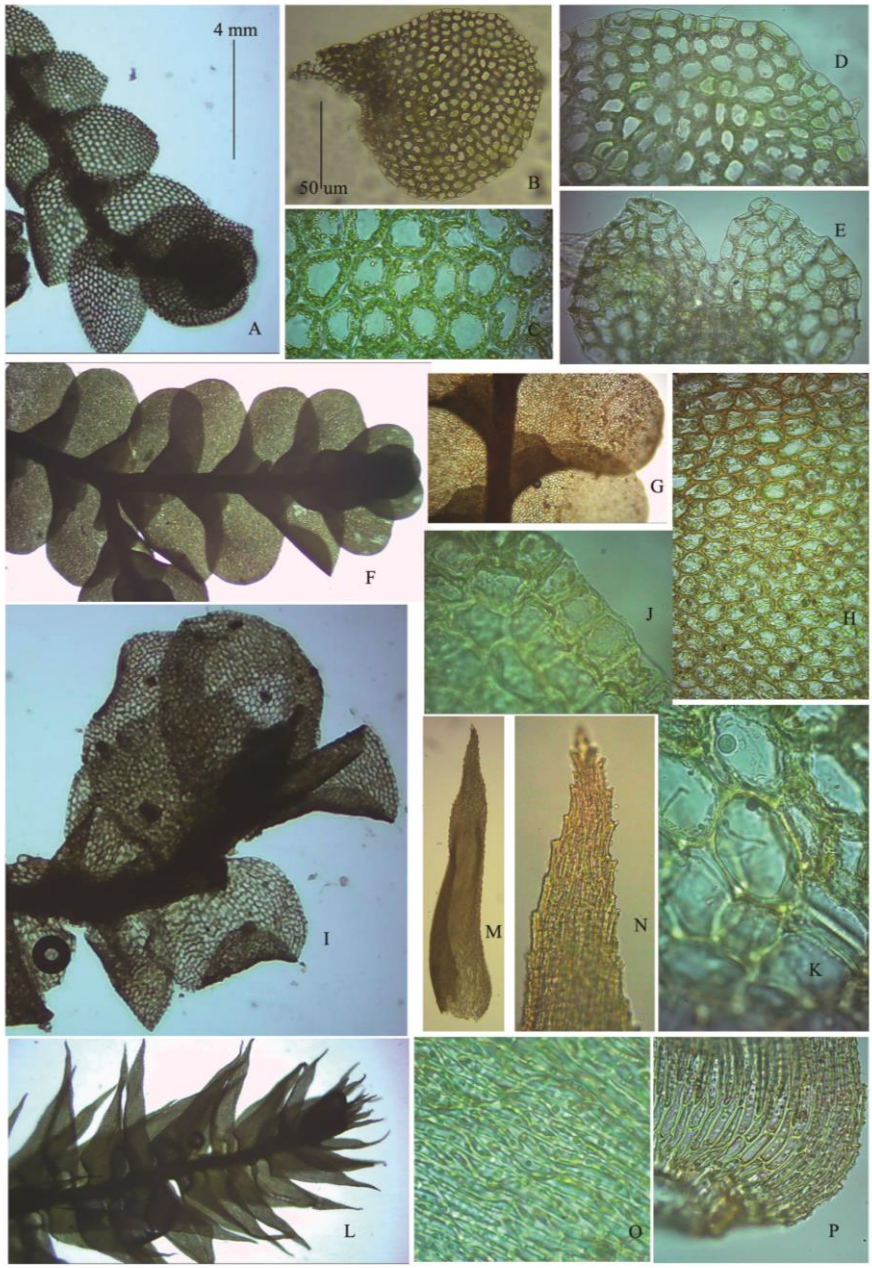

Plate 4. A-E; *Lejeunea cavifolia* , A. Branch, B. Leaf, C. Basal cells, D. Marginal cells, E. Underleaf; F-H; *Radula obscura*, F. Branch, G. Branch showing the leaf lobule, H. Leaf cells; I-K. *Radula meyeri*, I. Branch, J. Leaf marginal cells, K. Basal cells; L-P. *Barbella turgida* , L. Branch, M. Leaf, N. Leaf tip cells, O. Middle cells, P. Basal cells (A,F,I,L, same length; all same length as B)