

A CONTRIBUTION TO THE BRYOFLORA OF THE WESTERN GHATS IN KARNATAKA STATE, INDIA

UWE SCHWARZ & JAN-PETER FRAHM¹

Abstract. Based on fieldtrips of the authors in 2012, a list of species collected in a small area of the Western Ghats (Coorg District, state of Karnataka) is presented. It includes 18 species of liverworts and hornworts as well as 76 species of mosses. 27 species of mosses are newly reported for the state of Karnataka, 6 species are new for Coorg province. *Holomitrium javanicum* Dozy & Molk. is reported as new to India. *Campylopus sedgwickii* Dix. described from Sri Lanka and so far only known from the type locality is a new synonym of *C. recurvus* Mitt. The list gives a rough inventory of the bryoflora in altitudes between 900 m and 1750 m and can be regarded as typical for the northern Western Ghats.

Key words: India, bryophytes, *Holomitrium javanicum*, Western Ghats

Uwe Schwarz, Prestige Grand Oak 202, 7th Main, 1st Cross, HAL IIInd Stage, Indira Nagar, Bangalore 560038, India; e-mail: schwarzu@lumot.de

Jan-Peter Frahm, Bonner Str., 56, D-53424 Rolandseck, Germany; e-mail: frahmjp@googlemail.com

INTRODUCTION

The state of Karnataka is situated north of the states of Kerala and Tamil Nadu, which are known for their rich bryophyte flora and long history of bryological exploration. The species richness is due to the Western Ghats, a mountain ridge stretching NNW – SSE along the west coast of the Indian subcontinent.

Karnataka covers only a small portion of the Western Ghats and this might be the reason that this part is bryologically not as well known and the former bryological research focussed famous regions such as the Nilgiri Mountains, Palni Hills, Kodaikanal and others.

Although India is the tropical country with the most intensive bryological exploration, highest number of bryologist and highest rate of bryological publications, many regions remain to be studied and many bryophyte groups are in need of a taxonomical revision. The fact that Manju and Rajesh (2011) reported 13 species as new to India and 4 for Kerala State from a single nature preserve shows that the bryoflora of India is far from being explored.

Therefore we as foreign bryologists take the opportunity to add the results of a collecting trip to a small region in the Western Ghats of Karnataka.

The collections are deposited in the herbaria of the authors (private herb. of Uwe Schwarz, hb. Frahm, BONN)

THE STUDY AREA

During the fieldtrip of the authors in November, 2012, only a small part of the mountain areas of Karnataka in the Coorg (Madikeri, Kodagu) District had been visited, which, however, seem to be typical and representative for the region. Coorg is the SW District of Karnataka bordering Kerala. The area is situated between 12.20°N and 12.22°N and 75.61°E and 75.67°E, about 18 km WNW of Virajpet (Fig. 1). A few additional locations have been visited along the road from Mysore to Madikeri, as well as from Madikeri to Virajpet. The highest point is Mt. Tadiandamol (1750 m). The study area (Fig. 2) covered the surroundings of Kabbe Holiday Resort and of Honey Valley

¹ Corresponding author

Homestay. Both are situated within an extensive belt of coffee plantations in about 1000–1200 m altitude. The higher regions above 1200 m to the summit region in 1500 m are covered by open meadows and fragments of low forests. The lower, cultivated area bears a submontane bryoflora. Species number and abundance of bryophytes are increasing above 1000 m (lower montane belt) and another floristic change can be observed above 1200 m. Open banks along the roads show a high variety of terrestrial species.

The area is drained by rivers flowing westwards comprising the Cauvery River and its tributaries. The closely located watershed to the east was not crossed.

The district enjoys a seasonal tropical climate with slight to medium humidity due to the proximity to the coast. Monsoon season starts in June and lasts till September, receiving a significant amount of rainfall till November. The dry season is

characterized by cool temperatures until February and increasing temperatures until May.

The average temperature ranges between 19° and 23° degrees Celsius with rare extremes going up to 35° and down to 9° degrees.

The annual rainfall for the Coorg district is about 3500 mm with an average number of 118 rainy days per year. Misty weather in the morning during the cooler months contributes to the precipitation. Data indicating the difference of rainfall between the lower and upper areas are not available.

The soils of the district consist of lateritic debris found in different stages of laterization. Loamy soils, suitable for cultivation can only be found along the rivers. The area between Madikeri and Virajpet consists of granitic gneiss. Rock habitats are usually found along cliffs of the mountains, on isolated rocks in open areas and at the banks of streams and tracks.

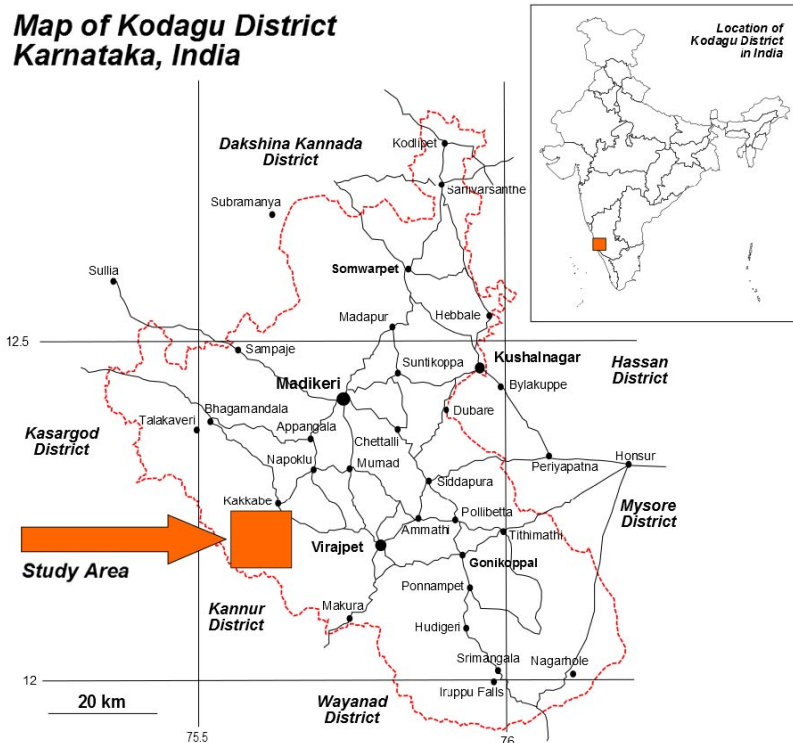


Fig. 1. Location of the study area within India and Coorg District. For detailed map see Fig. 2.

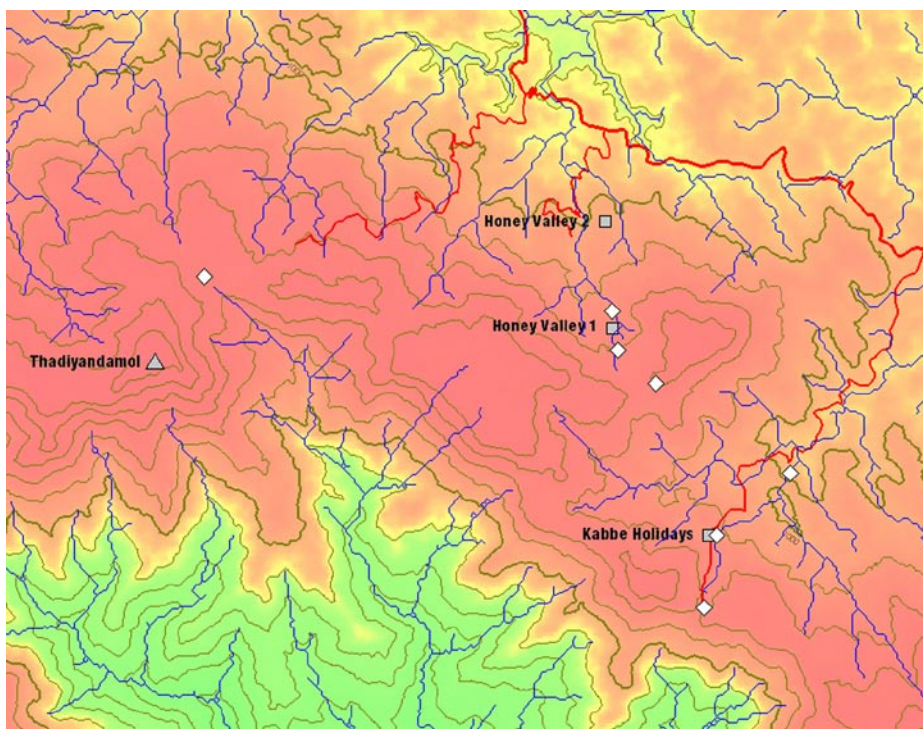


Fig. 2. Map of the study area. Dots – collection sites.

STATE OF KNOWLEDGE

Karnataka is a state of India for which no checklist was available till 2013, though there are checklists for the neighbouring states Kerala and Tamil Nadu. Therefore a first checklist of the mosses was compiled (Frahm *et al.* 2013) based on the few and scattered publications, which includes 152 species. Brotherus (1899) gave an account of mosses which were collected by T. L. Walker in 1897–1898 in the Coorg District. It includes records from Mt. Tadiandamol in our study area. Raghavan and Wadhwa (1968) gave an account of the mosses of the Agumbe-Hulical Ranges, which are located about 100 km north of the study area in Shimoga district. Results of a collection by L. J. Sedgwick, made in the Western Ghats about 300 km north to the study area were published by Dixon (1921). These three publications list altogether 144 moss species, subspecies and varieties. *Entodon plicatus*, *Hyophila involuta*, *Leucoloma taylorii* and *Pele-*

kium velatum are mentioned in all three published sources. Both Brotherus (1899) and Raghavan and Wadhwa (1968) mentioned *Brachymenium nepalense*, *Bryum argenteum*, *Cryptopapillaria fuscescens*, *Funaria hygrometrica*, *Macromitrium leptocarpum*, *M. sulcatum*, *Meteriopsis squarrosa*, *Octoblepharum albidum* and *Vesicularia reticulata*. Townsend (1988) contributed to the bryoflora of Karnataka publishing the results of a small collection from the Nandi Hills, approximately 100 km north of Bangalore. He reported 25 species that represent to a major degree species mentioned in the other publications.

General information on the bryoflora of India was obtained from the unpublished checklist of the bryophytes of India by Daniels, which gives no information on the distribution within India. A more recent checklist was published by Dandotiya *et al.* (2011), which includes distributional data, and lists all taxa reported from India including synonyms and not only the accepted names.

Recent checklists regarding the Southern India were presented by Daniels (2010) for Tamil Nadu and Manju *et al.* (2008) for Kerala, summarizing the history of bryological exploration, all references and the geographical data. Additional data were provided by Verma and Srivastava (2011) on the endemism of liverworts of the Western Ghats, Verma *et al.* (2011) on the mosses of the Nilghiri Hills. Helpful for us was Manju *et al.* (2008), Manju *et al.* (2011) as well as Manju and Rajesh (2011), who provided inventories of nature preserves of Kerala, and Alam *et al.* 2011, who compiled a checklist of the mosses of Palni Hills, Tamil Nadu, which served as comparison for our study area.

LIST OF SPECIES

The specimens cited are kept in the herbaria of the authors. The list is far from being complete. Difficult groups such as *Fissidens*, Sematophyllaceae and many liverwort genera as well as Lejeuneaceae are under-represented due to the lack of appropriate literature for accurate species identification.

The symbols used in the text are as follows:

*** New to India

** New to the state of Karnataka

* New to the province of Coorg

Photographs of many species were provided by Frahm (2013).

Anthocerotophyta

Phaeoceros laevis (L.) Prosk.

Frequent on roadside banks and open soil. The occurrence of *Phaeoceros laevis* subsp. *carolinianus* (Michx.) Prosk. has not been checked.

Marchantiophyta

Asterella wallichiana (Lehm. & Lindenb.) Pandé *et al.*

Locally abundant on bare soil along trail banks in coffee plantations, on rocks of walls and on open soil in grassland together with *Gongylanthus indicus* and *Entosthodon walli-*

chii. It is the most frequent thalloid liverwort in the area. The plants vary much in the width of the thalli and the thallus margins (narrow plants have a reddish border). The pseudoperianth is sometimes whitish, sometimes reddish, giving the impression of different species. The species is, however, distinguished from others of the genus by conical carpophor and dioicous sex conditions (Long 2006). *Asterella khasiana* (Griff.) Grolle is reported from the Western Ghats (e.g., Manju *et al.* 2009), which should have a flat carpophor. The differences between both were not clear, since young carpophors are hemiglobose and get flatter within the time.

Cephaloziella kiaeri (Austin) S. W. Arnell

Found intermixed with other bryophytes on soil and stone. The morphological diversity of plants from different collections indicates that the genus is represented by more than one species in the area.

Chandonanthus birmensis Stephani

Mt. Tandiandamol, on boulder in grassland with *Herbertus dicranus*.

Cololejeunea hasskarliana (Lehm. & Lindenb.) Stephani

Mt. Tadiandamol, on common epiphyll liverwort in remnant forest. It seems to be less frequent at lower altitudes.

Dumortiera hirsuta (Sw.) Nees

Chingara Estate House, waterfall, on wet rocks beside a stream in 900 and 1000 m.

Frullania obscura (Sw.) Dumort.

Kabbe Holiday Resort, trail to Mt. Kabbe, on small trees at the (planted) forest line at 1200 m (det. S. R. Gradstein).

Gongylanthus indicus S. C. Srivast. & P. K. Verma

Kabbe Mt., on soil in open grazed bushland above 1000 m.

Herbertus dicranus (Taylor) Trevis.

Mt. Tandiandamol, on boulder in grassland with *Chandonanthus birmensis*.

Jubula javanica Stephani

Mt. Tandiandamol, 1680 m, on rock in forest (det. S. R. Gradstein).

Lejeunea flava (Sw.) Nees

Common epiphyte to be found in almost all of the visited locations. It can easily be recognized by its yellowish green color and non glossy appearance.

Lophocolea kurzii Sande Lac.

Honey Valley, on rotten wood, resembling much *L. heterophylla* (Schrad.) Dumort.

Lophocolea muricata (Lehm.) Nees in Gottsche *et al.*

Mt. Tandiandamol, on shaded stone in remnant forest.

Lopholejeunea subfusca (Nees) Schiffner

Kabbe Mt., amongst other Lejeuneaceae on small tree at 1250 m (det. A. Schäfer-Verwimp).

Notoscyphus lutescens (Lehm. & Lindenb.) Mitt.

Frequent along roadside banks.

Pallacivinia levieri Schiffner

Honey Valley, on buttress. The habitat on bark as well the male scales arranged in one row distinguish this species from *P. lyellii* (Hook.) Carruth. (Grolle & Piippo 1986).

Spruceanthus* cf. *polymorphus (Sande Lac.) Verd.

Kabbe Valley, on rock (det. S. R. Gradstein).

Targionia hypophylla L.

Honey Valley, Chingara, twice on trail banks in coffee plantations, much rarer than the common *Asterella wallichiana*. The thalli are conspicuously

light green coloured (similar to *Asterella*) as compared with *T. hypophylla* from Europe, where it is dark blue green, and in appearance like *Targionia lorbeeriana* K. Müller, but lacks the characteristic smell of the latter. Therefore it might be that *T. hypophylla* is generally lighter coloured in India or it is another species.

Bryophyta****Actinodontium raphidostegium*** (C. Muelelr) Bosch. & Lac.

Near Kabbe Holidays, on coffee trees and trunks of other trees in the valley. It is recognized by the spirally arranged, not complanate leaves and double costa.

Aerobryopsis longissima (Dozy & Molk.) Fleisch.

Honey Valley and Kabbe Mt., scattered, pendant moss with short, very acute branches and long, fine, tortuouse leaf point.

Anomobryum auratum (Mitt.) A. Jaeger

In the whole stuffy area. The linear thick walled upper laminal cells and the costa vanishing well below the apex identify the specimens as *A. auratum* (Ochi 1985). The plants vary much in size, they can be less than one or several centimetres. The species frequently grows on rocks and rocky trail banks.

Atrichum pallidum Renauld & Cardot

Only once found on the way to Kabbe pass between grasses along the roadside. *Atrichum aculeatum* Card. & P. de la Varde is synonymous (Nyholm 1971). The species can be recognized by its small laminal cells (about 18 µm in diameter) and the low lamellae. Another species, *Atrichum obtusulum* (Müll. Hal.) A. Jaeger, is listed for India (Dandotiya *et al.* 2011). According to the Tropicos database (<http://www.tropicos.org>), it is a legitimate species, but not treated by Nyholm (1971).

*****Barbella bombycina*** (Ren. & Card.) M. Fleisch.

Waterfall below Chingara, Honey Valley, on stem.

*****Barbella pendula*** (Sull.) M. Fleisch.

Kabbe Valley, pendant moss, recognized by flagelliform apices of branches.

Barbula indica (Hook.) Spreng.

Found on trail banks in Kabbe Valley

Brachymerium exile (Dozy & Molk.) Sande Lac.

Kabbe Holiday Resort, on bare soil. The illustrations of the leaves of *B. exile* and *B. acuminatum* Harv. by Gangulee (1969–1972) look very similar, however, Ochi (1972) illustrates *B. exile* with long excurrent nerves and *B. acuminatum* with only percurrent nerves. The present specimens have a long excurrent arista.

*****Brachymerium longicolle*** Thér.

Kabbe Valley and Honey Valley, on rocks and tree trunks. Similar to *B. nepalense* but with distinct apophysis. So far it is known from the Himalaya region.

Brachymerium nepalense Hook.

Kabbe Holiday Resort, on tree trunk. Brotherus (1899) lists *B. nepalense* as common from Coorg, which has an indistinct apophysis as compared with *B. longicolle*.

Brachymerium sp.

Chingara Estate House, walk to Manjamotte. The plants are large and robust, have long appressed foliate stems, 1 cm long or more, and lanceolate leaves with narrowly incurved leaf margins, with long setae up to 3 cm with erect or inclined cylindrical capsule without apophysis. It grew on rock associated with *Bryum wightii*.

*****Bryum argenteum*** Hedw. var. *lanatum* (P. Beauv.) Hampe

Kabbe Holiday resort, on earth covered wall. This variety is characterized by the smaller size, the leaf tips curved outside and the occurrence in natural habitats, such as soil in open grassland. In

contrast, the much 'fatter' *B. argenteum* var. *argenteum* with straight leaf apices is a nitrophilous species from urban environments.

Bryum billardieri Schwaegr.

This *Bryum* of sect. *Rossulabryum* looks a miniature *Rhodobryum*. It forms a complex of closely related species which was treated by Mohamed (1982). The species is frequent on humic soil and earth covered rocks in forests at all elevations.

*****Bryum neelgheriense*** Mont.

This species is related to *B. billardieri* but has filamentous gemmae in the leaf axils. It was collected once in Honey Valley. Walker collected the species in Coorg on dry clay banks near Virajpet [as *B. ramosum* (Harv.) Mitt.]. The species is treated in the *B. billardieri* complex (Mohamed 1979) as well in the *B. wightii* complex (Mohamed 1982), but seems to be related to *B. billardieri* in the same way as *Bryum moravicum* Podp. and *B. capillare* Hedw. in Europe.

Bryum wightii Mitt.

It is the most common species of *Bryum* in the study area. A very conspicuous large species, often more than 10 cm, with conspicuous shining yellow-whitish-golden colour (according to Mohamed honey colour), which grows everywhere in exposed dry granite rocks in a typical association together with *Campylopus recurvus* and *Macromitrium densum*. Male plants were found once, however, no sporophytes. It can be identified using the work of Ochi (1985). As mentioned by the latter author, the species is very variable. The specimens are often gigantic for a species of *Bryum*, resembling *Aulacomnium palustre* (Hedw.) Schwaegr. Mohamed (1982) states that the size of the plants decreases from Ceylon northwards to India and that the specimens from the Western Ghats are usually smaller than the Ceylonese specimens. Thus, we cannot imagine how big the Ceylonese specimens will be. The size is in contrast to the dry habitat. Although Mohamed (1982) characterizes the habitat 'near wet areas

such as waterfalls', which is not the fact in our study area, where the species grows on small rocks and large boulders mainly in grassland, and also on rocky outcrops, where it prefers temporarily seeping inclined rocks similarly to the habitat of *Bryum alpinum* Brid. (with which it seems to be related) in Europe.

**Calymperes erosum* Müll. Hal.

Kabbe Valley on bark at lower altitudes, found often with *Octoblepharum*, rare, and not well developed. For a key to the southern Indian species of this genus, see Ellis (1989). The brood bodies are produced all around the excurrent costa and the teniolae stretch from the leaf base almost to the leaf tip.

Calypothecium wightii (Mitt.) M. Fleisch.

On bark in the forest around Chelavara Falls.

Campylopus fragilis (Brid.) Bruch & Schimp.
subsp. *goughii* (Mitt.) J.-P. Frahm

On bark, rotten wood and rocks, the most common species of *Campylopus* in the study area in elevations above 1000 m. For a revision of the Indian species, see Frahm (2012). The subspecies is recognized in the field by its small stature (< 2 cm) and white shining leaf bases because of thin walled hyaline basal laminal cells. The upper laminal cells are short oval to oblique. The costa is very wide (more than half of the leaf width) and has large hyaline ventral hyalocysts, which may be also recognized without transverse section. The leaf is contracted at base. This species was known from India as *C. goughii* (Mitt.) A. Jaeger before, but belongs clearly to *C. fragilis*, from which it differs only by the shape of the upper laminal cells (oval instead of quadrate) and the costa not widened below the middle of the leaf. *Campylopus fragilis* subsp. *fragilis* has characteristic bunches of brood leaves in the axils of the upper leaves, which seem to lack in subsp. *goughii*, which has rarely short reduced branches or deciduous normal developed leaves as means of vegetative propagation. Another vicariant

taxon, *C. fragilis* subsp. *zollingerianus* (Müll. Hal.) J.-P. Frahm, is found in Indonesia, which has shortly rectangular upper laminal cells instead of oval or quadrate ones.

**Campylopus ericoides* (Griff.) A. Jaeger

Mt. Kabbe, Mt. Tandiandamol, on rocks 1200–1500 m. This is a species difficult to recognize. It has subhyaline leaf tips, that means the excurrent costa can be shortly hyaline, almost hyaline or not. For that reason the species was listed in the *Campylopus* species of Sri Lanka (Frahm 1984) under two names, *C. involutus* (Müll. Hal.) A. Jaeger (with hair points) and *C. ericoides* (without hair points). The name refers to the involute margins of the upper parts of the leaves. The upper laminal are oval and thus identical with *C. schmidii*. Problematical are also the basal laminal cells, which are rectangular and thick walled, although they can be thin walled (presumably in perichaetial leaves). Significant is the presence of side nerves, which are never found in *C. schmidii*, but in species of subg. *Thysanomitrium*, such as *C. umbellatus*. Characteristic is also the transverse section of the costa, which shows ventral subhyalocysts, that means the ventral cells are not enlarged but as large as the median deuter cells.

***Campylopus recurvus* Mitt.

Mt. Kabbe, Mt. Tandiandamol, on rocks, boulders and outcrops, also on gravely soil in grassland at higher elevations above 1200 m. This species is easily recognized by its blackish colour and recurved leaves with hyaline hair points. The upper laminal cells are oval and the basal ones subquadrate and thick walled and show a border of many rows of linear thin walled cells. This border can also cover the whole leaf base giving the impression of hyaline basal laminal cells. The alar cells are conspicuously protruding into the costa. Superficially, this species resembles *Campylopus umbellatus* in the blackish colour and oval upper laminal cells but differs by the recurved leaf apices and the transverse section of the costa with ventral

hyalocysts and no ventral stereids. *Campylopus sedgwickii* Dix. described from Sri Lanka and so far only known from the type locality is a new synonym.

Campylopus recurvus (Mitt.) A. Jaeger, Ber. Thätigk. St. Gallischen Naturwiss. Ges. 1870–1871: 418, 1872. *Campylopus sedgwickii* Dix., J. Bot. 48: 303. 1910, *syn. nov.*

***Campylopus schmidii* (Müll. Hal.) A. Jaeger

Mt. Kabbe, on granitic outcrops at 1400 m. *Campylopus schmidii* is an older name for *C. aureus* Bosch & Sande Lac., a species widespread from Eastern Africa to Hawaii and India to northern Australia. It is a vicariant species of *C. pilifer* Brid. and differs from the latter only by the lack of lamellae at the back of the costa. As indicated by the collectors name, the type locality is in the Nilghiris. The species is characterized by oval upper laminal cells, rectangular thin-walled hyaline basal laminal cells, and the presence of hyaline hairpoints, which form pencil-like stem tips when well developed. Shade forms with reduced hairpoints are to distinguish from *C. ericoides* by hyaline thin-walled basal laminal cells. Both species can grow together in the same habitat. The plants are conspicuously golden-yellowish (cf., the name of *C. aureus*).

Campylopus umbellatus (Arn.) Par.

Mt. Kabbe, Mt. Manjamotte, Mt. Tandiamamol, on rocks at high altitudes. This is the most common species of *Campylopus* in SE Asia, where it grows in masses on rocks, typically along roadsides. The plants are usually blackish, the leaves have hairpoints and the stems have bud like perichaetia. In the study area, however, the species is dark green, has more often epilose or subepilose leaves and no perichaetia nor sporophytes. However, the species is recognized by the oval, pitted laminal cells, which are shortly rectangular and with a band of narrow hyaline cells only at the very base. The leaves are contracted at base and widest below the middle and show side nerves. The species was misnamed in India as *C. richardii* Brid. For details see Frahm (2012).

***Claopodium prionophyllum* (Müll. Hal.) Broth.

Waterfall below Chingaara, Honey Valley, on rocks along stream.

Cryptopapillaria fuscescens (Hook.) M. Menzel

Most frequent pendant moss in trees and bushes in the study areas.

***Curviciadium kurzii* (Kindb.) Enroth

Honey Valley, on rock near stream. The species is recognized by an intramarginal border of elongate like *Pinnatella alopecuroides*, from which it differs by smaller stature, subdendroid branching and shorter intramarginal border. The leaves are conspicuously hooked in dry state. According to Gangulee (1969–1972) and Dandotiya *et al.* (2011), this species is Himalayan in distribution.

Cyathophorum adianthum (Griff.) Mitt.

On bark on Mt. Tandiamamol where Walker had collected this species already in 1898–1899 (Brotherus 1899).

Daltonia sp.

Mt. Kabbe, on twig. All species of the genus listed by Gangulee (1969–1972) and Dandotiya *et al.* (2011) are reported from the Himalaya region. The key in Gangulee does not allow a proper identification.

Diaphanodon blandus (Harv.) Ren. & Cardot

Trail to Mt. Tandiamamol, Kabbe Mt., Honey Valley, base of tree and rocks. *Diaphanodon procumbens* is not included in Gangulee (1969–1972) and therefore it could not be decided whether the specimens might belong to the latter, which is mentioned by Dixon from Kanara.

Ditrichum sp.

Chingara Estate House, occasionally on vertical roadside banks with *Pogonatum* spp. etc. *Ditrichum tortipes* is the only species which Gangulee (1969–1972) reports from outside the Himalaya. Our collection is similar but the operculum ends

in a longer beak. Dandotiya *et al.* (2011) list also *D. amoenum* (Thwaites & Mitt.) Paris and *D. difficile* (Duby) M. Fleisch. from southern India.

*****Dixonia orientalis*** (Mitt.) H. Akiyama & Tsubota

Forest below Mt. Tandiandamol, on rock (det. J. Enroth).

*****Entodon chloropus*** Renaud & Cardot

Mt. Manjamotte, on rocks and branches.

****Entosthodon wallichii*** Mitt.

Everywhere frequent along roadside banks and on open soil in grass- and bushland. The species is characterized by the presence of a peristome, which, however, is easily detached that the capsules give the impression of an stegocarpous moss.

Fissidens sedgwickii Broth. & Dix.

Kabbe valley, on rocks in stream (det. M. A. Bruggeman-Nannenga). The plants are 2 mm wide, stiff and rigid, not contorted when dry. The leaves have a bistratose dorsal lamina and the vaginant lamina gets bistratose towards the costa. Insofar the specimen resembles *Pachyfissidens*, in which the species was originally described.

Floribundaria floribunda (Dozy & Molk.)

M. Fleisch.

Everywhere frequent on branches of trees and shrubs. The plants are very variable and can be small, only to 25 mm long and 1 mm wide, with acute or longely acuminate (unicellular) leaf tip. Therefore, it cannot be excluded that more species are hidden amongst the specimens, which needs, however, a more careful examination including the study of the types.

Funaria hygrometrica Hedw.

Kabbe Valley, on wall.

Garckea flexuosa (Griff.) Marg. & Nork.

Everywhere on roadside banks and trail banks, also on open bare loamy soil with *Trematodon*

spp., scattered or also in masses, often with immersed sporophytes.

Himantocladium cyclophyllum (Müll. Hal.)

M. Fleisch.

Kabbe Valley, on rock along stream (teste J. Enroth)

*****Himantocladium plumula*** (Nees) M. Fleisch.

Kabbe Valley, on rock along stream.

******Holomitrium javanicum*** Dozy & Molk.

Honey Valley, walk to Manjamotte, on branch ca 1300 m. The moss is conspicuous because of its flagellae in the axils of the upper leaves.

*****Homaliodendron crassinervium*** Thér.

On tree trunk in Honey Valley and Mt. Tandiandamol. This species has not yet been recorded outside the Himalaya, however, the taxonomy of the Indian representative of this genus needs clarification, since Dandotiya *et al.* (2011) do not have the species in their checklist. It seems to be characterized by relative small (1 mm) branch leaves, which are very short (1:2) and extremely long serrate leaf tips.

*****Homaliodendron exiguum*** (Bosch. & Sande

Lac.) M. Fleisch.

Found on bark at Mt. Tandiandamol, as well as on rotten wood in a small ridge along the way between Madikeri and Virajpet. The obtuse leaves make it easily distinguishable from the other species of the genus.

Homaliodendron flabellatum (Sm.) M. Fleisch.

Chingara Estate, in coffee plantation.

Hyophila involuta (Hook.) A. Jaeger

A pantropical species, usually growing in masses on rocks and concrete walls. Brotherus (1899) mentioned this species, but *H. cylindricarpa* (Hook ex Harv.) A. Jaeger from much more

collections, which has not been observed by the authors in the area.

*****Hypopterygium tamarisci* (Besch.) Kindb.**

Mt. Tandiandamol; waterfall behind pass above Honey Valley, scattered on rocks, rotten wood and base of tree trunks 1000–1650 m. The plants are of variable size and can sometimes be minute (*'H. tenellum'*), however, all intergradations can be observed in the field. *Hypopterygium tamarisci* is a pantropical species and was described under 81 (!) different names (Kruijer 2002). Dandotiya *et al.* (2011) listed five species from India, of which *H. aristatum* Bosch & Sande Lac. is a synonym of *H. flavolimbatum* Müll. Hal. and *H. tenellum* Müll. Hal. is synonymous with *H. tamarisci*. *Hypopterygium pachyloma* Dix. *ex* R. S. Chopra recorded from W. Bengal belongs to *Dendrohypopterygium arbuscula* (Brid.) Kruijer. Thus, only two but not five species are present in India. The second species in India, *H. flavolimbatus*, grows in India only at the flanks of the Himalayas and differs by leaves arranged in eight, not three rows.

*****Leucobryum juniperoideum* (Brid.) Müll. Hal.**

Mt. Tandiandamol, on tree trunk.

*****Leucoloma amoene-virens* Mitt.**

Everywhere frequent on tree trunks. In appearance, it is like a species of *Campylopus*, but with narrow costa and leaf margin of hyaline cells. It is the only representative of the genus in the area.

*****Macromitrium densum* Mitt.**

Everywhere on rocks in open habitats. The plants are characterized by blunt lingulate leaves and short ovoid to almost round capsules. It is only half the size of *M. sulcatum*. Gangulee (1969–1972) indicates this species only from Nepal.

***Macromitrium moorcroftii* Schwaegr.**

Only found once on bark near Chelavara Falls.

***Macromitrium sulcatum* Brid.**

By far the most common *Macromitrium* species in the study areas. It grows mostly on bark but can also found on stone and rarely on soil. The hyaline group of cells in the middle of the leaf base with adjacent papillose, rectangular cells and the lanceolate leaf shape distinguish it from all other species.

***Macromitrium* sp.**

Mt. Kabbe. This peculiar species was found occasionally on stone. Its circular, mamilliose cells that create trigones in the cell angles are most characteristic.

***Meteoriopsis reclinata* (Müll. Hal.) M. Fleisch.**

A common epiphyte in the study areas. The species name refers to the squarrose leaves.

****Microdus brasiliensis* (Duby) Thér.**

Trail to Mt. Kabbe, occasionally on bare soil, associated with *Garckea flexuosa* and *Trematodon longicollis*. Easy to recognize by the *Dicranella* like appearance of the plant and the almost globose capsules without peristome.

***Microcampylopus khasianus* (Mitt.) Giese & Frahm**

Once found in masses on soil of a trail E of Kabbe Pass. The checklist by Dandotiya *et al.* (2011) lists five species [*Campylopodium griffithii* (Mitt.) Mitt. *ex* Broth., *C. khasianus* (Griffiths) Paris, *C. phascoides* (Müll. Hal.) Paris, as well as *Microcampylopus khasianus* and *M. subnanus* (Müll. Hal.) Broth.], which are all identical with this species (Frahm 2012). The lack of stomata in the capsules clearly proves that it is a species of *Microcampylopus*, not *Campylopodium*.

***Octoblepharum albidum* (Hedw.) Mitt.**

A pantropical species in the study areas on tree trunks at elevations below 1000 m altitude, usually in small quantities.

*****Oxystegus tenuirostris*** (Hook. & Tayl.)

A. J. E. Smith

Kabbe Valley, on rocks in shady habitats. *Oxystegus cylindricus* (Bruch ex Brid.) Hilp. (Dandotiya *et al.* 2011) is not a separate species but a synonym.

Philonotis mollis (Dozy & Molk.) Mitt.

Everywhere on soil and rocks along roadsides. The plants are only 1 cm tall, although described by Gangulee as more than 2 cm, but fit the species description in other respects. They can be recognized by the blue-green colour of the leaves, which are very lax and distant along the stem.

Philonotis thwaitesii Mitt.

Kabbe valley, on wet rock in coffee plantation. In contrast to the previous species, these plants are densely foliate with a thick tomentum and have leaves with strongly involute leaf margins.

Pinnatella alopecuroides (Mitt.) M. Fleisch.

On tree trunk in Honey Valley.

*****Pinnatella kurzii*** (Kindb.) Wihj & Marg.

On tree trunk in Honey Valley.

****Pinnatella limbata*** Dix.

Waterfall below Chingaara House, on rock in stream (det. J. Enroth). This species was described by Dixon (1921) from Karnataka, and reportedly known from only one additional collection (see Enroth 1994) and is therefore regarded as critically endangered (J. Enroth, pers. com.), but the species has been collected several times in the area by the authors. A special publication by the first author dealing with the status of this species is under preparation. The name refers to the bistratose leaf border.

Pogonatum neesii (Müll. Hal.) Dozy

Common on roadside banks in the study areas. Hyvönen (1989) calls it the most common species of the genus in SE Asia. It has somewhat

flattened lamellae, which is papillose according to Hyvönen (1989), which is not the fact in our specimens. *Pogonatum neesii* is commonly treated as forma of *P. aloides* (Hedw.) P. Beauv. in the Indian literature, which is not the fact. Hyvönen (1989) writes: 'In the past, *Pogonatum aloides* has also been repeatedly been confused with the Asian *P. neesii*. The two species are very similar in that both have leaves curved in dry condition, and they have numerous teeth on the dorsal side of the wide costa. *P. neesii* is more variable in size, while *P. aloides* is almost always a plant with fairly short stems'.

*****Pogonatum patulum*** (Harv.) Mitt.

Honey Valley, Kabbe Valley. This is a minute species on bare soil of roadside banks. Eighteen species of *Pogonatum* have been so far reported from India (Dandotiya *et al.* 2011). The revision of the genus (Hyvönen 1989) cites only half the number for India. Four of them [*P. urnigerum* (Hedw.) P. Beauv., *P. microstomum* (R. Br. ex Schwägr.) Brid., *P. fastigiatum* Mitt., *P. nudiusculum* Mitt.] are large plants and *Polytrichum*-like species of higher altitudes. *P. proliferum* (Griff.) Mitt. has almost no lamellae, and *P. perichaetiale* (Mont.) A. Jaeger has strongly incrassate terminal cells of lamellae.

*****Pterobryopsis conchophylla*** (Renauld & Cardot) Broth.

Epiphytic in Honey Valley. The species has conspicuous flagellae. It is recognized by dendroid to subdendroid habit, ovate, concave leaves abruptly acuminate into a short point, quadrate alar cells, and costa reaching 2/3 of leaf length.

*****Pterobryopsis flexipes*** (Mitt.) M. Fleisch.

Epiphytic, rarely in Kabbe valley and ridge trail above Honey Valley.

*****Pterobryopsis gedehensis*** M. Fleisch.

Common and widespread on trees. The plants are very robust and have conspicuous flagellae similar to *P. conchophylla*, however, the costa is small and double and does not reach midleaf, like

the latter. The leaves are orbicular and very concave with a cucullate apex and abruptly narrowed in a fine long point. Although not reported from Karnataka before and not included in Gangulee (1969–1972), the species is quite frequent in the region. Of the six species (incl. *Pterobryon*) reported from Karnataka, only three are described and illustrated by Gangulee (1969–1972), who includes three more species from the Himalayas. Dandotiya *et al.* (2011) list twelve species in the genus for India.

Pterobryopsis tumida (Dix. ex Hook.) Dix.

Common epiphyte or pendant robust moss, frequent on tree trunks in all altitudes.

Racopilum cuspidigerum (Schwägr.) Ångstr.

Common and frequent on stones and walls. Dandotiya *et al.* (2011) listed four species [*R. cuspidigerum*, *R. intermedium* Hampe, *R. orthocarpum* Wils. ex Mitt. and *R. schmidii* (Müll. Hal.) Mitt.], while Gangulee (1969–1972) only two (*R. cuspidigerum* and *R. orthocarpum* Wilson ex Mitt.), which the latter differentiates by the position of the capsule (inclined viz. erect), although sporophytes were not found in India.

Racopilum sp.

We collected two species, a larger one with acute leaves and serrate leaf margins and a smaller one with obtuse leaf tips with smooth or finely crenulate margins. The first is attributed to *R. cuspidigerum* as compared with the illustration in Gangulee (1969–1972). We have no name for the second one. Since Gangulee describes and illustrates *R. orthocarpum* with serrate leaf margins, the unknown species could be *R. schmidii*. This is supported by the fact that Müller described (*Botanische Zeitung* 1854: 558) the leaves as oblong with crenulate margins. However, Van Zanten (2006) placed *R. schmidii* as a synonym to *R. cuspidigerum*.

Rhodobryum giganteum (Schwaegr.) Paris

On rocks, only at Mt. Tadiandamol in 1650 m altitude. The species looks similar to *Rh. roseum*

(Hedw.) Limpr., which is only a bit smaller but has single teeth, whereas *Rh. giganteum* has the teeth in pairs.

Schoenobryum concavifolium (Griff.) Gangulee

Honey Valley, on coffee trees.

*****Symphysodontella tortifolia*** Dix.

Kabbe valley, in coffee plantation, a conspicuous dendroid epiphyte.

*****Thamniopsis utacamundiana*** (Mont.) W. R. Buck

On rocks in the forest below the summit of Mt. Tadiandamol. The plants are conspicuously reddish.

*****Thuidium cymbifolium*** (Dozy & Molk.) Dozy & Molk.

Mt. Tadiandamol at 1650 m, on rocks and fallen tree trunks. It's one of the frequent *Thuidium* species in the area that was found around the homestays at 1100 m up the remnant forests.

*****Thuidium orientale*** Mitt. ex Dix.

Kabbe Valley, on rock beside stream. Recognized by the spinose back of the costa.

Trachypodopsis serrulata (P. Beauv.) Besch.

Kabbe Valley, occasionally on rocks in coffee plantation.

Trematodon longicollis Michx.

Kabbe Valley and Honey Valley, occasionally on soil banks, sometimes in masses. A pantropical species which is often reported in the Indian bryological literature, although Chopra (1975) does not recognize it. The species can be recognized by the long column, which is about three times as long as the urn. The size of the plants varies much, small plants with shorter setae give the impression of a separate species but have the same spore size and ornamentation.

***Trematodon* sp.**

On soil bank at Kabbe Resort. The plants are minute and the urn is of about the same length as the column.

***Trichosteleum monostictum* (Thwaites & Mitt.) Broth.**

On rotten wood in a remnant forest at Mt. Tadiandamol. This species was already reported by Brotherus (1899) from the same location. *Trichosteleum stigmosum* Mitt. that was recently reported by Manju *et al.* (2012) from Kerala shows a close resemblance to *T. monostictum*. Both species are closely related to *T. boschii* (Dozy & Molk.) A. Jaeger and should be studied in more detail in future.

***Weissia edentula* Mitt.**

Honey Valley, on roadside banks and trail banks, also on open bare loamy soil. It is quite often associated with *Garckea flexuosa* and *Philonotis* species. All the collections bear sporogons that make it easy to distinguish it from other *Pottiaceae*.

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