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Mosses of southwest Ethiopian montane forests – notes on their occurrence pattern and many new country records

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One hundred and thirty-nine taxa of mosses are reported from the montane forest zone of southwest Ethiopia. Of these, 53 taxa are new country records and *Meteoriopsis reclinata* (Müll.Hal.) M.Fleisch. ex Broth. is, in addition, new to Africa. Most of the new records are of species also found in Uganda, Kenya or Tanzania, but there are some surprises, such as *Fabronia perciliata* Müll.Hal. with the closest location in South Africa and Namibia, *Entodontella cameruniae* Broth. previously known only from West Africa and *Bryomaltaea obtusifolia* (Hook.) Goffinet, otherwise reported only from the Democratic Republic of the Congo. We list all taxa and give a short account of their frequency and in which habitat and on which substrate they grow. That such a large proportion of the species are new to the country suggests that Ethiopia is bryologically very under-explored, and that further exploration will reveal many additional species. In particular, the remnant forests of southwest Ethiopia are likely to be of great importance as bryophyte hotspots.

Keywords: Afromontane forest, Bryophyte, Ethiopia, Substrate

Introduction

The first checklist of the Horn of Africa (Ethiopia, Eritrea and Somalia) reported 177 mosses (Cufodontis, 1951) and according to the most recent checklist for Africa (O'Shea, 2006), 274 mosses have been reported from Ethiopia. However, the number of moss species occurring in the country is likely to be much greater, given that the neighbouring country of Kenya has 492 species recorded in the same checklist, and that the montane forest ecosystems of the two countries have many features in common. We recently published 51 new country records of liverworts, based on inventories of bryophytes from forests and homegardens in southwest Ethiopia (Hylander *et al.*, 2010), with a further 11 new country records published in Ellis *et al.* (2014). In this paper, we report on the mosses recorded by us in the same region, and provide brief notes on their habitats and substrate preferences.

Study Area and Methods

Study area

Most of the collections described in this paper came from two different field projects investigating the

distribution of biodiversity across agro-ecological landscapes around the town of Bonga (7.27°N, 36.27°E), the administrative headquarters of the Kaffa zone of Southern Nations, Nationalities and Peoples Regional State in southwest Ethiopia. This area is characterised by an undulating topography ranging in altitude between 1650 and 2200 m a.s.l., with an annual precipitation of around 1800–2000 mm. The landscape is a mosaic, with both remnant moist Afromontane forests (Friis *et al.*, 2010) and open agricultural areas with small-holder farmers.

Methods

Our study focused on the epiphytic vascular plant and bryophyte plant communities of isolated trees in home gardens. However, we also investigated the epiphytic flora on shrubs, including coffee (*Coffea arabica* L.) which is common here. In one of the projects we also inventoried all species that occurred in a number of 20 × 10 m plots. We also investigated plantations of exotic trees and forest sites in order to compare their floras with those of the home gardens. We climbed trees to access the canopy in many places. The patterns of species richness and composition in relation to habitat types, distances from forest and time since disturbance are described in Hylander & Nemomissa

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(2008, 2009, 2017). In the present paper, we concentrate on floristic information as well as habitat and substrate associations.

In addition to the collections made during these investigations, we also report a few species from other regions of southwest Ethiopia which we visited occasionally, for example from the north of Tepi (07.39°N, 35.39°E) at around 2300 m elevation, in a more humid area than Bonga.

Results

The following list comprises 139 moss taxa, of which 54 are new country records. Two species that we collected have been discussed before: *Fissidens curticostratus* Brugg.-Nann., Hylander & Pursell was newly described from material collected during the present study (Bruggeman-Nannenga, 2009) and *Physcomitrella magdalanæ* De Sloover, collected by us in southwest Ethiopia, was reported new to Ethiopia by Medina *et al.* (2015). However, this is the first complete list of the mosses reported from southwest Ethiopia, although many species have already been included in the appendices of two ecological papers covering the region (Hylander & Nemomissa, 2009, 2017), but without information on their habitats or the substrate on which they occurred.

The following species were found to be dominant or abundant in some of the surveyed habitats in our study area:

Disturbed mesic to moist soil: *Fissidens androgynus*, *F. submarginatus*, *F. usambaricus*, *Philonotis* spp., *Physcomitrella magdalanæ*, *Pogonatum* spp.

Exposed trees in agricultural landscapes:

Trunks: *Brachymenium* spp., *Erythrodontium julaceum*, *Syntrichia fragilis*

Crowns: *Braunia secunda*, *Leptodontium viticulosoides*

Half-shaded coffee shrubs: *Cryphaea rutenbergii*, *Entodontopsis nitens*, *Fabronia pilifera*, *Macrocoma* spp., *Schoenobryum concavifolium*, *Schwetschkea fabronioides*

Shaded trees and shrubs:

Base: *Hypopterygium tamarisci*, *Octoblepharum albidum*, *Porotrichum stipitatum*, *Racopilum africanum*, *Thamniopsis utacamundiana*, *Wijkia jungneri*

Trunks and shrubs in understory: *Entodontella cameruniae*, *Floribundaria* spp., *Neckera remota*, *Orthostichella pandurifolia*, *Porotrichum elongatum*

Crown: *Regmatodon orthostegius*

Dead wood: *Phyllodon* spp., *Rhynchostegium* cf. *distans*, *Thamniopsis utacamundiana*, *Vesicularia* spp., *Wijkia jungneri*

Streams: *Fissidens* spp., *Porotrichum stipitatum*

Annotated species list

* New to Ethiopia

** New to Africa

Full collection details are provided for only a single specimen of each of the 54 taxa new to Ethiopia. Geographical coordinates are given either in decimal degrees or in UTM (WGS84 in both cases). Distributional information is mostly derived from O'Shea (2006). Representative collections of most species are deposited at ETH. Some duplicates are also held in S and in the private herbarium of K. Hylander (KHY), or with the specialists who identified or confirmed the collections. All collections were made by Kristoffer Hylander, unless otherwise indicated.

Anomodontaceae

Herpetineuron tocoae (Sull. & Lesq.) Cardot: Only two known localities, growing as an epiphyte in open forest sites between 1900 and 2000 m a.s.l. Widespread in tropical Africa; also in South Africa and Madagascar.

Archidiaceae

**Archidium* sp.: Bonga; KDP guesthouse; on soil in garden; 1785 m a.s.l.; 9 February 2006; 7.25116°N 36.25385°E, KHY 4347 (KHY); *det.* Hylander.

On soil. Sterile specimen. Genus new to Ethiopia. The most widespread species in Africa is *Archidium ohioense* Schimp. *ex* Müll.Hal.

Bartramiaceae

**Leiomela bartramioides* (Hook.) Paris: Tepi; 25 km N towards Mettu; growing on a soil bank in forest; 2300 m a.s.l.; 21 January 2009; 7.39089°N 35.38821°E; KHY 7931 (ETH, KHY); *det.* Hylander.

Only one record of this montane species, but areas above 2000 m a.s.l. are poorly represented in the collections. Local in tropical West and East Africa including Kenya and Tanzania.

Philonotis sp.: Common in ditches along roads.

Brachytheciaceae

Aerolindigia capillacea (Hornsch.) M.Menzel: Rather frequently found as an epiphyte in forest and semi-forest coffee stands, often on rather thin branches and frequently with capsules. Scarce in tropical East Africa, and Madagascar.

Brachythecium ruderale (Brid.) W.R.Buck: Found a few times on soil or on stumps in plantations of *Cupressus lusitanica* Mill. or at the forest edge. In Ethiopia, previously reported under the name *Brachythecium implicatum* (Hornsch. *ex* Müll.) A.Jaeger. Widespread in tropical East Africa, extending to South Africa.

Brachythecium cf. *gloriosum* (Müll.Hal.) Kindb.: Shiny species found regularly as an epiphyte on semi-exposed trees. *Brachythecium gloriosum* is also known from a few other East African countries.

**Rhynchostegiella* cf. *litorea* (De Not.) Limpr.: Bonga, Gimbo, Kaja Arba; 3 km N of Bonga; growing on *Nuxia congesta* R.Br. ex Fresen.; 1743 m a.s.l.; 8 November 2006; 37N 806496 196591; *KHY 6402* (ETH); det. Hylander (another specimen in S identified by Michael Ignatov).

Epiphytic in afro-montane forest. Several records on *Schefflera abyssinica* (Hochst. ex A.Rich.) Harms. Genus new to Ethiopia. In Africa, this species has been reported only from South Africa.

Rhynchostegium cf. *distans* Besch.: Common on dead wood and on soil in forests and plantations of *Cupressus* L. Regularly found with capsules. Also known from Uganda, Tanzania and some of the islands in the Indian Ocean.

Rhynchostegium bello-intricatum (Müll.Hal. ex Broth.) Paris: Frequent epiphytic species in forests and in semi-open habitats. Often found on coffee. Often fertile. Previously known under the name *Schimperella bello-intricata* (Broth.) W.R.Buck. Widespread in tropical Africa.

Palamocladium leskeoides (Hook.) E.Britton: Found once as an epiphyte on a liana at the forest edge. Widespread in Africa but no records from West Africa.

Schwetschkea fabronioides (Welw. & Duby) Broth.: Common epiphytic species on shrubs, including coffee, in partial shade. Previously reported from Ethiopia under the synonym *Schwetschkea schweinfurthii* Müll.Hal. Formerly placed in the Leskeaceae (Buck & Pôrto, 2010). Recorded also from West, Central and East Africa.

Squamidium brasiliense (Horns.) Broth.: Infrequent epiphytic species in afro-montane forest, often on shrubs. Probably overlooked because of its superficial similarity to *Orthostichella pandurifolia* and *O. welwitschii*. Known from East and southern Africa; closest records from Kenya.

Within the Brachytheciaceae, we also found several species of *Eurhynchium* or *Oxyrrhynchium*, and also some taxa not yet named to genus or species.

Bryaceae

Anomobryum julaceum (P.Gaertn., B.Mey. & Scherb.) Schimp.: Occasionally found on soil at stream margins. Widespread in Africa.

Brachymenium capitulatum (Mitt.) Paris: Frequent epiphyte on both trees and shrubs, including coffee, in exposed sites. Widespread in Africa.

Brachymenium leptophyllum (Bruch & Schimp. ex Müll.Hal.) Bruch & Schimp. ex A.Jaeger: Common on exposed stems and in tree crowns in less exposed places. Widespread in Africa.

Brachymenium systylium (Müll.Hal.) A.Jaeger: Occasional on exposed stems and in tree crowns. Widespread in Africa.

Brachymenium sp.: Abundant on exposed stems and in tree crowns. The largest and most common *Brachymenium* in the collections. Resembling *B. nepalense* Hook., not yet known from Ethiopia, or *B. rigidum* Broth. & Paris, recently reported from the area (Müller & Flügel, 2016).

Bryum apiculatum Schwägr.: Occasional on boulders in or close to streams. Widespread in Africa.

Bryum argenteum Hedw.: Found once on a tree base in the agricultural landscape. Widespread in Africa.

Bryum huillense Welw. & Duby: A frequent species on tree bases; sometimes on woody debris or soil in forest. Widespread in Africa.

**Rhodobryum commersonii* (Schwägr.) Brid.: Bonga, Gimbo; Keya Kella, 6 km N of Bonga towards Diri Guma; growing on ground; 1746 m a.s.l.; 1 November 2006; 37N 809937 195438; *KHY 5570* (ETH); det. Hylander.

Frequent on the forest floor especially in plantations of *Cupressus lusitanica*. Known from many African countries including Kenya, Tanzania and Uganda.

We also collected a few other species of the Bryaceae belonging to the genera *Brachymenium*, *Bryum* and perhaps *Pohlia* that we have not yet been able to identify.

Calympereaceae

**Calymperes* sp.: Bonga; rare in tree crown; 1703 m a.s.l.; 19 January 2009; 37N 800839 197010; *KHY 7742* (KHY); det. Hylander.

Epiphyte, rare in the crown of an *Albizia gummi-fera* (J.F.Gmel.) C.A.Sm. in the agricultural landscape. Genus new to Ethiopia. Several *Calymperes* species are widespread in Africa.

**Syrrophodon gaudichaudii* Mont.: Bonga; growing on *Phoenix reclinata* Jacq.; 1800 m a.s.l.; 26 November 2008; 37N 802500 190700; *KHY 7740* (ETH); det. Hylander.

Occasional epiphyte on lower stems and on dead wood in humid forests, often on stems of *Phoenix reclinata*. Widespread in Africa.

Syrrophodon gardneri (Hook.) Schwägr.: Frequent as an epiphyte on lower stems and on dead wood, often in humid sites in the forests. Recorded in many countries across tropical Africa.

Cryphaeaceae

Cryphaea rutenbergii Müll.Hal.: Common epiphytic species, mainly on shrubs. Frequent both in forests and in more open habitats. Known from East and southern Africa; closest records from Kenya.

Schoenobryum concavifolium (Griff.) Manuel.: Common epiphytic species, especially on shrubs, often in rather exposed positions. Widespread in Africa.

Daltoniaceae

Daltonia cf. *angustifolia* Dozy & Molk.: Infrequent as an epiphyte on branches both at lower and higher levels in the canopy. *D. angustifolia* has been recorded from both East and West Africa.

**Daltonia latolimbata* Broth.: Tepi; 25 km N of, along road to Mettu; epiphytic on *Ilex mitis* (L.) Radlk.; 2300 m a.s.l.; 21 January 2009; 7.39089°N 35.38821°E; *KHY* 7929 (ETH, KHY); *det.* Hylander, *conf.* Hedenäs.

One collection from a humid locality at 2300 m a.s.l. Found in Central and East Africa; closest records from Kenya.

Dicranaceae

Campylopus flaccidus Renaud & Cardot: Grew on soil banks. Abundant when present. Recently reported from the area (Müller & Flügel, 2016). Widespread in Africa.

**Campylopus flexuosus* (Hedw.) Brid.: Bonga; E of Catholic Church; on stumps in *Eucalyptus grandis* W.Hill plantation; 1704 m a.s.l.; 6 November 2006; 37N 803803 197754; *KHY* 4743 (ETH, JPF); *det.* Jan-Peter Frahm.

Occasional in tree crowns of forest trees. Widespread in Africa.

Campylopus savannarum (Müll.Hal.) Mitt.: Commonly recorded in tree crowns in the forest. Sometimes also epiphytic on tree boles. Widespread in Africa.

**Holomitrium cylindraceum* (Besch.) Wijk & Margad.: Bonga; growing in tree crown; 1775 m a.s.l.; 14 October 2008; 37N 808318 199877; *KHY* 5685 (KHY); *det.* Hylander.

Only found once, as an epiphyte on branch in forest. Three varieties of this species have been recognised from East and southern Africa. Our specimen is identified only to species level.

**Dicranella* sp.: Bonga; between Bonga and Wushwush; in ditch at forest edge; 1847 m a.s.l.; 20 January 2009; 37N 8005472 189260; *KHY* 7945 (ETH, KHY); *det.* Hylander.

On roadbanks at two sites. Genus new to Ethiopia.

Entodontaceae

Entodon geminidens (Besch.) Paris: Common on tree bases and lower parts of stems in forests and forest edges. Sometimes found on soil. Often fertile. Known from a few scattered countries throughout West, East and southern Africa.

Erythrodontium julaceum Hook.: Common epiphyte on exposed trunks and thick branches of trees. Often fertile. *Erythrodontium julaceum* was first reported from Ethiopia in Majestyk (2009), but based on a collection originally published in Bizot et al. (1978) as *E. rotundifolium* (Müll.Hal.) Paris and conserved in NY. Mostly recorded from East African countries.

Erythrodontium squarrosum (Hampe) Paris: Less frequent than *E. julaceum* in similar habitats. Widespread in tropical and southern Africa, and first reported from Ethiopia in Bizot et al. (1978) under the synonym *E. subjulaceum* (Müll.Hal.) Paris. Although not reported from the country in Majestyk's 2009 revision of the genus, apparently he did not examine the Danish collections of *Erythrodontium* from Ethiopia, described in Bizot et al. (1978), which are conserved in Copenhagen (C). Widespread in Africa.

Erpodiaceae

Erpodium beccarii Müll.Hal. ex Venturi: Epiphytic on an exposed tree in a home garden. Seems to be rare in this landscape. Widespread in East and southern Africa.

Fabroniaceae

Fabronia pilifera Hornsch.: Abundant on coffee in partially shaded locations. Widespread in Africa.

**Fabronia perciliata* Müll.Hal.: Bonga, Gimbo; Sheka, 5 km in NE direction; growing on *Vernonia* Schreb. sp.; 1928 m a.s.l.; 13 December 2006; 37N 806844 200046; *KHY* 4621 (ETH, S); *det.* Hedenäs.

Found a few times as an epiphyte on trees in home gardens and forests. Previously known only from South Africa and Namibia.

Levierella neckeroides (Griff.) O'Shea & Matcham: Frequent on partially shaded coffee shrubs and on shade trees in home gardens. Widespread in Africa, but many countries without records.

**Rhizofabronia persoonii* (Schwägr.) M.Fleisch.: Bonga; Araba Yeba forest, 3 km E of Wushwush; on tree fern in forest; 1798 m a.s.l.; 11 December 2006; 37N 807754 187334; *KHY* 7963 (ETH); *det.* Hylander (another specimen in S confirmed by Hedenäs).

Regular on stems of the tree fern *Cyathea manniana* Hook. in damp locations. Two varieties are known from tropical Africa, but our specimens are identified only to species level.

Fissidentaceae

Fissidens androgynus Bruch ex C.Krauss: Common and variable species on soil and epiphytic on lower trunks. Widespread in Africa.

**Fissidens beckettii* Mitt.: Bonga, Gimbo; Kicho, 1.5 in NNE direction; growing on ground, 1801 m a.s.l.; 17 December 2006; 37N 820674 195430; *KHY* 4535 (KHY, IBN); *det.* Hylander, *conf.* Ida Bruggeman-Nannenga.

On soil in a field. Only one record, but probably overlooked. Known from a few countries in South, Central and East Africa; closest records from Tanzania.

Fissidens bogosicus Müll.Hal.: Found once on a river bank. Widespread in East, Central and southern Africa.

**Fissidens borgenii* Hampe: Bonga, Gimbo; Ufudo; growing on *Phoenix reclinata*, 1701 m a.s.l.; 11 December 2006; 37N 812689 193444; *KHY 4532* (KHY, IBN); *det.* Hylander, *conf.* Ida Bruggeman-Nannenga.

Few records as epiphyte in afro-montane forest. Widespread in Africa.

**Fissidens cryptoneuron* P.de la Varde: Bonga, Gimbo; Socha forest, 2 km E of Diri Guma; growing on *Phoenix reclinata*; 1769 m a.s.l.; 7 November 2006; 37N 815925 202349; *KHY 4786* (ETH); *det.* Hylander (another specimen in IBN confirmed by Bruggeman-Nannenga).

Rather frequent epiphytic species in forests. Fairly widespread in tropical Central and East Africa; closest records from Kenya and Tanzania.

Fissidens curticosatus Brugg.-Nann., Hylander & Pursell: Rather frequent epiphyte on trees and shrubs, mostly in forests. Described from our collections (Bruggeman-Nannenga, 2009).

**Fissidens intromarginatus* (Hampe) A.Jaeger.: Bonga; Shapa, 1.5 km WSW of path crossing stream; on stream bank, 1900 m a.s.l.; 31 March 2007; 7.23825°N 36.21529°E; *KHY 4721* (KHY, IBN, ETH); *det.* Hylander, *conf.* Ida Bruggeman-Nannenga.

On stream bank; only one collection. Widespread in Africa.

**Fissidens leucocinctus* Hampe: Bonga; at the waterfall; growing on boulder in stream; 1821 m a.s.l.; 11 February 2006; 7.26785°N 36.27206°E; *KHY 4492* (ETH, IBN); *det.* Hylander, *conf.* Ida Bruggeman-Nannenga.

On rocks in streams in a few places. Widespread in Africa; closest records are from Kenya and Uganda.

**Fissidens metzgeria* (Müll.Hal.) Broth.: Bonga; growing on moist ground at stream margin; 1908 m; 14 October 2008; 37N 808318 199877; *KHY 8002* (ETH); *det.* Hylander.

On wet soil in stream margins or in ditches. Two known localities. Distribution from West to East tropical Africa; closest records are from Uganda and Tanzania.

**Fissidens ovatus* Brid.: Bonga; on the road to Tepi; growing on stream bank; 1600 m a.s.l.; 10 February 2006; 7.28207°N 36.20485°E; *KHY 4418* (ETH, IBN); *det.* Ida Bruggeman-Nannenga.

One collection from a stream bank. Widespread in Africa.

Fissidens porrectus Mitt.: On soil banks. A few collections. Widespread in Africa.

**Fissidens ramulosus* Mitt.: Bonga; Socha forest, 2.5 km SE of Diri Guma; on ground in *Pinus patula* Schiede ex Schltdl. & Cham. plantation; 1879 m a.s.l.; 7 November 2006; 37N 814781 202131; *KHY 4526* (ETH, IBN); *det.* Ida Bruggeman-Nannenga.

Can be found both on soil and as an epiphyte. Often in disturbed environments such as in home gardens and plantations. Widespread in Africa.

**Fissidens sciophyllus* Mitt.: Bonga; Barta forest, 3 km ENE of Bonga; growing on roots, 1940 m a.s.l.; 14 December 2006; 37N 804121 199310; *KHY 4528* (ETH, IBN); *det.* Ida Bruggeman-Nannenga.

Common epiphytic species in forests, especially on lower trunks. Also on other substrates such as soil and woody debris. Widespread in Africa.

**Fissidens serratus* Müll.Hal.: Bonga; Boka forest, SW of Checha Chata; growing on *Schefflera abyssinica* (Hochst. ex A.Rich.) Harms.; 1920 m a.s.l.; 10 December 2006; 37N 799133 194287; *KHY 4780* (ETH); *det.* Hylander

Rather frequent on woody debris and sometimes epiphytic. Widespread in Africa; closest records from Kenya and Tanzania.

**Fissidens submarginatus* Bruch ex C.Krauss: Bonga; Boka forest; growing on ground; 1956 m a.s.l.; 9 December 2006; 37N 796675 194564; *KHY 4534* (KHY, IBN); *det.* Hylander, *conf.* Ida Bruggeman-Nannenga.

Rather common on stream banks and road cuttings and other types of bare soil. Widespread in Africa.

**Fissidens usambaricus* Broth.: Bonga; 1.5 km SE of the town; growing on ground in *Pinus patula* plantation; 1970 m a.s.l.; 15 December 2006; 37N 802515 198227; *KHY 4527* (ETH, IBN); *det.* Hylander, *conf.* Ida Bruggeman-Nannenga.

Frequent on bare soil, both in dry sites and along streams. Widespread in Africa with closest records from Uganda and Kenya.

Funariaceae

**Entosthodon borbonicus* Besch.: Bonga; on the way to Wushwush; growing on ground in ditch; 1842 m a.s.l.; 10 February 2006; 7.27878°N 36.18436°E; *KHY 4427* (KHY, BG); *det.* Bernard Goffinet.

Found once on a road bank. In mainland Africa it was previously only found in Rwanda, but has been recorded on several islands in the Indian Ocean, including Madagascar.

Funaria hygrometrica Hedw. Found in a few places on disturbed soil and on ash after fires. Widespread in Africa.

Physcomitrella magdalenae De Sloover: Occasional on bare soil, e.g. field margins. Recently

reported from Ethiopia by Medina *et al.* (2015) from our collections. The species is endemic to Africa, known from a few countries in West, Central and East Africa.

Hedwigiaceae

Braunia secunda (Hook.) Bruch & Schimp.: Frequent on large branches high up in trees in the agricultural landscape. Occasionally with capsules. Widespread in East and southern Africa.

Hypnaceae

Chryso-hypnum cavifolium (Dixon) Ochyra & Sharp: Rather common in plantations of *Cupressus lusitanica*; less frequent in native forest. Grows on tree bases and woody debris and sometimes on small boulders. Known from East and southern Africa.

Chryso-hypnum frondosum (Mitt.) W.R.Buck: Similar habitats as *C. cavifolium*, but probably less frequent. Reported as new by Müller & Flügel (2016), but had been already found by F. G. Meyer in 1964 (Meyer 8886; S; reg. no. B240063). Recorded from East and Central Africa.

**Ectropothecium perrotii* Renauld & Cardot: Bonga; Kaya Kela forest; growing on woody debris; 1721 m a.s.l.; 1 November 2006; 37N 810198 195071; *KHY 4638* (KHY, S); *det.* Hedenäs. Grew on coarse woody debris in one locality in a forest. Known from a few African countries; closest records from Uganda.

**Entodontella cameruniae* Broth.: Bonga; at the waterfall area; growing on a *Dracaena* L. stump; 1821 m a.s.l.; 11 February 2006; 7.26785°N 36.27206°E; *KHY 4476* (ETH, S); *det.* Hedenäs. Rather widespread on trunks in closed forests. Frequently fertile. Superficially rather similar to *Entodon geminidens*, sometimes growing in association with it. Previously reported only from Camerun and Guinea.

Hypnum cupressiforme Hedw. On rock in forest at higher elevations (2500–3000 m a.s.l.). One collection. Widespread in Africa.

**Isopterygium mbangae* (Müll.Hal.) A.Jaeger: Bonga; Boka forest; growing on woody debris; 1956 m a.s.l.; 9 December 2012; 37N 796675 194564; *KHY 4634* (ETH, S); *det.* Hedenäs. Rather frequent on woody debris in forests, and on soil in forests and plantations. Known from a few countries in West and East Africa.

**Phyllodon perplanicaulis* (Broth.) Kis: Bonga; Shera Keja forest; growing at base of *Maytenus* Molina sp.; 1778 m a.s.l.; 18 December 2006; 37N 805537 189849; *KHY 6233* (ETH); *det.* Hylander (another specimen in S identified by Hedenäs). Creeping on dead wood in forests. Sometimes together with *P. truncatulus*, but probably less

frequent. Recorded from a few countries in West and Central Africa, but also in Uganda (Hedenäs & Watling, 2005).

**Phyllodon truncatulus* (Müll.Hal.) W.R.Buck: Bonga; Araba Yeba forest; growing on dead wood; 1798 m a.s.l.; 11 December 2006; 37N 807754 187334; *KHY 4663* (KHY, S); *det.* Hylander, *conf.* Hedenäs.

On coarse wood debris in forests. Difficult to differentiate from *P. perplanicaulis* in the field, but probably the more common. Widespread in Africa with the closest records from Uganda (Hedenäs & Watling, 2005).

Rhacopilopsis trinitensis (Müll.Hal.) E.Britton *ex* Dixon: Rather infrequent on large branches in the canopy or as epiphyte on stems in forests. Widespread in Africa.

**Taxiphyllum taxirameum* (Mitt.) M.Fleisch.: Bonga; 1 km N of the town; growing on ground in *Cupressus* plantation; 1717 m a.s.l.; 11 November 2006; 37N 804582 196570; *KHY 4633* (ETH, S); *det.* Hedenäs.

Found on soil and tree bases in a few places in forests and tree plantations. The only other African mainland record is from Uganda; also on Indian Ocean Islands.

Vesicularia sp.: Common on dead wood in forests. We were unable to identify the specimens to species. There are many both widespread and restricted species recorded from Africa.

Hypopterygiaceae

Cyathophorum africanum Dixon: Infrequent epiphytic species on the boles of forest trees. Restricted to Central and East Africa.

Hypopterygium tamarisci (Sw. *ex* Sw.) Brid. *ex* Müll.Hal.: Common on tree bases and epiphytic on lower trunks in forests. Widespread in Africa.

Leskeaceae

Pseudoleskea sp.: On soil near a waterfall. One collection. Two *Pseudoleskea* species have been previously reported from Ethiopia; both with a rather wide distribution in Africa.

Lindbergia patentifolia Dixon: Epiphytic on rather exposed trees, for example in home gardens. Recently found in northern Ethiopia (Kürschner & Neef, 2012). Recorded from a few countries in East and southern Africa.

Leucobryaceae

Leucobryum sp.: Frequent in humid localities on tree bases and dead wood. Two *Leucobryum* species have been previously recorded from Ethiopia (Bizot *et al.*, 1978). Many species are listed from Africa including both species with widespread and restricted distributions.

**Octoblepharum albidum* Hedw.: Bonga; Barta forest, 3 km ENE of Bonga; growing on *Syzygium*

guineense (Willd.) DC.; 1940 m a.s.l.; 14 December 2006; 37N 804121 199310; *KHY* 5585 (ETH); *det.* Hylander.

Frequent epiphyte on boles or large branches, mostly in forests, preferably in humid microclimates. Widespread in Africa.

Leucodontaceae

Forsstroemia producta (Hornsch.) Paris: Occasional epiphytic species. Often on shrubs, such as coffee, in partially shaded conditions. Recorded from several countries in East and Central Africa.

Meteoriaceae

Aerobryopsis capensis (Müll.Hal.) M.Fleisch.: Rare epiphytic plant which can, however, be easily confused with *Floribundaria vaginans* in the field. Widespread in Africa.

Floribundaria floribunda (Dozy & Molk.) M.Fleisch.: Abundant and dominant pendent epiphytic species on trunks and shrubs in afro-montane forest. Often with *Orthostichella pandurifolia*. Widespread in Africa.

Floribundaria vaginans (Welw. & Duby) Broth.: Common epiphytic species in forests. More robust than *F. floribunda*. Widespread in Africa.

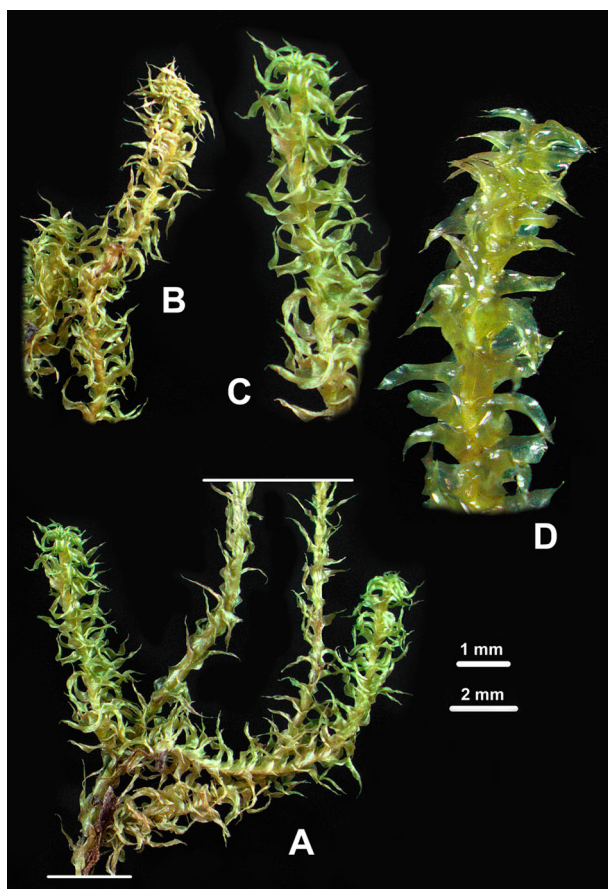


Figure 1 *Meteoriopsis reclinata* (Müll.Hal.) M.Fleisch. ex Broth. (A) Portion of shoot with branches (dry). (B, C) Branches (dry). (D) Branch (moist). Scales: A, B = 2 mm; C, D = 1 mm. (From *KHY* 4468).

***Meteoriopsis reclinata* (Müll.Hal.) M.Fleisch. ex Broth.: Bonga; near the waterfall; growing on lianas; 1821 m a.s.l.; 11 February 2006; 7.26785°N 36.27206°E; *KHY* 4468 (ETH, S); *det.* Hedenäs. (Figure 1)

Epiphytic on lianas hanging from tree at the forest edge. Only one collection. First record from Africa. Widespread species in Asia, from India to Japan and the western Pacific, extending to northern Australia (Manuel, 1977).

Orthostichella pandurifolia (Müll.Hal.) W.R.Buck: Abundant and dominant moss hanging from most trees and shrubs in the afro-montane forest, often with *Floribundaria floribunda*. *Orthostichidium involutifolium* (Mitt.) Broth. has also been reported from the area (Bizot et al., 1978; Müller & Flügel, 2016). It resembles *O. pandurifolia* and might have been overlooked during the present study, though it is likely to be infrequent given our numerous collections of *O. pandurifolia*. Known from East and southern Africa.

Orthostichella rigida (Müll.Hal.) B.H.Allen & Magill: Epiphytic. Found once on a fallen branch of a tree at an elevation of 2300 m a.s.l. Previously reported from Ethiopia under the synonym *Pilotrichella ampullacea* (Müll.Hal.) A.Jaeger. Recorded from East and Central Africa.

**Orthostichella welwitschii* (Duby) B.H.Allen & Magill: Bonga; Kaya Kella forest, 6 km N of Bonga; on coffee shrubs in forest; 1721 m a.s.l.; 1 November 2006; 37N 810198 195071; *KHY* 4612 (S, KHY); *det.* Hedenäs.

Pendent epiphytic species in forests. It might be somewhat overlooked since it is similar to *O. pandurifolia* and *Squamidium brasiliense* in the field. Widely distributed in sub-Saharan Africa; closest records from Kenya (Allen & Magill, 2007).

Papillaria africana (Müll.Hal.) A.Jaeger: Not very frequent pendent epiphytic species in forests. Widespread in East and southern Africa.

Trachypodopsis serrulata (P.Beauv.) M.Fleisch.: Rather rare epiphytic species at 1700 m a.s.l. Much more frequent at 2300 m. Also on soil at the high elevation sites. Widespread in Africa.

Mniaceae

**Epipterygium tozeri* (Grev.) Lindb.: Bonga; W of Wushwush; growing on stream bank; 1600 m a.s.l.; 10 February 2006; 7.28207°N 36.20485°E; *KHY* 4408 (ETH, S); *det.* Hedenäs. Few collections in a ditch and along a stream. Previously known from Kenya and Rwanda in mainland Africa.

Plagiomnium rhynchophorum (Hook.) T.J.Kop.: Found on moist soil along a stream and in a ditch. Widespread in Africa.

Neckeraceae

Homaliodendron piniforme (Brid.) Enroth: Probably widespread epiphytic species in forests. Superficially similar to *Porotrichum usagarum*, so the relative frequency of these two species in the investigated area is difficult to estimate. Recorded in many countries across tropical West and East Africa.

Neckera remota Bruch & Schimp. ex C. Müll.: Common epiphytic species on both large trees and shrubs in forests. Also found in shaded locations in the agricultural landscape. Recorded in many countries across tropical West and East Africa.

**Pinnatella minuta* (Mitt.) Broth.: Bonga; Fide forest, along road towards Tepi; growing on *Ilex mitis*; 1192 m a.s.l.; 10 February 2006; 7.22606°N 35.51899°E; *KHY 4446* (S); *det.* Hylander, *conf.* Johannes Enroth.

Found as an epiphyte in forests a few times. Widespread in Africa, with the closest record from Kenya.

Porotrichum elongatum (Welw. & Duby) A. Gepp: Common epiphytic species in the forest. Widespread in Africa.

Porotrichum stipitatum (Mitt.) W.R. Buck: Common in humid sites in forests on tree bases and on rocks. Widespread in Africa.

Porotrichum usagarum Mitt.: Epiphytic species. The frequency of *P. usagarum* in the area was difficult to assess because of its superficial resemblance to *Homaliodendron piniforme*. Widespread in Africa.

Orthotrichaceae

**Bryomaltaea obtusifolia* (Hook.) Goffinet.: Bonga; Boka forest, east of the road, 6 km S of Bonga; growing on *Sapium ellipticum* (Hochst.) Pax.; 1956 m a.s.l.; 9 December 2006; 37N 796675 194564; *KHY 4729* (ETH, KHY, RG); *det.* Ricardo Garilleti.

One collection from a large branch on a forest tree (*Sapium ellipticum* (Hochst.) Pax). In Africa only known from The Democratic Republic of the Congo.

**Codonoblepharon microtheca* (Dixon ex Malta) Matcham & O'Shea: Bonga; growing on *Albizia gummifera*; 1745 m a.s.l.; 25 November 2008; 37N 818754 191275; *KHY 5925* (ETH, KHY, BG); *det.* Hylander.

Found at only one site, an exposed tree in the agricultural landscape. Found in several East African countries.

Macrocoma abyssinica (Müll. Hal.) Vitt.: Widespread epiphytic species, often on shrubs in exposed or partly shaded locations. Most records are from countries in East Africa.

**Macrocoma orthotrichoides* (Raddi) Wijk & Margad.: Bonga; E of Catholic Church; growing on coffee

in home garden; 1784 m a.s.l.; 6 November 2006; 37N 804156 197647; *KHY 4724* (ETH, RG); *det.* Ricardo Garilleti.

A few records are from habitats also favoured by *M. abyssinica*, and when sterile it cannot be separated from that species. Recently found in Uganda (Wilbraham, 2008), otherwise, mostly a neotropical species.

Macrocoma tenuis (Hook. & Grev.) Vitt.: Common epiphytic species on exposed branches in tree crowns in forests or on shrubs in the agricultural landscape. Widespread in East and southern Africa.

Macromitrium sulcatum (Hook.) Brid.: Widespread epiphytic species in tree crowns in forests and on isolated trees in the agricultural landscape. Sometimes lower down on exposed trunks. Widespread in Africa.

Orthotrichum aequatoreum Mitt.: Epiphytic on shrubs, e.g. coffee, in rather exposed situations. Rather frequent. Also recorded from several other East African countries.

Orthotrichum denticulatum Lewinsky: Epiphytic on shrubs, e.g. coffee, in rather exposed situations. Rare. In Africa recorded also from Rwanda and Tanzania.

Orthotrichum firmum Venturi: Found a few times as an epiphyte on shrubs in rather exposed habitats. Local in East, Central and southern Africa.

Schlotheimia ferruginea (Hook. & Grev.) Brid.: Widespread epiphytic species in tree crowns in forests and on isolated trees in the agricultural landscape. Sometimes lower down on exposed stems. Recorded mostly from southern Africa, but also from Tanzania.

Schlotheimia percuspidata Müll. Hal.: Widespread epiphytic species in tree crowns in forests and on isolated trees in the agricultural landscape. Sometimes lower down on exposed stems. Local in East and southern Africa.

**Zygodon erosus* Mitt.: Bonga, growing in crown of *Albizia gummifera*; 1915 m a.s.l.; 13 October 2008; 37N 80805 8199978; *KHY 5938* (ETH, KHY, RG); *det.* Ricardo Garilleti.

Less frequent than *Z. trichomitrius* but not uncommon. Found in the same habitats. Known from a few countries in Africa including Kenya, South Africa and Tanzania.

**Zygodon trichomitrius* Hook. & Wilson: Bonga; growing in crown of *Albizia gummifera*; 1852 m a.s.l.; 26 November 2008; 37N 802496 190648; *KHY 5937* (ETH, RG); *det.* Ricardo Garilleti.

Relatively frequent on rather exposed trees in agricultural landscapes or in the crown of forest trees. Known from a few countries in Africa with the closest record from Tanzania.

Pilotrichaceae

**Cyclodictyon brevifolium* Broth. in Mildbr.: Bonga; Barta forest, 3 km ENE of Bonga; growing on base of *Sapium ellipticum*; 1940 m a.s.l.; 14 December 2006; 37N 804121 199310; *KHY 4690* (ETH, S); *det.* Hedenäs.

Few collections, mostly from woody debris in humid forests. Known from a few Central/eastern African countries, including Uganda and Burundi. Genus new to Ethiopia.

Cyclodictyon spp.: Provisional identifications of other collections of *Cyclodictyon* are *C. delicatum* P.de la Varde, *C. dixonianum* Demaret and *C. vallis-gratiae* (Müll.Hal.) Kuntze, but none are yet confirmed.

Lepidopilium lastii Mitt.: Found occasionally along forest streams on branches. Perhaps overlooked. Widespread across tropical Africa.

**Thamniopsis utacamundiana* (Mont.) W.R.Buck: Bonga; Gera Beki forest, 6 km NE of Bonga; growing on woody debris; 1881 m a.s.l.; 13 December 2006; 37N 808207 199666; *KHY 4687* (ETH, S); *det.* Hedenäs.

Common on dead wood, on roots and on tree bases in forests. Previously recorded from South and East Africa with closest records from Kenya and Uganda.

Polytrichaceae

Pogonatum gracilifolium Besch.: Occasional on road banks. Widespread in Africa.

Polytrichum commune Hedw.: Occasional on road banks. Wide mats in boggy area at 2300 m a.s.l. Widespread in Africa.

Pottiaceae

Chionoloma bombayense (Müll.Hal.) P.Sollm.: Rather frequent in forests and in somewhat more open areas. Almost always epiphytic on trunks, but occasionally on smaller branches, or on shrubs. Rarely found fertile. Widespread in Africa. We note that *C. bombayense* s.s. occurs only in India, and that an undue number of taxa have been synonymised under this name (Alonso et al., 2016). A new taxonomic revision is awaited, which may clarify whether our collections belong to one or several species, and which name(s) should be applied.

**Hyophila involuta* (Hook.) A.Jaeger: Bonga; growing on boulder in grazing area; 1900 m a.s.l.; 15 October 2009; 37N 807000 199000; *KHY 5931* (ETH, PS); *det.* Hylander, *conf.* Philip Sollman. Occasional on stream banks, but also in drier places, such as on boulders. Widespread in Africa.

Leptodontium viticulosoides (P.Beauv.) Wijk & Margad.: Frequent species in canopies of large trees in the agricultural landscape. Widespread in Africa.

Streptopogon erythrodontus (Taylor) Wilson: Frequent on shrubs in agricultural landscapes. Local, but recorded from East, West and southern Africa.

**Syntrichia amphidiacea* (Müll) Zander: Bonga; growing on *Albizia gummifera*; 1828 m a.s.l.; 27 November 2008; 37N 809990 186868; *KHY 5923* (ETH, PS); *det.* Philip Sollman.

Frequent on boles of large trees in agricultural landscapes, often on sun-exposed trees. On mainland Africa known from both South and East Africa with closest records from Uganda and Tanzania.

Syntrichia fragilis (Taylor) Ochyra: Frequent on sun-exposed tree bases in the agricultural landscape. Widespread in East and southern Africa.

Prionodontaceae

Prionodon ciliatus Besch.: Found once epiphytic on a tree in a semi-open environment along a road. Most records are from East Africa.

Pterobryaceae

Calyptothecium acutifolium (Dusén) Argent: Epiphytic in forests, often on the bole of trees but also sometimes on shrubs. Rather frequent. Widespread in Africa.

**Calyptothecium hoehnelii* (Müll.Hal.) Argent: Bonga; Shecha forest, 6 km SW of Bonga; growing on *Olea* L. sp.; 1997 m a.s.l.; 10 December 2006; 37N 800478 190943; *KHY 5589* (ETH, S); *det.* Hylander, *conf.* Hedenäs.

Found a few times in the area. Epiphytic on the bole of forest trees. Widespread in Africa with records from both Eritrea and Kenya.

Racopilaceae

Racopilum africanum Mitt.: Common on bases of trees and on dead wood in forests and semi-open sites, including coffee plantations. Widespread in Africa.

Regmatodontaceae

**Regmatodon orthostegius* Mont.: Bonga; growing in the tree crown; 1912 m a.s.l.; 3 November 2008; 37N 804891 186506; *KHY 5954* (ETH); *det.* Hylander.

Rather frequent on branches in the forest canopy. Often fertile and easily recognised by the whitish peristome. Known from several countries across the continent.

Rhachitheciaceae

**Jonesiobryum dumboi* Eb.Fisch., D.Killmann & Sérus.: Bonga, growing on bole of *Albizia gummifera*; 1787 m a.s.l.; 17 January 2009; 37N 812804 200514; *KHY 7751* (ETH); *det.* Hylander, (the other specimen identified by Bernard Goffinet).

On two *Albizia* trees – on one stem in a home garden and in one crown in the forest. Otherwise known only from Uganda.

**Rhachithecium perpusillum* (Thwaites & Mitt.) Broth: Bonga; home garden 500 m NE of Wushwush; growing on *Albizia gummifera*; 1880 m a.s.l.; 11 December 2006; 37N 808536 185180; *KHY* 5574 (ETH); *det.* Hylander (another specimen confirmed by Bernard Goffinet)
Regularly on exposed trees in the agricultural landscape. Easily overlooked because of its tiny size, but often quite abundant on the stems. Found in several countries across Africa.

Sematophyllaceae

**Radulina borbonica* (Bél.) W.R.Buck: Bonga; Kaya Kela forest, 6 km N of Bonga; growing on woody debris; 1721 m a.s.l.; 1 November 2006; 37N 810198 195071; *KHY* 4707 (ETH, S); *det.* Hylander, *conf.* Hedenäs.
In this environment, infrequent on dead wood in forests. Widespread in Africa.

Sematophyllum spp.: We have not been able to identify the *Sematophyllum* specimens to species level, but based on morphological variation, we believe that there are at least four species in the material. Most collections are from forests, either epiphytic, on tree bases or on dead wood.

Wijkia jungneri (Broth.) H.A.Crum: Abundant on dead wood and tree bases in the forest. Sometimes also on soil. *Wijkia trichocolea* (Müll.Hal.) H.A.Crum is also recorded from the area (Bizot *et al.*, 1978; Müller & Flügel, 2016) and might have been overlooked in this investigation because of its similar appearance in the field. However, we have many collections of *W. jungneri* and none of *W. trichocolea*. Recorded from both West and East Africa.

Splachnaceae

**Tayloria solitaria* (Hedw.) T.Kop. & W.Weber: Bonga; growing on crown of *Albizia* sp.; 1912 m a.s.l.; 3 November 2008; 37N 804891 186506; *KHY* 5942 (ETH, KHY, BG); *det.* Bernard Goffinet.
Frequent epiphyte in the crown of trees on large branches. Known from a few African countries, including Tanzania.

Stereophyllaceae

Entodontopsis nitens (Mitt.) W.R.Buck & Ireland: Common epiphytic species, often on shrubs or lianas. Found in forests as well as shaded sites in gardens. Frequent on coffee. Widespread in Africa.

Thuidiaceae

**Haplocladium angustifolium* (Hampe & Müll.Hal.) Broth. Bonga; Socha forest, 2.5 km SE of Diri Guma; growing on *Cupressus lusitanica*; 1874 m a.s.l.; 7 November 2006; 37N 814753 202110; *KHY* 4672 (ETH, S); *det.* Hedenäs.

Found occasionally on soil or tree bases, often in disturbed habitats such as in plantations or gardens. Recorded in South, Central and East Africa, with closest records from Kenya and Tanzania.

Hylocomiopsis cylindricarpa Thér. Rather frequent on large branches in tree crowns in the agricultural landscape. In Africa reported from rather few countries, but across a wide geographic extent including West, Central and East Africa.

Pelekium chenagonii (Müll.Hal. *ex* Renauld & Cardot) Touw: Frequent on tree bases and dead wood in forests and plantations. Recently reported from Ethiopia and this area (Müller & Flügel, 2016). Widespread in Africa.

**Pelekium varians* Touw: Bonga; Socha forest, 2 km E of Diri Guma; growing on *Cordia africana* Lam.; 1769 m a.s.l.; 7 November 2006; 37N 815925 202349; *KHY* 4677 (S); *det.* Hedenäs.
Rare epiphyte in forest. Perhaps overlooked. Widespread in Africa.

Pelekium versicolor (Müll.Hal.) Touw: Rare to frequent as an epiphyte on forest trees and on *Cupressus* trees in plantations. Widespread in Africa, but less frequent from West Africa.

**Rauiella praelonga* (Schimp. *ex* Besch.) Wijk & Margad.: Bonga; 4 km S of Gimbo; growing on *Ficus vasta* Forssk. in home garden; 1754 m a.s.l.; 17 December 2006; 37N 813942 192890; *KHY* 4679 (ETH, KHY); *det.* Hylander, *conf.* Hedenäs.

Found a few times on large trees with little shade, e.g. *Schefflera abyssinia* (Hochst. *ex* A.Rich.) Harms. Previously recorded from several East African and southern African countries.

Discussion

It is clear that the moss flora of Ethiopia remains poorly known, since we were able to report so many species new to the country merely by inventorying random plots in forests and agricultural areas, with limited surveys elsewhere in the area. The same applies to the liverworts, where we reported an even larger proportion of the records as new species to the country (Hylander *et al.*, 2010). Many large mosses of the canopy or the trunks of trees were collected by Ib Friis and colleagues from 14 localities in southwestern Ethiopia during two expeditions in the early 1970s, and subsequently identified and reported by Bizot *et al.* (1978). However, since their principal aim was to study vascular plants, it is not surprising that many of the less frequent and smaller species were overlooked (see also Müller & Flügel, 2016 for a similar but smaller dataset).

There is certainly much more to find in the area that we have studied and because of the altitudinal changes

in species composition of bryophyte communities (e.g. Frahm and Gradstein, 1991; Pócs, 1994; Sanger and Kirkpatrick, 2015), the study of habitats at both lower and higher elevations than those covered by us is likely to yield new and interesting data on the bryophytes of this region.

In terms of habitats and substrates, riverine forests, rocky outcrops and bare soil are under-represented in our material and should be investigated more thoroughly in order to get a more complete understanding of the bryoflora of this region. Furthermore, epiphytic species of tree crowns in forests are probably less well represented due to our focus on one tree species, *Albizia gummifera*, which seems to have fewer epiphytes than some other tree species (K. Hylander, pers. obs.).

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