

Mosses of Mt. Kinabalu, Borneo, Malaysia

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Abstract. The moss flora of Mt. Kinabalu, Borneo, Malaysia was investigated in 2005. The mosses recognized comprise 18 families, 43 genera and 97 species except pleurocarpous mosses. *Ditrichum heteromallum*, *Fissidens braunii* and *Syrrhopodon tjibodensis* are new additions to the moss flora of Borneo Island. For each species recognized here, locality, substrate, specimen number and taxonomic note are provided.

Key words: bryophytes, mosses, Mt. Kinabalu, Borneo, Malaysia

This study deals with the moss flora of Mt. Kinabalu, Borneo, Malaysia based on the collections made under a research program, “Biodiversity inventory in the Western Pacific region,” by the National Museum of Nature and Science, Tokyo. The first author has studied the moss flora of the alpine regions in East Asia with special interest of the endemic taxa (Higuchi & Arikawa, 2005, 2006; Higuchi & Lin, 2005, 2007). In 2005 we made a field research and collected bryophytes mainly from Mt. Kinabalu area and Mahua in Crocker Range Park situated southwest of Mt. Kinabalu.

Mt. Kinabalu (6°04'N, 116°33'E) is located in Sabah, and is the highest (Low's peak, 4,095 m alt.) in Southeast Asia as well as Borneo Island. Many botanists visited Mt. Kinabalu and studied its flora. In bryophytes, many interesting taxa have been reported from Mt. Kinabalu. The first list of the bryophytes in the Kinabalu Park was presented by Frahm *et al.* (1990). Subsequently several authors have contributed additions to the bryophyte flora of the area (cf. Akiyama *et al.*, 2001). The moss flora of Borneo Island has been

compiled by Touw (1978) who enumerated 649 taxa from Borneo Island. Recently Suleiman *et al.* (2006) revised the catalog of the mosses of Borneo Island and listed 721 taxa from Borneo Island. Tan and Iwatsuki (1999) proposed that Mt. Kinabalu is one of the four hot spots of the moss diversity in Malaysia.

The purpose of this study is to investigate the moss flora of Mt. Kinabalu and to compile it based on the specimens collected.

Materials and Methods

Field studies were carried out in September, 2005, and a total of ca. 450 specimens were collected. The main sites investigated are divided as follows (Fig. 1).

- I: Mt. Kinabalu, from Timpohon Gate (1860 m alt.) to Laban Rata (3270 m alt.), along trail, September 7, 2005.
- II: Mt. Kinabalu, from Laban Rata (3270 m alt.) to Paka Cave (3000 m alt.), along trail, September 8, 2005.



Fig. 1. Photographs showing the area investigated. 1. View of Mt. Kinabalu from the Park Headquarters. 2. Trail between the Timpohon Gate and Layang Layang where *Dawsonia beccarii* is growing. 3. Gorge near Paka Cave where *Takakia lepidozoides* is growing. 4. Sayat Sayat Mountain Hut. 5. Forest along Silau Silau trail. 6. Mahua Waterfalls.

III: Mt. Kinabalu, from Laban Rata (3270 m alt.) to Low's Peak (4095 m alt.), along trail, September 9, 2005.

IV: Mt. Kinabalu, from Laban Rata (3270 m alt.) to Timpohon Gate (1860 m alt.), along trail, September 10, 2005.

V: Mt. Kinabalu, Headquarter, along Silau-silau Taril (1550 m alt.) (Fig. 1: 5) and Bukit Burung Trail (1620 m alt.), September 11, 2005.

VI: Mt. Kinabalu, Headquarter, along Liwagu Taril (1500–1700 m alt.), September 12,

2005.

VII: northern part of Crocker Range Park, around the entrance of Mahua Waterfalls (1080 m alt.), September 15, 17, 2005.

VIII: northern part of Crocker Range Park, from entrance to Mahua Waterfalls (1080–1160 m alt.) (Fig. 1: 6), September 16, 2005.

Results and Discussion

The mosses recognized in this study comprise 18 families, 43 genera and 97 species except pleurocarpous mosses. Among them *Ditrichum heteromallum*, *Fissidens braunii* and *Syrrhopodon tjibodensis*, are new additions to the moss flora of Borneo Island, although the area investigated is bryologically well-explored as compared with other areas in Southeast Asia. Touw (1978) and Suleiman *et al.* (2006) enumerated 447 and 582 taxa from Sabah in Borneo Island respectively. Sabah is evidently the richest district of mosses in Borneo Island. The richness of bryophyte species in Sabah is probably due to the presence of Mt. Kinabalu which has resulted in the development of species confined to this area. For example, *Takakia lepidozoides* was recorded from Borneo by Hattori (1963a, b), which is a hyper-oceanic element and has an interesting disjunctive range from Himalaya to West and North Pacific Arc (Schuster, 1983). The occurrence of *Takakia lepidozoides* may give a hint of the origin of bryophyte flora of Mt. Kinabalu. Because its sporophytes and antheridia have never been found. The presence of many endemic taxa as well as the relict taxa such as *Takakia* suggests that the bryophyte flora of Mt. Kinabalu have an old origin. While the new record of *Ditrichum heteromallum* from Mt. Kinabalu is easier to comprehend, since they have numerous sporophytes with mature spores, which enable it to extend the range.

Enumeration of species

The families, genera and species are arranged alphabetically. The generic position follows

Goffinet and Buck (2004). In the following enumeration an asterisk (*) preceding a species indicates “new to Borneo.” Each species is referred by collecting site (I-VIII), substrate and specimen number, and some species taxonomic notes. The specimens cited here are deposited in the herbaria of the Department of Botany, National Museum of Nature and Science (formerly National Science Museum) (TNS), the Institute for Tropical Biology & Conservation, Universiti Malaysia Sabah (UMS), and the Kinabalu National Park.

Andreaceae

Andreaea rupestris Hedw., Spec. Musc. 47 (1801).

III: on rock-cliff, Higuchi 44908 (+*Grimmia affinis*), 44914, 44922 (+*Grimmia affinis*); on rock, Arikawa 5242, 5245 (+*Grimmia affinis*).

Bartramiaceae

Bartramia aurescens Dixon, J. Linn. Soc. Bot. 50: 94 (1935).

III: on soil, Higuchi 44912; on rock-crevice, Higuchi 44915; on soil, Arikawa 5251, 5252 (+*Pohlia flexuosa*), 5254.

Breutelia arundinifolia (Duby) M. Fleisch., Musci Fl. Buitenzorg 2: 630 (1904).

IV: on rock-cliff, Higuchi 44980, 44999; on tree-trunk, Arikawa 5323.

Breutelia kinabaluensis Dixon, J. Linn. Soc. Bot. 50: 94 (1935).

IV: on rock, Arikawa 5270.

Philonotis calomicra Broth. in Schum. & Lauterb., Fl. Deutsch. Schutzgeb. 88 (1900).

VII: on soil at trail bank, Arikawa 5429. VIII: on rock-cliff, Higuchi 45226 (+*Bryum apiculatum*), 45305 (+*Weissia controbersa*).

Philonotis hastata (Duby) Wijk & Margad., Taxon 8: 74 (1959).

VIII: on rock-cliff, Higuchi 45314.

Philonotis secunda (Dozy & Molke.) Bosch & Sande Lac., Bryol. Jav. 1: 156 (1861).

IV: on rock-cliff, Higuchi 44940; on soil, Arikawa 5266. VI: on rock-cliff, Arikawa 5420,

Higuchi 45184; on soil at trail bank, Higuchi 45181.

Bryaceae

Brachymerium nepalense Hook. in Schwägr., Spec. Musc. Suppl. 2(1): 131 (1824).

V: on trunk of tree fern, Higuchi 45013.

Bryum apiculatum Schwägr., Spec. Musc. Suppl. 1(2): 102 (1816).

VIII: on soil at trail bank, Higuchi 45226 (+*Philonotis calomicra*).

Bryum argenteum Hedw., Spec. Musc. 181 (1801).

II: on soil, Higuchi 44899; Arikawa 5236. III: on rock-crevice, Higuchi 44903, 44905 (+*Oxystegus tenuirostris*), 44909, 44910 (+*Leptodontium flexifolium*); on soil, Arikawa 5239, 5240 (+*Oxystegus tenuirostris*).

Bryum billardieri Schwägr., Spec. Musc. Suppl. 1(2): 115 (1816).

VIII: on soil, Higuchi 45241.

Bryum clavatum (Schimp.) Müll.Hal., Syn. 1: 292 (1848).

II: on rock, Arikawa 5195. IV: on soil at trail bank, Higuchi 44978.

Bryum sp.

VIII: on rock-cliff, Higuchi 45310.

Notes. Plants (Higuchi 45310) have oblong-lanceolate leaves somewhat twisted when dry, reddish basal part of leaves and tomenta of rhizoids on stems. These characteristics indicate the plants to be closely related to *Bryum pseudotriquetrum*. However, leaf margins are plane and not well-bordered and the habitat is rather lowland, which shows the difference from alpine *Bryum pseudotriquetrum*.

Bryum russulum Broth. & Geh., Oefv. Finsk. Vet. Soc. Foerh. 40: 175 (1898).

III: on rock-crevice, Higuchi 44924. IV: on soil, Higuchi 44990; on soil-cliff, Higuchi 44976; on humus, Arikawa 5297; on rock covered with soil, Arikawa 5308.

Notes. Plants growing at the Low's peak (Higuchi 44924) are small, and have leaves spirally twisted when dry. They look like *Bryum capillare* in appearance, but they are different from *B. capillare* by the absence of long apiculus

at the leaf apex.

Orthodontium infractum Dozy & Molk., Ann. Sc. Nat. Bot. ser. 3, 2: 33 (1844).

III: on soil at trail bank, Higuchi 44939.

Rhodobryum aubertii (Schwägr.) Ther., Recueil Publ. Soc. Havraise Etud. Div. 89(2): 128 (1922).

VIII: on rock, Arikawa 5457; on boulder, Higuchi 45229, Arikawa 5455; on soil, Arikawa 5478, 5483.

Rhodobryum giganteum (Schwägr.) Paris, Ind. Bryol. 1116 (1898).

VI: on humus, Arikawa 5423.

Calymperaceae

Exostratum blumei (Nees ex Hampe) L. T. Ellis, Lindbergia 11: 25 (1985).

V: on rock-cliff, Higuchi 45052.

Leucophanes octoblepharioides Brid., Bryol. Univ. 1: 763 (1827).

VIII: on basal part of tree, Higuchi 45259; on tree-trunk, Arikawa 5446; on decaying log, Higuchi 45212; on rock, Arikawa 5463.

Mitthyridium flavum (Müll.Hal.) H. Rob., Phytologia 32: 433 (1975).

V: on fallen tree-trunk, Higuchi 45026.

Mitthyridium undulatum (Dozy & Molk.) H. Rob., Phytologia 32: 435 (1975).

VII: on tree-trunk, Higuchi 45215.

Octoblephalum albidum Hedw., Spec. Musc. 50 (1801).

VI: on basal part of tree, Higuchi 45161.

Syrrhopodon japonicus (Besch.) Broth. in Engler & Prantl, Nat. Pfl. ed. 2, 10: 233 (1924).

V: on root, Higuchi 45068; on decaying log, Higuchi 45043 (+*Syrrhopodon prolifer*).

Syrrhopodon prolifer Schwägr., Spec. Musc. Suppl. 2(2): 99 (1827).

V: on decaying log, Higuchi 45043 (+*Syrrhopodon japonicus*). VI: on soil at trail bank, Arikawa 5380.

**Syrrhopodon tjibodensis* M.Fleisch., Musci Fl. Buitenzorg 1: 209 (1904). (Fig. 1)

V: on tree-trunk, Higuchi 45059.



Fig. 2. *Syrrhopodon tjibodensis*. 1. Leaf. 2. Median laminal cells. 3. Gemmae arising from near limb base of adaxial leaf surface. 4. Gemma. Scales for 1 in 1 mm, for 2 in 10 μm and for 3 & 4 in 100 μm . (All from Higuchi 45059.)

Notes. *Syrrhopodon tjibodensis* is characterized by its narrowly lingulate-lanceolate leaves (Fig. 2: 1), apex of cancelline tissue ending in an approximately transverse line (Fig. 2: 1), leaf margins bordered by a narrow, pellucid marginal stereome and gemmae arising from the edges of the costa above the cancellinae (Fig. 2: 3). This species is widely distributed in tropical Asia and Malesia but generally uncommon (Eddy, 1990). This species grows on tree-trunk in the forest at ca. 1550 m alt. along Bukit Burung Trail.

Dicranaceae

Dicranella setifera (Mitt.) A. Jaeger, Ber. S. Gall. Naturw. Ges. 1870–71: 376 (1872).

IV: on tree-stump, Arikawa 5316. VI: on soil at bank, Higuchi 45176, Arikawa 5418; on rock-cliff, Arikawa 5422.

Dicranoloma assimile (Hampe) Paris, Ind. Bryol. ed. 2, 2: 24 (1904).

VI: on tree-trunk, Higuchi 45123; on decorticated log, Arikawa 5394.

Dicranoloma blumii (Nees) Paris, Ind. Bryol. ed. 2, 2: 25 (1904).

IV: on root, Higuchi 44983; on tree-trunk, Arikawa 5285, 5300. V: on decaying log, Higuchi 45047 (+*Dicranoloma reflexum*).

Dicranoloma brevisetum (Dozy & Molk.) Paris, Ind. Bryol. ed. 2, 2: 25 (1904).

II: on decaying stump, Arikawa 5223. IV: on base of tree-trunk, Higuchi 44970.

Dicranoloma havilandii Broth., Mitteil. Inst. Allg. Bot. Hamburg 7(2): 117 (1928).

II: on boulder, Higuchi 44874.

Dicranoloma reflexum (Müll. Hal.) Renaud, Essai Leucoloma 14 (1909).

V: on decaying log, Higuchi 45047.

Leucoloma molle (Müll. Hal.) Mitt., J. Linn. Soc. Bot. Suppl. 1: 13 (1859).

VIII: on basal part of tree, Higuchi 45262.

Microdus sumatranus (Dixon) A. Eddy, A Hand-

book of Malesian Mosses 1: 113 (1988).

VI: on soil at trail bank, Higuchi 45138, Arikawa 5416.

Diphysciaceae

Diphyscium mucronifolium Mitt. in Dozy & Molk., Bryol. Jav. 1: 35 (1855).

II: on rock-cliff, Higuchi 44876. V: on rock-cliff, Higuchi 45053. VI: on rock-cliff, Higuchi 45137; on boulder, Higuchi 45143. VIII: on boulder, Higuchi 45295.

Ditrichaceae

Ditrichum difficile (Duby) M. Fleisch., Musci Fl. Buitenzorg 1: 300 (1904).

II: on soil-cliff, Higuchi 44901; on rock-crevice, Arikawa 5191; on soil, Arikawa 5196.

**Ditrichum heteromallum* (Hedw.) Britt., N. Am. Fl. 15: 64 (1913). (Fig. 3)

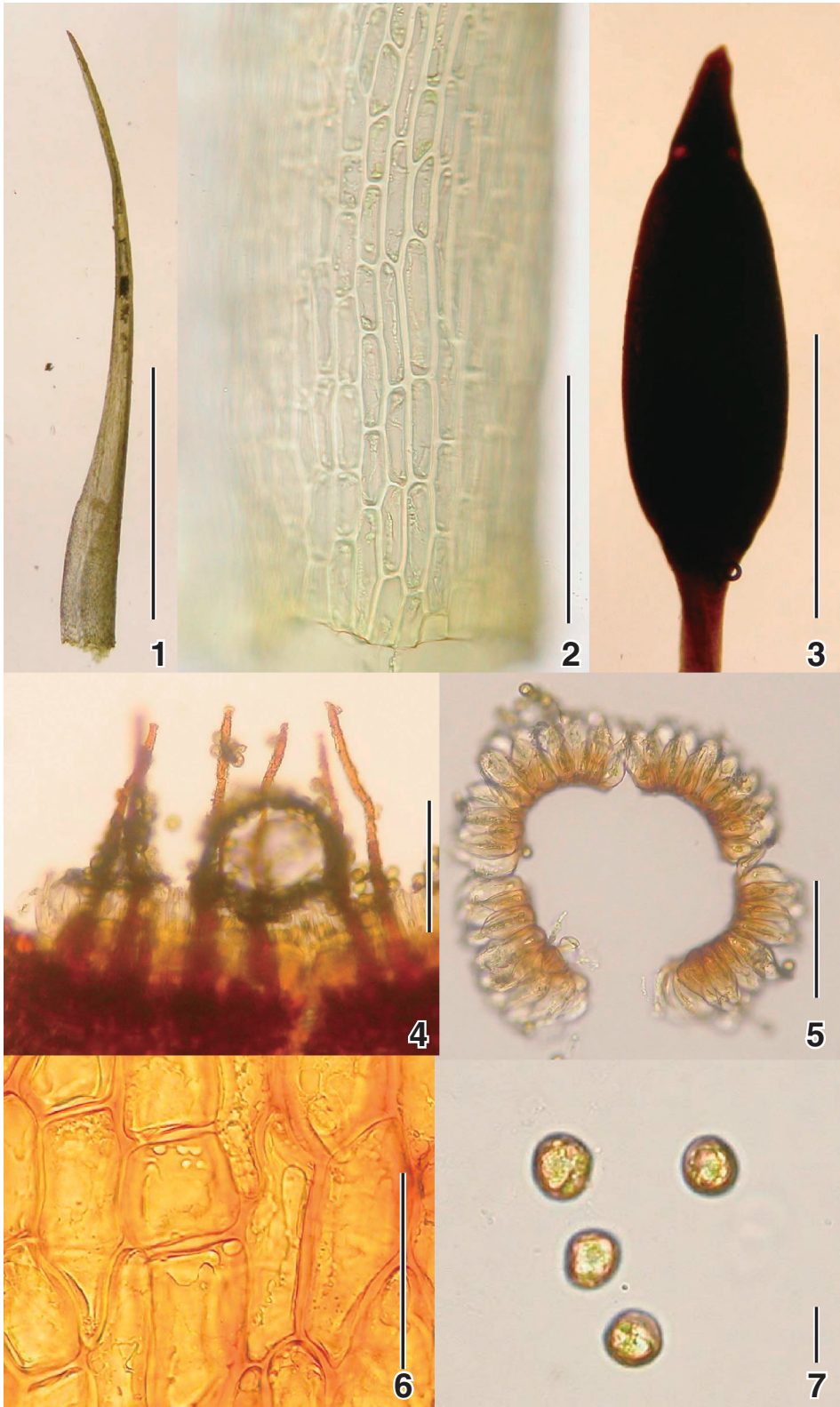
II: on soil, Higuchi 44897; on rock covered with soil, Arikawa 5234.

Notes. *Ditrichum heteromallum* is characterized by leaves gradually tapering to a long subula (Fig. 3: 1), leaf margins plane, elongate rectangular to linear basal cells at sheathing base (Fig. 3: 2), erect capsule (Fig. 3: 3) and lightly papillose peristome teeth (Fig. 3: 4). This species is distributed in Europe, northern, central and eastern Asia, North and South Americas, New Guinea, Australia and New Zealand (Matsui & Iwatsuki, 1990). Eddy (1988) wrote in the note of *Ditrichum difficile*, "The widespread, temperate species, *D. heteromallum* (Hedw.) Britt. has not been recorded from the region but could well occur in mountainous areas." This species grows on soil at 3000–3150 m alt. between Paka Cave and Laban Rata.

Fissidentaceae

**Fissidens braunii* (Müll. Hal.) Dozy & Molk.,

Fig. 3. *Ditrichum heteromallum*. 1. Leaf. 2. Basal laminal cells. 3. Capsule. 4. Peristome. 5. Annulus. 6. Exothelial cells. 7. Spores. Scales for 1 & 3 in 1 mm, for 2, 4 & 5 in 100 μm , for 6 in 50 μm and for 7 in 10 μm . (All from Higuchi 44897.)



Bryol. Jav. 1: 1 (1854). (Fig. 4)

IV: on trunk of tree fern, Arikawa 5321.

Notes. *Fissidens braunii* is characterized by its epiphytic habitat, elimbate leaves with percurrent costa (Fig. 4: 2) and rounded base to the dorsal lamina (Fig. 4: 3). This species is widespread in Malesia from New Guinea to Sumatra and the Malay Peninsula and Polynesia (Eddy, 1988). This species grows on the trunk of tree fern at ca. 2600 m alt. between Layang Layang and Timpohon Gate.

Fissidens ceylonensis Dozy & Molk., Ann. Sc. Nat. Bot. ser. 3, 2: 304 (1844).

VII: on boulder, Higuchi 45202.

Fissidens crassinervis Sande Lac., Naturk. Verh. K. Ak. Wet. Amsterdam 13: 3 (1872).

VIII: on soil-cliff, Higuchi 45290.

Fissidens crispulus Brid., Mant. Musc. 187 (1819).

V: on rock-cliff, Arikawa 5358. VI: on boulder, Higuchi 45097.

Fissidens hyalinus Hook.f. & Wilson, J. Bot. 3: 89 (1840).

VIII: on soil-cliff, Higuchi 45286 (+*Fissidens kinabaluensis*).

Fissidens javanicus Dozy & Molk., Bryol. Jav.



Fig. 4. *Fissidens braunii*. 1. Plant. 2. Apical parts of leaves. 3. Basal parts of leaves. Scales for 1 in 1 mm and for 2 & 3 in 100 μm . (All from Arikawa 5321.)

1: 11 (1855).

VIII: on rock-cliff, Higuchi 45254.

Fissidens kinabaluensis Z.Iwats., J. Hatt. Bot. Lab. 32: 269 (1969).

VIII: on soil-cliff, Higuchi 45286 (+*Fissidens hyalinus*), Arikawa 5484.

***Fissidens nobilis* Griff.**, Calcutta J. Nat. Hist. 2: 505 (1842).

VI: on soil-cliff, Higuchi 45164. VII: on boulder, Higuchi 45218. VIII: on rock-cliff, Higuchi 45253, Arikawa 5425.

Fissidens pellucidus Hornsch., Linnaea 15: 146 (1841).

V: on soil-cliff, Higuchi 45017; on soil, Arikawa 5344, 5364; on rock-cliff, Higuchi 45054. VI: on soil at bank, Arikawa 5401.

Fissidens plagiocliloides Besch., J. de Bot. 12: 293 (1898).

V: on soil at bank, Arikawa 5367.

Fissidens punctulatus Sande Lac., Natuurk. Verh. K. Ak. Wet. Amsterdam 13: 2 (1872).

VII: on soil and root, Arikawa 5444. VIII: on boulder, Higuchi 45272.

Fissidens wichurae Broth. & M.Fleisch., Hedwigia 38: 127 (1899).

VI: on rock-cliff, Higuchi 45149. VIII: on soil at bank, Arikawa 5480.

Fissidens zollingeri Mont., Ann. Sc. Nat. Bot. ser. 3, 4: 114 (1845).

VIII: on rock-cliff, Higuchi 45275, 45300; on brick, Higuchi 45307.

Funariaceae

Entosthodon buseanus Dozy & Molk., Bryol. Jav. 1: 31 (1855).

IV: on soil, Arikawa 5310.

Grimmiaceae

Grimmia affinis Hornsch., Flora 2: 85 (1819).

III: on rock-cliff, 44922 (+*Andreaea rupestris*), Arikawa 5246, 5259; on rock-crevice, Higuchi 44907, 44908 (+*Andreaea rupestris*); on rock, Arikawa 5245 (+*Andreaea rupestris*); on boulder, Arikawa 5258; on soil, Arikawa 5248.

Racomitrium lanuginosum (Hedw.) Brid., Mant. Musc. 79 (1819).

III: on rock, Arikawa 5249; on humus, Higuchi 44929.

Racomitrium subsecundum (Hook. & Grev.) Mitt., Kew J. Bot. 9: 324 (1857).

III: on rock-crevice, Higuchi 44921, Arikawa 5257. IV: on rock, Arikawa 5267.

Leucobryaceae

Bryohumbertia subcomosa (Dixon) J.-P.Frahm, Tropical Bryology 1: 9 (1989).

IV: on boulder, Arikawa 5314; on decorticated log, Arikawa 5318.

Campylopus ericoides (Griff.) A.Jaeger, Ber. S. Gall. Naturw. Ges. 1870–71: 424 (1872).

III: on rock-crevice, Higuchi 44911.

Campylopus fragilis (Brid.) Bruch & Schimp. subsp. ***zollingerianus*** (Müll.Hal.) J.-P.Frahm, Tropical Bryology 4: 61 (1991).

Syn. *Campylopus crispifolius* E. B. Bartram

II: on soil, Higuchi 44872, 44896, Arikawa 5235; on rock covered with soil, Arikawa 5199. III: on rock-crevice, Higuchi 44927, Arikawa 5256. IV: on soil-cliff, Higuchi 44979, Arikawa 5295.

Notes. Plants (Higuchi 44979, Arikawa 5295) are rather small and have gemmae. This is cited as *Campylopus crispifolius* E. B. Bartram in Suleimann *et al.* (2006).

Campylopus schmidii (Müll.Hal.) A.Jaeger, Ber. S. Gall. Naturw. Ges. 1870–71: 439 (1872).

IV: on soil-cliff, Higuchi 44987; on decorticated log, Arikawa 5305.

Campylopus umbellatus (Arn.) Paris, Ind. Bryol. 264 (1894).

V: on rock-cliff, Higuchi 45080; on rock, Arikawa 5268; on soil at bank, Arikawa 5378.

Dicranodontium fleischerianum W.Schultze-Motel, Taxon 12: 127 (1963).

II: on soil, Higuchi 44889.

Leucobryum aduncum Dozy & Molk. var. ***scalare*** (Müll.Hal. ex M.Fleisch.) A.Eddy, A Handbook of Malesian Mosses 2: 11 (1990).

VI: on humus, Higuchi 45126.

Leucobryum bowringii Mitt., J. Linn. Soc. Bot. Suppl. 1: 26 (1859).

V: on humus, Higuchi 45010; on decaying log, Higuchi 45051. VI: on soil, Higuchi 45107.

Leucobryum chlorophyllosum Müll.Hal., Syn. 2: 535 (1851).

VIII: on decaying log, Higuchi 45297.

Leucobryum javense (Brid.) Mitt., J. Linn. Soc. Bot. Suppl. 1: 25 (1859).

V: on humus, Higuchi 45011; on soil at trail bank, Higuchi 45031

Leucobryum juniperoideum (Brid.) Müll.Hal., Linnaea 18: 689 (1845).

VII: on rotten log, Arikawa 5498.

Leucobryum scabrum Sande Lac., Ann. Mus. Bot. Lugd. Bat. 2: 292 (1866).

V: on soil, Arikawa 5343.

Mniaceae

Plagiomnium rhynchophorum (Hook.) T.J.Kop., Hikobia 6: 57 (1971).

V: on soil, Higuchi 45036.

Plagiomnium succulentum (Mitt.) T.J.Kop., Ann. Bot. Fenn. 5: 147 (1968).

VI: on root, Higuchi 45151. VII: on soil at trail bank, Arikawa 5430; on buttress root, Higuchi 45205.

Pohlia elongata Hedw., Spec. Musc. 171 (1801).

II: on soil, Higuchi 44894, Arikawa 5231.

Pohlia flexuosa Hook., Icon. Pl. Par. 1: 19 (1836).

II: on soil at trail bank, Arikawa 5198. III: on rock-crevice covered with soil, Higuchi 44917, Arikawa 5252 (+*Bartramia aurescens*), 5253; on soil at trail bank, Higuchi 44933.

Orthotrichaceae

Macromitrium angustifolium Dozy & Molk., Ann. Sc. Nat. Bot. ser. 3, 2: 311 (1844).

VII: on branch, Higuchi 45223.

Macromitrium blumei Nees ex Schwägr., Spec. Musc. 4:316B (1842).

VI: on fallen bark, Higuchi 45110.

Macromitrium clemensiae E.B.Bartram, Philipp. J. Sc. 61: 242 (1936).

VI: on fallen tree-trunk, Higuchi 45191.

Macromitrium ochraceum (Dozy & Molk.) Müll.Hal., Bot. Zeit. 3: 544 (1845).

II: on tree-trunk, Higuchi 44868, Arikawa 5232. IV: on tree-trunk, Arikawa 5265. VI: on fallen branch, Higuchi 45127.

Schlotheimia rubiginosa C.H.Wright in Stapf, Trans. Linn. Soc. London Bot. ser. 2, 4: 257 (1894).

II: on tree-trunk, Higuchi 44891.

Schlotheimia wallisii Müll.Hal., Linnaea 37: 173 (1872).

VI: on fallen branch, Higuchi 45174.

Zygodon intermedius Bruch & Schimp., Bryol. Eur. 3: 41 (1838).

II: on tree-trunk, Higuchi 44886, 44887.

Zygodon orientalis (Dixon) Goffinet, Monographs in Systematic Botany from the Missouri Botanical Garden 98: 287 (2004).

Syn. *Leptodontiopsis orientalis* Dixon

III: on tree-trunk, Higuchi 44931. IV: on tree-trunk, Higuchi 44942; on branch, Arikawa 5276 (+*Zygodon reinwardtii*).

Zygodon reinwardtii (Hornsch.) A.Braun in Bruch & Schimp., Bryol. Eur. 3: 41 (1838).

II: on tree-trunk, Higuchi 44900; on branch, Arikawa 5193, 5238, 5276 (+*Zygodon orientalis*).

Polytrichaceae

Dawsonia beccarii Broth. & Geh., Rev. Bryol. 23: 78 (1896).

I: on soil at bank, Higuchi 44867. IV: on soil-cliff, Higuchi 44985; on soil, Arikawa 5306.

Dawsonia longifolia (Bruch & Schimp.) Zanten var. *superba* (Grev.) Zanten, Lindbergia 4: 133 (1977).

V: on soil, Higuchi 45069.

Pogonatum camusii (Thér.) Touw, J. Hatt. Bot. Lab. 60: 26 (1986).

VI: on soil at trail bank, Higuchi 45156.

Pogonatum cirratum (Sw.) Brid. subsp. *macrophyllum* (Dozy & Molk.) Hyvönen, Acta Bot. Fenn. 138: 33 (1989).

IV: on soil, Higuchi 44989, Arikawa 5307, 5315. V: on soil at trail bank, Higuchi 45021, Arikawa 5355.

Pogonatum flexicaule Mitt., J. Linn. Soc. Bot. Suppl. 1: 152 (1859).

II: on rock-cliff, Higuchi 44879.

Pogonatum neesii (Müll.Hal.) Dozy, Ned. Kruidk. Arch. 4(1): 75 (1856).

III: on rock-crevice, Higuchi 44925. IV: on soil, Arikawa 5304. VI: on rock-cliff, Higuchi 45157; on soil at trail bank, Higuchi 45182.

Pogonatum piliferum (Dozy & Molck.) Touw, J. Hatt. Bot. Lab. 60: 29 (1986).

VI: on soil at trail bank, Higuchi 45136, Arikawa 5400.

Pogonatum urnigerum (Hedw.) P.Beauv., Prodr. 84 (1805).

II: on rock, Arikawa 5210; on soil, Higuchi 44895, Arikawa 5237. III: on soil, Higuchi 44932, Arikawa 5260.

Pottiaceae

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

II: on soil-cliff, Arikawa 5197. III: rock, Arikawa 5264.

Hyophila involuta (Hook.) A.Jaeger, Ber. S. Gall. Naturw. Ges. 1871–72: 354 (1873).

V: on concrete, Higuchi 45077. VIII: on brick, Higuchi 45306.

Leptodontium flexifolium (Dicks.) Hampe in Lindb., Oefv. K. Vet. Ak. Foerh. 21: 227 (1864).

III: on rock-crevice, Higuchi 44904, Arikawa 5247; on soil, Arikawa 5243. IV: on rock, Higuchi 44967.

Oxystegus tenuirostris (Hook. & Tayl.) G. L. Sm., J. Bryol. 9: 393 (1977).

II: on boulder, Higuchi 44898; on decaying stump, Higuchi 44885. III: on rock-crevice covered with soil, Higuchi 44905 (+*Bryum argenteum*), 44906, Arikawa 5241. IV: on boulder, Higuchi 44965. VIII: on rock-cliff, Higuchi 45243.

Pseudosymblepharis bombayensis (Müll. Hal.) P.Sollman, Tropical Bryology 12: 2 (1996).

VI: on concrete, Higuchi 45124; on basal part of tree, Higuchi 45093.

Weissia controversa Hedw., Spec. Musc. 67 (1801).

VIII: on soil at trail bank, Higuchi 45305 (+*Philonotis calomicra*).

Rhacocarpaceae

Rhacocarpus alpinus (C. H. Wright) Paris, Ind. Bryol. Suppl. 291 (1900).

III: on rock, Higuchi 44928, 44930.

Sphagnaceae

Sphagnum cuspidatum Ehrh. ex Hofm., Deutschl. Fl. 2: 22 (1796).

I: on humus, Higuchi 44866.

Sphagnum junghuhnianum Dozy & Molck., Nat. Verh. K. Ak. Wet. Amsterdam 2: 8 (1854).

IV: on soil, Arikawa 5303; on humus, Higuchi 44981.

Sphagnum sericeum Müll. Hal., Bot. Zeit. 5: 481, 484 (1847).

IV: on stump and root, Arikawa 5317.

Takakiaceae

Takakia lepidozoides S.Hatt. & Inoue, J. Hatt. Bot. Lab. 19: 137 (1958).

II: on rock-cliff, Higuchi 44869.

Notes. Hattori (1963a, b) firstly reported *Takakia lepidozoides* from Borneo Island based on the collections from Mt. Kinabalu, from a gorge near Paka Cave and above the cave between ca. 3000 m alt. and 3200 m alt. Subsequently Akiyama (1999) in his genetic study of *Takakia lepidozoides* described the habitat of the species at Mt. Kinabalu as "Beside a stream in tropical montane *Quercus* forest, ca. 3000 m alt. Partially shaded, or at rather sunny site." We observed the species growing on the basal part of the rock-cliff at basin of a small waterfall near Paka Cave (Fig. 1: 3). It grows sporadically in small populations. Higuchi and Lin (2005) pointed out in the first record of *Takakia lepidozoides* in Taiwan that the size and growth form of plants were different between sheltered places and exposed ones. *Takakia lepidozoides* observed in

this study are larger plants and loose mats as compared to the population of sheltered places.

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ボルネオ (マレーシア) のキナバル山の蘚類

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ボルネオ (マレーシア) のキナバル山の蘚類フロラを2005年に調査した。今回の調査で本地域から18科43属97種の蘚類 (腋蘚類を除く) を確認した。それらのうち、*Ditrichum heteromallum*, *Fissidens braunii*, *Syrrhopodon tjibodensis* はボルネオの蘚類フロラに新たに加わるものであった。各種について、産地、基物、標本番号を示した。