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The Bryophytes of Sabah (North Borneo) with Special Reference to the BRYOTROP  
Transect of Mount Kinabalu. IX. Rhizogoniaceae (Bryopsida)

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ANDRIES TOUW

## The bryophytes of Sabah (North Borneo) with special reference to the BRYOTROP transect of Mount Kinabalu.

### IX. *Rhizogoniaceae* (*Bryopsida*)

#### Abstract

Touw, A.: The bryophytes of Sabah (North Borneo) with special reference to the BRYOTROP transect of Mount Kinabalu. IX. *Rhizogoniaceae* (*Bryopsida*). – Willdenowia 19: 237–243. – 1989. – ISSN 0511–9618.

Four genera and six species of *Rhizogoniaceae* have been found in Borneo. Keys are given to these species, as well as information on their total range, distribution in Borneo, ecology, and variability. The treatment of *Rhizogonium* is in fact a revision of the genus for West Malesia. Lectotypes are proposed for *Hymenodon pilifer* subsp. *sericeus*, and *Pyrrhobryum latifolium*.

#### Introduction

The *Rhizogoniaceae* are erect growing, usually tufted pleurocarps that are very peculiar in the position of the perichaetia, which are borne at the base of the stem in all Malesian representatives. Furthermore, they are characterized by leaves with a strong costa, short, firm-walled cells, and a usually serrate or dentate, often bordered margin. The family and its constituent genera have been discussed recently by Manuel (1980), Churchill & Buck (1982) and Koponen, Touw & Norris (1986). The present contribution closely follows the last treatment, which also includes original illustrations and references to older illustrations for all Bornean species. Consequently only the illustrations published in the last paper (Koponen, Touw & Norris 1986) are cited here.

#### Key to the Bornean species of *Rhizogoniaceae*

1. Leaves piliferous ..... *Hymenodon pilifer*
- Leaves blunt, acute, or acuminate, but not piliferous ..... 2
2. Leaves distichous (basal leaves excepted), bearing single teeth; costa abaxially smooth; leaf border (if present) unistratose, consisting of elongate cells ..... 3
- Leaves in more than two rows, bearing geminate teeth; costa abaxially toothed; leaf border (if present) bistratose, consisting of cells similar to the inner lamina cells ..... 4
3. Leaves narrowly ovate-lingulate or lanceolate-lingulate, longitudinally orientated (all in one plane); leaf base hardly or not decurrent; leaf apex serrulate or serrate by unicellular teeth .....  
..... *Rhizogonium graeffeanum*

- Leaves ovate or ovate-lanceolate, mostly obliquely orientated; leaf base often long-decurrent; leaf apex mostly coarsely serrate by pluricellular teeth . . . . . *Rhizogonium lamii*
- 4. Peristome single. Leaves up to 2 mm long; border absent in places, especially at the leaf base . . . . . *Hymenodontopsis stresemannii*
- Peristome double. Leaves longer; border complete or lacking near the leaf apex . . . . . 5
- 5. Synoicous; perichaetial leaves abruptly acuminate from a broad base, rarely exceeding 2.5 mm in length (n=12) . . . . . *Pyrrhobryum spiniforme*
- Dioicous; perichaetial leaves usually gradually tapering, ca. 3–7 mm long (n=6) . . . . . *Pyrrhobryum latifolium*

*Hymenodon* Hook. f. & Wils. in J. Bot. (Hooker) 3: 548 (1844).

Apart from the characters mentioned in the key, *Hymenodon* is characterized by its erect capsules, single peristome (the endostome being absent), stems that are strongly interwoven by reddish tomentum, glaucous leaves having crenulate or entire leaf margins, and leaf cells that are mostly mamillate. Of the five species recognized by Karttunen & Bäck (1988) two occur in Malesia, and only one has been found in Borneo. All species grow almost exclusively on the trunk of tree ferns and are rarely found on other substrates like thoroughly rotten wood, tree roots, or raw humus.

*Hymenodon pilifer* Hook. f. & Wils. subsp. *sericeus* (Dozy & Molk.) Kartt. & Bäck in Ann. Bot. Fenn. 25: 90 (1988).

≡ *Mielichhoferia sericea* Dozy & Molk., Musci Frond. Ind. Archip. Ind. 17 (1844).

Syntypi: Java, *Korthals s.n.* (Lecto- L!); Borneo, *Korthals s.n.* (L!). – Lectotypus hic designatus.

Ic.: Koponen, Touw & Norris 1986: 4, fig. 2a-h (sub *Hymenodon sericea*).

*Hymenodon pilifer* subsp. *sericeus* can be recognized easily by its long-awned leaves, and might be confused with *H. angustifolius* Sande Lacoste only. In the former the terminal cell constitutes at least half of the length of the awn, and the lamina is more than 10 cells wide on each side of the costa. In *H. angustifolius* the terminal cell measures less than half of the length of the awn, the lamina is narrower, and the peristome is absent.

No type was mentioned in the protologue, but in a hand-written manuscript kept in the herbarium of Dozy and Molkenboer the two Korthals collections are mentioned that figure also in their next publication (Dozy & Molkenboer 1846). A third specimen listed there (collected by Zippelius) is also present in their herbarium, but has been provided with a separate description and a name never published. Therefore, the two Korthals collections are considered syntypes of *Mielichhoferia sericea*. Though the label of the Bornean collection bears no further information with regard to the collecting locality it must have originated from Kalimantan Selatan, the only region visited by Korthals in 1836. Both syntypes are from tree ferns.

Geographical range: Philippines (Luzon), Borneo (SAB?, KSE), Sumatra, Java, Flores, Celebes, Ternate, New Guinea, Bismarcks; *Hymenodon pilifer* Hook. f. & Wils. subsp. *pilifer* is restricted to S Australasia. Altitudinal range (Borneo): unknown; elsewhere (900–) 1500–3000 m.

Specimen examined: the syntype only.

*Hymenodontopsis* Herz. in Hedwigia 57: 235 (1916).

Monotypic genus.

*Hymenodontopsis stresemannii* Herz. in Hedwigia 57: 235 (1916).

Syntypi: Mittel-Ceram, Epiphyt der Baumfarnregion am Gunung Pinaia, ca. 2530–2750 m, *Stresemann* 264 (Syn- JE, not seen, iso- L!), 325 (Syn- JE, not seen, iso- L!).

Ic.: Koponen, Touw & Norris 1986: 7, fig. 4a-g.

*Hymenodontopsis stresemannii* superficially resembles *Hymenodon pilifer* subsp. *sericeus* by its erect capsules, single peristome, often glaucous gametophores interwoven by reddish tomentum, and (less marked) preference for the trunks of tree ferns. However, in *H. stresemannii* the single peristome consists of the endostome (Shaw & Anderson 1986), the glaucous colour may be absent, and the leaf shape, partially bistratose border bearing geminate teeth, abaxially toothed costa, and smooth lamina cells are strongly reminiscent of *Pyrrhobryum*, for which the plants may easily be mistaken at first view.

Geographical range: Borneo (KIN), Ceram, New Guinea.

Altitudinal range (Borneo): 2100–2800 m (very few data); elsewhere reported from 1200 to 3600 m.

Specimen examined:

KIN: Mesilau River, 7000 ft., *Clemens 51487b* (FH).

*Rhizogonium* Brid. in Bryol. Univ. 2: 663 (1827).

In *Rhizogonium* the very small lower leaves of the stem are not distinctly arranged in rows, but the much larger distal leaves are strictly distichous, often asymmetrical, provided with single teeth, and either unbordered or more or less bordered by elongate cells.

The genus is accepted here in the circumscription given by Manuel (1980) with the refinements added by Koponen, Touw & Norris (1986). A difference between *Rhizogonium* and *Pyrrhobryum* not yet mentioned is found in the cells of the leaf base. In *Rhizogonium* they are longer than wide, and longer than the median laminal cells, whereas they are isodiametrical and similar to the median laminal cells in *Pyrrhobryum*. Differentiated basal leaf cells are also present in *Hymenodontopsis*.

All collections available from Borneo have been revised and are listed below.

*Rhizogonium graeffeanum* (C. Muell.) Jaeg. in Ber. Thätigk. St. Gallischen Naturwiss. Ges. 1873/74: 220 (1875).

= *Mnium graeffeanum* C. Muell. in J. Mus. Godeffroy 3(6): 11 (1874).

Typus: Samoa, Savaii, inter alios muscos specimina perpauca sterilia inveni, *Graeffe s.n.* (not seen).

= *Rhizogonium salakanum* Broth. in Möll. in Hedwigia 60: 319 (1919). – Typus: Indonesia, Java, Salak, *Möller s.n.* (Holo- H-BR!) – cf. Koponen, Touw & Norris 1986.

Ic.: Koponen, Touw & Norris 1986: 10, fig. 5f-i.

*R. graeffeanum* forms glaucous green or whitish green plants superficially resembling *Fissidens*, and has been mistaken for *Hymenodon* occasionally, from which it differs strongly by its distichous non-pili-

ferous leaves. After line 4 of the description published in Koponen, Touw & Norris (1986, p. 12) the following lines that were omitted in print should be inserted: [Upper] 'leaves mostly touching each other or slightly overlapping, orientated longitudinally or nearly so, mostly ovate-lingulate or lanceolate-lingu-' [late]. Line 9–12 of the same description should be erased.

The Bornean plants of *R. graeffeanum* are similar to those found in the Philippines and New Guinea. The leaves are gradually narrowed upwards, and the costa is usually very shortly excurrent or percurrent. If shorter, it is continued up to the leaf apex by cells distinctly longer than the ordinary laminal cells. The Bornean plants of *R. salakanum* reported by Iwatsuki & Noguchi (1975) show the same features and differ from the type of *R. salakanum*, which represents the form of *R. graeffeanum* predominant in the Malay Peninsula, Sumatra, and Java (and not yet found in Borneo). In that form the leaf apex is more abruptly rounded, and in many leaves the costa ends below the leaf apex and is separated from it by ordinary, nearly isodiametric leaf cells.

*R. graeffeanum* is a mountain forest species growing in permanently moist places, in partial or full shade, on thoroughly rotten wood, tree bases, roots, or humus accumulations, and mostly under overhanging parts of the substrate or the surrounding vegetation.

Geographical range: Philippines (Luzon, Mindanao), Borneo (SAB, KIN, SAR, KTI), Malay Peninsula, Sumatra, Java, New Guinea, Solomons, New Caledonia, Fiji, Samoa, Australia (Queensland, New South Wales).

Altitudinal range (Borneo): 1100–2650 (–2850) m.

Specimens examined:

BRYOTROP: XV: 3527. – XVIIa: 4600, 4634. – XIX: 3089, 3100. – XXI: 3257, 3285, 3303. – XXIII: 4924. – XXV: 3690.

Additional collections from Borneo: KIN: 1400–1900 m, *Iwatsuki 250285* (NICH); *ibid.*, 2000–2146 m, *Iwatsuki 250447* (NICH); *ibid.*, 2146–2500 m, *Iwatsuki 250741 p.p.* (NICH); *ibid.*, 2500–2850 m, *Iwatsuki 251109* (NICH); *ibid.*, 2550–2650 m, *Kodama 40647* (NICH); *ibid.*, 6700 ft., *Meijer B 12165* (L); *ibid.*, 2146–2500 m, *Mizutani 252672 p.p.* (NICH); *ibid.*, 5200 ft., *Shea 2956* (NICH). – SAR: G. Mulu, 1750 m, *Touw 21089a* (L). – KTI: Peak of Balikpapan, 1100–1150 m, *Meijer B 2258* (L).

*Rhizogonium lamii* Reim. in Hedwigia 69: 123 (1929) ("*Lamii*").

Typus: Nova Guinea neerlandica, in reg. flum. Mamberamo, in monte Doorman, 2500 m, *Lam 1955* (Holo- B†, Lecto- U!, iso- GRO!).

= *Rhizogonium pseudodistichum* Nog. & Iwats. in J. Hattori Bot. Lab. 39: 322 (1975). – Typus: Malaysia, Sabah, Mt. Kinabalu, between Kamaranga Radio Station and Second Radio Station, 2146–2500 m, *Iwatsuki 250739a* (Holo- NICH!) – cf. Koponen, Touw & Norris 1986.

Ic.: Manuel 1981: 451, fig. 1 (as *R. novae-hollandiae*); Koponen, Touw & Norris 1986: 10, fig. 5a-e.

*Rhizogonium lamii* is a species displaying both altitudinal and geographical variability. Though the extremes are strikingly different no infraspecific taxa could be distinguished. The type belongs to a very tall form known from New Guinea only, with stems measuring ca. 2–6.5 cm in length, and leaves that are orientated almost transversally, weakly asymmetrical, opaque, and dull.

A widespread more slender form (including the type of *R. pseudodistichum*) has stems ca. 1–3 cm tall, and leaves that are orientated obliquely to almost longitudinally, distinctly asymmetrical, more or less translucent, often somewhat shining, mostly broadly ovate or elliptic, and indistinctly or not at all acuminate. It has been collected throughout the geographical range of the species (Malaya excepted), most

often between 2400 and 3500 m, but it has also been found as low as 1500 m. In Borneo it has been found on Mt. Kinabalu only.

In both forms mentioned so far the leaf base is strongly decurrent and often almost reaches the next lower leaf, thus presenting an easy way to distinguish *R. lamii* from *R. graeffeanum*. This is not the case in the still more slender West Malesian expression of the species absent from New Guinea (thus not included in the description presented in Koponen, Touw & Norris 1986). In these plants the leaf base often is hardly decurrent or very narrowly decurrent only. They furthermore differ from the more robust plants occurring outside New Guinea by leaves that are narrower (ca. 0.5–0.7 vs. 0.7–1.2 mm), mostly ovate-oblong to lanceolate, and gradually narrowed to a distinctly acuminate or almost cuspidate apex. In Borneo, these plants are more widespread than those belonging to the more robust form, and usually are found at lower altitudes (ca. 1000–2500 m). At first, they were thought to represent a separate taxon, but upon analysis of the many new collections that have become available in recent years no discontinuities between these forms could be detected.

All Bornean, Sumatran, and Malayan collections previously assigned to *R. novae-hollandiae* (Brid.) Brid. by Dixon (1926, 1932, 1935) and Manuel (1981) belong here. They are very close to *R. novae-hollandiae* indeed, but in the latter species the leaves are distinctly imbricate and cuspidate, and bear unicellular teeth only. Both species resemble the American *R. lindigii* (Hampe) Mitt., that has been reported from Sumatra by Crum (1981). Though not having seen the collection concerned I presume that it belongs to *R. lamii* too. *R. lindigii* has a more strongly differentiated leaf border, lamina cells that are smaller on average (ca. 10–17  $\mu\text{m}$  vs. 12–35  $\mu\text{m}$  in shortest diameter), a usually percurrent or short-excurrent costa, and leaves that are wider in relation to their length (ca. 1.6–2.0 vs. 2.1–2.8).

*R. lamii* has also been confused with and is very close to the Australasian *R. distichum* (Sw.) Brid. which has imbricate leaves often postically secund when dry. Iwatsuki & Noguchi (1975) mentioned leaf shape as a point of difference between these two species, but in *R. lamii* this character shows a very wide variation, including shapes indistinguishable from those in *R. distichum*. Seta length may be different as it measures up to ca. 2.5 (–4.5) cm in *R. distichum*, and up to 9 cm in *R. lamii*, but as yet only 7 collections containing well developed sporogones have become available of the latter (none from Borneo). The report of *R. distichum* from Mt. Kinabalu based on a Burbidge collection (Mitten & Wright 1894) very likely relates to *R. lamii*, but this could not be established firmly as Mitten's herbarium contains an unnamed Burbidge collection (of *R. lamii*) only.

In Borneo, *R. lamii* appears to grow in situations similar to those mentioned from New Guinea: shady places in mountain forests, mostly on bases of trees or on rotten logs, and occasionally terrestrial (on humus).

Geographical range: Philippines (Luzon, Mindanao), Borneo (SAB, KIN, SAR, KTI), Malay Peninsula, Sumatra, New Guinea, Samoa (?).

Altitudinal range (Borneo): 1000–3000 m.

Specimens examined:

BRYOTROP: XVI: 4262. – XVIIa: 4604. – XXIII: 3327, 3330. – XXV: 3640, 3662. – XXX: 4059.

Additional collections from Borneo: KIN: 6000 ft., *Burbidge s.n.* (NY); *ibid.*, 7200 ft., *Holtum 25655* (BM, GRO); *ibid.*, 2146–2500 m, *Iwatsuki 250737* (NICH), *250739* (NICH), *250739a* (NICH), *250741 p.p.* (NICH); *ibid.*, *Meijer B 10206* (L); *ibid.*, 1800 m, *Wood 1551* (BM, GRO). – SAR: G. Mulu, 4200 ft., *Keng 883* (L); *ibid.*, 1250 m, *Touw 20744* (L); *ibid.*, 1750 m, *Touw 21089* (L); *ibid.*, 1900 m, *Touw 21100* (L). – KTI: Peak of Balikpapan, 1000 m, *Meijer B 1637* (L); Mt. Tibang, 1400 m, *Mjöberg s.n.* (FH).

*Pyrrhobryum* Mitt. in J. Linn. Soc., Bot. 10: 174 (1868).

The Bornean species of *Pyrrhobryum* belong to the *P. spiniforme* (*Rhizogonium spiniforme*) complex. In

recent years strongly different ideas concerning the number of taxa and their rank have been advocated (Iwatsuki 1969, 1972, Inoue & Iwatsuki 1976, Lai 1978, Manuel 1981, Koponen, Touw & Norris 1986). Accepting the concept of Koponen, Touw & Norris (1986) here, only two species have been recognized, differing mainly in chromosome number and sexual condition. As a rule, geminate teeth and isodiametrical inner cells are lacking in the comparatively short acumen of the perichaetial leaves of *P. spiniforme*, whereas they usually are present in the longer acumen of the perichaetial leaves of *P. latifolium*. Most BRYOTROP collections of the latter had perichaetial leaves far shorter than usual (up to ca. 3.5 mm). One collection (BRYOTROP 4415) has perichaetial leaves measuring 3.5 mm, some geminate teeth and isodiametrical inner cells, but was assigned to *P. spiniforme* because of its synoicous condition and abruptly contracted perichaetial leaves.

Both species grow in abundance on decaying wood, but are also found on trunks and roots of living trees and shrubs, and less often on rocks and terrestrial (on raw humus), particularly in forests on poor sandy soil.

*Pyrrhobryum spiniforme* (Hedw.) Mitt. in J. Linn. Soc., Bot. 10: 174 (1868).

= *Hypnum spiniforme* Hedw., Sp. Musc. Frond. 236 (1801) = *Rhizogonium spiniforme* (Hedw.) Bruch in Krauss in Flora 29: 134 (1846).

Typus: Jamaica, *Sloane s.n.* (G, not seen).

Ic.: Koponen, Touw & Norris 1986: 17, fig. 8a-h.

Geographical range: pantropical (Borneo: SAB, KIN, SAR, KBA, KTE).

Altitudinal range (Borneo): 600–2500 m.

Specimens examined:

BRYOTROP: IX: 4400, 4415. – XIII: 3040, 3046, 4856. – XVIIa: 4777. – XIXa: 4154.

Additional collection from Borneo: KTE: Dusun River, *Korthals s.n.* (L).

*Pyrrhobryum latifolium* (Bosch & Sande Lac.) Mitt. in J. Linn. Soc., Bot. 10: 175 (1868).

= *Rhizogonium latifolium* Bosch & Sande Lac. in Dozy & Molkenboer, Bryol. Jav. 2: 2 (1861).

Syntypi: Banca, in locis umbrosis ad terram et ad arbores inter Kimah et Simpan, 2. 8. 1858, *Amann (=Kurz)* 43 (Lecto- L!); Banca, in sylvis prope Batoeroesak, *Amann (=Kurz) s.n.* (L!) – Lectotypus hic designatus.

= *Pyrrhobryum longiflorum* Mitt. in J. Linn. Soc., Bot. 10: 174 (1868) = *Rhizogonium longiflorum* (Mitt.) Jaeg. in Ber. Thätigk. St. Gallischen Naturwiss. Ges. 1873/74: 223 (1875). – Typus: Borneo, Sabah, Labuan I., *Motley s.n.* (Holo- NY, not seen) – cf. Koponen, Touw & Norris 1986.

Ic.: Koponen, Touw & Norris 1986: 15, fig. 7a-k.

The type of *P. latifolium* represents a very robust form with very broad stem leaves and perichaetial leaves. That form might be restricted to lowland areas of West Malesia (specimens seen from the Malay Peninsula, the Riouw Archipelago, Sumatra, Bangka, Lepar, Belitung, KBA, KTE, and KTI). Most Bornean plants resemble *P. spiniforme* in general appearance and represent the narrow leaved expression formerly recognized as *P. longiflorum*. The latter form appears to be much more common and widespread in Malesia than appears from the published information. The relation between these strikingly different forms deserves further study.

The collection which Dixon (1916) assigned to *Rhizogonium medium* Besch. var. *laxifolium* Thér. consists of compact tufts of rather small male plants, and is interpreted here as a small form of *P. latifolium*.

Geographical range: widespread in tropical and subtropical E and SE Asia; Malesian specimens seen from the Philippines, S Thailand, Malay Peninsula, Riouw Archipelago, Borneo (SAB, KIN, SAR, BRU, KBA, KTE, KSE, KTI), Sumatra, Bangka, Belitung, Lepar, Java, Lombok, Celebes, New Guinea.

Altitudinal range (Borneo): from sea level up to 2100 m.

Specimens examined:

BRYOTROP: Ia: 4559 (cf.). – XI: 4330, 4359. – XII: 4682. – XIII: 3012. – XV: 3498. – XVII: 3430. – XVIIa: 4635. – XIXb: 4735. – XXI: 3267.

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