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Bryophyte flora of the Huon Peninsula, Papua New Guinea. LXVI. Meesiaceae (Musci), with lists of boreal to temperate disjunct, bipolar, and widely spread species in New Guinea

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Meesia triquetra (Richter) Ångstr. is the only species of the family Meesiaceae occurring in Western Melanesia and New Guinea. Two collections are from high elevation wetland areas, where the plant presumably has a similar habitat ecology on wet soils as in its northern localities. Documented list of boreal to temperate northern hemisphere bryophyte species having disjunct occurrences in New Guinea, list of bipolar species, and list of widely distributed species are presented. Most of disjunct species and bipolar species are either plants of high elevation open and rocky habitats or wetland habitats such as shore meadows or bogs in New Guinea. Widely distributed species occur either in habitats created by man's activities, or are plants of open or shaded rocky habitats, preferably cliffs.

Key words: bipolar species, boreal to temperate disjunct bryophytes, "cosmopolitan" species, *Meesia,* Papua New Guinea, taxonomy, West Irian

INTRODUCTION

This paper belongs to a series dealing with the bryophyte flora of Western Melanesia, which includes West Irian, Papua New Guinea and the Solomon Islands. Essential background information of materials and methods, and abbreviations of collecting localities and geographical areas used

in this study are given in part I (Koponen & Norris 1983) and VII (Norris & Koponen 1985). The previous parts of the Huon Peninsula series are listed in Koponen *et al*. (1991) and in Koponen (1993, 1995). The previous papers in the series are Pócs *et al.* (1994) and Pócs and Piippo (1999). Our studies are mainly based on the collections of Koponen and Norris from the Huon Peninsula, Papua New Guinea (H). However, no specimens of *Meesia* (Richter) Ångstr. were collected during the Koponen-Norris expedition of 1981. This study is a confirmation of the reports of Bartram (1942, 1961).

FAMILY MEESIACEAE SCHIMP. 1856

Plants can be placed with certainty in the family Meesiaceae by the following combination of observations: (1)wetland plant with dense red-brown, papillose and heavily branched rhizoids; (2) rhizoids arranged on almost orbicular macronematal apparati in a median axillary position relative to the leaves; (3) axillary hairs numerous and persistent with the basal several cells so red-brown as to be seen even through the leaf bases. The three genera in this small family are largely plants of peatlands, often calcareous. Two of the genera (*Paludella* Brid. and *Amblyodon* B.S.G.) are monotypic. *Paludella* is restricted to the Northern Hemisphere, with *Meesia* and *Amblyodon* occurring in the Southern Hemisphere. *Meesia* has not yet been studied on a world-wide scale but such a study would certainly yield fewer than 10 and probably nearer to 5 species.

Meesia is easily recognised when sporophytes are present: no other plant has such a long seta with a strongly arcuate capsule whose peristome includes a strongly reduced exostome greatly exceeded by the longer endostome. The frequent retention of the cucullate calyptra on the neck of the capsule is a feature shared only with *Discelium* Brid. (Disceliaceae). Microscopically, the variety of leaf form and insertion is striking in such a small genus. Leaf form varies from ligulate with a very broad costa in *M. uliginosa* Hedw. to ovate with a narrow costa in *M. triquetra* (Richter) Ångstr. The leaf insertion varies from strongly 3-ranked (*M. triquetra*) to weakly 5-ranked (*M. uliginosa*), and this is reflected in the shape of the stem cross-sections (rounded-triangular or rounded-pentagonal).

Meesia triquetra, with *M. uliginosa*, are bipolar plants of wetlands, mostly high elevation or high latitude sites. Streimann (1998) presents the former as a bipolar species of the Northern Hemisphere and of Australia; Schofield (1974) presents the latter in similar fashion.

Meesia triquetra (Richter) Ångstr. (Fig.1)

Nov. Acta R. Soc. Sci. Upsal. 12: 357. 1844. — *Mnium triquetrum* L. in Richter, Codex Bot. Linn. 1045. 1840.

Meesia trifaria Crum, Steere & Anderson, Bryologist 68: 434. 1965.

Meesia tristicha Bruch, Flora 9: 165. 1826.

Plants in small tufts or cushions mostly interspersed with other bryophytes, to 6 cm high, dark green to grass-green above, occasionally red-brown below due to dense rhizoids. Stems pale brown to yellow brown, closely foliate, with leaves keeled, spreading and laterally rolled when dry, spreading when moist, not secund but appearing crispate. Margin plane to recurved at mid-leaf but plane below and near the apex, strongly decurrent by a strip up to 4 cells wide at the top, extending to insertion of next lower leaf. Leaves entire throughout or minutely serrulate on the distal 1/2–2/3, to 4 mm long, lanceolate and broadest at about 1/3, 2.5:1, with the apex acute to acuminate. Cells throughout lamina in regular rows, smooth with angular lumens. Median cells of lamina moderately thick-walled with rectangular lumens, to 20 µm broad, rather variable in length, mostly 1–2.5:1. Marginal cells of leaf somewhat more narrow and proportionately longer than adjacent more interior cells. Cells across the leaf base somewhat longer and more pellucid than median cells but otherwise similar. Cells of alar region not differentiated. Macronematal initials to 120 µm broad, orbicular, median axillary in insertion. Costa filling about 1/10 of the leaf base, gradually tapering to the subpercurrent to percurrent apex. Lamina unistratose throughout. Costa cross section with a stongly differentiated ad- and abaxial epidermis surround a large cluster of stereid cells. Stem cross section rounded triangular, with a stereome of 1–2 very strongly

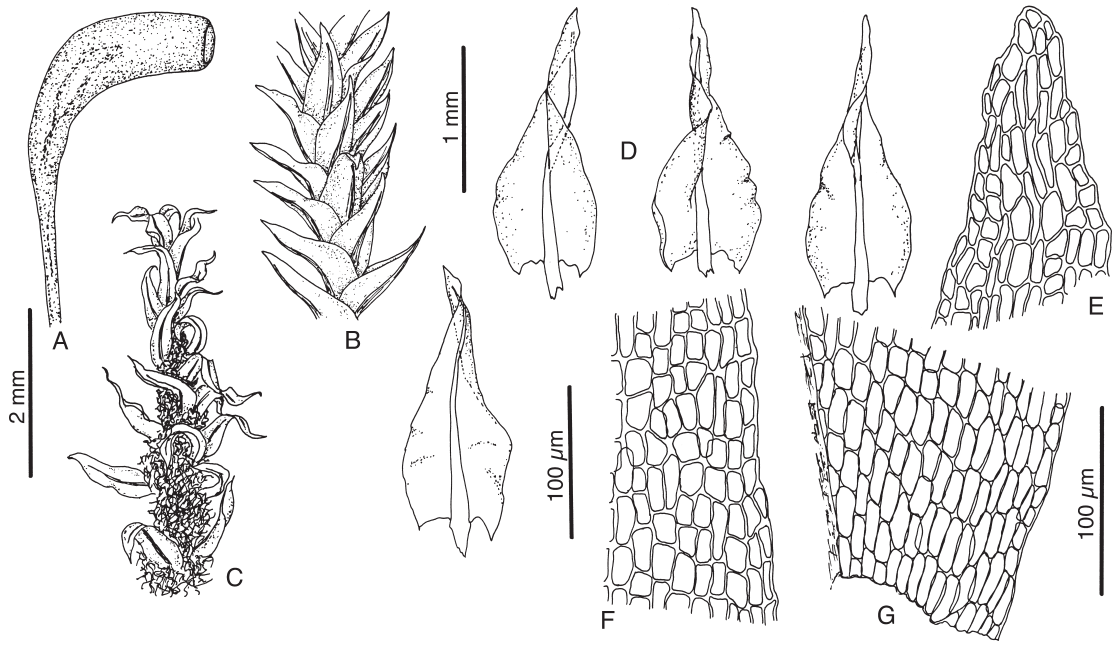

Fig. 1. *Meesia triquetra* (Richter) Ångstr. (from *Brass 9256*, FH). — A: Capsule. — B, C: Habit of plant. — D: Leaves. — E: Leaf apex. — F: Leaf margin at mid-leaf. — G: Leaf base. Scale bars: 2 mm for A–C, 1 mm for D, 100 µm on the left for E and F, and 100 µm on the right for G.

differentiated, small, red-brown and pachydermous cells, and with the central strand well-defined. Rhizoids restricted to the axillary macronematal apparati, red-brown, densely papillose, extensively but irregularly branched, to 20 µm wide at base. Axillary hairs to 180 µm long with 3–4 rather elongate brown cells and a single rather thin-walled cylindrical terminal cell.

Presumably dioicous but antheridial material not seen in our material. Perichaetia terminal but with perichaetial bracts similar to vegetative leaves. Seta to 60 mm long, straight and smooth, brown to yellow brown. Urn arcuate and asymmetric, to 4 mm long, oblong to short cylindric, brown to yellow brown, wrinkled when dry but not regularly sulcate. Operculum short conic. Neck of dry capsule moderately well-defined, not much wrinkled when dry, comprising up to 1/2 of capsule length. Suboral exothecial cells transversely elongate in 5–8 rows, 0.5–0.8: 1, to 15 µm broad. Median exothecial cells to 25 µm broad, hexagonal and thin-walled, 1–2: 1. Stomata not seen. Annulus poorly defined. Exostome inconspicuous, inserted far below mouth of capsule and hardly protruding from mouth, to 100 µm long, brownish to hyaline with prominent ventral trabeculae. Endostome inconspicuously keeled, smooth or nearly so with basal membrane inconspicuous, but with 1–2 cilia. Spores spherical, finely papillose, to 40 µm.

Illustration: Crum & Anderson (1981: pl. 296); Sharp *et al.* (1994: fig. 436); Smith (1978: fig. 219: 4–5).

Meesia triquetra is unlikely to be mistaken for any other New Guinea moss. In that geographic area it is the only acrocarpous moss with such a strongly tristichous arrangement of its ovate leaves. Both of the specimens reported here come from literature reports validated by actual examinations of the voucher specimens. These two collections are as expected from high elevation wetland areas where the plants presumably occupy perennially wet soils.

Range on the Huon Peninsula: None.

Range in Western Melanesia: West Irian. *7.* Lake Habbema, covering open bogs, 3 225 m, *Brass 9256* (FH!); Papua New Guinea. *13.* Laiagam Subdistrict. Yobobos grassland area in swamp at source of Lagaip River, *Hoogland & Schodde 7618* (F!).

Total range: Am 1–2; Eur; As 4: PNG; Austr 1.

DISCUSSION

Meesia triquetra is one of a large number of mainly boreal to temperate northern hemisphere species which have disjunct occurrences in New Guinea and Australia. Hyvönen (1989) listed 14 such mainly northern hemisphere taxa. He also recognized 5 species as "Miscellaneous species", and 17 "Widely distributed species". We add the hepatic flora of New Guinea into this discussion, and recognize three groups which are presented in Table 1. There are probably some more species in each of the groups (for instance Dr. A. Touw has told us of *Hylocomium splendens* (Hedw.) B.S.G. in New Guinea), but we include here only the flora which we have confirmed so far.

The first group (A in Table 1) consists of species which have rather wide ranges in the northern hemisphere in boreal to temperate vegetation zones, and which have disjunct occurrence in New Guinea. Most of them grow in natural plant communities in New Guinea. Only *Scopelophila ligulata* (Spruce) Spruce has been collected in habitats heavily disturbed by man's activities, and *Fissidens taxifolius* Hedw. and *Timmiella anomala* (B.S.G.) Limpr. may grow in garden areas. Most of the rest of species are either plants of high elevation open and rocky habitats or wet habitats such as shore meadows or bogs. The same is true of the second group, the bipolar species (B in Table 1). They have wide ranges in the northern hemisphere and disjunct occurrences in various parts of the antiboreal and antitemperate zones, and on high tropical mountains. Plants of both groups have the same habitat ecology in New Guinea as they have in their boreal to temperate areas. None of them can survive in the really tropical conditions near sea level.

The plants of the third group (C in Table 1) have rather wide distribution in the northern hemisphere and also in more southern areas. We exclude pantropical widely distributed and "subcosmopolitan" species from this discussion. Ecologically there are two different groups. Some are "weedy" plants most common in habitats created by man's activities, although their original habitats surely are primeval. These are marked by an asterisk on Table 1. The second group are plants of rocky habitats, preferably cliffs. They can tolerate rather open habitats, and accordingly, can survive in garden areas in New Guinea, if suitable cliffs are available. In New Guinea they may have wide altitudinal distribution, which is another evidence of their flexibility and ability to adapt in different temperatures. However, only a few of them can tolerate most tropical conditions at the sea level.

Streimann (1998) compared the bryophyte floras of North Europe and Australia and found 112 moss and 14 liverwort species that are common to these areas. Nine of the species he listed as bipolar are on our list of New Guinea bryophytes (Group B), and 12 of 20 taxa listed by us as widespread occur in Australia (Group C). Streimann also concluded that at least 12 species of mosses are recent introductions by man to Australia. None of them have been recorded for New Guinea.

The minimum of 21 northern hemisphere boreal to temperate bryophyte species (Group A) and at least 17 bipolar species have disjunct occurrences in high elevations in New Guinea (Group B). The problems of bipolar distribution of plants and disjunctions on oceanic islands have been discussed in many connections (Du Rietz 1940, Schofield & Crum 1972, Schofield 1974, Schuster 1968, 1983, Zanten & Pócs 1981, Gradstein & Váňa 1987, Ochyra 1992, Hedenäs 1999). To our mind it is unnecessary to discuss at length on the possible ways and timing of arrival of the disjunct flora in New Guinea. The geological history of New Guinea above sea level is rather recent, it first appeared ca. 10 million years ago (Piippo 1992, Piippo & Koponen 1997) and rapidly rose to the elevation of more than 4 000 m. The taxa listed in the Table 1, groups A and B are not taxonomically different from the plants of their boreal and temperate or austral populations and this suggests comparatively recent introductions. The most probable explanation of these disjunctions is long distance dispersal. During the rather rapid upheavel of New Guinea the arriving diaspores were shed in areas where the low elevation tropical flora could not compete, and these boreal to temperate plants could establish themselves as constant members of plant communities. Most of the bipolar bryophytes in Australia occur in similar habitats as in New Guinea, either on rocky habitats or in wetland plant communities (Streimann 1998).

Table 1. — A: Northern Hemisphere boreal to temperate bryophytes disjunct in New Guinea (some of them extending their range to South America). — B: Northern Hemisphere boreal to temperate and bipolar bryophytes occurring in New Guinea. — C: "Cosmopolitan", and widely distributed bryophytes occurring in New Guinea (excluding pantropical species). Nomenclature follows that in the "Huon Peninsula" series (Koponen *et al.* 1983–1996). Some additional information from Schuster (1968) and Grolle (1968). * = "cosmopolitan" species.

Species	Habitat	Altitude	Data from
A			
Anastrophyllum assimile (Mitt.) Steph.	primeval	3 700 – 3 800	(Váňa & Piippo 1989b)
Anastrophyllum minutum (Schreb.) R. M. Schust.	primeval	3 700 – 4 500	(Váňa & Piippo 1989b)
Blepharostoma trichophyllum (L.) Dumort.	primeval	3 600 – 4 500	(Grolle & Piippo 1984)
Bryoerythrophyllum ferruginascens (Stirt.) Giac.	mostly primeval	1 800 – 3 570	(Norris & Koponen 1989)
Epipterygium tozeri (Grev.) Lindb.	primeval	750 – 2 400	(Koponen & Norris 1985)
Fissidens taxifolius Hedw.	disturbed or primeval	1 400 – 2 900	(Norris & Koponen 1987)
Grimmia affinis Hornsch.	primeval	4 000 – 4 500	(Koponen & Norris 1986)
Hygrohypnum luridum (Hedw.) Jenn.	primeval	2 800 – 3 650	(Enroth & Ignatov 1999)
Jungermannia confertissima Nees	primeval	3 250	(Váňa & Piippo 1989a)
Jungermannia sphaerocarpa Hook.	primeval	3 250	(Váňa & Piippo 1989a)
Leptodictyum humile (P. Beauv.) Ochyra	primeval	2 430	(Ochyra *et al.* 1991)
Mnium lycopodioides Schwaegr.	primeval	3 250 – 4 500	(Koponen & Norris 1983b)
Nowellia curvifolia (Dicks.) Mitt.	primeval	2 850 – 2 900	(Piippo 1984b)
Plagiomnium rostratum (anon.) T. J. Kop.	primeval	2 550	(Koponen & Norris 1983b)
Pogonatum urnigerum (Hedw.) P. Beauv.	primeval	3 300 – 3 700	(Hyvönen 1986)
Pohlia elongata Hedw.	primeval	2 800 – 3 600	(Koponen & Norris 1985)
Rhytidium rugosum (Hedw.) Kindb.	–	4 500 – 4 700	(Akiyama *et al.* 1991)
Scopelophila cataractae (Mitt.) Broth.	primeval	1 100 – 1 350	(Norris & Koponen 1989)
Scopelophila ligulata (Spruce) Spruce	disturbed	1 300 – 2 000	(Norris & Koponen 1989)
Timmiella anomala (B.S.G.) Limpr.	disturbed or primeval	2 100 – 3 400	(Norris & Koponen 1989)
Trichostomum crispulum Bruch	primeval	1 400 – 2 700	(Norris & Koponen 1989)
B			
Andreaea rupestris Hedw.	primeval	4 660	(Norris & Koponen 1988)
Anthelia juratzkana (Limpr.) Trev.	primeval	4 000 – 4 800	(Váňa & Piippo 1989b)
Bartramia halleriana Hedw.	primeval	3 560 – 3 800	(Virtanen 1999)
Brachythecium plumosum (Hedw.) B.S.G.	primeval	1 830 – 3 570	(Ignatov *et al.* 1999)
Brachythecium rutabulum (Hedw.) B.S.G.	primeval	3 400	(Ignatov *et al.* 1999)
Bryoerythrophyllum recurvirostre (Hedw.) Chen	primeval	2 660 – 4 000	(Norris & Koponen 1989)
Bryum microerythrocarpum Müll. Hal. & Kindb.	disturbed	1 700 – 3 500	(Koponen & Norris 1984)
Campyliadelphus polygamus (B.S.G.) Kanda	primeval	2 430 – 2 800	(Ochyra *et al.* 1991)
Didymodon rigidicaulis Müll. Hal. Saito	mostly primeval	2 100 – 3 600	(Norris & Koponen 1989)
Limprichtia revolvens (anon.) Loeske	primeval	3 860	(Ochyra *et al.* 1991)
Lophocolea bidentata (L.) Dumort.	primeval	2 850 – 3 300	(Piippo 1985)
Meesia triquetra (Richter) Ångstr.	primeval	3 200	(present paper)
Polytrichastrum longisetum (Brid.) G. L. Sm.	primeval	3 225 – 3 400	(Hyvönen 1986)
Racomitrium lanuginosum (Hedw.) Brid.	primeval	3 790 – 4 390	(Wade & McVean 1969, Koponen & Norris 1986)
Sarmentypnum sarmentosum (Wahlenb.) Tuom. & T. J. Kop.	primeval	3 550	(Ochyra *et al.* 1991)
Schistidium apocarpum (Hedw.) B.S.G.	primeval	2 300 – 4 300	(Ochyra *et al.* 1991)
Warnstorfia fluitans (Hedw.) Loeske	primeval	2 300 – 4 300	(Ochyra *et al.* 1991)
C			
Aneura pinguis (L.) Dumort.	–	–	(Grolle & Piippo 1984)
Anoectangium aestivum (Hedw.) Mitt.	mostly disturbed	500 – 3 570	(Norris & Koponen 1989)
Anomobryum julaceum (Gaertn. *et al.*) Schimp.	primeval	2 400 – 3 600	(Koponen & Norris 1984)
Barbula indica (Hook.) Spreng.	disturbed or primeval	100 – 2 900	(Norris & Koponen 1989)
**Bryum argenteum* Hedw.	disturbed or primeval	1 750 – 3 350	(Koponen & Norris 1984)
Bryum capillare Hedw.	mostly primeval	700 – 2 500	(Koponen & Norris 1984)
Bryum coronatum Schwaegr.	disturbed or primeval	1 500 – 3 000	(Koponen & Norris 1984)
Distichium capillaceum (Hedw.) B.S.G.	primeval	2 850 – 3 600	(Norris & Koponen 1988)
**Funaria hygrometrica* Hedw.	mostly disturbed	300 – 3 225	(Enroth 1991)
Gymnostomum aeruginosum Sm.	primeval	2 400	(Norris & Koponen 1989)

Continued

Table 1. Continued.

Species	Habitat	Altitude	Data from
Hymenostylium recurvirostre (Hedw.) Dixon	mostly disturbed	1 200 – 3 600	(Norris & Koponen 1989)
Hyophila involuta (Hook.) A. Jaeger	disturbed or primeval	0 – 2 500	(Norris & Koponen 1989)
**Leptobrym pyriforme* (Hedw.) Wils.	disturbed	2 200 – 2 900	(Koponen & Norris 1985b)
Leptodontium flexifolium (With.) Hampe	disturbed or primeval	640 – 3 570	(Norris & Koponen 1989)
Leptodontium viticulosoides (P. Beauv.) Wijk. & Marg.	disturbed	2 070 – 2 200	(Norris & Koponen 1989)
Marchantia polymorpha L.	primeval	2850 – 3 570	(Bischler & Piippo 1991)
Oxystegus tenuirostris (Hook. & Tayl.) A. J. E. Smith	disturbed or primeval	1 400 – 3 550	(Norris & Koponen 1989)
Polytrichum juniperinum Hedw.	primeval	2 450 – 4 000	(Hyvönen 1986)
Reboulia hemisphaerica (L.) Raddi	primeval	1 350 – 3 400	(Piippo 1988)
**Trichostomum brachydontium* Bruch	disturbed	440 – 2 770	(Norris & Koponen 1989)
**Weissia controversa* Hedw.	disturbed or primeval	1 200 – 2 800	(Norris & Koponen 1989)

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