

Taxonomic Studies of Asiatic Species of Aneuraceae (Hepaticae). VI. *Riccardia fruticosa* (Steph.) Furuki, comb. nov., Described from New Guinea and Its Related Species

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Abstract *Aneura fruticosa* Steph. is resurrected and is transferred to the genus *Riccardia* as *Riccardia fruticosa* (Steph.) Furuki, comb. nov. Its related species, *Riccardia aspera* (Steph.) Grolle and *Riccardia heteroclada* Schiffn. are treated taxonomically. The name *Aneura limbata* Herz. is reduced to a synonym of *R. fruticosa*, and the names *Aneura merapiensis* Steph. and *Riccardia hendersonii* Schiffn. ex Verd. are reduced to synonyms of *R. heteroclada*.

Key words: taxonomy, Hepaticae, Aneuraceae, *Riccardia*.

Aneura fruticosa Steph., described from New Guinea by Stephani (1917), has large, fleshy and somewhat simple thalli that are similar to the genus *Aneura*. However, this species clearly belongs to the genus *Riccardia* by the characters of female branches and calyptrae, and it was reduced to a synonym of *Riccardia anguste-alata* (Steph.) Hewson by Hewson (1970). *R. anguste-alata* has an erect, cylindrical axis (Hewson, 1970) and can be considered as a member of subgenus *Riccardia* sect. *Riccardia* subsect. *Acrostolia* (Dum.) Hässel which was circumscribed as having erect cylindrical axis by Hässel (1972). *A. fruticosa* has a prostrate and not cylindrical main axis, thus it differs from all members of subsect. *Acrostolia*.

The large, fleshy thalli of *A. fruticosa* coupled with its *Aneura*- or *Lobatiriccardia*-like aspect suggest that it may belong to the subgenus *Anomoneura* Schust. of *Riccardia* including only *Riccardia cochleata* (Hook. f. et Tayl.) O. Kuntze (Schuster, 1964). Furuki (1991) discussed the taxonomy of the subgenera of *Riccardia* in relation to the form and distribution of mucilage hairs on the surface of thallus, and reduced subgenus *Anomoneura* to a synonym of subgenus *Riccardia*, in having the same type of mucilage hairs.

On the following pages the author treats

Riccardia fruticosa (Steph.) Furuki, comb. nov., and related species. They have large, prostrate, fleshy thalli which consist of large inner cells and small epidermal cells as shown in cross-sections, and have calyptrae covered with clavate protuberances.

Materials and Methods

The methods and measurements used for description follow those of Furuki (1991).

Key to Species

1. Surface of thallus strongly verrucose
.....*R. aspera*
1. Surface of thallus smooth2
2. Thallus with narrow, micro-thalloid branchlets. Margin of axis serrulate
.....*R. heteroclada*
2. Thallus without micro-thalloid branchlets. Margin of axis tumid to entire
.....*R. fruticosa*

The species

1. *Riccardia fruticosa* (Steph.)
Furuki, comb. nov.
(Figs. 1 & 2)

Aneura fruticosa Steph., Spec. Hepat. 6:27 (1917), syn. nov. Typus: NEW GUINEA. Flumen Tami, 1913, D.L. Schultze, no. 7 (G-012056!, ex hb. Berlin-holotypus).
Aneura limbata Herz., Mitt. Inst. Allg. Botanik

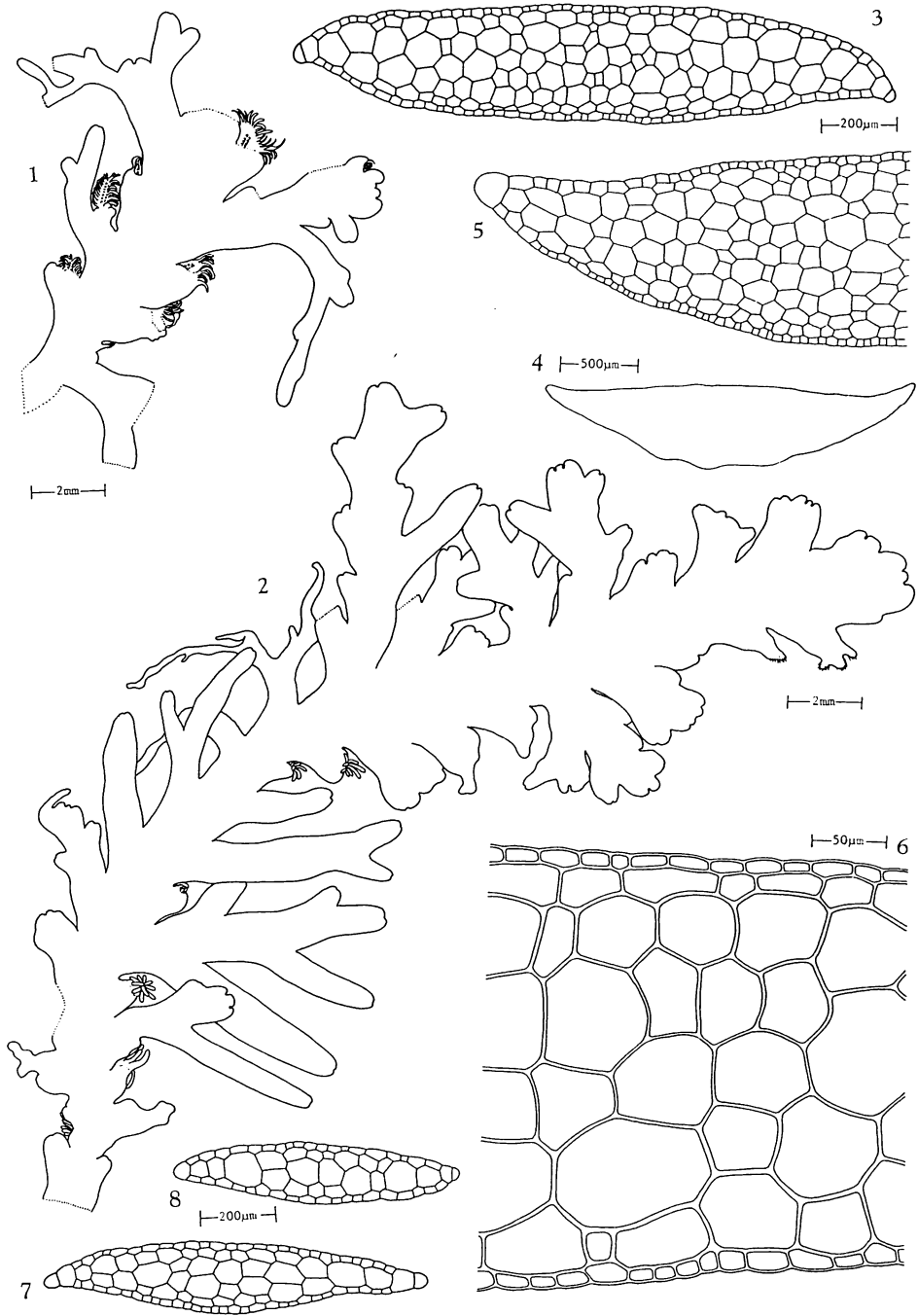


Fig. 1. *Riccardia fruticosa* (Steph.) Furuki. 1, 2, Female Plants, dorsal view. 3-6, Cross-sections of main axis; 5, part of 4; 6, part of 3. 7, 8, Cross-sections of branch. 1, 7 were drawn from holotype (in G); 2-5, 7, 8 from holotype of *Aneura limbata* (in JE).

Hamburg 7: 184 (1931), syn. nov; non Steph., Hedwigia 30: 203 (1891). Typus: MALAYSIA. West-Borneo, 500 m, coll. H.

Winkler, no. 3369 (JE!-holotypus).
Anatomy. Thalli large, prostrate, fleshy, yellowish to dark brown, not pigmented in

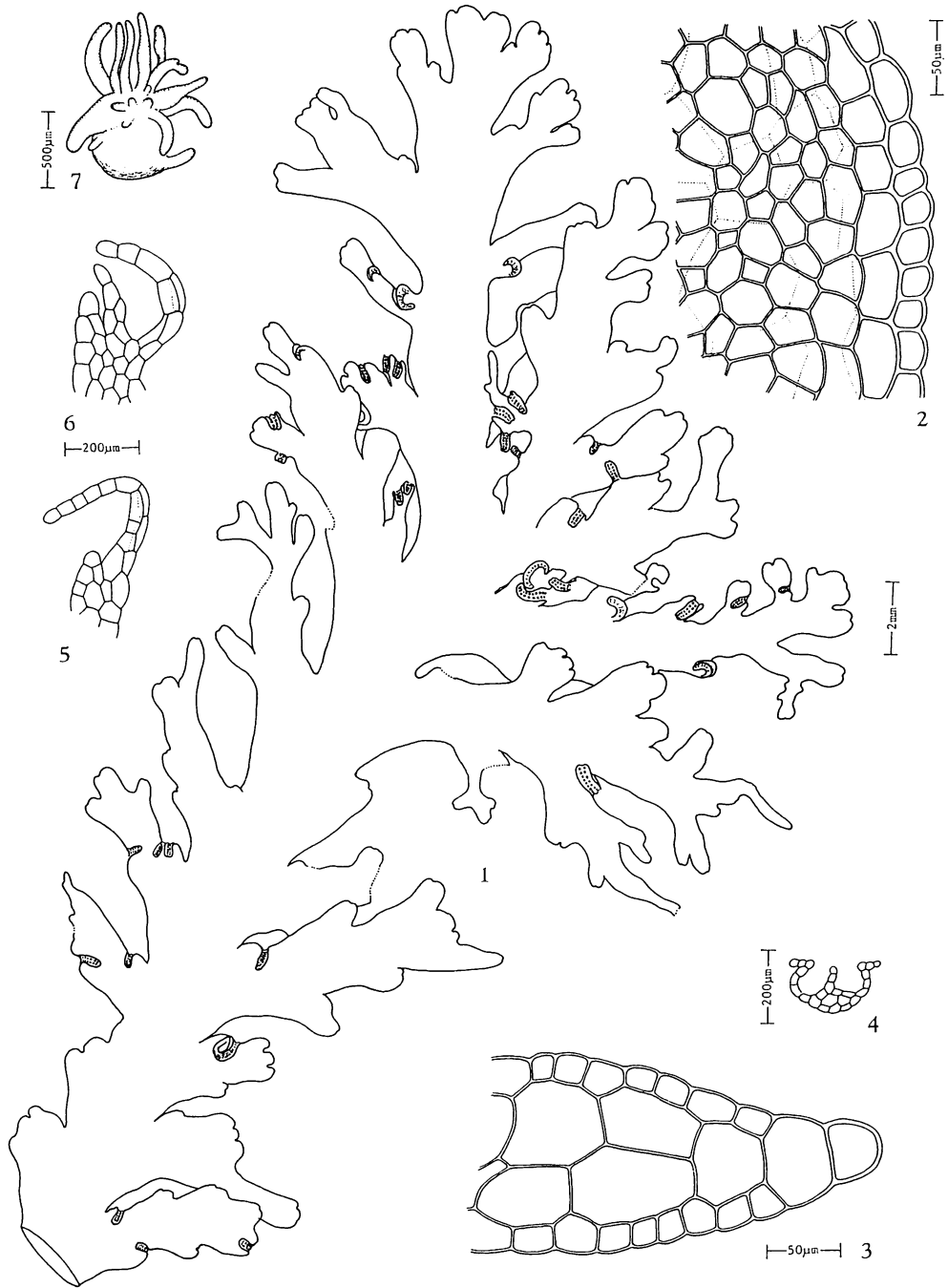


Fig. 2. *Riccardia fruticosa* (Steph.) Furuki. 1, Male plant, dorsal view. 2, Marginal cells of branch. 3, Part of cross-section of branch. 4, Cross-section of male branch. 5, 6, Paraphyses. 7, Young calyptra. 1, 4 were drawn from Richards 5792 (in NICH); 2, 3, 5, 6 from holotype (in G); 7 from holotype of *Aneura limbata* (in JE).

herbarium, smooth on surface, deeply dissected at apices, terminal-laterally branched, pinnately to bipinnately branched, having

poorly to moderately developed branches, entire to tumid along margins, bordered by weakly thick-walled cells. Cross-sections of

thallus composed of small epidermal cells and large inner cells, lacking trigones. Main axis to 60 mm long, 1.5–2.5 mm wide; cross-sections plano-convex to concave-convex, 7–14 cells (320–540 μm) thick, obtuse to acute at margins, slightly incurved by marginal cells. Ultimate branches to 4 mm long, to 1.2 mm wide; cross-sections elliptical, 5–6 cells (150–200 μm) thick, obtuse at margins. Epidermal cells of thallus polyangular, 25–50 \times 5–15 μm , 1/5–1/4 the inner cells in size, thin-walled. Inner cells polyangular, 125–250 \times 55–80 μm . Cells along margins 18–22 \times 15–20 μm , somewhat tumid. Oil bodies unknown. Mucilage hairs in 2 rows on ventral surface of thallus. Rhizoids scattered on ventral surface of thallus. Gemmae unknown.

Dioicous. Male branches lateral on branches, descending, rarely branched, 125–175 μm thick, 150–250 μm wide, with to ca. 15 pairs of chambers; marginal wing horizontally spreading, 2–3 cells wide. Female branches usually lateral on main axis, horizontal to descending; paraphyses hair-like to fringed scale-like, 8–12 cells (50–80 μm) high, cells wide at base. Calyptrae with long, clavate protuberances.

Sporophytes unknown.

Habitat. Usually on decaying logs and roots of trees in mossy forest.

Distribution. Malaysia (Borneo) and New Guinea.

Selected Specimens Examined. MALAYSIA. Borneo, Mt. Tembuyokon, coll. W. Meijer, no. B11421 (L); Mt. Kinabalu, between Kambanga Radio Station and Water Falls, ca. 2000–2140 m alt., coll. M. Mizutani, no. 2492 (NICH-252492), P. Richards, no. 5792 (NICH).

Remarks. This species is characterized by (1) thalli prostrate and large, (2) margins of axis slightly incurved, (3) margins of branches having narrow alar portion, (4) marginal cells somewhat thick-walled, and (5) calyptrae having long clavate protuberances.

Riccardia fruticosa was treated as a synonym of *Riccardia anguste-alata* (Hewson, 1970), but it differs from the latter as discussed above.

The appearance of this species looks like that of the genera *Aneura* and *Lobatiriccardia*, among which *L. lobata* (Schiffn.) Furuki is most similar to this species in having

opaque, brownish, large and bi-tripinnate thalli. However, this species differs from the latter by the morphology of rhizoids and female branches. This species has few rhizoids scattered on ventral surface of thallus and well developed, long female branches, but *L. lobata* has numerous rhizoids all over the ventral surface and mound-like female branches (Furuki, 1991). These are indeed the criteria for distinguishing *Aneura* and *Lobatiriccardia* from *Riccardia* (Furuki, 1991). In addition to this, the calyptrae differ between this species and *L. lobata*. Calyptrae of this species are covered with multicellular, clavate protuberances on surface, but *L. lobata* has calyptrae covered with unicellular hairs.

This species is closely related to *Riccardia cochleata* (Hook. f et Tayl.) O. Kuntze distributed in New Zealand, Australia and Tasmania, but differs from the latter by the marginal cells of thallus. This species always has quadrate marginal cells similar to the rest of the dorsal epidermal cells, but the latter usually has distinctively elongate ones (Brown and Braggins, 1989).

The holotype of *Aneura limbata* Herz. is identical with *R. fruticosa* in having the same anatomy of thallus and calyptrae.

2. *Riccardia aspera* (Steph.) Grolle (Figs. 3 & 4)

Riccardia aspera (Steph.) Grolle, J. Hattori Bot. Lab. (30): 117 (1967). = *Aneura aspera* Steph., Spec. Hepat. 6:21 (1917). Typus: NEW GUINEA. Flumen Tami, s.d., D.L. Schultze, no. 8 (G-012053), ex hb. Berlin-holotypus).

Anatomy. Thalli medium to large, prostrate, fleshy, blackish brown in herbarium, strongly verrucose on surface, dissected at apices, terminal-laterally branched, pinnately to tripinnately branched, having moderately developed branches, entire along margins. Cross-sections of thallus having small epidermal cells and large inner cells, lacking trigones. Main axis to 60 mm long, 0.8–1.5 mm wide; cross-sections plano-convex to concave-convex, 7–13 cells (200–520 μm) thick, obtuse to acute at margins. Ultimate branches to 2 mm long, to 0.5 mm wide; cross-sections elliptical, 5–6 cells (100–130

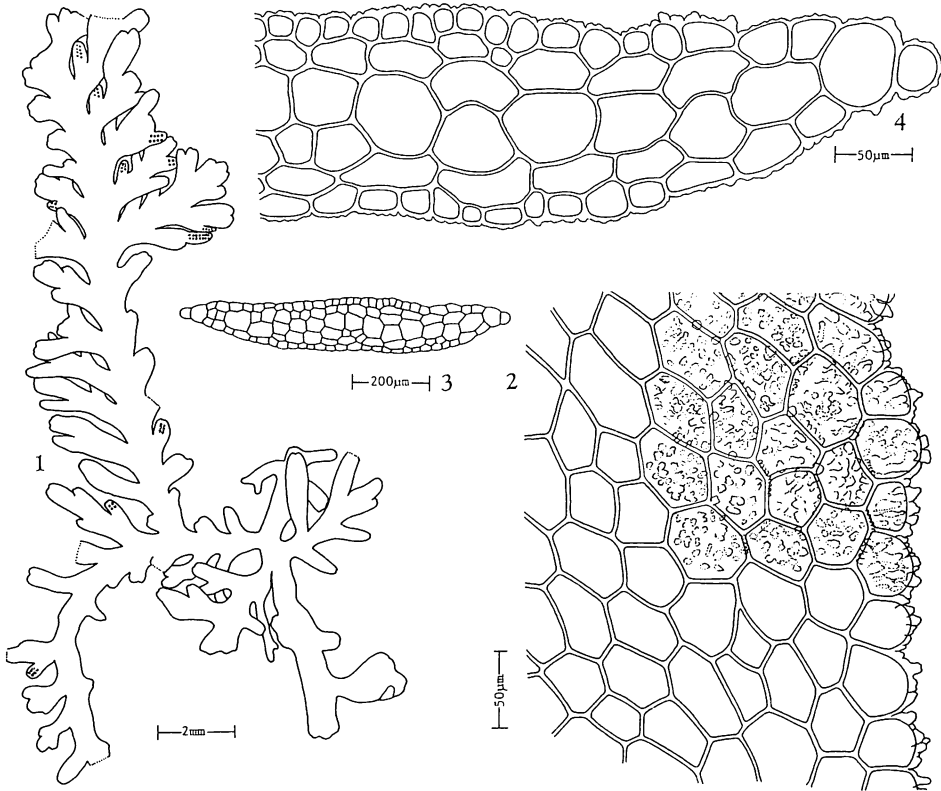


Fig. 3. *Riccardia aspera* (Steph.) Grolle. 1, Male plant, dorsal view. 2, Marginal cells of branch. 3, 4, Cross-sections of branch; 4, part of 3. All were drawn from holotype (in G).

μm) thick, acute with a narrow alar portion (unistratose alar portion 1–2 cells wide). Epidermal cells of thallus polyangular, 40–60 × 20–35 μm, 1/4–1/3 the inner cells in size, thin-walled. Inner cells polyangular, 90–130 × 40–55 μm. Cells along margins same as those of other epidermal cells. Oil bodies light brown, globose to ovoid, 10–15 × 8–12 μm, botryoid, consisting of small to large, distinct granules, totally lacking in epidermal cells, 1 (2) in each inner cell. Mucilage hairs in 2 rows on ventral surface of thallus. Rhizoids scattered on ventral surface of thallus. Gemmae unknown.

Dioicous. Male branches lateral on branches, horizontal, rarely branched, 250–300 μm thick, 400–600 μm wide, with to ca. 30 pairs of chambers; marginal wing horizontally spreading, 1–3 cells wide. Female branches usually lateral on main axis, horizontal; paraphyses hair-like to fringed scale-like, 8–12 cells (60–80 μm) high, 4–5 cells wide at base. Calyptrae with long, clavate

protuberances.

Setae 2 cm long, 200–300 μm thick. Capsule-valves 1100–1300 μm long, 400–450 μm wide; cells of outer layer thickened on adaxial radial and inner tangential walls, sometimes extending slightly to outer tangential walls; cells of inner layer thickened on adaxial radial and inner tangential walls. Elaters 300–600 μm long, 12–14 μm thick. Spores 10–14 μm in diam.

Habitat. Usually on wet humus, fallen logs and trunks of trees in mossy forest.

Distribution. Malaysia (Borneo), Indonesia (Celebes, Seram) and New Guinea.

This species has been reported only from New Guinea (Hewson, 1970).

Selected Specimens Examined. MALAYSIA. Borneo, Ulu Liwagu, 2150–2500 m, coll. M. Mizutani, no. 3717 (NICH-253717). INDONESIA. Celebes, B. Poka Pindjang, 2000 m alt., coll. G. Kjellber, no. 37, ex NY (NICH). Seram, Kecamatanu, Tehoru, en route from Losa to Nihehata, coll. H. Akiyama 16539 (KYO).

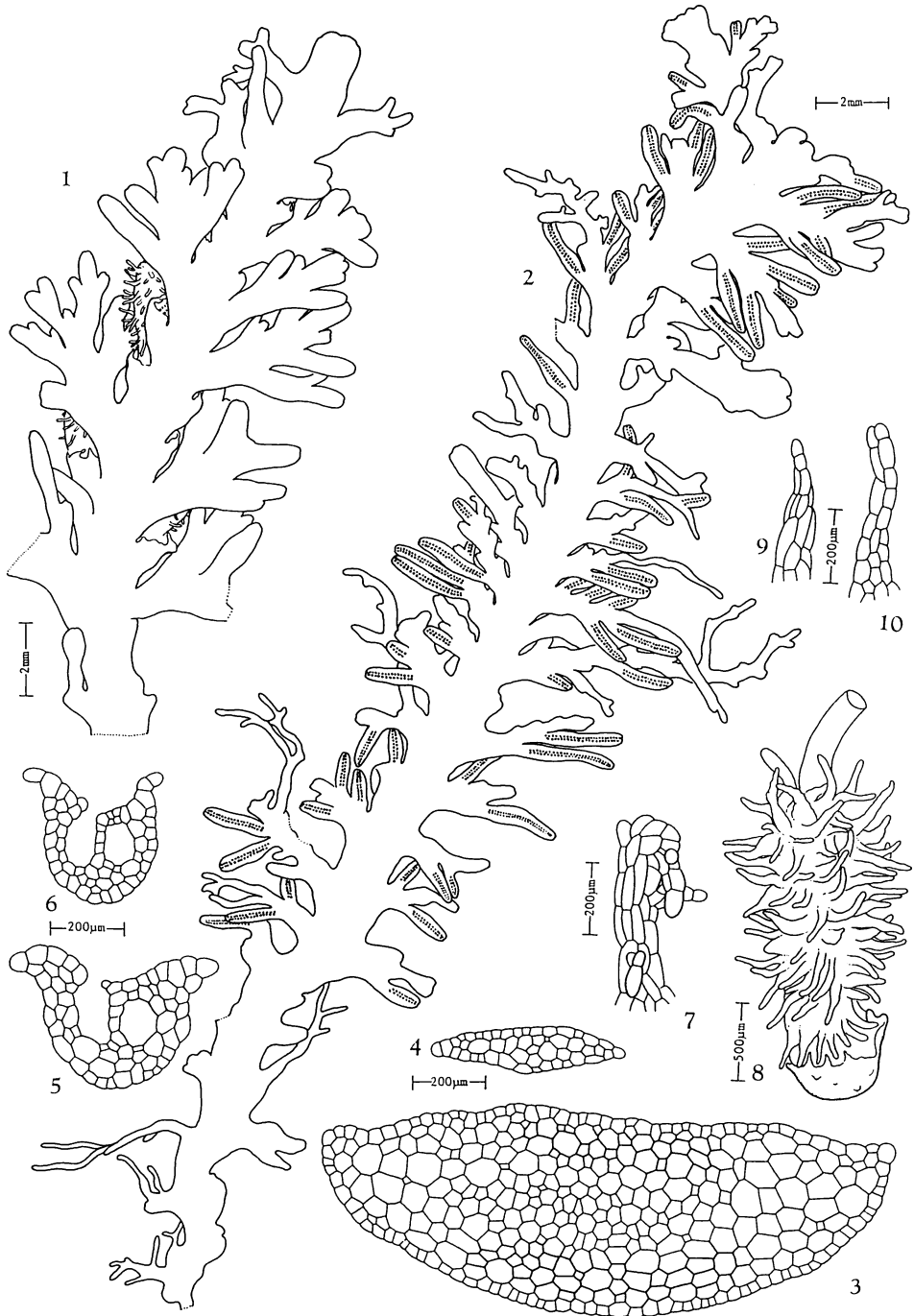


Fig. 4. *Riccardia aspera* (Steph.) Grolle. 1, Female plants with calyptrae, dorsal view. 2, Male plant, dorsal view. 3, Cross-section of main axis. 4, Cross-section of branch. 5, 6, Cross-sections of male branch. 7, Paraphysis. 8, Calyptra. 9, 10, Hairs on surface of calyptrae. All were drawn from Akiyama 16593 (in KYO).



Fig. 5. *Riccardia heteroclada* Schiffn. 1, 4, Female plants. 2, 5, Male plants; 2, dorsal view; 5, ventral view. 3, Plant with micro-thalloid branchlets, ventral view. 6, Part of micro-thalloid branchlets. 1-3, 6 were drawn from lectotype of *Riccardia serrulata* (Schiffner 216 in PRC); 4 from holotype of *Aneurina merapiensis* (in G); 5 from lectotype (Schiffner 222 in W).

NEW GUINEA. Vogelkop Pen., Nettori Range, 2100 m alt., coll. P. van Royen and H. Sleumer, no. 8005 (L). Morobe, Mt. Kaindi-

Edie Creek, ca. 8000 ft., coll. H. J. Hewson, no. 544. H. 65. 117. 805 (L).

Remarks. This species is characterized by

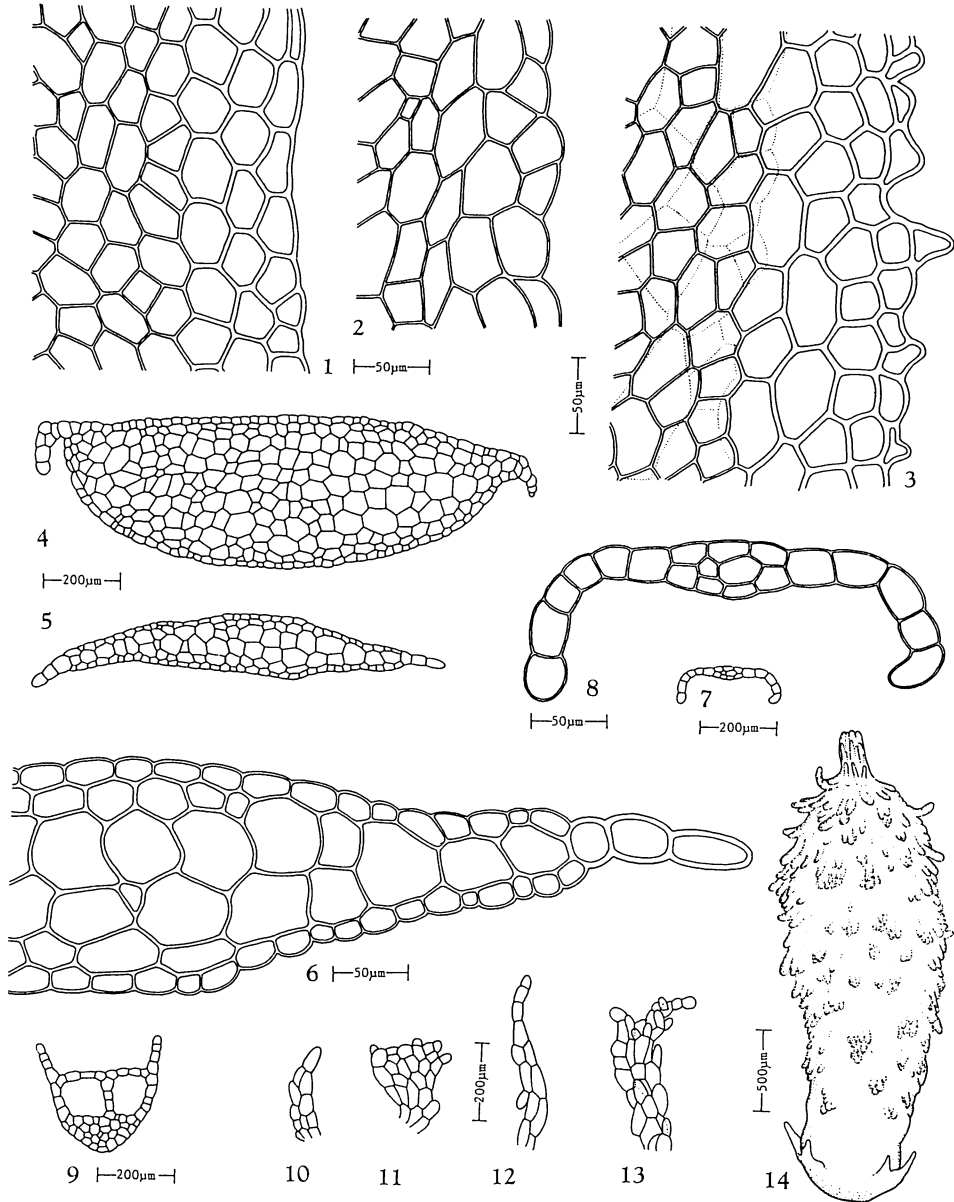


Fig. 6. *Riccardia heteroclada* Schiffn. 1-3, Marginal cells of branches. 4, Cross-section of main axis. 5, 6, Cross-section of branch; 6, part of 5. 7, 8, Micro-thalloid branchlets. 9, Cross-section of male branch. 10-13, Paraphyses. 14, Calyptra. 1 was drawn from lectotype (Schiffner 222 in W); 2 from holotype of *Aneura merapiensis*; 3-14 from lectotype of *Riccardia serrulata* (Schiffner 216 in PRC).

(1) thalli large, (2) surface of thallus strongly verrucose, (3) margins of branches having narrow alar portion, and (4) calyptrae having clavate protuberances.

This species is easily distinguished from the other two species treated here by its strongly verrucose thallus surface, which is very rare in this genus. Among other Asian

species of this genus, only *Riccardia crassa* (Schwaegr.) Mass. has similar verrucae on the surface of the thallus, but they are more striate than those of *R. aspera*.

3. *Riccardia heteroclada* Schiffn.
(Figs. 5 & 6)

Riccardia heteroclada Schiffn., Denkschr.

- Kaiserl. Akad. Wiss. Math.-Naturwiss. Kl. 67: 175 (1898). = *Aneura heteroclada* (Schiffn.) Steph., Spec. Hepat. 1: 239 (1899). Typus: INDONESIA. Java, Prov. Preanger, Tjibodas, 1600 m, V. Schiffner, Iter Indicum 1893/94, no. 219 (G!-syntypus). Sumatra occid., 2050–2500 m, V. Schiffner, Iter Indicum, 1893/94, nos. 220 (n.v.), 221 (n.v.), 222 (W!-lectotypus selected here; JE!, PR!-isolectotypi).
- Riccardia serrulata* Schiffn., Denkschr. Kaiserl. Akad. Wiss. Math.-Naturwiss. Kl. 67: 174 (1898). Typus: INDONESIA. Java, Prov. Batavia, in monte Salak, 1200 m, V. Schiffner, Iter Indicum 1893/94, no. 209 (W!-syntypus); Prov. Preanger, Tjibodas, 1500–1700 m, V. Schiffner, Iter Indicum 1893/94, nos. 210 (G!, JE!, L!-syntypi), 211 (G!-syntypus), 212 (n.v.), 213 (PR!, PRC!, W!-syntypi); Prov. Preanger, Tjiburum, 1540–2025 m, V. Schiffner, Iter Indicum 1893/94, nos. 214 (n.v.), 215 (n.v.), 216 (PRC!-lectotypus selected here; G!, W!-isolectotypi). Sumatra, in monte Singalang, 1840–2000 m, V. Schiffner, nos. 217 (W!-syntypus), 218 (n.v.).
- Aneura merapiensis* Steph., Spec. Hepat. 6: 33 (1917), syn. nov. Typus: INDONESIA. Sumatra, Mt. Merapi, coll. Ernst, no. 32 (G!-holotypus).
- Riccardia hendersonii* Schiffn. ex Verd., Ann. Bryol. 10: 124, 128 (1838 “1837”), nom. inval., syn. nov. Typus: MALAYSIA. Malay Pen., Pahang, Cameron’s Highlands, coll. M. R. Henderson, in Fr. Verdoorn (ed.), Hepaticae Selectae et Criticae, Ser. X, no. 491 (G!, HIRO!, JE!, L!, NICH!-syntypi).
- Anatomy.* Thalli large, prostrate, fleshy, blackish brown in herbarium, smooth on surface, dissected at apices, terminal-laterally branched, pinnately to tripinnately branched in primary to secondary branches, multi-branched in micro-thalloid branchlets, having moderately to well-developed branches, entire to serrulate along margins, bordered by thick-walled cells. Cross-sections of thallus composed of small epidermal cells and large inner cells, lacking trigones. Main axis to 50 mm long, 0.8–1.4 mm wide, entire to serrulate at margins; cross-sections plano-convex to concave-convex, 7–12 cells (200–450 μm) thick, incurved, winged at margins (unicellular alar portion 2–3 cells wide). Primary and secondary branches to 4 mm long, to 0.5 mm wide, entire to serrulate at margins; cross-sections plano-convex to concave-convex, 4–10 cells (100–150 μm) thick, winged (unistratose alar portion 2–3 cells wide). Micro-thalloid branches well-developed, multi-pinnately branched, to 1 mm long, to 0.2 mm wide, entire and undulate at margins; cross-sections linear, 3 cells (30–35 μm) thick, winged (unistratose alar portion 3–6 cells wide). Epidermal cells of thallus polyangular, 30–55 \times 20–35 μm , 1/4–1/3 the inner cells in size, thin-walled. Inner cells polyangular, 100–125 \times 25–50 μm . Cells along margins variable in shape and size, 15–25 \times 15–25 μm . Oil bodies light brown, globose to oblong, botryoid, composed of small, distinct granules; oil bodies in epidermal cells ovoid to oblong, 15–20 \times 8–12 μm , 1 in each cell; oil bodies in inner cells oblong, 15–30 \times 10–15 μm , 1–2 in each cell. Mucilage hairs in 2 rows on ventral surface of thallus. Rhizoids scattered on ventral surface of thallus. Gemmae unknown.
- Dioicous. Male branches usually lateral on micro-thalloid branchlets, descending, not branched, 200–250 μm thick, 250–350 μm wide, with to ca. 15 pairs of chambers; marginal wing erect to obliquely spreading, 3–5 cells wide. Female branches usually lateral on main axis, horizontal; paraphyses hair-like to fringed scale-like, 8–12 cells (60–80 μm) high, 2–3 cells wide at base. Calyptrae with multicellular clavate protuberances, but not so clearly clavate.
- Sporophytes unknown.
- Habitat.* Usually on wet fallen logs, rocks, soil and humus in mossy forest.
- Distribution.* Philippines (Negros), Malaysia (Borneo, Malay Pen.), Indonesia (Java, Sumatra) and Solomon Is.
- Selected Specimens Examined.* PHILIPPINES. Negros Is., in A. D. E. Elmer (distrib.), Philippine Islands Plants, no. 10005 (W). MALAYSIA. Malay Pen., Cameron’s Highlands, 4800 ft. alt., coll. R. E. Hottmann, no. 2338b (NICH). Borneo, Mt. Niut, along Kembayung River, 1100 m alt., coll. G. Shea, no. 28526 (NICH). INDONESIA. Java, Res. Priangan, G. Gede, ca. 1950 m, coll. Fr. Verdoorn, in Fr. Verdoorn (ed.), Hepaticae Selectae et Criticae,

Ser. X, no. 490 (HIRO, JE, L, NICH). SOLOMON IS. S. Kolombangara, mossy forest, 1700 m, coll. Braithwaite, no. 4401 (JE).

Remarks. This species is characterized by (1) thalli large, (2) thalli having micro-thalloid branchlets, (3) margins of thallus (except branchlets) serrulate, (4) margins of axis incurved, (5) margins of thallus having a wide alar portion, (6) marginal cells of thallus thick-walled, and (7) calyptrae having clavate protuberances.

This species is easily distinguished by the micro-thalloid branchlets, which are unique branches seen only in this species among the members of the Aneuraceae.

Aneura merapiensis and *Riccardia hendersonii* have micro-thalloid branchlets which are the same as those of *R. heteroclada*, and are conspecific with *R. heteroclada*.

Riccardia heteroclada and *R. serrulata* were described in the same publication by Schiffner (1898), in which *R. serrulata* was separated from *R. heteroclada* by the serrulate margins of thallus in contrast to entire margins. However, they can not be distinguished, because the margins of the main axis and branches (except branchlets) show a wide range of variation from entire to serrulate conditions. *R. heteroclada* is the correct name rather than *R. serrulata* (ICBN Art. 11.5), because the epithet *heteroclada* was the first chosen to be used at specific rank (Stephani, 1899).

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- (Received 13 January 1998)

アジア産スジゴケ科の分類学的研究 VI. ニューギニア産 *Riccardia fruticosa* (Steph.) Furuki (新組合せ) とその近縁種

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Aneura fruticosa Steph. は、ニューギニアから Stephani (1917) によって新種として記載されたが、Hewson (1970) によって、*Riccardia anguste-alata* (Steph.) Hewson の同種異名とされた。しかし、両者は、様々な形質の違いによって別種と見なすべきものであることが明らかになった。そこで本報では、*A. fruticosa* を生殖器官の特徴に基づき、ミドリゼニゴケ属 *Aneura* からスジゴケ属 *Riccardia* に移し、新組合せ *Riccardia fruticosa* (Steph.) Furuki を作った。また、*Aneura limbata* Herz. は本種の同種異名とした。加えて、本種の近縁種として、*Riccardia aspera* (Steph.) Grolle と *Riccardia heteroclada* Schiffn. を認め、*Aneura merapiensis* Steph. と *Riccardia hendersonii* Schiffn. ex Verd. を新たに *R. heteroclada* の同種異名とした。