

Studies on freshwater red algae of Malaysia I. Some taxa of the genera *Batrachospermum*, *Ballia* and *Caloglossa* from Pulau Tioman, West Malaysia

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This paper deals with a collection of freshwater red algae from Pulau Tioman. Two species are described here as new taxa: *Batrachospermum crispatum* differs from *B. procarpum* in having a long club-shaped trichogyne; *Batrachospermum tiomanense* differs from *B. procarpum* in having sparsely branched primary branchlets and numerous almost unbranched secondary branchlets. Two species, *Batrachospermum godronianum* and *Ballia prieurii*, are recorded here for the first time from Malaysia.

Key Index Words: *Ballia prieurii*; *Batrachospermum crispatum*, sp. nov.; *Batrachospermum godronianum*; *Batrachospermum tiomanense*, sp. nov.; *Malaysia*; *Rhodophyta*; *taxonomy*.

Over the last decade some papers have been published dealing with the freshwater red algae of Peninsular Malaysia. RATNASABAPATHY (1972) listed, with brief notes and some descriptions, algae from Gunung Jerai (Kedah Peak), including of one species of *Batrachospermum*. The algal species of Sungai Gombak (Gombak River) were reported by RATNASABAPATHY (1975) and BISHOP (1973), who listed seven taxa of freshwater red algae, namely, *Auduinella* sp., *Batrachospermum* sp. 1, *Batrachospermum* sp. 2, *Hildbrandtia rivularis*, *Caloglossa* sp., *Ballia* sp. and *Compsopogon* sp.. Based on the collection made during the Joint Malaysia-Japan Project of Scientific Investigation into Freshwater Lakes of Malaysia, KUMANO (1978) described several new taxa, these being three species of *Batrachospermum* from Tasek Bera (Lake Bera), *Tuomeya gibberosa* from Sungai Maron

Kanan, *Caloglossa ogasawaraensis* var. *latifolia* from Sungai Cherok and *Ballia pinulata* from Sungai Gombak. Recently, RATNASABAPATHY and SETO (1981) described two new species of *Thorea* from Sungai Gombak and Sungai Tahan. Regarding the freshwater red algae of Pulau Tioman (Tioman Island), RATNASABAPATHY (1977) reported in a preliminary list the occurrence of *Kyliniella* sp., *Batrachospermum* sp., *Bostrychia* sp. and *Caloglossa ogasawaraensis*. The present paper deals with the freshwater red algae from Pulau Tioman in more detail.

Location of study areas

Pulau Tioman, lying some 30 km off the east coast of Peninsular Malaysia, is the largest of a group of 64 volcanic islands (Fig. 1). Its area is about 114 km². The island has a generally rugged geomorphology and the

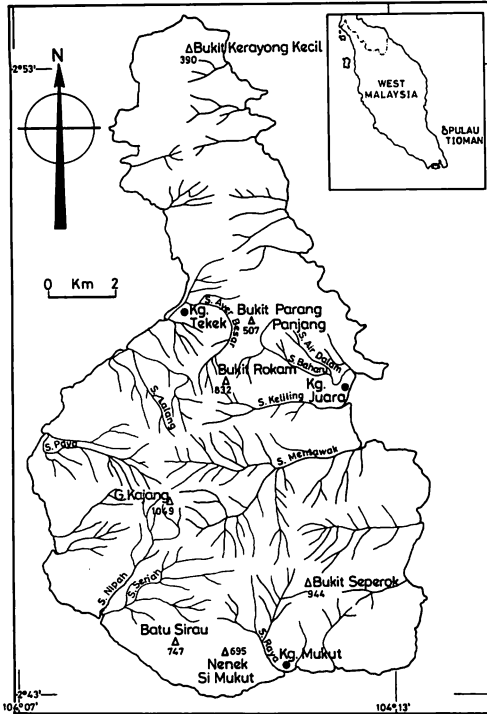


Fig. 1. Map of Pulau Tioman, west Malaysia.

relatively few flat lands are coastal. Geologically the oldest rocks are of volcanic origin and appear to be Permian-Triassic in age (KHOO 1977). The occurrence of raised coral reefs at Kampong Tekek and Kampong Juara, indicates a former higher sea level. The drainage pattern is mostly dendritic. There are several freshwater brooks, streams and tributaries. The largest streams such as Sungai Mentawak, S. Keliling, S. Ayer Besar and S. Baharu rise from peaks around 830 m to over 1040 m above the sea level. In general the streams on the eastern half of the island flow across a variety of volcanic rocks, whilst those of the western flow over plutonic rocks, mainly consisting of granitoids. The stream waters are clear, aerated and unpolluted. Practically all human settlement is along the coast and river estuaries. Representative streams, including S. Ayer Besar and S. Baharu, sampled from 21-29 May 1974 during the morning and afternoon showed a temperature range of

25.5-26.5°C and a pH range of 5.2 to 5.8. The acidic nature of the waters is somewhat similar to that found in several upcountry streams of Peninsular Malaysia.

Descriptions of species

1. *Batrachospermum godronianum* SIRODOT 1884, p. 235, tab. 18, figs. 1-12: MORI 1975, p. 470.

Fruiting triecious, 2-4 cm high, 200-400 μm wide, richly and irregularly branched, mucilaginous, brown. Axial cell cylindrical, 20-30 μm wide, 120-400 μm long. Whorls globular or barrel-shaped, separated or compressed. Cortical filaments moderate. Primary branchlets richly branched, consisting of 5-8 cell-stories; cells of fascicles ellipsoidal, fusiform or obovoid. Secondary branchlets few. Antheridia globular or ovoid, 3-4 μm wide, 4-6 μm long, terminal on primary branchlets. Carpogonium bearing branch consisting of 3-7 barrel-shaped cells, arising from the basal cell of a primary branchlet or laterally from the intercalary cell of a primary branchlet and often arising as a lateral of a carpogonium bearing branch; carpogonium about 5 μm wide at the base, about 5 μm wide at the apex, 25-30 μm long; trichogyne elongated, club-shaped. Bracts numerous, some with sterile carpogonia. Gonimoblasts 1-3, globular, 100-140 μm in diameter scattered in an outer half of a whorl, sometimes exerted from a whorl. Carposporangia globular or obovoid, 8-10 μm wide, 10-12 μm long.

Specimens examined: Sungai Ayer Besar, Pulau Tioman, Malaysia (RATNASABAPATHY, Nos. 16, 22, 24 and 30, 24/V 1974).

Habitat: Attached to submerged stream rocks, stones or bottom gravel, sometimes associated with *Caloglossa*, in the middle and upper reaches of Sungai Ayer Besar.

The Malaysian specimens are slightly smaller in size than the Japanese *Batrachospermum godronianum*, but is identical in many respects. This species is reported for the first time from Malaysia.

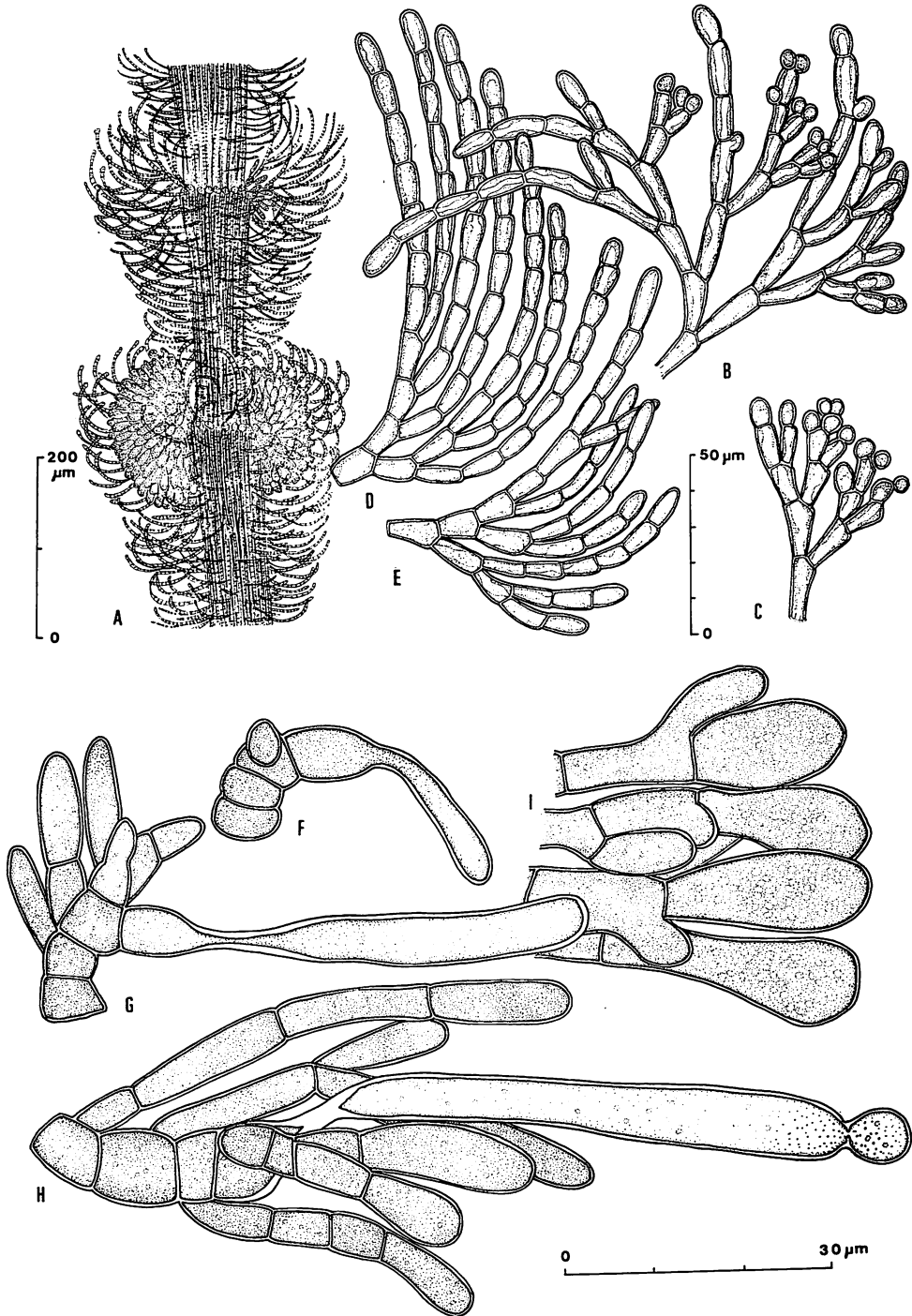


Fig. 2. *Batrachospermum crispatum* KUMANO et RATNASABAPATHY, sp. nov. A. Structure of whorls showing curled or hooked primary and secondary branchlets and gonimoblasts inserted centrally; B-C. Antheridia lateral on primary and secondary branchlets unilaterally branched; D-E. Primary and secondary branchlets, curled, hooked and unilaterally branched; F-G. Development of the carposogonium; H. A fertilized carposogonium with gonimoblast initials; I. Clavate carposporangia terminal on gonimoblast filaments.

2. *Batrachospermum crispatum* KUMANO et RATNASABAPATHY, sp. nov. (Fig. 2)

Frons trioica, 2-3 cm alta, 200-350 μm crassa, plus minusve dichotome ramosa, valde mucosa, aeruginosa. Cellulae axiales cylindricae, 30-35 μm crassae, 200-300 μm longae. Verticilli pyriformes, pluerumque contigui. Ramuli primarii crispatis, unilateriter ramificantes, ex 5-13 cellulis constantes; cellulae fasciculorum cylindricae vel fusiformes, 5-8 μm crassae, 10-20 μm longae; pili nuli. Ramuli secundarii numerosi, crispatis, totum internodium obtegentes. Antheridia globosa vel ovoidea, 4-6 μm crassa, 6-8 μm longa, in ramulis primariis et secundariis lateralialia. Ramuli carpogoniferi e cellulis basi ramulorum primariorum orientes, breves, ex cellulis 3-4 doliiformibus constantes; carpogonium basi 5-9 μm crassum, apice 5-7 μm crassum, 54-75 μm longum; trichogyne cylindrica indistincte pedicellata. Bracteae numerosae et brevissimae. Gonimoblasti singli vel duo, globosi vel semiglobosi, 140-190 μm crassi, in centro verticilli inserti. Carposporangia clavata vel obovata, 9-10 μm crassa, 17-30 μm longa.

Frond trioecious, 2-3 cm high, 200-350 μm wide, more or less dichotomously branched, strongly mucilaginous, deep green with a mixture of blue. Axial cells cylindrical, 30-35 μm wide, 200-300 μm long. Whorls pyriform, very often touching each other. Primary branchlet curled, unilaterally branched, consisting of 5-13 cell-stories; cells of fascicles cylindrical or fusiform, 5-8 μm wide, 10-20 μm long; hairs none. Secondary branchlets numerous, curled, covering all internode. Antheridia globose or ovoid, 4-6 μm wide, 6-8 μm long, lateral on primary and secondary branchlets. Carpogonium bearing branch arising from the basal cell of a primary branchlet, short, consisting of 3-4 barrel-shaped cells; carpogonium 5-9 μm wide at the base, 5-7 μm wide at the apex, 54-75 μm long; trichogyne cylindrical, indistinctly stalked. Bracts numerous and very short. Gonimoblasts single or couple, globular or semiglobular, 140-190 μm wide,

inserted centrally. Carposporangia clavate or obovoid, 9-10 μm wide, 17-30 μm long.

Holotype: Sungai Ayer Besar, Pulau Tioman, Malaysia (RATNASABAPATHY, No. 21, 24/V 1974, Private Herbarium, Department of Botany, University of Malaya). Isotype: (RATNASABAPATHY, No. 21, 24/V 1974, Herbarium of Faculty of Science, Kobe University).

Habitat: Attached to submerged stream rock and stones in upper reaches of Sungai Ayer Besar; the same habitat as *B. godronianum*.

Batrachospermum crispatum resembles *B. procarpum* Skuja 1931 in having curled or hooked primary and secondary branchlets and a large gonimoblast inserted centrally, but differs in the shape of trichogynes and carpospores, these differences suggesting that this species belongs to the section *Viridia* of SIRODOT (1884).

3. *Batrachospermum tiomanense* KUMANO et RATNASABAPATHY, sp. nov. (Fig. 3)

Frons trioica, ca 2 cm alta, 150-300 μm crassa, plus minusve dichotome ramosa, parum mucosa, olivaceo-viridia. Cellulae axiales cylindricae, 30-40 μm crassae, 250-350 μm longae. Verticilli pyriformes, in parte vetustiore frondis obconici. Ramuli primarii sparsim ramificantes, ex 13-15 cellulis constantes; cellulae fasciculorum cylindricae vel fusiformes, 4-5 μm crassae, 8-13 μm longae; pili nuli. Ramuli secundarii numerosi, sparsim ramificantes, totum internodium obtegentes. Antheridia globosa vel ovoidea, 3-5 μm crassa, 4-6 μm longa, in ramulis secundariis unilateralia. Ramuli carpogoniferi e cellulis basi ramulorum primariorum orientes, longi, valde tortuosi, ex cellulis 6-10 disci-vel doliiformibus constantes; carpogonium basi 6-9 μm crassum, apice 7-9 μm crassum, 37-40 μm longum; trichogyne urniformis, distincte pedicellata, ad basim saepe flexa. Bracteae numerosae, brevissimae. Gonimoblasti singli, globosi, magni, 100-140 μm diametro, in centro verticilli inserti. Carposporangia globosa vel ovoidea, 6-10 μm crassa, 8-12 μm longa.

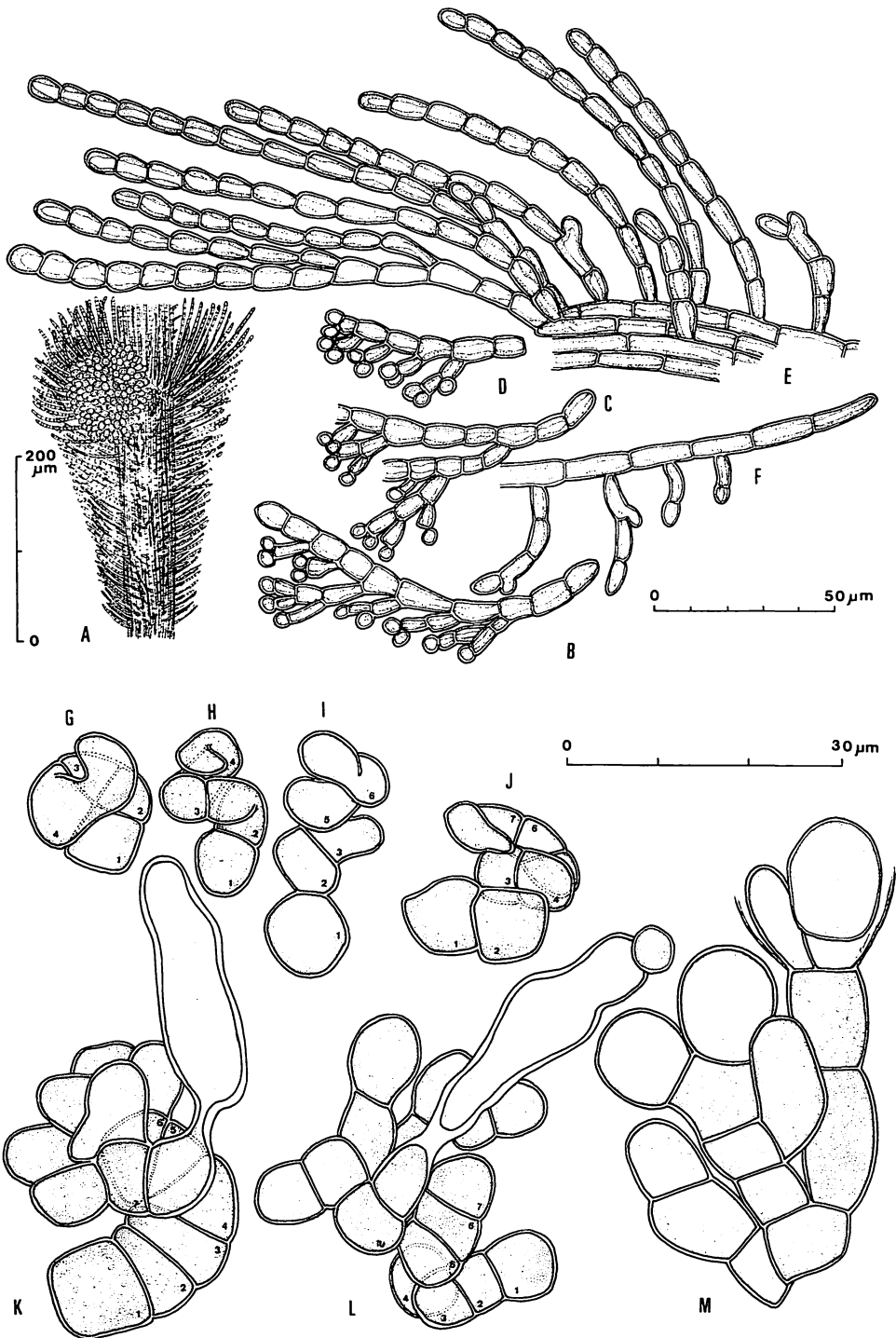


Fig. 3. *Batrachospermum tiomanense* KUMANO et RATNASABAPATHY, sp. nov. A. Structure of obconical whorls showing primary and secondary branchlets and a gonimoblast inserted centrally; B-D. Antheridia lateral on secondary branchlets; E-F. Sparsely branched primary branchlets, cortical filament and secondary branchlets; G. A carposporangium initial and a carposporangium bearing branch at a very young stage; H-J. Stages in maturation of a carposporangium bearing branch becoming coiled and twisted; K. Urn-shaped trichogyne formed terminally on a twisted carposporangium bearing branch consisting of seven cells; L. A fertilized carposporangium; M. Ovoid carposporangia terminal on gonimoblast filaments.

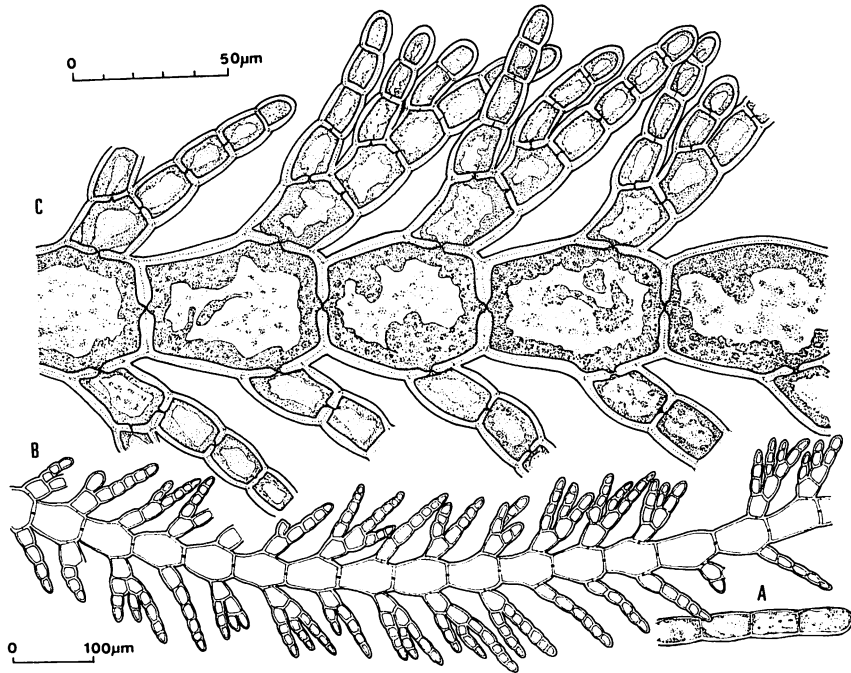


Fig. 4. *Ballia prieurii* KÜTZING A. Terminal portion of thallus with a rounded apical cell; B-C. Structure of thallus showing the non-corticated axis and branchlets, opposite and unilaterally branched.

Frond trioecious, about 2 cm high, 150–300 μm wide, more or less dichotomously branched, not very mucilaginous, olive-green. Axial cells cylindrical, 30–40 μm wide, 250–350 μm long. Whorls pear-shaped, in an aged portion of thallus inverted conical. Primary branchlets sparsely branched, consisting of 13–15 cell-stories; cells of fascicles cylindrical or fusiform, 4–5 μm wide, 8–13 μm long; hairs none. Secondary branchlets numerous, sparsely branched, covering all the internodes. Antheridia globular or ovoid, 3–5 μm wide, 4–6 μm long, unilateral on secondary branchlets. Carpogonium bearing branch arising from the basal cell of a primary branchlet, long, strongly twisted, consisting of 6–10 disc- or barrel-shaped cells; carpogonium 6–9 μm wide at the base, 7–9 μm wide at the apex, 37–40 μm long; trichogyne urn-shaped, distinctly stalked, often bent at the base. Bracts numerous, very short. Gonimoblast single globular, large, 100–140 μm in diameter, inserted cen-

trally. Carposporangia globular or ovoid, 6–10 μm wide, 8–12 μm long.

Holotype: Sungai Ayer Besar, Pulau Tioman, Malaysia (RATNASABAPATHY, No. 15, 24/V 1974, Private Herbarium, Department of Botany, University of Malaya). Isotype: (RATNASABAPATHY, No. 15, 24/V 1974, Herbarium of Faculty of Science, Kobe University).

Habitat: Attached to side of large submerged boulders on right bank of upper reaches of Sungai Ayer Besar.

Batrachospermum tiomanense also resembles *B. procarpum* SKUJA 1931 in having a twisted carpogonium bearing branch but differs in the shape of the whorls which consist of sparsely branched primary branchlets and numerous almost unbranched secondary branchlets without hairs. This species belongs to the section *Contorta* of SKUJA (1831).

4. *Ballia prieurii* KÜTZING 1847 p. 37, 1849 p. 663, 1862 p. 12, tab. c-f; DE TONI 1903

p. 1896; BOURRELLY 1970 p. 254, pl. 71, fig. 6, pl. 72, figs. 1-2; STARMACH 1977 p. 256, fig. 108 d-e. (Fig. 4)

Frond 5-7 mm high, 200-230 μm wide, dichotomously branched. Axis non-corticated, consisting of subhexagonal or octagonal cells, terminating in a broadly rounded tip; axial cells large about 50 μm wide and about 60 μm long. Branchlets opposite, unilaterally branched, 100-150 μm long, consisting of 3-6 cell-stories, gradually tapering towards the apex, each terminating in a subconical cell of about 10 μm wide, 10-12 μm long; basal cell of branchlet pentagonal or barrel-shaped, 18-25 μm wide, 16-27 μm long.

Specimens examined: Sungai Ayer Besar, Pulau Tioman, Malaysia (RATNASABAPATHY, Nos. 18 and 27, 24/V 1974).

Habitat: This species was found in two freshwater collections of mainly liverworts.

This species was first described from rivulets in Cayenne in French Guiana and it was found for the first time in Malaysia.

5. *Caloglossa ogasawaraensis* OKAMURA 1897 p. 13, figs. a-d, 1908 p. 183, pl. 37, figs. 1-11; SKUJA 1938 p. 631, tab. 35, figs. 1-10.

Frond about 2 cm high, dichotomously, rarely trichotomously branched, articulate, consisting of narrow leafy segments, purple. Narrow leafy segments linear-lanceolate, attenuating more narrowly towards the base, 150-600 μm wide, 1-7 mm long. Rhizoids and similar leafy segments produced laterally from the constricted portion and from the margins of leafy segments. Tetrasporangia unknown in Malaysian specimens.

Specimens examined: Sungai Ayer Besar and Sungai Air Dalam, Pulau Tioman, Malaysia (RATNASABAPATHY, Nos. 19, 22, 28 and 30, 24/V 1974, and Nos. 33 and 48, 26/V 1974).

Habitat: Attached to submerged or partially exposed but wet stones and pebbles or on bottom sand in middle and upper reaches of Sungai Ayer Besar and Sungai Air Dalam; sometimes associated with *Batrachospermum crispatum*, *B. godronianum*,

Bostrychia sp. and *Compsopogon* sp.; occasionally epiphytic on submerged trailing roots.

This species was reported previously from Pulau Tioman by RATNASABAPATHY (1977).

Discussion

In addition to the above described species, *Compsopogon* sp. and *Bostrychia* sp. were collected from Pulau Tioman. However, the authors could not identify them to species because they were found in fragments. The five genera representing seven species encountered in the two streams samples in the small island, Pulau Tioman, indicate that freshwater red algae are more widely distributed than generally believed. From the biogeographical point of view it is noted that *Batrachospermum godronianum* and *Caloglossa ogasawaraensis* range from temperate and subtropical to tropical latitude. That Pulau Tioman, included in the Sunda Shelf, was in pleistocene times probably part of a large land mass linked to Peninsular Malaysia and adjacent islands including Indonesia is one factor that suggest the possible extension of our new species to at least Indonesia.

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M. ラトナサバパティー*・熊野 茂**：マレーシア産淡水産紅藻 I. 西マレーシア、ティオマン島のカワモヅク属、バリア属およびアヤギヌ属の数種について。

ティオマン島のアイア・ベサー川からカワモヅク属の2新種が記載された。*Batrachospermum crispatum* KUMANO et RATNASABAPATHY, sp. nov. は *B. procarpum* SKUJA に似るが、長い棍棒形の受精毛を持つ点で異りカワモヅク属の *Viridia* 節に属する。*B. tiomanense* KUMANO et RATNASABAPATHY, sp. nov. は同じく *B. procarpum* に似るが、殆んど分枝しない2次輪生枝、分枝のまばらな1次輪生枝を持つ点で区別できる。カワモヅク属の1種 *B. godronianum* SIRODOT およびバリア属の1種 *Ballia prieurii* KÜTZING がマレーシア新産として報告された。またホソアヤギヌ *Caloglossa ogasawaraensis* OKAMURA がアイア・ベサー川とアイア・ダラム川から報告された。(*マレーシア クアラルンプール マラヤ大学植物学教室, **657 神戸市灘区六甲台 神戸大学理学部生物学教室)