Jap. J. Phycol. (Sôrui) 30: 119-124. June 20, 1982

Studies on freshwater red algae of Malaysia II. Three species of *Batrachospermum* from Sungai Gombak and Sungai Pusu, Selangor, West Malaysia

M. RATNASABAPATHY* and Shigeru KUMANO**

* *Department of Botany, University of Malaya, Kuala Lumpur, Malaysia.*
** *Department of Biology, Faculty of Science, Kobe University, Rokko-dai, Nada-ku, Kobe, 657 Japan*

RATNASABAPATHY, M. and KUMANO, S. 1982. Studies on freshwater red algae of Malaysia II. Four taxa of Batrachospermaceae from Sungai Gombak and Sungai Pusu, Selangor, West Malaysia. Jap. J. Phycol. 30: 119-124.

The present paper deals with a part of the collection of freshwater red algae from Sungai Gombak and Sungai Pusu. Three species of *Batrachospermum* are described here as new taxa. *Batrachospermum gombakense* differs from the taxa belonging to the section *Turficola* in having a very short carpogonium bearing branch consisting of only one or two cells. *B. hirosei* differs from *B. intortum* Jao in the size and shape of the tricohogyne and in the absence of monosporangia. *B. hypogynum* differs from *B. breutelii* in having rosette like hypogynous cells.

Key Index Words: Batrachospermum gombakense, *sp. nov.*; Batrachospermum hirosei, *sp. nov.*; Batrachospermum hypogynum, *sp. nov.*; *Malaysia*; *Rhodophyta*; *Taxonomy.*

The water chemistry and biology of Sungai Gombak were briefly reported by NORRIS and CHARLTON (1962). BISHOP (1973) provided a comprehensive treatment of the limnology and biology of the river, including the description of the freshwater algae especially in the main river. RATNASABAPATHY collected algal species, including those identified in the samples supplied by BISHOP, for the use of students attending field courses. This handout formed the basis of his publication of 1975, which included species of *Auduinella, Batrachospermum, Hildbrandtia* and *Ballia.* KUMANO (1978), who was exploring Tasik Bera, the largest natural lake in Malaysia from 1970-1973, under the Joint Malaysia-Japan Project of Scientific Investigation into Freshwater Lakes of Malaysia as a contribution to IBP, extended his field investigations to the Gombak River and reported on *Ballia pinnulata, Batrachospermum vagum* and *Caloglossa ogasawaraensis* var. *latifolia.* RATNASABAPTHY and SETO (1981) have described *Thorea clavata* from a tributary of the river.

Batrachspermum described here were collected from tributaries of Sungai Gombak, namely, one close to the Field Studies Centre of University of Malaya named here the Field Studies Centre tributary and another Sungai Pusu (Fig. 1). At the time of collecting the samples in the morning the water temperature and pH at the Field Studies Centre tributary and Sungai Pusu were 23.0-24.5°C, pH 6.2-7.1 and 25.4-26.0°C, pH 6.5-6.9 respectively.

Description of species

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

Frons dioica, 1-2 cm alta, 200-400 μm cras-

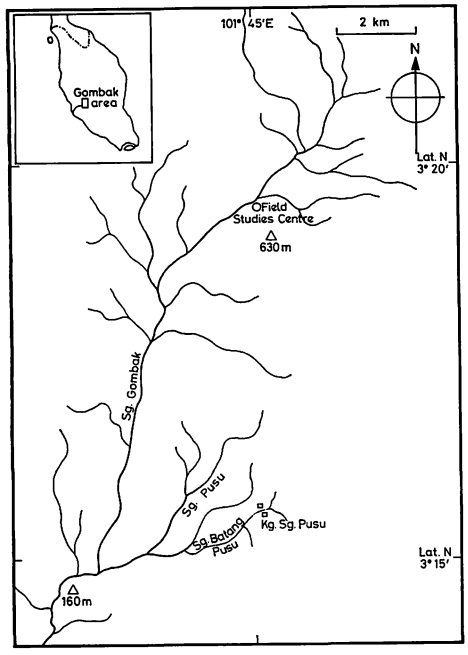

Fig. 1. Map showing Gombak River (Sungai Gombak) and its tributaries.

sa, plus minusve dichotome ramosa, parum mucosa, viridia. Cellulae axiales cylindricae, 10-40 μm crassae, 40-100 μm longae. Verticilli contigui et plus minusve compressi. Ramuli primarii unilateraliter ramificantes, ex 9-15 cellulis constantes; cellulae fasciculorum cylindricae vel doliiformes, 5-7 μm crassa, 5-10 μm longae; pili nuli. Fila corticalia bene evoluta. Ramuli secundarii numerosi, totum internodium obtegentes. Antheridia globosa, 4-8 μm crassa in diametro, in ramulis lateralibus vel ramulis abbreviatis terminalia. Ramuli carpogoniferi e cellulis basi ramulorum primariorum orientes, ex cellulis 1-2 hexagonis constantes; carpogonium basi 3-5 μm crassum, apice 10-15 μm crassum, 40-50 μm longum; trichogyne indistincte pedicellata, obconico-clavaeformis. Bracteae e cellulis 1-2 hexagonis orientes. Gonimoblasti singli, elliptici, magni, 140-210 μm crassi, 185-330 μm longi, in centro verticilli inserti. Carposporangia obovoidea, 8-11 μm crassa, 20-25 μm longa.

Frond dioecious, 1-2 cm high, 200-400 μm wide, more or less dichotomously branched, not very mucilaginous, green. Axial cells cylindrical, 10-40 μm wide, 40-100 μm long. Whorls touching each other, more or less compressed. Primary branchlets unilaterally branching, consisting of 9-15 cell-stories; cells of fascicles cylindrical or barrel-shaped, 5-7 μm wide, 5-10 μm long; hairs none. Cortical filaments well-developed. Secondary branchlets numerous, covering all the internodes. Antheridia globose, 4-8 μm in diameter, terminal on lateral branchlets or on shortened branchlets. Carpogonium bearing branch arising from the basal cell of a primary branchlet, consisting of 1-2 hexagonal cells; carpogonium 3-5 μm wide at the base, 10-15 μm wide at the apex, 40-50 μm long; trichogyne inversed conical or club-shaped, indistinctly stalked. Bracts arising form 1-2 hexagonal .cells. Gonimoblast single, elliptical, big, 140-210 μm wide, 185-330 μm long, inserted centrally. Carposporangia obovoid, 8-11 μm wide, 20-25 μm long.

Holotype: Sungai Gombak, Selangor, Malaysia (RATNASABAPATHY No. 1220, 31/V 1976, Private Herbarium, Department of Botany, University of Malaya). Isotype: (RATNASABAPATHY No. 1221, 31/V 1976, Herbarium of Faculty of Science, Kobe University).

Habitat: Attached to large submerged rocks or boulders, 10-25 cm below the surface of clear stream waters which flow through reserved forest.

Distribution: Known from the type locality only.

SIRODOT (1884) assigned *B. vagum* (ROTH) AG. with ten varieties, *B. dimorphum* KÜTZING and *B. bambusinum* BORY to the section *Turficola* of *Batrachospermum*. ISRAELSON (1942) reported three species of this section from Sweden, viz., *B. vagum* (ROTH) AG., *B. vogesiacum* T. G. SCHULTZ and *B. globosporum* ISRAELSON. JAO (1941) described *B. sinense* JAO as a new member to this section and SKUJA (1968) also described *B. vagum* (ROTH) AG. var. *periplocum* SKUJA belonging to this section. *B. gombakense* KUMANO et RATNASABAPATHY belongs to this section based on the nature of the

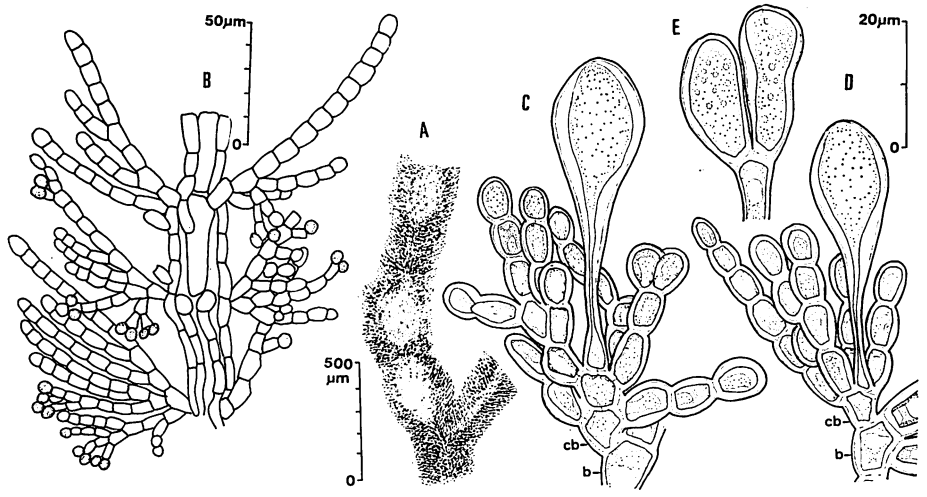

Fig. 2. *Batrachospermum gombakense* KUMANO et RATNASABAPATHY, sp. nov. A. A part of frond with confluent whorls and gonimoblasts inserted centrally; B. Structure of whorls with antheridia; C. A carpogonium and a carpogonium bearing branch consisting of two cells (cb); D. A carpogonium bearing branch consisting of only one cell (cb), arising from the basal cell (b) of primary branchlets; E. Carposporangia.

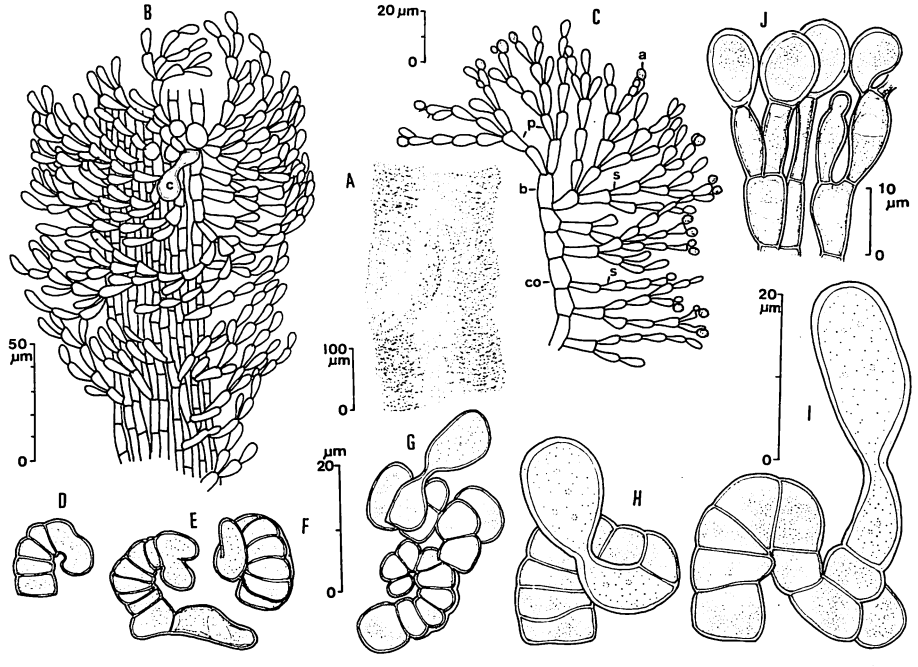

Fig. 3. *Batrachosdermum hirosei* RATNASABAPATHY et KUMANO, sp. nov. A. A part of frond with confluent whorls and a gonimoblast inserted centrally; B. Structure of whorls showing primary and secondary branchlets, well-beveloped cortical filaments and carpogonium (c); C. A part of a whorl showing a basal cell (b) of primary branchlets (p), a cortical filament (co), secondary branchlets (s) and antheridia (a); D-I. Development of twisted carpogonium bearing branch; J. Carposporangia.

trichogyne that is indistinctly stalked and conically inversed and has a single large gonimoblast inserted centrally. But *B. gombakense* differs from the above mentioned taxa in having a very short carpogonium-bearing branch consisting of only one or two hexagonal cells, from which many bracts arise.

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

Frons monoica, 1-3 cm alta, 100-220 μm crassa, plus minusve irregulariter ramosa, valde mucosa, viridis vel fusca. Callulae axiales cylindricae, 15-30 μm crsaasae, 100-190 μm longae. Verticilli pyriformes, in parte vetustiore frondis obconici vel contigui. Ramuli primarii abundanter ramificantes, ex 6-8 cellulis constantes; cellulae fasciculorum fusiformes vel ovoideae, 4-5 μm crassae, 4-14 μm longae; pili nuli. Fila corticalia bene evoluta. Ramuli secundarii numerosi, totum internodium obtegentes. Antheridia globosa, 3-5 μm diametro, in ramulis primariis et secundariis terminalia. Ramuli carpogoniferi e cellulis basi ramulorum primariorum orientes, longi, ex cellulis 6-13 doliiformibus constantes, valde tortuosi; carpogonium basi 4-10 μm crassum, apice 7-10 μm crassum, 19-35 μm longum; trichogyne ellipsoidea vel irregulariter spathulata, distincte pedicellata. Bracteae breves. Gonimoblasti singli, globosi vel semiglobosi, magni 110-200 μm crassi, 100-140 μm alti, in centro verticilli inserti. Carposporangia obovoidea vel globosa, 7-8 μm crassa, 8-15 μm longa.

Frond monoecious, 1-3 cm high, 100-220 μm wide, more or less irregularly branched, very mucilaginous, green or brown. Axial cells cylindrical, 15-30 μm wide, 100-190 μm long. Whorls pear-shaped, in an aged frond inversed conical or touching each other. Primary branchlets abundantly branching, consisting of 6-8 cell-stories; cells of facicles fusiform or ovoid, 4-5 μm wide, 4-14 μm long; hairs none. Cortical filaments well developed. Secondary branchlets numerous, covering all the internodes. Antheridia globose, 3-5 μm in diameter, terminal on primary and secondary branchlets. Carpogonium bearing branch arising from the basal cell of a primary branchlet, long, consisting of 6-13 barrel-shaped cells, strongly twisted; carpogonium 4-10 μm wide at the base, 7-10 μm wide at the apex, 19-35 μm long; trichogyne ellipsoidal or irregularly spatula-shaped, distinctly stalked. Bracts short. Gonimoblast single, globular or semi-globular, large, 110-200 μm wide, 100-140 μm high, inserted centrally. Carposporangia obovoid or globose, 7-8 μm wide, 8-15 μm long.

Holotype: Sungai Pusu, Selangor, Malaysia (RATNASABAPATHY No. 1201 b, 2/VI 1979, Private Herbarium, Department of Botany, University of Malaya). Isotype: (RATNASABAPATHY No. 1201 b, 2/VI 1979, Herbarium of Faculty of Science, Kobe University).

Habitat: Attached to sides of submerged rock about 10 cm below the surface of clear, quiet and shaded pool waters of Sungai Batang Pusu near Kampung Sungai Pusu.

Distribution: Known from the type locality only.

Batrachospermum hirosei resembles *B. intortum* JAO (1941) which belongs to the section *Contorta* in having a strongly twisted carponium bearing branch, but differs in the size and the shape of the trichogyne, in having confluent whorls due to the development of the secondary branchlets and in the absence of monsporangia. This species is named in honour of Dr. Hiroyuki HIROSE, Professor Emeritus of Kobe University for his scholarly and dedicated service to phycological advancement and his help and continued interest in our studies on freshwater red algae.

3. *Batrachospermum hypogynum* KUMANO et RATNASABAPATHY, sp. nov. (Fig. 4)

Frons monoica, 3-7 cm alta, 300-570 μm crassa, plus minusve irregulariter ramosa, valde mucosa, brunnea vel vinacea. Cellulae axiales cylindricae, 30-90 μm crassae, 150-380 μm longae. Verticilli vel distantes et ellipsoidei, vel contigui et plus minusve compressi. Ramuli primarii abundanter, vel plus minusve unilateraliter ramificantes, ex

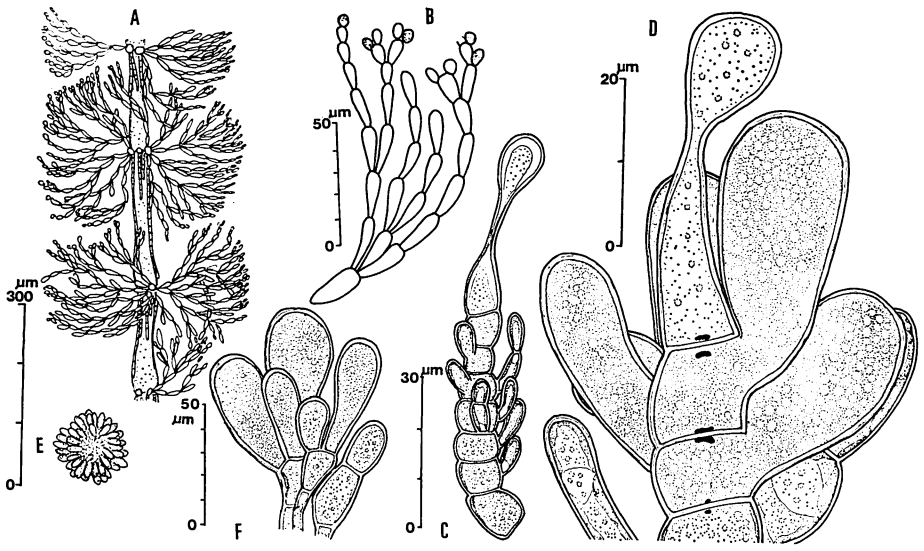

Fig. 4. *Batrachospermum hypogynum* KUMANO et RATNASABAPATHY, sp. nov. A. Structure of whorls; B. Primary branchlets with antheridia; C. A young carpogonium bearing branch; *D*. Terminal portion of a carpogonium bearing branch with hypogynous cells; E. A gonimoblast; F. Carposporangia formed terminally on gonimoblast filaments.

8-11 cellulis constantes; cellulae inferiores fasciculorum arcuato-clavaeformes, 5-7 μm crassae, 17-23 μm longae, cellulae superiores fusiformes vel ellipsoideae, 3-5 μm crassae, 6-10 μm longae; pili nuli. Ramuli secundarii rari. Antheridia ovoidea vel globosa, 4-6 μm diametro, in ramulis primariis terminalis vel lateralia. Ramuli carpogoniferi e cellulis basi ramulorum primariorum orientes, 40-70 μm longi, ex cellulis 5-9 doliiformibus constantes; carpogonium basi 8-10 μm crassum, apice 10-13 μm crassum, 40-45 μm longum; trichogyne indistincte pedicellata, urniformis. Cellulae hypogynae rosulatae, lateraliter prolatae, magnae. Bracteae inferiores numerosae, elongatae. Gonimoblasti singuli, globosi, 100-200 μm diametro, in peripheria verticilli exserti. Carposporangia magna, obovoidea vel clavata, 18-35 μm cressa, 50-65 μm longa.

Frond monoecious, 3-7 cm high, 300-570 μm wide, more or less irregularly branched, strongly mucilaginous, deep brown or wine-colour. Axial cells cylindrical, 30-90 μm wide, 150-380 μm long. Whorls distant and ellipsoidal, or touching each other and more or less compressed. Primary branchlets abundantly or more or less unilaterally branched, consisting of 8-11 cell-stories; lower cells of fascicles arcuate-club-shaped, 5-7 μm wide, 17-23 μm long, upper cells fusiform or ellipsoidal, 3-5 μm wide, 6-10 μm long; hairs none. Secondary branchlets rare. Antheridia ovoid or globose, 4-6 μm in diameter, terminal or lateral on primary branchlets. Carpogonium bearing branch arising from the basal cell of a primary branchlet, 40-70 μm long, consisting of 5-9 barrel-shaped cells; carpogonium 8-10 μm wide at the base, 10-13 μm wide at the apex, 40-45 μm long; trichogyne indistinctly stalked, urn-shaped. Hypogynous cells in rosette, laterally elongated, large. Lower bracts numerous, elongated. Gonimoblast single, globular, 100-200 μm in diameter, extended from the perphery of a whorl. Carposporangia big, obovoid or clavate, 18-35 μm wide, 50-65 μm long.

Holotype: Sungai Pusu, Selangor, Malaysia (RATNASABAPATHY No. 1201, 2/VI 1979, Private Herbarium, Department of Botany, University of Malaya). Isotype: (RATNASA-

BAPATHY No. 1201, 2/VI 1979, Herbarium of Faculty of Science, Kobe University).

Habitat: Attached to submerged stones up to 15 cm below the surface of clear, swift, shaded waters of a small creek, about 30-45 cm wide, of Sungai Batang Pusu near Kampung Sungai Pusu.

Distribution: Known from the type locality and Sungai Air Terjun, Pulau Langkawi, Malaysia.

Batrachospermum hypogynum resembles *B. breutelli* RABENHORST which belongs to the section *Aristatae* in general appearance, but differs in having the rosette like hypogynous cell and having large carporangia but not forming tetrasporangia. In *B. hypogynum*, a nutritive hypogynous cell of the carpogonium bearing branch becomes enlarged laterally and produces protuberances upwards in a rosette. After fertilization, the protoplasmic connection among the carpogonium, the hypogynous cells and the underlying cells is especially pronounced. The carpospores of this species often germinate within obovoid or clavate carposporangia, and initiate an uniseriate creeping filament as reported in the other taxa of *Batrachospermum*.

Acknowledgements

We wish to express our grateful thanks to the University of Malaya for the generous providing the field and laboratory facilities, and to Dr. Hiroyuki HIROSE, Professor Emeritus of Kobe University for many useful discussions, constant encouragement and critical comments on our manuscript.

References

BISHOP, J.E. 1973. Limnology of a small Malaysian River, Sungai Gombak. W. Junk, The Hague.

ISRAELSON, G. 1942. The freshwater Florideae of Sweden. Symb. Bot. Upsal. 6: 1-134.

JAO, Ch. Ch. 1941. Studies on the freshwater algae of Chian. VIII. A preliminary account of the Chinese freshwater Rhodophyceae. Sinensia 12: 245-290.

KUMANO, S. 1978. Notes on freshwater red algae from West Malaysia. Bot. Mag. Tokyo 91: 97-107.

NORRIS, R.C. and CHARLTON, J.I. 1962. A chemical and biological survey of the Sunagi Gombak. Government Printers, Kuala Lumpur.

RATNASABAPATHY, M. 1970. Freshwater algae of the Gombak River. Field handout mineo, 5 pp.

RATNASABAPATHY, M. 1975. Preliminary observations on Gombak river algae at the Field Studies Centre, University of Malaya. Phykos 14: 15-23.

RATNASABAPATHY, M. and SETO, R. Investigation on two species of *Thorea* Bory (Rhodophyta) found in West Malaysia. Phykos (in press)

RATNASABAPATHY, M. ahd SETO, R. 1981. *Thorea prowsei*, sp. nov. and *Thorea clavata*, sp. nov. (Rhodophyta, Nemaliales) from West Malayaia. Jap. J. Phycol. 29: 243-250.

SIRODOT, S. 1884. Les Batrachospermes. Libraire de l'Académie de Médicine, Paris.

SKUJA, H. 1933. Untersuchungen über die Rhodophyceen des Süsswassers. III. Arch. Protistenk. 80: 357-366.

SKUJA, H. 1968. Eigentümliche morphologische Anpassung eines *Batrachospermum* gegen mechanische Schädigung in fliessendem Wasser. Österr. Bot. Z. 116: 55-64.

STARMACH, K. 1977. Phaeophyta and Rhodophyta. In Flora Słodkowodna Poliski 14. Polska Akademia Nauk, Warszawa.

M. ラトナサバパティー*・熊野　茂: マレーシア産淡水産紅藻 II. 西マレーシア, ゴンバ川およびプス川のカワモヅク属の3種**

首都クアラ・ルンプール近郊のゴンバ川とその支流からカワモヅク属の3新種を報告する。*Batrachospermum gombakense* KUMANO et RATNASABAPATHY, sp. nov. はカワモヅク属の *Turfocola* 節に属するが, 他の種とは1～2細胞からなる非常に短い造果器をつける枝をもつ点で区別できる。*B. hirosei* RATNASABAPATHY et KUMANO, sp. nov. は *B. intortum* JAO に似るが, 受精毛の形と大きさおよび単胞子を持たぬ点が異なる。*B. hypogynum* KUMANO et RATNASABAPATHY, sp. nov. はカワモヅク属のどの種ともロゼット状の器下細胞をもつ点で区別できる。(*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)