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## Two New Varieties of *Batrachospermum* (Rhodophyta) from Mt. Albert Edward, Papua New Guinea

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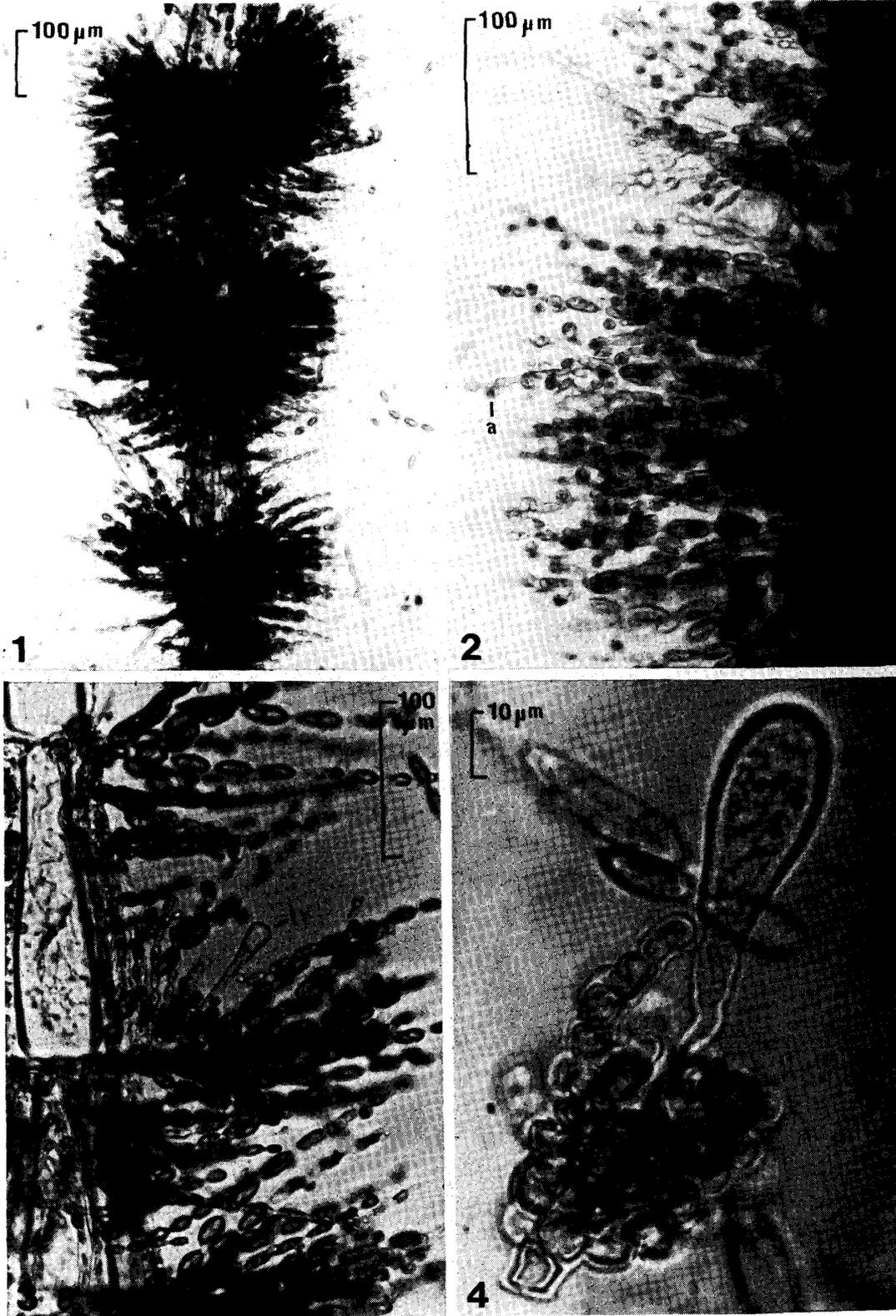
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As regards the freshwater Rhodophyta, especially the genus *Batrachospermum*, of south-east Asia, SKUJA (1938) described *Batrachospermum lochmodes* as a new species from Dijeng Plateau in Java Island in Indonesia. Recently, KUMANO (1978) described six new taxa including new species of the genus *Batrachospermum*, *Ballia* and *Tuomeya* from West Malaysia. Two species of *Sirodotia* were reported by KUMANO (1982), moreover, five species of *Batrachospermum* were described as new species by RATNASABATHY and KUMANO (1982a, 1982b) from West Malaysia. From Papua New Guinea, JOHNSTONE *et al.* (1980) reported *Batrachospermum* sp. for the first record of freshwater Rhodophyta, then, this species was described as a new species, *B. nova-guineense*, by KUMANO and JOHNSTONE (1983). Another new species of *Batrachospermum* collected from the Papuan highlands was recently described and named it as *B. woitapense* by KUMANO (1983). The present paper deals with two new varieties of *Batrachospermum* collected from the subalpine and temperate swamps near Mt. Albert Edward, Central District of Papua New Guinea.

### Location and Habitat

The coastal lowlands in the Central District of Papua New Guinea are covered with tropical rain forests, interspersed with mangrove forests. On the other hand, Mt. Albert Edward is about 4,000 m alt., and there are many stagnant waters and temporary pools in the subalpine swamps around the summit of the mountains. Near the summit of Mt. Albert Edward, a gentle and vast slope extends from 3,300 m to 3,000 m alt. A subalpine swamp carpets this gentle slope, and there are many stagnant pools and small streams in this highlands in the heart of tropical Papua New Guinea. Specimens of *Batrachospermum vagum* var. *undulato-pedicellatum* were collected by WATANABE from a stagnant pool in this subalpine swamp, where the water pH was 5.7 on 25th October 1975.



At about 3,000 m alt., there are evergreen broad-leaved forests, some of which were replaced with secondary grasslands caused by forest fire. Specimens of *B. moniliforme* var. *obtrullatum* were collected by WATANABE from a small stream in this secondary grassland, where we can find many tree ferns and the water pH was 5.5 on 24th October 1975.

### Descriptions of Varieties

#### *Batrachospermum vagum* (ROTH) AG. var. *undulato-pedicellatum*

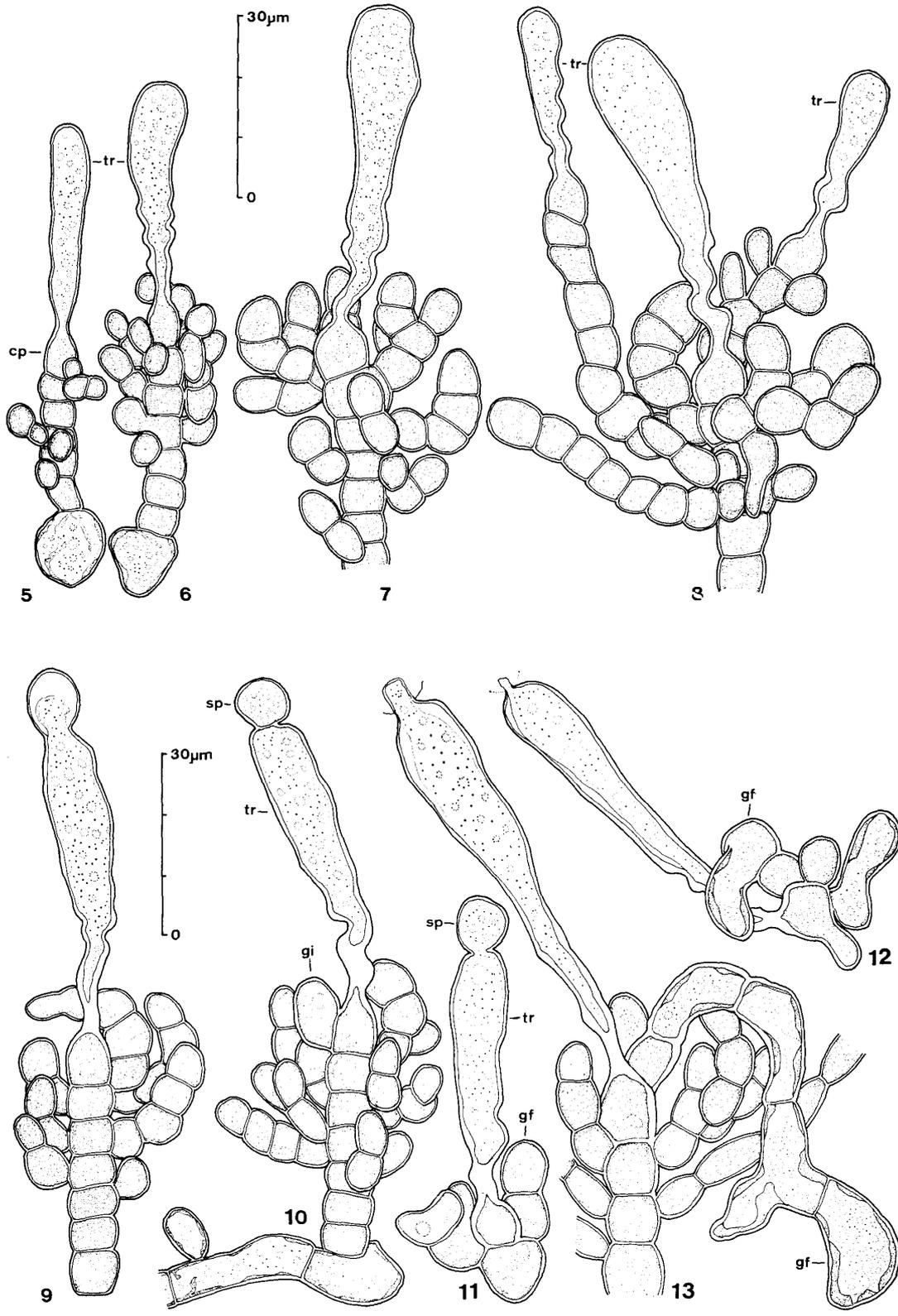
KUMANO et WATANABE, var. nov. (Figs. 1-4, 5-13)

Frons trioica, 3-5 cm alta, 400-600  $\mu\text{m}$  crassa, plerumque pseudodichotome ramosa, mucosa, aeruginosa. Cellulae axiales cylindricae, 80-150  $\mu\text{m}$  crassae, 400-500  $\mu\text{m}$  longae. Verticilli ellipsoidei, in parte vetustire frondis contigui et plus minusve compressi. Ramuli primarii abundanter ramificantes, ex 6-9 cellulis constantes; cellulae pyriformes, fusiformes vel ovoideae; pili raro. Fila corticalia bene evoluta. Ramuli secundarii numerosi, totum internodium obtegentes. Antheridia globosa, 7-8  $\mu\text{m}$  diametro, in ramulis primariis et secundariis terminalia et lateralia. Ramuli carpogoniferi e cellulis basi ramulorum primariorum vel e cellulis intercalari ramulorum carpogoniferorum orientes, 20-35  $\mu\text{m}$  longi, ex cellulis 4-8 disci- vel doliiformibus constantes; carpogonium basi 5-8  $\mu\text{m}$  crassum, apice 7-13  $\mu\text{m}$  crassum, 40-70  $\mu\text{m}$  longum; trichogyne claviformis vel obconica, undulato-pedicellata. Bractee numerosi, breves. Gonimoblasti singuli, semiglobosi, in centro verticilli inserti, saepe abortivi. Monosporangia ? globosa, ca. 10  $\mu\text{m}$  diametro, in ramulis primariis et secundariis terminalia vel lateralia.

Frond trioecious, 3-5 cm high, 400-600  $\mu\text{m}$  wide, usually pseudodichotomously branched, mucilaginous, green with a bluish tinge. Axial cells cylindrical, 80-150  $\mu\text{m}$  wide, 400-500  $\mu\text{m}$  long, Whorls ellipsoidal, in young part of frond touching each other and more or less compressed. Primary branchlets abundantly branching, consisting of 6-9 cell-stories; cells of fascicles pear-shaped, fusiform or ovoidal; hairs rare. Cortical filaments well-developed. Secondary branchlets numerous, covering all the internodes. Antheridia globose, 7-8  $\mu\text{m}$  in diameter, terminal or lateral on primary and secondary branchlets. Carpogonium-bearing branch arising from the basal cell of the primary branchlet and from the intercalary cells of the carpogonium-bearing branch, 20-35  $\mu\text{m}$  long, consisting of 4-8 disc- or barrel-shaped cells; carpogonium 5-8  $\mu\text{m}$  wide at the base, 7-13  $\mu\text{m}$  wide at the apex, 40-70  $\mu\text{m}$  long; trichogyne club-shaped or inversed conical with a undulate stalk. Bracts numerous, short. Gonimoblast single,

Figs. 1-4. *Batrachospermum vagum* (ROTH) AG. var. *undulato-pedicellatum* KUMANO et WATANABE, var. nov.

1. Structure of whorls.
2. Antheridia terminal or lateral on primary and secondary branchlets.
3. A part of thallus showing axial cells, primary branchlets, cortical filaments, secondary branchlets and a carpogonium-bearing branch with a mature carpogonium.
4. A carpogoniumbearing branch showing a carpogonium with an abconical trichogyne and an undulated stalk. (a: antheridium, tr: trichogyne).



semiglobular, inserted centrally, often abortive. Monosporangia ? globose, ca. 10  $\mu\text{m}$  in diameter, terminal or lateral on the primary and secondary branchlets.

Holotypus: Stagnant pool, 3,000 m alt. toward Mt. Albert Edward, Central District, Papua New Guinea (*Watanabe No. 51285*, 25/X1975, Herbarium of Faculty of Science, Kobe University). Isotypus: *Watanabe No. 51285*, Herbarium, Tsukuba Botanical Gardens, National Science Museum, TNS.

Other Papuan specimens examined: *Watanabe No. 51286*, *No. 51287* (stagnant pools, 3,000 m alt., 25/X 1975), *No. 51292*, *No. 51293* (small streams, 3,000 m alt., 26/X 1975), *No. 51301*, *No. 51302* (stagnant pools, 3,300 m alt., 27/X 1975).

Habitat: This variety grows in small stagnant pools and small streams in subalpine swamps of Papua New Guinea, where the water pH was 5.7.

Distribution: Known from the type locality and its vicinities.

This new variety resembles *B. vagum* var. *vagum*, which is often found in highland swamps in temperate regions. However, *B. vagum* var. *undulato-pedicellatum* differs from the latter in having the trichogyne undulate stalked and the carpogonium-bearing branch arising as laterals of the carpogonium-bearing branch itself.

As indicated by the sectional name, *Turficola*, *B. vagum* is a moor-dweller. In fact, it was reported characteristic of lakes, tarns, ditches and water-holes in peaty moors in Sweden (ISRAELSON, 1941). *B. vagum* is also common at high altitudes. STRØM (1926) collected *B. vagum* from high mountains in Norway. He stated that specimens from Haugastøl at 1,230 m alt. were poorly developed and those from Myrdal at 800 m alt. (61°N) sterile, whereas Myrdal at 850 m alt. were beautifully developed. MORI (1975) reported this species from Hachimantai at 1,614 m alt. in Japan. The type locality of *B. vagum* var. *undulato-pedicellatum* is a stagnant pool in subalpine swamp at about 3,000 m alt.. The discovery of a new variety of *B. vagum* in tropical Papua New Guinea was therefore not surprising.

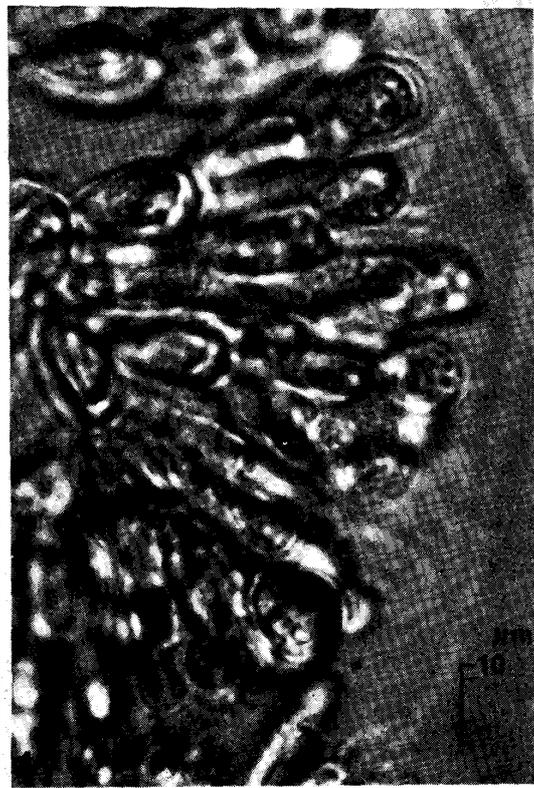
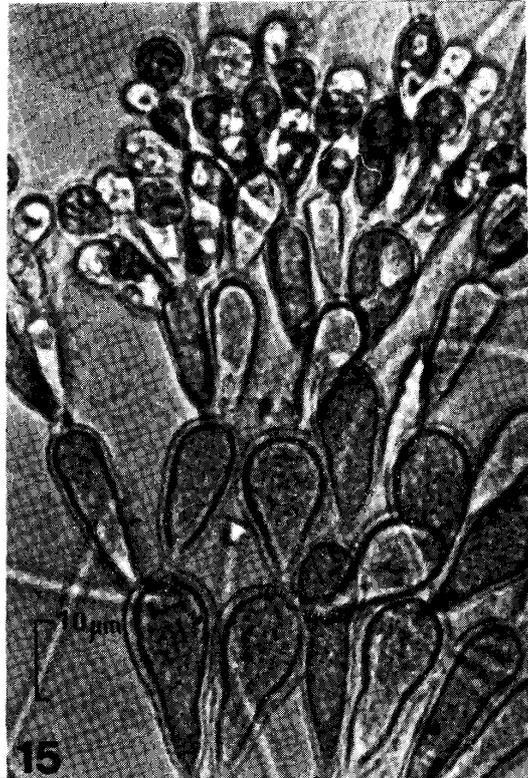
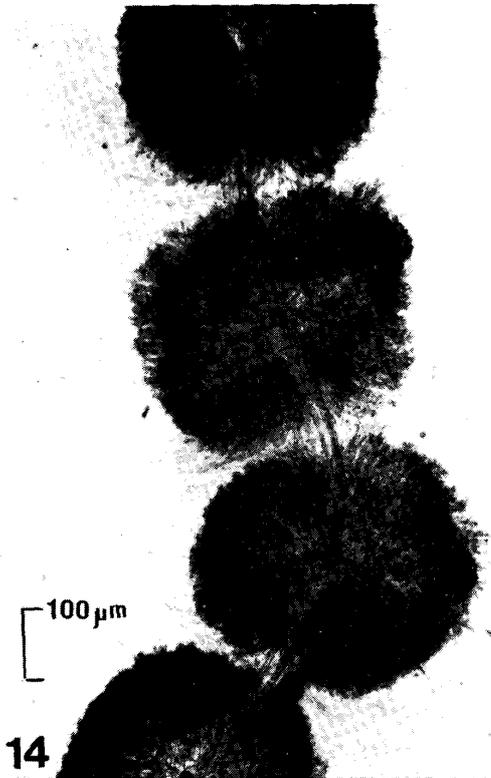
*Batrachospermum moniliforme* ROTH var. *obtrullatum*

KUMANO et WATANABE, var. nov. (Figs. 14–17, 18–27)

Frons monoica, 3–7 cm alta, 400–900  $\mu\text{m}$  crassa, plus minusve irregulariter ramosa, mucosa, fusca vel brunnea. Cellulae axiales cylindricae, 30–60  $\mu\text{m}$  crassa, 150–600  $\mu\text{m}$  longae. Verticillin globosi vel doliiformis, plus minusve distantes. Ramuli primarii abundanter ramificantes, ex 8–11 cellulis constantes; cellulae inferiores fasciculorum claviformes, 5–10  $\mu\text{m}$  crassae, 25–45  $\mu\text{m}$  longae; cellulae superiores fusiformes, 5–9  $\mu\text{m}$  crassae, 12–17  $\mu\text{m}$  longae; praesentes. Fila corticalis evoluta. Ramuli secundarii rari. Antheridia globosa, 5–6  $\mu\text{m}$  diametro, in ramulis primariis terminalia.

Figs. 5–13. *Batrachospermum vagum* (ROTH) AG. var. *undulato-pedicellatum* KUMANO et WATANABE, var. nov.

5. A carpogonium-bearing branch with a young carpogonium. 6–7. Stages in the development of a carpogonia with undulated stalks. 8. Carpogonium-bearing branches developed as laterals of a carpogonium-bearing branch. 9. A fertilized carpogonium. 10–13. Early stages in the development of the gonimoblast filament. (cp: carpogonium, gf: gonimoblast filament, gi: gonimoblast initial, sp: spermatium, tr: trichogyne).



Ramuli carpogoniferi e cellulis basi ramulorum primariorum orientes, ex cellulis 6–9 doliiformibus constantes; carpogonium basi 4–6  $\mu\text{m}$  crassum, apice 13–18  $\mu\text{m}$  crassum, 30–37  $\mu\text{m}$  longum; trichogyne obrullata, indistincte pedicellata. Bractee numerosae, elongatae. Gonimoblasti 1–3, globosi, 50–100  $\mu\text{m}$  diametro, in peripheria verticilli inserti. Carposporangia globosa vel obovoidea, 7–10  $\mu\text{m}$  crassa, 10–15  $\mu\text{m}$  longa.

Fronde monoecious, 3–7 cm high, 400–900  $\mu\text{m}$  wide, more or less irregularly branched, mucilaginous, grayish brown or brown. Axial calls cylindrical, 30–60  $\mu\text{m}$  wide, 150–600  $\mu\text{m}$  long. Whorls globose or barrel-shaped, more or less separated. Primary branchlets abundantly branched, consisting of 8–11 cell-stories; lower cells of fascicles club-shaped, 5–10  $\mu\text{m}$  wide, 25–45  $\mu\text{m}$  long; upper cells pear-shaped, 5–9  $\mu\text{m}$  wide, 12–17  $\mu\text{m}$  long; hairs present. Cortical filaments developed. Secondary branchlets rare. Antheridia globose, 5–6  $\mu\text{m}$  in diameter, terminal on primary branchlets. Carpogonium-bearing branch arising from the basal cell of the primary branchlet, consisting of 6–9 barrel-shaped cells; carpogonium 4–6  $\mu\text{m}$  wide at the base, 13–18  $\mu\text{m}$  wide at the apex, 30–37  $\mu\text{m}$  long; trichogyne angled obovate, obrullate, indistinctly stalked. Gonimoblasts 1–3, globose, 50–100  $\mu\text{m}$  in diameter, inserted in periphery of whorl. Carposporangia globose or obvoidal, 7–10  $\mu\text{m}$  wide, 10–15  $\mu\text{m}$  long.

Holotypus: Small stream, 3,300 m alt. toward Mt. Albert Edward, Central District, Papua New Guinea (*Watanabe No. 51305*, 28/X 1975, Herbarium of Faculty of Science, Kobe University). Isotypus: *Watanabe No. 51305*, Herbarium, Tsukuba Botanical Gardens, National Science Museum, TNS.

Other Papuan specimens examined: *Watanabe No. 51274* (small stream, 2,900 m alt., 24/X 1975), *No. 52562* (near Field Station of A. N. U., 3,500 m alt., 5/I 1974) and *No. 52570* (stream from Lake Aunde, 3,500 m alt., 5/I 1974).

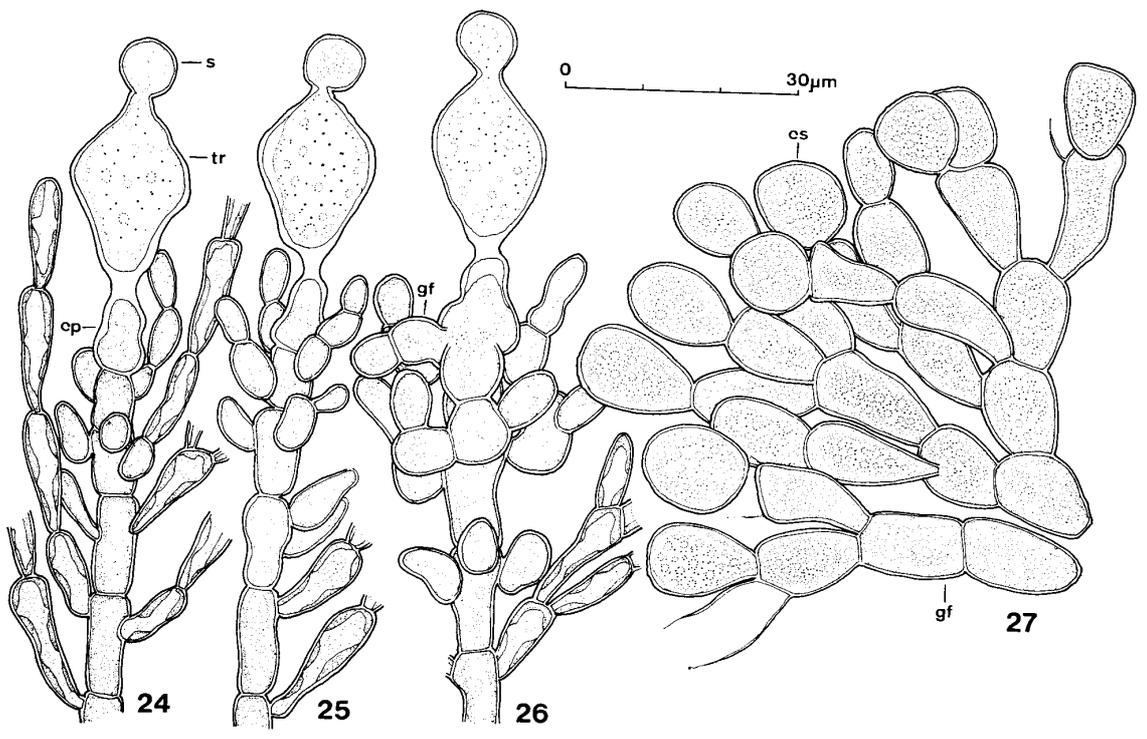
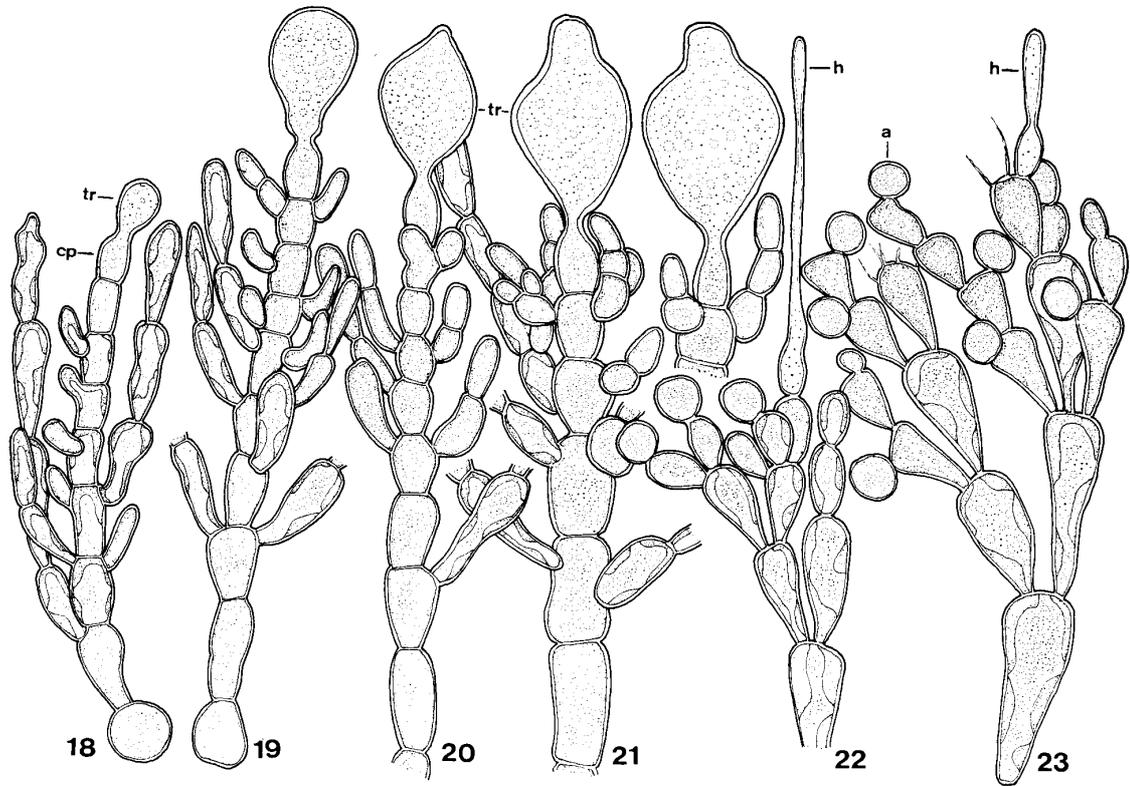
Habitat: This variety grows in small streams in secondary grassland of Papua New Guinea, where the water pH was 5.5.

This new variety resembles *B. moniliforme* var. *moniliforme*, which is often found in the temperate lowlands. However, *B. moniliforme* var. *obtrullatum* differs from the latter in having the obrullate or angled obovate trichogyne.

As already pointed out by KUMANO (1980), most taxa of the section *Moniliformia* are distributed widely in the temperate regions of Korea, China and Japan in Asia. Exceptionally, *B. nova-guineense* KUMANO et JOHNSTONE (1983) and *B. lochmodes* SKUJA (1938) were described from tropical Papua New Guinea and Indonesia. The former species was collected from the Papuan lowland, whereas the latter was reported from Djeng Plateau in Indonesia at about 2,000 m alt., where the water temperature was 16.1°C and the water pH was 6.7. It is therefore rather subtropical or temperate in the Djeng Plateau. The type locality of *B. moniliforme* var. *obtrullatum* is a small

Figs. 14–17. *Batrachospermum moniliforme* ROTH var. *obtrullatum* KUMANO et WATANABE, var. nov.

14. Structure of whorls showing gonimoblasts inserted periphery of whorls. 15. Antheridia terminal on primary branchlets. 16. A carpogonium-bearing branch terminated a fertilized carpogonium with an abtrullate trichogyne. 17. Carposporangia terminal on gonimoblast filaments.



stream in the grasslands at about 3,000 m alt., where we can find many tree ferns, it is also subtropical or temperate region in the heart of tropical Papua New Guinea.

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### Summary

Two varieties of *Batrachospermum* (Rhodophyta, Nemalionales) are described as new taxa from the subalpine and temperate swamps near Mt. Albert Edward, Central District of Papua New Guinea. One of them, *Batrachospermum (Turficola) vagum* (ROTH) Ag. var. *undulato-pedicellatum*, var. nov., differs from var. *vagum*, which is often found in the temperate highlands swamps, in having the trichogyne with an undulate stalk. Another one, *Batrachospermum (Moniliformia) moniliforme* ROTH var. *obtrullatum*, var. nov., differs from others of this species in having an abtrullate trichogyne.

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Figs. 18-27. *Batrachospermum moniliforme* ROTH var. *obtrullatum* KUMANO et WATANABE, var. nov.

18-19. Early stages in the development of carpogonia with rounded trichogynes. 20-21 Mature carpogonia with angled obovate or obtrullate trichogynes. 22-23. Terminal portions of primary branchlets with antheridia and hairs. 24-25. Fertilized carpogonium with spermatia. 26. An early stage in the development of gonimoblast filaments. 27. Carposporangia terminal on gonimoblast filaments. (a: antheridium, cp: carpogonium, cs: carposporangium, gf: gonimoblast filaments, h: hair, s: spermatia, tr: trichogyne).

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