

**Studies on freshwater red algae of Malaysia V.
Early development of carposporophytes of *Batrachospermum
cylindrocellulare* KUMANO and *B. tortuosum* KUMANO**

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Observations on the early development of the carposporophytes of *Batrachospermum cylindrocellulare* and *B. tortuosum* are presented. The carpogonium-bearing branch of *B. cylindrocellulare* is relatively short and is not provided with bracts in the early stage of development so that its differentiation from the vegetative fascicles is remarkable. The carpogonium-bearing branch of *B. tortuosum* becomes curved strongly in the progress of its development. The trichogyne of this species is formed asymmetrically and falls sideways on the terminal cell of the carpogonium-bearing branch.

Key Index Words : *Batrachospermum cylindrocellulare* ; *Batrachospermum tortuosum* ; *carposporophytes development* ; *Malaysia*.

The degree of differentiation of the carpogonium-bearing branch from the vegetative fascicles varies from species to species in the genus *Batrachospermum*. KUMANO et al. (1970) emphasized that the more highly the carpogonium-bearing branch is differentiated, the shorter is its length. Thus, for example, the section *Aristatae* is characterized by the possession of a long carpogonium-bearing branch whilst the section *Contorta* is characterized in having a twisted carpogonium-bearing branch. KUMANO (1978) described *Batrachospermum cylindrocellulare* and *B. tortuosum* from West Malaysia, and he assigned the former to the section *Moniliformia* and the latter to the section *Contorta*. This paper deals with the early development of the carposporophytes of the above two

species in detail from the point of view of phylogeny.

Materials used in the Present Study

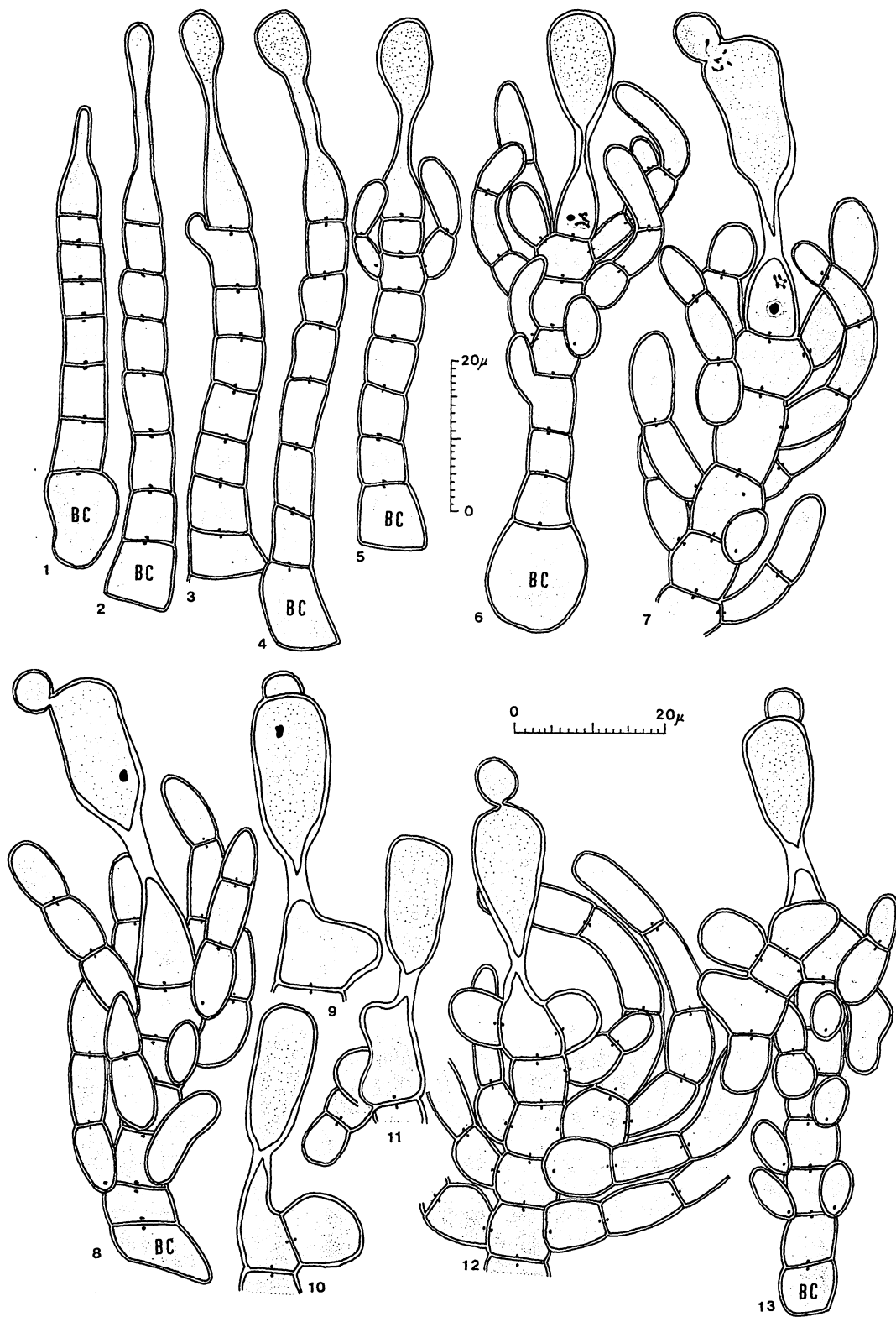
Materials used in the present study were collected from Fort Iskandar in Tasik Bera, Pahang, Malaysia by the author on 16th April, 1971 (*B. cylindrocellulare*) and 12th July, 1971 (*B. tortuosum*). Specimens have been deposited in the Herbarium of the Faculty of Science, Kobe University.

Observations

1. *Batrachospermum cylindrocellulare* KUMANO Fig. 1. (1-13).

The carpogonium-bearing branch of this

Fig. 1. *Batrachospermum cylindrocellulare* KUMANO 1-4. The early stage in the development of carpogonium-bearing branches without bracts; 5-6. Carpogonium-bearing branches showing mature carpogonia with spatula-shaped trichogynes; 7-8. Carpogonium-bearing branches showing fertilized carpogonia with spatula-shaped trichogynes and bracts; 9-13. The early stages in the development of gonimoblast initials and gonimoblast filaments. (BC: basal cell of the whorl).



species arises from the basal cell of the whorl, consists of 6-8 barrel-shaped cells, and, in the early stage of the development, has no bracts. The differentiation of the carpogonium-bearing branch from the vegetative fascicles is very remarkable. The terminal portion of the carpogonium sticks out, becomes a rod shaped initial of the trichogyne and finally gives rise to an ovoid or spatula shaped trichogyne with a long stalk (Fig. 1. 1-6). After fertilization, the basal portion of the carpogonium extends a lateral outgrowth and cuts off the first initial of the gonimoblast filament, then on the opposite side of the carpogonium a further initial is produced in the same manner (Fig. 1. 8-13). The well-developed carpogonium-bearing branch is shorter than the vegetative fascicles of the whorl and is provided with numerous long bracts embracing the gonimoblasts, which are inserted in the middle of the whorl.

2. *Batrachospermum tortuosum* KUMANO
Fig. 2. (1-19).

The carpogonium-bearing branch of this species consists of 3-4 somewhat disc-shaped cells and arises from the basal cell of the whorls. In the process of development, the carpogonium-bearing branch becomes curved strongly to one side. The side portion of the carpogonium protrudes and develops into a cylindrical initial of the trichogyne (Fig. 2. 3-4), thus the trichogyne becomes to be formed asymmetrically. This situation is very different from the other species of *Batrachospermum* in that the trichogyne is formed asymmetrically and falls sideways on the terminal cell of the carpogonium-bearing branch. A well-developed trichogyne often bends at the basal portion at an angle of 90° or more (Fig. 2. 9-13, 15). As the trichogyne bends, the carpogonium-bearing branch twists spirally because its cells elongate on one side

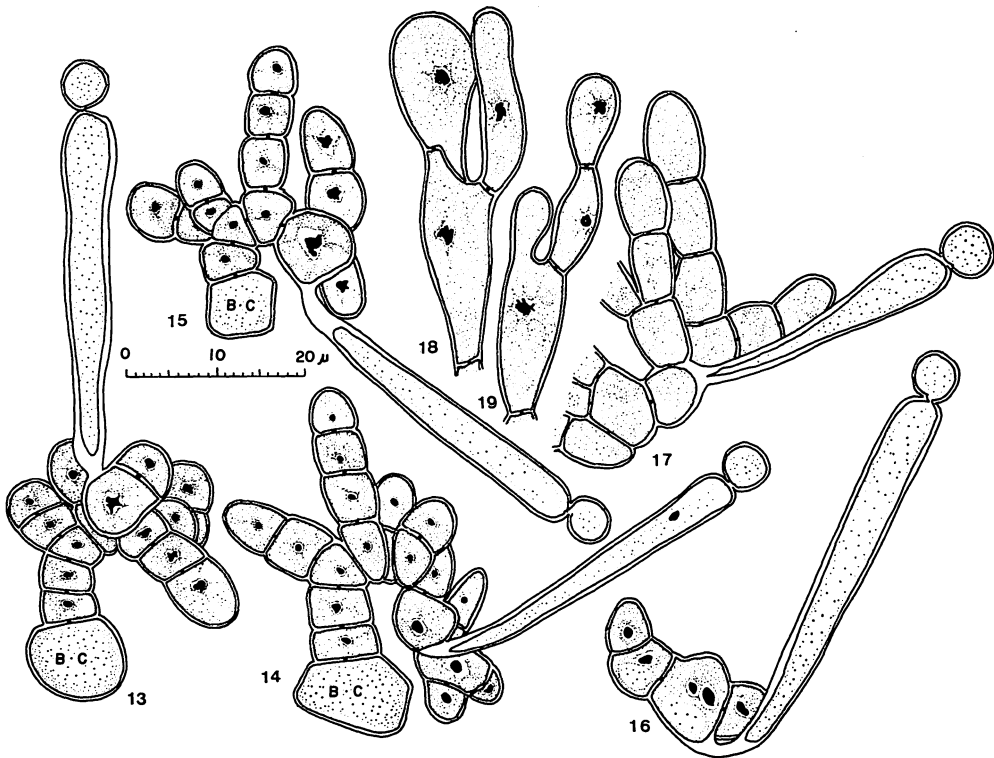
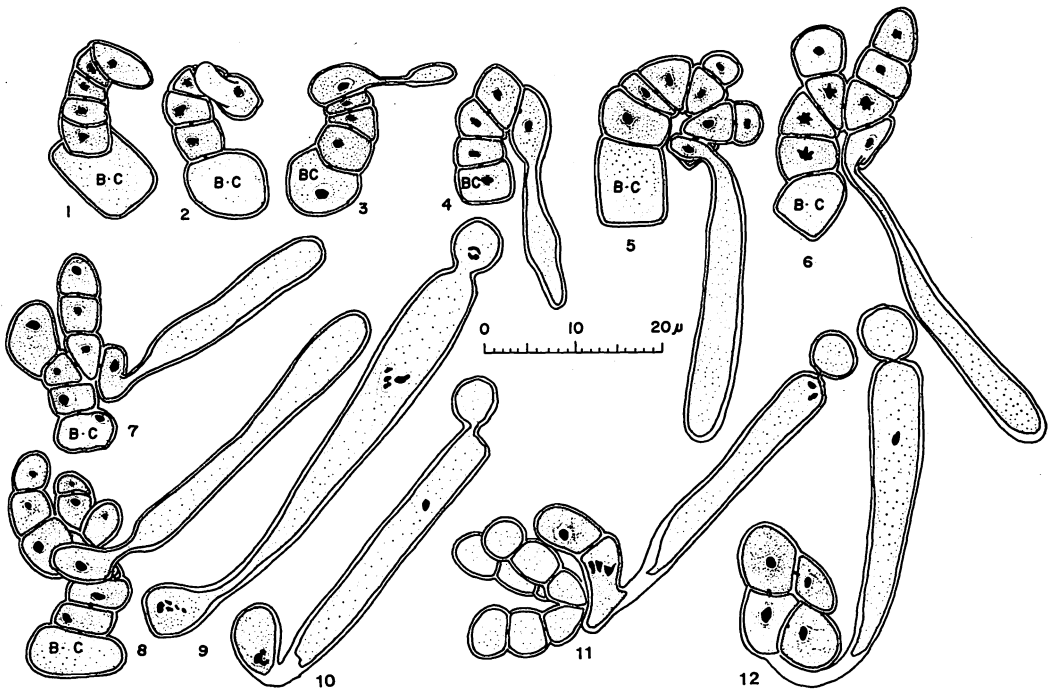
only, thus becoming triangular in shape as observed in longitudinal view. As a result of the above mentioned development, the terminal portion of the trichogyne faces outward of the whorl. After fertilization, the manner of the development of the gonimoblast is the same as those of other species of *Batrachospermum* (Fig. 2. 10-16). The gonimoblast grows out into radially branched filaments (Fig. 2. 17, 19) and forms a big hemispherical gonimoblast inserted centrally in the whorl.

Discussion

Among the taxa having the long carpogonium-bearing branches, the section *Moniliformia* is regarded as a primitive one and the section *Aristatae* as an advanced one. KUMANO and RATNASABAPATHY (1982) pointed out that *Batrachospermum beraense* is a primitive form among the species in the section *Aristatae*, because its trichogyne is not so large, the carpogonium-bearing branch consists of 7-11 barrel-shaped cells and is less differentiated, and the 2-3 gonimoblasts are scattered within the whorl, whereas *B. cayennense* also of this section is considered as an advanced form because its carpogonium-bearing branch is very long, consisting of 9-14 cells, its differentiation from the vegetative branchlets is clearly recognizable, and its cells are very different from those of the vegetative branchlets in the size and the shape. In *B. cylindrocellulare*, assigned to the section *Moniliformia*, the carpogonium-bearing branch consists of 5-8 barrel-shaped cells, however, in its early stage of development, it is similar to that of *B. cayennense*. Therefore, *B. cylindrocellulare* is here regarded as an intermediate form between the sections *Moniliformia* and *Aristatae*.

The section *Contorta* is characterized in

Fig. 2. *Batrachospermum tortuosum* KUMANO 1-2. Very early stages in the development of carpogonium-bearing branches; 3-4. The early stages in the development of carpogonium-bearing branch, showing cylindrical trichogynes formed asymmetrically; 5-8. Strongly curved carpogonium-bearing branches and mature carpogonia with trichogynes often bent at the basal portions; 9-10. Fertilized carpogonia; 11-17. The early stages in the development of gonimoblast filaments; 18-19. Carposporangia development terminal on gonimoblast filaments. (BC: basal cell of the whorl).



having a twisted carpogonium-bearing branch, whose length varies from species to species. Some taxa such as *B. tortuosum* and *B. tortuosum* var. *majus*, whose carpogonium-bearing branch is also curved, have been assigned to this section by KUMANO (1978, 1982). As pointed out above, this condition is very different from the taxa belonging to the section *Viridia* in that the trichogyne of *B. tortuosum* is formed asymmetrically and falls sideways on the terminal cells of the carpogonium-bearing branch. Recently, KUMANO and RATNASABAPATHY (1984) described *B. bakarensis* as a new species from West Malaysia, which resembles the above-mentioned two taxa belonging to the section *Contorta* in having the slightly curved carpogonium-bearing branch. However, they pointed out that *B. bakarensis* closely resembles those species belonging to the section *Viridia* in having a short carpogonium-bearing branch and a club-shaped trichogyne. Therefore, some taxa such as *B. tortuosum* and *B. bakarensis* may be regarded as the intermediate forms between the sections *Contorta* and *Viridia*. Further collections and studies of hitherto unencountered new species of *Batrachospermum* from the relatively unexplored areas such as South-east Asia could substantiate this point of view.

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References

- KUMANO, S. 1978. Notes on freshwater red algae from West Malaysia. *Bot. Mag. Tokyo* 91: 87-107.
- KUMANO, S. 1982. Two taxa of the section *Contorta* of the genus *Batrachospermum* (Rhodophyta, Nemalionales) from Iriomote Jima and Ishigaki Jima, subtropical Japan. *Jap. J. Phycol.* 30: 289-296.
- KUMANO, S. and RATNASABAPATHY, M. 1982. Studies on freshwater red algae of Malaysia III. Development of carporophytes of *Batrachospermum cayennense* MONTAGNE, *B. beraense* KUMANO and *B. hypogynum* KUMANO et RATNASABAPATHY. *Bot. Mag. Tokyo* 95: 219-228.
- KUMANO, S. and RATNASABAPATHY, M. 1984. Studies on freshwater red algae of Malaysia IV. *Batrachospermum bakarensis*, sp. nov. from Sungai Baka, Kelantan, West Malaysia. *Jap. J. Phycol.* 32: 19-23.
- KUMANO, S., SETO, R. and HIROSE, H. 1970. On the development of the carposporophytes in several species of the *Batrachospermaceae*, with special reference to their phylogenetic relations. *Bull. Jap. Soc. Phycol.* 18: 116-120. (in Japanese).

熊野 茂: マレーシア産淡水産紅藻 V. *Batrachospermum cylindrocellulare*
KUMANO および *B. tortuosum* KUMANO の果胞子体の初期発達

Batrachospermum cylindrosellare の造果器をつける枝は比較的短かく栄養 (輪生) 枝からの分化は顕著である。その発達の初期には側枝を具えていない点で *B. cayennense* に似ている。この点などから判断して *B. cylindrocellulare* はモノリフォヒミア節とアリストタエ節を繋ぐ中間型と推察される。*B. tortuosum* の造果器をつける枝は短い、発達が進むにつれて強く彎曲すると受精毛が不相称的に生じる点でコントルタ節に属すると考えている。本種や棍棒形の受精毛を具え、造果器をつける枝が僅かに彎曲する *B. bakarensis* などの種が、コントルタ節とヴィリディア節を繋ぐ中間型であると推察される。(657 神戸市灘区六甲台 神戸大学理学部生物学教室)