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Ryozo Seto, R. N. Yadava and Shigeru Kumano: Development of short spinous branchlets of *Compsopogon aeruginosus* var. *catenatum* (Compsopogonaceae, Rhodophyta)

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Krishnamurthy (1962) mentioned that *Compsopogon aeruginosa* is very similar to *C. coeruleus*, but can be distinguished by two sharp features: 1) the monospores are comparatively small, and 2) the older thallus and the main axis bear short spinous branchlets. The latter feature, short spinous branchlets, is observed on the Indian specimens collected from various parts of Gujrat by Patel and Francis (1969) and the Japanese specimens from Lake Shinji by Nakamura and Chihara (1983).

Compsopogon aeruginosus var. *catenatum*, which has spinous branchlets in the nodulated axis, was described as a new variety by Yadava and Pandey (1980) based on the Indian specimens collected from Dorania River at Bareilly. A new form of *Compsopogon aeruginosus* with spinous branchlets was also reported by Singh and Pandey (1986) from Nakatia River. This paper deals with the development of spinous branchlets based on the specimen of *Compsopogon aeruginosus* var. *catenatum* collected from Nakatia River in India.

Observations

1. **Specimens examined in the present study:** The specimens of *Compsopogon aeruginosus* var. *catenatum* collected by R. N. Yadava from Nakatia River near Bareilly in India in August 1988 were deposited in the herbaria of Department of Botany, University of Allahabad in India, and Department of Biology, Faculty of Science, Kobe University in Japan.

2. **Development of filamentous branches prior to cortication:** The younger portion of the thallus remains uniseriate. Prior to cortication, an erect thallus may give rise to several angular branches by oblique divisions of axial central cells. The cell destined to form a filamentous branch pushes out laterally and distally and the protuberance thus formed is delimited by a cross-wall as the initial cell of a filamentous branch. The initial cell then undergoes successive transverse divisions to give rise to a uniseriate filamentous branch (Figs. 1-3). This filamentous branch may eventually develop cortical cells in the same manner as the main axis. Filamentous branches generally originate to form an angle of 30 to 60 degrees with reference to the main axis. Leteral filamentous branches of main thalli are also richly branched, arise alternatively, and are uniseriate.

Then, a uniseriate filamentous branch is formed by a series of discoid cells developed by repeated transverse divisions of the dome-shaped apical cell. A few cells below the apical cell of a branch do not divide while other axial rows of cells divide periclinally and form a number of peripheral segments. These cells subsequently transform into a single layer of cortical cells. Further anticlinal and transverse divisions result in the formation of one or two layers of cortical cells.

3. **Development of short spinous branchlets:** The old thallus bears many short spinous branchlets. They usually originate at right angles to the main axis from central cells of the old thalli, which have well-deve-

loped cortical cells, usually more than one layer (Figs. 4-7, 10-14, 15-16 and 18).

In the old thallus, a spinous short branchlet is formed by a division of a central cell. On the apical half of a central cell, a small protuberance is formed, which is delimited by a cross-wall as the initial cell of a short spinous branchlet (Fig. 4). This initial cell undergoes successive transverse divisions to give rise to a short spinous branchlet (Figs. 5-7). In the young stage short spinous branchlets do not have cortical cells (Figs. 5-7).

These short spinous branchlets eventually develop central cells and a large number of surrounding cortical cells in the same manner as filamentous branches (Figs. 8, 10, 17-18). Sometimes, short spinous branchlets may newly develop on the old spinous branchlets in the same manner (Figs. 8-9 and 17). In other words, short spinous branchlets may grow out into uniseriate filamentous branches of limited length (Figs. 9, 13-16).

Discussion

Krishnamurthy (1962) observed the Indian specimens of *Compsopogon aeruginosus* and mentioned that the old thallus bears short spinous branchlets. These branchlets are laterals of thalli, which developed from an uncorticated segment of the axis the development of which was arrested, while the main axis formed a cortex. Patel and Francis (1969) observed short spinous branchlets on the main axis as well as on the older parts of lateral branches of *C. aeruginosus*. Based on the Japanese specimens of *C. aeruginosus*, Nakamura and Chihara (1983) observed many short spinous branchlets, which originated from the outermost cortical cells in the old part of main axis, and they did not differentiate into central and cortical cells.

In *C. aeruginosus* var. *catenatum*, Yadava and Pandey (1980) mentioned that peripheral cells of the thallus serve as initials, which divide transversely resulting into short spinous branchlets and these spine-like structures are not morphologically different from filamentous branches. Thus, short spinous branchlets are in young or arrested states of the filamentous ones.

Singh and Pandey (1986) observed short spinous branchlets of a new form of *C. aeruginosus* and mentioned that short spinous branchlets originate directly from the central cells or from large cortical cells of the innermost layer of thallus. The short spinous branchlets may grow out into branched uniseriate filamentous short laterals of limited growth.

In the present study, it is observed that a short spinous branchlet of *C. aeruginosus* var. *catenatum* originates from a central cell of main axis. In the old thallus, an initial cell of a short spinous branchlet is formed by the divi-

Figs. 1-3. Development of a filamentous lateral branch of *Compsopogon aeruginosus* (J. Ag.) Kuetzing var. *catenatum*. 1. A protuberance formed on a central cell. 2. An initial cell formed by the oblique division of a central cell. 3. Three-celled stage of a filamentous lateral branch.

Figs. 4-7. Development of a short spinous branchlet. 4. An initial cell of a short spinous branchlet formed by the division of a central cell. 5. Side view of two-celled stage of short spinous branchlet originated at right angle to the main axis. 6. Surface view of two-celled stage of a short spinous branchlet. 7. Five-celled stage of a short spinous branchlet.

Figs. 8-9. Development of short spinous branchlets and an uniseriate filamentous branch on the old spinous branchlet. 8. Three short spinous branchlets newly formed by the division of central cells. 9. Forming the uniseriate filamemtous branch of limited length.

Fig. 10. Forming several central cells and cortical cells in a short spinous branchlet.

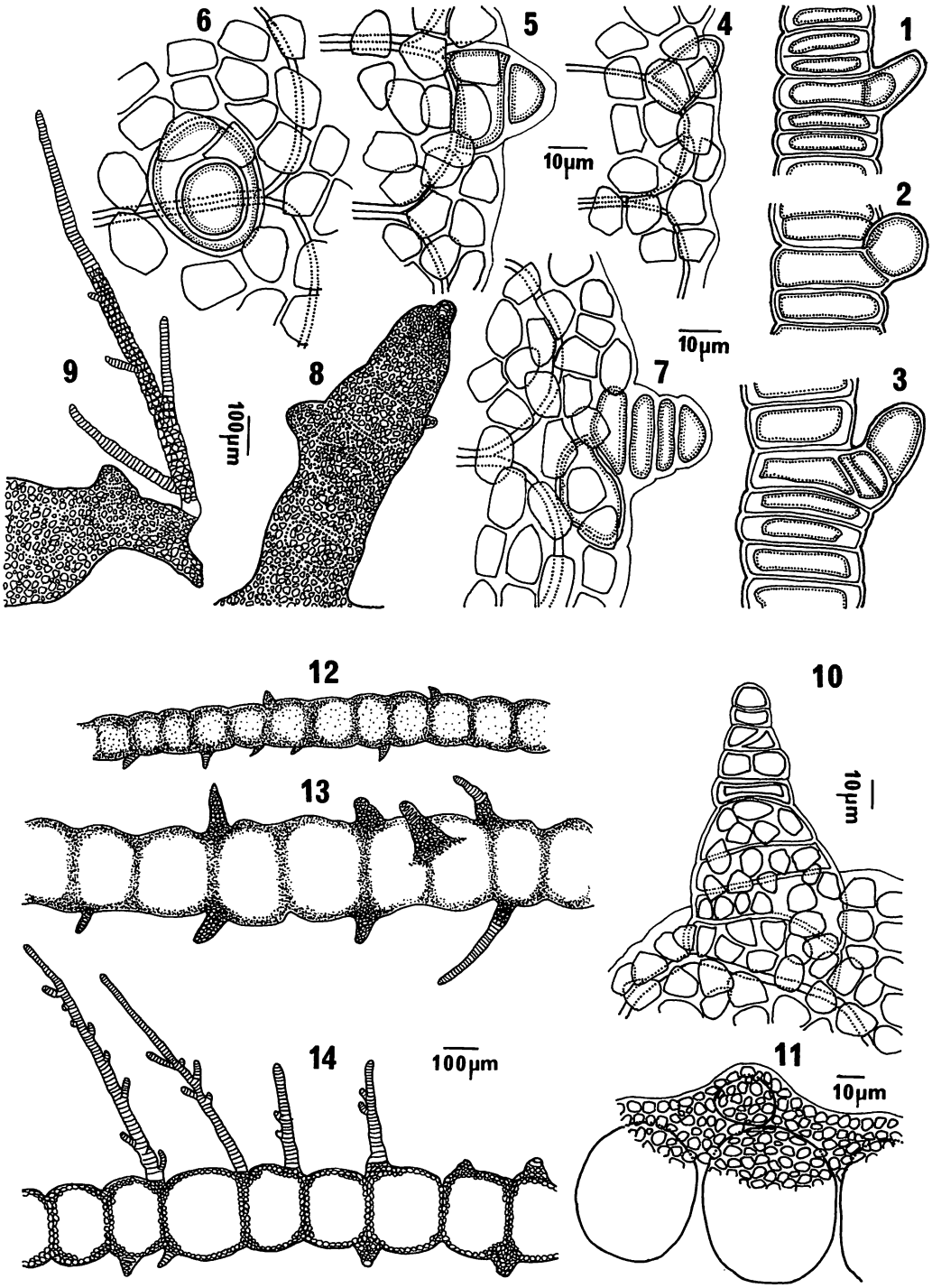
Fig. 11. A short spinous branchlet showing arrested stage of development.

Figs. 12-14. Various developmental stages of short spinous branchlets. 12. A corticated thallus with many short spinous branchlets. 13. An nodulated thallus with many well-developed short spinous branchlets. 14. A thallus with four uniseriate filamentous branches and several short spinous branchlets in arrested stages.

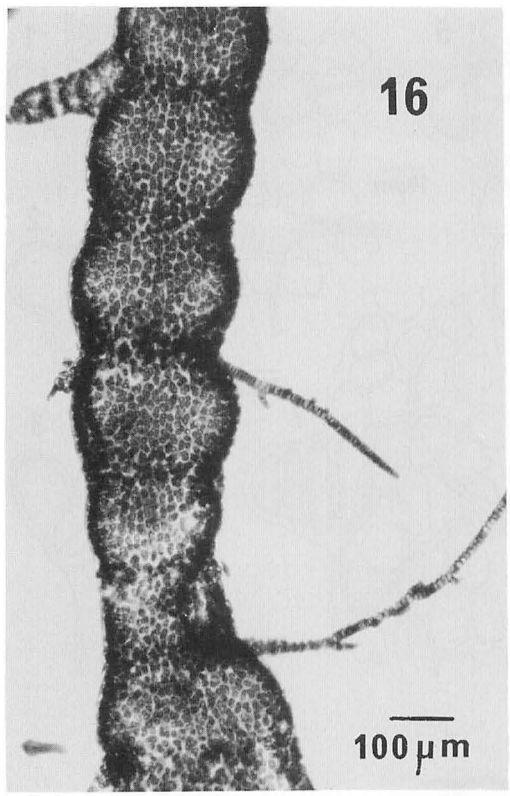
Figs. 15-16. Various developmental stages of short spinous branchlets. 15a. A corticated thallus with many short spinous branchlets. 15b. A nodulated thallus with many well-developed short spinous branchlets. 16. A thallus with two uniseriate filamentous branchlets and three short spinous branchlets.

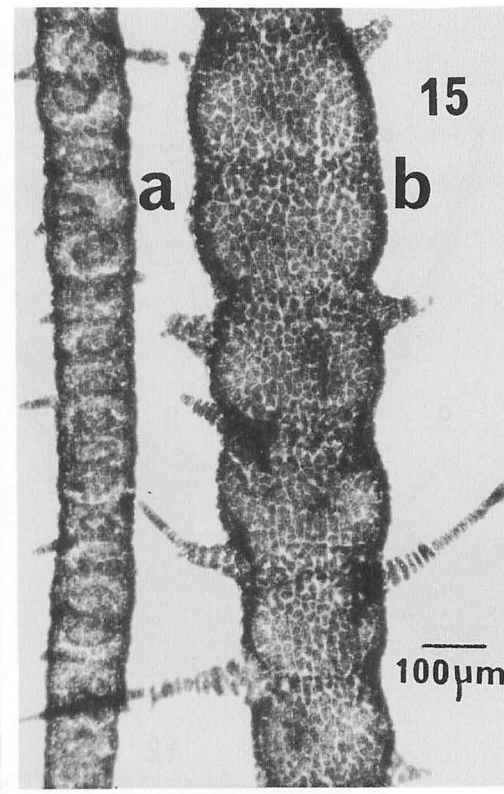
Fig. 17. Two spinous branchlets (arrows) newly formed by the division of each central cell on the old spinous branchlet.

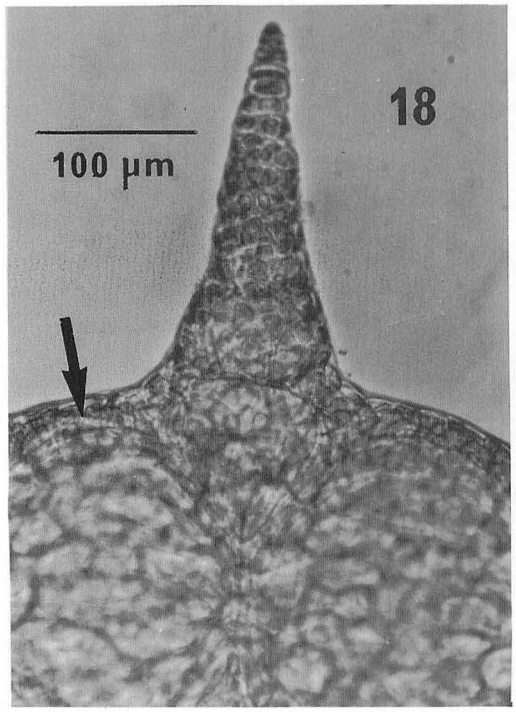
Fig. 18. Development of a short spinous branchlet formed by the division of a central cell (arrow).

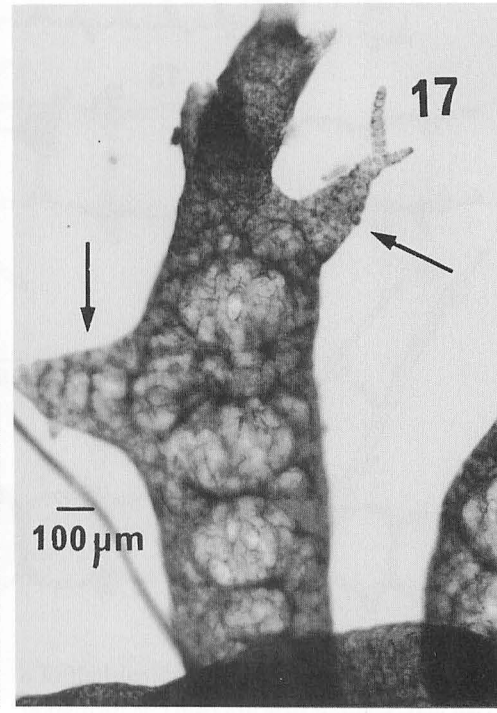


sion of a central cell. On the apical half of a central cell, a small protuberance is formed at the right angle to the main axis, which is delimited by a cross-wall as an initial of a short spinous branchlet. This initial cell develops into short spinous branchlets consist-


16
100 µm


15
a
b
100µm


18
100 µm


17
100µm

ing of central cells and cortical cells, then it undergoes successive transverse divisions to give rise to a short uniseriate filamentous branch.

The short spinous branchlet does not originate from the central cell in the uncorticated uniseriate portion of thallus, but from those in the corticated portion of thallus, while the uncorticated uniseriate thallus produces only filamentous lateral branches. A series of developmental events from an arrested stage of spinous branchlet to a well-developed filamentous branch are observed. It appears that each central cell has the ability to produce lateral branchlets at various stages of development.

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瀬戸良三*・R. N. Yadava・熊野　茂***：インド産淡水紅藻 *Compsopogon aeruginosus* var. *catenatum* の刺状小枝の形成**

インドで採集された *Compsopogon aeruginosus* var. *catenatum* の標本によって，本変種の顕著な特徴である刺状小枝の形成を明らかにした。本変種の通常の側枝は，本属の他の種と同様，単列糸状体の中軸細胞から新生される。一方，皮層細胞のよく発達した枝の中軸細胞から刺状小枝の始原細胞が必ず生じ，この細胞の分裂によって刺状小枝が形成される。このことから，刺状小枝形成過程は通常の側枝のそれと本質的に異ならないと考えられる。

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