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Observation on *Laurencia surculigera* Tseng (Ceramiales; Rhodophyta) and its Infrageneric Position

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Abstract

The structure of the frond and reproductive organs has been observed and illustrated for plants of *Laurencia surculigera* Tseng collected in Kyushu, Japan. The most noteworthy character of the species is its well developed discoid secondary holdfast (*surculi*) which form on short, sterile branchlets. The species fits well into the section Palisadae under the subgenus *Chondrophycus*, having palisade-like cortical cells that lack longitudinal secondary pit-connections between them. Tetrasporangia are cut off abaxially and are arranged in a right-angle manner.

Introduction

After establishing two subgenera based on studies of Japanese species of the genus *Laurencia* (Saito, 1967), Saito (1969a) discovered a distinct suite of species from the Pacific coast of North America which he named the Spectabilis Group. This group could not be classified in either of the two subgenera, for tetrasporangia were cut off adaxially, as opposed to abaxially. As a result of our ongoing studies, we have recently concluded that there should be four groups in the genus at the subgeneric rank, rather than the two originally described. Formal proposals of new subgenera would be premature at this time, however, because of a lack of broad comparative studies within the genus.

In the present report we describe the structure of the frond and reproductive organs of *Laurencia surculigera* Tseng (1943), originally described on sterile material from Hong Kong and now represented by fertile material from Japan. We will then discuss the infrageneric position of this species.

The Japanese material of *L. surculigera* was first collected in Kyushu by Dr. S. Migita of Nagasaki University. Although one of us (Y.S.) had previously visited growing site and collected some specimens, Dr. Migita helped us substantially in collecting material, for which we express our sincere appreciation. Dr. C.F. Chang in the Institute of Oceanology, Academia Sinica, kindly gave us a part of Dr. C.K. Tseng's herbarium specimen (#2747) to compare with Japanese material. To both we are glad to give our sincere appreciation. We are also grateful to Dr. G.T. Kraft of the University of Melbourne for comments on the manuscript.

Laurencia surculigera Tseng Figs. 1-21.

Tseng, 1943, 192, pl. 1, figs. 4 & 5; 1983, 154, pl. 80, fig. 3; Saito, 1969, 159, fig. 11, B; 1977, 216, figs. 1-3.

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Japanese name: Iwakagari (Saito, 1977).

Specimens studied: Creeping on rock in middle to lower littoral zones in the vicinity of the Marine Biological Station of Nagasaki University, Nomozaki-Machi, Nagasaki Prefecture, Japan. 13 July 1976 (♂♀⊕), 14 July 1977 (♀⊕), 29 July 1977 (♂♀⊕), 7 July 1978 (♂♀⊕), 30 July 1978 (♀⊕), leg. Migita. 28 June 1980 (♂♀ & sterile), leg. Migita, Fujita & Saito. 15 July 1980 (♂♀⊕ & sterile), 29 July 1980 (♂♀⊕), leg. Migita.

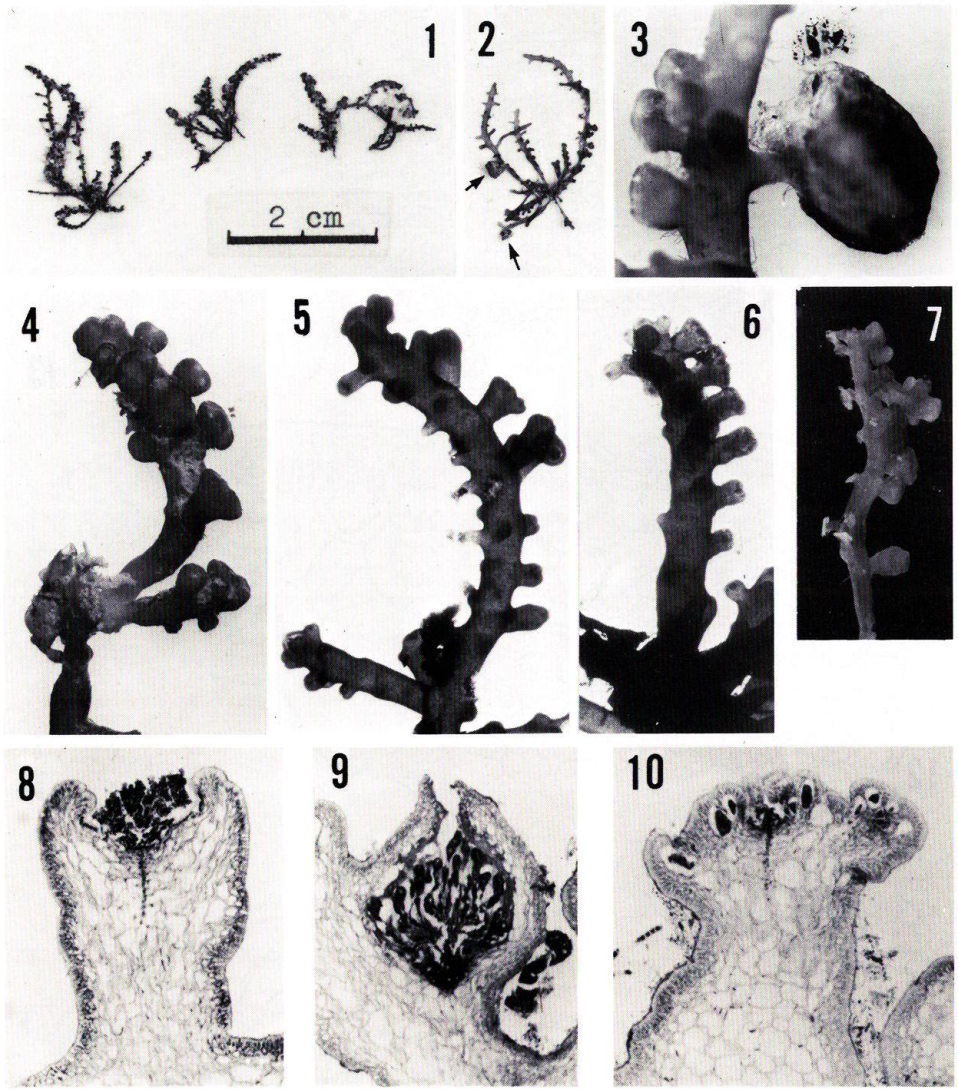
Plants are brownish or dark purplish red in color, have a firm and cartilaginous texture, and adhere lightly to paper when pressed. Fronds initially grow from a basal disc and usually form a clump, without stoloniferous coalesced basal branches. Plants spread basically in a radial manner, becoming secondarily attached to rock or other algae (Figs. 2, 3, 15 & 16) by means of small, numerous discoid holdfasts (*surculi*) which form at the tips of short branchlets (Figs. 2, 3, 7, 15 & 16). Such branchlets sometimes have an apical pit-like depression with a group of cells containing densely staining protoplasm at the bottom (Fig. 16). Although erect frond can be produced, they are never common. Erect or creeping main branches are cylindrical, 660–1120 μm in diameter, and up to 2.5 cm long. Most main branches are arcuate, with fertile branchlets, when present, usually arranged dorsally and secundly (Figs. 4–7). Erect main branches are usually sub-paniculately branched (Fig. 4), whereas creeping ones bear fertile branchlets upwardly and sterile, thin and small branchlets with secondary holdfasts downwardly (Figs. 5–7).

Epidermal cells in surface views of main axes are irregularly polygonal in shape, 17.2–24.3 (mean$\pm$standard deviation: 19.3$\pm$2.7) μm long by 16.6–22.0 (mean$\pm$S.D.: 20.8$\pm$3.5) μm broad, whereas those in the ultimate branchlets are laterally elongated, 6.9–9.7 (mean$\pm$S.D.: 8.3$\pm$1.4) μm long by 15.5–20.9 (mean$\pm$S.D.: 18.2$\pm$2.7) μm broad (Figs. 11 & 12). Epidermal cells in transverse sections of the ultimate branchlets are arranged in transverse sections of the ultimate branchlets are arranged in palisades, elongated radially, 21.5–28.1 (mean$\pm$S.D.: 24.8$\pm$3.3) μm long by 10.2–14.0 (mean$\pm$S.D.: 12.1$\pm$1.9) μm broad (Fig. 14). Secondary pit-connections between epidermal cells are absent (Figs. 11–14), as are lenticular thickenings in the walls of medullary cells (Figs. 13 & 14).

In male plants, ultimate branchlets bearing antheridial depressions are turbinate and usually arranged densely along the outside of arcuate creeping branches (Figs. 4 & 8). Fertile trichoblasts within the antheridial depression become dichotomo-alternately branched, the axial cell row being terminated by a large vesicular cell (Figs. 18 & 19). Spermatangial mother cells are derived from the pericentral cells of each antheridial axial cell and give rise to ovoid spermatangia. Each spermatium contains a large and distinct nucleus at the top (Fig. 19).

Cystocarps are ovoid and situated laterally on fertile branchlets (Figs. 5, 9 & 17).

Stichidial branchlets on tetrasporophytes are wart-like or clavate in shape and usually arise secundly from arcuate creeping branches (Fig. 6). Tetrasporangial initials are cut off abaxially from mother cells which were originally pericentral cells of an axial cell in the stichidial branchlet (Fig. 20). Tetrasporangia are divided tetrahedrally and are confined to the apical part of the stichidium, thus being dispersed at right angles to the axial cell row (Figs. 10 & 12).



Figs. 1–10. *Laurencia surculigera* Tseng.

Fig. 1. Habit of tetrasporangial specimens collected in the vicinity of Marine Biological Station of Nagasaki University, Nomozaki-Machi, Nagasaki Prefecture, Japan, on 15 July 1980.

Fig. 2. Tetrasporangial specimen attached to fragments of broken clay-slate by means of a discoid holdfast (arrow); collected at the same locality as above on 13 July 1976. ×1.

Fig. 3. Close up of one of the above holdfast. ×10.

Fig. 4. Part of a male frond. ×6.

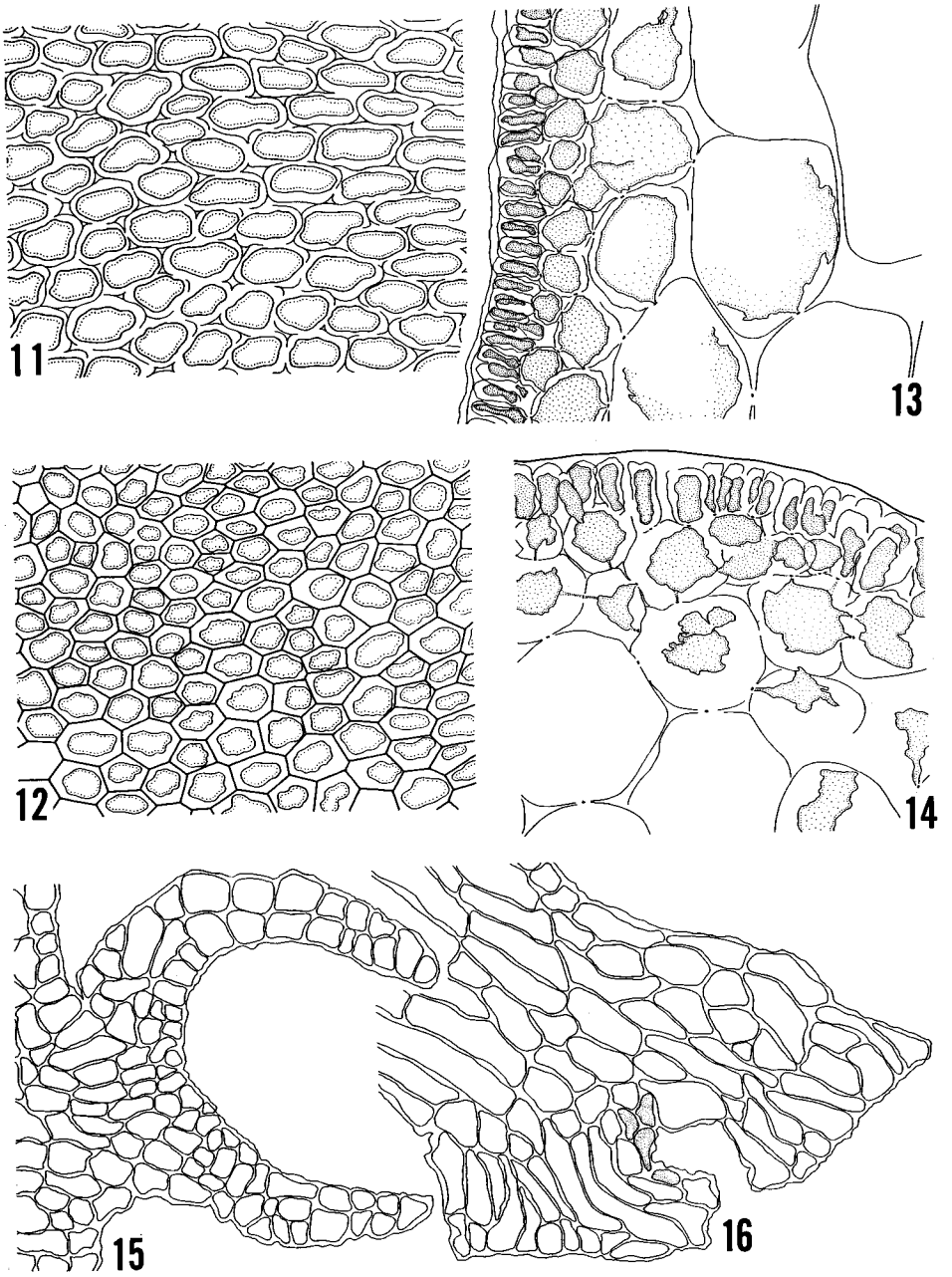
Fig. 5. Part of a cystocarpic frond. ×6.

Fig. 6. Part of a tetrasporangial frond. ×6.

Fig. 7. Part of a tetrasporangial frond showing discoid holdfasts in dark-field. ×5.

Fig. 8. Median longitudinal section through an antheridial receptacle. ×60.

Fig. 9. Median longitudinal section through a ripe cystocarp (cf. Fig. 17). ×60.



Figs. 11–16. *Laurencia surculigera* Tseng.

Fig. 11. Surface view of frond showing the cortical cell arrangement in the apical portion of an ultimate branchlet. ×400.

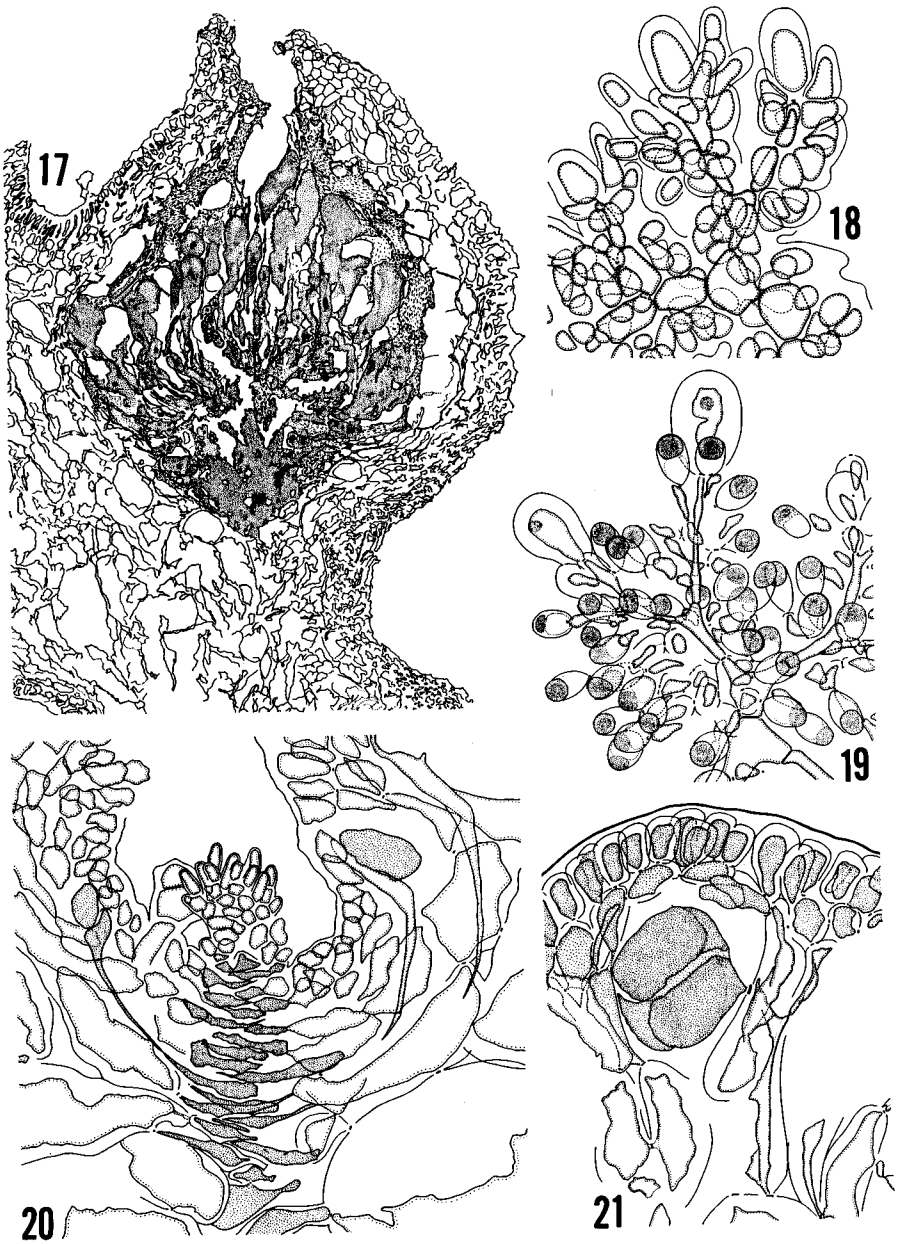
Fig. 12. Surface view of frond showing the cortical cell arrangement in a main branch. ×220.

Fig. 13. Longitudinal section through a branch. ×300.

Fig. 14. Transverse section through a branch. ×360.

Fig. 15. Longitudinal section through a holdfast attached to a terete alga. ×220.

Fig. 16. Longitudinal section through a discoid holdfast attached to clay-slate. ×220.



Figs. 17-21. *Laurencia surculigera* Tseng.
Fig. 17. Longitudinal section through a ripe cystocarp. ×140.
Fig. 18. Apical portion of a young antheridium. ×1200.
Fig. 19. Apical portion of a mature antheridium. ×1200.
Fig. 20. Part of a median longitudinal section through a stichidial branchlet showing a tetrasporangial initial on an elongated pericentral cell. ×360.
Fig. 21. A part of median longitudinal section through a stichidial branchlet, showing a divided tetraporangium near the periphery of the apical surface of a stichidium. ×280.

Discussion

Laurencia surculigera was considered by Tseng (1943) to be a member of the section Palisadae, closely related to *L. perforata* (Bory) Montagne and *L. palisada* Yamada. We agree and in addition, place it in the subgenus *Chondrophycus* on the basis of its lack of secondary pit-connections between each epidermal cell and the right angle arrangement of its tetrrasporangia. Tseng (1943) also compared his Hong Kong specimens with *L. paniculata* J. Agardh, and noted the soft and fleshy texture of both species. We believe that such softness might be due to the young and sterile condition of the Hong Kong specimens.

A distinctive feature of *L. surculigera* is its secondary discoid holdfast (*surculi*), which originate at precise locations on sterile branchlets. There sometimes exists an apical pit-like depression at the central part of discoid holdfast, and the grouped cells containing rich protoplasm at the base of the pits (Fig. 16). We believe that such cells must be degenerating axial cells, because of their position as well as their rich protoplasm. So, the discoid holdfast could be explained that the origin was a regular sterile branchlet.

There are size differences between Japanese populations of *L. surculigera* and the Chinese specimen illustrated by Tseng (1983, pl. 81, fig. 3). However, the Japanese plants otherwise conform well to the type specimen in regard to the highly characteristic secondary adhesive organ.

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