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Shigeo Kawaguchi: The reproductive morphology of *Prionitis articulata* Okamura (Halymeniaceae, Rhodophyta) from Japan

Key Index Words: Carpopeltis articulata—*Halymeniaceae*—Prionitis articulata—*reproductive morphology*—*Rhodophyta.*

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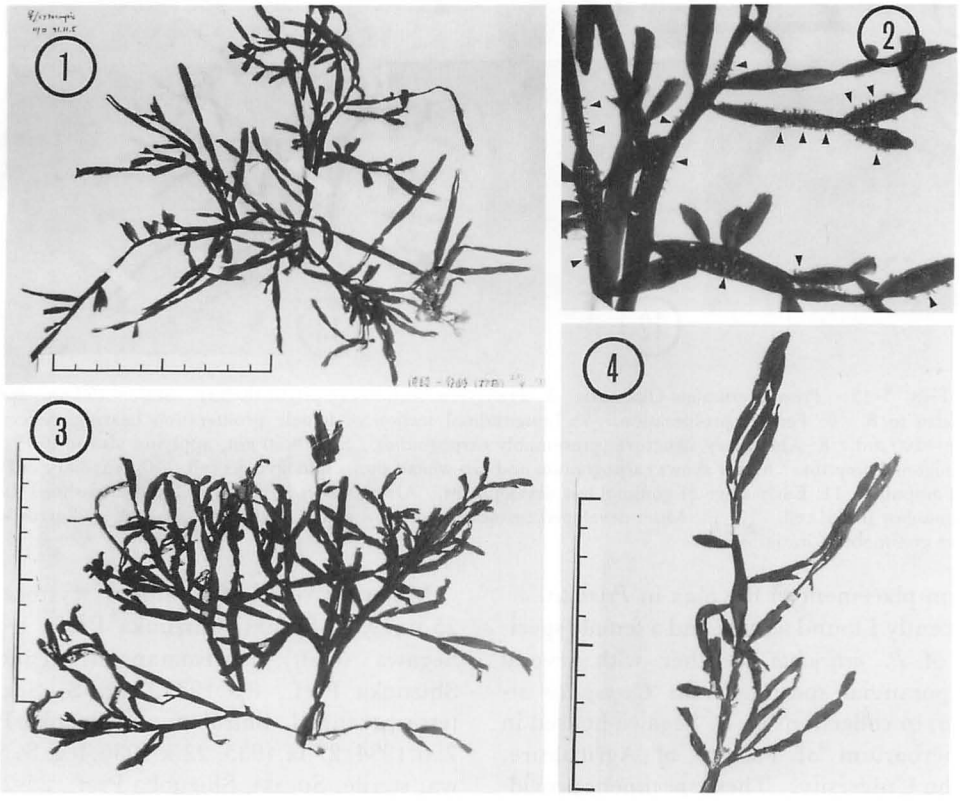
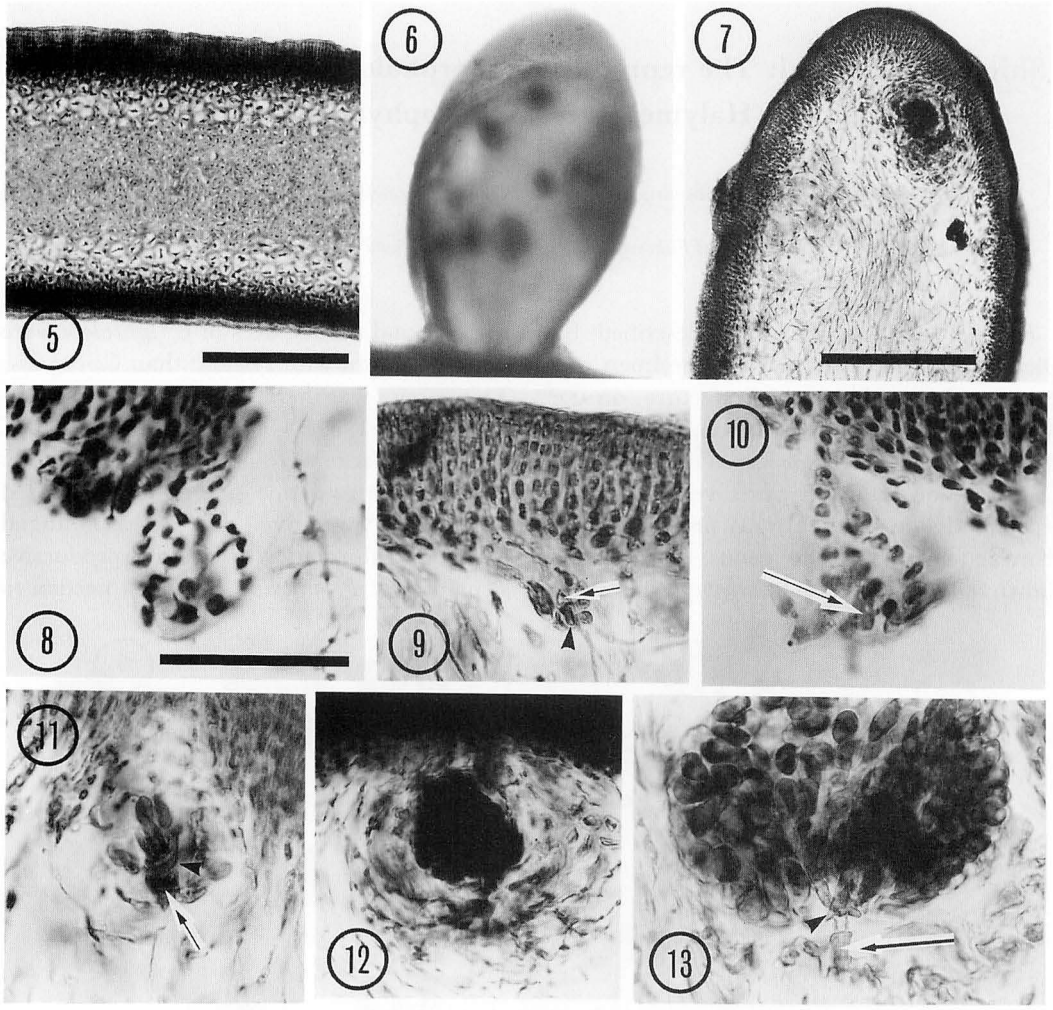
Prionitis articulata was first described by Okamura (1899, P.5.) from a specimen collected at Iragozaki, Aichi Prefecture, on the central Pacific coast of Japan. Okamura (1909) subsequently transferred this species to *Carpopeltis* on the basis of its vegetative and reproductive features. In my previous paper (Kawaguchi 1989), the genus *Prionitis* was shown to be distinct from *Carpopeltis* in several respects and the features of *C. articulata* were more in accord with *Prionitis* than *Carpopeltis*. This species was therefore restored to *Prionitis* (Kawaguchi 1989). However, due to its rarity, sexual plants were not available for study at that time and my discussion was based solely on vegetative and tetrasporangial features. Information on sexual reproductive structures of *P. articulata* has been needed to



Figs. 1–4. Herbarium specimens of *Prionitis articulata* Okamura collected by S. Segawa and deposited in the Herbarium, Faculty of Agriculture, Kyushu University. Scale=10 cm. 1: Female specimen collected at Susaki on 25 September 1935. 2: Magnification of Fig. 1. Arrowheads show minute reproductive proliferations. 3: Tetrasporangial specimen collected at Shirahama on 22 October 1936. 4: Male specimen collected at Tanoura on 8 October 1935.

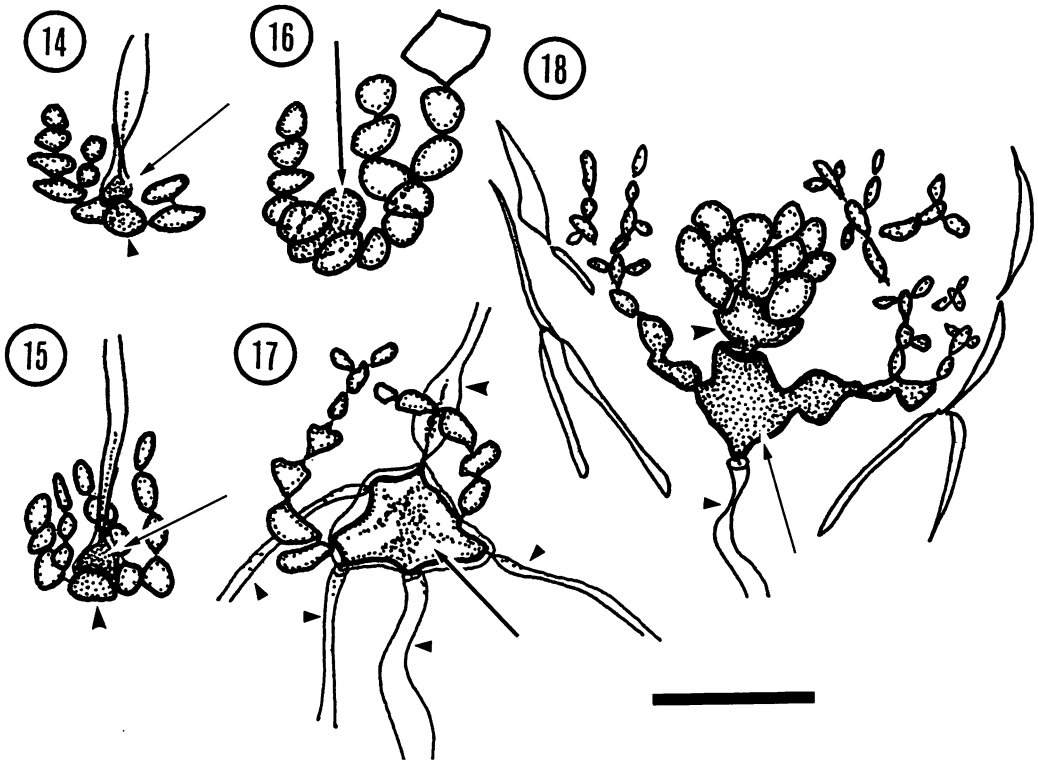


Figs. 5–13. *Prionitis articulata* Okamura. 5: Transverse section of upright thallus. Scale=150 μm, applying also to 6. 6: Female proliferation. 7: Longitudinal section of female proliferation bearing cystocarp. Scale=100 μm. 8: Ampullary structure (presumably carpogonial). Scale=50 μm, applying also to 9–13. 9: Carpogonial ampulla. Arrow shows carpogonium and arrowhead shows hypogynous cell. 10: Auxiliary cell (arrow) ampulla. 11: Early stage of gonimoblast development. Arrow shows auxiliary cell and arrowhead shows gonimoblast initial cell. 12, 13: More developed cystocarps. Arrow shows auxiliary fusion cell and arrowhead shows gonimoblast initial cell.

confirm placement of the alga in *Prionitis*.

Recently I found a male and a female specimen of *P. articulata* together with several tetrasporangial specimens (as *Carpopeltis articulata*) in collections by S. Segawa housed in the herbarium of Faculty of Agriculture, Kyushu University. These specimens provided the opportunity to describe sexual reproductive features of *P. articulata* for the first time and to make additional observations on vegetative and tetrasporangial structures.

Materials used for study: cystocarpic, 25.ix.1935, Susaki, Shizuoka Pref., leg. S. Segawa (drift); spermatangial, Tanoura, Shizuoka Pref., 8.x.1935, leg. S. Segawa; tetrasporangial, Shirahama, Shizuoka Pref., 7.xi.1934, 27.ix.1935, 22.x.1936, leg. S. Segawa; sterile, Susaki, Shizuoka Pref., 25–27.iii, 30.xi, 1935, leg. S. Segawa; sterile, Shirahama, Shizuoka Pref., 7.ix.1934, leg. S. Segawa; sterile, Tanoura, Shizuoka Pref., ii.1938, leg. S. Segawa.



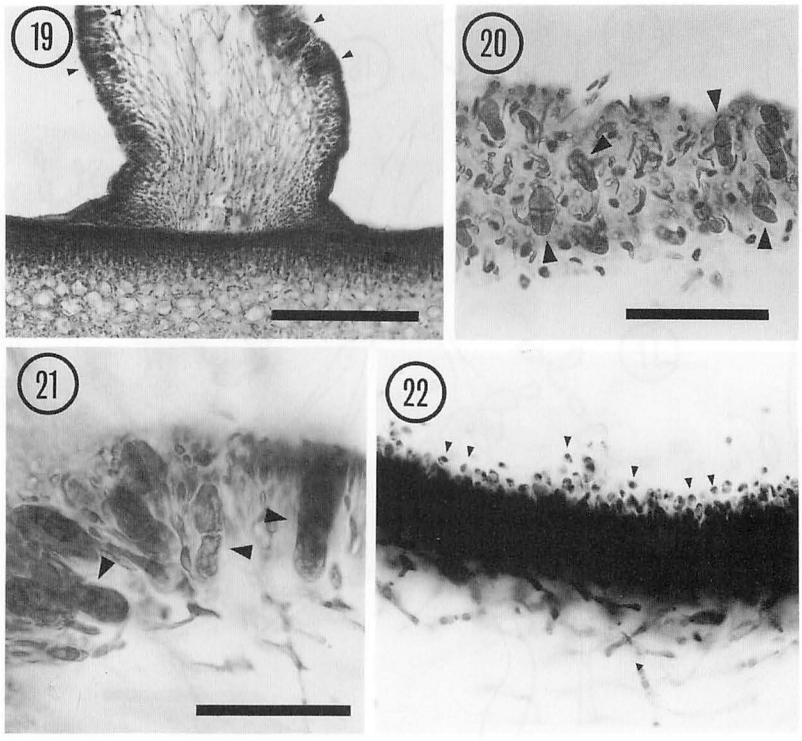
Figs. 14–18. *Prionitis articulata* Okamura. Scale=200 μm. 14, 15: Carpogonial ampulla. Arrow shows capogonium and arrowhead shows hypogynous cell. 16: Auxiliary cell (arrow) ampulla. 17: Production of connecting filaments (small arrowhead) from carpogonial fusion complex (arrow) with trichogyne (large arrowhead). 18: Cystocarp development. Arrow shows auxiliary fusion complex with connecting filament (small arrowhead) and large arrowhead shows gonomoblast initial. Note that lateral filaments are produced from ampullary cells.

Hand sections were made with a razor blade from small pieces excised from the dried specimens and resoaked in seawater. Sections were stained with a 0.5% cotton blue solution (Kawaguchi and Masuda 1984) and mounted in a glycerol/seawater mixture. Microscope slides used for study are held by the author.

The fertile specimens used in this study were 8–20 cm long. Several upright thalli developed from a scutate holdfast, each having a short terete stipe to 3–4 mm long. Upright thalli are compressed throughout, and are repeatedly articulated into cuneate or ellipsoid segments, 1–5 cm long × 3–5 mm wide. Branching is di-or trichotomous, or irregularly proliferous from the margin or the surface of the thallus, occasionally giving rise to a very entangled appearance (Figs. 1, 3, 4).

The upright thallus is up to 500 μm thick in section and consists of a compact cortex and a dense filamentous medulla. The outer cortex consists of small, isodiametric cells tightly arranged in anticlinal rows 7 to 8 cells deep. This layer connects to an inner layer of larger, polygonal to rounded cells, also tightly packed and connected laterally by secondary pit-connections. The medulla consists of densely interwoven filaments and occupies about one third of the thallus (Fig. 5).

Male and female reproductive structures are confined to minute reproductive proliferations, as are tetrasporangia (Figs. 6, 7). These proliferations develop from the surfaces or the margins of the thalli in the upper portion of a plant (Fig. 2). The male proliferations are spindle-shaped, 400–500 μm wide × 700–800 μm long. The female proliferations are spindle-shaped or occasionally slightly compressed, 750–900 μm wide × 800–



Figs. 19–22. *Prionitis articulata* Okamura. 19: Longitudinal section of tetrasporangial proliferation through vegetative segment. Arrowhead shows tetrasporangium. Scale=200 μm. 20: Tetrasporangia (arrowhead) scattered in the proliferation. Scale=100 μm. 21: Tetrasporangium (arrowhead) formation. Scale=50 μm, applying also to 22. 22: Spermatium (arrowhead) formation.

1100 μm long (Fig. 6). The tetrasporangial proliferations are circular in outline, 1000–1300 μm wide × 1200–1400 μm long × 250–300 μm thick (Fig. 19). The medullary filaments of reproductive proliferations are more laxly arranged than in vegetative segments (Figs. 7, 19).

Spermatangia are formed from outermost cortical cells, and are 4–5 μm long × 2–3 μm wide (Fig. 22). Carpogonial branches and auxiliary cells are separately formed in ampullary cell clusters (Figs. 8–10, 14–16). Carpogonial ampullae were rare in the specimen at hand, but a carpogonial branch was observed to consist of a carpogonium and a hypogynous cell (Figs. 9, 14, 15). Auxiliary cell ampullae were common and sparingly branched to the second order (Figs. 10, 16). Auxiliary cells are slightly larger than other ampullary cells and are centrally located in the bottom of the ampulla (Fig. 16). After putative fertilization, several connecting filaments are cut off from a large cell, presumably a carpogonial fusion complex (Fig. 17). A connecting filament fuses with an auxiliary cell which subsequently produce gonimoblasts toward the thallus surface (Figs. 11, 18). Whether the connecting filament ceased to grow at the fusion point or further grew to another auxiliary cell was not ascertained in the specimen at hand. During gonimoblast development ampullary cells produce lateral filaments (Fig. 18). Mature cystocarps are reniform to rounded, 120–150 μm in diameter, and deeply submerged in the medulla (Figs. 12, 13). Pericarps are scarcely evident in the mature cystocarps (Fig. 13). Tetrasporangia are scattered in the proliferations (Figs. 20, 21) and are narrowly ellipsoidal, 40–50 μm long × 10–15 μm wide.

The presence of carpogonial branches and auxiliary cells within separate ampullary cell

clusters clearly places *P. articulata* within the Halymeniaceae (Chiang 1970). As discussed in my previous paper (Kawaguchi 1989), *Prionitis* is characterized by a combination of the following features: 1) rigid, cartilaginous thalli, 2) compact cortical and medullary layers, 3) absence of refractive medullary cells, 4) confinement of reproductive structures to distal segments and/or to proliferations. Vegetative features and the presence of minute tetrasporangial proliferations of *P. articulata* were consistent with this circumscription and the species was therefore placed in this genus (Kawaguchi 1989). The present study has confirmed that spermatangia and cystocarps are also confined to minute reproductive proliferations, and that auxiliary cells are formed in sparingly branched ampullae. The last feature is not exclusive to *Prionitis* within this family, but is considered to be a distinctive reproductive feature of this genus (Chiang 1970). *P. articulata* is therefore confirmed as a typical member of *Prionitis* on the basis of both vegetative and reproductive features.

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References

Chiang, Y. M. 1970. Morphological studies of red algae of the family Cryptonemiaceae. Univ. Calif. Publs. Bot. **58**: 1–95.

Kawaguchi, S. 1989. The genus *Prionitis* (Halymeniaceae, Rhodophyta) in Japan. Journ. Fac. Sci., Hokkaido Univ. Ser. V (Botany) **14**: 193–257.

Kawaguchi, S. and Masuda, M. 1984. The identity of *Gigartina prolifera* Hariot (Rhodophyta). Jap. J. Phycol. **32**: 227–233.

Okamura, K. 1899. Contributions to the knowledge of the marine algae of Japan. III. Bot. Mag. Tokyo **13**: 2–10, 35–43.

Okamura, K. 1909. Icones of Japanese Algae II (3, 4). Tokyo.

川口栄男：フシキントキ（紅藻，ムカデノリ科）の生殖器官

これまで栄養体と四分胞子体についてのみ記載されていたフシキントキ *Prionitis articulata* Okamura の雌雄生殖器官の観察を，九州大学農学部に保存されている標本に基づいて行なった。本種の雌雄生殖器官は，四分胞子嚢と同様，藻体表面及び縁辺から生じる微小な生殖のための副枝 (minute reproductive proliferation) に形成される。造果枝と助細胞は離れてフラスコ状の細胞糸 (ampulla) 内に生じ，助細胞 ampulla はまばらに分枝する。

これらの特徴は，本種がまちがいなくムカデノリ科に属し，栄養体の構造と四分胞子嚢の形成位置により本種をキントキ属の種であるとした見解（川口 1989）を，雌性生殖器官の点からも支持することを示す。（812 福岡市東区箱崎 6 丁目　九州大学農学部水産学第二教室）

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