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Notes on *Odonthalia kamtschatica* (RUPRECHT) J. AGARDH (Ceramiales, Rhodophyta)[1]

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Odonthalia kamtschatica (RUPRECHT) J. AGARDH (Rhodomelaceae, Ceramiales) is described and illustrated on the basis of specimens recently collected near the type locality. Tetrasporangia are borne on penultimate and ultimate orders of narrow lateral branches and proliferations. Two tetrasporangia are produced in each of 4–16 successive segments of these branches, including one or two segments congenitally fused to the parent axis. These features clearly distinguish *O. kamtschatica* from other costate species with which it has often been confused, and ally it with *O. yamadae* MASUDA, which is suggested to be a vicariant species.

Key Index Words: Kamchatka—Odonthalia—Odonthalia kamtschatica—*Rhodomelaceae*—*Rhodophyta*—*taxonomy.*

The red alga *Odonthalia kamtschatica* (RUPRECHT) J. AGARDH (Rhodomelaceae, Ceramiales) was originally described by RUPRECHT (1850) as *Atomaria kamtschatica* on the basis of specimens collected at Petropavlovsk, Avacha Bay, on the eastern Kamchatka Peninsula. It was transferred to *Odonthalia* by J. AGARDH (1863). Since then, it has been reported from various localities of the north Pacific (SETCHELL and GARDNER 1903; COLLINS 1913; KYLIN 1925; OKAMURA 1932, 1936; TOKIDA 1934, 1950, 1954; YAMADA and TANAKA 1944; SCAGEL 1957; CHIHARA 1967; WIDDOWSON 1974; SCAGEL *et al.* 1986). Although RUPRECHT's description of cystocarpic plants is clear, this species has been confused with other species of *Odonthalia* as discussed by MASUDA and YAMADA (1981).

Further studies based on the cystocarpic lectotype specimen (MASUDA 1981a; MASUDA and YAMADA 1981) have amplified the original description. In this paper, we describe and illustrate tetrasporangial plants for the first time based on recent collections near the type locality. The characteristic features of *Odonthalia kamtschatica* are discussed and compared with several related species.

Materials and Methods

Specimens were collected at four localities in Avacha Bay: Cape Seroglazka (53°02′42″N, 158°35′30″E, vegetative, May 24, 1984, leg. V.I. STRELKOV); Cape Kazak (52°57′40″N, 158°27′30″E, tetrasporangial, May 6, 1988, leg. A.G. BAZHIN); Stones Tri Brata (52°54′00″N, 158°42′02″E, vegetative, September 15, 1987, leg. A.G. BAZHIN); and Vilyuchinskaya Harbor (52°38′35″N, 158°25′32″E, tetrasporangial, May 2, 1988, leg. N.G. KLOCZCOVA; tetrasporangial and cystocarpic, May 4, 1988, leg. N.G. KLOCZCOVA). *Odonthalia kamtschatica* grows abundantly on rocks at 3–12 m depth in Avacha Bay.

The exterior morphology of dried herbarium specimens was studied with a dissect-

[1] Dedicated to the memory of the late Dr. Munenao KUROGI (1921–1988), Professor Emeritus of Hokkaido University.

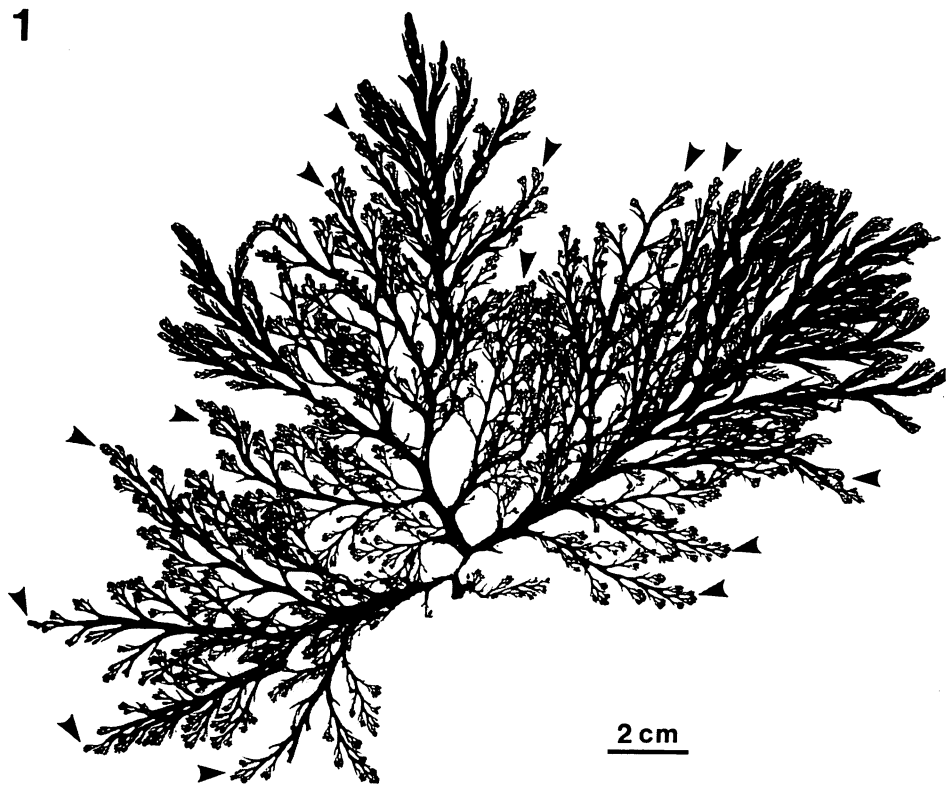


Fig. 1. First-year tetrasporangial specimen of *Odonthalia kamtschatica* with broad vegetative branches and narrow reproductive branches (arrowheads) collected at Cape Kazak, Avacha Bay, eastern Kamchatka on May 6, 1986.

ing microscope. For microscopic examination of anatomical structure, portions were removed, preserved in 70% ethyl alcohol and sectioned by hand using a razor blade and pith stick.

Voucher specimens are deposited in the herbaria of Faculty of Science, Hokkaido University, Sapporo (SAP) and the Kamchatka Department of Environment, Pacific Institute of Geography, Petropavlovsk-Kamchasky.

Observations

Several upright thalli, 8–19 cm high and dark red in color, arise from a common basal disc. Each thallus is monopodial and branched in an alternate-distichous manner (Fig. 1). The main axis is terete just above the basal disc and 0.8–1.6 mm in diameter, becoming immediately compressed above. It is broader at the point of insertion of lateral branches, attaining a width of 2.5–3.3 mm at non congenitally-fused area with its laterals in the lower and middle portions.

The majority of first-order branches are indeterminate, up to 6–12 cm long, and are divided into progressively shorter branches to 5–6 orders. The proximal one or two branches of 2–5 orders remain unbranched. Proliferations are formed from the margins of the main axis. Those initiated in axils formed by the main axis and injured first-order branches resemble indeterminate first-order branches, but have terete bases rather than the flattened bases characteristic of ordinary lateral branches. Many narrow reproductive proliferations develop on the perennating main axes of second-year thalli (Fig. 2).

Midribs are visible on the lower to upper portions of the main axis (Figs. 3–6) and on the lower to middle portions of well-developed

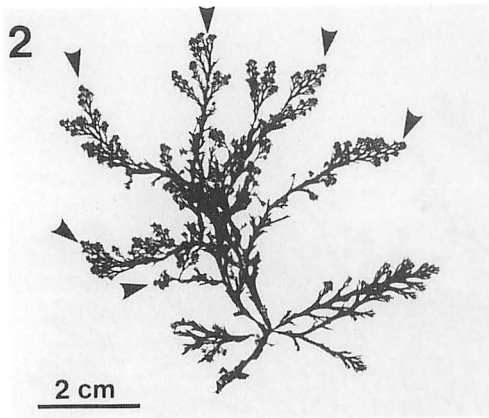
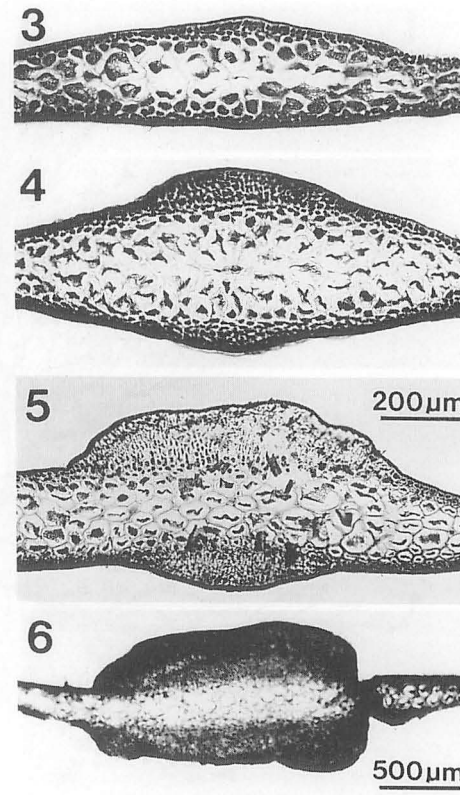


Fig. 2. Second-year tetrasporangial specimen of *Odonthalia kamtschatica* with many reproductive proliferations (arrowheads) collected at Vilyuchinskaya Harbor, Avacha Bay on May 2, 1988.



Figs. 3–6. Cross sections of a main axis of *Odonthalia kamtschatica* collected at Stones Tri Brata, Avacha Bay on September 15, 1987, showing development of a midrib: 3, upper portion; 4, 5, middle portion; 6, lower portion. Scale in Fig. 5 applies also to Figs. 3 and 4.

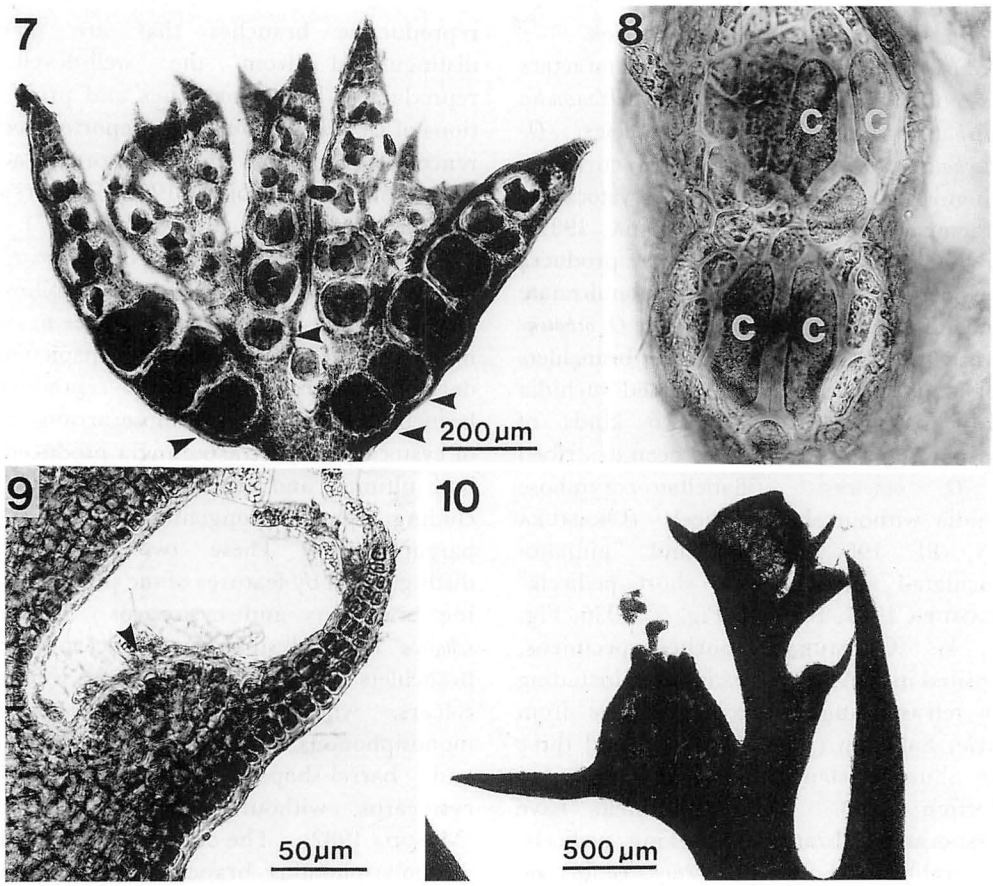
first-order branches and proliferations. Midribs are produced by successive divisions of cortical cells, and do not develop equally on both sides (Figs. 4, 5). They appear on only one side of the upper portion of the main axis (Fig. 3) and the middle portion of first-order branches and proliferations.

Penultimate and ultimate branches of narrow lateral branches (Fig. 1) produce tetrasporangia (Fig. 7). Tetrasporangia are also formed on penultimate and ultimate branches of proliferations less than 5 mm in length and on longer, narrow proliferations (Fig. 2). Tetrasporangial branches are arranged entirely in an alternate-distichous manner and are compressed, 650–1800 μm long and 180–240 μm wide. Two tetrasporangia are produced in each of 4–16 successive segments of the branches, including one or two segments congenitally fused with the parent axis (Fig. 7). Each sporangium is provided with two cover cells (Fig. 8). Tetrahedrally divided sporangia are 120–170 μm in diameter.

Procarp-bearing branchlets and cystocarps are arranged on narrow branches and short proliferations in a flexuose-racemose manner. Procarp-bearing branchlets are polysiphonous (Fig. 9). As cystocarps form, distal sterile segments of these branchlets develop into long calcars (Fig. 10). Maturing cystocarps are urceolate and have elevated necks; fully mature cystocarps have not been observed. Cystocarps examined are 700–900 μm long by 580–750 μm wide and with 280–800 μm long calcars (Fig. 10).

Discussion

Our observations of polysiphonous procarp-bearing branchlets and urceolate cystocarps with long calcars are identical with earlier reports based on the lectotype specimen of *Odonthalia kamtschatica* (MASUDA 1981a; MASUDA and YAMADA 1981). Our study confirms that tetrasporangia are also borne on narrow reproductive branches (similar to those of cystocarpic plants) that are distinctly different from the broader vegetative



Figs. 7–10. Reproductive structures of *Odonthalia kamtschatica* collected at Vilyuchinskaya Harbor, Avacha Bay on May 2, 1988 (7, 8) and May 4, 1988 (9, 10): 7, tetrasporangial branches, note tetrasporangia being formed at the congenitally-fused area between the axis and ultimate laterals (arrowheads); 8, two segments of a tetrasporangial branchlet, showing cover cells (c) (the tetrasporangia being out of focus); 9, polysiphonous procarpial branchlet, note the procarp-bearing segment being shown by an arrowhead; 10, two cystocarps with well-developed calcars. Scale in Fig. 9 applies also to Fig. 8.

branches characteristic of this species.

In second-year plants, the broad main axes are eroded and overgrown by proliferous reproductive branches. These thalli, composed of narrow proliferations (Fig. 2, Tokida 1934, Pl. V), are sufficiently different from first-year plants to cause confusion as to their identity. Nevertheless, proliferations have terete bases in contrast with the compressed bases of ordinary lateral branches, so that thalli composed chiefly of narrow reproductive proliferations can be identified as perennating individuals of *O. kamtschatica*.

At present, twelve species have been described in the genus *Odonthalia* (Masuda 1982). They are divided into two groups, depending on the presence or absence of midribs. *Odonthalia kamtschatica* is included in the costate group together with the following seven species: 1) *O. dentata* (Linnaeus) Lyngbye, the type species, 2) *O. kawabatae* Masuda, 3) *O. lyallii* (Harvey) J. Agardh, 4) *O. ochotensis* (Ruprecht) J. Agardh, 5) *O. setacea* (Ruprecht) Perestenko, 6) *O. washingtoniensis* Kylin and 7) *O. yamadae* Masuda. Although these species can be distinguished by reproductive features (Masuda 1982), it is often difficult to distinguish species on the basis of vegetative features alone. Hence, non-reproductive

specimens of *O. kamtschatica* have been confused with other closely related species.

We can now use tetrasporangial characters for a more complete comparison of *Odonthalia kamtschatica* with other costate species. *O. kamtschatica* and *O. ochotensis* are currently distinguished on the basis of cystocarpic characters (MASUDA and YAMADA 1981). Our results show that *O. kamtschatica* produces tetrasporangia on ultimate and penultimate branches, whereas tetrasporangia in *O. ochotensis* are restricted to ultimate branchlets (RUPRECHT 1850), i.e. well-defined stichidia with constricted bases. Two kinds of tetrasporangial branches have been described for *O. ochotensis*: "flabellato-corymbose stichidia without short pedicels" (OKAMURA 1923, Pl. 196, Fig. 4) and "pinnato-fasciculated stichidia with short pedicels" (OKAMURA 1923, Pl. 196, Fig. 5; 1936, Fig. 422, 4). OKAMURA's voucher specimens, deposited in SAP, were examined, including four tetrasporangial specimens: one from Chirie, Sakhalin (June 15, 1912) and three from Shumsh Island, the north Kuriles (no collection date). These specimens have tetrasporangial branchlets lacking pedicels, comparable to those of *O. kamtschatica*; no specimens with pedicellate tetrasporangial stichidia are present. We believe that OKAMURA's original description was based on collections composed of more than one species, one of which is *O. kamtschatica.*

Specimens of *Odonthalia setacea* and *O. lyallii* can be distinguished from those of *O. kamtschatica* by their monosiphonous procarp-bearing branchlets, ecalcarate cystocarps and tetrasporangial stichidia with constricted bases (MASUDA 1981a; MASUDA and MILLER, unpublished), although these species are all similar to one another vegetatively.

Odonthalia kawabatae, with its narrow thalli, broadly ovoid cystocarps, and well-defined tetrasporangial stichidia (MASUDA 1981b), is readily distinguished from *O. kamtschatica.* Fertile specimens of *O. dentata* (NEWTON 1931; MASUDA and YAMADA 1981) and *O. washingtoniensis* (SETCHELL and GARDNER 1903, as *O. semicostata*; MASUDA and YAMADA 1981) possess minute axillary or marginal reproductive branches that are readily distinguished from the well-developed reproductive lateral branches and proliferations of *O. kamtschatica.* The reported occurrence of *O. dentata* in the North Pacific (RUPRECHT 1850; TOKIDA 1954; PERESTENKO 1977) is questionable (LINDSTROM 1977).

Odonthalia kamtschatica and *O. yamadae* are closely related and have the following vegetative and reproductive features in common: 1) large, broad thalli, 2) conspicuously developed midribs, 3) narrow reproductive branches, 4) flexuose-racemose arrangement of cystocarps, 5) tetrasporangia produced on both ultimate and penultimate branches, including segments congenitally fused to the parent axis. These two species are distinguished by features of the procarp-bearing branchlets and cystocarps. *O. kamtschatica* has polysiphonous procarp-bearing branchlets and urceolate cystocarps with long calcars, whereas *O. yamadae* possesses monosiphonous procarp-bearing branchlets and barrel-shaped or broadly ovoid cystocarps without conspicuous calcars (MASUDA 1982). The occurrence of procarps on polysiphonous branchlets is considered a primitive feature in the family Rhodomelaceae (HOMMERSAND 1963; MASUDA 1982). The distributional range of *O. kamtschatica* extends from the Kamchatka Peninsula through the middle Kuriles to Sakhalin (MASUDA and YAMADA 1981). As pointed out by WIDDOWSON (1974), records of its occurrence on the east coast of the North Pacific (SETCHELL and GARDNER 1903; COLLINS 1913; KYLIN 1925; SCAGEL 1957; SCAGEL *et al.* 1986) need verification. On the other hand, the present known range of *O. yamadae* is narrowly restricted to the eastern coast of Hokkaido (MASUDA 1982). The monosiphonous procarp-bearing branchlets of *O. yamadae* may be a derived character associated with its vicariant speciation from the more broadly distributed and primitive *O. kamtschatica* to the south.

Acknowledgments

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増田道夫*・Olga N. SELIVANOVA**：紅藻カムチャツカノコギリヒバ (イギス目フジマツモ科) について

基準標本産地の近くから最近採集された標本に基づいて，紅藻カムチャツカノコギリヒバ *Odonthalia kamtschatica* (RUPRECHT) J. AGARDH の形態的特徴の記載と図示を行った。四分胞子嚢は栄養枝よりも幅の狭い生殖枝と副枝の最末小枝と末位から二番目の枝に，4–16節連続して二列に形成される。四分胞子嚢枝の基部はくびれず，最末小枝の場合には軸と癒合している1–2節にも四分胞子嚢を生じる。これらの特徴は，今まで本種と混同されてきた他の中肋を持つノコギリヒバ属の種から，本種を明瞭に区別し，アッケシノコギリバ *O. yamadae* MASUDA との近い類縁を示している。(*060 札幌市北区北10条西8丁目　北海道大学理学部植物学教室・**Kamchatka Department of Environment, Pacific Institute of Geography, Far East Science Branch, Academy of Sciences of the USSR, Petropavlovsk-Kamchasky, 683000, USSR)