

Re-examination of the Type of *Delesseria kurilensis* Ruprecht (Delesseriaceae, Rhodophyta)

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Evidence is presented to demonstrate that the type of *Delesseria kurilensis* Ruprecht belongs to *Congregatocarpus* rather than *Tokidadendron* (both genera of the red algal family Delesseriaceae), and the new combination of *Congregatocarpus kurilensis* (Ruprecht) M.J. Wynne is proposed.

Key Words: *Congregatocarpus*, *Delesseria kurilensis*, Delesseriaceae, marine algae, Rhodophyta, taxonomy, *Tokidadendron*

INTRODUCTION

The status of *Delesseria kurilensis* Ruprecht (1850, 1851) has long remained uncertain. J. Agardh (1872, 1876, 1898) did not refer to it in his three treatments of the red algal family Delesseriaceae. De Toni (1900) did not recognize *D. kurilensis* but referred to the name under his discussion of *Yendonia* [*Delesseria*] *crassifolia* (Ruprecht) Kylin. Kylin (1924) did not mention the name *Delesseria kurilensis* in his monographic treatment of the family. Sinova (1954) treated *D. kurilensis* as a taxonomic synonym of *Yendonia* [*Delesseria*] *crassifolia* (Ruprecht) Kylin, which was followed by Wynne (1970). Finally, Perestenko (1983) proposed that it belonged to the genus *Tokidadendron* M.J. Wynne (Wynne 1970), and she made the transfer, *T. kurilense* (Ruprecht) Perestenko. However, even then it was not described in any detail nor depicted in her publication. She transferred it to that genus and treated the type of *Tokidadendron*, *T. bullatum* (N.L. Gardner) M.J. Wynne as a later taxonomic synonym.

MATERIALS AND METHODS

A number of herbarium specimens were examined in this study, and they are listed below. Herbarium abbreviations follow Holmgren *et al.* (1990).

***Delesseria kurilensis* Ruprecht. Holotype in LE. Urup [Uruppu] Island, Kuril Islands.**

***Congregatocarpus pacificus* (Yamada) Mikami [to become *Congregatocarpus kurilensis*]**

Isotype (of *Pseudophycodrys pacifica* Yamada) in MICH (Kushiro, Hokkaido, Japan: August, 1924, leg. Y. Yamada, distributed as "*Delesseria crassifolia* Rupr."

Isotype also in UC (UC 280021)

RUSSIA. Kuril Islands. Zelyonyj (Green) Island: 20.vi.1964, leg. V. Drobyshev, 15.5 m (MICH). Sakhalin. 5 km from Popov Cape: 28.vii.1974, leg. L. Perestenko, cast up (MICH). Sakhalin. west coast, Antonova: 28.vii.1963, leg. A. Gruzov, 6.5-7.5 m, rocky bottom (MICH). Sakhalin. Gastello settlement, Poronajsk region: 19.vii.2002: 19.vii.2002, leg. D. Koryakov N27, cast up (MICH). Sakhalin. Grebenskaya settlement, Makarov region: 21.vii.2002, leg. D. Koryakov N50, sublittoral (MICH); 7.viii.2002, leg. A.G. Johnson (MICH). Sakhalin. Poronajsk City, Poronajsk region: 14.vii.2002, leg. D. Koryakov N15 and N33, cast up (MICH). Sakhalin, Sea of Okhotsk: 3.viii.1993, leg. N. Klochkova, sublittoral, cystocarpic (MICH). Sakhalin. Kombumori: viii.1925, leg. J. Tokida, cystocarpic (UC).

JAPAN. Mitsuishi, Hokkaido: viii.1924, leg. Y. Yamada (UC). Nossapu, Hokkaido: 16.viii.1966, leg. M. Yoshizaki 8-087, cystocarpic (MICH). Samani, Hidaka Province: 15.ii.1973, leg. H. Mikami, tetrasporic (MICH). Urakawa, Hidaka Province: 23.ix.1971, leg. H. Mikami, cystocarpic

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(MICH). Kiritappu, Nemuro: x.1971, leg. H. Mikami, cystocarpic (MICH). Muroran, Hokkaido: viii.1958, leg. I. Shihira 31726, 31788 [distributed as "*Phycodrys fimbriata* (De la Pylaie) Kylin"] (MICH).

ALASKA, USA. East Cape, Buldir Island, Aleutians: 20.vi.1974, leg. M. Dick, epiphytic on *Laminaria longipes* (AKA).

***Tokidandron kurilense* [to become *Tokidadendron bullatum*]**

ALASKA, USA. south shore of Shemya Island, Aleutian Islands: 28.,viii.1949, leg. J. Jordal 2795 (MICH). St. Makarius Bay, Amchitka Island, Aleutian Islands: 12.iii.1968, leg. M. Wynne 1282, mid-littoral, tetrasporic (MICH); 16.iii.1968, leg. M. Wynne 1364, tetrasporic (MICH); 13.viii.1970, leg. M. Wynne AM 565 (MICH). Duck Cove, Amchitka Island, Aleutian Islands: 23.x.1972, leg. P. Lebednik AM 1257 (MICH). Chitka Point, Amchitka Island, Aleutian Islands: 15.viii.1970, leg. M. Wynne AM 523 (MICH). Silver Bay, near Sitka: 31.vii.1980, leg. M. Wynne 5235 (MICH). Three Entrance Bay, near Sitka: 25.vii.1980, leg. M. Wynne 5215 (MICH). East side of Hecata Island, south Sea Otter Sound: 9.viii.1980, leg. M. Wynne 5379 (MICH). Halibut Point, Sitka: 26.vii.1980, leg. M. Wynne 5027, lower littoral (MICH). Pirates Cove, midway between Sitka and Cape Baranof: 28.vii.1980, leg. M. Wynne 5107, attached, (MICH). Zaikof Bay, at NE end of Montague Island: 26.iv.1975. cystocarpic, distributed by University of Alaska Herbarium (MICH). Kuluk Bay, Adak Island, Aleutian Islands: 2.ix.1972, leg. P. Lebednik AD 1055, intertidal (MICH). South Beach, Attu Island, Aleutian Islands: 16.v.1992, leg. D. Guthrie 193, shallow subtidal (MICH), 4.vi.1992, leg. D. Guthrie 721, shallow subtidal (MICH). Unalaska Island, Aleutian Islands: 8.v.1932, leg. W. Eyerdam, tetrasporic (MICH).

RUSSIA. Bering Island, Commander Islands: 27.vi.1972, leg. T. Zakhodnova (MICH); 13.ix.1986, leg. O. Selivanova (MICH). Staraya Gavan Bay, Bering Island: 6.ix.1988, leg. Goriyanina, cast up (MICH). Sea of Japan. Olga Inlet: summer, 1986, leg. N. Klochkova (MICH).

JAPAN. Kiritappu, Nemuro: 10.iv.1970, leg. H. Mikami, tetrasporic and cystocarpic (MICH).

RESULTS

An examination of the type specimen of *Delesseria kurilensis* in LE has shown it to be a very robust, coarse specimen (Fig. 1), with an overall height of 16 cm, branched to the second order. The erosion of the lamina

of the primary blade and also partly in that of secondary blades leaves behind broad midribs 3-5 mm in width. Thus, after erosion of the blades, the persistent midribs become the primary and secondary axes. Branches arise from the midribs of the parent blade. The blades of the second order of branching are 20-30 mm in width. Blades are mostly polystromatic with prominent lateral venation. Veins are often oppositely placed. The specimen is sterile

This aspect in the type specimen of *Delesseria kurilensis* (Fig. 1) is very similar to the appearance of the type specimen of *Pseudophycodrys pacifica* Yamada as seen in pl. II of Yamada (1930). Specimens of *Congregatocarpus pacificus* in MICH have been examined and compared with the type specimen of *Delesseria kurilensis*. Dr. Michio Masuda of SAP has informed me (via email, 8.vii.2005) that the type locality of *Pseudophycodrys pacifica* is Kushiro, eastern Hokkaido, Japan, and that the type specimen (SAP 8043) was collected from Kushiro in August 1924 by Y. Yamada. A specimen in MICH (Fig. 2), originally identified and distributed as "*Delesseria crassifolia* Rupr." by Yamada, is an isotype. In his initial identification and distribution of this alga as "*Delesseria crassifolia*", Yamada was following the determination of this species by Okamura (1921). But later Yamada (1930) stated that he had been able to examine "cotype specimen" of *Delesseria crassifolia* Ruprecht in Harvey's herbarium (in TCD, Dublin). Yamada then appreciated that the specimens in "the northern parts of Japan" that had been referred to "*Delesseria crassifolia*" [currently *Yendonia crassifolia* (Ruprecht) Kylin] were "quite different in habit from Ruprecht's specimen, having a much more robust frond". He proceeded to describe his Japanese material as the new species *Pseudophycodrys pacifica*. He later transferred it to *Laingia* (Yamada 1932) after Kylin advised him of its resemblance to *Laingia hookeri* (Lyll ex Harvey) Kylin of New Zealand (Kylin 1929). Some years later this species was made to serve as the type of the new genus *Congregatocarpus* (Mikami 1971a). Zinova (1972), without knowledge of Mikami's establishment of *Congregatocarpus* the previous year, also described a new genus, *Okamurina*, based on *Pseudophycodrys pacifica* Yamada (1930). [Zinova (1972) actually cited the later *Laingia pacifica* (Yamada) Yamada (1932).] This Yamada-collected specimen (Fig. 2), in its habit, with eroded main axes 3-4 mm in breadth, the shape and breadth of the blades, its deep red-purple color, and the texture is strikingly similar to the type specimen of *Delesseria kurilensis* in LE (Fig. 1).



Figs 1, 2. *Congregatocarpus pacificus*. **Fig. 1.** Type specimen of *Delesseria kurilensis* Ruprecht in LE. **Fig. 2.** Cystocarpic specimen, ISOTYPE of *Pseudophycodrys pacifica* Yamada in MICH [distributed as "*Delesseria crassifolia*", non Ruprecht.] Scale bar = 5 cm.

DISCUSSION

For the family Delesseriaceae Kylin (1924, 1956) recognized two subfamilies, the Delesserioideae ('Delesserieae') and the Nitophylloideae ('Nitophylleae'). The former subfamily was characterized by growth from a single apical cell undergoing transverse divisions and

lacking intercalary cell divisions in the primary cell row along with the restriction of procarps to the primary cell row, and the latter family had a scattered arrangement of procarps and growth either by marginal initials or a single apical cell undergoing transverse divisions but with intercalary divisions occurring in the primary cell row.

Mikami (1973) made some observations that were at

odds with Kylin's delineation of the two subfamilies. In a few genera that had their procarps restricted to primary cells rows (and thus apparent members of the Delesserioideae), Mikami noted the occurrence of intercalary cell divisions in primary cell rows. Mikami observed such a pattern in *Congregatocarpus pacifica* (Yamada) Mikami (Mikami 1970, as *Laingia pacifica*), in *Tokidadendron* (Mikami 1971b, as *Pseudophycodrys rainosukei* Tokida), and in *Neohypophyllum middendorffii* (Ruprecht) M.J. Wynne (Mikami 1971c, as *Hypophyllum middendorffii*). Mikami (1973) placed these three genera in their own informal category, the "Congregatocarpus group", the only group in the subfamily Delesserioideae in which intercalary cell divisions occurred in the primary axial row. This "group" was later recognized by Wynne (2001) as the tribe Congregatocarpeae. This tribe was assigned to the Delesserioideae on the basis that the procarps are restricted to primary cell rows and that the midrib is composed of many elongate rhizoidal cells.

In Perestenko's (1983) comparative Table differentiating the species of Delesseriaceae occurring in the extreme eastern seas of Russia, she indicated that *Tokidadendron kurilense* and *Congregatocarpus pacificus* were in agreement in regard to eight of the 12 anatomical and reproductive criteria listed in a comparative Table. Her Table showed that these two taxa were separated (in her assessment) from one another by the following four criteria:

Tokidadendron kurilense

- 1) intercalary cell divisions not occurring in first-order cell rows;
- 2) tetrasporangia are produced on ordinary blades, not located in discrete sori;
- 3) carpogonial branches are produced both on cells of the first-order rows and also on veins on the surface of the blade (these veins being equivalent to the first-order rows of lateral blades);
- 4) the blades are monostromatic.

Congregatocarpus pacificus

- 1) intercalary cell divisions occurring in first-order cell rows;
- 2) tetrasporangia are produced on ordinary blades and are located in discrete sori;
- 3) carpogonial branches are produced on first-order rows of specialized (small) proliferations;
- 4) the blades are three or more cell layers and differentiated into a medulla and cortical layers.

In regard to the first alleged distinction, however, Mikami (1971b, as *Pseudophycodrys rainosukei*) had shown that intercalary cell divisions do occur in first-order rows of *Tokidadendron kurilense*. Although such divisions are not present in the apical regions of younger blades (Mikami's fig. 3), they are detectable in the apical regions of older blades (Mikami's fig. 4). This report confirmed Nagai's (1941, as *Ps. rainosukei*) earlier claim that he observed this feature one time.

Wynne (1970, as *Tokidadendron bullatum*) described the tetrasporangia as not being in discrete sori but scattered over the intercostal alae, whereas Mikami (1971b) referred to "tetrasporangial sori" as being "scattered on the intercostal region" of the blades. Tokida (1954, as *Laingia pacifica*) was the first to observe tetrasporangiate plants in *Congregatocarpus*, saying that the tetrasporangia are "found scattered irregularly over the surface of the blade". Mikami (1971a) stated that the tetrasporangial sori are scattered over the surface of the thallus. Examination of a tetrasporangiate specimen of *C. pacificus* in MICH [Samani, Hidaka Prov., Japan, 15.ii.1993, leg. H. Mikami] showed the tetrasporangia to be scattered randomly over the blade surface, except for regions of veins and blade edges, but they are not localized in discrete sori. Therefore, this second criterion does not serve to separate *Tokidadendron* and *Congregatocarpus*.

Intercostal regions of blade in *Tokidadendron* have been described as being "one to three cell-layered" by Tokida (1932, as *Pseudophycodrys rainosukei*) or monostromatic by Wynne (1970). Blades of *Congregatocarpus* are usually described as being polystromatic except at the edges (Mikami, 1971a). According to Tazawa (1975) the blades of *C. pacificus* are polystromatic, "consisting of three to five layers of cells", although proliferations are monostromatic except for the midrib and lateral veins. Okamura (1921, as *Delesseria crassifolia*) depicted both monostromatic and polystromatic regions of the blades, and Wynne (1990) also noted both monostromatic and polystromatic regions of blades in Alaskan specimens. Vegetatively, these two taxa can be confusingly similar, and Tokida (1934) admitted that he mixed the two up in his 1932 paper. The specimens depicted in his plate X were correctly determined as *Ps. rainosukei* (= *Tokidadendron*), but the specimen depicted in his plate IX actually was *Laingia pacifica* (= *Congregatocarpus*).

The two most reliable criteria for separating *Tokidadendron* and *Congregatocarpus* are the nature of the



Figs 3, 4. *Tokidadendron bullatum* (N.L. Gardner) M.J. Wynne. **Fig. 3.** Proliferation of new blades from persistent axes at the start of the second growing season (Amchitka Island, Wynne AM 565). **Fig. 4.** Mature tetrasporangial specimen (Amchitka Island, Wynne 1282). Scale bar = 5 cm.

production of the cystocarps (on ordinary blades in *Tokidadendron* but on small specialized proliferations that show a clustered arrangement in *Congregatocarpus*, as the generic name alludes to) and the primarily monostromatic intercostal regions of the blades of *Tokidadendron* but the primarily polystromatic intercostal regions of the blades of *Congregatocarpus*.

Ruprecht's (1850, 1851) description of *Delesseria kurilensis* was very brief. He indicated that it was from Urup [Uruppu] Island, which is located in the southern Kuril Islands, an archipelago running between Hokkaido, Japan, and Kamchatka, Russia, The Kurils separate the Sea of Okhotsk from the western North Pacific Ocean. Ruprecht stated that it resembled *Yendonia*

[*Delesseria*] *crassifolia* (Ruprecht) Kylin and occurred on the rhizome of *Neoptilota* [*Plumaria*] *asplenioides* (Esper) Scagel *et al.* and possibly on the kelp *Thalassiophyllum clathrum* (S.G. Gmelin) Postels & Ruprecht. He said that its blades were shorter and more elliptical than those of *Y. crassifolia*, not rounded distally but rather sharply pointed, with branching, oppositely placed lateral veins. Ruprecht also said that his new species closely resembled in form the small-leaved variety of *Delesseria sanguinea* (Linnaeus) J.V. Lamouroux that he was familiar with from the island of Funen, in the Baltic Sea, south-central Denmark, but it differed in its dark purple-red color and in its wider and shorter blades. Ruprecht indicated that he did not observe fertile material in his new species.

The persistent and perennating midrib (stipe) in *Tokidadendron* has a horny consistency (Wynne 1970, figs 22 and 23). In cross-section it is shown to be composed of numerous densely packed rhizoidal filaments (Wynne 1970, fig. 33). The comparable midrib of *Congregatocarpus*, although thickened, lacks the horny consistency and lacks the very densely compacted organization that is present in the midrib of *Tokidadendron*. Observations made on abundant populations of *Tokidadendron bullatum* at Amchitka Island, the Aleutians, allowed Wynne (1970) to describe this alga as being perennial. Typically, a single primary blade is produced in the first growing season, and that blade is eroded down to the thickened, cartilaginous midrib that persists until the next growing season. New blades arise as proliferations from the persistent stipes (Fig. 3) in the next growing season, and this process appears to be repeated. Reproductive stages occur on second-year specimens (Fig. 4).

The lack of fertile type specimen in *Delesseria kurilensis* forces us to rely on vegetative characteristics. The general habit of a large thallus with branching to two orders, eroded primary and second axes with broadly thickened but non-horny midribs and the mostly polystromatic nature of the blades all point to the conclusion that this type specimen is best assigned to *Congregatocarpus* rather than to *Tokidadendron*. The formation of new proliferations from persistent stipes has not been observed in the type specimen of *Delesseria kurilensis* (Fig. 1) nor in the isotype of *Congregatocarpus* [*Pseudophycodrys*] *pacificus* (Fig. 2). In light of this interpretation that *Delesseria kurilensis* belongs to

Congregatocarpus rather than to *Tokidadendron*. The following transfer is effected:

Congregatocarpus kurilensis (Ruprecht) M.J. Wynne comb. nov.

Basionym: *Delesseria kurilensis* Ruprecht, [1850] 1851: 233. *Phycologia Ochotiensis*, Ex Middendorff's *Sibirische Reise* I(2).

Taxonomic synonym: *Pseudophycodrys pacifica* Yamada, 1930: 32, pl. 2, fig. 1.

Laingia pacifica (Yamada) Yamada, 1932: 122.

Congregatocarpus pacificus (Yamada) Mikami, 1971a: 246.

Okamura pacifica (Yamada) Zinova, 1972: 71.

Tokidadendron kurilense (Ruprecht) Perestenko, 1983: 53.

Delesseria crassifolia Ruprecht f. *pulcherrima* Sinova, 1940: 95, fig. 21.

Therefore, the type species of *Tokidadendron* and its taxonomic synonymy follows:

*Tokidadendron bullatum*¹ (N.L. Gardner) M.J. Wynne 1970: 108, figs 21-29, 33, 39.

Basionym: *Phycodrys bullata* N.L. Gardner 1927: 339, pl. 67.

Taxonomic synonym: *Phycodrys ambigua* N.L. Gardner 1927: 338, pl. 70 (fide Wynne, 1982, 1983).

Tokidadendron ambiguum (N.L. Gardner) M. J. Wynne 1970: 112.

Taxonomic synonym: *Pseudophycodrys rainosukei* Tokida 1932: 27, figs 11, 12; pls 9, 10 (fide Wynne, 1970).

These two genera are partly overlapping in their distributions in the upper North Pacific. *Congregatocarpus* has a range in Japan (Okamura 1921, as *Delesseria crassifolia*, non Ruprecht 1851; Yamada 1930; Yoshida 1998), Korea (Okamura 1921, as *D. crassifolia*; Lee and Kang 1986), eastern Russia (Perestenko 1980, 1984, 1994; Selivanova and Zhigadlova 1997a, 1997b; Klochkova 1996, 1998), and the Aleutian Islands of Alaska (Wynne 1990). *Tokidadendron* also occurs along the North Pacific Rim: northern Japan (Tokida 1954; Yoshida 1998), eastern Russia (Perestenko 1984, 1994; Selivanova and Zhigadlova 1993, 1997a, 1997b) and the Aleutian Islands and elsewhere in Alaska (Gardner 1927; Wynne 1970; O'Clair and Lindstrom 2000), extending southward to northern British Columbia (Scagel *et al.* 1989).

In the Commander Islands in the northwestern North

1. According to Article 62.2(c) of the ICBN (Greuter *et al.* 2000) compounds of generic names ending in -dendron are neuter, *Tokidadendron* thus calling for *bullatum* as the specific epithet.

Pacific Selivanova and Zhigadlova (1997b) reported the co-occurrence of *Congregatocarpus pacificus* and *Tokidadendron kurilense* [now *T. bullatum*]. *Congregatocarpus pacificus* was reported to be very rare, found only in June, fertile, epilithic and subtidal (1.5 m. depth). *Tokidadendron* was said to be abundant, found from May to September, tetrasporic, epilithic, and both intertidal and subtidal (to a depth of 10 m.) and also cast ashore.

Sinova (1940) described *Delesseria crassifolia* Ruprecht f. *pulcherrima* from the Sea of Japan, a form with much larger blades than those known in the nominate form of the species, *Yendonia crassifolia* (Ruprecht) Kylin. Perestenko (1994) regarded *D. crassifolia* f. *pulcherrima* to be a taxonomic synonym of *Tokidadendron kurilense*, whereas in the present treatment it is assigned to *Congregatocarpus* and treated in the synonymy of *C. kurilensis*.

The name *Tokidadendron kurilense* (Ruprecht) Perestenko subsp. *japonicum* Perestenko (1994) has been treated as a "nom. inval." by Algae.base (Guiry *et al.* 2005) because of a lack of a figure or illustration as well as a lack of specific data for the type specimen.

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