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Taxonomic notes on *Odonthalia lyallii* (HARVEY) J. AGARDH and related species (Rhodophyta)

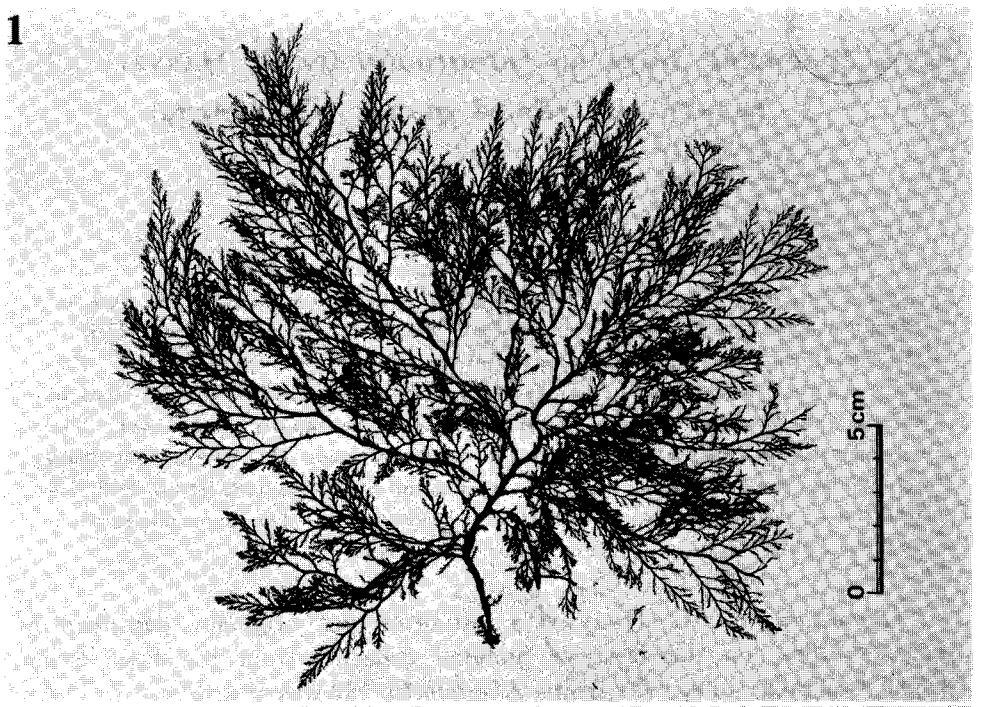
Michio MASUDA

The original specimens of *Odonthalia lyallii* (HARVEY) J. AGARDH were re-examined and several vegetative and reproductive features have been added to HARVEY's original description. The lectotype specimen has been designated. Previous reports of this species from the North Pacific were revised on the basis of examination of the voucher specimens on which the reports were based. The specimens of *O. lyallii* collected from the Aleutian Islands (OKAMURA, 1933, 1934), the Kurile Islands (NAGAI, 1941) and Washington State (COLLINS *et al.*, 1902) are referable to *Odonthalia setacea* (RUPRECHT) PERESTENKO. The taxonomic relationship between *O. lyallii* and related species is discussed.

Odonthalia lyallii (HARVEY) J. AGARDH was originally described by HARVEY (1862) on the basis of material collected from the Fuca Strait, British Columbia, under the genus *Rhodomela*. It was transferred to *Odonthalia* by J. AGARDH the following year (1863). The alga has been reported from various localities in the North Pacific (COLLINS *et al.*, 1902; SETCHELL and GARDNER, 1903; KYLIN, 1925; OKAMURA, 1933, 1934; KAWABATA, 1936; ZINOVA, 1940; NAGAI, 1941; SCAGEL, 1957). However, KAWABATA's record from Shikotan Island, southern Kuriles has been recently discounted by MASUDA (in press). PERESTENKO (1977) pointed out its similarity to *Odonthalia setacea* (RUPRECHT) PERESTENKO and concluded that the plants reported from the Commander Islands by ZINOVA (1940) and from Whidbey Island, Washington State by COLLINS *et al.* (1902) are identical with *O. setacea*. However, the original description of *O. lyallii* given by HARVEY (1862) is insufficient to circumscribe the alga since neither measurement data nor illustrations were given, although the gross morphological features of the alga are shown clearly. The purpose of this study is to describe *O. lyallii* in more detail using the original specimens, and to discuss the taxonomic relationship between *O. lyallii* and related species.

Materials

Two original specimens of *Odonthalia lyallii* (HARVEY) J. AGARDH, which are now preserved in the Herbarium of Trinity College (TCD), were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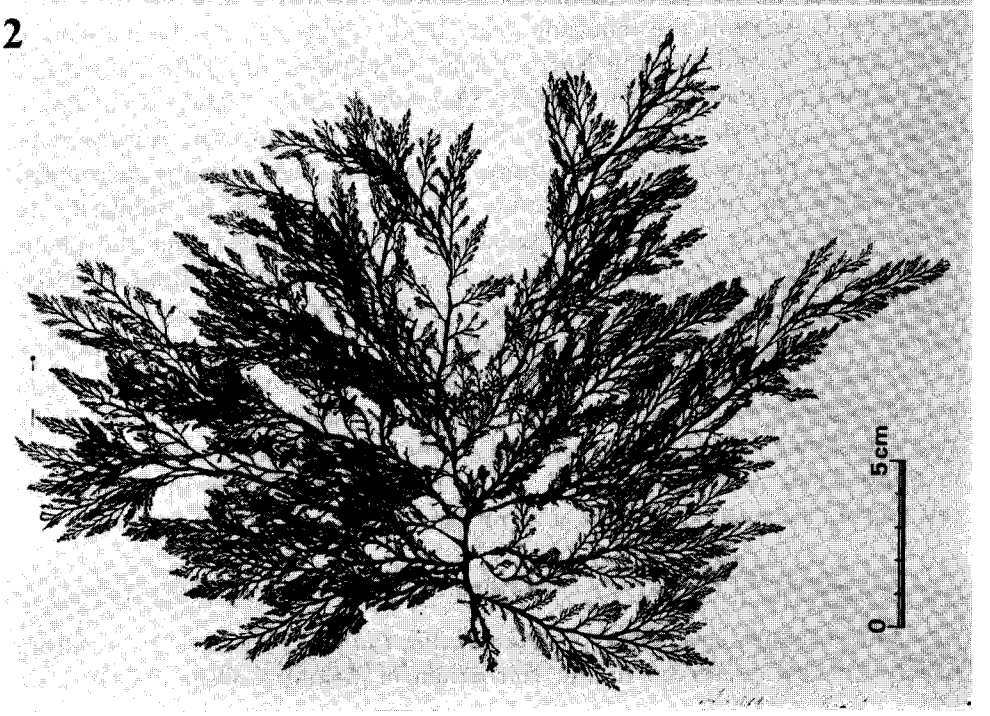
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examined. One is a cystocarpic specimen collected in March 1859 from the Fuca Strait, British Columbia, by D. LYALL (Fig. 1) and the other is a tetrasporangial specimen collected in April 1859 from the same locality by D. LYALL (Fig. 2). The cystocarpic specimen is designated here as the lectotype.

In addition, specimens identified by several investigators as *O. lyallii* were also examined. (1) Specimens from the Aleutian Islands: a cystocarpic specimen collected from Atka Island on June 4, 1931 by Y. KOBAYASHI and three tetrasporangial specimens collected from Amchitka Island on May 7, 1931 by Y. KOBAYASHI. These are voucher specimens on which OKAMURA's reports (1933, 1934) were based and are now deposited in his herbarium which is located in the Herbarium of Faculty of Science, Hokkaido University, Sapporo (SAP). (2) Specimens from the Kurile Islands: ten tetrasporasporangial specimens gathered from Urup Isl., middle Kuriles, on August 7 and 22, 1935 by M. NAGAI (SAPA); three cystocarpic and two tetrasporangial specimens collected from Shimshir Isl., middle Kuriles, on July 22, 1930 and August 21, 1935 by M. NAGAI (SAPA); three tetrasporangial specimens collected from Matsuwa Isl., middle Kuriles, on August 14, 1935 by M. NAGAI (SAPA, SAP 22052); seven tetrasporangial specimens gathered from Onnekotan Isl., middle Kuriles, on August 15, 1935 by M. NAGAI (SAPA); and six cytocarpic and five tetrasporangial specimens collected from Paramshir Isl., northern Kuriles, on July 30, 1930 and August 4, 1932 by M. NAGAI (SAPA). These are NAGAI's voucher specimens and are now deposited in the Herbarium of Plant Pathology, Faculty of Agriculture, Hokkaido University, Sapporo (SAPA) and SAP. (3) Specimens from Washington State: a cystocarpic and a tetrasporangial specimens collected from Whidbey Island in 1901 by N. L. GARDNER and distributed in P. B. A. 940 (COLLINS *et al.*, 1902); a cystocarpic specimen collected from Whidbey Island in June 1901 by N. L. GARDNER and distributed from the Herbarium of the University of California (UC) (*Gardner* 193; this is deposited in the Herbarium of Tokyo University of Fisheries); and a cystocarpic specimen collected from the same island on May 21, 1966 by P. S. DIXON (TCD).

Results

Observations of the original specimens: Erect thalli arise from a common

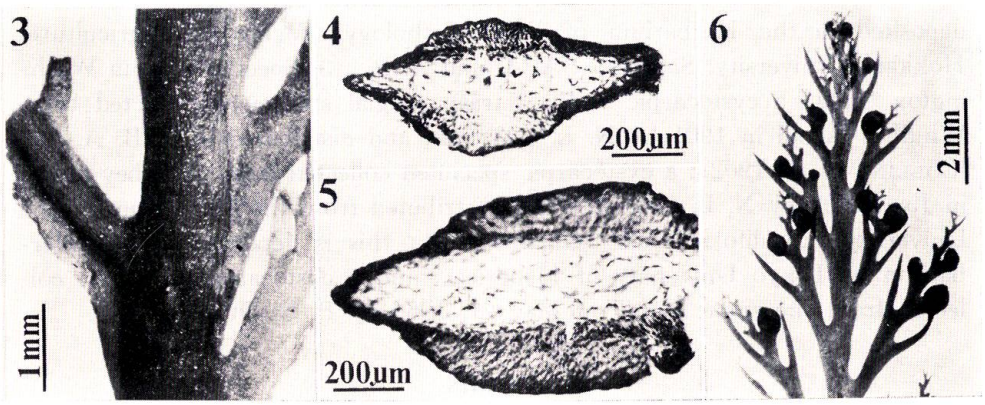
Odonthalia lyallii (HARVEY) J. AGARDH

Fig. 1. Lectotype specimen (cystocarpic) collected from the Fuca Strait, British Columbia in March 1859 by D. LYALL (TCD).

Fig. 2. Tetrasporangial specimen collected from the Fuca Strait in April 1859 by D. LYALL (TCD).

basal disc and are branched alternate-distichously in a single plane (Figs. 1, 2). They are dark red in color and adhere well to paper after drying. The main axes are almost terete above the basal disc, becoming immediately compressed and reach a maximum breadth of 2 mm at the lower portion. The first order branches are longest in the middle portion of the main axis, reaching up to 15–16 cm in length and are divided into progressively shorter branches up to the sixth order. Lateral branches of any order are simple in the proximal portion and branched above. Although HARVEY (1862) made no mention of midribs, the original specimens examined have conspicuous midribs (Figs. 3–5). The midribs are formed by successive divisions of cortical cells at the median portion of the main axis. They are also evident at the lower to middle portions of the first order branches and the lower portion of the second order branches (Figs. 3–5). Several adventitious branches are borne on the lower to middle portions of the main axis.

The majority of indeterminate branches of the lectotype specimen produce procarp-bearing branchlets and cystocarps, which show various stages of development, and are arranged in a flexuose-racemose manner from the middle to upper portions (Fig. 6) in accordance with HARVEY's description (1862). Procarp-bearing branchlets are found at the uppermost portion of the branches. They are simple and monosiphonous (Figs. 7–9). Procarps are probably borne on the suprabasal segment of the branchlets, although



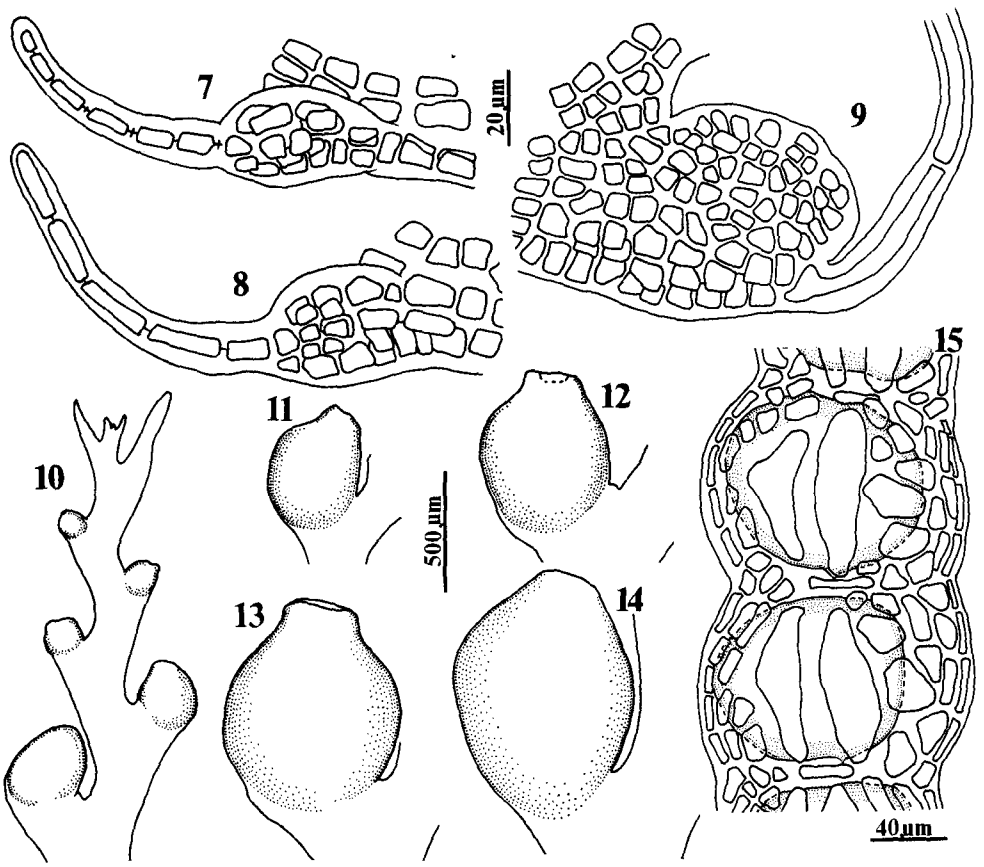
Odonthalia lyallii (HARVEY) J. AGARDH

Fig. 3. Lower portion of a first order branch, showing midribs (photomicrograph of the lectotype specimen).

Figs. 4, 5. Cross sections of a second order branch (4) and of a first order branch (5), shown in Fig. 3.

Fig. 6. Fertile portion of the lectotype specimen, showing arrangement of cystocarps.

the development could not be traced. As cystocarps develop, the monosiphonous portion of the procarp-bearing branchlets falls off as in the case of *Polysiphonia* and many other genera bearing trichoblasts in the Rhodomelaceae. Hence, cystocarps of this species are devoid of calcars (Figs. 10-14). Mature cystocarps are ovoid as reported by HARVEY (1862) and 600-900 μm in height and 420-700 μm in diameter with rather narrow ostioles of 120-280 μm in diameter (Figs. 12-14). They sometimes possess slightly elevated necks of 20-120 μm in height (Figs. 12, 13).



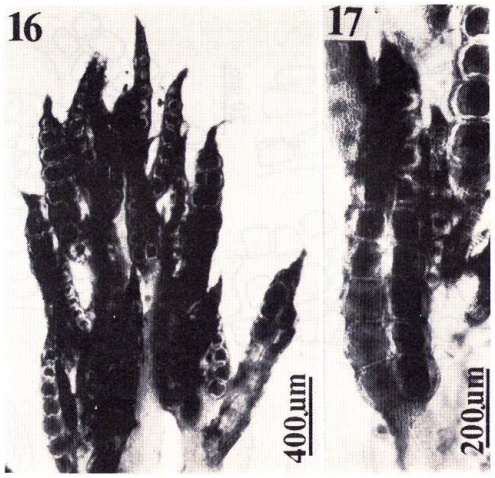
Odonthalia lyallii (HARVEY) J. AGARDH

Figs. 7-9. Procarp-bearing branchlets.

Figs. 10-14. Various developmental stages of cystocarps.

Fig. 15. Portion of a tetrasporangial stichidium (flank-side view); the two elongated cells in each segment are cover cells. Figs. 7-14 from the lectotype; Fig. 15 from a specimen shown in Fig. 2.

The tetrasporangial stichidia are borne on the upper portion of indeterminate branches of any order and are close to each other (Fig. 16). They are compressed, attenuated at the proximal portion and have acuminate tips. The stichidia measure 900–1600 μm in length, 240–280 μm in diameter and are 160–180 μm in thickness. Two tetrasporangia are formed in each of 6 to 12 (sometimes up to 16) successive segments of the stichidia (Fig. 17). Each sporangium is provided with two cover cells on the flank side (Fig. 15). Mature tetrasporangia are 112.5–130.0 μm × 112.5–120.0 μm and divide tetrahedrally.



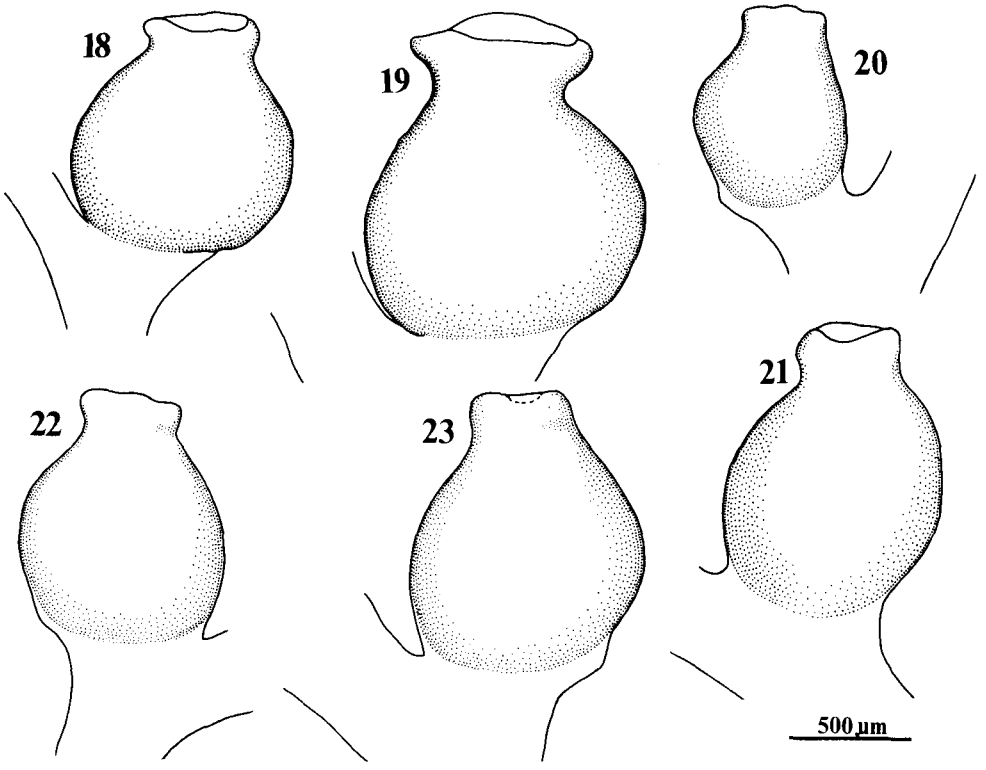
Odonthalia lyallii (HARVEY) J. AGARDH

Figs. 16, 17. Tetrasporangial stichidia borne on a plant shown in Fig. 2.

Observations of specimens from the Aleutian Islands, the Kurile Islands and Washington State: Specimens from the Aleutians are in agreement with the description and illustration given by OKAMURA (1934). Based on OKAMURA's voucher specimens some additional data regarding reproductive features is given here to supplement his description (1934). Although OKAMURA stated that the cystocarps are ovate, they are urceolate and have elevated necks as seen in his illustration (Pl. 308, fig. 5). They are 875–1250 μm in height and 725–1075 μm in diameter. They possess wide ostioles of 265–500 μm in diameter and elevated necks of 180–330 μm in height. The tetrasporangial stichidia are 800–1500 μm in length, 240–260 μm in diameter and 130–160 μm in thickness. The tetrasporangia are formed in two longitudinal rows of 5 to 10 successive segments of the stichidia. The mature tetrasporangia are 115–135 μm × 110–130 μm in size.

NAGAI (1941) reported *Odonthalia lyallii* from southern to northern

Kuriles. However, a check of his voucher specimens reveals that they are heterogeneous (MASUDA and YAMADA, in press). The specimens cited above (see Materials) are in agreement with NAGAI's description of this species. These specimens were collected during late July and late August and so they are older and darker in color than aforementioned Aleutian specimens. They are similar in other respects to the Aleutian specimens. The urceolate cystocarps are 850-1250 μm in height, 750-1100 μm in diameter and possess wide ostioles of 380-750 μm in diameter and elevated necks of 150-400 μm in height (Figs. 18, 19). The tetrasporangial stichidia are 800-1600 μm in length, 220-260 μm in diameter and 140-160 μm in thickness. Two tetrasporangia are formed in each of 6-12 successive segments of the stichidia,



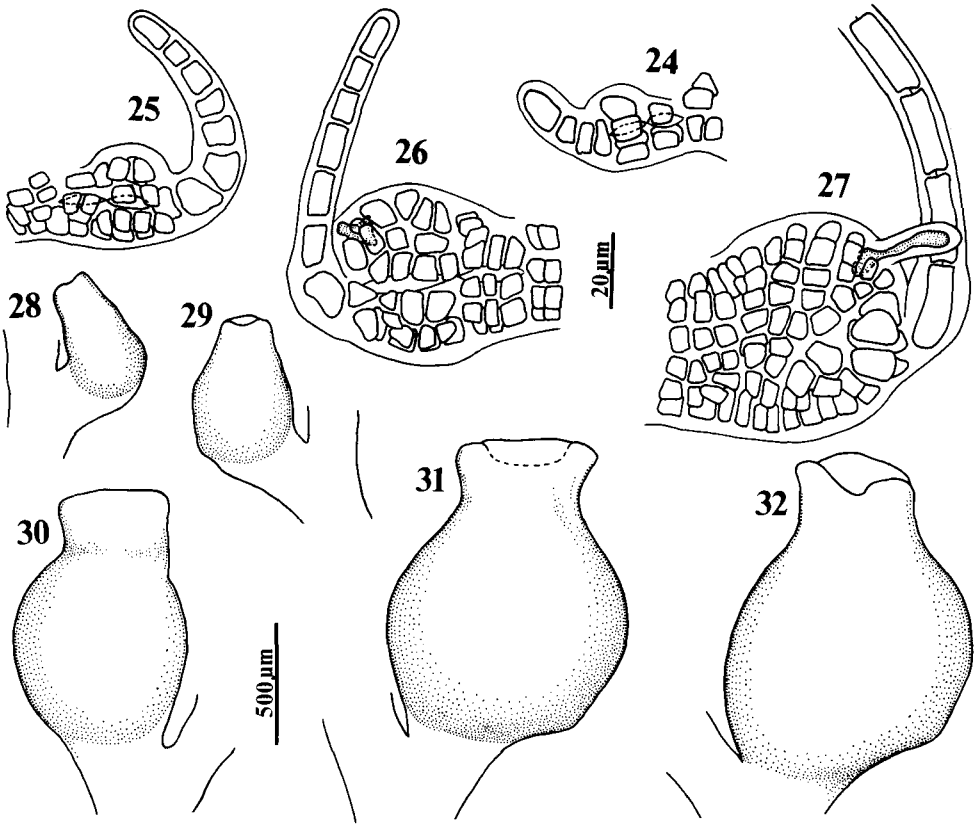
Odonthalia setacea (RUPRECHT) PERESTENKO

Figs. 18, 19. Mature cystocarps borne on a plant collected from Paramshir Isl., Kuriles on August 4, 1932 by M. NAGAI (SAPA).

Figs. 20-23. Mature cystocarps borne on plants from Whidbey Isl., Washington State: 20, collected in 1901 by N. L. GARDNER (P. B. A. 940); 21, collected in June 1901 by N. L. GARDNER (*Gardner* 193); 22, 23, collected on May 21, 1966 by P. S. DIXON (TCD).

although the vast majority of the sporangia are empty after spore liberation and only the two-cover cells of each sporangium are visible.

The gross morphological features of the Washington specimens were illustrated by SETCHELL and GARDNER (1903). The specimens examined agree with their illustrations. The specimens in P. B. A. (COLLINS *et al.* 1902) and the specimen collected by DIXON possess slightly elevated midribs at the lower portion of main axes and of lower first order branches, whereas the remaining specimen (*Gardner* 193) has conspicuous midribs as does the lectotype specimen of *O. lyallii*. The urceolate cystocarps are 800-1150 μm in height, 630-980 μm in diameter and possess ostioles of 270-



Odonthalia setacea (RUPRECHT) PERESTENKO

Figs. 24-27. Procarp-bearing branchlets borne on a plant collected from Bering Isl., Commander Islands on July 22, 1972 by T. ZAKHODNOVA (SAP).

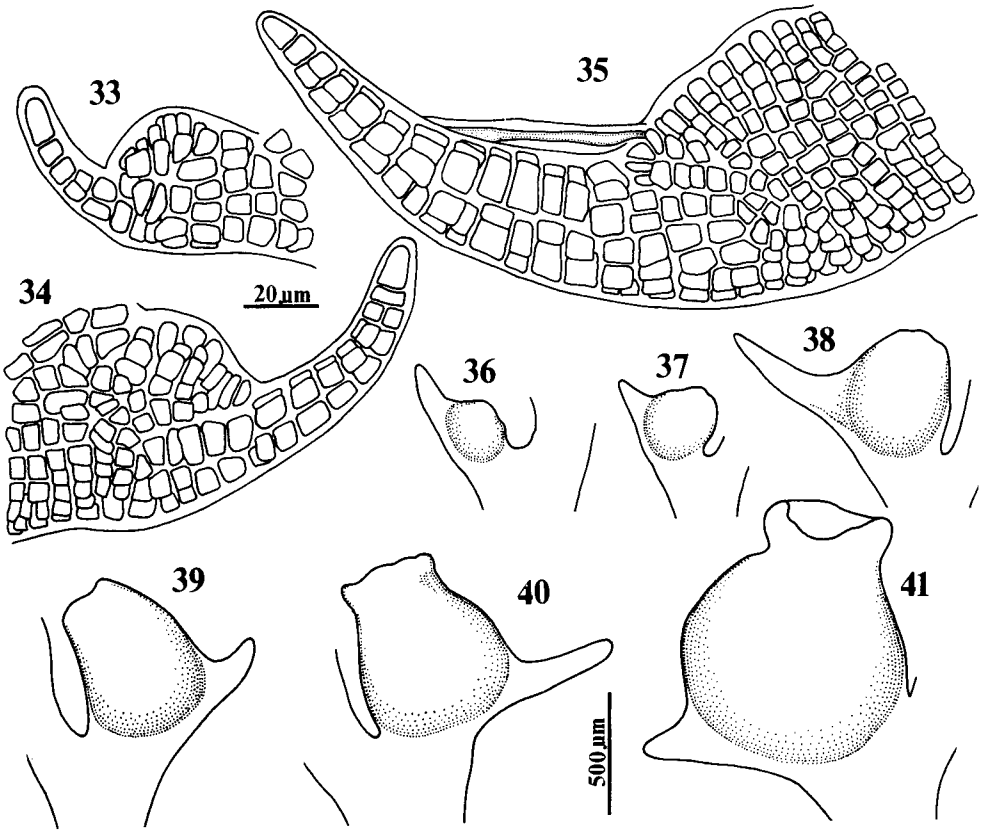
Figs. 28-32. Various developmental stages of cystocarps borne on a plant collected from Mednyi Isl., Commander Islands on July 10, 1972 by L. P. PERESTENKO (SAP).

500 μm in diameter and elevated necks of 120–280 μm in height (Figs. 20–23). The tetrasporangial stichidia are 950–1150 μm in length, 220–250 μm in diameter and are 150–170 μm in thickness. Two tetrasporangia are produced in each of 6–13 successive segments of the stichidia. Mature tetrasporangia are 107.5–125.0 μm × 105.0–112.5 μm in size.

Discussion

The specimens from the Aleutian Islands, the Kurile Islands and Washington are similar in vegetative and tetrasporangial features to the original specimens of *Odonthalia lyallii*. However, they differ from the latter in having urceolate cystocarps with wide ostioles and elevated necks. They are similar to *O. setacea* (RUPRECHT) PERESTENKO in this respect (RUPRECHT, 1850; PERESTENKO, 1977; MASUDA and YAMADA, 1980). *O. lyallii* and *O. setacea* are closely related species, as pointed out by PERESTENKO (1977). The only recognizable difference between the two is the nature of the cystocarp. According to MASUDA and YAMADA (in press), cystocarpic features of this genus such as their shape, size, arrangement and position, have taxonomic significance at the species level. *O. lyallii* and *O. setacea* are similar to each other in the arrangement and position of cystocarps. Furthermore, their procarp-bearing branchlets are similar, as shown in Figs. 7–9 and 24–27. However, they are distinguishable by the shape and size of cystocarps. Various developmental stages of cystocarps in *O. setacea* are shown in Figs. 28–32 on the basis of material collected from Mednyi Isl., Commander Islands on July 10, 1972 by L. P. PERESTENKO (SAP, cf. MASUDA and YAMADA, 1980). A comparison of these cystocarps with those of *O. lyallii* shown in Figs. 10–14 discloses that the cystocarps of both the species differ from each other in every stage of development. This suggests that there is an essential difference between both the cystocarps in their growth patterns. Furthermore, the cystocarps of *O. lyallii* are smaller than those of *O. setacea*. These differences seem to be minor but should not be neglected. Further experimental analysis of the taxonomic features of both the species is necessary. Until sufficient data has been collected, it seems best to maintain these two species as separate. The specimens from the Aleutians, Kuriles and Washington State examined are referable to *O. setacea*.

Odonthalia lyallii and *O. setacea* are similar to *O. kamtschatica* (RUPRECHT) J. AGARDH in that they have expansive thalli, conspicuous midribs and cystocarps arranged in a flexuose-racemose manner. KYLIN (1925) stated that he examined the type specimnes of *O. kamtschactia* and



Odonthalia kamtschatica (RUPRECHT) J. AGARDH

Figs. 33–35. Procarp-bearing branchlets.

Figs. 36–41. Various developmental stages of cystocarps. All figures depicted from the lectotype specimen collected at Petropavlovsk, Kamchatka Peninsula in 1848 by WOSNESSENSKY (LE).

O. setacea in J. AGARDH's herbarium housed in the Herbarium of the Botanical Museum, Lund (LD) and that, in his opinion, two species are so closely related to each other that he could hardly see any essential difference between them. However, there are now no type specimens of the two species in J. AGARDH's herbarium (Dr. O. ALMBORN, pers. comm.). It seems that KYLIN examined parts of the original specimens of both the species. In this connection the type materials of *O. kamtschatica* including the lectotype are now deposited in the Herbarium of the Komarov Botanical Institute of the Academy of Sciences, Leningrad (LE) (PERESTENKO, 1977; MASUDA and YAMADA, in press). According to an examination of the lectotype specimen of *O. kamtschatica*, it is distinguished from *O. lyallii* and *O. setacea* by the

nature of its procarp-bearing branchlets and cystocarps. The procarp-bearing branchlets are polysiphonous (Figs. 33–35) and grow into calcars, and so the cystocarps possess conspicuous calcars (Figs. 36–41). On the other hand, the procarp-bearing branchlets of *O. lyallii* and *O. setacea* are monosiphonous (Figs. 7–9, 24–27) and deciduous. The cystocarps are devoid of calcars (Figs. 10–14, 28–32). Polysiphonous procarp-bearing branchlets are known for *O. dentata* (L.) LYNGBYE (FALKENBERG, 1901; ROSENVINGE, 1923–24; KYLIN, 1934), *O. ochotensis* (RUPRECHT) J. AGARDH (RUPRECHT, 1850) and *O. kawabatae* MASUDA (in press), all of which possess conspicuous calcars.

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