Jpn. J. Phycol. (Sôrui) 40: 385–391, December 10, 1992

Yoshidaphycus gen. nov., based on *Branchioglossum ciliatum* Okamura (Delesseriaceae, Rhodophyta)

Hideo Mikami

Sapporo University, Nishioka 3-7-3-1, Sapporo, Hokkaido, 062 Japan

Mikami, H. 1992. *Yoshidaphycus* gen. nov., based on *Branchioglossum ciliatum* Okamura (Delesseriaceae, Rhodophyta). Jpn. J. Phycol. 40: 385–391.

The new genus *Yoshidaphycus* is described based on observations of *Branchioglossum ciliatum* Okamura, using recently collected materials from the Seto Inland Sea. This new genus in the *Hypoglossum* group of the Delesseriaceae is characterized by several modes of branching. The most common mode of branching gives the false impression of arising from the blade margin, but in reality these branches have an endogenous origin, arising from an axial cell, growing outward within the parent blade, and finally exiting at the margin of the parent blade. Less frequent modes of branching are the more ordinary marginal branching, in which apical cells of second-order rows are transformed into primary apical cells, as well as the adventitious origin of a branch from any marginal cell. Other characteristics that distinguish this new genus are the reproductive structures restricted to the special proliferating branchlets arising from the blade margin, and the production of terminal carposporangia.

Key Index Words: Branchioglossum ciliatum—*Delesseriaceae*—Hypoglossum *group*—*Morphology*—*Taxonomy*—Yoshidaphycus ciliatus.

Branchioglossum ciliatum was described by Okamura (1931) based on a few tetrasporic specimens from the Seto Inland Sea ['Iyo', Ehime Pref.] and the west coast of Kyushu [Nagasaki Pref.], Japan. Since then, this alga was rarely encountered, and morphological details were unknown except for the original description given by Okamura (1931). Recent collections from several localities of the Seto Inland Sea near the type locality provided an opportunity to examine its morphology in detail. The results obtained led me to establish a new genus because of the unique combination of vegetative and reproductive characteristics.

Materials and Methods

Collections were made by SCUBA diving at several localities in the Seto Inland Sea, Japan, during the course of a marine flora survey undertaken by the members of Kobe University and Hokkaido University. Materials were preserved in 5% formalin seawater. Pieces of a thallus were mounted in glycerin on glass slides after being stained with 1% aniline blue. Sections were made by hand using a razor blade. Voucher specimens were deposited in the herbarium of the Faculty of Science, Hokkaido University (SAP).

Observations

Gross morphology: The thallus (Fig. 1, 2) is ribbon-like, thin and membranaceous, up to 22 cm high and 10-15 mm wide, 2-3 times alternately branched from the margin. Several shoots originate from a small discoid holdfast, with a very short stem abruptly expanded into the main blade. Additional attaching discs are produced from the blade margin in the lower part of the thallus (Fig. 8). Uniseriate rhizoidal filaments are issued from the blade (Fig. 5). The midrib is inconspicuous. Blades are monostromatic except the midrib, which become polystromatic after the production of cortical cells (Fig. 6, 7). At

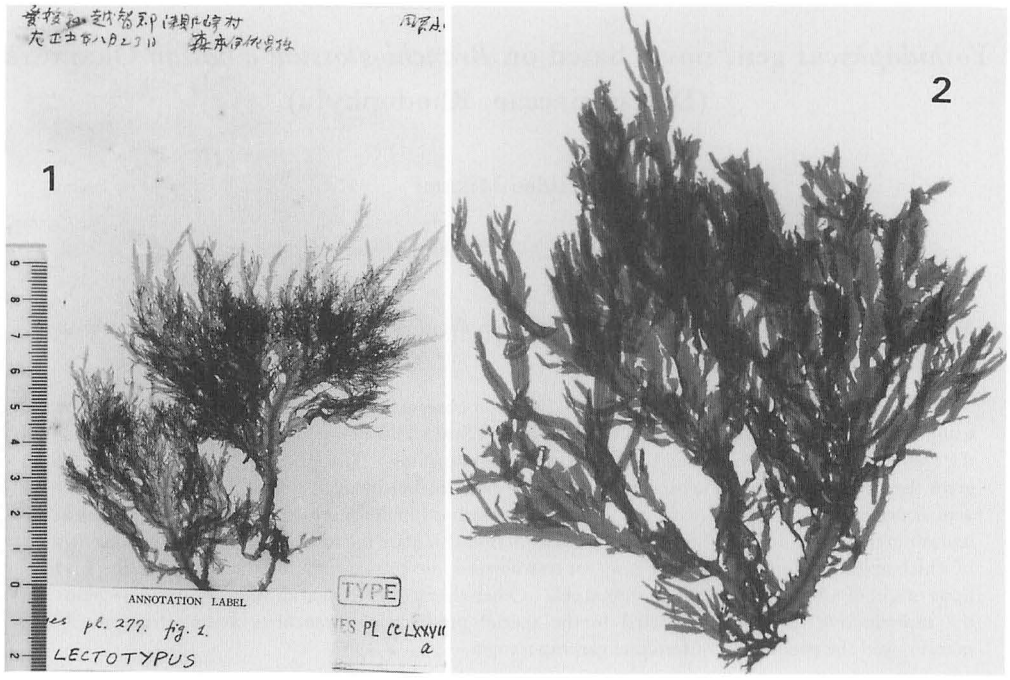


Fig. 1. Lectotype of *Branchioglossum ciliatum* Okamura. Setozaki-mura, Ehime Prefecture, Aug. 23, 1916. Leg. I. Morimoto. SAP herb. Okamura.

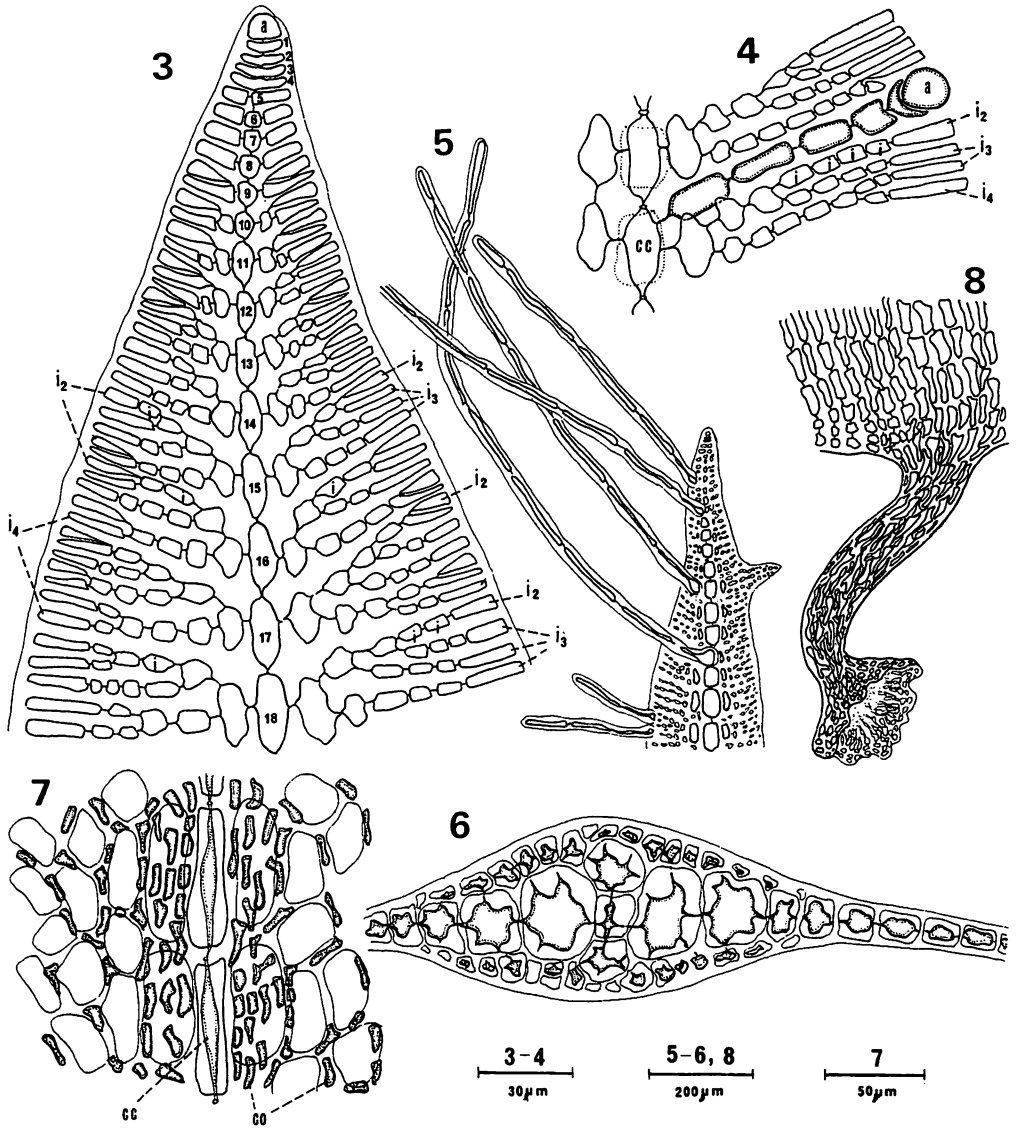
Fig. 2. A specimen from Obashima Isl., Ehime Pref., leg. S. Enomoto, Oct. 10, 1990, SAP 056669. Scale same as in Fig. 1.

maturity, many small filamentous branchlets are issued from the margin. Reproductive structures are formed on these filamentous branches.

Apical organization: Growth of the blade is initiated by a transversely dividing apical cell, which produces cells of the first-order cell row (Fig. 3). No intercalary cell division occurs in the first-order cell row. Apical cells of second- and third-order cell rows reach the blade margin. Several cells of the second-order cell rows do not give rise to the third-order cell rows because an intercalary cell division sometimes occurs in the second-order cell rows (Fig. 3, 14). In fully grown parts, fourth-order cell rows are often produced (Fig. 14).

Branching mode: There are three modes of branching of the blade. The most common mode is endogenous branching from the cells of the first-order cell row. The initial of a branch is cut off from an axial cell distally from the lateral pericentral cells and extends in the blade along the second-order cell row. The cells in this cell row produce pericentral cells while they are extending in the blade (Fig. 14). After reaching the margin the terminal cell emerges and becomes an apical cell of the branch of next order (Fig. 4, 14). These endogenous branches at times become free before they reach the blade margin. New branches can be formed from the transformation of apical cells of the second-order cell row, as in the species of the genus *Branchioglossum* (Fig. 15). Another mode is that any marginal cell can adventitiously be transformed into an apical cell of a new blade (Fig. 13).

Female reproductive organization: Procarps are produced acropetally on the first-order cell row of special small lanceolate blades on the margin. The origin of special bladelets is both endogenous and exogenous. A procarp consists of a supporting cell, a 4-celled carpogonial branch and 2 groups of sterile cells (Fig. 9). Only one procarp on a

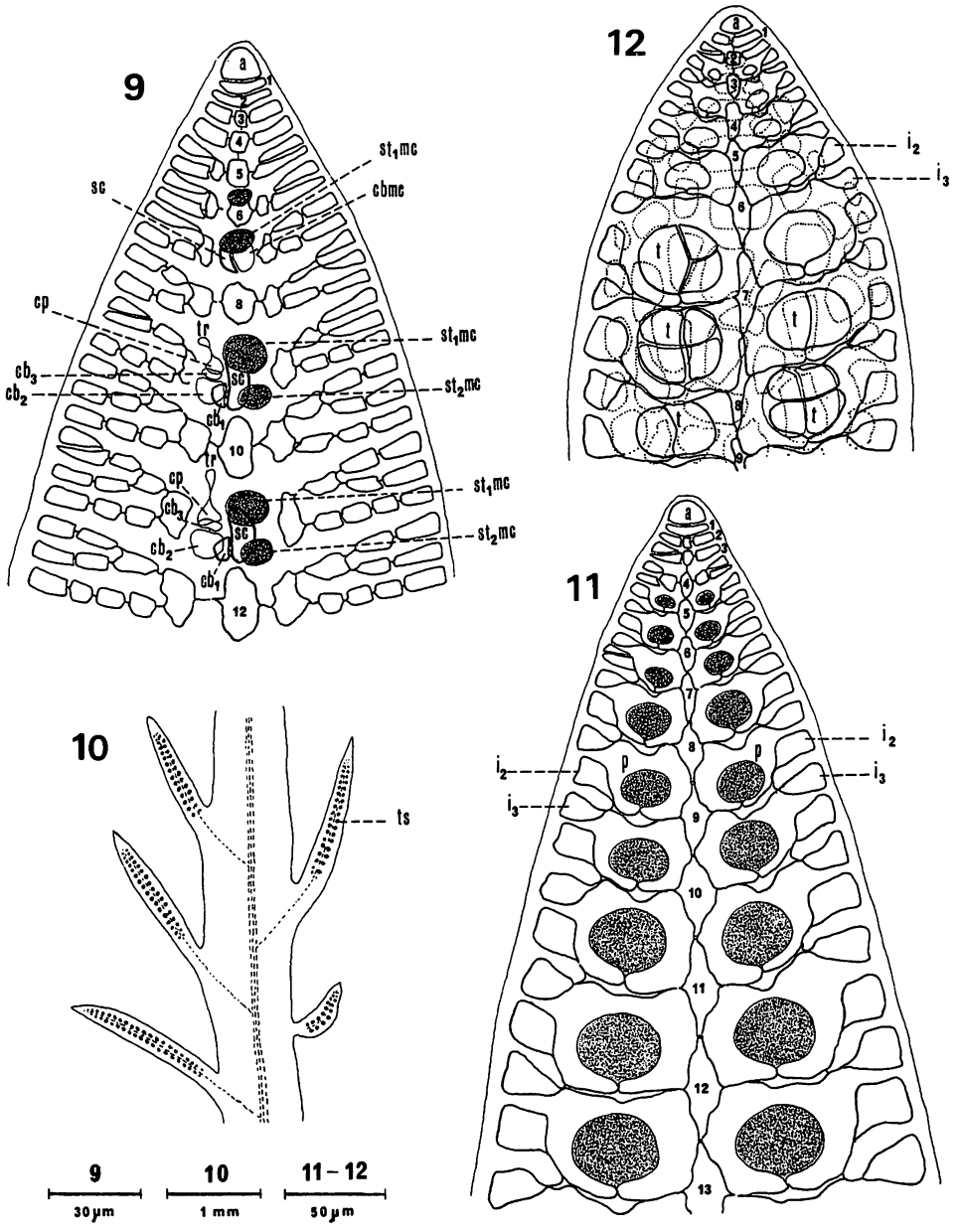


Figs. 3–8. *Yoshidaphycus ciliatus* (Okamura) Mikami. 3. Apical organization. 4. Endogenous origin of branch. 5. Rhizoidal filaments from the blade. 6. Cross section of the thallus showing monostromatic alae and midrib region with cortical cells. 7. Surface view of midrib area. 8. Secondary attaching disc from the margin of the blade. a: apical cell; cc: central cell; co: cortical cell; 1–18: cells in the first-order cell row; i_1, i_2, i_3, i_4: initials of second-, third- and fourth-order cell rows.

blade gives rise to a cystocarp, which is pot-shaped with an ostiole (Fig. 16, 17). A pericarp is lined with several rhizoidal cells (Fig. 17). Carposporangia are terminal on the gonimoblast, elliptical to long elliptical in shape, measuring 28–42 × 110–145 μm (Fig. 18).

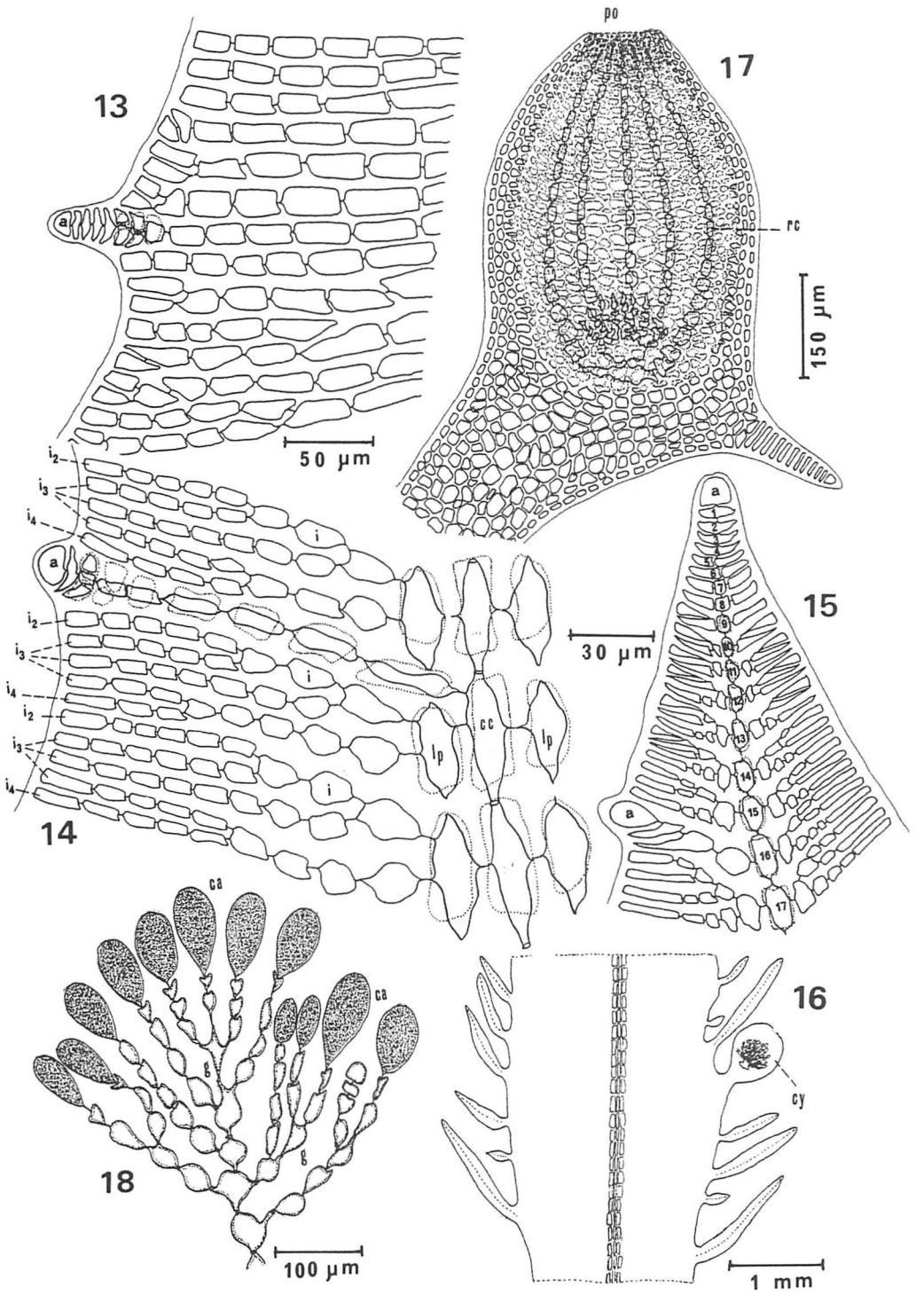
Spermatangia: Spermatangial sori cover the surface of broad lanceolate marginal branchlets except the midrib and marginal area (Fig. 19).

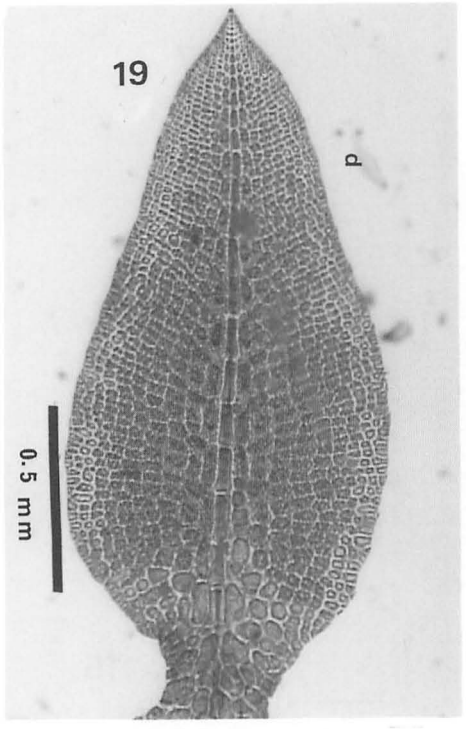
Tetrasporangia: Tetrasporangia are produced on small special linear branchlets, which may be endogenous or exogenous in origin, issued from the margin (Fig. 10-12). Tetrasporangial primordia are cut off from lateral



Figs. 9–12. *Yoshidaphycus ciliatus* (Okamura) Mikami. 9. Formation of procarps. 10. Tetrasporangia in fertile branchlets. 11. Arrangement of tetrasporangial primordia. 12. Tetrasporangia tetrahedrally or cruciately divided. a: apical cell; cb_{1-3}: cells in carpogonial branch; cbmc: carpogonial branch mother cell; cp: carpogonium; i_2, i_3: initials of second and third-order cell rows; sc: supporting cell; st_1mc: mother cell of first group of sterile cells; st_2mc: mother cell of second group of sterile cells; ts: tetrasporangium.

Figs. 13–18. *Yoshidaphycus ciliatus* (Okamura) Mikami. 13. Adventitious origin of branch from blade margin. 14. Endogenous branching. 15. Branching from the transformation of second-order cell row. 16. Cystocarp on a fertile branchlet. 17. Young cystocarp with pericarp lined by rhizoidal cells. 18. Gonimoblast filaments with terminal carposporangia. a: apical cell; ca: carposporangium; cc: central cell; cy: cystocarp; i: cell produced by intercalary division; i_1, i_2, i_3, i_4: initials of second-, third- and fourth-order cell rows; lp: lateral pericentral cell; po: ostiole; rc: rhizoidal cell.


13
a
50 µm
17
po
rc
150 µm
i2
i3
i4
a
i
i
i
i
i2
i3
i4
i2
i3
i4
cc
lp
lp
14
30 µm
15
a
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
a
ca
ca
g
g
18
100 µm
16
cy
1 mm



Figs. 19. A branchlet with spermatangial sori.

pericentral cells and arranged symmetrically in two rows along the midrib (Fig. 11). Mature tetrasporangia are 40-52 μm in diameter and divide tetrahedrally or cruciately (Fig. 12).

Discussion

This species is attributable to the *Hypoglossum* group of the Delesseriaceae, by the position of procarps on the first-order cell row and its apical organization, in which intercalary divisions do not occur in the first-order cell rows and all initials of second- and third-order cell rows reach the blade margin (Kylin 1924, Mikami 1973, Wynne 1989). The observations described above show that this species has a special combination of characteristics. An endogenous branching usually emerges from the blade margin. This mode of endogenous branching is somewhat similar to that reported in *Hypoglossum anomalum* Wynne & Ballantine (1986), where a pair of endogenous branches emerges from the blade surface at a certain distance from the midrib and rarely close to the margin. Reproductive structures are restricted to the special linear or lanceolate branchlets issued from the blade margins. The origin of these branchlets is either endogenous or exogenous or adventitious. Carposporangia are terminal on the gonimoblast filaments. This character contrasts to the condition in the genus *Branchioglossum*, in which carposporangia are produced in chains (Mikami 1979, Yoshida & Mikami 1992). This combination of characteristics warrants the proposal of a new genus in the *Hypoglossum* group of the Delesseriaceae:

Yoshidaphycus gen. nov.

Frons plana compressa monostromatica, crescentia apicalis ut in genera *Branchioglossum* et *Hypoglossum*, venis transversalis et lateralibus destituta. Ramification alternate, endogene et exogene, e margine enascentia. Structurae reproductivae ad prolificationes lineares limitatis. Procarpia cystocarpa ut in genero *Hypoglosso* delesseriaceae aedifica. Carposporangia terminales. Tetrasporangia e cellulis pericentrales laterales enascentia.

Frond flat ribbon-like, monostromatic except midrib, apical organization similar to genera *Branchioglossum* and *Hypoglossum* in that all apical cells of second- and third-order cell rows reach the margin. Lateral veins absent. Branching alternate, with different modes of origin: endogenously from axial cells with branch lying in plane of parent blade and exiting at blade margin, or exogenously from the transformation of apical cell of the second-order cell rows, or adventitiously from the margin. Reproductive structures confined to special branchlets linear or lanceolate in shape, arising from the blade margins. Procarps as in *Branchioglossum* and *Hypoglossum*, with a 4-celled carpogonial branch, two groups of sterile cells on a supporting cell. Carposporangia terminal on the gonimoblast filaments. Tetrasporangia cut off from the lateral pericentral cells.

Species typicus: *Yoshidaphycus ciliatus* (Okamura) Mikami, comb. nov.

Basionym: *Branchioglossum ciliatum* Okamura, Icones of Japanese Algae 6: 50. pl. 277, f. 1-10. 1931. Lectotype: Tetrasporic, Setozaki-mura, Ehime Pref., Leg. Isao Morimoto, Aug. 23, 1916, SAP herb. Okamura (Fig. 1).

Other specimens examined: Off Imabari, Ehime Pref., Leg. S. Yagi, no date, SAP herb. Okamura; Obashima Isl., Ehime Pref., Leg. S. Enomoto, Oct. 10, 1990, SAP 056667-9 (Fig. 2); Namikata, Ehime Pref., Leg. S. Enomoto, May 9, 1990, SAP 056665; Bingo-nada, Hiroshima Pref., Leg. H. Taki, May 11, 1936, SAP 056663; Mukaishima Isl., Hiroshima Pref., Leg. H. Taki, Mar. 22, 1935, SAP 056662; Ikata, Ehime Pref., Leg. S. Ninomiya, Aug. 1982, SAP 052320; Tomioka, Kumamoto Pref., Leg. T. Yoshida, SAP 045054, 050614; Nagasaki, no date, SAP herb. Okamura; Takeno, Hyogo Pref., Leg. S. Enomoto, SAP 056664; Wagu, Mie Pref., anon. Apr. 14, 1934, SAP herb. Okamura.

Etymology: The genus is named in honor of Dr. Tadao Yoshida, Faculty of Science, Hokkaido University.

Acknowledgments

I wish to express my sincere thanks to Dr. T. Yoshida, Hokkaido University, for his continuous cooperation in the study of Japanese Delesseriaceae and for his encouragements and assistance in preparing the manuscript. I am particularly grateful to Dr. M. J. Wynne, the University of Michigan, for his valuable suggestions on the manuscript. Thanks are also due to Prof. S. Enomoto, Kobe University, for providing the opportunity to obtain the materials and to Mr. K. Kogame, Hokkaido University, for his kindness in taking photographs.

References

Kylin, H. 1924. Studien über die Delesseriaceen. Lunds Univ. Arsskr. (N. F. Avd. 2) **20**(6): 1–111.

Mikami, H. 1973. On the procarp and the male plant in *Branchioglossum nanum* Inagaki. Bull. Jap. Soc. Phycol. **21**: 24–28.

Mikami, H. 1979. On *Erythroglossum bipinnatifidum* (Rhodophyceae, Delesseriaceae) from Chile. Jpn. J. Phycol. **27**: 35–38.

Okamura, K. 1931. Icones of Japanese Algae. **6**: 49–62. pl. 276–280.

Wynne, M. J. 1989. A reassessment of the *Hypoglossum* group (Delesseriaceae, Rhodophyta), with a critique of its genera. Helgoländer Meeresunters. **42**: 511–534.

Wynne, M. J. and Ballantine, D. L. 1986. The genus *Hypoglossum* (Delesseriaceae, Rhodophyta) in the tropical western Atlantic, including *H. anomalum* sp. nov. J. Phycol. **22**: 185–193.

Yoshida, T. and Mikami, H. 1992. *Branchioglossum spiniferum* sp. nov. (Delesseriaceae, Rhodophyta) from north Kyushu, Japan. Jpn. J. Phycol. **40**: 379–384.

三上日出夫：ヒゲムラサキ属 *Yoshidaphycus*（紅藻コノハノリ科）について

ヒゲムラサキ *Branchioglossum ciliatum* Okamura の観察に基づき新属 *Yoshidaphycus* を記載した。この新属はコノハノリ科の *Hypoglossum* 群のなかで分枝様式などで独特である。すなわち，ふつう分枝は葉片の縁辺から生ずるが，これは中軸細胞から分岐したものが第二位細胞列に沿って葉片のなかを伸長して縁辺に達して分枝となる内生的なものである。その他にも第二位細胞列の頂端細胞が変成する場合と，不特定の縁辺細胞から発達することもある。生殖器官が縁辺に生ずる特別な細い小枝にのみ形成されること，果胞子嚢が造胞糸に一個ずつ頂生することも，近縁の属と区別される特徴である。（062 札幌市豊平区西岡3条7丁目3-1　札幌大学）