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Observations on morphology of *Hypoglossum minimum* YAMADA and *H. geminatum* OKAMURA (Delesseriaceae, Rhodophyta)

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Among the species of *Hypoglossum* attributed to Japan, reproductive as well as vegetative structures of *H. minimum* YAMADA and *H. geminatum* OKAMURA were studied with materials recently collected at Wakayama Prefecture, Japan.

H. minimum, usually with simple blades, has procarps composed of a supporting cell, a 4-celled carpogonial branch and 2 groups of sterile cells. Cystocarps are spherical with a conspicuous ostiole. Spermatangial sori are small linear patches arranged parallelly on both sides of midrib. Tetrasporangia are cut off adaxially from 2nd and 3rd order cells including lateral pericentral cells and form an elliptical sorus along the midrib.

H. geminatum has creeping blades from which pairs of blades are formed on the dorsal side of the midrib. The female structure is similar to that of *H. minimum*. Spermatangial sori are ovate to elongate elliptical in shape and formed on both sides of the midrib. Tetrasporangia are cut off adaxially from the cells of 2nd order row including lateral pericentral cells. In the tetrasporangial sorus, no 3rd order cell row is formed. In this respect, the mode of tetrasporangial formation is similar to *H. revolutum* known from Australia.

Key Index Words: *Delesseriaceae*; Hypoglossum; H. geminatum; H. minimum; *Rhodophyta*; *taxonomy*.

The genus *Hypoglossum* KÜTZING (1843), based on *H. woodwardii* KÜTZING (=*H. hypoglossoides* (STACKHOUSE) COLLINS et HERVEY), is characterized in the Delesseriaceae by having all tertiary apical cells reaching the thallus margin, the absence of intercalary division in every order of cell rows, tetrasporangia being formed from cortical cells, having the alae only one cell thick and branching from the midrib. In their study of South Australian species, WOMERSLEY and SHEPLEY (1982) extended the circumscription of the genus to include species where (1) not all second-order cells produce third-order cell rows and (2) tetrasporangia are produced from cells of second- and third-order rows and in some species (but not all) from cortical cells and separate cover cells do not occur.

Up to the present, 7 species are assigned to the *Hypoglossum* from Japanese coast. Among these species, *H. serratifolium* OKAMURA was recently reported on its morphological features (MIKAMI 1985). Concerning the other species, reproductive as well as vegetative structures were not well documented, because of scantiness of suitable materials. We were able to obtain freshly collected specimens of *H. minimum* YAMADA and *H. geminatum* OKAMURA with reproductive structures. Observations on these materials are given here.

Materials and Methods

Collections were carried out in late November 1984 by skin diving at several localities in Wakayama Prefecture, Pacific coast of central Japan. Formalin preserved materials were stained with erythrosin aqueous solution and mounted in glycerin. Specimens deposited in the herbarium of the Faculty of Science, Hokkaido University (SAP) were also examined.

Results

Hypoglossum minimum YAMADA

Vegetative structure: Several blades arise from a small flattened basal disc (Figs. 1, 4), attaching to old branches of *Sargassum* in the subtidal zone. The blades are erect, usually simples, spatulate or oblanceolate in shape, with round apex and entire margin, measuring up to 9 mm long and 2 mm wide, very rarely issuing branches from the midrib. The blades are single layered except the midrib (Fig. 3). Lateral vein is absent. An apical cell divides transversely to give rise to a first-order cell row. All cells of second-order rows produce third-order cell rows abaxially, and all apical cells of the third-order rows reach the thallus margin. No intercalary cell division occurs in every cell rows (Fig. 2).

Reproductive structure: Spermatangial sori are produced on both sides of the midrib forming somewhat parallel patches, separated by sterile area (Figs. 1b, 5, 6, 7). The procarp is borne acropetally on the first-order cell row (Fig. 8). It consists of a supporting cell, a 4-celled carpogonial branch and 2 groups of sterile cells. The first and second cells of the carpogonial branch are round in shape, the second one (cb_2) being the largest. One cystocarp usually develops on the midrib of the upper part of a blade (Figs. 1a, 11), rarely 2 to 3 cystocarps are observed with only one matured. The cystocarp (Fig. 12) is nearly spherical in shape provided with a definite aperture. Carposporophyte is composed of much branched gonimoblast filaments (Figs. 9, 10). Carposporangia develop terminally, obovoid to pyriform in shape, measuring 50-60 μm in diameter.

Well defined tetrasporangial sori develop on the upper part of the blade, ovate to somewhat irregularly elongated in shape (Fig. 13). Tetrasporangia are first cut off acropetally from the lateral pericentral cells, then from other adjacent second- and third-order cells (Fig. 14). They are formed neither from transverse pericentral nor from cortical cells. Mature tetrasporangia are 70-100 μm in diameter. Cortical cells are present at or before the initiation of tetra-

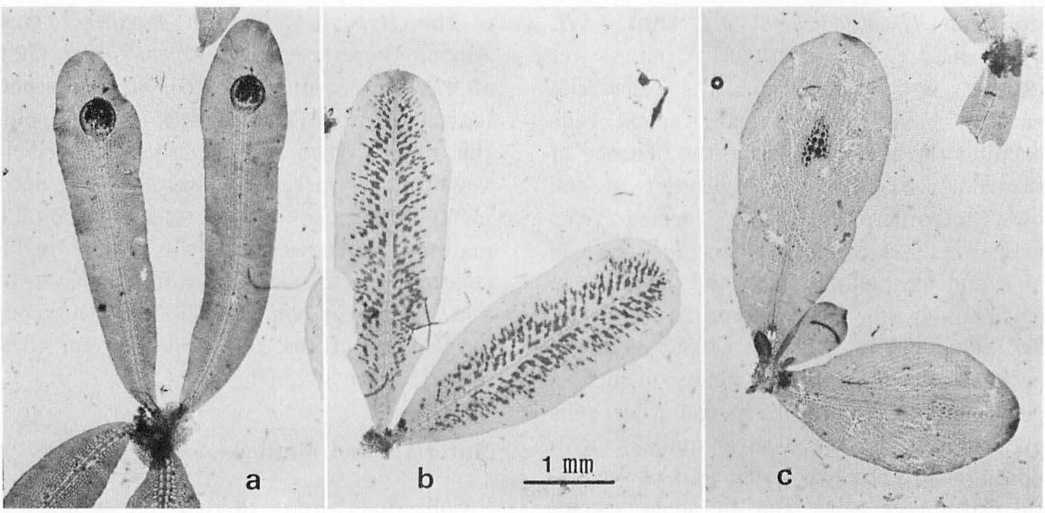
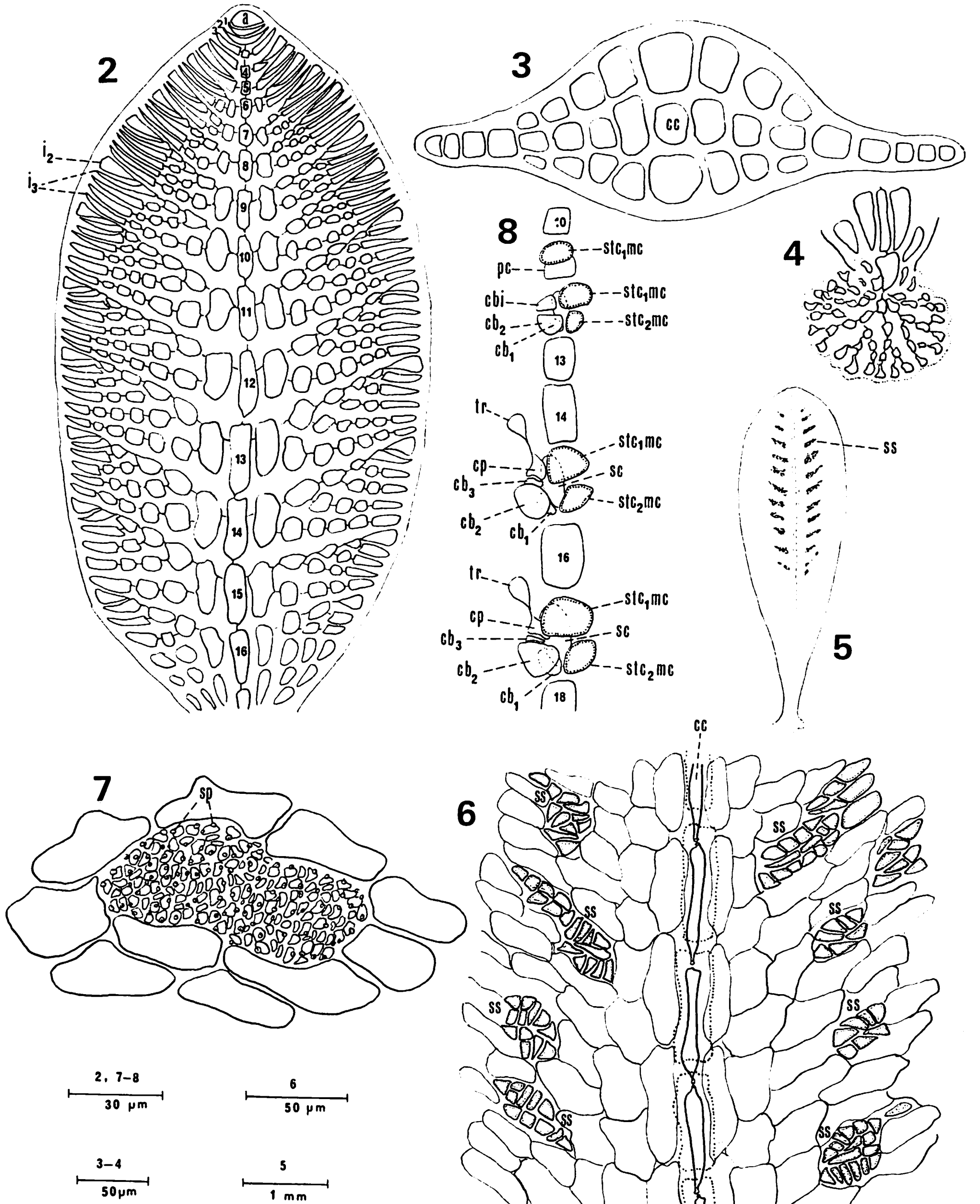
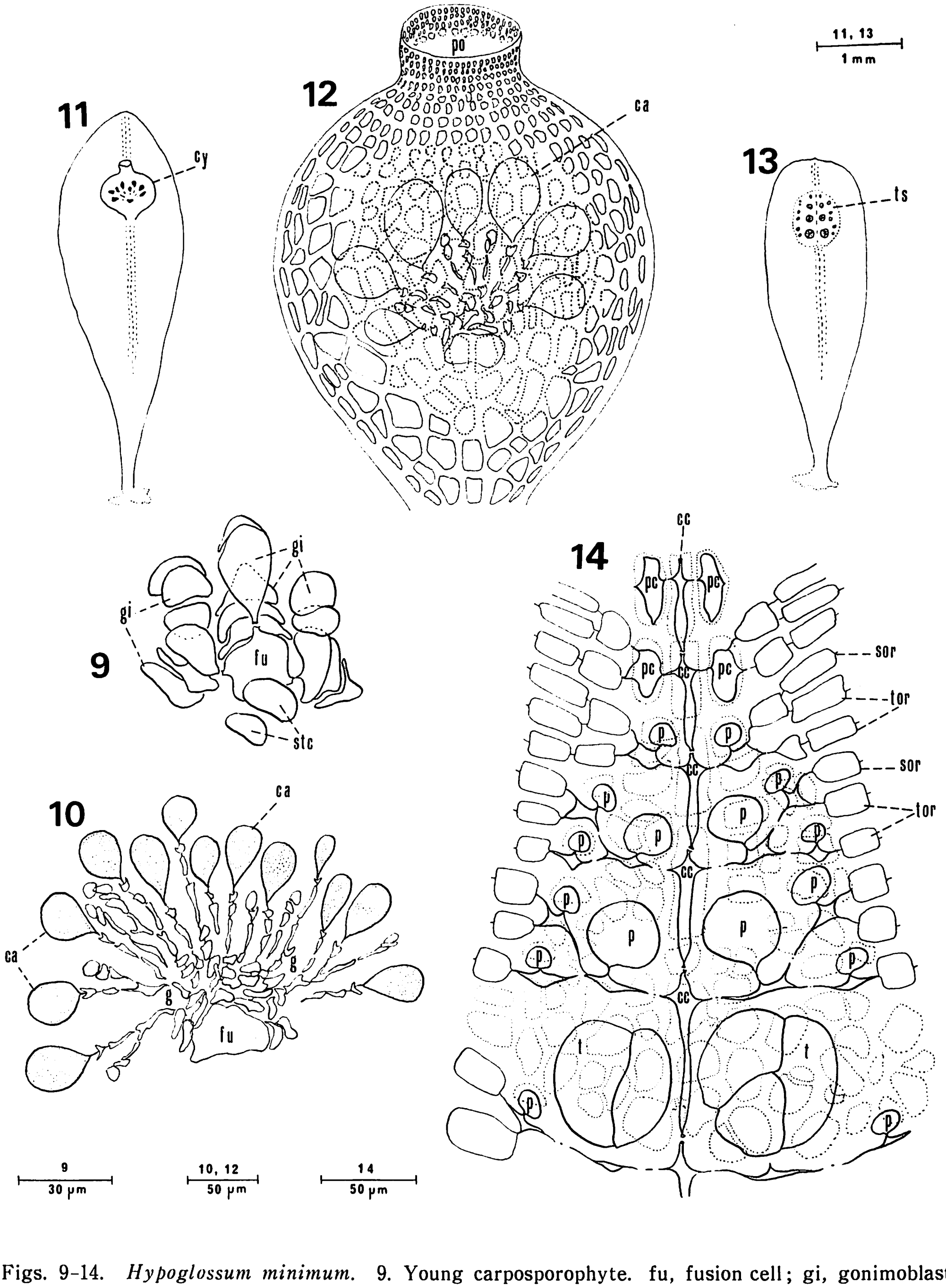


Fig. 1. *Hypoglossum minimum* YAMADA. a, female, b, male, and c, tetrasporangial plants. Hikigawa, Wakayama Pref., Nov. 26, 1984. T. YOSHIDA.



Figs. 2-8. *Hypoglossum minimum.* 2. Young blade, showing all third-order initials reach thallus margin. a, apical cell; i_2, i_3, initials of 2nd and 3rd order rows; numerals 4-16, segments of apical cell. 3. Cross section of blade. cc, central cell. 4. Basal part with attaching disc. 5. Male plant. ss, spermatangial sorus. 6. Young spermatangial sori. 7. Mature spermatangial sorus. sp, spermatangium. 8. Development of procarp. cbi, initial cell of carpogonial branch; cb_{1-3}, first, second and third cells of carpogonial branch; cp, carpogonium; pc, pericentral cell; sc, supporting cell; stc_1mc, stc_2mc, mother cells of first and second groups of sterile cells; tr, trichogyne.



Figs. 9-14. *Hypoglossum minimum.* 9. Young carposporophyte. fu, fusion cell; gi, gonimoblast initial; stc, sterile cell. 10. Mature carposporophyte. ca, carposporangium; g, gonimoblast. 11. Blade with cystocarp. cy, cystocarp. 12. Cystocarp. po, ostiole. 13. Blade with tetrasporangial sorus (ts). 14. Tetrasporangial sorus. cc, central cell; p, tetrasporangial primordia; pc, pericentral cell; sor, second order row; t, tetrasporangium; tor, third order row.

sporangial primordia.

This species was originally described by YAMADA (1936) based on the materials collected from Naha, Okinawa Prefecture, South Japan. The original materials used by him were 4 microscopic slides deposited in SAP. The lectotype was selected from them. It is a tetrasporic specimen about 2 mm long and 0.6 mm wide. The type was said to be epiphytic on a species of *Carpopeltis*. But the specimens at hand were found growing on the old *Sargassum* plants, and a report of this species from Sado Island, Niigata Prefecture (KONNO and NODA 1980), was also based on the plants on *Sargassum*.

Hypoglossum geminatum OKAMURA

Vegetative structure: The thallus grows on the frond of *Carpopeltis angusta* found in subtidal region, and consists of creeping blades issued from a small attaching disc (Figs. 15c, 19) and distal free lateral blades. The creeping primary blades are linear in shape, with entire margin, measuring 5 mm or more in length and less than 1 mm in width. Terminal part of the creeping blade often transforms into a new secondary attaching disc, which again gives rise to new blades. From the dorsal side of a midrib, several pairs of laterals are issued (Figs. 15c, 17, 18). They may become indeterminate creeping axes equivalent to the parent axis, giving rise to next order blades.

Growth takes place by the activity of an apical cell which divides transversely forming a first-order cell row (Fig. 16). All cells of the second-order rows bear third-order rows. All third-order initials reach thallus margin. The thallus is single layered except the midrib. Vein is absent on alae.

Reproductive structure: Spermatangial sori are usually formed on the ultimate blades and occupy both sides of midrib, and are ovate to long elliptical in shape (Fig. 20). Spermatangia develop on the cells of second- and third-order rows (Fig. 21). Formation of the spermatangia proceeds from proximal to distal area. Pericentral cells usually do not produce spermatangia and remain sterile, so that the spermatangial sori are separated on each ala.

The orocarp is produced acropetally on the first order cell row of ultimate blades (Fig. 22). It is composed of a supporting cell, a 4-celled carpogonial branch and 2 groups of sterile cells. The second cell of the carpogonial branch (cb_2) is the largest in size (Fig. 22).

Before fertilization, the first and second sterile cells remain undivided. One cystocarp usually develops on the midrib of the ultimate blade (Fig. 24). The cystocarp (Fig. 25) is

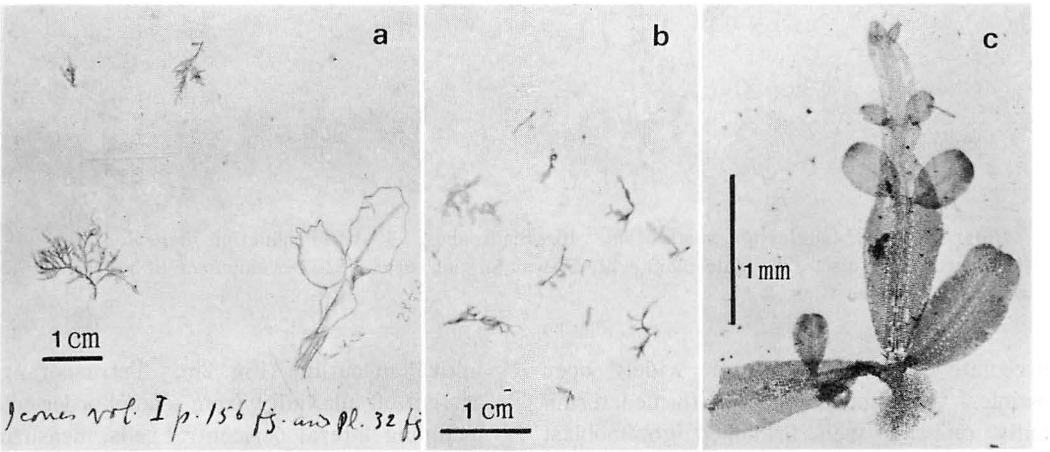
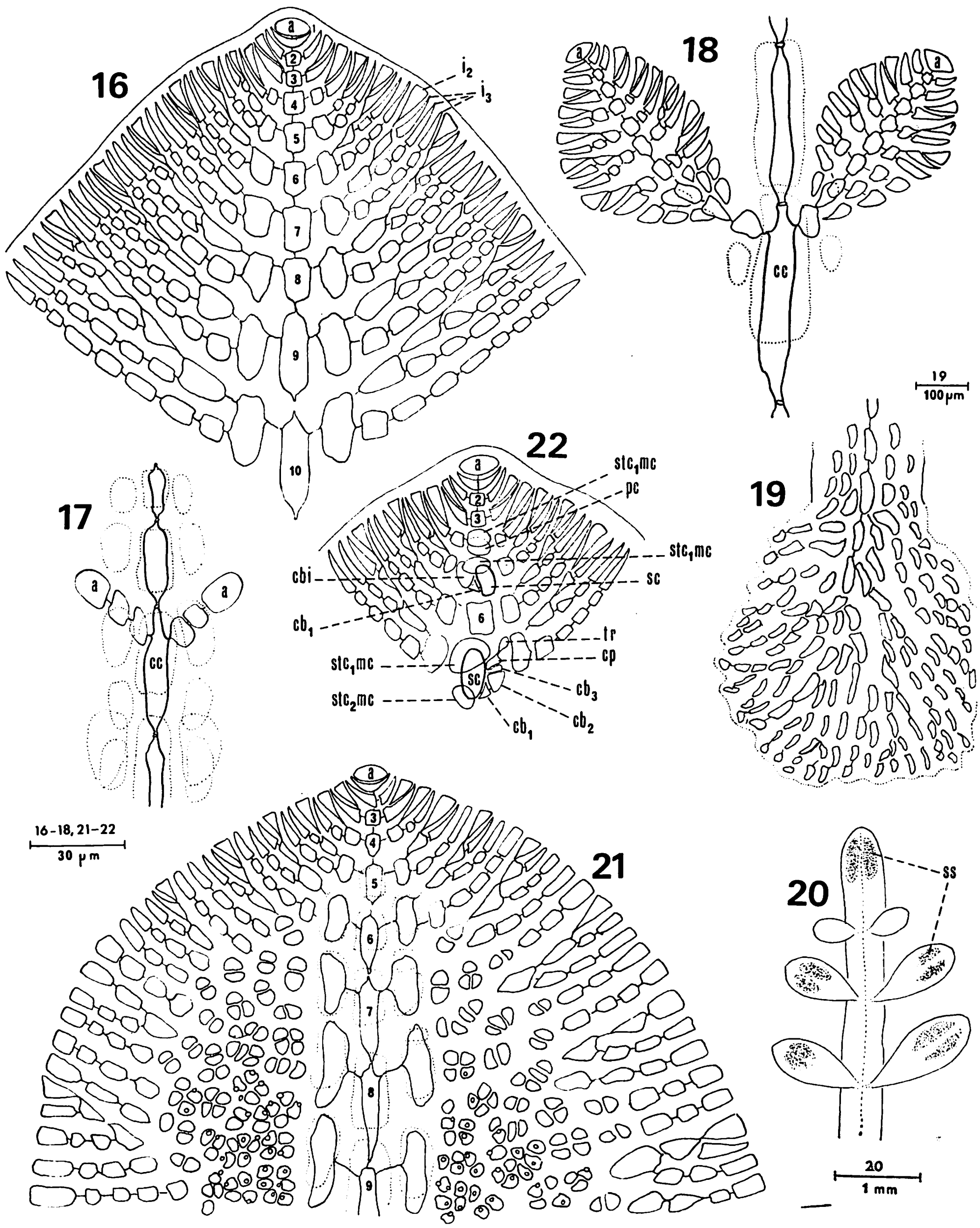


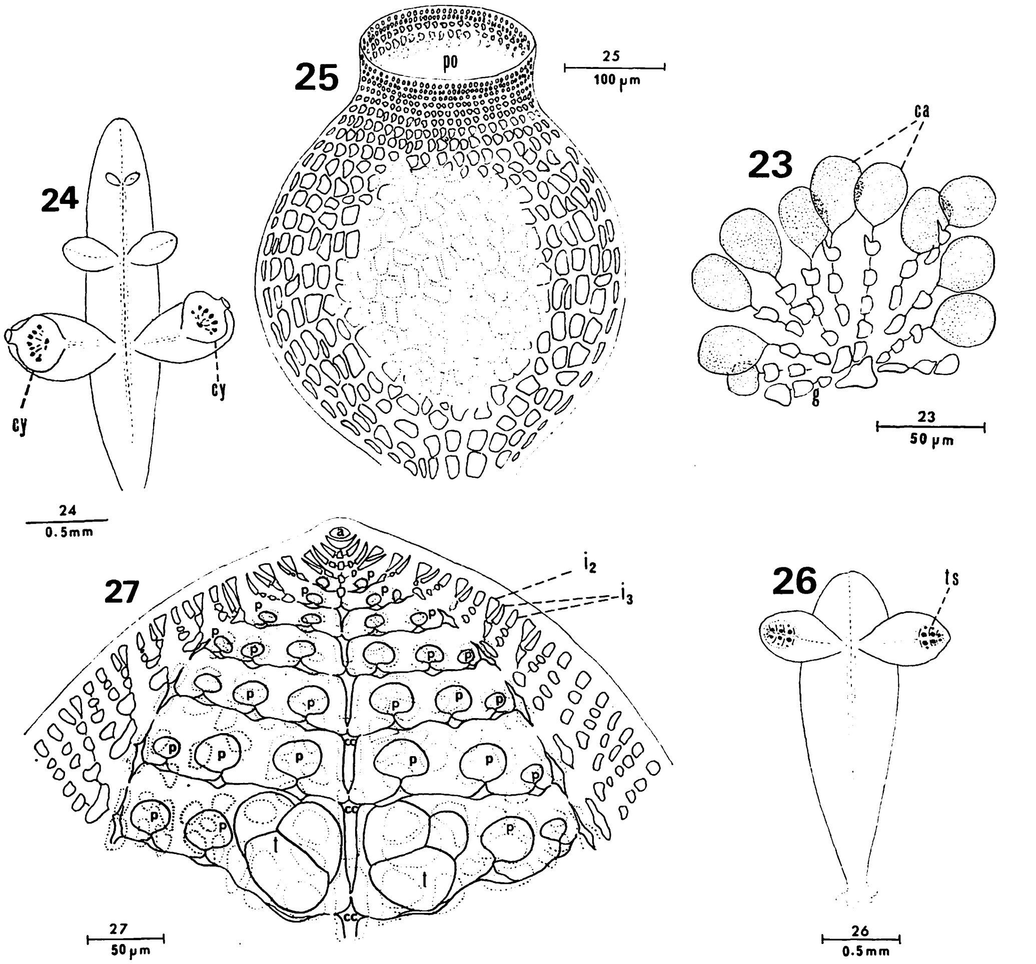
Fig. 15. *Hypoglossum geminatum* OKAMURA. a, the lectotype. Misaki, Kanagawa Pref., K. YENDO. b, Yenoshima, Kanagawa Pref., K. OKAMURA. c, Young plant. Ichie, Wakayama Pref., Nov. 26, 1984. T. YOSHIDA.



Figs. 16-22. *Hypoglossum geminatum*. 16. Blade apex. 17-18. Production of new blades. 19. Basal attaching disc. 20. Male plant. 21. Spermatangial sorus. 22. Development of procarp. For abbreviations, see Figs. 2-14.

urceolate in shape with a widely open ostiole. Carposporangia are formed terminally on the well branched gonimoblast filaments (Fig. 23).

The tetrasporangial sorus is formed on the upper part of ultimate blades, oval to elliptical in outline (Fig. 26). Tetrasporangia are cut off adaxially from second-order cells, including lateral pericentral cells, measuring 70-80 μm in diameter (Fig. 27). No third-order cell row is formed within the sorus, but it is present outside the sorus.



Figs. 23-27. ***Hypoglossum geminatum.*** 23. Mature carposporophyte. 24. Cystocarpic plant. 25. Cystocarp. po, ostiole. 26. Tetrasporangial plant. 27. Tetrasporangial sorus. For abbreviations, see Figs. 2-14.

This species was first described by OKAMURA (1908). He observed two specimens. The one (Fig. 15a) was collected by Yendo from Misaki, Kanagawa Prefecture, Pacific coast of central Japan. This seems to be suitable for selection as the lectotype, because this was used for the original illustration by OKAMURA. The other specimen (Fig. 15b) was collected by OKAMURA himself from Yenoshima, Kanagawa Prefecture, and was clearly noted that it grew on *Carpopeltis angusta.* Our specimens were also found growing on old thalli of the same species. In his illustration, OKAMURA (1908, pl. 32, fig. 12) gave a figure of cystocarp with serrated ostiole margin. This might be caused from the fact that he observed only dried materials. Our specimens have ostioles always with smooth margin as shown in Fig. 25.

Discussion

Many species of the genus *Hypoglossum,* including the type *H. hypoglossoides,* have usually their thalli of more than 10 cm high, up to 40 cm in *H. harveyanum* (J. AGARDH) WOMERSLEY & SHEPLEY (1982). As for the Japanese species, *H. serratifolium* OKAMURA attains more than 25 cm high (MIKAMI

1985). The thalli of *H. minimum* and *H. geminatum*, here treated, are less than 1 cm in length, and constitute the smallest members of the genus. *H. minimum* is unique in the genus in that this species has usually simple blades and branching is very rarely encountered. *H. caloglossoides* WYNNE & KRAFT (1985), recently described from Lord Howe Island, South Pacific, is similar in size and habit to *H. geminatum*. In these two species, the primary blades become creeping on the substratum, and secondary blades are issued in pairs from the dorsal side of the primary ones.

There are two types in the mode of tetrasporangium formation in the genus *Hypoglossum*. In one type, the tetrasporangial initials are cut off from the second and third-order cell rows as in many species observed up to data. The mode of tetrasporangium formation of *H. minimum* (Fig. 14) is similar to that of *H. protendens* (J. AGARDH) J. AGARDH reported by WOMERSLEY and SHEPLEY (1982), but in *H. minimum* tetrasporangia are not originated from transverse pericentral cells. In another type, the tetrasporangial initials are cut off only from second-order cells, and development of third-order cell rows is suppressed within the tetrasporangial sorus (Fig. 27). This type was first recognized in *H. revolutum* (HARVEY) J. AGARDH from Australia (WOMERSLEY and SHEPLEY, 1982) and was verified here in *H. geminatum*. This is the second example in the genus.

The shape of spermatangial sori is another characteristic in recognizing the species. In species such as *H. heterocystoideum* (J. AGARDH) J. AGARDH (=*H. hypoglossoides* (HARVEY) WOMERSLEY et SHEPLEY) and *H. geminatum*, the sori form elongate patches along the midrib (Fig. 20). Whereas in *H. harveyanum* and *H. minimum*, the sori are small linear patches separated by sterile areas arranged parallelly on both sides of the midrib (Figs. 1b, 5).

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吉田忠生*・三上日出夫: 紅藻コノハノリ科ヒメベニハノリとベニハノリについて**

日本産ベニハノリ属植物のうち，ヒメベニハノリ *Hypoglossum minimum* YAMADA とベニハノリ *H. geminatum* OKAMURA の新しい材料を和歌山県で得てその構造を精査した。

ヒメベニハノリはふつう単葉で，分枝がほとんどない。プロカルプは支持細胞と1組の造果枝，2群の中性細胞よりなる。嚢果は壷状で，はっきりした開口部をもつ。精子嚢群は中肋の両側に並列し，平行した細い群を多数生ずる。四分胞子嚢は側生周心細胞を含め，第2・第3位列の細胞から切りだされ，この属のふつうの様式を示し，楕円形の胞子嚢群を作る。

ベニハノリは，ほふくする葉片の中肋から対になった葉片を生ずる。雌性生殖器官はヒメベニハノリの場合とだいたい同様で，嚢果の開口部の縁辺は平滑で，原記載のときの図とは異なる。精子嚢群は中肋をはさんで対になって生ずる。四分胞子嚢は側生周心細胞を含む第2位列の細胞からだけ切りだされ，胞子嚢群のなかでは第3位列を生じない点で，この属ではオーストラリア産の *H. revolutum* と共に例外的である。 (* 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 ** 062 札幌市豊平区西岡 3-7-3-1 札幌大学女子短期大学部)