# A Systematic Study of the *Phyllophoraceae* and *Gigartinaceae* from Japan and its Vicinity

BY

HIDEO MIKAMI

## Introduction

For several years the present writer has been studying systematically the Japanese species of the *Phyllophoraceae* and *Gigartinaceae* under the guidance of Prof. Y. YAMADA, in the Botanical Institute, Faculty of Science, Hokkaido University. The materials used for the present study mainly consist of the specimens belonging to the Faculty of Science, Hokkaido University; those of the Faculty of Science, the Tokyo University which includes the specimens of the late Prof. K. YENDO; those of the Faculty of Agriculture of Hokkaido University which contains the specimens of the late Prof. K. MIYABE, and those of the writer himself. In addition to these collections, many other specimens were submitted to the writer's examination by many people at home and abroad.

Here, the writer wishes to express his cordial thanks to his teacher, Professor Y. YAMADA, for kind guidance during the course of this work. The writer is very thankful to Dr. Y. SAKAI for valuable suggestions regarding his study. Sincere thanks are also due to Prof. H. HARA in the Botanical Institute, Faculty of Science, Tokyo University, who kindly allowed him to study Dr. YENDO's specimens, to Prof. G. F. PAPENFUSS in the Department of Botany, University of California, Berkeley, to Dr. J. TH. KOSTER in the Rijksherbarium, Leiden, to Dr. A. D. ZINOVA in the Botanical Institute of the Academy of Sciences, Leningrad, and to Dr. I. A. ABBOTT in the Hopkins Marine Station, Pacific Grove, California, who kindly allowed the writer to see precious specimens. Thanks are also due to all gentlemen in the Botanical Institute, Faculty of Science, Hokkaido University, and in other institutes, who sent the writer their valuable specimens.

The type specimens of the plants newly named here are deposited in the Herbarium, Botanical Institute, Faculty of Science, Hokkaido University.

## *Phyllophoraceae*

Key to the genera

1. Frond with cylindrical branches; tetrasporangia absent; monosporangia in small nemathecia . . . . . *Ahnfeltia*

1. Frond with all or the ends of branches flattened; tetrasporangia present . . 2
   2. Cystocarps in long linear nemathecia . . . . . *Stenogramme*
   2. Cystocarps not as above . . . . . *Gymnogongrus*

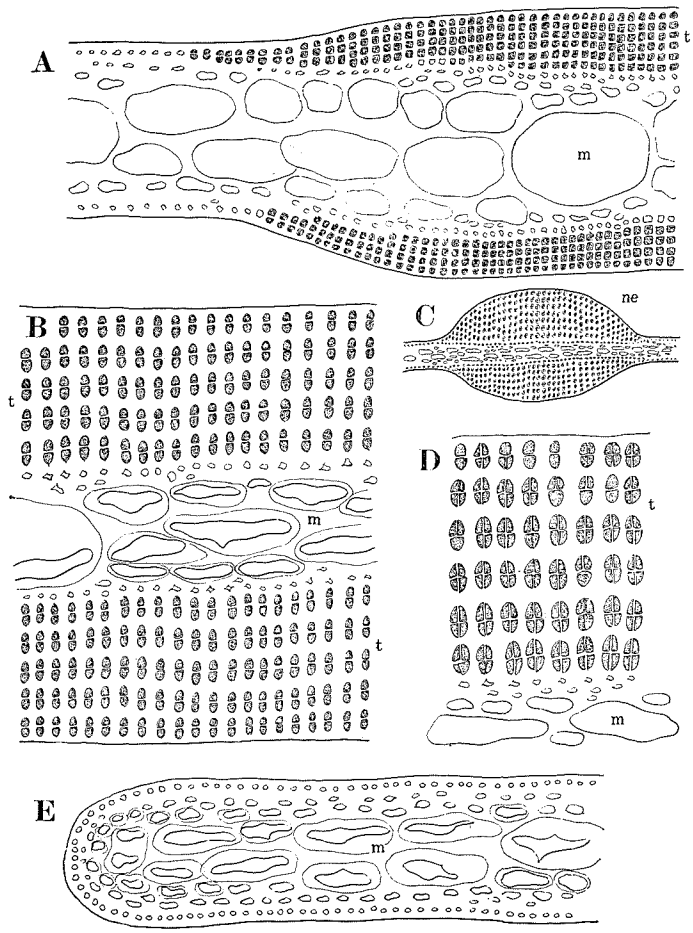


Fig. 1. *Stenogramme interrupta* (AG.) MONTAGNE

A. Transverse section of thallus, showing early development of sporangia. × 180.
B. Transverse section of thallus, with two-celled sporangia. × 180.
C. Mature nemathecia in transverse section. × 30.
D. The same, more highly magnified. × 180.
E. Marginal portion of thallus in transverse section. × 180.

m, medulla; ne, nemathecia; t, tetrasporangia.

## *Stenogramme*

### ***Stenogramme interrupta*** (AG.) MONTAGNE

Fig. 1

"Montagne, in Duchartre, Rev. Bot., 1846, p. 483"; HARVEY, Phyc. Brit., 1846, tab. 157; Id., Phyc. Austral., 1858, tab. 220; KÜTZING, Sp. Alg., 1849, p. 873; J. AGARDH, Sp. Alg. II, 1851, p. 391; Id., Epicr., 1876, p. 215; DE TONI, Syll. Alg. IV, 1897, p. 239; OKAMURA, Illust. Mar. Alg. Jap. Vol. I, no.3, 1901, p. 29, pl. XI; Id., Icon. Jap. Alg., Vol. VI, 1929, p. 10, pl. 256; Id., Nippon Kaisoshi, 1936, p. 641, Fig. 306; *Delesseria interrupta* AG. Sp. Alg., 1823, p. 179.

Japanese name: Hasujigusa.

Locality: Seto, Wakayama Pref. (INOH, June 1940); Enoshima, Kanagawa Pref. (YAMADA, Apr. 1932). Growing on rocks.

Frond caespitose, membranaceous, rather rigid below, flaccid and often delicately thin above, 5–10 cm in height, attaching to substratum by a small conical disc, stipitate, three to five times dichotomously or subdichotomously divided, rapidly expanding into a fan-shaped membrane; laciniae linear, 3–7 mm broad, obtuse, repeatedly forked, sometimes irregularly dichotomous; margin usually flat and entire, sometimes provided with minute fringing processes; tissue composed of two layers, cortical and medullary; cortex consisting of 1–3 rows of minute coloured cells, arranged perpendiculary to the surface of the frond; medullary layer consisting of large round cells, arranged horizontally to the surface of the frond; transition from medulla to cortex considerably abrupt; tetrasporangial sori (namathecia) round or oval, prominent, scattered irregularly on both surfaces of the frond, originating from the cells of the cortical layer; tetrasporangia 12–30 $\mu$ in diam., cruciately divided; cystocarps not observed in our materials; colour fine clear pinky red; specimens scarcely adhere to paper in drying.

The present alga is rather delicate and flaccid. It shows a strong resemblance to *St. californica* HARVEY in general appearance except the small dimension.

## *Gymnogongrus*

### ***Gymnogongrus flabelliformis*** HARVEY

Figs. 2–3

HARVEY, in GRAY's List of Jap. Pl., 1856, p. 332; SURINGAR, Alg. Jap., 1870, p. 36, t. XXIV B; DE TONI, Phyc. Jap. nov., 1895, p. 25; Id., Syll. Alg. IV, 1897, p. 248; OKAMURA, Icon. Jap. Alg., vol. IV, 1921, p. 128, pl. 181–182; Id., Nippon Kaisoshi, 1936, p. 643.

Japanese name: Okitsunori.

Type locality: Shimoda, Shizuoka Pref.

Locality: Very common on both the Pacific coast and Japan Sea coast.

Growing on rocks.

Frond caespitose, cartilaginous, compressed, narrow-linear, 3–8 cm high or more, arising from callous disc, regularly and repeatedly dichotomous, fan-shaped in general outline, closely forking with erecto-patent branches standing on roundish axils, often with long intervals below and with short one above; branches linear and compressed, almost equal in breadth (1–1.5 mm), ending in obtuse or pointed bifurcate apices, but sometimes becoming very slender and almost filiform; margin with or without proliferations; tissue composed of two layers, cortical and medullary; cortex consisting of 4–5 rows of small, globular or rectangular pigmented cells, 3–8 $\mu$ in diam., arranged closely with their longer axis perpendicular to the surface of the frond; medullary layer consisting of large thin-walled cells, roundish or elliptical in transverse section, 50–65 (–150) $\mu$ in diam. at the central portion; transition from medulla to cortex gradual; tetrasporangia not observed; cystocarps almost globular, produced in ultimate and penultimate segments, often several seriated in one (rarely two) rows, slightly prominent on both surfaces; procarp abundant, with 1–2-sterile cells issuing from the first cell of the carpogonial branch; gonimoblast filaments abundant, directly connected with medullary cells by the pit-connections; both the special medullary filaments (Faserhülle) and the special absorbent filaments absent; carpospores aggregated, ovoid, 10–17.5 $\mu$ in diam.; colour dark reddish purple or greenish-purple, changing to blackish in drying; specimens not adhering to paper in drying.

The present species is one of the commonest seaweeds in Japan, and is known to be very variable in external appearance.

While, on the internal structure of the present species OKAMURA (1935) notes as follows; "In *Gymnogongrus* I think that the inner cells having very wide calibres are mixed with those of smaller ones and reticulately constructed like parenchymatic tissue.".

According to the writer's observation, however, in older compressed portions of the frond the cells are rather looser than those in the young branches, and they seem just like densely imbedded in intercellular matrix as in Fig. 2 (D).

The structure of the procarp of this alga was reported by J. TOKIDA and T. MASAKI (1959) with material from Tachimachimisaki, Hakodate, and about the same results were obtained by the writer in the Samani-specimens. The procarps of this species consist of a large supporting (auxiliary) cell bearing a three-celled carpogonial branch as in Fig. 2 (A). The carpogonial branch is strongly curved in such a way that the carpogonium becomes to lie close to the supporting (auxiliary) cell. Moreover, one or two sterile cells with dense contents issuing from the first cell of the carpogonial branch were distinctly observed.

To his regret, the writer has not been able to observe the union of the car-

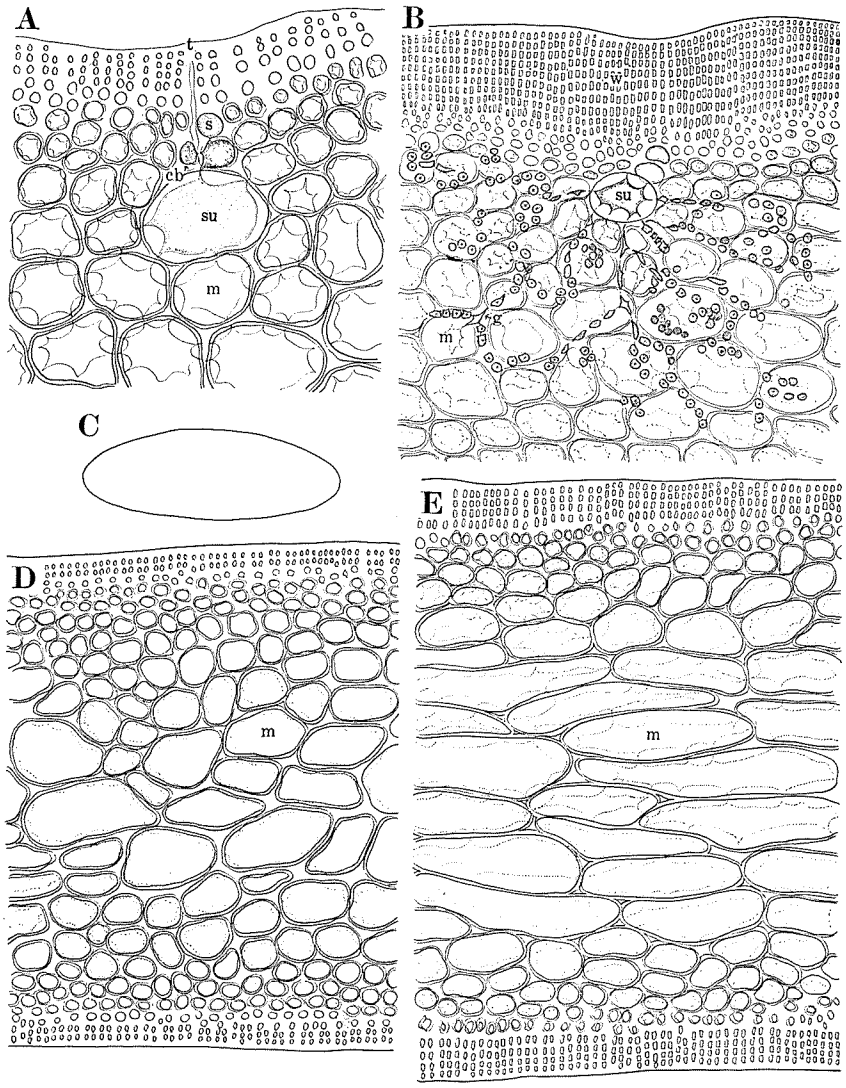


Fig. 2. *Gymnogongrus flabelliformis* HARVEY

A. Transverse section of thallus with procarp. × 340.
B. Early development of gonimoblasts in transverse section. × 180.
C. Transverse section of thallus. × 30.
D. The same, more highly magnified. × 180.
E. Longitudinal section of thallus. × 180.

cb, carpogonial branch; g, gonimoblast; m, medulla; s, sterile cell; su, supporting cell; t, trichogyne; w, wall of cystocarp.

pogonium and the auxiliary cell. The structure and development of the gonimoblasts are quite similar to those of *Ahnfeltia*. That is, the medullary cells in the vicinity of the auxiliary cell are gradually enlarge and they acquire rich contents.

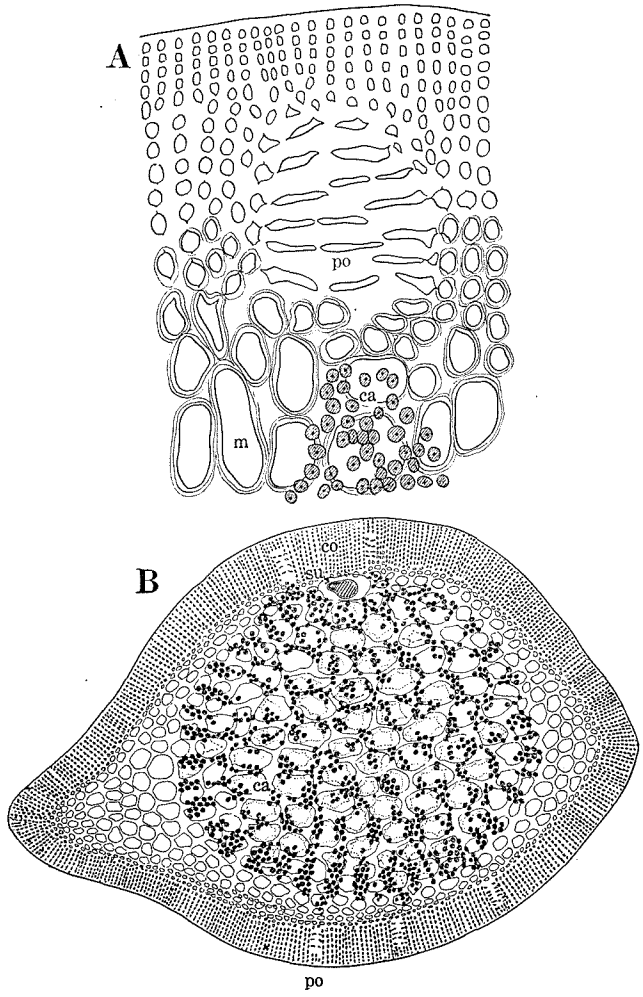


Fig. 3. *Gymnogongrus flabelliformis* HARVEY
A. Aperture of cystocarp. × 260.
B. Mature cystocarp in longitudinal section. × 60.
ca, carposporangia; co, cortex; m, medulla;
po, aperture; su, supporting cell.

The gonimoblast filaments are abundant and slender. They directly communicate with the swollen medullary cells, and their contents are exhausted for

the further developments of the gonimoblasts. Accordingly, the special medullary filaments (Faserhülle) and the special absorbent filaments are entirely lacking in this plant. The carpospores are rather small and densely aggregate, round or ovoid, measuring 10–17.5 $\mu$ in diameter. On the other hand, the cortical layers above the procarp are markedly thickened by the secondary cell divisions. The apertures are formed on both surfaces of a cystocarp.

Fig. 3 (A) shows an ostiole and a group of almost matured carposporangia.

## Ahnfeltia

Key to the species and variety

1. Frond prostrate with small erect papillae . . . . . *Ahn. gracilis*
1. Frond erect . . . . . 2
   2. Frond complicated . . . . . 3
   2. Frond not complicated . . . . . 4
3. Branches up to 0.5 mm in diameter . . . . . *Ahn. plicata*
3. Branches up to 0.3 mm in diameter, forming spherical mass . . . . . *Ahn. plicata* var. *tobuchiensis*
   4. Main branch compressed or subcylindrical . . . . . 5
   4. Main branch cylindrical in general . . . . . 6
5. Main branch slightly canaliculate . . . . . *Ahn. yamadae*
5. Main branch not so . . . . . *Ahn. paradoxa*
   6. Frond regularly branched in dichotomous manner . . . . *Ahn. furcellata*
   6. Frond irregularly branched in di-trichotomous manner, sometimes quite simple . . . . . *Ahn. concinna*

### ***Ahnfeltia plicata*** (HUDS.) E. FRIES

Fig. 4

"Fries, Fl. Scan., 1835, p. 310"; J. AGARDH, Sp. Alg., II, 1851, p. 311; Id., Epicr., 1876, p. 206; HARVEY, Ner. Bor. Amer., 1853, p. 168; FARLOW, Mar. Alg. New Engl., 1881, p. 147; KJELLMAN, Alg. Arctic Sea, 1883, p. 166; Id., Beringh. Alg., 1889, p. 30; DE TONI, Syll. Alg. IV, 1897, p. 254; Id., Syll. Alg. VI, 1924, p. 201; SAUNDERS, Harriman Alaska Exped., 1901, p. 435; SETCHELL et GARDNER, Alg. N. W. Amer., 1903, p. 305; COTTON, Mar. Alg. Corea, 1906, p. 369; KYLIN, Studien, 1907, p. 130; Id., Mar. Alg. Friday Harbor, 1925, p. 30; Id., Calif. Rhodophyc., 1941, p. 26; Id., Rhodophyc., 1944, p. 58; KYLIN et SKOTTSBERG, Subantarktischen, 1919, p. 9; SKOTTSBERG, Mar. Alg., 2, 1923, p. 10; SINOVA, Alg. Ochotsk, 1930, p. 108; Id., Alg. Petrov Isl., 1938, p. 52, Fig. 3 c, d, e; ROSENVINGE, Reproduction, 1931 a, p. 554; NEWTON, British Seaweeds, 1931, p. 414, Fig. 246; OKAMURA, Alg. Alaska, 1933, p. 89; Id., Nippon Kaisoshi, 1936, p. 646; TAYLOR, N. E., N. Amer., 1937, p.

295, pl. 37, Fig. 1. pl. 40, Fig. 6; TOKIDA et OHMI, Mar. Alg. Tobuchi, 1941, p. 431; KINOSHITA, Itanigusa, 1941, p. 272; TOKIDA, Mar. Alg. S. Saghalien, 1954, p. 175; TOKIDA et MASAKI, Mar. Alg. Oshoro, 1959, p. 187.

"*Fucus plicatus* HUDSON, Fl. Angl., ed. alt., 1762, p. 589"; TURNER, Historia Fucorum Vol. 3, 1811, p. 107, pl. 180.

*Gigartina plicata* LAMOUROUX, Essai, 1813, p. 48; LYNGBYE, Tentamen Hydr., 1819, p. 42; POSTELS et RUPRECHT, Illustr. Alg., 1840, p. 16.

*Gymnogongrus plicatus* HARVEY, Phyc. Brit., I, 1847, p. XXI (no. 108), III, 1851, pl. 288; KÜTZING, Sp. Alg., 1849, p. 789; Id., Tab. Phyc., 1869, pl. 66; RUPRECHT, Tange Ochotsk., 1851, p. 326; HAUCK, Meeresal., 1885, p. 138.

Japanese name: Netsuki-itanigusa.

Locality: Shozanbetsu, Rumoe Prov. (KAWASHIMA, July 1960). Cast ashore.

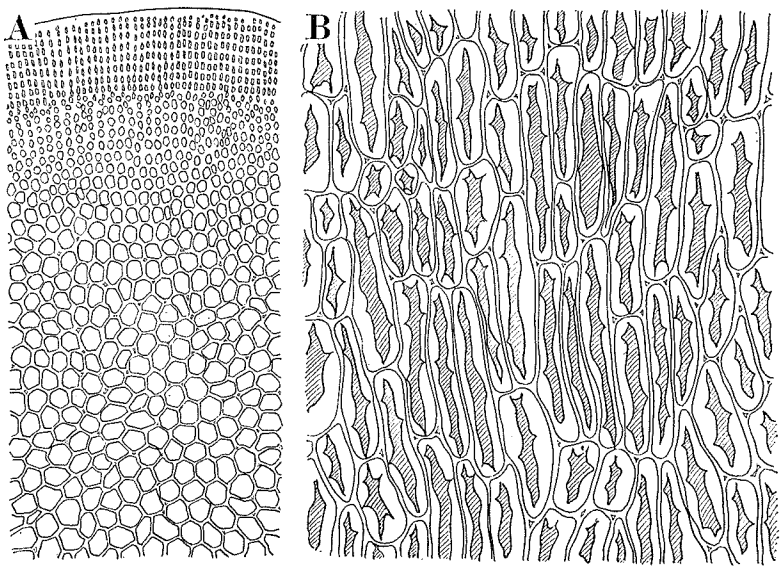


Fig. 4. *Ahnfeltia plicata* (HUDS.) E. FRIES
A. Transverse section of thallus. × 380.
B. Longitudinal section of thallus. × 380.

Frond gregarious, usually 5–10 cm high, dense and bushy, often much entangled; branches cylindrical or subcylindrical throughout almost whole length, in transverse section circular or slightly oblong, ca. 240–500 $\mu$ in diam., branching frequent in a regular decompound-dichotomous manner, rather distant below and with short interval above with a patent rounded axil; lateral proliferation borne anywhere on branches, secund, often aggregate, simple or once or twice forked;

cortex consisting of 4–6 rows of isodiametric small, subsquare, somewhat roundly angled cells, cells 2.5–4.5×2–3 $\mu$ in diam., arranged perpendicularly to the surface of the frond; medullary layer parenchymatous, consisting of cylindrical cells; cells 15–40×4.5–6 $\mu$ in longitudinal section, arranged horizontally to the surface of the frond; transition from medulla to cortex extremely gradual; reproductive organ not observed; colour purplish red when fresh, changing to blackish in drying; specimens not adhering to paper in drying.

The morphology of the vegetative organs of *Ahn. plicata* was described in detail by ROSENVINGE (1931). Moreover, the nemathecia and the development of the spores in the same species were fully reviewed by GREGORY (1930), CHEMIN (1930) and ROSENVINGE (1931).

In the writer's hand, there is a single sterile specimen of *Ahn. plicata* collected at Shozanbetsu, Rumoe Prov., Hokkaido. The cortex is composed of small, square cells with slightly round angles, and arranged in radial rows having the same diameter in transverse section while the central parts of the frond are built up of long isodiametric cylindrical cells as in Fig. 4(B).

### var. ***tobuchiensis*** KANNO et MATSUBARA

KANNO et MATSUBARA, in Jour. Fish., no. 35, 1932, p. 128, pl. I, Figs. A, B, pl. 2, Figs. 1, 2, 8; OKAMURA, Nippon Kaisoshi, 1936, p. 646; NAGAI, Mar. Alg. Kurile Isl., 1941, p. 182; TOKIDA et OHMI, Mar. Alg. Tobuchi, 1941, p. 431; TOKIDA, Mar. Alg. S. Saghalien, 1954, p. 176.

Japanese name: Itanigusa.

Locality: Muroran, Iburi Prov. (NAKAMURA, Oct. 1935); Nemuro, Nemuro Prov. (KAWASHIMA, June 1960). Cast ashore.

The present variety is distributed in Saghalien, the Kuriles and Hokkaido. As pointed out by several authors, the present variety is easily distinguishable from the typical form of the species by the remarkable thinness of the frond and by the glomerate thallus. In 1932, KANNO and MATSUBARA reported the presence of nemathecia in *Ahn. plicata* all the year round.

But the writer failed to find them in the present variety as well as in the typical form of *Ahn. plicata.*

## ***Ahnfeltia concinna*** J. AGARDH

Figs. 5–6

J. AGARDH, Sp. Alg. II, 1851, p. 312; Id., Epicr., 1876, p. 207; DE TONI, Syll. Alg. IV, 1897, p. 256; YENDO, Not. Alg. New to Jap. V, 1916a, p. 256; OKAMURA, Icon. Jap. Alg., IV, 1922, p. 173, 179, pl. 191, Figs. 1–7; Id., Alg. Isl. Hatidyo, 1930, p. 95; Id., Nippon Kaisoshi,

1936, p. 645.

Japanese name: Saimi.

Locality: Hachijo Isl., (YAMADA, FUNAHASHI, July 1951). Growing on rocks extending from the mid-tide to a little over the high tide mark.

Frond gregarious, erect, with numerous branches growing erect from a common prostrate disc-shaped holdfast, cylindrical or subcylindrical, 5–10 (–15) cm high, 1–2 mm in diam., substipitate for a more or less long distance from the base, wiry, rigid, sometimes quite simple, but more usually sparingly or repeatedly branched upward in a di-trichotomous manner, provided with proliferous branches;

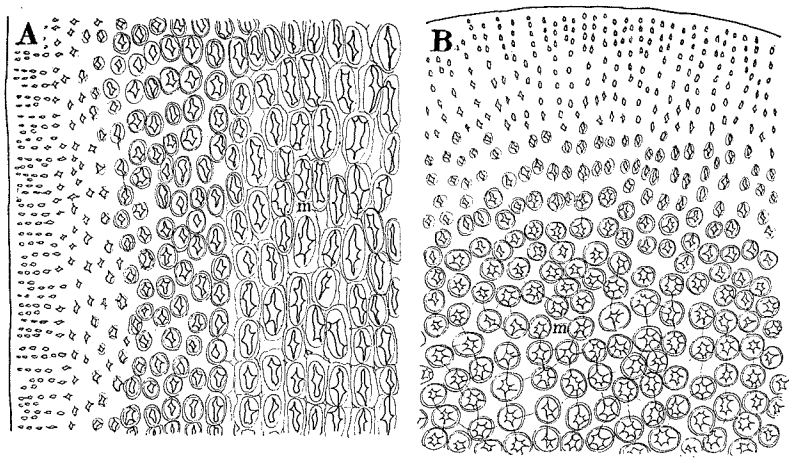


Fig. 5. *Ahnfeltia concinna* J. AGARDH
A. Longitudinal section of thallus. × 180.
B. Transverse section of thallus. × 180.
m, medulla.

branches cylindrical or slightly compressed, often corrugato-flexuose; prostrate portion in longitudinal section consisting of small compact filaments of small cells with uniform diameter, perpendicular to the substratum; tissue of erect thallus composed of two layers, cortical and medullary; cortex of 5–7 (–14) rows of small, subglobular or ellipsoidal cells, 2.5–4 $\mu$ in dimensions, arranged closely with their longer axis perpendicular to the surface of the frond; medullary layer parenchymatous, cells rather loose, roundish or elliptical in transverse section, 5.0–7.5 $\mu$ in diam. at the central portion; transition from medulla to cortex quite gradual; cystocarps many approximated in upper branches, slightly swollen out forming warty prominences with aperture; procarp with sterile cell; gonimoblast filaments

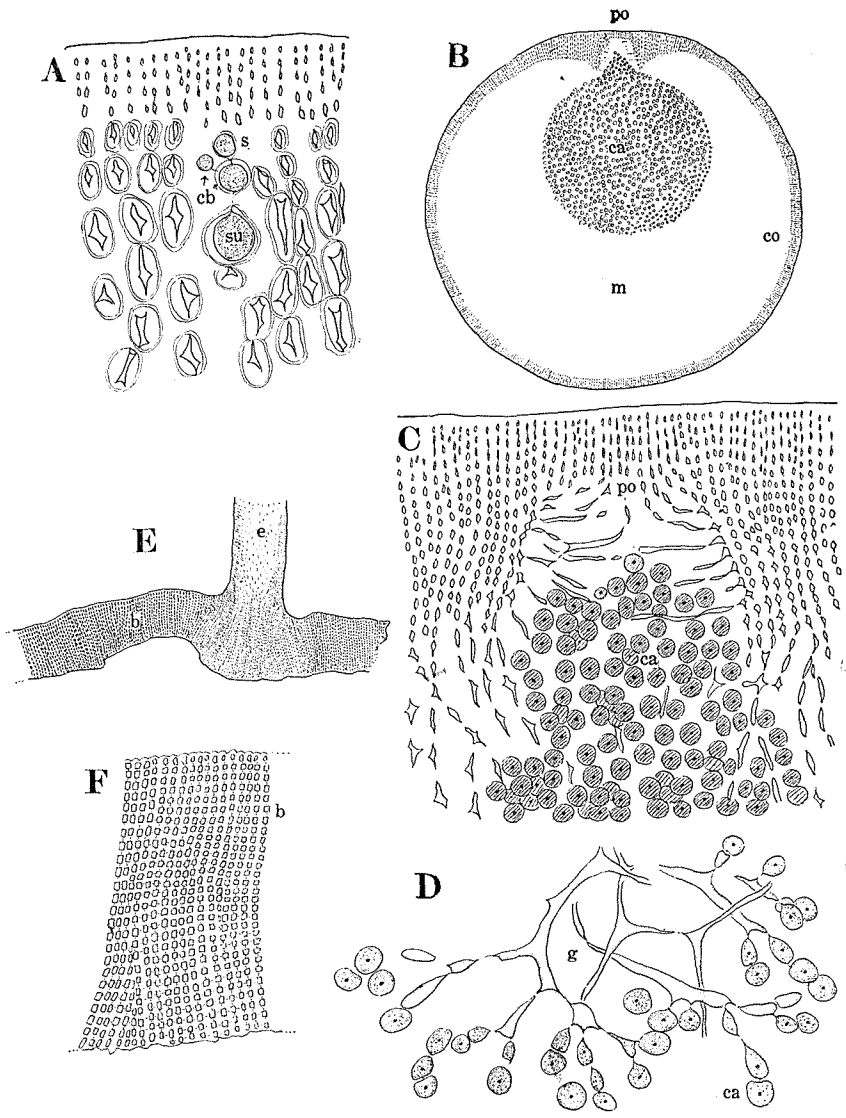


Fig. 6. *Ahnfeltia concinna* J. AGARDH

A. Transverse section of thallus with procarp. × 360.
B. Distribution of carposporangia in transverse section of thallus. × 30.
C. Aperture of cystocarp. × 195.
D. Groups of carposporangia. × 360.
E. Longitudinal section of basal creeping portions (diagrammatic). × 30.
F. The same, more highly magnified. × 195.

b, basal portion; ca, carposporangia; cb, carpogonial branch; co, cortex; e, erect thallus; g, gonimoblast; m, medulla; po, aperture of cystocarp; s, sterile cell; su, supporting cell.

abundant, distributed in one side in transverse section, densely branched, directly connected with swollen medullary cells; special medullary filaments (Faserhülle) and special absorbent filaments absent; carpospores aggregated, round or ovoid, 10–15 $\mu$ in diam. at maturity; colour dark purple or greenish purple, becoming almost black in drying; specimens not adhering to paper in drying.

The occurrence of the present species in the Japanese waters was reported at first from Chiba Pref., Kanagawa Pref. and Mie Pref. by YENDO (1916), and for the second time from Ogasawarajima (Bonin Islands) by OKAMURA (1922). The specimens which the writer refers to the present species were collected by YAMADA and FUNAHASHI in July, 1951 on the Island of Hachijo.

The description of the species given above was mainly drawn from Hachijo materials. A well-grown typical form of the present species has the numerous erect branches growing from a common prostrate disc-shaped base.

The prostrate portion has a parenchymatic structure of firm consistence, being built up of almost quadrangular cells arranged in more or less vertical rows. The erect branches are cylindrical or subcylindrical, substipitate for a somewhat long distance from the base, and sparingly or repeatedly branched in a di-trichotomous manner with proliferous branches. The internal structure is rather loose, and the cells are densely imbedded in intercellular substance. The specimens at hand are all cystocarpic. The cystocarp is chracteristic forming warty prominences with an aperture. Carpogonial branches are three-celled. As shown in Fig. 6 (A), one sterile cell arising from the first cell of the carpogonial branch is recognized. The medullary cells in the vicinity of the procarp are gradually enlarge with dense contents. The gonimoblast-threads develop towards the swollen medullary cells, and are aggregate in one side in transverse section of the erect branches. Soon after, the gonimoblast cells directly communicate with the swollen medullary cells. Consequently, the contents of the swollen medullary cells are exhausted for the further development of the gonimoblasts. The sterile cells of the gonimoblast lose most of their contents, as the carposporangia develop. In the present alga, both the special medullary filaments and the special absorbent filaments are entirely wanting. The carpospores are aggregate, round or ovoid, measuring 10–15 $\mu$ in diameter.

### *Ahnfeltia furcellata* OKAMURA

Fig. 7

OKAMURA, Icon. Jap. Alg., vol. VII, 1934, p. 16–17, pl. 310, Figs. 6–10; Id., Nippon Kaisoshi, 1936, p. 646.

Japanese name: Husa-saimi.

Locality: Ashizuri-misaki, Kochi Pref. (YAGI, without data of collection; OUCHI, July

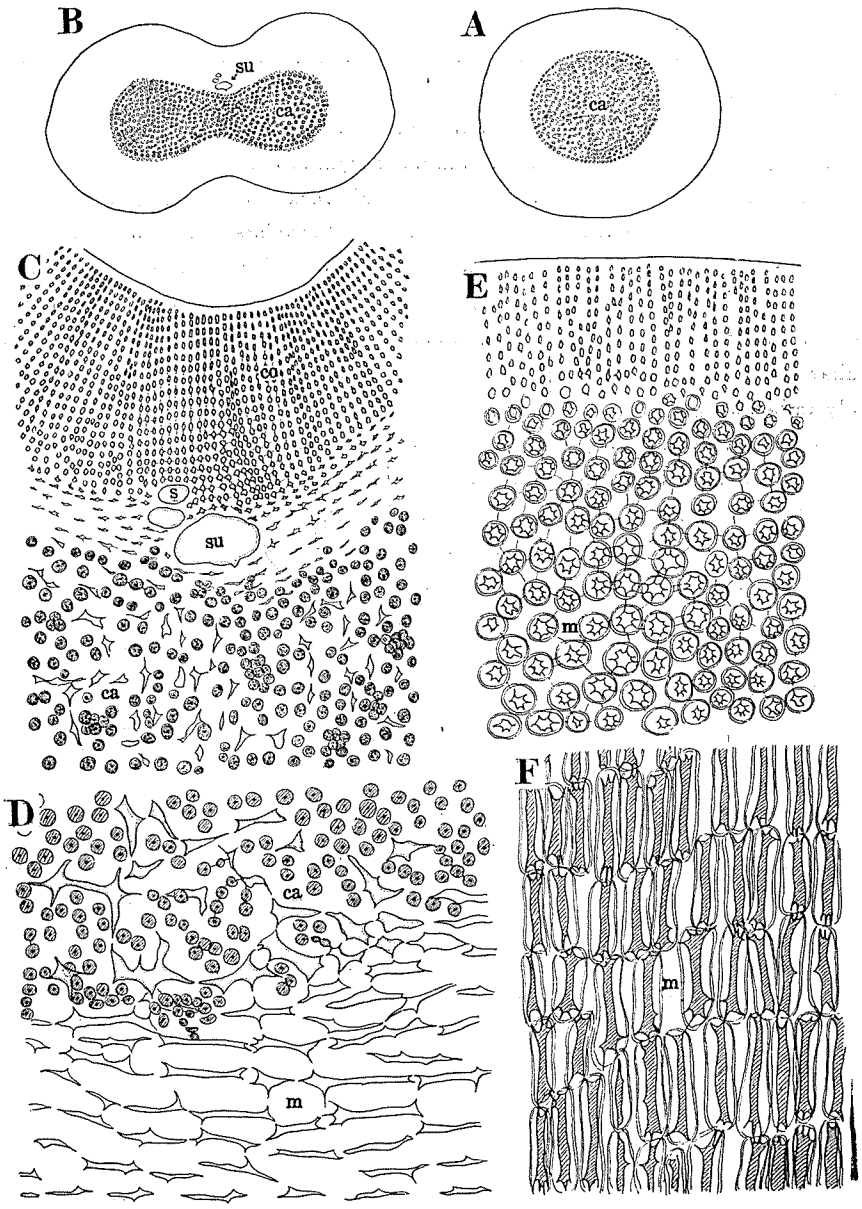


Fig. 7. *Ahnfeltia furcellata* OKAMURA

A. Distribution of carposporangia in transverse section of thallus. × 30.
B. Distribution of carposporangia in transverse section of bifid thallus. × 30.
C. The same, more highly magnified. × 200.
D. Longitudinal section of thallus with almost mature carposporangia. × 200.
E. Transverse section of thallus. × 200.
F. Longitudinal section of thallus. × 200.

ca, carposporangia; co, cortex; m, medulla;
s, sterile cell; su, supporting cell.

1958). Growing on rocks between tide marks.

Frond caespitose, cartilaginous, 3–10 cm in length, 1–1.5 mm in diam., arising from a callus disc, almost terete, in lower portion stem-like for more or less long distance, frequently branched, particularly more often and densely in upper parts; branches regularly decompound-dichotomous, corymbose in general outline, usually without lateral proliferations, widely parted, with forks becoming gradually closer to each other above, ending in equal height, furcellate, fastigiate in ultimate segments, ending in blunt apices; tissue composed of two layers, cortical and medullary; cortex composed of 8–10 (–18) rows of cells arranged perpendicular to the surface of the frond, cells small, subglobular isodiametric, 2.5–5.0 $\mu$ in dimensions; medullary layer consisting of isodiametric parenchymatous cells, rather loose as if densely imbedded in intercellular matrix, elliptical or roundish in transverse section, mostly arranged horizontally to the surface of the frond in longitudinal section; transition from medulla to cortex rather gradual; cystocarps swollen out, produced in the ultimate segments, occasionally in the turning point of the terminal segments; procarp with sterile cell; gonimoblast filaments abundant, densely branched, directly connected with swollen medullary cells by the pit-connections; special medullary filaments (Faserhülle) and special absorbent filaments absent; carpospores aggregated, round or ovoid, 10–15 $\mu$ in diam. at maturity; colour dark purplish red; specimens not adhering to paper in drying.

The present species was established by OKAMURA (1934) on the basis of the specimens from Ehime Pref. and Kochi Pref. etc. The structure of thallus and the development of the gonimoblast in the present species are quite similar to those of *Ahnfeltia concinna*. The present alga is, as far as the writer has observed, closely related to *Ahn. concinna*. J. AG. from which it differs by the regularly decompound-dichotomous divergence and by the gonimoblast embedded in the central portion of the frond.

### ***Ahnfeltia paradoxa*** (SURINGAR) OKAMURA

Figs. 8–10

OKAMURA, Icon. Jap. Alg., vol. VII, 1934, p. 13, pl. 309–310, Figs. 11–16; Id., Alg. Seto-Kanayama, Journ. Jap. Bot., vol. 10, no. 3, 1934, p. 164; Id., Nippon Kaisoshi, 1936, p. 647.

*Gymnogongrus paradoxus* SURINGAR, "Illustr., II, 1874, p. 13, t. 8–9"; HARIOT, Alg. de Yokosuka, 1891, p. 221, no, 31; OKAMURA, Nippon Sorui Meii (2nd ed., in Jap.), 1916, p. 32.

*Gymnogongrus furcellatus* (AG.) J. AG. var. *japonicus* HOLMES, On Mar. Alg. fr. Jap., 1895, p. 256, t. XI, Fig. 2; OKAMURA, Nippon Sorui Meii (2nd ed., in Jap.), 1916, p. 33.

Japanese name: Harigane.

Locality: Uchinoura, Kagoshima Pref. (NAKAMURA, Aug. 1940); Shikinejima, Tokyo Pref. (INOH, Aug. 1939); Izu-Susaki, Shizuoka Pref. (YAMADA, NAKAMURA, Apr. 1938);

Enoshima, Kanagawa Pref. (YAMADA, Oct. 1923; KAWASHIMA, Mar. 1951); Misaki, Kanagawa Pref. (OKAMURA, July 1932; SEGI, May 1944); Ohara, Chiba Pref. (YAMADA, July 1925); Futomi, Chiba Pref. (MURAOKA, Aug. 1933); Shirahama, Chiba Pref. (MURAOKA, Aug. 1934); Hanafuchi, Miyagi Pref. (KUROGI, Apr. 1950); Ofunato-Akasaki, Iwate Pref. (KAWASHIMA, May 1951). Growing on rocks.

Frond caespitose, perennial, 15–45 cm high and 1–1.5 mm broad, arising from a discoidal disc, cylindrical at the base, gradually compressed in main branches, gradually corticated with many cortical layers and thus becoming subterete in age, distantly or more or less closely dichotomous or subdichotomous, with short simple or bifurcate lateral proliferations with constricted base, which often grow up to furcellately decompound dichotomous branches; main axis often obscurely traceable;

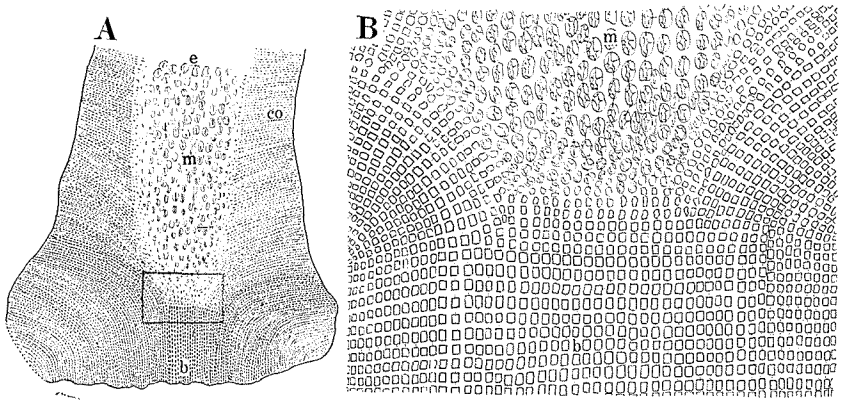


Fig. 8. *Ahnfeltia paradoxa* (SURINGAR) OKAMURA
A. Longitudinal section of basal portion. × 30.
B. The same, more highly magnified. × 180.
b, basal portion; co, cortex;
e, erect thallus; m, medulla.

branches patent, ending in bifid or blunt apices; discoidal basal portion in longitudinal section consisting of small compact filaments of uniform diameter perpendicular to the substratum; tissue of erect thallus composed of two layers, cortical and medullary; cortex of 5–10 rows of small, globular or rectangular isodiametric cells, 2.5–3 75 × 2.5–7.5 $\mu$ in dimensions, arranged perpendicularly to the surface of the frond; medullary layer consisting of parencymatous cells, often rather loose, elliptical or roundish in transverse section, 12.5–25 (–37.5) $\mu$ in diam. at the central portion; transition from medulla to cortex rather gradual; cystocarp hemispherical, swollen out on both surfaces of ultimate or penultimate segments of ramuli, or almost globular, single or 2–3 or more seriated in one row; procarp with sterile

cell; gonimoblast filaments elongate, densely branched, directly connected with swollen medullary cells by the pit-connections; special medullary filaments (Faserhülle) and special absorbent filaments absent; corpospores densely aggregated, round or ovoid, 10–15 $\mu$ in diam. at maturity; colour reddish purple or beautiful red when fresh, changing to dark reddish purple in drying; specimens not adhering to paper in drying.

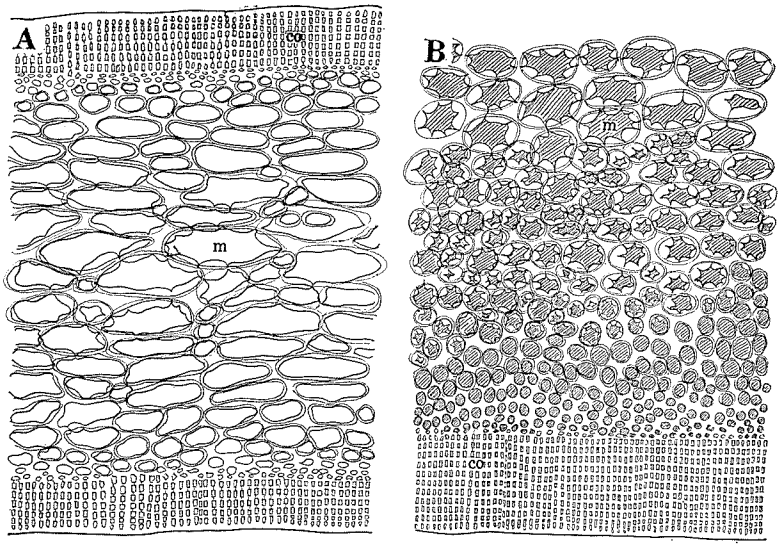


Fig. 9. *Ahnfeltia paradoxa* (SURINGAR) OKAMURA
A. Longitudinal section of thallus. × 180.
B. Transverse section of thallus. × 180.
co, cortex; m, medulla.

The frond of the present species is known to be exceedingly variable in habit and is widely distributed in Japan. As mentioned above, the discoidal base of the frond consists of small compact cell-filaments with firm consistence which are arranged perpendicularly to the substratum in longitudinal section. While, the nutritious tissue in the present alga is transformed from the medullary cells themselves. That is, the medullary cells in the vicinity of the procarp gradually enlarge and filled with dense contents. Among them, the special intercalary cells which are commonly found in *Chondrus* do not develop, as far as the writer is aware. The gonimoblast filaments are directly connected with the swollen medullary cells. In the result, the contents of them are exhausted for the further development of the gonimoblasts. Accordingly, both the special medullary filaments and special absorbent filaments are entirely wanting in the present species.

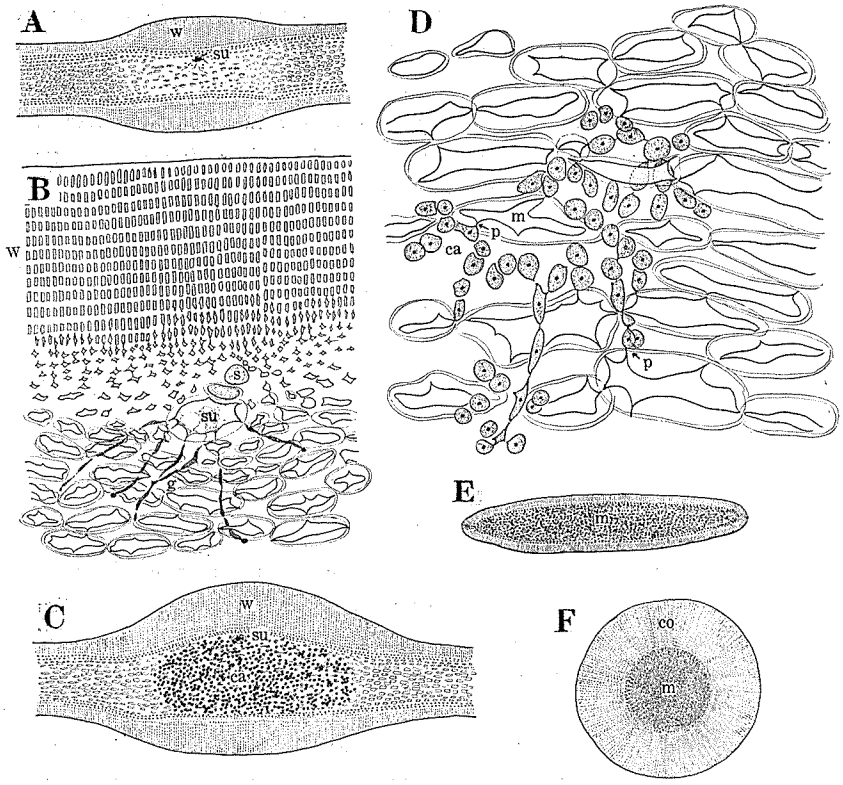


Fig. 10. *Ahnfeltia paradoxa* (SURINGAR) OKAMURA

A. Longitudinal section of female thallus, showing thickening cortex. × 30.
B. Procarp and young gonimoblasts. × 180.
C. Longitudinal section of younger cystocarp. × 30.
D. Fusions of gonimoblast filaments and medullary cells. × 350.
E. Transverse section of upper portion. × 12.
F. Transverse section of lower portion. × 30.

ca, carposporangia; g, gonimoblast; m, medulla; p, pit-connection; s, sterile cell; su, supporting cell; w, wall of cystocarp.

On the other hand, the cortical layer above the procarp is markedly thickened by the secondary cell divisions. In the description of this species, OKAMURA (1934) states as follows: "The plant named by SURINGAR (1874) as *Gymnogongrus paradoxus* has compressed frond having cystocarps swollen out on the surface of branches, and that named by HOLMES (1895) as *Gymnogongrus furcellatus* var. *japonicus* has cylindrical stem and cystocarps globularly swollen out all round the branchlets.

Those two species seem to me to be one and the same……These differences of habit I think to be due to the difference of climatic or other physical conditions between southern and northern parts……".

Though the internal structure of the present species is denser than those of other species of *Ahnfeltia* (e. g. *Ahn. concinna* J. AG., *Ahn. furcellata* OKAMURA), at present the writer follows OKAMURA's (1934) opinion.

### ***Ahnfeltia gracilis*** (YAMADA) YAMADA et MIKAMI, comb. nov.

Pl. IV, 1; Figs. 11-12

*Besa gracilis* YAMADA, Notes on Some Jap. Alg., II, 1931, p. 73, Fig. 3; OKAMURA, Nippon Kaisoshi, 1936, p. 660.

Japanese name: Besa.

Type locality: Enoshima, Kanagawa Pref.

Locality: Enoshima, Kanagawa Pref. (YAMADA, Oct. 1923). Growing on rocks.

Frond densely or loosely gregarious, arising from an indefinitely expanded base on the substratum, carnoso-cartilaginous, cylindrical, small, up to 6 mm high, almost equal in breadth, ca. 1 mm in diam., simple, clavate or often divided dichotomously with a wide angle, or dichotomous again, or rarely trichotomous, with round apex; margin without proliferations; prostrate crustaceous portion in longitudinal section consisting of compact parallel filaments of uniform small cells, which are perpendicular to the substratum and parallel to each other; tissue of the erect part composed of two layers, cortical and medullary; cortex consisted of 4-6 rows of isodiametric, small, subsquarish or subglobular cells with diam. of 2.5-5.0 $\mu$, arranged perpendicularly to the surface of the frond; medullary layer consisting of isodiametric parenchymatous cells, more or less loose, cells as if densely imbedded in intercellular matrix, anastomosing to each other, roundish or elliptical in transverse section, and mostly arranged horizontally to the surface of the frond in longitudinal section; transition from medulla to cortex extremely gradual; cystocarps swollen out in the upper portion of the simple frond, making the frond evidently clavate; procarp with large sterile cell; gonimoblast filaments abundant, deeply embedded within upper portion of erect thallus, densely branched, directly connected with swollen medullary cells by the pit-connections; both special medullary filaments (Faserhülle) and special absorbent filaments entirely wanting; carpospores aggregated, round or ovoid, 7.5-12.5 $\mu$ in diam. at maturity; colour dark purplish red; specimens not adhering to paper in drying.

This interesting alga was first described in Japan by YAMADA (1931) under the name *Besa gracilis* YAMADA, on the basis of the specimens from Enoshima,

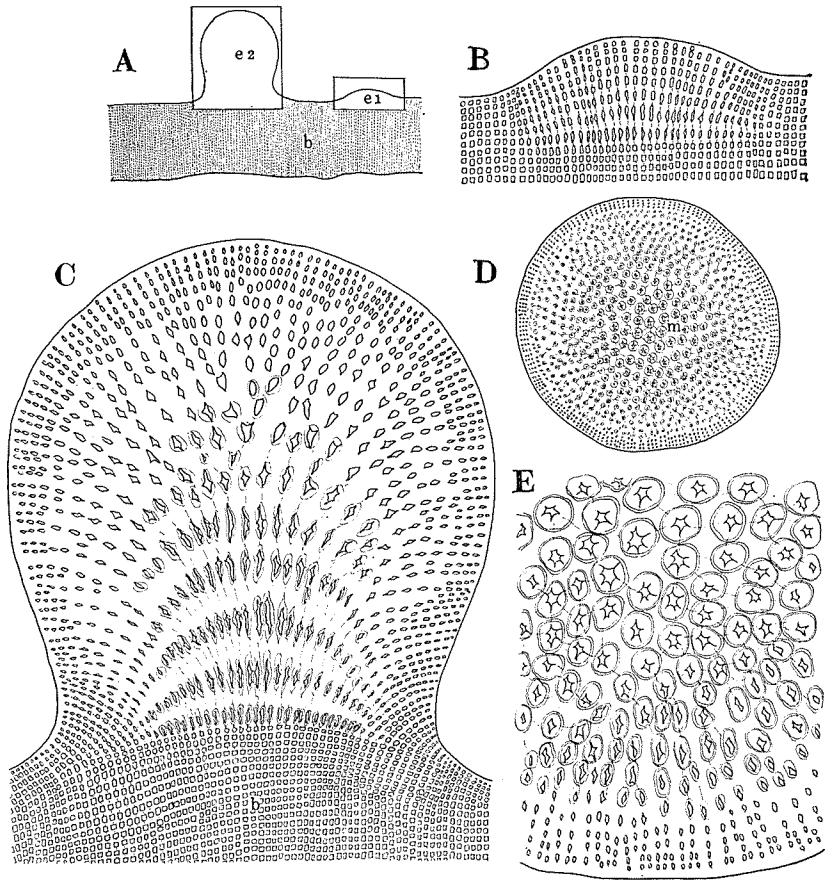


Fig. 11. *Ahnfeltia gracilis* (YAMADA) YAMADA et MIKAMI

A. Vertical section of basal creeping thallus, with two erect thalli (e1 and e2). × 30.

B. Early development of erect thallus (Magnification of Fig. A, e1). × 180.

C. Further development of erect thallus (Magnification of Fig. A, e2). × 180.

D. Transverse section of thallus. × 60.

E. The same, more highly magnified. × 180.

b, basal portion; e, erect thallus; m, medulla.

Kanagawa Pref., but after a histological investigation of the type specimens preserved in the Herbarium of the Department of Botany, Hokkaido University, it ought to be referred to the genus *Ahnfeltia* because of the procarp with sterile cell and the structure of the frond as mentioned above. The present alga is very closely related to *Besa papillaeformis* SETCHELL though the writer has not been able to examine the type specimen in SETCHELL's collection, from which it differs

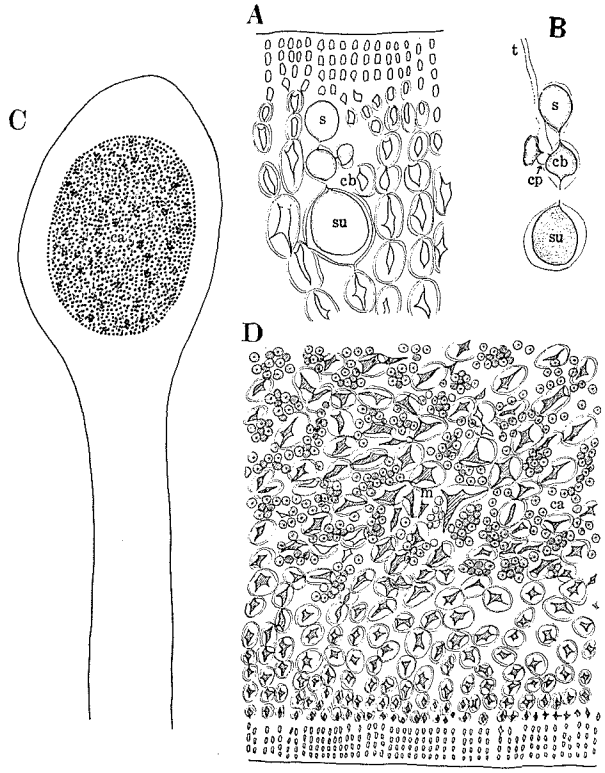


Fig. 12. *Ahnfeltia gracilis* (YAMADA) YAMADA et MIKAMI
A, B. Transverse section of thallus with procarp. × 300.
C. Distribution of gonimoblasts in vertical section of erect thallus. × 25.
D. The same, more highly magnified. × 160.
ca, carposporangia; cb, carpogonial branch; cp, carpogonium; m, medulla; s, sterile cell; su, supporting cell; t, trichogyne.

in being slenderer and longer and much more branched as compared with the latter. Originally, the genus *Besa* was established by SETCHELL (1912) on the basis of the specimens from Land's End, the northern extremity of San Francisco, California, when he considered that his species grew epiphytically (or hemiparasitically)

on a crustaceous plant like *Hildenbrandtia*.

While, on the relation between *Besa* and *Hildenbrandtia*, GARDNER (1917) states as follows; "At Cypress Point (Monterey County, California) *Besa* grows in profusion, but I was not able to find any tetrasporic *Hildenbrandtia*. Material of *Hildenbrandtia* scraped from the rocks and placed either in sea water or in formaline immediately give up a bright orange-coloured pigment, whereas plants of *Besa* collected in the same locality when treated likewise do not give up their pigment. It seems best at present to keep the genera separate awaiting further evidence of connection or distinction. If tetraspores can be found on papillae of *Besa* the question of the distinctness of the two genera will be cleared up."

According to the writer's observation, the present alga is composed of the expanded basal thallus and the dwarf erect ones. The prostrate thallus has parenchymatous structure of firm consistence, being built up of approximately quadrangular cells arranged in more or less vertical rows. The height of the cells is rather variable, from half to twice the breadth. The erect fronds clearly arise as outgrowths from the prostrate thallus. Namely, a vertical section of the shoots shows the transition from the prostrate thallus to the erect fronds as in Fig. 11 (A, B). The erect fronds are simple and clavate or somewhat compound, being often di- or rarely trichotomously divided. They are up to 6 mm high, 1 mm diam. The tissue of the erect frond is composed of two layers, cortical and medullary. The structure of the procarps and the development of the gonimoblast are essentially the same as other ones of *Ahnfeltia*. Namely, the procarp of the present species consists of a large supporting (auxiliary) cell and a three-celled carpogonial branch.

The carpogonial branch is strongly curved in such a way that the carpogonium becomes to lie close to the supporting (auxiliary) cell. Moreover, in the present alga, one sterile cell with dense cytoplasm issuing from the first cell of the carpogonial branch was clearly observed as in Fig. 12 (A, B). The medullary cells in the vicinity of the auxiliary cell gradually enlarge and they become swollen out. The gonimoblast filaments directly communicate with the swollen medullary cells.

Therefore, in the present species, both the special medullary filaments (Faserhülle) and special absorbent filaments are wanting. The carpospores are aggregate, round or ovoid, measuring 7.5–12.5 $\mu$ in diameter.

***Ahnfeltia yamadae*** (SEGAWA) MIKAMI, comb. nov.

Pl. I; Fig. 13

*Chondrus yamadae* SEGAWA, New or Noteworthy Alg. Izu I, 1941, p. 262, Fig. 9, pl. 57.

Japanese name: Hane-saimi. (nom. nov.).

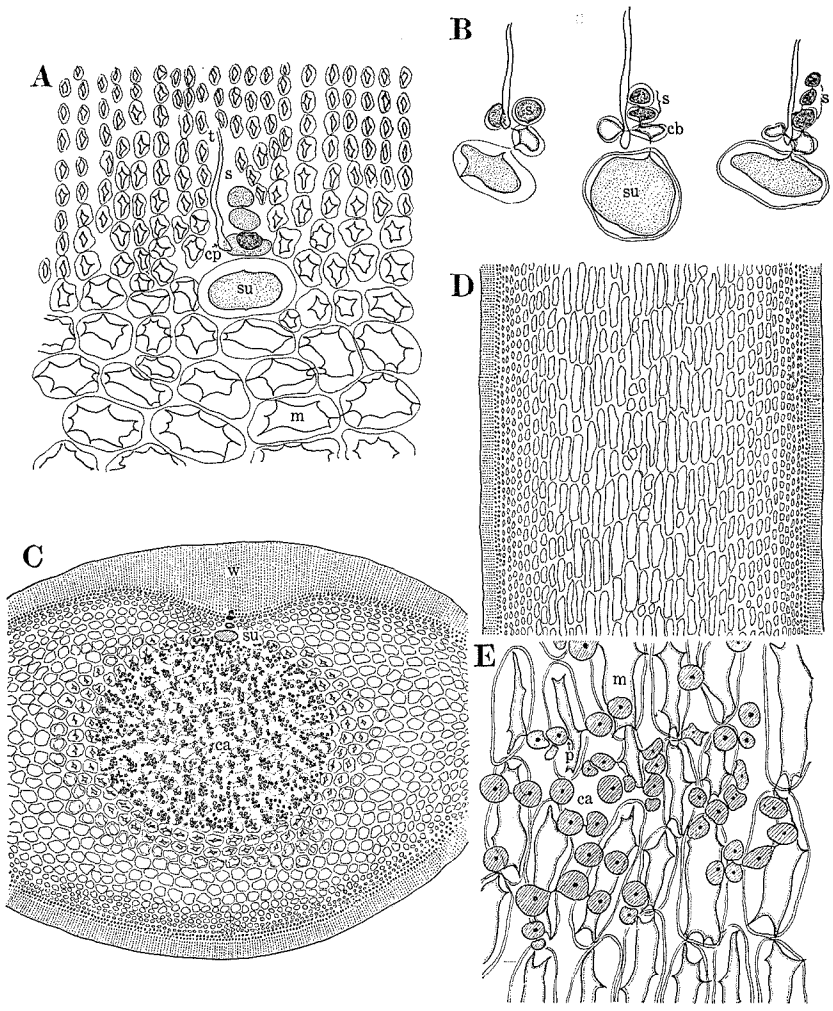


Fig. 13. *Ahnfeltia yamadae* (SEGAWA) MIKAMI

A, B. Procarp with sterile cells. × 350.

C. Transverse section of a younger cystocarp. × 55.

D. Longitudinal section of upper thallus. × 55.

E. Development of carposporangia in longitudinal section. × 350.

ca, carposporangia; cb, carpogonial branch; cp, carpogonium; m, medulla; p, pit-connection; s, sterile cells; su, supporting cell; w, wall of cystocarp.

Type locality: Susaki, Shizuoka Pref.

Locality: Izu-Ito, and Shiofukimisaki, Shizuoka Pref. (CHIHARA, July 1960).

Frond caespitose, cartilaginous, 10–25 cm in height, attaching to substratum by a scutate disc, subterete for a short distance at the base, regularly or irregularly and dichotomously or subdichotomously divided; main segments 2–6 mm broad, linear and compressed, slightly canaliculate, pinnately and densely ornamented with distichous branchlets; branchlets subcylindrical, slightly constricted at the base, simple or 1–2 times forked, sometimes fan-shaped in outline, up to 3 cm long, and 1–2 mm broad; in robust frond often with subcylindrical branches on the both surfaces; tissue composed of two layers, cortical and medullary; cortex consisted of 6–8 rows of small, ellipsoidal or elongated cells, diminishing in diameter outwardly, arranged closely with their longer axis perpendicular to the surface of the frond; medullary layer consisting of parenchymatous cells, cells roundish or elliptical in transverse section, 25–37.5 $\mu$ in diam. at the central portion of branches; in main segments, larger or smaller parenchymatous cells intermingled; cell membrane 1–2 $\mu$ thick; transition from medulla to cortex gradual; tetrasporangia not observed; cystocarps clavate, produced only in the lateral subcylindrical branches, often arranged in a row; procarp rather abundant, with 1–3-sterile cells; special medullary filaments (Faserhülle) and special absorbent filaments absent; gonimoblasts elongate, directly connected with swollen medullary cells by pit-connections; carpospores aggregated, ovoid, ca. 10–12.5 (–15) $\mu$ in diam.; colour dark reddish purple, changing to brownish in drying; speciments not adhering to paper in drying.

S. SEGAWA described the present alga under the name of *Chondrus yamadae* in 1941, stating as follows: "The species shows some likeness to *Chondrus pinnulatus* (HARV.) OKAMURA. But in the fruiting and the mode of branching, the alga differs distinctly from the latter species." As far as the writer observed, however, it ought to be referred to the genus *Ahnfeltia* instead of *Chondrus* by the following characteristics. The fronds are dichotomously or subdichotomously divided in general. The main segments are 2–6 mm broad, linear and compressed except the lower portion. The pinnate branches occur from both sides of the main segments and they are subcylindrical. In the robust frond, the vertical branches develop on the both surfaces. They are subcylindrical and slightly constricted at the base. The tissue of the frond is composed of two layers, cortical and medullary. The cortex composed of 6–8 rows of small elongated, to the surface of the frond perpendicularly arranged cells. The medullary layer parenchymatous, consisted of cylindrical cells with diameter of 20–30 $\mu$ in general. They are rather loose, and look like as if they were densely imbedded in intercellular matrix. The cell wall is 1–2 $\mu$ thick. The cystocarps are swollen out in the middle portion of the branches.

The structure of the procarps, and the formation of the nutritive cells are

essentially similar to those of *Ahnfeltia* (e. g. *Ahn. furcellata* OKAMURA, *Ahn. gracilis* (YAM.) YAMADA et MIKAMI). That is, the procarp consists of a large supporting (auxiliary) cell and a three-celled carpogonial branch. In the present alga, one to three sterile cells with dense cytoplasm issuing from the first cell of the carpogonial branch were clearly observed as in Fig. 13 (A, B). The medullary cells in the vicinity of the auxiliary cell gradually enlarge with rich contents, and they are swollen out. Presently, the young gonimoblast filaments directly communicate with the swollen medullary cells. Accordingly, the contents of the medullary cells are exhausted for the development of the gonimoblast. So, in the present alga, both the special medullary filaments (Faserhülle) and special absorbent filaments are entirely wanting. The carpospores are ovoid, 10–12.5 (–15) $\mu$ in diameter.

According to SEGAWA, the specimens collected from Ito, Shizuoka Pref., in May, are all young. Ones from Shirahama collected in July, 1937, are very large but yet sterile. Only one cast up on the shore of Shirahama in October is completely mature.

While, the writer would like to record that the specimens with young cystocarps (Ito, Shizuoka Pref., July 1960) were sent to him by Dr. M. CHIHARA.

## *Gigartinaceae*

Key to the genera

1. Cystocarps in papillate outgrowth from thallus surface . . . . . *Gigartina*
1. Cystocarps not in papillate outgrowth . . . . . 2
   2. Tetrasporangia developing by direct transformation of subcortical cells . . . . . *Rhodoglossum*
   2. Tetrasporangia developing from cells of special filaments on medullary filaments . . . . . 3
3. Gonimoblast usually surrounded by special medullary filaments (Faserhülle) . . . . . *Iridaea*
3. Gonimoblast usually not surrounded by special medullary filaments . . . . . *Chondrus*

## *Gigartina*

Key to the species

1. Frond generally subpinnately divided; "Faserhülle" present . . . . . 2
1. Frond generally dichotomously or irregularly divided; "Faserhülle" absent . . 4
   2. Frond crooked . . . . . *G. intermedia*

2. Frond erect . . . . . 3
3. Frond narrow linear . . . . . *G. tenella*
3. Frond slightly flattened . . . . . *G. teedii*
4. Frond always lacking papillae on the surface . . . . . *G. ochotensis*
4. Frond with numerous papillae on the surface . . . . . 5
5. Cystocarpic papillae erect, and often compound . . . . . *G. pacifica*
5. Cystocarpic papillae curved at the base, always simple . . . . *G. mamillosa*

### ***Gigartina intermedia*** SURINGAR

Fig. 14

SURINGAR, Alg. Jap., 1870, p. 30. t. 17, B; J. AG., Epicr., 1876, p. 204; DE TONI, Syll. Alg. IV, 1900, p. 199; OKAMURA, Alg. Jap. Exsic. Fasc. II, no. 58; Id., Icon. Jap., vol. 1, 1909, p. 171, pl. 35; Id., Nippon Sorui Meii (2nd ed.), 1916, p. 30; Id., Nippon Kaisoshi, 1936, p. 651.

Japanese name: Kai-nori.

Type locality: "in mari Japonico".

Locality: Amakusa-Tomioka, Nagasaki Pref. (YAMADA, Mar. 1937); Hinomisaki, Shimane Pref. (NAKAMURA, Aug. 1942); Enoshima, Kanagawa Pref. (YAMADA, Apr. 1932); Misaki, Kanagawa Pref. (SEGI, Apr. 1938); Jo-gashima, Kanagawa Pref. (YAMADA, May 1940); Inubozaki, Chiba Pref. (MIKAMI, Aug. 1959); Hirota, Iwate Pref. (KAWASHIMA, June 1954); Oshoro, Shiribeshi Prov. (INAGAKI, Aug. 1932). Growing on rocks at high tide.

Frond gregarious, cartilaginous, 2–6 cm high, pulvinate, forming irregular overlapping masses, widely extended over rocks, firmly attaching to substratum by holdfasts, slender cylindrical at the base, irregularly branched in a subpinnate manner; branches adhering to each other, compressed, often somewhat canaliculate, patent, 2–3 (–4) mm broad at the broadest portion, tapering to both ends, attenuated upwards into a sharp point, strongly recurved; tissue composed of three layers, cortical, subcortical and medullary; cortex consisted of 4–7 rows of small cells, cells oblong or elongated, diminishing in diameter outwardly, arranged closely with their longer axis perpendicular to the surface of the frond; subcortical layer consisting of 3–4 series of subglobular, rather loosely arranged cells; medulla composed of anastomosing slender rhizoidal cells, connected with the neighbouring ones by plasmic threads, mostly arranged horizontally to the surface of the frond in longitudinal section; tetrasporangia not found; cystocarps almost globular, sessile, simple or often aggregating together along the margin of frond; procarp without sterile cell; gonimoblast compacted, with extremely large anastomosing sterile cells; special medullary filaments (Faserhülle) abundant, developing by the secondary cell division of the medullary cells, and circularly arranged around the gonimoblast masses; special absorbent filaments abundant and connected with the special medul-

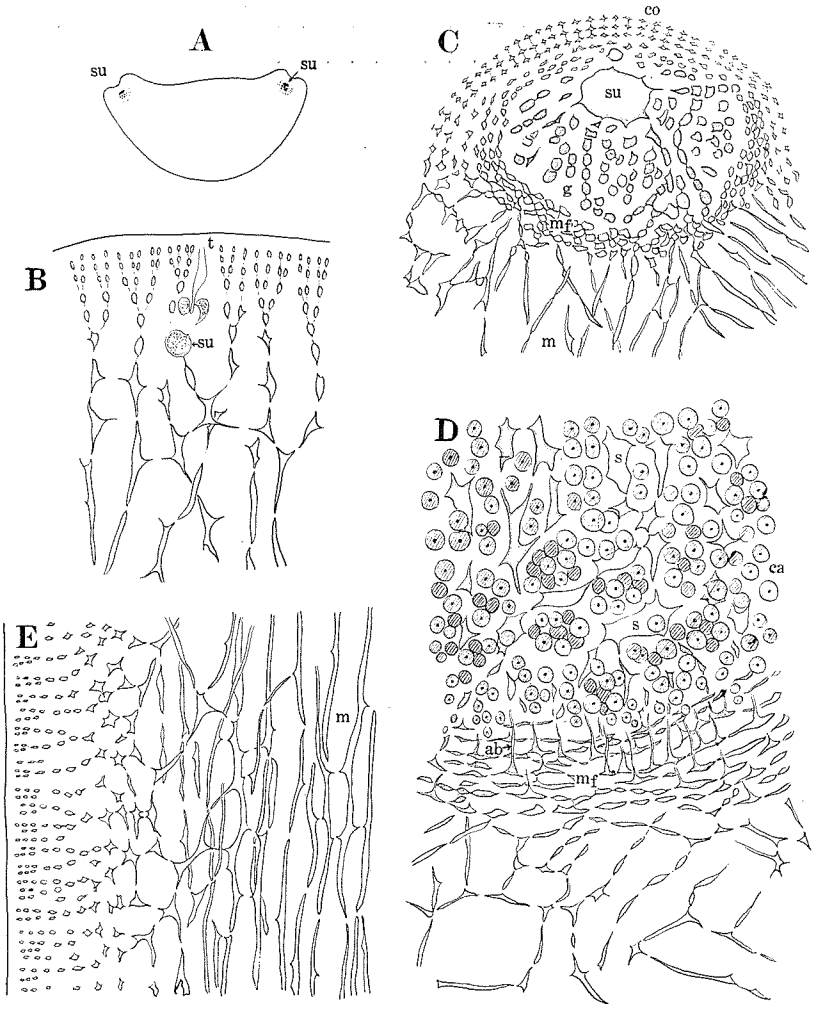


Fig. 14. *Gigartina intermedia* SURINGAR

A. Transverse section of thallus with two younger cystocarps. × 15.
B. Transverse section of thallus with procarp. × 180.
C. Early development of gonimoblasts and special medullary filaments (Faserhülle). × 180.
D. Transverse section of thallus with almost mature gonimoblasts. × 180.
E. Longitudinal section of thallus. × 180.

ab, special absorbent filaments; ca, carposporangia; co, cortex; g, gonimoblast; m, medulla; mf, special medullary filaments (Faserhülle); s, sterile gonimoblast; su, supporting cell; t, trichogyne.

lary filaments; carpospores aggregated in openings formed by sterile gonimoblast, subglobose or ovoid, 15–20 $\mu$ in diam.; colour dark purplish red with bluish iridescence when fresh; specimens imperfectly or not adhering to paper in drying.

The present species is one of the commonest seaweeds from our coast and it was first described by SURINGAR (1870). This alga is rather closely related to *Gigartina tenella* HARVEY, but is distinguishable from the latter by the more loose and slender medullary structure and by the crooked thallus. While, the structure of the procarp of the present species is entirely the same as that of *Chondrus*. Namely, the carpogonial branch is three-celled and bents characteristically in such a manner that the carpogonium lies lateral to the supporting (auxiliary) cell. The basal cell of the carpogonial branch is the largest while the carpogonium is the smallest. The development of the special medullary filaments (Faserhülle) and gonimoblast in the present species is similar to that of *Rhodoglossum*. That is, the "Faserhülle" originate abundantly by the secondary cell division from the hyphae in the vicinity of the auxiliary cell. They gradually enlarge with protoplasmic contents. Thus, the "Faserhülle" function as the nutritious tissue. Fig. 14 (C) shows the younger special medullary filaments (Faserhülle) and the younger gonimoblasts. The gonimoblast develops inwardly, forming a spherical, anastomosing plexus. The primary gonimoblast with short articulations is thus surrounded by the "Faserhülle". Presently, between the "Faserhülle" (haploid origin) and gonimoblast (diploid), numerous special absorbent filaments are developed from the gonimoblast cells, and they communicate with the cells of "Faserhülle". So, through the absorbent filaments the contents of the "Faserhülle" are exhausted for the development of the primary gonimoblasts. Consequently the nutritive "Faserhülle" are shrinked which remain as slender "Faserhülle" on the outermost circumference of cystocarp. On the other hand, the primary gonimoblast-plexus is at first quite firm in consistency, but becomes laxer at an older stage as a result of the progressive increase in number of the multitudinous terminal and lateral carposporiferous branchlets. Finally, the sterile cells of the primary gonimoblast lose most of their contents, as the terminal carposporangia develop. Thus, the carposporangia arise in the open spaces of the sterile gonimoblast and become aggregate, subglobose or ovate, measuring 15–20 $\mu$ in diameter.

### ***Gigartina tenella*** HARVEY

Figs. 15–16

HARVEY, Char. of New Alg. in Proceed. Amer. Acad. 4, 1859, p. 331, n. 52; SURINGAR, Alg. Jap., 1870, p. 29, t. 17, A; J. AG., Epicr., 1876, p. 204; DE TONI, Phyc. Jap. Nov., 1895, p. 24, n. 32; Id., Syll. Alg. IV, 1900, p. 201; OKAMURA, Alg. Jap. Exsic. Fasc. 1, no. 9; Id., Icon. Jap. Alg., 1, 1908, p. 159–163, pl. 33; Id., Nippon Sorui Meii (2nd ed.), 1916, p. 30; Id.,

Alg. Isl. Hatidyo, 1930 a, p. 95; Id., Nippon Kaisoshi, 1936, p. 650; INAGAKI, Mar. Rhodophyc. Oshoro Bay, 1933, p. 32; TOKIDA, Phyc. Observ. V, 1942, p. 89.

*Chondrus filiformis* OKAMURA et SEGAWA, in SEGAWA, Mar. Alg. Susaki, 1935, p. 81, pl. 19, Fig. 2, Text-figs. 2-3; OKAMURA, Nippon Kaisoshi, 1936, p. 657.

Japanese name: Suginori.

Type locality: Kaikai-shima, Loo Choo Isl.

Locality: Nomosaki, Nagasaki Pref. (TANAKA, Apr. 1935); Seto, Wakayama Pref. (INOH, June 1940); Wagu, Mie Pref. (INOH, June 1942; SEGI, Apr. 1944); Sugashima, Mie Pref. (YAMADA, May 1943); Susaki near Shimoda, Shizuoka Pref. (INOH, June 1941); Shimoda, Shizuoka Pref. (TSUJI, Aug. 1958); Nojimazaki, Chiba Pref. (MURAOKA, Aug. 1934); Kamo, Yamagata Pref. (HIROHASHI, June 1960); Oshoro, Shiribeshi Prov. (MIKAMI, July 1960).

Growing on rocks between tide-marks, often in tide-pools.

Frond caespitose, cartilaginous, filiform, compressed or linear, erect or creeping, 5-8 (-12) cm high, arising from a knob-like disc, slender, cylindrical at the base, more or less irregularly pinnate with alternate and opposite branches intermixed; branches patent, tapering towards both ends, being attenuated upwards into a slender sharp point, often slightly recurved; breadth of main and side branches almost same throughout, but much varying in different fronds according to their habitats ranging scarcely 1-2 (-3) mm; tissue composed of three layers, cortical, subcortical and medullary; cortex composed of 5-7 rows of abundant, small, ellipsoidal cells, diminishing in diameter outwardly, arranged closely with their longer axis perpendicular to the surface of the frond; subcortical layer composed of 3-4 series of rather loosely arranged, subglobose, ovoid or irregular cells; medullary layer consisting of anastomosing rhizoidal cells, connected with the neighbouring cells by plasmic threads, mostly arranged horizontally to the surface of the frond in longitudinal section. Tetrasporangia formed beneath the superficial cortical layer, developing from the inner cortical cells by their direct transformation; cystocarps globular or subspherical, simple or often aggregating each other in two or three along the sides of branches; gonimoblast densely compacted with extremely large anastomosing sterile cells; special medullary filaments (Faserhülle) abundant, considerably thick, developing by the secondary cell division of the medullary cells, circularly arranged around the gonimoblast masses; special absorbent filaments originating from gonimoblast

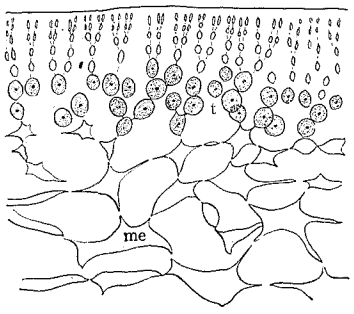


Fig. 15. *Gigartina tenella* HARVEY
Longitudinal section of thallus with younger sporangia. ×180.
me, medulla;
t, tetrasporangia.

cells, communicated with special medullary filaments; carpospores aggregated, subglobose or ovoid, 12.5–20 $\mu$ in diam.; colour livid purple with bluish iridescence; specimens not adhering to paper in drying.

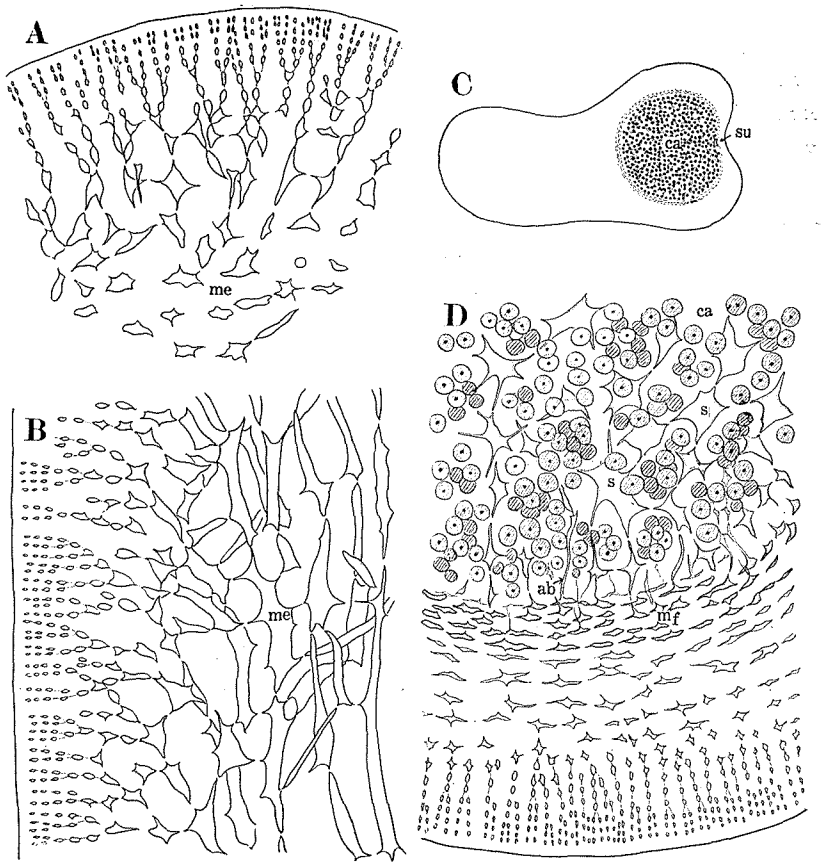


Fig. 16. *Gigartina tenella* HARVEY

A. Transverse section of thallus. × 180.
B. Longitudinal section of thallus. × 180.
C. Transverse section of a younger cystocarp. × 30.
D. The same, more highly magnified. × 180.

*ab*, absorbent filament; *ca*, *carposporangia*; *me*, medulla; mf, special medullary filaments (Faserhülle); s, sterile gonimoblast; su, supporting cell.

HARVEY (1859) established the present species on the basis of specimens from Kaikai-shima, north of the Loo Choo Islands. He states (cf. HARVEY, 1959)"..... Allied to *Gigartina teedii*, but much more slender and small, and less decompound,

with arching branches." On the other hand, the present species is very closely related to *G. intermedia* SUR., from which it differs slightly by having more or less erect fronds and by the structure of frond more dense than in the latter. In a specimen gathered by TSUJI in August, the writer could examine the development of the tetrasporangia (Fig. 15). They develop from the inner cortical cells by their direct transformation as in *Rhodoglossum*. While, TOKIDA pointed out that the tetrasporangia of *Chondrus filiformis* OKAMURA et SEGAWA were formed intercalarily near the base of the anticlinal rows of the cortical cells, and in this respect it agrees with the nature of *Gigartina* but not with that of *Chondrus*.

SEGAWA wrote to Dr. TOKIDA that *Chondrus filiformis* is most probably nothing but tetrasporophyte of *Gigartina tenella*. The writer also agrees with Dr. TOKIDA's and Dr. SEGAWA's opinions, after having made comparison with the type specimen kindly loaned from the Herbarium of the Mitsui Foundation by the late Dr. SEGAWA.

The development of the cystocarp in the present species is quite similar to those of *G. intermedia* SURINGAR, as far as the writer observed.

Fig. 16 (C) shows the distribution of the gonimoblast filaments and the special medullary filaments (Faserhülle) in transverse section of a young cystocarp.

### ***Gigartina teedii*** (ROTH) LAMOUROUX

Fig. 17

LAMOUR., Essai., 1813, p. 49, t. 4, Fig. 11; J. AG., Sp. Alg. II, 1851, p. 266; Id., Epicr., 1876, p. 192; HARVEY, Phyc. Brit., 1851, tab. 266; ARDISS., Phyc. Med. I, 1883, p. 168; HAUCK, Meeresalg., 1885, p. 136, Fig. 54; DE TONI, Syll. Alg. IV, 1900, p. 202; OKAMURA, Icon. Jap. Alg., vol. 1, 1908, p. 163, pl. 33; Id., Nippon Sorui Meii (2nd ed.), 1916, p. 31; Id., Nippon Kaisoshi, 1936, p. 651; Id., Alg. Jap. Exsic. Fasc. II, no. 57; SEGAWA, Mar. Alg. Susaki, 1935, p. 82.

"*Fucus Teedii* TURN., Hist. Fucorum. 1808, t. 208".

*Chondrocanthus Teedii* KÜTZ., Phyc. gener., 1843, p. 399.

*Chondroclonium Teedii* KÜTZ., Sp. Alg., 1849, p. 740; Id., Tab. Phyc. XVII, 1867, t. 66.

Japanese name: Shikin-nori.

Locality: Ise-Toshijima, Mie Pref. (INAGAKI, Aug. 1930); Misaki, Kanagawa Pref. (YAMADA, Apr. 1923; SEGI, May 1944). Growing on rocks between tide-marks near high tide, often in tide-pools.

Frond cartilagineo-membranaceous, flaccid, flat or linear, acuminate, often densely tufted, 8–15 cm high, excessively branched in an alternate and opposite manner, all the divisions horizontally patent; branches slightly flexuose, shorter and longer intermixed, always beset with short spine-like, horizontally patent ramuli; main branches in luxuriant specimens, divided three or four times, varying from a few mm to 4–5 mm in breadth, tapering towards both ends; different specimens

vary much in the amount of branching and in the breadth of the frond; in a robust frond, surface often with proliferations of the shape of minute teeth; tissue composed of three layers, cortical, subcortical and medullary; cortex consisting of 5–7 rows of small, ellipsoidal cells, diminishing in diameter outwardly, arranged closely with their axis perpendicular to the surface of the frond; subcortical layer rather incon-

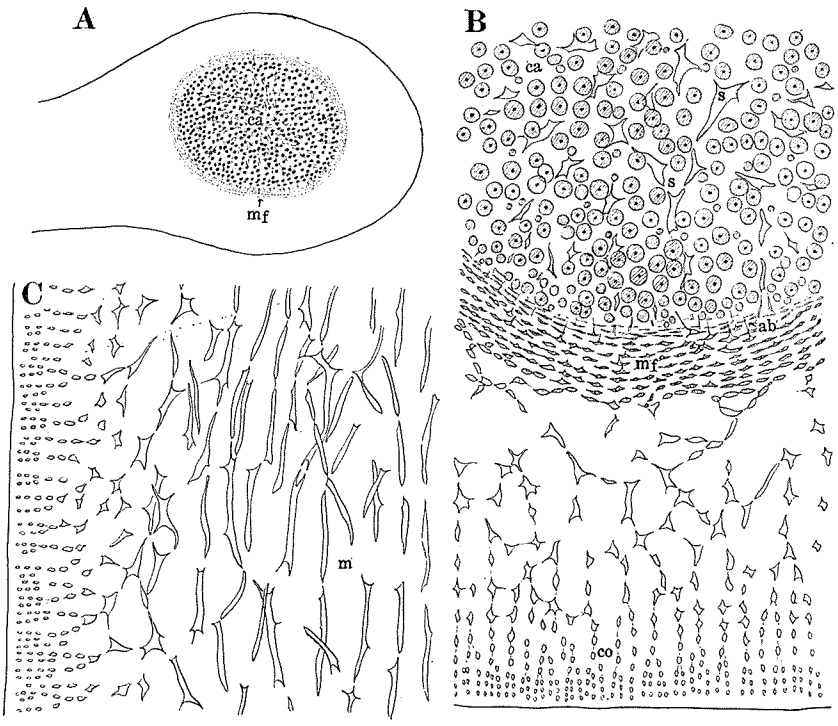


Fig. 17. *Gigartina teedii* (ROTH) LAMOUROUX

A. Transverse section of a younger cystocarp. × 30.

B. Transverse section of thallus with almost mature gonimoblast and "Faserhülle". × 180.

C. Longitudinal section of thallus. × 180.

ab, special absorbent filament; ca, carposporangia; co, cortex; m, medulla; mf, special medullary filaments (Faserhülle); s, sterile gonimoblast.

spicuous, of 3–4 series of rather loosely arranged, subglobose or irregular cells; medullary layer consisting of anastomosing slender cells, connected with the neighbouring cells by plasmic threads, mostly arranged horizontally to the surface of the frond in longitudinal section; tetrasporangia not found; cystocarps subspherical, or hemispherical, small, borne on the side or base of minute spines, sessile, simple

or rarely aggregative; gonimoblast densely compacted, with extremely large anastomosing cells; special medullary filaments very abundant, developing by the secondary cell division of the medullary cells, circularly arranged around the gonimoblast masses; special absorbent filaments plentiful, originating from the gonimoblast cells, connected to the special medullary filaments in order to obtain the nutriments; carpospores aggregated in an opening of the sterile gonimoblasts, subglobose, 12.5–17.5 (–20) $\mu$ in diam.; colour purple-red varying to greenish; specimens imperfectly adhering to paper in drying.

The present plant certainly relates very closely both to *Gigartina tenella* HARVEY and to *Gigartina intermedia* SURINGAR, but, from which it differs in the following points. The main segments in the present species are often broadly flat. The slender or spine-like branchlets are given off from the margin of the frond. Moreover, in a robust frond, the minute tooth-like proliferations develop on the surface of the frond. On the other hand, the developments of the nutritive tissue and gonimoblast are entirely similar to those of *G. tenella* HARVEY and *G. intermedia* SURINGAR. Namely, a special nutritive tissue arises from hyphae, produced in large numbers from the medullary cells. In the mature cystocarp this tissue (Faserhülle) forms a fibrous envelope around the groups of carpospores.

### ***Gigartina pacifica*** KJELLMAN

Fig. 18

KJELLMAN, Om Beringhafv. Algfl., 1889, p. 31, pl. 1, Figs. 21–22; DE TONI, Syll. Alg., IV, 1897, p. 217; OKAMURA, Icon. Jap. Alg. vol. 1, 1908, p. 165, pl. 34, Figs. 1–8; Id., Nippon Sorui Meii (2nd ed.), 1916, p. 31; SETCHELL et GARDNER, A preliminary survey on *Gigartina*, 1933, p. 296; TOKIDA, Mar. Alg. S. Saghalien, 1954, p. 182.

*Gigartina unalaschcensis* YENDO (non RUPRECHT), Notes Alg. New to Jap., IV, 1916, p. 54, Fig. 2 ("unalaskensis"); SINOVA, Algues de la Mer Ochotsk., 1930, p. 107; INAGAKI, Mar. Rhodophyc. Oshoro Bay, 1933, p. 33; TOKIDA, Mar. Alg. Robb. Isl., 1934a, p. 20; OKAMURA, Nippon Kaisoshi, p. 652, Fig. 310; NAGAI, Mar. Alg. Kurile Islands II, 1941, p. 183, pl. 4, Figs. 31–32.

Japanese name: Ibonori.

Type locality: Bering Island.

Locality: Bentenjima, Aomori Pref. (YAMADA); Yamasedomari, Oshima Prov. (YAMADA); Esashi, Oshima Prov. (YAMADA, NAKAMURA, Apr. 1940); Ranshima, Shiribeshi Prov. (S. AKIYAMA, July 1929); Zenibako, Shiribeshi Prov. (MIKAMI, July 1958); Harutachi, Hidaka Prov. (YAMADA, Aug. 1953); Samani, Hidaka Prov. (NAKAMURA, July 1943; MIKAMI, Sep. 1958); Horoman, Hidaka Prov. (MIKAMI, Mar. 1959); Shiretoko-misaki, Abashiri Prov. (YAMADA, Sept. 1943); Rishiri, Soya Prov. (INAGAKI, Aug. 1934); Shikotan Isl., (KAWABATA, July 1933); Sokobetsu, Kunashiri Isl., (NAGAI, Aug. 1931).

Frond caespitose, complanate, subcoriaceous, ca. 3–7 cm high, 300–600 $\mu$ thick, 0.5–4.5 cm wide at the broadest part, arising from a small discoidal disc, narrowly cuneate at the base, once or twice (rarely up to 5 times) dichotomously divided, quickly expanding into segments with narrow axils, assuming fan-shape; segments broad-cuneate somewhat recurved at the margin, with numerous papillose processes on both surfaces and margin; processes complanate and lanceolate, sometimes dichotomous or palmate, in each of which one or two (rarely three or more) cystocarps immersed; tissue composed of three layers, cortical, subcortical and medullary; cortex consisting of 5–8 rows of small, oblong or elongated cells, arranged closely with their longer axis perpendicular to the surface of the frond; subcortical layer consisting of 3–5 series of subglobular or irregularly shaped cells, rather loosely arranged; medullary layer consisting of anastomosing rhizoidal cells, joined with the neighbouring cells by plasmic threads, mostly arranged horizontally to the surface of the frond in longitudinal section; tetrasporangia not found; cystocarps papillate or almost globular, immersed in papillose processes on both surfaces and margin, reaching 1–2 mm in diam. at maturity; gonimoblast compacted with densely anastomosing sterile cells, and directly connected with the swollen medullary cells in order to obtain the nutrition; medullary nutritive cells rather abundant, mainly developed by the intercalary cell division of medullary cells, irregularly arranged around the supporting (auxiliary) cell; accordingly, both special medullary filaments and special absorbent filaments absent; carpospores 2–4-aggregated in general, subglobose or ovoid, 12.5–17.5 $\mu$ in diam.; colour dark brownish red with bluish iridescence when fresh, changing to dull black; specimens not adhering well to paper in drying.

The present species was established by KJELLMAN in 1889, on the basis of specimens from Bering Island. Afterwards, YENDO (1916) amalgameted the present alga with *Gigartina unalaschcensis* RUPRECHT.

But, because of the above-mentioned characteristics the writer agrees with SETCHELL and GARDNER's (1933) and TOKIDA's (1954) opinions that the plant figured by KJELLMAN (1889) is a broad form of *Gigartina ochotensis* RUPRECHT. As pointed out by TOKIDA, *G. unalaschcensis* f. *grandifolia* NAGAI corresponds to the typical form of *G. pacifica* and *G. unalaschcensis* f. *typica* NAGAI to the narrow form of *G. pacifica* verging toward *G. ochotensis*. Namely, three forms established by NAGAI (f. *grandifolia*, f. *typica*, and f. *irregularis*) are linked with each other by intermediate forms.

A well-grown typical form of the present alga has the multifid frond from a small discoidal base. It is complanated, narrowly cuneate at the base, once or twice (rarely up to five times) dichotomously divided with quickly expanding segments, assuming fan-shaped or reniform general outline. The tissue is composed

of three layers, cortical, subcortical and medullary as in *Chondrus*. On the margins as well as on the surface of lobes, there are numerous papillose processes, in each of which one or two cystocarps are found immersed. Unfortunately, the fusion of the carpogonium and the auxiliary cell was not observed.

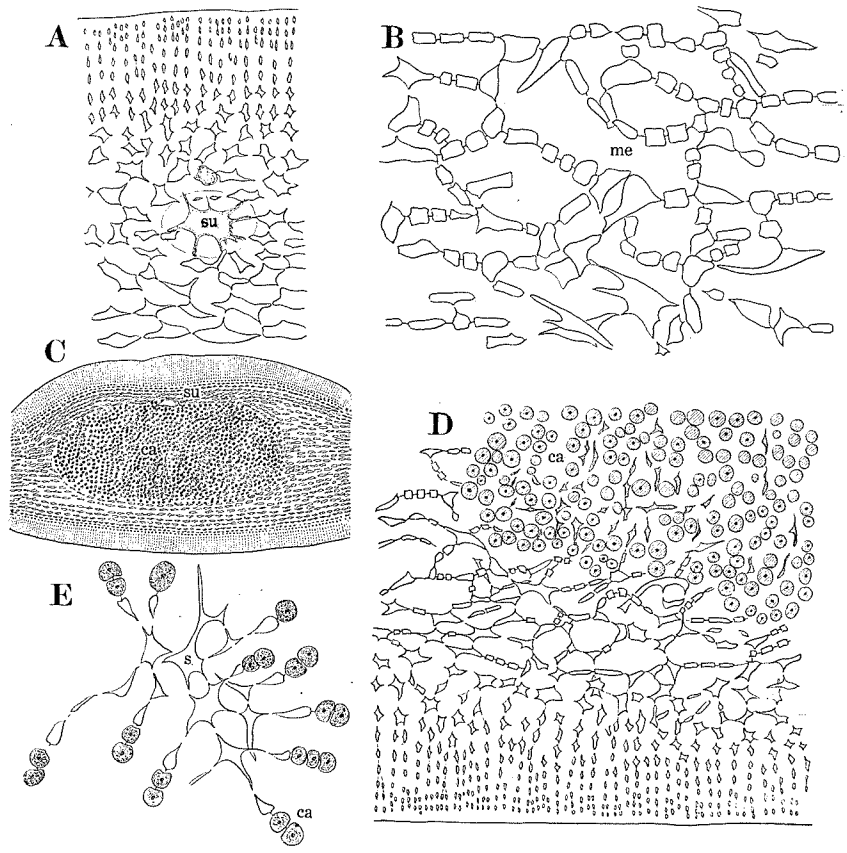


Fig. 18. *Gigartina pacifica* KJELLMAN

A. Longitudinal section of thallus with procarp. × 180.
B. Formation of nutritive (medullary) tissue. × 350.
C. Longitudinal section of a young cystocarp. × 30.
D. The same, more highly magnified. × 180.
E. Younger carposporangia. × 350.

ca, carposporangia; me, medulla; s, sterile gonimoblast; su, supporting cell.

The formation of the nutritive system of the present species is similar to that of *Chondrus*. Namely, the nutritive cells mainly develop by the intercalary division of the medullary cells in the vicinity of the supporting (auxiliary) cell. They

gradually enlarge and become to acquire rich cytoplasm. Soon, the young gonimoblast filaments directly communicate with them. Thus, the nourishment of the swollen medullary cells are exhausted for the further development of the gonimoblast. Accordingly, both the special medullary filaments (Faserhülle) and the special absorbent filaments as seen in other species of *Gigartina* (e. g. *G. tenella*, *G. intermedia*, and *G. teedii*) are entirely wanting.

Finally, the sterile cells of the primary gonimoblast lose most of their contents, as the terminal carposporangia develop.

The carpospores are subglobose or ovoid, and 2–4-aggregated, measuring 12.5–17.5 $\mu$ in diameter.

### ***Gigartina ochotensis*** (RUPR.) RUPRECHT

Fig. 19

"RUPRECHT, Litt. Herb. Acad. Petropol"; KJELLMAN, Om Beringhafv. Algfl., 1889, p. 31; DE TONI, Syll. Alg. IV, 1897, p. 228; Id., Syll. Alg. VI, 1924, p. 182; YENDO, Not. Alg. New. Jap., Bot. Mag. Tokyo, vol. 30, 1916, p. 57; OKAMURA, Mar. Alg. Mutsu Bay, 1927, p. 11; Id., Icon. Jap. Alg., vol. V, 1928, p. 185, pl. 247; Id., Nippon Kaisoshi, 1936, p. 651; SINOVA, Algues de la Mer Ochotsk, 1930, p. 107; INAGAKI, Mar. Rhodophyc. Oshoro Bay, 1933, p. 34; SETCHELL et GARDNER, A Preliminary survey on *Gigartina*, 1933, p. 296; TAKAMATSU, Mar. Alg. Tsugaru, 1938, p. 49, pl. 5; NAGAI, Mar. Alg. Kurile Islands II, 1941, p. 186, pl. 4; YAMADA et TANAKA, Mar. Alg. Akkeshi Marine Biological Station, 1944, p. 71; TOKIDA, Mar. Alg. S. Saghalien, 1954, p. 181.

*Chondrus mamillosus* var. *ochotensis* RUPRECHT, Tange Ochot. Meer., 1851, p. 318.

Japanese name: Hoso-ibonori.

Locality: Utoro, Abashiri Prov. (YAMADA, Apr. 1943); Akkeshi Daikokujima, Kushiro Prov. (YAMADA, July 1924). Growing on rocks in the littoral belt.

Frond gregarious, complanate, flabellate, subcoriaceous, 3.0–7.5 cm high, arising from a callous disc, with a short subcylindrical base, 2–6 times di- rarely trichotomously or subpinnately or partly fasciculately or irregularly divided, soon expanding into segments, with patent axils, assuming fan-shaped outline; segments narrow-cuneate or narrow-linear, slightly constricted at the base, 2–5 mm broad at the broadest portion, having papillose processes or flat lobules on the terminal margin, often also on the upper lateral margins; tissue composed of three layers, cortical, subcortical and medullary; cortical layer composed of 5–7 rows of small, oblong or somewhat elongated cells, diminishing in diameter outwardly, arranged closely with their longer axis perpendicular to the surface of the frond; subcortical layer composed of 3–5 series of subglobular or irregularly shaped cells, rather loosely arranged; medullary layer consisting of anastomosing rhizoidal cells, connected with

the neighbouring ones by plasmic threads, mostly arranged horizontally to the surface of the frond in longitudinal section; tetrasporangia not observed; cystocarps slightly or considerably swelling up on both surfaces, changed to papillae-form processes on the terminal margin of both upper and lateral, 1.5 mm in diam. at maturity; gonimoblast compacted, with densely anastomosing sterile cells, directly

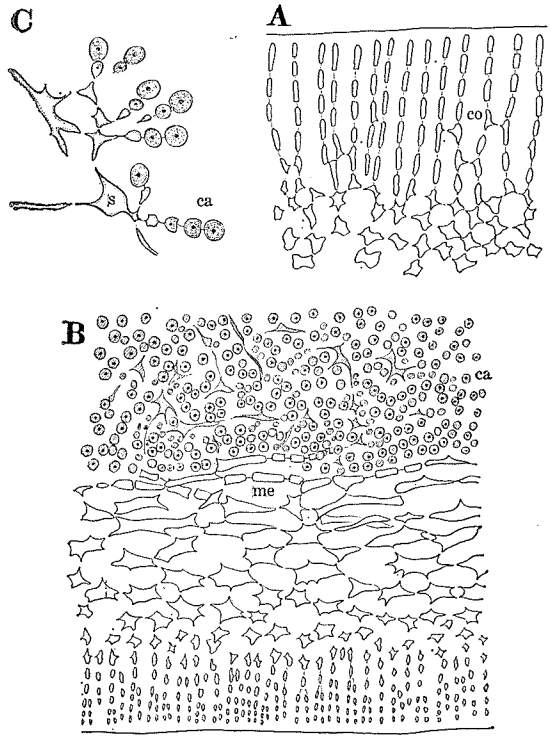


Fig. 19. *Gigartina ochotensis* (RUPRECHT) RUPRECHT
A. Longitudinal section of cortex. × 330.
B. Longitudinal section of thallus with younger carposporangia. × 180.
C. The same, more highly magnified. ×330.
ca, carposporangia; co, cortex; me, medulla;
s, sterile gonimoblast.

connected with the swollen medullary cells; medullary nutritive cells rather few, mainly developed by the intercalary division of medullary cells, irregulary arranged around the auxiliary cell; both special medullary filaments (Faserhülle) and special absorbent filaments absent; carpospores 2–4-aggregated in general, subglobose, ovoid, 10–15 $\mu$ in diam.; colour dark brownish purple with bluish iridescence when fresh; specimens not adhering to paper in drying.

As mentioned above, the present species stands very closely to *Gigartina pacifica* KJELLMAN. It is often hardly distinguishable from the extremely simple form of the latter species. The present alga in general case, however, is characterized by the narrower segments and the absolute absence of the papillate processes on the surface of the frond. In the specimens from Akkeshi, Kushiro Prov., a much more divided fronds are found. They are 5–7 cm high and 2.0 to 3.5 mm wide at the broadest part in a dried state. The division of the frond occurs subdichotomously, at times fasciculately or polychotomously above. The formation of the nutritive system and the development of the gonimoblast in the present alga are entirely similar to those of *Gigartina pacifica* KJELLMAN.

### ***Gigartina mamillosa*** (GOOD. et WOODW.) J. AGARDH

Figs. 20–21

J. AGARDH, Alg. Mar. Mediterr., 1842, p. 104; Id., Sp. Alg. vol. II, 1851, p. 273; Id., Epicr., 1876, p. 199; HARVEY, Phyc. Brit. vol. II, 1849, pl. 199; KJELLMAN, Alg. Arct. Sea, 1883, p. 167; YENDO, Notes on Alg. Jap., IV, 1916, p. 58; OKAMURA, Nippon Sorui Meii (2nd ed.), 1916, p. 31; Id., Nippon Kaisoshi, 1936, p. 652; ROSENVINGE, Mar. Alg. Denmark, 1931, p. 509.

*Mastocarpus mamillosus* KÜTZING, Phycol. Gener., 1843, p. 398, Tab. 76 III; Id., Tab. Phycol. XVII, 1867, pl. 39.

Japanese name: Ikanoashi.

Locality: Izu-Shimoda, Shizuoka Pref. (NEGORO, Mar. 1933); Izu-Shirahama, Shizuoka Pref. (CHIHARA, May 1960).

Frond caespitose, cartilaginous, 6–18 cm high, up to 4.5 cm wide at the broadest part, attached to the substratum by means of a small disc-shaped base, filiform at the base, immediately compressed, sometimes strongly canaliculated and contorted, soon expanded widely or cuneately upwards, divided subdichotomously, palmately or very irregularly; segments broad-cuneate or linear, with abundant papillose processes on both surfaces and on margins; processes clavated with swollen tip, solitary, in each of them one cystocarp immersed, curved at the base; tissue composed of three layers, cortical, subcortical and medullary; cortex consisted of 6–10 rows of small, oblong or elongated cells, diminishing in diamter outward, arranged closely with their longer axis perpendicular to the surface of the frond; subcortical layer consisted of 3–5 series of subglobular cells, rather loosely arranged; medullary layer composed of anastomosing isodiametric cells, generally arranged horizontally to the surface of the frond in longitudinal section; tetrasporangia not observed; cystocarps formed in papillae (bended at the base) on both surfaces and on margin of flat frond, 1.0–1.5 mm in diam.; procarp consisting of a large supporting (auxiliary) cell and a three-celled carpogonial branch, without sterile cell;

medullary nutritive cells considerably abundant in quantity, mainly developed by the intercalary division of medullary cells, irregularly arranged around the supporting (auxiliary) cell; gonimoblast filaments elongate, directly communicated with the swollen nutritive cells; accordingly, both special medullary filaments (Faserhülle) and special absorbent filaments absent; carpospores aggregated, subglobose, 10–15 $\mu$ in diam.; colour dark purplish red when fresh, changing to black in drying; specimens not adhering to paper in drying.

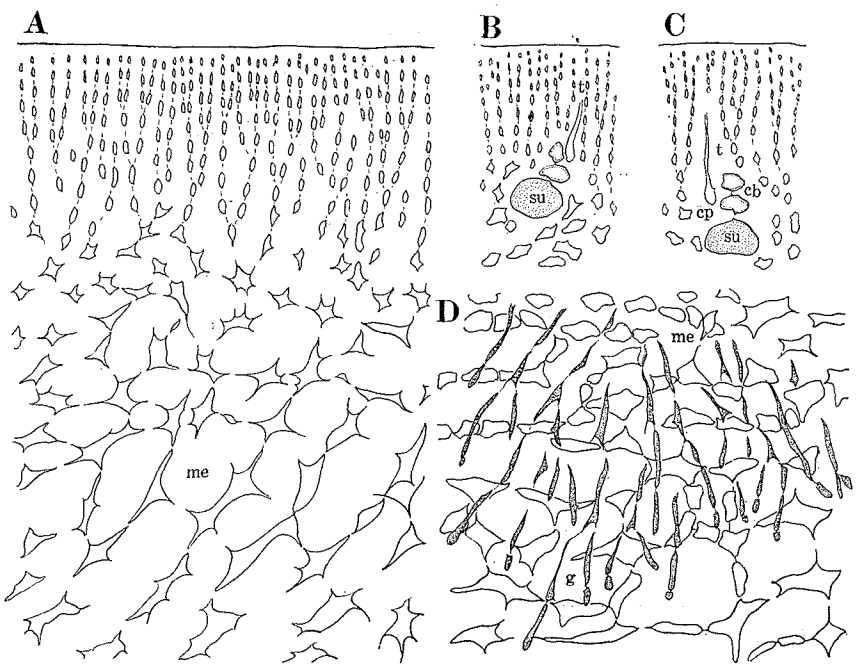


Fig. 20. *Gigartina mamillosa* (GOOD. et WOODW.) J. AGARDH
A. Longitudinal section of thallus. × 330.
B, C. Procarp. × 330.
D. Gonimoblast filaments in longitudinal section. × 330.
cb, carpogonial branch; cp, carpogonium; g, gonimoblast; me, medulla; su, supporting cell; t, trichogyne.

YENDO (1916) referred some specimens collected at Shimoda, Shizuoka Pref. at Enoshima, Kanagawa Pref. and at Asamushi, Aomori Pref. to the present species. The writer also came to the same opinion as the YENDO's one at least concerning the specimens from Izu-Shimoda and Izu-Shirahama, Shizuoka Pref.

The present alga is very variable in outer appearance according to the locality.

The lower part of the frond is generally gradually tapering towards the base; the base is more stem-like, while in some cases it is broadly cuneate. The attachment disc has a parenchymatous structure of firm consistence, being built up of approximately quadrangular cells arranged in more or less vertical rows. The frond is closely related in structure to that of *Gigartina pacifica* and *Gigartina ochotensis*.

The writer could not observe the antheridia and tetrasporangia in the present materials.

The cystocarp arises in the papillae covering the flat frond. The structure of the procarps in our meterials is exactly the same as that of the genus *Chondrus*. That is, as mentioned in the diagnosis, they consist of a large supporting (auxiliary) cell and a three-celled carpogonial branch as in Fig. 20 (B, C). The carpogonial branch is strongly curved in such a way that the carpogonium becomes to lie close to the supporting (auxiliary) cell. Very regrettably, the union of the carpogonium and the auxiliary cell was not observed. The formation of the nutritive system of the present alga is primarily similar to that of *G. pacifica* and *G. ochotensis*. The nutritive cells are rather abundant in quantity, and develop in accordance with the intercalary division of the medullary cells as in Fig. 21 (A). Namely, the medullary cells with intercalary cells in the vicinity of the auxiliary cell gradually enlarge and become to acquire rich cytoplasm. Soon, the young gonimoblast filaments directly communicate with them. Consequently, the nourishments of the swollen medullary cells are exhausted for the further development of the gonimoblasts. Therefore,

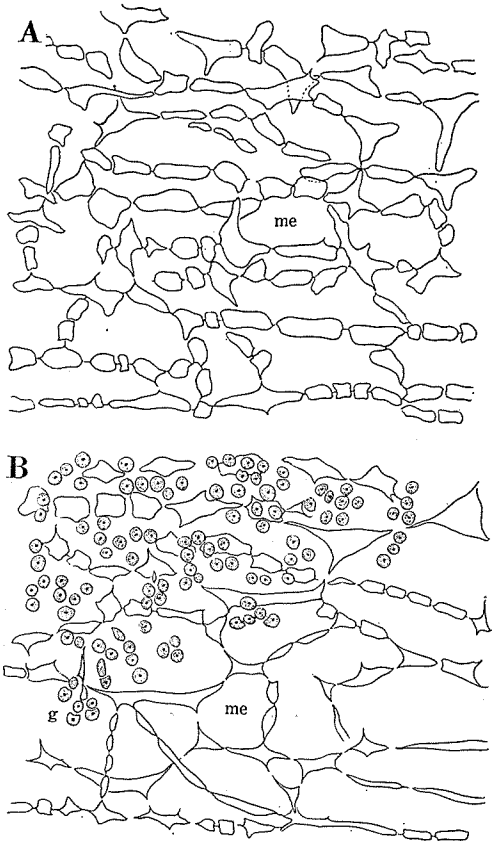


Fig. 21. *Gigartina mamillosa* (GOOD. et WOODW.) J. AGARDH

A. Nutritive medullary cells with intercalary cells in longitudinal section. × 340.

B. Medullary cells and gonimoblasts. × 340.

g, gonimoblast; me, medulla.

in the present alga, both the special medullary filaments (Faserhülle) and the special absorbent filaments are not to be found.

*Gigartina mamillosa* has been classified by SETCHELL and GARDNER (1933) under the series *Palmatae*, one of three series established by the same authors under the genus *Gigartina*. Series *Palmatae* is said to be very closely related to *Chondrus*, especially in the absence of special medullary filaments (Faserhülle).

Because of the above-mentioned characteristics the writer agrees with SETCHELL and GARDNER's opinion.

On the contrary, as has already been described, in *Gigartina tenella*, *G. intermedia*, *G. teedii* etc., the gonimoblasts are surrounded by special medullary filaments. According to ROSENVINGE (1931), ripe and partly emptied cystocarps were met with at Thisted (Denmark) in August. But, in Izu Prov. in this country, they could be observed as early as in March and May.

## *Chondrus*

Key to the species

1. Frond linear . . . . . 2
1. Frond somewhat broad, flat . . . . . 3
   2. Branching regularly dichotomous, major branches generally scarcely with proliferous branchlets . . . . . *Ch. elatus*
   2. Branching often irregular, major branches with few or many proliferous branchlets . . . . . *Ch. pinnulatus*
3. Cystocarps ovate, spherical or subspherical, restricted to marginal segments and on proliferous branchlets . . . . . *Ch. crispus*
3. Cystocarps not as above . . . . . 4
   4. Cystocarps wart like, mainly scattered over upper half of frond . . . . . *Ch. verrucosus*
   4. Cystocarps universally ocellated, scattered over almost all parts of frond . . 5
5. Tetrasporangia developing from the whole medullary cell . . . *Ch. giganteus*
5. Tetrasporangia developing from shallow medullary cell . . . . . 6
   6. Cystocarps truly circular in outline . . . . . *Ch. yendoi*
   6. Cystocarps often irregular in outline . . . . . *Ch. ocellatus*

### *Chondrus pinnulatus* (HARVEY) OKAMURA

OKAMURA, Icon. Jap. Alg., VI, 3, 1930, p. 19, pl. 261, 263, Figs. 1-6.

Frond caespitose, compressed or cylindrical, 10–20 cm high, 3–4 mm (broader ones 8 mm) broad in main branches, attached to the substratum by means of a common scutate disc, regularly dichotomously divided in some fronds, but com-

monly more or less irregular, often densely branched in a divaricato-dichotomous as well as a pinnate manner, very rarely proliferated from the surfaces; branches linear, compressed or tereti-compressed, widely patent with round axil, ending in sharp or blunt points; branchlets often pinnately arranged at short distance along both sides of branches, compressed or subcylindrical, mostly simple or divided or rarely palmately parted; tissue composed of three layers, cortical, subcortical and medullary; cortex composed of 5–7 rows of small, oblong or elongated cells, diminishing in diameter outward, arranged perpendicularly to the surface; subcortical layer consisting of 3–4 series of subglobular cells, arranged in anticlinal order; medullary layer consisting of elongated cells, mostly arranged in longitudinal rows; tetrasporic sori spot-like, elliptical or oblong, scattered over proliferated branches and the upper part of branches, very slightly swollen out, sometimes densely aggregated in branches; tetraspores subglobose or ovoid, cruciately divided, 50–62.5×37.5–50 $\mu$ in diam.; procarps consisting of a large supporting (auxiliary) cell and a three-celled carpogonial branch; gonimoblast-threads elongate, communicating with the swollen medullary cells in the vicinity of the auxiliary cell; cystocarps large, elliptic or oval, scattered in branches and branchlets, slightly swollen out; carpospores ovoid, 22.5–27.5 (–40) $\mu$ in diam.; colour dark purplish red, fading to yellowish; specimens imperfectly or not adhering to paper in drying.

The present alga was first described as *Gymnogongrus pinnulatus* HARVEY (1856). Afterwards, it was transferred to *Chondrus* by OKAMURA (1930). Namely, he states as follows: "At a glance, the present sterile plant represents in its cross section the structure like *Gymnogongrus*; but carefully studying, the tissue is not regularly parenchymatic as in that genus, but cells are loosely set like *Chondrus*, and the longitudinal section of frond at once shows the structure of that genus. The existence of tetrasporic sori in infracortical layer tells us the nature of *Chondrus*". The external and internal structures of the thallus of this alga were throughly described and illustrated by HARVEY (1856), OKAMURA (1930) and other phycologists. The variability of the present species is well known. In 1941, NAGAI divided the present species into two forms, viz., f. *typicus* NAGAI and f. *conglobatus* NAGAI. Afterwards, TOKIDA (1954) examined a considerable number of Saghalien specimens from various localities and distinguished among them four forms and two subforms. The key to the forms and subforms of *Ch. pinnulatus* here adopted is a slight modification of that given by TOKIDA (1954).

Key to the forms and subforms

1. Branchlets cylindrical or subcylindrical . . . . . f. *armatus*
1. Branchlets compressed . . . . . 2
   2. Branch apices broadened . . . . . 3

2. Branch apices narrow and mostly subulate . . . . . 4
3. Frond densely conglobate . . . . . f. *conglobatus*
3. Frond not so, often cristate at apices . . . . . f. *cervicornis*
4. Frond narrow throughout . . . . . 5
4. Frond partly somewhat broadened . . . . . 6
5. Frond subdichotomously and laterally branched . . . . . f. *pinnulatus*
5. Frond dichotomo-flabellately branched . . . . . f. *flabellatus*
6. Terminal segments elongate . . . . . f. *longicornis*
6. Terminal segments short . . . . . 7
7. Marginal pinnae minute teeth-shaped . . . . . f. *ciliatus* subf. *angustus*
7. Marginal pinnae not so minute . . . . . f. *ciliatus* subf. *latus*

### f. ***pinnulatus***

Figs. 22–24

OKAMURA, Icon. Jap. Alg., VI, 3, 1930, p. 19, pl. 261, 263, Figs. 1-6; Id., Nippon Kaisoshi, 1936, p. 657; TOKIDA, Mar. Alg. Robb. Isl., Saghalien, 1932, p. 13, pl. 5, Fig. b; Id., Mar. Alg. S. Saghalien, 1954, p. 178; KAWABATA, Mar. Alg. Shikotan Isl., 1936, p. 209; TAKAMATSU, Mar. Alg. Sanriku, 1938 a, p. 122; SINOVA, Alg. Petrov Isl., Sea of Japan, 1938, p. 50; NAGAI, Mar. Alg. Kurile Isl., II, 1941, p. 188.

*Gymnogongrus pinnulatus* HARVEY, in GRAY's List Plant. Jap., 1856, p. 332; MARTENS, Tange v. Preus. Exp. Ost Asien, 1866, p. 133; J. AGARDH, Epicr., 1876, p. 214; DE TONI, Syll. Alg. IV, 1897, p. 253; OKAMURA, Nippon Sorui Meii (2nd ed.), 1916, p. 33.

*Chondrus pinnulatus* (HARV.) OKAMURA f. *typicus* NAGAI, Mar. Alg. Kurile Isl., II, 1941, p. 188; TOKIDA, Mar. Alg. S. Saghalien, 1954, p. 179, pl. XIV, Figs. c-d.

Japanese name: Hirakotoji.

Locality: Zenibako, Shiribeshi Prov. (MIKAMI, July 1958); Horoman, Hidaka Prov. (MIKAMI, Aug. 1956); Erimo, Hidaka Prov. (MIKAMI, July 1957); Shoya, Hidaka Prov. (MIKAMI, Mar. 1959). Growing on rocks in the lower littoral and upper sublittoral belts.

Frond narrow throughout, subdichotomously and laterally branched.

As noted above, *Chondrus pinnulatus* is very variable in habit, but most specimens are referred to f. *pinnulatus*.

The development of the tetrasporangia was observed distinctly. As in Fig. 22 (A–C) they arise as special branches from the medullary cells. According to the writer's observation, the sporangia do not arise in free-end but in network among the medullary cells. The tetrasporangial sori appear as sesamoid spots, and they are slightly bulging on one surface of the proliferated branches and the upper portion of branches. The development proceeds from the base towards the top of the frond.

The structure of the procarp is essentially the same as in *Chondrus crispus*. Namely, they consist of a large supporting (auxiliary) cell and a three-celled

carpogonial branch (Fig. 23, B). The supporting (auxiliary) cell rich in protoplasm belongs to the inner cortex, and is linked with the surrounding vegetative cells by secondary pit-connections. Moreover, the carpogonial branch is strongly curved in such a way that the carpogonium becomes to lie close to the supporting cell. The

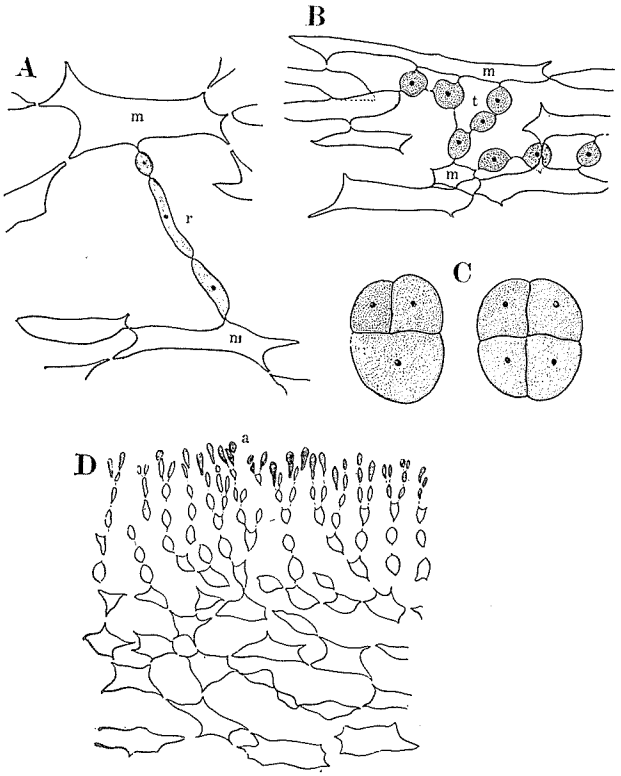


Fig. 22. *Chondrus pinnulatus* (HARVEY) OKAMURA f. *pinnulatus*
A. Early development of tetrasporangia in horizontal section. × 300.
B. Further development of tetrasporangia in longitudinal section. × 300.
C. Mature sporangia. × 300.
D. Antheridial development. × 300.
a, antheridium; m, medulla; r, rudiment of tetrasporangia; t, tetrasporangia.

union of the carpogonium and the auxiliary cell was observed clearly as in Fig. 23, B–C. That is, after fertilization the carpogonium communicates with the auxiliary cell by a short connection, while the medullary cells in the vicinity of the auxiliary cell gradually enlarge and acquire rich contents. Soon, the gonimoblast filaments develop from auxiliary cell and communicate with the swollen

medullary cells in order to obtain the nutrition (Fig. 24, A–C). Consequently, the contents of the swollen medullary tissue are exhausted for the further development of the gonimoblasts. At last the medulla becomes almost completely displaced by

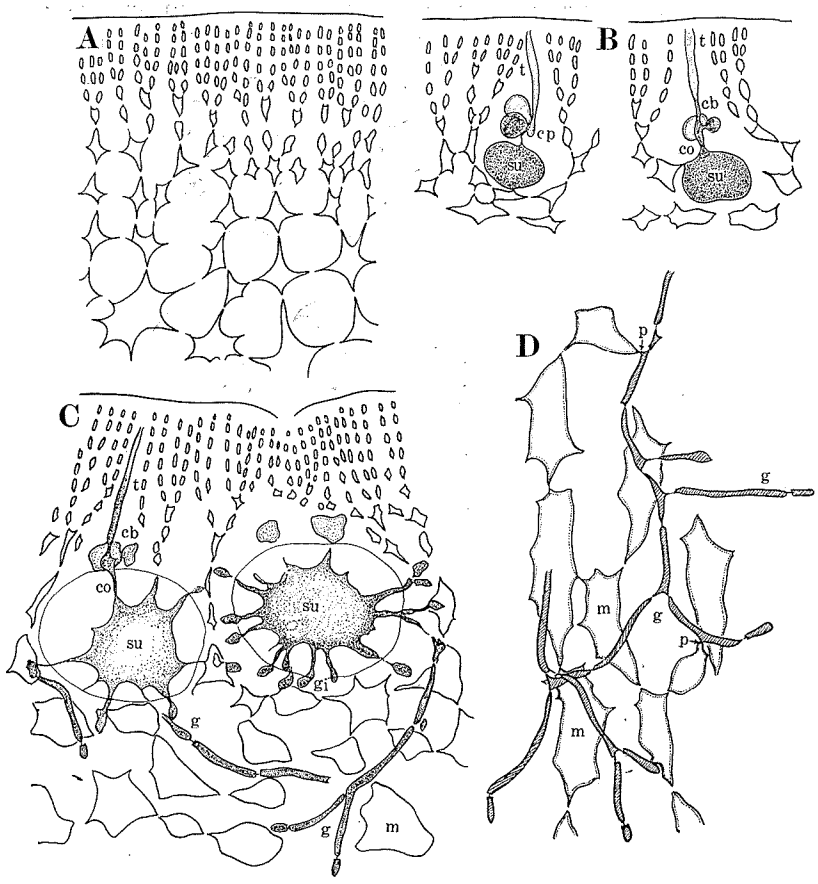


Fig. 23. *Chondrus pinnulatus* (HARVEY) OKAMURA f. *pinnulatus*
A. Transverse section of thallus. × 330.
B. Procarp in longitudinal section. × 330.
C. Fusion of carpogonium with auxiliary cell (su). × 330.
D. Young gonimoblast. × 330.
cb, carpogonial branch; co, connecting filament;
cp, carpogonium; g, gonimoblast; gi, gonimoblast-initial;
m, medulla; p, pit-connection; su, supporting cell.

the numerous groups of carpospores produced from the gonimoblast. The cystocarps are large and elliptical, slightly elevated, and formed in a few numbers in lateral branchlets and upper branches. The carpospores are ovoid, 22.5–27.5 $\mu$ in

diam., and are liberated from the swollen fruits after decay of the fronds.

The antheridial sori are born on the upper parts of the frond. The antheridia are ovate in shape and 2.5–4 $\mu$ in size. Most commonly an antheridium develops obliquely on a younger antheridial mother cell, as far as the writer observed.

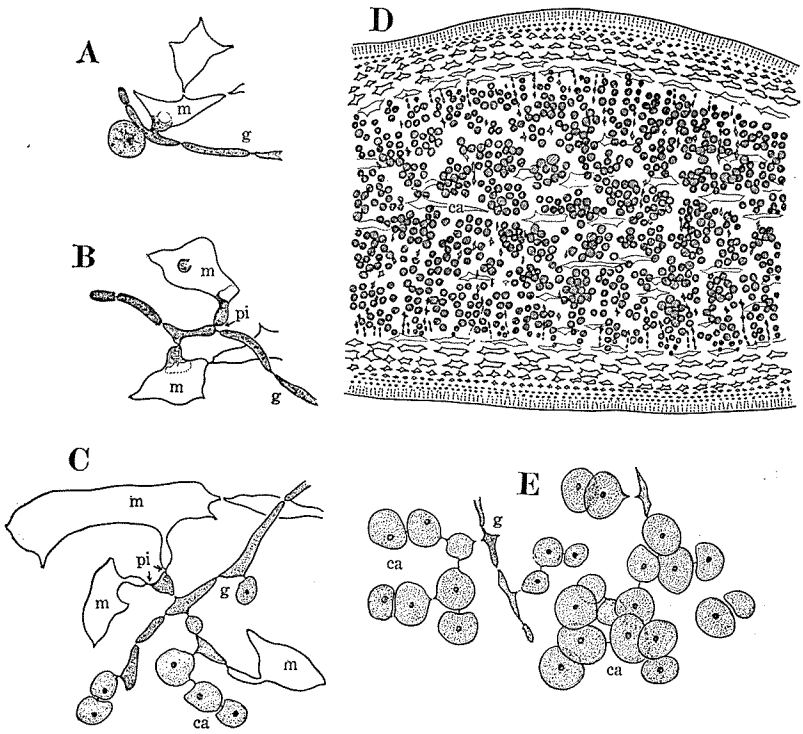


Fig. 24. *Chondrus pinnulatus* (HARVEY) OKAMURA f. *pinnulatus*
A, B, C. Connections of gonimoblasts with medullary cells. × 330.
D. Longitudinal section of thallus with mature carposporangia. × 55.
E. The groups of carposporangia. × 330.
ca, carposporangia; g, gonimoblast; m, medulla; pi, pit-connections between gonimoblast and medullary cell.

f. ***armatus*** (HARVEY) YAMADA et MIKAMI, comb. et stat. nov.

Pl. II; Fig. 25

*Cystoclonium*? *armatum* HARVEY, in GRAY's List of plants collected in Japan, 1856, p. 332; MARTENS, Tange v. Preus. Exp. Ost. Asien, 1866, p. 118; J. Ag., Epicr., 1876, p. 239; DE TONI, Syll. Alg. IV, 1897, p. 316; Id., Phyc. Jap. Nov., 1895, p. 26; OKAMURA, Nippon Sorui Meii (2nd ed.), 1916, p. 36.

*Chondrus armatus* (HARV.) OKAMURA, Icon. Jap. Alg., VI, 3, 1930, p. 21, pl. 262, 263, Figs. 7–12; Id., Nippon Kaisoshi, 1936, p. 657; INAGAKI, Mar. Rhodophyc. Oshoro Bay, 1933, p. 29; TAKAMATSU, Mar. Alg. Tsugaru, 1938, p. 47; Id., Mar. Alg. Sanriku, 1938 a, p. 121; Id., Mar. Alg. Japan Sea, 1939, p. 63; TOKIDA et OHMI, List Mar. Alg. Tobuchi Lake, 1941, p. 431; HASEGAWA, A List Mar. Alg. Okushiri Isl., 1949, p. 60; TOKIDA, Mar. Alg. S. Saghalien, 1954, p. 178; TOKIDA et MASAKI, A List of Mar. Alg. Oshoro Marine Biological Station, 1959, p. 187.

Japanese name: Toge-tsunomata.

Type locality: Hakodate, Hokkaido.

Locality: Maizuru, Kyoto Pref. (UMEZAKI, July 1950); Asamushi, Aomori Pref. (MIKAMI, Aug. 1959); Zenibako, Shiribeshi Prov. (MIKAMI, July 1956; Aug. 1957; Aug. 1958; Sept. 1958); Abashiri, Abashiri Prov. (MIKAMI, Sept. 1957). Growing on rocks in the lower littoral and sublittoral belts.

Branchlet cylindrical or subcylindrical, with a spinose apex.

The present alga was first described by HARVEY (1856) under the name of *Cystoclonium*? *armatum* on the basis of the specimens from Hakodate, Hokkaido. Afterwards, it was transferred to the genus *Chondrus* by OKAMURA (1930). The most characteristic feature of it is possessing the cylindrical or subcylindrical spinose branchlets, which usually indicate at once the present alga. But it is exceedingly variable in external shape according to the localities. In this respect, OKAMURA (1930) mentioned as follows: "It resembles *Chondrus pinnulatus* (HARV.) OKAMURA, and there are many forms which are difficult to distinguish one from the other". On the other hand, in the description of *Ch. pinnulatus* he says: "When the proliferated branchlet of *Ch. pinnulatus* is subterete and pointed, then it looks like *Ch. armatus*, and there are many forms which are difficult to distinguish one from the other". Studying various forms of *Ch. armatus* (HARV.) OKAMURA from the above mentioned localities, the authors have come to the conclusion that all of them are to be considered after all as one form of *Ch. pinnulatus* (HARVEY) OKAMURA. According to writer's observation, the development of the tetrasporangia in this material is entirely similar to that of *Ch. pinnulatus* f. *pinnulatus*. Namely, the sporangia do not arise in free-end but in network among the medullary cells. The tetrasporangial sori are produced at first on the middle portion of the cylindrical branchlets as a small patch with either round or sesamoid outline, and as the stage advences it grows larger towards around the branchlets.

The structure of the procarp of the material is exactly the same as that of *Ch. pinnulatus* f. *pinnulatus*. To his regret, the writer has not been able to observe the union of the carpogonium and the auxiliary cell in the present alga. The gonimoblast filaments occur internally and the radiating gonimoblast-threads develop towards the medullary cells. While, the medullary cells in the neighbourhood of

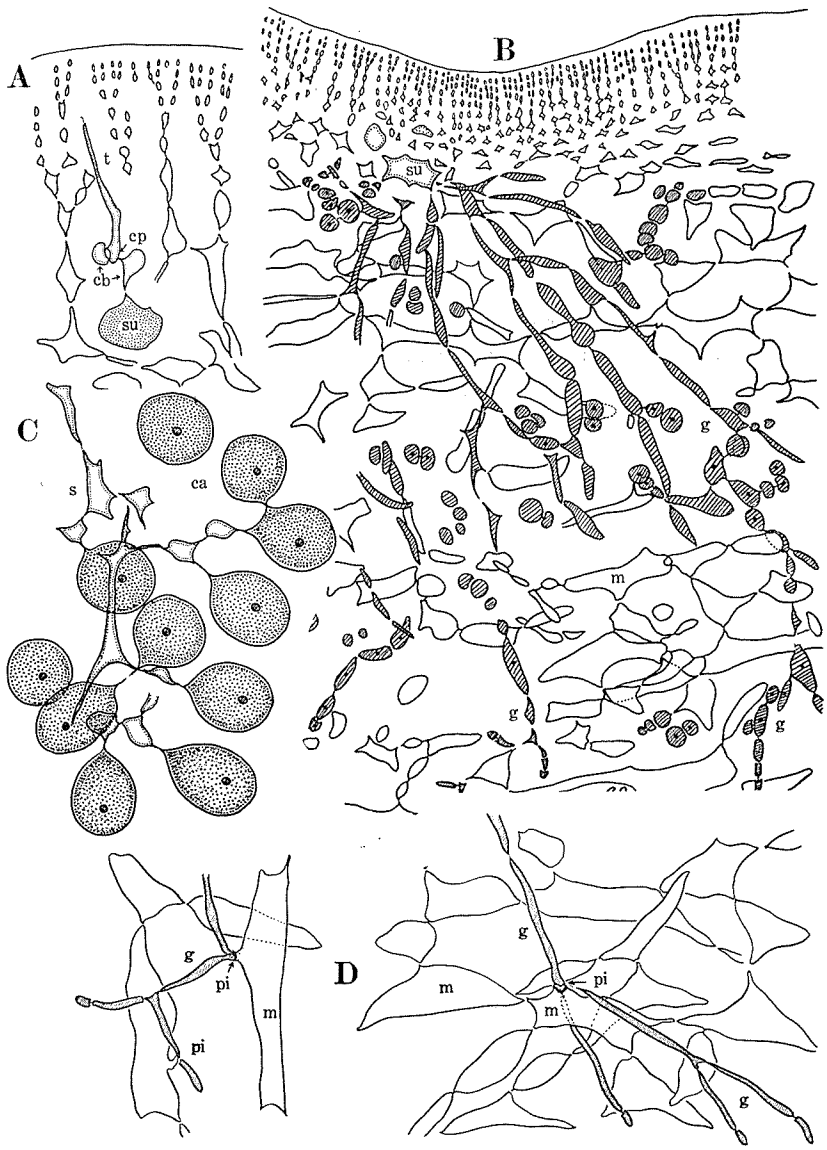


Fig. 25. *Chondrus pinnulatus* (HARVEY) OKAMURA
f. *armatus* (HARVEY) YAMADA et MIKAMI

A. Transverse section of thallus with procarp. × 350.
B. The same, more advanced stage. × 180.
C. Mature carposporangia. × 350.
D. Fusion of gonimoblast filaments and medullary cells in longitudinal section. × 350.

ca, carposporangia; cb, carpogonial branch; cp, carpogonium; g, gonimoblast; m, medulla; pi, pit-connection; s, sterile gonimoblast; su, supporting cell; t, trichogyne.

the supporting (auxiliary) cell gradually enlarge as in *Ch. pinnulatus* f. *pinnulatus*. Soon after, the younger gonimoblast filaments directly communicate with the swollen medullary cells, whose contents are exhausted for the development of the gonimoblasts. The sterile cells of the gonimoblast lose most of their contents, as the carposporangia develop. The carpospores are ovate, measuring 25–40 $\mu$ in diameter, being somewhat larger than those of f. *pinnulatus*.

### f. ***flabellatus*** TOKIDA

TOKIDA, Mar. Alg. S. Saghalien, 1954, p. 179, pl. XIV, Fig. E.

Japanese name: Uchiwa-hirakotoji (nom. nov.).

Locality: Zenibako, Shiribeshi Prov. (MIKAMI, July 1956; Aug. 1957; July 1958; Sept. 1958); Saghalien (cf. TOKIDA, 1954, p. 179). Growing on rocks in the lower littoral and upper sublittoral belts.

Frond narrow throughout, dichotomo-flabellately branched.

The present forma is characterized by its dichotomo-flabellate branching.

In Zenibako, Shiribeshi Prov. Hokkaido, it grows very luxuriantly. In the internal structure as well as the reproductive organs, they agree quite well with *Ch. pinnulatus* f. *pinnulatus*.

### f. ***longicornis*** TOKIDA

TOKIDA, Mar. Alg. S. Saghalien, 1954, p. 179, pl. XV, Figs. A–B.

Japanese name: Hasami-hirakotoji (nom. nov.).

Locality: Erimo, Hidaka Prov. (MIKAMI, Aug. 1955); Saghalien (cf. TOKIDA, 1954, p. 179). Growing on rocks in the lower littoral and upper sublittoral belts.

Frond partly somewhat broadened, and terminal segments elongate.

The present forma is characteristic by the elongate terminal segments.

TOKIDA has reported that it is endemic in the western coast (Nayoshi, Aniwa Bay; Merei, Nakashiretoko) and the eastern coast (Hota; Minabetsu; Unetonnai) of S. Saghalien. Our specimens from Erimo, Hidaka Prov. are also referable to the present form.

### f. ***ciliatus*** subf. ***latus*** TOKIDA

TOKIDA, Mar. Alg. S. Saghalien, 1954, p. 180, pl. XIV, Fig. B.

Japanese name: Kushi-hirakotoji (nom. nov.).

Locality: Horoman, Hidaka Prov. (MIKAMI, Aug. 1956); Izumihama, Tokachi Prov. (MIKAMI, July 1957); Saghalien (cf. TOKIDA, 1954, p. 180). Growing on rocks in the lower and upper littoral belts.

Frond remarkably broadened, marginal pinnae more or less broad.

The specimens which agree well with TOKIDA's description and photograph are found in the collection from Horoman, Hidaka Prov. and Izumihama, Tokachi Prov. In the internal nature, they agree quite well with f. *pinnulatus*.

### f. ***ciliatus*** subf. ***angustus*** TOKIDA

TOKIDA, Mar. Alg. S. Saghalien, 1954, p. 180, pl. XIV, Fig. A.

Japanese name: Hosoba-kushi-hirakotoji (nom. nov.).

Locality: Saghalien (cf. TOKIDA, 1954, p. 180).

Frond partly broadened, and marginal pinnae minutely teeth-shaped.

The writer has failed to find out this subform among his collections.

### f. ***cervicornis*** TOKIDA

TOKIDA, Mar. Alg. S. Saghalien, 1954, p. 180, pl. XV, Figs. C–E.

Japanese name: Tosaka-hirakotoji (nom. nov.).

Locality: Saghalien (cf. TOKIDA, 1954, p. 180).

Frond dichotomo-laterally or irregularly branched, branches broadened at apices.

TOKIDA states as follows: "Forma *cervicornis* is so distinctly characterized as to lead one to incline strongly to treat it as a distinct species. It is distributed in the cold water region of the Peninsula of Nishinotoro and in the northernmost localities on the eastern coast from Kaihyo-to northward".

Forma *cervicornis* is characterized by the broadened (often cristate) apices of branches. The writer could not find any specimens referable to this forma in his collection.

### f. ***conglobatus*** NAGAI

NAGAI, Mar. Alg. Kurile Isl., 1941, p. 188.

Japanese name: Chishima-hirakotoji (nom. nov.).

Locality: Kurile Islands (cf. NAGAI, 1941, p. 189).

Frond di- or polychotomously or short-palmately branched, densely conglobate.

According to NAGAI's description, f. *conglobatus* is usually smaller than f. *typicus* (=f. *pinnulatus*). A denser formation of the branches which are provided with somewhat broadened ramuli is chracteristic of the present forma. The writer has failed to find out it among his materials.

### ***Chondrus ocellatus*** HOLMES

HOLMES, New Mar. Alg. Jap., 1895, p. 252, pl. IX, Fig. 2.

Frond carnoso-membranaceous, caespitose, 2–17 cm high, attached to the substratum by means of a small callous disc, subcylindrical at the very base, soon compressed and expanded, flat, linear, linear-cuneate, simple or once or twice forked, or with 5–7 times repeatedly dichotomous; segments patent with broadly roundish axils, ending in ligulate, obtuse, bifid or emarginated apices; margin entire, slightly thickened, with simple or 2–3 times forked, shorter or longer, cuneate or ligulate proliferations, ending in bifid or blunt apices; in robust fronds proliferating even from surfaces; tissue composed of three layers, cortical, subcortical and medullary; cortex consisting of 6–8 rows of small, oblong or elongated cells, diminishing in diameter outward, arranged closely with their longer axes perpendicular to the surface; subcortical layer of 3–5 series of subglobular cells, arranged in anticlinal order; medullary layer consisting of slender long rhizoidal cells, mostly arranged in parallel with the surface of the frond; tetrasporangial sori densely scattered all over the frond forming small dot like, elliptic or irregularly roundish spots in surface view, sometimes confluent with each other; tetraspores subglobose or ovoid, 37.5–55 $\mu \times$ 37.5–40 $\mu$ in diam., cruciately divided; procarps consisting of a large supporting (auxiliary) cell and a three-celled carpogonial branch; gonimoblast-threads elongate, directly communicate with the swollen medullary cells in the vicinity of the auxiliary cell; cystocarps roundish or elliptical or often irregular in surface view, more or less prominent on one side and concaved on the other, ocellated, and sometimes slightly swollen out on both sides, scattered all over the frond; carpospores ovoid, 20–25 (–27.5) $\mu$ in diam.; colour purplish red, often becoming greenish; specimens imperfectly or not adhering to paper in drying.

The present species was established by HOLMES in 1895 on the basis of the specimens from Shimoda, Shizuoka Pref. It is one of the commonest seaweeds from our coast, especially along the Pacific coast of the Main Island of Japan, and it grows on the rocks extending between tide marks and below low tide. The present species somewhat resembles *Ch. yendoi* YAMADA et MIKAMI, but it is distinguished from the latter by its extremely slender medullary filaments and by the irregularly and strongly ocellated cystocarps. This species shows some resemblance to *Ch. verrucosus* MIKAMI, but can be distinguished from it by the thinness of the frond and by the distributions of the gonimoblast and tetrasporangia.

The species is separable into the four following forms.

Key to the forms

1. Frond nearly flat . . . . . 2
1. Frond somewhat linear . . . . . 3
   2. Frond generally 8–17 cm tall . . . . . f. *ocellatus*
   2. Frond generally 2–3 cm tall . . . . . f. *parvus*

3. Frond with almost same breadth throughout . . . . . f. *aequalis*
3. Frond not as above . . . . . f. *crispoides*

### f. ***ocellatus***

Figs. 26–28

HOLMES, New Mar. Alg., 1895, p. 252, pl. IX, Fig. 2; OKAMURA, Nippon Sorui Meii (2nd ed.), 1916, p. 29; Id., Icon. Jap. Alg. VI, 1932, p. 83; Id., Nippon Kaisoshi, 1936, p. 653.

*Chondrus ocellatus* HOLMES f. *typicus* OKAMURA, Icon. Jap. Alg. VI, 1932, p. 84, pl. 291; Id., Nippon Kaisoshi, 1936, p. 655, Fig. 311, 1.

Japanese name: Tsunomata.

Type locality: Shimoda, Shizuoka pref.

Locality: Kada, Wakayama Pref. (SHIMIZU, May 1949); Yuzaki, Wakayama Pref. (MIHASHI, Mar. 1955); Tategasaki, Mie Pref. (SEGI, Mar. 1959); Izu-Shimoda, Shizuoka Pref. (CHIHARA, May 1959); Susaki near Shimoda, Shizuoka Pref. (YAMADA, NAKAMURA, Apr. 1938; INOH, May 1941); Izu-Shirahama, Shizuoka Pref. (CHIHARA, Apr. 1959); Enoshima, Kanagawa Pref. (YOSHIDA, Mar. 1957); Tateyama, Chiba Pref. (ENOGUCHI, June 1959); Inubozaki, Chiba Pref. (MIKAMI, Aug. 1959); Hirota, Iwate Pref. (KAWASHIMA, June 1954); Yonezaki, Iwate Pref. (TOBA, Sept. 1936).

Frond flat, stipitate, cuneately broadened upwards, 8–17 cm high, 3–4 times patently dichotomously divided, with or without marginal proliferations.

*Chondrus ocellatus* HOLMES is very variable in external appearance, but most of them are referable to the present forma. The present forma is characterized by the broader fronds. The tissue is composed of three layers, cortical, subcortical and medullary.

The cortex is rather thick, being composed of 6–8 rows of small, oblong or elongated cells, arranged closely with their longer axes perpendicular to the surface. The subcortical layer is built up of 3–5 series of subglobular or oblong cells, arranged in anticlinal order. The medullary tissue is consisting of slender rhizoidal cells, which are mostly arranged in parallel with the surface of the frond. In the central portion, the articulations of the medullary cells are often extremely elongated.

The development of the tetrasporangia was traced as shown in Fig. 26. Fig. 26 (B) represents the rudiment of tetrasporangia. The sporangia scarcely do not arise in free-end but in a network among the medullary cells except the central medulla. They are cruciately divided. The tetrasporangial sori appear as dark-red spots, and are scattered all over the frond. They are more irregular in outline and more numerous than the cystocarps and often confluent each other.

The structure of the procarp is essentially the same as in *Ch. pinnulatus* (HARV.) OKAMURA. Fig. 27 (C) shows a large supporting (auxiliary) cell and a three-celled carpogonial branch. Unfortunately, the union of the carpogonium and the auxiliary

cell in the present material was not observed.

Fig. 28 (A) represents a typical ocellated cystocarp in longitudinal section. The formations of the nutritive tissue of the present alga is primarily similar to that of *Ch. crispus*. Namely, the medullary cells with intercalary cells in the vicinity of

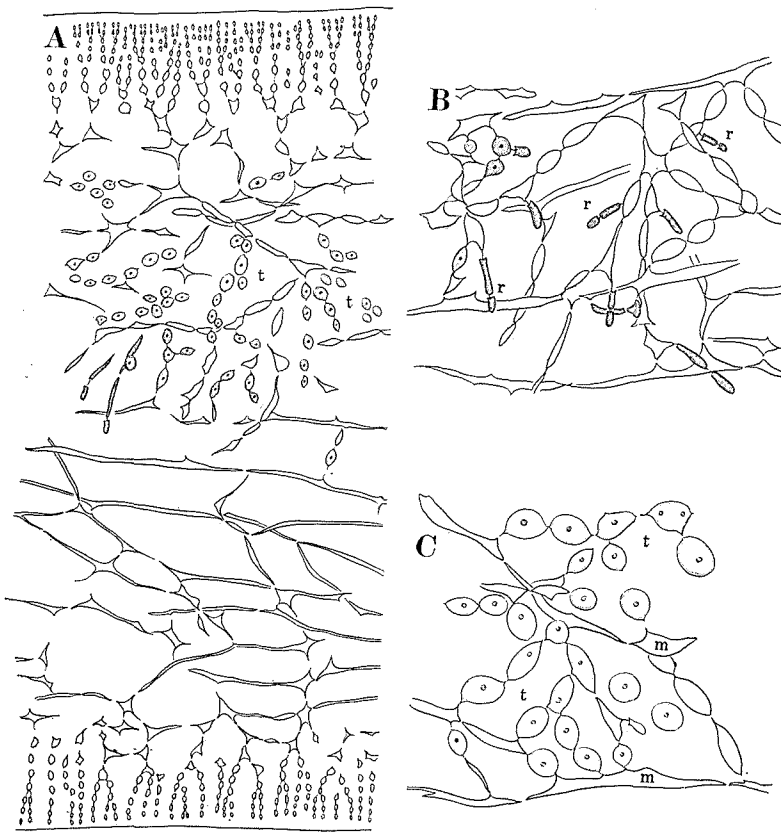


Fig. 26. *Chondrus ocellatus* HOLMES f. *ocellatus*

A. Longitudinal section of thallus with young sporangia. × 180.
B. Early development of sporangia. × 330.
C. Further development of sporangia. × 330.
m, medulla; r, rudiment of tetrasporangia;
t, tetrasporangia.

the auxiliary cell gradually enlarge and become to acquire rich contents. Soon after, the young gonimoblast filaments directly communicate with them in order to obtain the nutrition. Consequently, the contents of the swollen medullary cells are exhausted for the development of the gonimoblasts. In the typical case, the

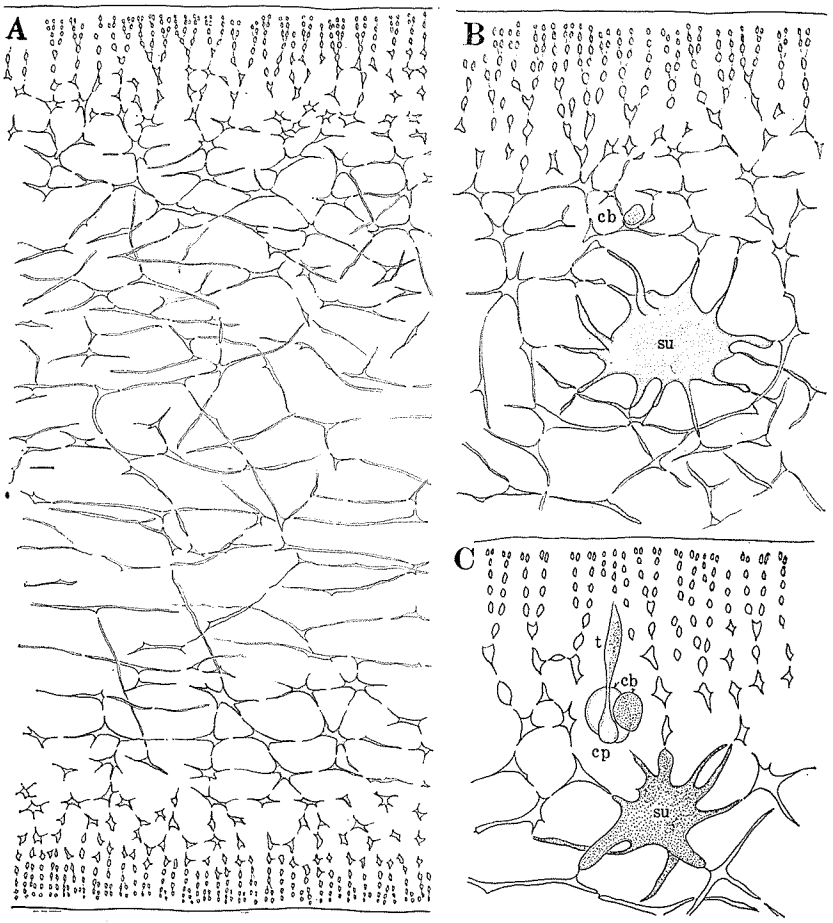


Fig. 27. *Chondrus ocellatus* HOLMES f. *ocellatus*
A. Longitudinal section of thallus. × 180.
B, C. Procarps. × 350.
cb, carpogonial branch; cp, carpogonium;
su, supporting cell; t, trichogyne.

numerous groups of carposporangia occur at a distance from the auxiliary cell. The outer appearance of the cystocarps, accordingly, looks as if it were of ocellated shape in surface view. The cystocarps are distributed all over the frond.

f. ***parvus*** MIKAMI, f. nov.

Pl. III, 1

Japanese name: Hime-tsunomata (nom. nov.).

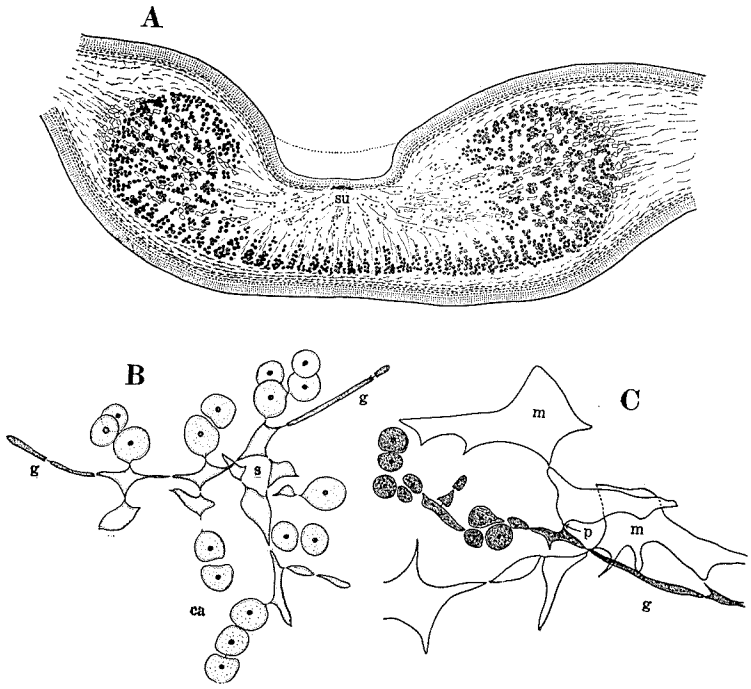


Fig. 28. *Chondrus ocellatus* HOLMES f. *ocellatus*

A. Longitudinal section of thallus with mature carposporangia. ×$\frac{1}{2}$30.
B. Groups of young carposporangia. × 330.
C. Connections of gonimobalst filaments and medullary cells. × 330.
ca, carposporangia; g, gonimoblast; m, medulla; p, pit-connection; s, sterile gonimoblast; su, supporting cell.

Type locality: Shimonoseki, Yamaguchi Pref.

Locality: Shimonoseki, Yamaguchi Pref. (OGATA, Feb. 1960).

Frons parva, circumscriptione flabellata, ca. 2–3 cm alta, stipitata, in partes membranaceas cuneatim dilatata, semel terve subdichotome vel raro palmatim divisa, margine integra vel nonnihil irregulariter lobata.

Frond small, flabellate in outline, about 2–3 cm high, stipitate, cuneately broadened upwards into membranaceous parts, 1–3 times rather subdichotomously or rarely palmately divided, at margin entire or somewhat irregularly lobed.

This form differs from f. *ocellatus* only by the smaller dimension. They are 2–3 cm high in general. The development of the gonimoblast and the arrangement of the tetrasporangia are entirely the same as those of f. *ocellatus*. All specimens were collected by Mr. E. OGATA.

f. ***aequalis*** MIKAMI, f. nov.

Pl. III, 3; Fig. 29

Japanese name: Yase-tsunomata (nom. nov.).

Type locality: Shiriyazaki, Aomori Pref.

Locality: Shiriyazaki, Aomori Pref. (KAWASHIMA, Aug. 1956); Shimofuro, Aomori Pref. (KAWASHIMA, Aug. 1955; MIKAMI, Aug. 1959).

Frons carnoso-membranacea, ca. 3–4.5 cm alta, stipitata, bis quaterve dichotome ramosa; segmentis linearibus, ca. 2–4 mm latis, margine integris vel nonnihil irregulariter lobatis.

Frond carnoso-membranaceous, ca. 3–4.5 cm high, stipitate, 2–4 times dichotomously divided; segments linear, almost equal in breadth, about 2–4 mm wide, at margin entire or somewhat irregularly lobed.

The present forma is characterized by its narrow frond with almost same breadth.

It is apt carelessly to *Rhodoglossum affine* (HARV.) KYLIN (Syn. *Chondrus*

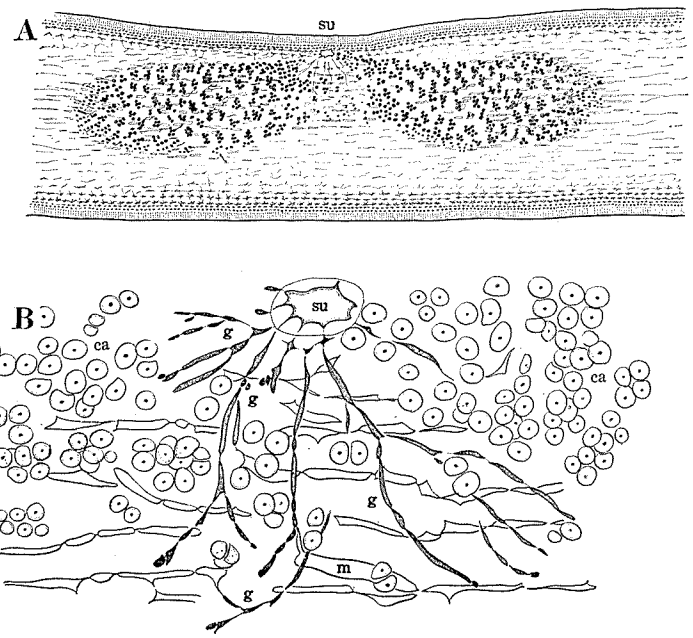


Fig. 29. *Chondrus ocellatus* HOLMES f. *aequalis* MIKAMI

A. Longitudinal section of a young cystocarp. × 50.

B. The same, more highly magnified. × 180.

ca, carposporangia; g, gonimoblast; m, medulla; su, supporting cell.

*affinis* HARVEY).

For instance, in his "Notes on Algae new to Japan. VIII (1918), p. 67", YENDO reported *Chondrus affinis* HARVEY from Hokkaido and Aomori Pref. etc. The present forma shows indeed a strong resemblance to some form of *Rh. affine* (HARV.) KYLIN in external appearance. However, the brief description in YENDO's work does not give any concrete idea of the reproductive nature of it. Fortunately, the writer has been able to examine many specimens of *Rhodoglossum affine* (HARV.) KYLIN kindly loaned from the Herbarium of the University of California by Dr. G. F. PAPENFUSS. Furthermore, the writer could examine some fresh materials of the same plant through the kindness of Dr. I. A. ABBOTT in the Hopkins Marine Station, Pacific Grove, California. As far as the writer understand from the specimens, they agree very well with the description and figures of *Rh. affine* (HARV.) KYLIN by KYLIN. Namely, in *Rh. affine* the tetrasporangia are formed by the direct transformation of the subcortical cells, as noted by KYLIN (1928, 1941).

In the present forma (f. *aequalis*), on the contrary, they are formed as accessory branches arised on the medullary cells. Namely, it is the same as those of f. *ocellatus*. The writer considers that *Rhodoglossum affine* (HARV.) KYLIN may not be distributed in our boundary.

f. ***crispoides*** MIKAMI, f. nov.

Pl. III, 2; Fig. 30

Japanese name: Tochaka-damashi (nom. nov.).

Type locality: Shimofuro, Aomori Pref.

Locality: Shimofuro, Aomori Pref. (MIKAMI, Aug. 1959).

Frons carnoso-membranacea, ca. 3–7 cm alta, repetite dichotomo-flabellata, margine integra vel saepe prolifera; cystocarpiis ocellatis.

Frond carnoso-membranaceous, ca. 3–7 cm high, repeatedly dichotomous, flabellate, entire or often proliferous at margin; cystocarps ocellate.

The present forma resembles *Chondrus crispus* (L.) STACKHOUSE in external appearance. But this resemblance of f. *crispoides* to *Ch. crispus* is merely superficial, the former being distinguishable from the latter by the ocellated cystocarps and by the more slender medullary filaments, etc. In f. *crispoides* the development of the gonimoblast and tetrasporangia are quite similar to those of f. *ocellatus*. Fig. 30 shows the distribution of tetrasporangia; they do not arise in free-end but in network among the medullary cells except the central medulla.

***Chondrus yendoi*** YAMADA et MIKAMI, sp. nov.

Frons carnoso-membranacea, caespitosa, 5–30 cm alta, basi discoidea, sursum

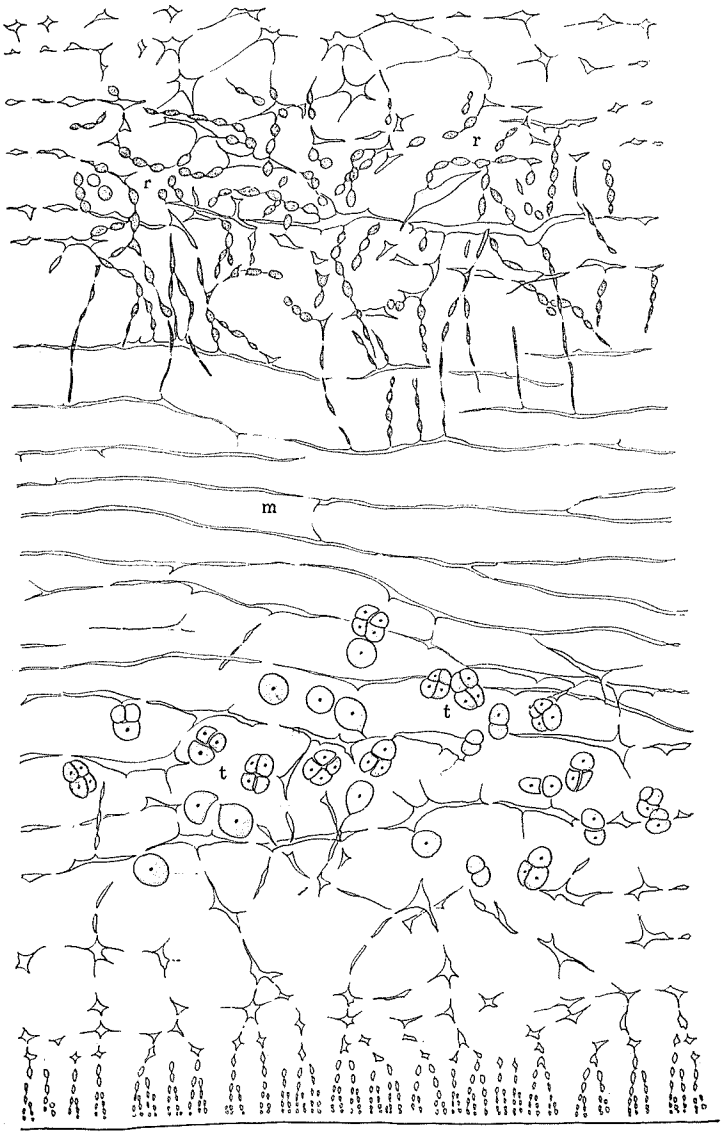


Fig. 30. *Chondrus ocellatus* HOLMES f. *crispoides* MIKAMI
Longitudinal section of thallus with both young and almost mature sporangia. × 200.
m, medulla; r, rudiment of tetrasporangia; t, tetrasporangia.

mox late vel cuneatim expansa, saepe subdichotome vel palmatim vel irregulariter divisa; lobis ovatis vel oblongo-ovatis vel reniformibus, marginibus integris vel raro fimbriatis; textu e cortice, strato subcorticale et medulla composito; cortice e cellulis minutis, elongatis, vel ellipsoideis, ad superficiem perpendiculariter 4–6-ordinatis dispositis; strato subcorticale e cellulis paene subglobosis 3–5-anticlinis ordinatis; medulla e filamentis libere aperteque anastomosantibus; soris tetrasporangiis numerosis, per totam superficiem frondis disseminatis, rotundis, ovatis, interdum confluentibus, tetrasporis cruciatis, 33–50 $\mu$ in diam.; cystocarpiis per totam superficiem frondis disseminatis, numerosis, paene ocellatis, 1–3 mm in diam., carposporis ovoideis vel oblongis 20–30 (–32) $\mu$ in diam., colore saturate violaceo-purpureo; specimina exsicatione chartae imperfecte sive vix adhaerent.

Frond carnoso-membranaceous, caespitose, 5–30 cm high, attached to the substratum by means of a disc-shaped base, soon expanded widely or cuneately upwards, simple or often divided subdichotomously, palmately or very irregularly; lobes ovate or oblong-ovate or reniform, mostly entire or rarely fimbriate on margin; tissue composed of three layers, cortical, subcortical and medullary; cortex composed of 4–6 rows of small, oblong or elongated cells, arranged closely with their longer axes perpendicular to the surface; subcortical layer consisting of 3–5 series of subglobular cells, arranged in anticlinal order; medullary layer consisting of slender filaments with loose meshes, in the vicinity of young cystocarps sending out many, to the surface of the frond vertically arranged cell branches; tetrasporangial sori numerous, scattered widely on the whole frond except the basal portion, round or ovate in surface view, sometimes confluent with each other; tetraspores cruciate, 33–50 $\mu$ in diam.; procarp consisting of a large supporting (auxiliary) cell bearing a three-celled carpogonial branch; gonimoblast-threads occur inward, communicate with swollen medullary cells; special medullary filaments (Faserhülle) and special absorbent filaments completely lacking; cystocarps scattered widely on the whole frond except the basal portion, numerous, somewhat ocellate, 1–3 mm in diam.; carpospores ovate, oblong-ovate 20–30 (–32) $\mu$ in diam.; colour dark violet purple, with bluish iridescence; specimens imperfectly or not adhering to paper in drying.

The present species is widely distributed in Hokkaido and the southern Kuriles. It was first referred to *Iridaea laminarioides* BORY (var. *cornucopiae* J. AG., var. *cordata* S. et G., var. *laminarioides* J. AG.) by YENDO in 1917. Since that time the present alga has passed among us under that name, but later under *Iridophycus cornucopiae* (P. et R.) S. et G. However, the writer pointed out in the paper cited below that the present alga is not *Iridaea*, but *Chondrus*. Namely, at a glance over the external appearance, it is easily taken as *Iridaea*. According to the writer's observations, however, the cystocarps of the present species are not true globosity as in *Iridaea*-species, but they are somewhat ocellated, and the section

of them clearly shows the structure of the genus *Chondrus*. That is, the absence of special medullary filaments (Faserhülle) and the special absorbent filaments tell us the nature of *Chondrus* instead of *Iridaea*.

The present species is closely related to *Chondrus ocellatus* HOLMES, but differs from the latter in the fact that the fronds are ginkgo leaf-shaped in general, the medullary filaments are more or less thick, and the cystocarps are truly circular in outline, etc.

Three following different forms are distinguishable.

Key to the forms

1. Frond with many marginal lobes . . . . . f. *fimbriatus*
1. Frond as a rule entire at margin . . . . . 2
   2. Frond ovate or reniform with shallow or deep bifurcate apex . . f. *yendoi*
   2. Frond 2–3 times and subdichotomously or palmately divided . . . . . f. *subdichotomus*

### f. ***yendoi***

Figs. 31–33

MIKAMI, On the so-called *Iridophycus cornucopiae* in Hokkaido, 1958, p. 80–83, Bull. Jap. Soc. Phycol. 6 (2) (in Japanese).

*Iridaea laminarioides* YENDO (non BORY), Notes Alg. new to Jap., VI, 1917, p. 77; INAGAKI, Mar. Rhodophyc. Oshoro Bay, 1933, p. 30, Fig. 9; OKAMURA, Nippon Kaisoshi, 1936, p. 658; Sinova, Alg. Petrov Isl., 1938, p. 51.

*Iridaea laminarioides* var. *cornucopiae* YENDO (non J. AG.), Notes Alg. new to Jap. VI, 1917, p. 78; OKAMURA, Mar. Alg. Mutsu Bay, 1927, p. 11; Id., Nippon Kaisoshi, 1936, p. 658.

*Iridaea laminarioides* var. *cordata* YENDO (non S. et G.), Notes Alg. new to Jap. VI, 1917, p. 80; OKAMURA, Nippon Kaisoshi, 1936, p. 659.

*Iridaea laminarioides* var. *laminarioides* YENDO (non J. AG.), Notes Alg. new to Jap. VI, 1917, p. 81; OKAMURA, Nippon Kaisoshi, 1936, p. 659.

*Iridophycus cornucopiae* TOKIDA (non S. et G.), On "Ginnanso", 1938, p. 2; NAGAI, Mar. Alg. Kurile Isl., II, 1941, p. 189, pro parte (identity inferred from locality); YAMADA et TANAKA, Mar. Alg. Akkeshi, 1944, p. 72; HASEGAWA, List Mar. Alg. Okushiri Isl., 1949, p. 60; KAWASHIMA, List Mar. Alg. Iwate Pref., II, 1955, p. 32; TOKIDA, Mar. Alg. S. Saghalien, 1954, p. 183.

Japanese name: Yezo-tsunomata (nom. nov.).

Type locality: Oshoro, Shiribeshi Prov.

Locality: Onagawa, Miyagi Pref. (INOH, June 1942); Ooma, Aomori Pref. (YAMADA); Yamasedomari near Hakodate (YAMADA, June 1931); Todohokke, Oshima Prov. (MIYABE, July 1894); Oshoro, Shiribeshi Prov. (MIKAMI, May 1957; May 1958); Samani, Hidaka Prov. (MIKAMI, Aug. 1956; Mar. 1957); Enrumu-misaki, Hidaka Prov. (MIKAMI, Mar. 1956; Apr.

1958); Erimo, Hidaka Prov. (MIKAMI, July 1960); Oshirabetsu, Tokachi Prov. (MIKAMI, Aug. 1955); Abashiri, Kitami Prov. (MIKAMI, Sept. 1957); Konbumori, Kushiro Prov. (YAMADA, May 1945); Rausu, Nemuro Prov. (HASEGAWA, Aug. 1944); Atoiya, Kunashiri Isl., Kurile (NAGAI et SHIMAMURA, Aug. 1929); Rebuniso, Kunashiri Isl., Kurile (NAGAI et SHIMAMURA, July 1929); Arimoe, Etorofu Isl., Kurile (NAGAI, Aug. 1930); Kamuikotan, Etorofu Isl., Kurile (NAGAI, July 1934); Shikotan Isl. (KAWABATA, July 1934); Tomunai, Saghalien (MIYABE, Aug. 1906); Shiretoko-misaki, Saghalien (MIYABE, Aug. 1906); Ishihama, Saghalien (TOKIDA, Aug. 1926). Growing on rocks in the littoral belt.

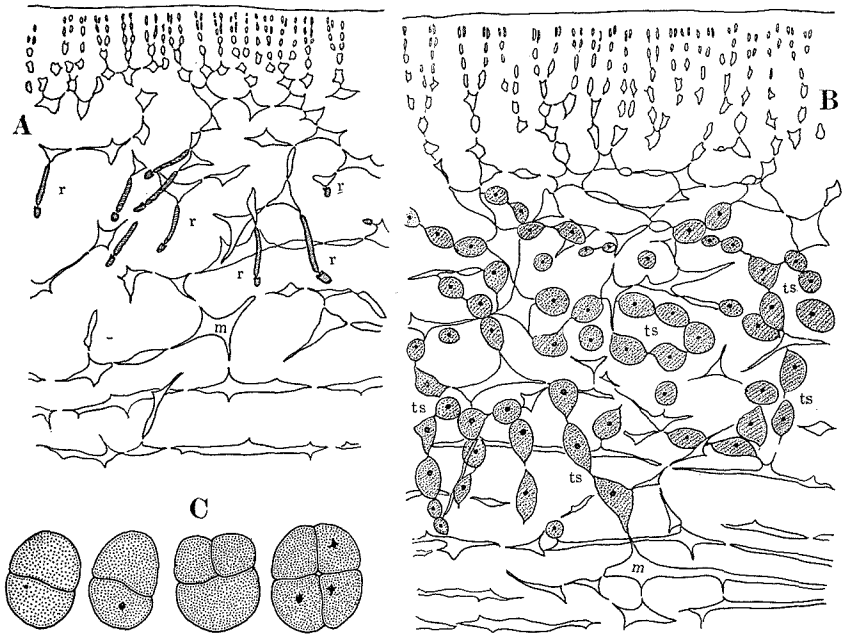


Fig. 31. *Chondrus yendoi* YAMADA et MIKAMI f. *yendoi*
A. Longitudinal section of thallus with sporangial rudiments. × 300.
B. Further development of sporangia. × 300.
C. Mature tetrasporangia. × 300.
m, medulla; r, sporangial rudiment; ts, tetrasporangia.

Frond carnoso-membranaceous, ovate or reniform, having shallow or deep bifurcate apex.

*Chondrus yendoi* YAMADA et MIKAMI is very variable in form and size of the frond, but most of them are referable to f. *yendoi*. Plants from the south-eastern part of Hokkaido, especially those from Prov. Hidaka are well developed attaning the height of 20–30 cm. The frond is composed of three layers, cortical, subcortical and medullary. The cortical layer consists of 4–6 rows of small, oblong

or elongated assimilating cells which are arranged closely with their longer axes perpendicular to the surface of the frond. The subcortical layer is composed of 3–5 series of subglobular cells which are arranged in anticlinal order. The medullary layer consists of slender anastomosing rhizoidal cells forming loose meshes and arranged horizontally to the surface of the frond.

The development of the tetrasporangia of these materials was traced distinctly. Fig. 31 (A) shows the young accessory branches (sporangial rudiment) which have arisen on the shallow medullary cells. In general case, the sporangial rudiments are produced accessorily from the outer medullary cells to the inner medullary ones. Soon, they branch, and communicate with the neighbouring cells. The tetrasporangia arise by the intercalary division of the accessory branches.

In the result, the sporangia of the present alga are chained in network among the shallow medullary cells except the central medulla as in Fig. 31 (B).

The tetrasporangial sori are observed being scattered widely on the frond except the base. They are round or ovate in surface view and sometimes they become confluent with each other. The tetrasporangia are measuring 33–50 $\mu$ in diam., cruciately divided. The structure of the procarps of the present materials is exactly the same as that of *Chondrus pinnulatus* (HARV.) OKAMURA. Namely, they consist of a large supporting (auxiliary) cell and a three-celled carpogonial branch as in Fig. 33 (A, B). Unfortunately, the union of the carpogonium and the supporting (auxiliary) cell was not observed. After the connection of the carpogonium with the auxiliary cell, the gonimoblasts are sent out internally and they develop towards the medullary cells.

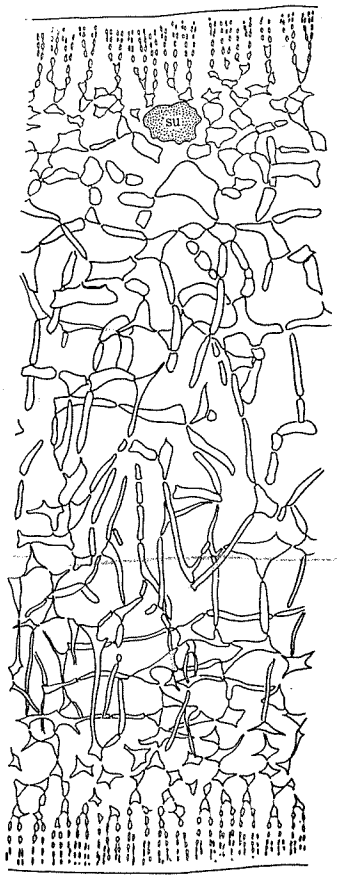


Fig. 32. *Chondrus yendoi* YAMADA et MIKAMI f. *yendoi*
Longitudinal section of thallus. × 160.
su, supporting cell.

About that time, the medullary cells in the vicinity of the auxiliary cell gradually enlarge and become to acquire rich cytoplasm. At the same time they send out many cell branches which are frequently arranged vartically to the surface of the frond as in Fig. 32. Presently, the gonimoblast filaments directly communicate with

the swollen medullary cells. In the result, the contents of the swollen medullary tissue are exhausted for the development of the gonimoblasts. Accordingly, in the present alga, both the special medullary filaments (Faserhülle) and special absorbent filaments are lacking. The ripe gonimoblast is composed of a number of distinct nuclei as in the other species of *Chondrus*. The carpospores are ovate or oblong-ovate, measuring 20–32 $\mu$ in diameter.

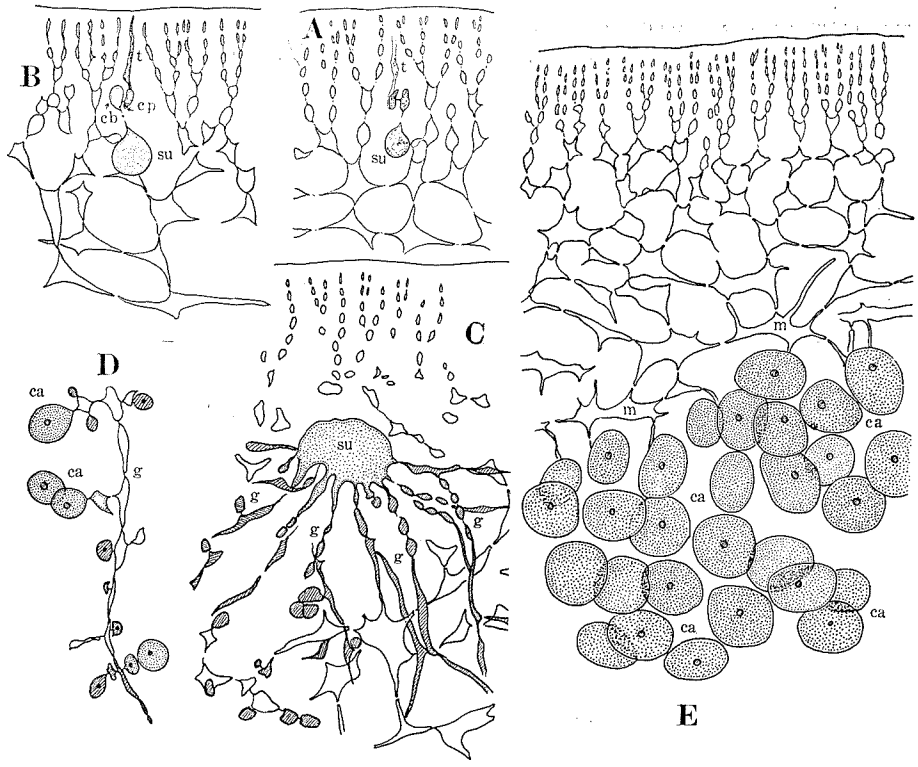


Fig. 33. *Chondrus yendoi* YAMADA et MIKAMI f. *yendoi*
A, B. Transverse section of thallus with procarp. × 330.
C, D. Early development of gonimoblasts. × 330.
E. Mature carposporangia. × 330.
ca, carposporangia; cb, carpogonial branch; cp, carpogonium; m, medulla; su, supporting (auxiliary) cell; t, trichogyne.

The cystocarps are observed being scattered widely on the fronds except the base. They are circular in outline, and mature or large ones are often ocellated. In surface view, they are very variable in size, 1–3 mm in diam., and sometimes they become confluent with each other.

f. ***subdichotomus*** MIKAMI, f. nov.

Pl. IV, 2

Japanese name: Eda-tsunomata (nom. nov.).

Type locality: Erimo, Hidaka Prov.

Locality: Samani, Hidaka Prov. (MIKAMI, Mar. 1956); Higashi-fuyushima, Hidaka Prov. (MIKAMI, Apr. 1958); Horoizumi, Hidaka Prov. (MIKAMI, Apr. 1958); Izumihama, Tokachi Prov. (MIKAMI, July 1957); Tomoshiru, Nemuro Prov. (MIYABE, Aug. 1894); Toshirari, Etorofu Isl., Kurile (NAGAI, Aug. 1931).

Frons carnoso-membranacea, bis terve subdichotome vel palmatim vel raro irregulariter ramosa, margine integra.

Frond carnoso-membranaceous, 2–3 times subdichotomously or palmately or rarely irregularly divided, entire at margin.

This form is very common along the south-eastern coast of Hokkaido, especially Hidaka Prov. They are characteristic in subdichotomous or palmate branching. The development of the gonimoblasts and the arrangement of the tetrasporangia are entirely the same as those of f. *yendoi*.

f. ***fimbriatus*** MIKAMI, f. nov.

Japanese name: Fusa-tsunomata (nom. nov.).

Type locality: Oshirabetsu, Tokachi Prov.

Locality: Oshirabetsu, Tokachi Prov. (MIKAMI, July 1960); Izumihama, Tokachi Prov. (MIKAMI, July 1957).

Frons carnoso-membranacea, simplex vel saepe subdichotome ramosa, marginibus fimbriatis.

Frond carnoso-membranaceous, simple or often subdichotomously divided, fimbriate at margin.

The present form is often found in Tokachi Prov., especially in the neighbourhood of Oshirabetsu. It is easily recognized and distinguished from the others by having many marginal lobes. In the YENDO Herbarium of the University of Tokyo, there are four specimens under the temporary name of "*Chondrus japonicus*" which were most probably collected by YENDO (without date and locality of collection), and are referable to the present forma.

***Chondrus crispus*** (L.) STACKHOUSE

Figs. 34–36

STACKHOUSE, Ner. Brit., ed. 1, 1797, p. XXIV; LYNGBYE, Hydro. Dan., 1819, p. 15, tab. 5, A, B; GREVILLE, Alg. Brit. 1830, p. 125, pl. 15; KÜTZING, Phycol. Gen., 1843, p. 398, tab. 73 III; Id., Sp. Alg., 1849, p. 735; Id., Tab. Phyc. Bd. 17, 1867, tab. 49; HARVEY, Phyc. Brit.

III, 1846, pl. 63; J. AGARDH, Sp. Alg., II (1), 1851, p. 246; DE TONI, Syll. Alg. IV, 1897, p. 180, VI, 1924, p. 170; "DARBISHIRE, *Chondrus*, Liverpool Marine Biology Committee, Memoirs IX. 1902"; SETCHELL et GARDNER, Alg. N. W. Amer., 1903, p. 297; KYLIN, Studien, 1907, p. 123; Id., Keim. Florideenspor., 1917, p. 12; Id., Stud. Entwickl. Florid., 1923, p. 19; Id., Rhodophyc. schwed. Westk., 1944, p. 59; TAYLOR, Mar. Alg. N. E. coast N. Amer., 1937, p. 281; SINOVA, Alg. Petrov Isl., 1938, p. 50.

*Fucus crispus* LINNE, "Mantissa plant., 1767, p. 134."

*Fucus polymorphus* LAMOUR. Diss. sur plus. especes de Fucus, 1805.

*Chondrus ocellatus* f. *crispus* OKAMURA, Icon. Jap. Alg., VI, 1932, p. 85, pl. 292, Fig. 2; Id., Nippon Kaisoshi, 1936, p. 656; INAGAKI, Mar. Rhodophyc. Oshoro Bay, 1933, p. 28; TOKIDA et MASAKI, Mar. Alg. Oshoro, 1959, p. 187.

Japanese name: Tochaka.

Locality: Maizuru, Kyoto Pref. (UMEZAKI, July 1950); Karashima, Toyama Pref. (OOSHIMA, Aug. 1959); Asamushi, Aomori Pref. (MIKAMI, Aug. 1959); Oshoro, Shiribeshi Prov. (MIKAMI, July 1956; July 1959); Zenibako, Shiribeshi Prov. (MIKAMI, July 1958; Aug. 1958); Asari, Shiribeshi Prov. (MIKAMI, Aug. 1959); Yagishiri Isl., Rumoe Prov. (MIKAMI, July 1959). Growing on rocks in the littoral belt.

Frond carnoso-membranaceous, caespitose, generally 5–8 cm tall, attached to the substratum by means of a disc-like holdfast, wedge-shaped at base, soon gradually expanded upward, dichotomously and repeatedly divided; segments linear-compressed or narrow-lanceolate, or broad-membranous, usually somewhat closely divided and crisped in the ultimate segments; apices of ultimate segments obtuse to acute; margin entire, or at times with small proliferous bladelets; cortex composed of 5–7 rows of small, oblong or elongated cells, diminishing in diameter outwardly, arranged perpendicularly to the surface of the frond; subcortical layer consisting of 3–5 series of subglobular or elongated cells, arranged in anticlinal order; medullary layer consisting of elongated cells, mostly arranged in longitudinal rows, 5–15 $\mu$ in inner diameter; tetrasporic sori scattered over the upper portions of the frond and also the adventitious shoots, forming dark-red elongated spots, slightly bulging on both faces of the frond, often confluent each other, and no limit between the fused sori; tetrasporangia lying in globose masses embedded in the medulla, tetraspores cruciately divided, 37.5–45 $\mu$ in diam.; cystocarps scattered over the upper portions of the frond and also the adventitious shoots, oblong or round, prominent (not ocellated) on one or rarely on both surfaces of the frond; gonimoblast-threads elongate, connected with the swollen medullary cells in the vicinity of the auxiliary cell; special medullary filament and special absorbent filament absent; carpospore ovate, 20–25 (–27.5) $\mu$ in diam.; colour dark red-purple, often becoming greenish; specimens imperfectly adhering to paper in drying.

The occurrence of the present species in the Japanese waters was reported at first by OKAMURA (1902), and for the second time by YENDO (1911). Later on,

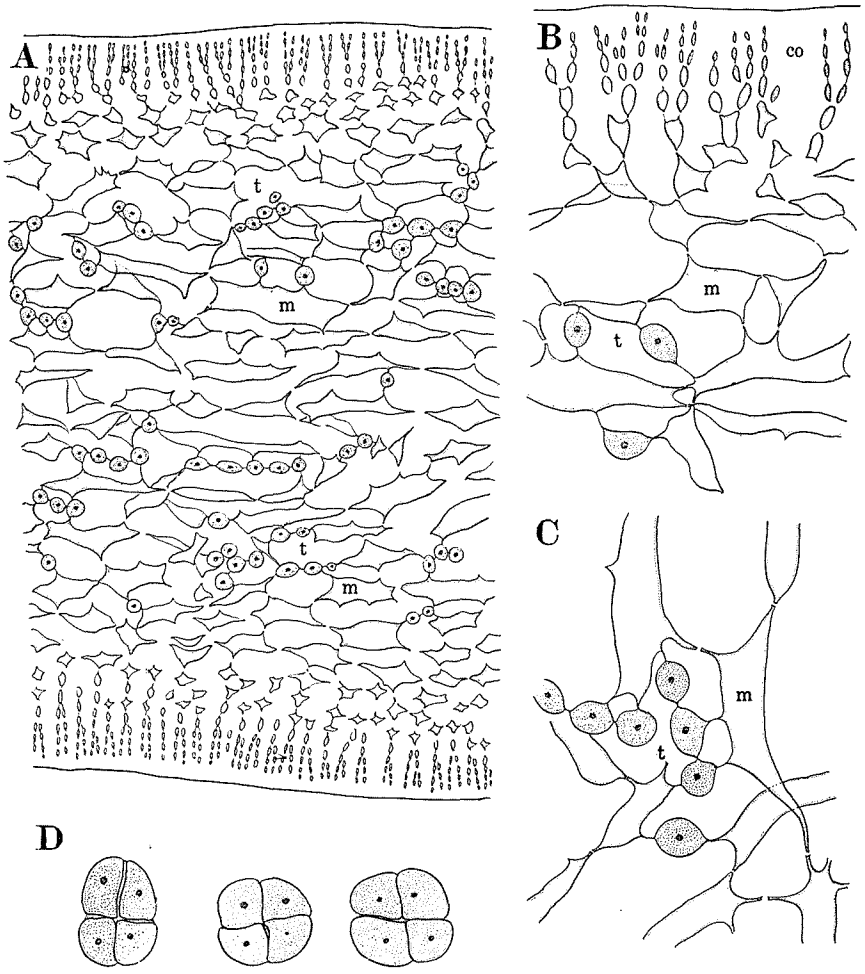


Fig. 34. *Chondrus crispus* (L.) STACKHOUSE

A, B. Longitudinal section of thallus with young sporangia.
A, × 200; B, × 350.

C. Horizontal section of thallus with young sporangia. × 350.

D. Mature sporangia. × 350.

co, cortex; t, tetrasporangia; m, medulla.

OKAMURA (1932) treats the present material under the name of *Ch. ocellatus* HOLMES f. *crispus* OKAMURA, but this is probably incorrect.

Full account of *Ch. crispus* (L.) STACKH. has been given by KYLIN (1907, 1917, 1923), GRUBB (1925), ROSENVINGE (1931), etc. The writer's materials agree quite

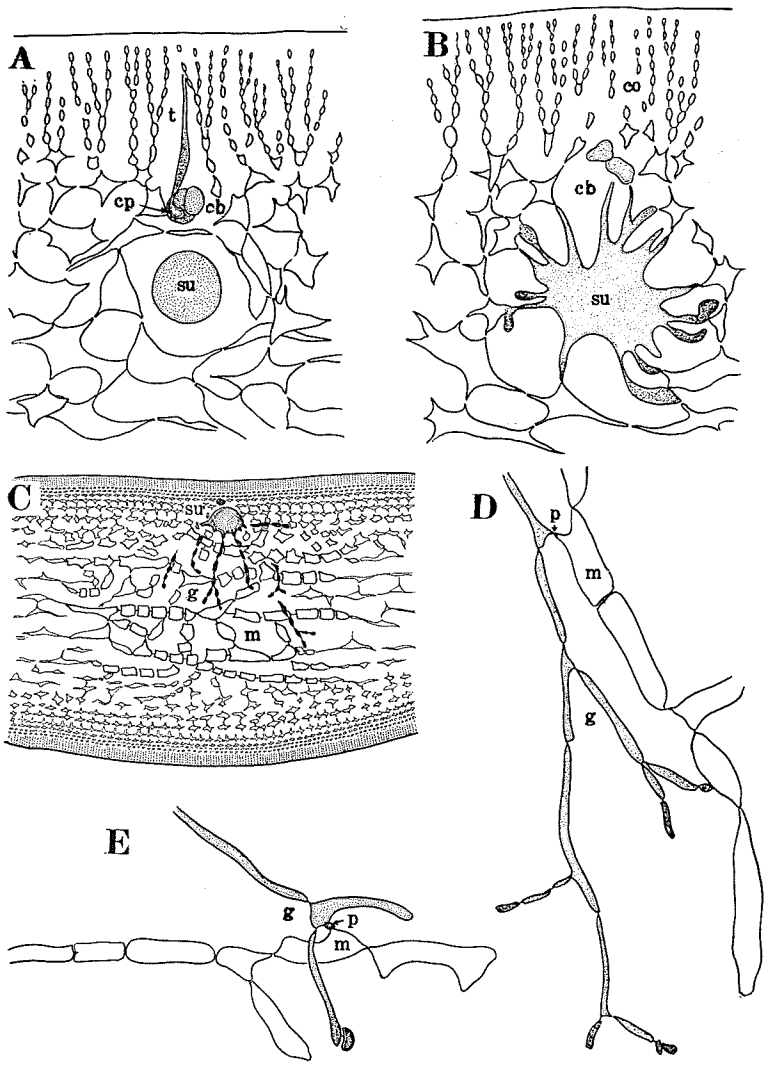


Fig. 35. *Chondrus crispus* (L.) STACKHOUSE

A. Longitudinal section of thallus with procarp. × 380.
B, C. Gonimoblast-initials and young gonimoblast. B, × 380; C, × 60.
D, E. Fusion of gonimoblast filaments with medullary cells. × 380.
cb, carpogonial branch; co, cortex; cp, carpogonium; g, gonimoblast; m, medulla; p, pit-connection; su, supporting cell; t, trichogyne.

well with their descriptions and figures, especially in the shape and distribution of the cystocarps. Indeed, at first sight the present species has some resemblance in habit to *Chondrus ocellatus* HOLMES. However, it differs from the latter by the hemispherical (not ocellated) cystocarp and by the reproductive organs scattered over the upper portions of the frond and by the somewhat thicker medullary cells.

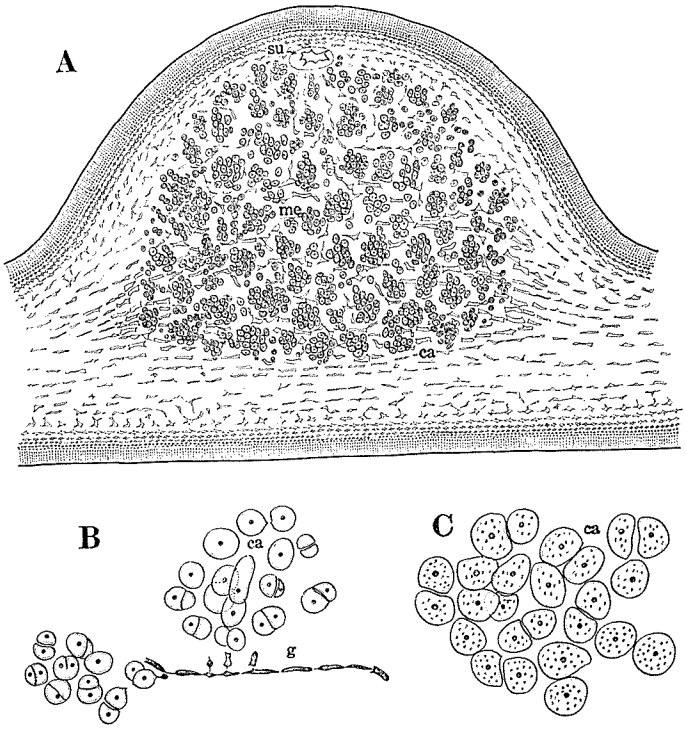


Fig. 36. *Chondrus crispus* (L.) STACKHOUSE

A. Longitudinal section of thallus with mature carposporangia. × 50.
B. Groups of young carposporangia. × 180.
C. Mature carposporangia. × 180.

ca, carposporangia; g, gonimoblast;
su, supporting cell; me, medulla.

The cortex is composed of 5–7 rows of small, oblong or elongated cells. The last 2–3 cells in the cortical cell-rows are particularly narrow and contain no starch, whereas the inner cells are more or less filled with starch-grains. The subcortical layer consists of several series of subglobular or elongated cells which are arranged in anticlinal order. The medullary tissue is built up of elongated cells arranged in longitudinal rows, 5–15 $\mu$ in inner diameter. They are generally thicker than

those of *Ch. ocellatus* HOLMES. The cells of the outer longitudinal cell-rows are much shorter than the inner ones, and gradually pass into the cortical layer.

The tetrasporangial sori appear as dark-red spots, slightly bulging on both surfaces of the frond. They are small elongated spots, and often confluent each other. They occupy the upper portions of the frond and the adventitious shoots. The development of the tetrasporangia was traced as shown in Fig. 34. Namely, the sporangia arise in the branched cell-rows from the medullary cells. Finally, they are chained in a network among the whole medullary cells. They are cruciately divided, and 37.5–45 $\mu$ in diameter. Fig. 35 (A) represents the structure of the procarp. Unfortunately, the fusion of the carpogonium and the auxiliary cell was not observed. Fig. 35 (C) shows the development of the younger gonimoblast. At that time, in the vicinity of the auxiliary cell, the medullary cells gradually enlarge by the rich contents. Among them, the intercalary cells are frequently observed. The union of the gonimoblasts and swollen medullary cells was observed clearly as shown in Fig. 35 (D, E). That is, the nourishment reaches at first the gonimoblast only by way of the auxiliary cell, however, soon after, the contents of the swollen medullary tissue are exhausted for the further development of the gonimoblasts. The cystocarp appears as an oblong or round swelling, up to 2 mm long, and is not ocellate, but prominent on one or sometimes on both faces of the frond. In general way, they occupy the upper portions of the frond and the adventitious shoots.

In the narrow fronds only one cystocarp is present at the same level. In the broader ones several cystocarps may occur in the same segment, and it then happens that two are contiguous, but the limit between them is always distinct. On the other hand, hyaline hairs were detected by ROSENVINGE (1931) in tetrasporiferous specimens collected at Hirtshals, Skagerak, in July, 1914, but they are not observed in our materials as far as the writer has examined.

### ***Chondrus verrucosus*** MIKAMI, sp. nov.

Pl. V; Figs. 37–38

*Chondrus ocellatus* HOLMES f. *canaliculatus* OKAMURA, Icon. Jap. Alg. VI, 1932, p. 84, pl. 291, Fig. 2, pl. 293, Figs. 2–9; Id., Nippon Kaisoshi, 1936, p. 654, pl. 311, Figs. 2–3; KAWASHIMA, A List Mar. Alg. Iwate, 1955, p. 32.

Japanese name: Ibo-tsunomata.

Type locality: Inubozaki, Chiba Pref.

Locality: Inubozaki, Chiba Pref. (MIKAMI, Aug. 1959); Tateyama, Chiba Pref. (ENOGUCHI, June 1959); Futomi, Chiba Pref. (S. ISHIKAWA, Mar. 1936); Izu-Shirahama, Shizuoka Pref. (CHIHARA, Apr. 1959).

Frons caespitosa, carnoso-membranacea, 8–17 cm alta, a stipite distincto cune-

atim dilatata, canaliculata, simpliciuscula vel semel-quater dichotome, regulariter vel irregulariter divisa, marginibus nudis; cortice e cellulis minutis, elongatis vel ellipsoideis, ad superficiem perpendiculariter 5–8 ordinatis dispositis; strato subcorticale e cellulis stellatis 4–6-anticlinis ordinatis; medulla e filamentis libere aperteque anastomosantibus; soris tetrasporangiferis numerosis, per totam superficiem frondis disseminatis, ovoideis, ovato-oblongis, cruciatis 25–37.5 (–42.5) × 20–30 $\mu$ in diam.; cystocarpiis numerosis, super frondis disseminatis, verruciformis, in una pagina prominentibus, 1–4 mm in diam., carposporis ovatis, 15–20 $\mu$ in diam.; colore saturate purpureo vel fusco-purpureo; specimina exsiccatione imperfecte vel non adhaerent.

Frond caespitose, carnoso-membranaceous, 8–17 cm high, attached to the substratum by means of a small disc, long cuneate, canaliculate at base, rarely simple or 1–4 times dichotomously and very regularly or irregularly divided; segments patent with broadly roundish axils, ending in ligulate, obtuse, bifid or emarginated apices; margin entire in general; cortex composed of 5 to 8 (or more) rows of small, elongate or ellipsoidal cells, diminishing in diameter outwardly, arranged closely with their longer axis perpendicular to the surface; subcortical layer consisting of 4–6 series of star-like cells, arranged in anticlinal order; medullary layer very thick, composed of slender cell rows; tetrasporangial sori scattered on the upper part of the frond as elliptic or irregular spots in surface view, often confluent each other; tetraspores ovoid or ovate-oblong, rather small, 25–37.5 (–42.5) × 20–30 $\mu$ in diam., cruciately divided; cystocarps very large and considerably numerous, scattered on upper half of the frond, verruciform, strongly elevated on one side, ca. 1–4 mm in diam.; gonimoblast-threads abundant, connecting with the plentiful swollen medullary cells; intercalary medullary cells abundant; carpospores ovate, 15–20 $\mu$ in diam.; colour dark purple or blackish purple; specimens not perfectly adhering to paper in drying.

The present new species is very distinct and peculiar in nature. The verruciform cystocarp and strongly canaliculated frond are unrivalled characters.

*Chondrus ocellatus* HOLMES f. *canaliculatus* OKAMURA, mentioned in his "Icon. Jap. Alg. VI, 1932, p, 84." appears to me to be the dwarfish fronds of the present species.

This species can be distinguished from *Ch. ocellatus* HOLMES by the remarkably thicker and strongly canaliculated fronds, and by the distributions of the gonimoblasts and tetrasporangia.

On the other hand, this new species seems to be related to *Ch. canaliculatus* (J. AG.) GREVILLE, but is distinguishable from the latter by the external appearance.

The typical fronds in the present alga are 3–4 times regularly dichotomously divided. Fig. 37 (A) shows the distribution of the tetrasporangia. In this plant the tetrasporangial sori are formed as subglobose masses in the comparatively shallow

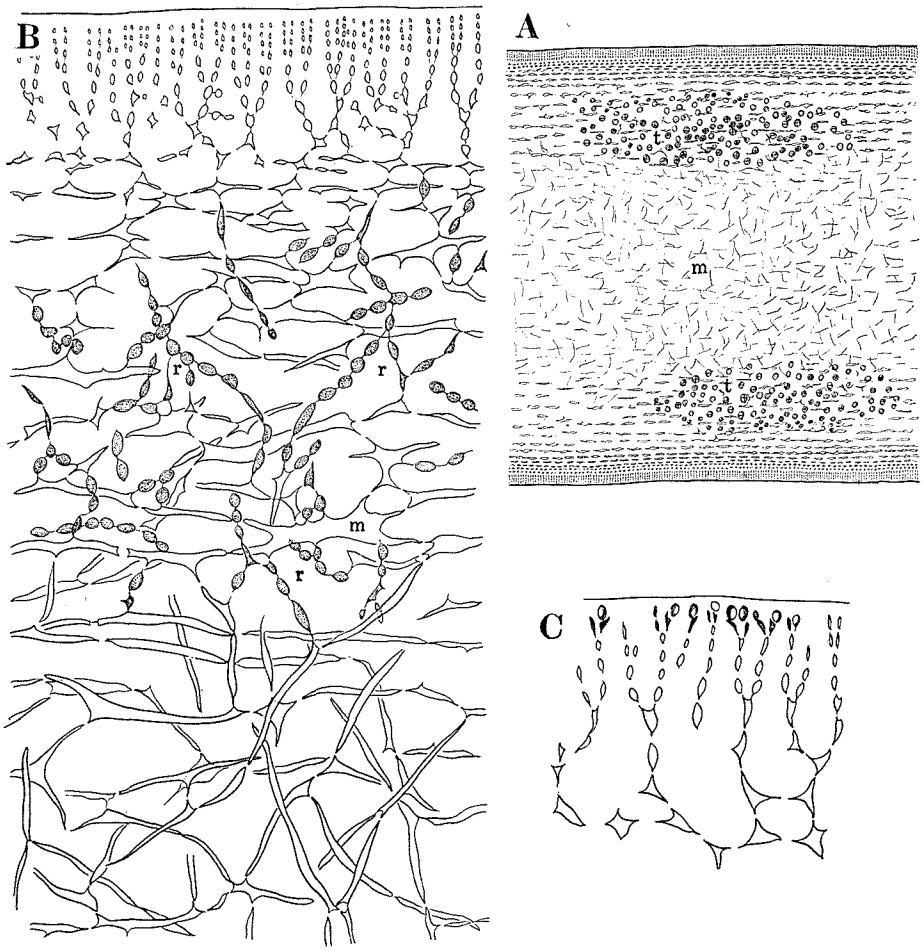


Fig. 37. *Chondrus verrucosus* MIKAMI

A. Longitudinal section of thallus with sporangia. × 30.
B. Early development of sporangia in longitudinal section. × 200.
C. Antheridial development. × 380.
m, medulla; r, rudiment of tetrasporangia;
t, tetrasporangia.

medulla. As shown in Fig. 37 (B), the sporangial rudiments communicate with the neighbouring medullary cells and consequently, the tetrasporangia arise in a network among the shallow medulla except the central one. They are cruciately divided, measuring 25–37.5 (–42.5) × 20–30 $\mu$ in diameter.

Fig. 38 (A) represents a young cystocarp. In general case, the younger gonimo-

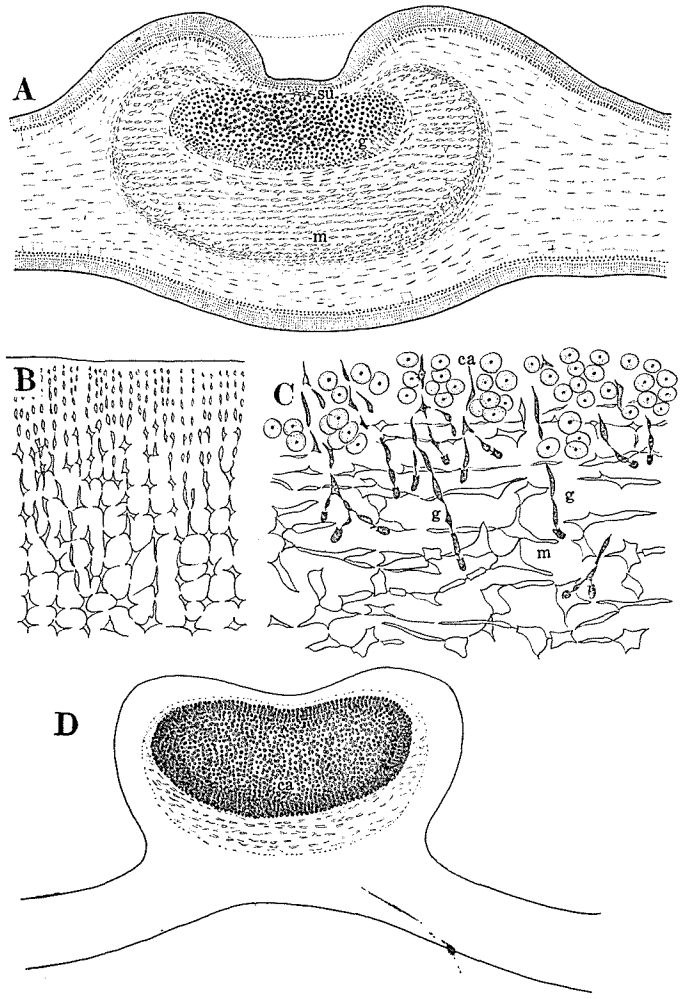


Fig. 38. *Chondrus verrucosus* MIKAMI

A. Longitudinal section of a cystocarp. × 30.
B. Longitudinal section of cortex. × 200.
C. Development of gonimoblast. × 200.
D. Mature cystocarp. × 15.

ca, carposporangia; g, gonimoblast; m, medulla; su, supporting cell.

blasts form a globose mass as shown in the same figure. At that time, the medullary cells in the vicinity of the auxiliary cell gradually enlarge and become to acquire rich contents. Soon after, the gonimoblast-threads communicate with the

swollen medullary cells probably in order to obtain the nutriments. Thus, the contents of the swollen medullary tissue are exhausted for the development of the gonimoblasts. While, the cortical cells except just above the procarp show active division so that the mature fruits appear as prominent unilateral swellings on the frond. The cystocarps are usually much elevated on one side, considerable in number, and distributed in the upper half of the frond.

In the present plant the young antheridial sori are observed on an upper half of the frond. The antheridia are generally elliptical or ovate in shape and about 4–6 $\mu$ in diam. The antheridial mother cells are clavate with somewhat swollen tips, from which one antheridium is obliquely cut (Fig. 37, C).

The specimens from Izu-Shirahama (Shizuoka Pref.) attain a height of 10–16 cm., and are rather regularly 4–6 times dichotomous. The main segments are broadly canaliculate with slight concavo-convex, 5–10 mm wide, and commonly have broader segments, especially towards the apices. The segment is remarkably patent with round axil. The cystocarps are very protuberant on one (convex) side, and aggregated on the upper part of the frond.

### *Chondrus giganteus* YENDO

YENDO, Nov. Alg. Jap. Decas 1–111, Bot. Mag. Tokyo, 34, 1920, p. 4.

Frond carnoso-membranaceous, 10–40 cm high, attached to the substratum by means of a small disc, cuneate at base, soon gradually expanded, simple, often dichotomously or rarely palmately divided, sometimes proliferated from surfaces in robust fronds; blades linear-lanceolate, 2–8 cm broad, with the upper end gradually tapering to an acute or to a rounded tip; margin of blade with or without proliferous bladelets; bladelets linear-lanceolate with roundish axils, cuneate or small oblong with constricted base; cortex consisted of 5–6 anticlinal rows of small, oblong or elongated cells, diminishing in diameter outwardly; subcortical layer composed of 3–5 series of subglobular cells, arranged in anticlinal order; medullary layer consisting of rhizoidal cells, mostly arranged horizontally to the surface of the frond in longitudinal section; tetrasporangial sori densely scattered over the blade and bladelets, sesamoid dot-like in surface view, frequently confluent each other; mature tetrasporangia lying in globose masses embedded in the central medulla; tetraspores subglobose or ovoid, 37.5–50 $\mu$ in diam., cruciately divided; cystocarps roundish or elliptical, more or less rising on both surfaces, slightly ocellate, scattered over the frond, 2–3 mm (or more) in diameter; gonimoblast filaments abundant, composed of extremely slender and elongated cells, connected with the medullary nutritive cells in the circumference of the auxiliary cell; medullary nutritive cells remarkably swollen, arranged irregularly with intercalary cells; carpospores ovoid, 20–25 $\mu$ in diam.; colour russet or brownish dull red; specimens

imperfectly or not adhering to paper in drying.

In 1920, YENDO described the present species on the basis of specimens from Inubozaki, Chiba Pref. Afterwards, OKAMURA (1932) has treated the present alga as a form of *Chondrus ocellatus* HOLMES.

After the histological investigations of YENDO's materials preserved in the Herbarium of the University of Tokyo as well as the fresh materials from the type locality collected by the writer himself, the writer came to the conclusion that there are following differences between *Chondrus ocellatus* HOLMES and *Chondrus giganteus* YENDO:

1. medullary filaments extremely slender (*Ch. ocellatus*) or rather thick (*Ch. giganteus*).
2. tetrasporangial sori embedded in the whole medulla (*Ch. giganteus*) or generally produced outside of the central medulla (*Ch. ocellatus*).

Under the species the two following forms are separable.

Key to the forms

1. Frond 20–40 cm high, linear-lanceolate . . . . . f. *giganteus*
1. Frond 10–20 cm high, flabellate with cuneate base . . . . . f. *flabellatus*

### f. *giganteus*

Pl. VI; Figs. 39–40

YENDO, Nov. Alg. Jap. Decas 1–111, Bot. Mag. Tokyo, 34, 1920, p. 4.

*Chondrus* sp.; YENDO, Mar. Botany (in Japanese), 1911, p. 592, Fig. 165.

*Chondrus ocellatus* HOLMES f. *giganteus* OKAMURA, Icon. Jap. Alg., vol. VI, 1932, pp. 80, 85, pl. 291, 293; Id., Nippon Kaisoshi, 1936, p. 655; TAKAMATSU, Mar. Alg. Matsushima Bay, 1936, p. 28; Id., Mar. Alg. Kinkwazan, 1936a, p. 64; Id., Mar. Alg. Tsugaru, 1938, p. 48; Id., Mar. Alg. Sanriku, 1938a, p. 122; Id., Mar. Alg. Japan Sea, 1939, p. 64.

Japanese name: Oba-tsunomata.

Type locality: Inubozaki, Chiba Pref.

Locality: Izu-Shirahama, Shizuoka Pref. (CHIHARA, Apr. 1959); Shichiriga-hama, Kanagawa Pref. (TAZAWA, Apr. 1955); Inubozaki, Chiba Pref. (MIKAMI, Aug. 1959); Nakaminato, Ibaraki Pref. (KAWABATA, Apr. 1955).

Frond carnoso-membranaceous, 20–40 cm high, 2–7 cm broad, linear-lanceolate.

This form corresponds to YENDO's original plant, and is only the local one being found on the coast extending from Prov. Izu to Prov. Hitachi, especially in the neighbourhood of the River Nakagawa and the R. Tonegawa.

The cortex of this alga is rather thin, and composed of 5–6 rows of small, oblong or elongated cells. The subcortical layer consists of 3–5 series of subglobular or star-shaped cells which are arranged in anticlinal row. The medulla

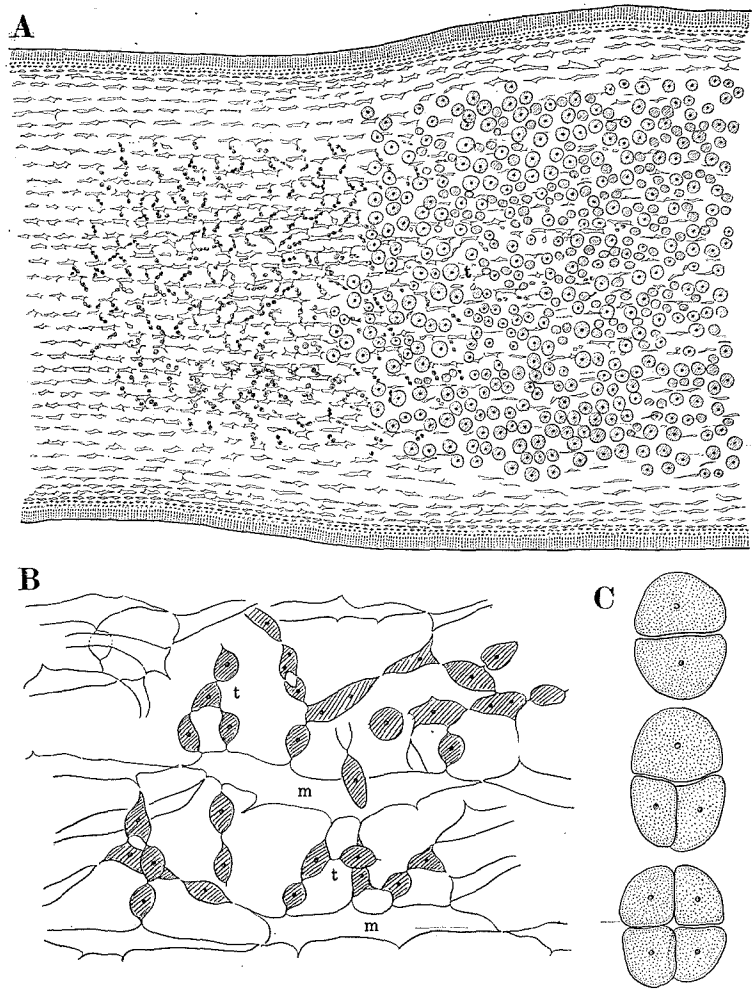


Fig. 39. *Chondrus giganteus* YENDO f. *giganteus*
A. Longitudinal section of thallus with young sporangia. × 50.
B. Early development of sporangia. × 330.
C. Mature sporangia. × 330.
m, medulla; t, tetrasporangia.

is composed of filamentous cells mostly arranged horizontally to the surface of the frond.

Comparing with *Ch. ocellatus* HOLMES, the articulations of the medullary cells in the present alga are considerably shorter than those in the former.

The development of the tetrasporangia was traced as in Fig. 39. The rudiment

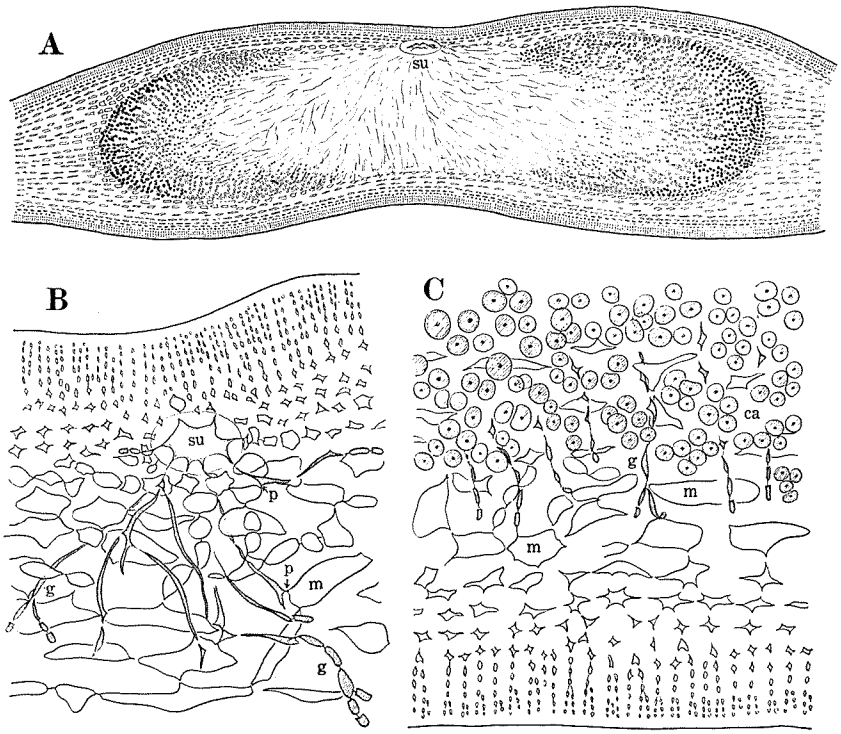


Fig. 40. *Chondrus giganteus* YENDO f. *giganteus*
A. Longitudinal section of a cystocarp. × 30.
B. Early development of gonimoblasts. × 180.
C. Older gonimoblasts. × 180.
ca, carposporangia; g, gonimoblast; m, medulla; p, pit-connection; su, supporting cell.

of tetrasporangia is formed as accessory branches on all medullary cells. Accordingly, the tetrasporangia arise in a network among the whole medullary cell. The tetrasporangial sori are observed being scattered over the blades and bladelets. They are sesamoid or ovate in surface view and frequently become confluent each other. The tetrasporangia are measuring 37.5–50 $\mu$ in diam., cruciately divided.

Fig. 40 (B) represents the development of the primary gonimoblasts. In general case, the contents of medullary cells in the vicinity of the auxiliary cell are exhausted for the development of the primary gonimoblast. Consequently, the groups of carposporangia in this plant occur at a distance from the auxiliary cell, as in *Ch. ocellatus* HOLMES. Fig. 40 (A) shows a mature cystocarp. It is slightly elevated on both surfaces of the frond. The carpospores are ovoid, measuring 20–25 $\mu$ in diameter.

f. ***flabellatus*** MIKAMI, f. nov.

Pl. VII, 1

*Chondrus ocellatus* HOLMES f. *typicus* TAKAMATSU (non OKAMURA), Mar. Alg. Tsugaru Strait, 1938, p. 48, pl. VI, Fig. 4.

Japanese name: Uchiwa-tsunomata (nom. nov.).

Type locality: Omazaki, Aomori Pref.

Locality: Oma-bentenjima, Aomori Pref. (KAWASHIMA, Mar. 1956; MIKAMI, Aug. 1959).

Frons carnoso-membranacea, flabellata, simpliciuscula vel subdichotome divisa, 10–20 cm longa, 2–4 (–8) cm lata, basi cuneata.

Frond carnoso-membranaceous, flabellate, simple or subdichotomously divided, 10–20 cm high, 2–4 (–8) cm broad, cuneate at base.

The present forma is commonly found in the above mentioned locality. The fan-shaped frond is one of the most distinct characteristic of this form. The frond is 10–20 cm in height, attaches to the substratum by means of a small discoidal base. The basal part of the frond is long stalk-like and gradually broadens upwards, and simple or subdichotomously divided. The blades are broadly cuneate, and frequently proliferated both from the margin and the surface of the frond. The proliferous blades are spatulate (sometimes bifurcate) and constricted at the base. The tetrasporangial sori are observed being widely scattered on the frond. They are round or ovate in surface view and often become confluent each other.

The development and arrangement of the tetrasporangia are quite similar to those of *Ch. giganteus* f. *giganteus*. The cystocarps are rather few, and are slightly elevated on both surfaces of the frond.

***Chondrus elatus*** HOLMES

Figs. 41–42

HOLMES, Mar. Alg. Japan, 1895, p. 252, t. IV, Fig. 1; DE TONI, Syll. Alg. IV, 1900, p. 182; OKAMURA, Nippon Sorui Meii, 1902, p. 28; Id., Alg. Jap. Exsic. no. 8; Id., Icon. Jap. Alg. IV, 1916, p. 38–40, pl. 160, Figs. 6–14; Id., Nippon Kaisoshi, 1936, p. 656; YENDO, Mar. Botany, 1911, p. 588, Fig. 164, 1; KAWASHIMA, List Mar. Alg. Iwate Pref. II, 1955, p. 32.

Japanese name: Kotoji-tsunomata.

Type locality: Enoshima, Kanagawa Pref.

Locality: Enoshima, Kanagawa Pref. (YAMADA, Apr. 1932; MURAOKA, Apr. 1935); Futomi, Chiba Pref. (MURAOKA, Aug. 1933; CHIHARA, Mar. 1957); Tateyama, Chiba Pref. (ENOGUCHI, July 1959); Inubozaki, Chiba Pref. (MIKAMI, Aug. 1959). Growing on rocks between tide marks.

Frond caespitose, cartilaginous, arising from callous disc, reaching 25 cm or more, 2–3.5 mm in thickness, tereti-compressed or rather linear, cylindrical at base, several times distantly and dichotomously branched above the halfway of the whole

length, widely parted and with roundish axils; branches frequent, ending in obtuse or bifurcate apices, equally broad or slightly narrow at base; branchlets short, occurring rarely from both margins of branches in almost horizontal direction, simple or mostly once forked; cortex consisting of 6–8 rows of small, oblong

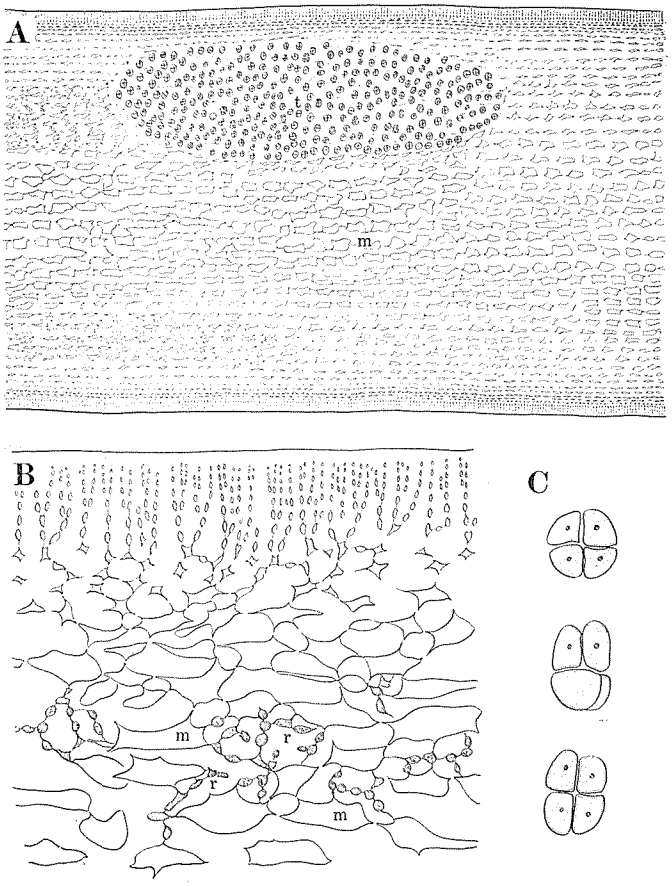


Fig. 41. *Chondrus elatus* HOLMES
A. Longitudinal section of thallus with sporangia. × 30.
B. Early development of sporangia. × 180.
C. Mature sporangia. × 350.
m, medulla; r, rudiment of tetrasporangia; t, tetrasporangia.

or elongated, anticlinally arranged, outwardly diminishing cells; subcortical layer of 3–5 series of subglobular or star-shaped cells, arranged in anticlinal order; medullary layer consisting of somewhat swollen, rhizoidal cells mostly arranged horizontally to the surface of the frond in longitudinal section; tetrasporic sori

densely scattered on the upper branches, like oval specks in surface view, sometimes confluent with each other; tetrasporangia lying in compressed masses immersed beneath the subcortex; tetraspores cruciately divided, 25–37.5 $\mu$ in diam.;

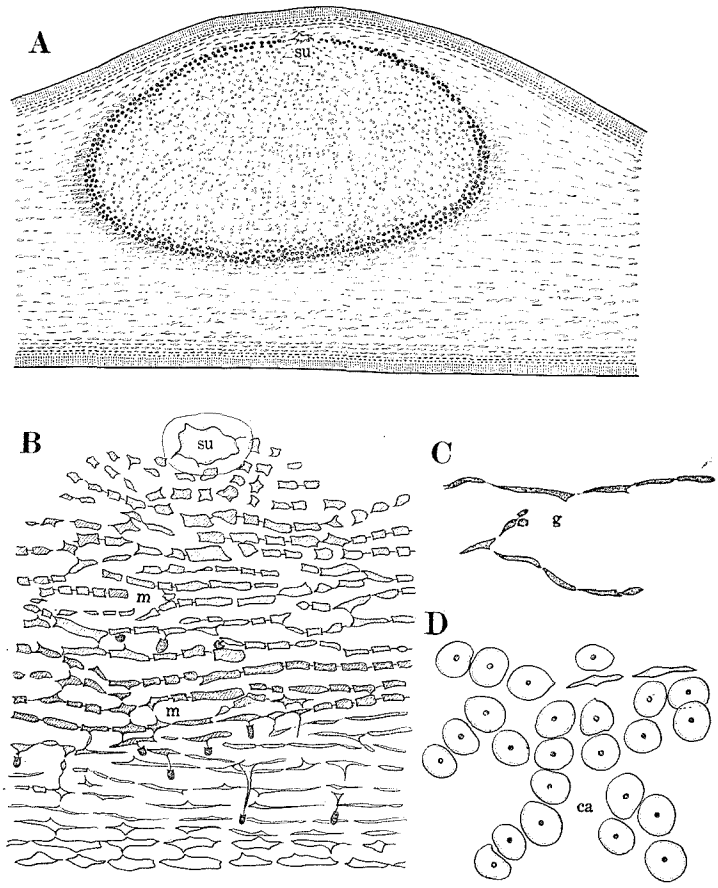


Fig. 42. *Chondrus elatus* HOLMES
A. Longitudinal section of a cystocarp. × 30.
B. Formation of nutritive (medullary) tissue. × 180.
C. Gonimoblast filament. × 350.
D. Carposporangia. × 350.
ca, carposporangia; g, gonimoblasts;
m, medulla; su, supporting cell.

cystocarps slightly prominent on one face of the frond, elliptical and more or less ocellated with an aperture, scattered over the upper branches, up to 1–2 mm in diam.; gonimoblast abundant, composed of extremely slender cells, and directly connected with the medullary nutritive cells; medullary nutritive cells swollen out

with abundant intercalary cells, mostly arranged horizontally to the surface of the frond in longitudinal section; carpospores ovate, 17.5–22.5 $\mu$ in diam.; colour purplish red when fresh, but in drying dull red with brownish tinge; specimens collapsed and longitudinally wrinkled at the main branch, not adhering to paper in drying.

The development of the tetrasporangia of this alga was traced distinctly as in Fig. 41. Fig. 41 (B) shows the younger sporangia which are formed in the shallow place of the medulla. They branch and communicate with the neighbouring medullary cells. The sporangia are chained in a network among the shallow medullary layer.

To the great regret of the writer, the union of the carpogonium and the auxiliary cell was not observed. The development of the nutritive tissue in the present species was observed as in Fig. 42, B. They consist of many rectangular cells arising from the medullary cells by the intercalary cell divisions, and are mostly arranged horizontally to the surface of the frond in longitudinal section. They gradually enlarge and become to acquire rich contents. On the other hand, the gonimoblast-threads are slender and communicate with the above mentioned nutritive cells. Consequently, the nourishments of them are exhausted for the development of the gonimoblasts. The groups of carpospores often occur at a distance from the auxiliary cell. The cystocarps are scattered over the upper branches, and slightly prominent on one surface of the frond. It is more or less ocellated with an aperture. The carpospores are ovate, 17.5–22.5 $\mu$ in diam. at maturity.

## *Iridaea*

### ***Iridaea cornucopiae*** POSTELS et RUPRECHT

Pl. VII, 2; Pl. VIII; Figs. 43–45

POSTELS et RUPRECHT, Illustr. Alg., 1840, p. 18, pl. 38, b; YENDO, Mar. Botany, 1911, p. 603, pro parte.

*Iridaea laminarioides* var. *cornucopiae* J. AG., Sp. Alg. II, 1851, p. 253; Id., Epicr., 1876, p. 180; YAMADA, Mar. Alg. Urup., 1935, p. 23.

*Iridophycus cornucopiae* (POST. et RUPR.) SETCHELL et GARDNER, *Iridophycus* in the Northern Hemisphere, Proc. Nat. Acad. Sci., 23 (3), 1937, p. 170; NAGAI, Mar. Alg. Kurile Isl., II, 1941, p. 189, pro parte.

*Iridophycus subdichotomum* NAGAI, Mar. Alg. Kurile Isl., II, 1941, p. 191, pl. 6, Fig. 5.

Japanese name: Kuroba-ginnanso.

Type locality: In oceano pacifico septemtrionali.

Locality: Urup Isl., Kurile (YAMADA, Aug. 1933); Onnekotan Isl., Kurile (NAGAI, Aug. 1935); Paramushiru Isl., Kurile (NAGAI, July 1930); Shimushiru Isl., Kurile (NAGAI, July 1930); Ketoi Isl., Kurile (NAGAI, Apr. 1935).

Frond caespitose, cartilaginous, 5–15 cm high, arising from a small scutate disc, narrow-cuneate below, becoming then expanded or shallowly or deeply bifurcate upwards, often subdichotomously or irregularly divided; lobes ovate or oblong-ovate, entire or rarely with proliferous lobes on the margin; tissue composed of three layers, cortical, subcortical and medullary; cortex of 4–6 rows of small, ellipsoidal cells, cells arranged with their longer axis perpendicular to the surface; subcortical layer composed of 3–5 series of subglobular or star-shaped cells, arranged in anticlinal order; medulla of network of slender rhizoidal cells, like small meshes; tetrasporangial sori scattered on the whole frond except the basal portion, slightly elevated, immersed within the shallow medulla; tetraspores subglobose, ovoid or elliptic-ovoid, cruciately divided, 20–30 $\mu$ in diam.; cystocarps numerous, scattered on the whole frond except the basal portion, hemispherically elevated on both surfaces, ca. 1–2 mm in diam., immersed deeply within the medulla; procarp consisting of a large supporting (auxiliary) cell and a three-celled carpogonial branch; gonimoblast rather crowded; special medullary filaments (Faserhülle) abundant, developing by secondary division of the medullary cells; special absorbent filaments originating from the gonimoblast tissue, communicated with special medullary filaments; mature carpospores ovoid, ca. 12.5–17.5 (–20) $\mu$ in diam.; colour reddish purple or sometimes dull purple; specimens imperfectly adhering to paper in drying.

The above-mentioned diagnosis is based mainly on the materials from Urup Isl. (Kuriles) collected by YAMADA in 1933.

Fortunately, the writer could examine both the cystocarpic and the tetrasporic original materials of *Iridaea cornucopiae* POSTELS et RUPRECHT (In mari septemtrionali inter Asiam et Americam ross. Exped. Lütk.) through the kindness of Dr. A. D. ZINOVA of the Herbarium of the Academy of Sciences in Leningrad. The illustration of the plant given by POSTELS and RUPRECHT (1840) shows a larger extreme among the type specimens. As far as the writer could ascertain from the type specimens, YAMADA's materials from Urup Isl. agree well with them. On the other hand, through the courtesy of Dr. M. TATEWAKI, the writer was able to examine some specimens of the genus *Iridaea* from the Kuriles collected by Dr. NAGAI in 1930 and 1935, which were deposited in the Herbarium of the Faculty of Agriculture, Hokkaido University. They are also to be referred to the present species. In external appearance, the present species shows so remarkable resemblance to *Chondrus yendoi* YAMADA et MIKAMI that it is often apt to be misidentified to the latter. The most important feature of the present species, however, is possessing the special medullary filaments (Faserhülle) and the special absorbent filaments.

In *Chondrus yendoi* YAMADA et MIKAMI, on the contrary, such characteristics can not be seen. The writer examined many specimens apparently of *Iridaea*

*cornucopiae-type* from various localities, viz., Hokkaido, Kunashiri Isl. (Kuriles), Etorofu Isl. (Kuriles) and Shikotan Isl. (Kuriles), but he failed to find a true *Iridaea cornucopiae* P. et R. among them. Fig. 43 (A) shows the distribution of the tetrasporangia. That is, the tetrasporangial sori in this alga are formed as a compressed masses in the comparatively shallow places of the medulla. The sporangial rudiments originate as an accessory branches from the medullary cells, and become communicate with neighbouring medullary ones. Thus, the tetrasporangia arise in a network among the shallow medulla. They are cruciately divided, measuring 20–30 $\mu$ in diam.

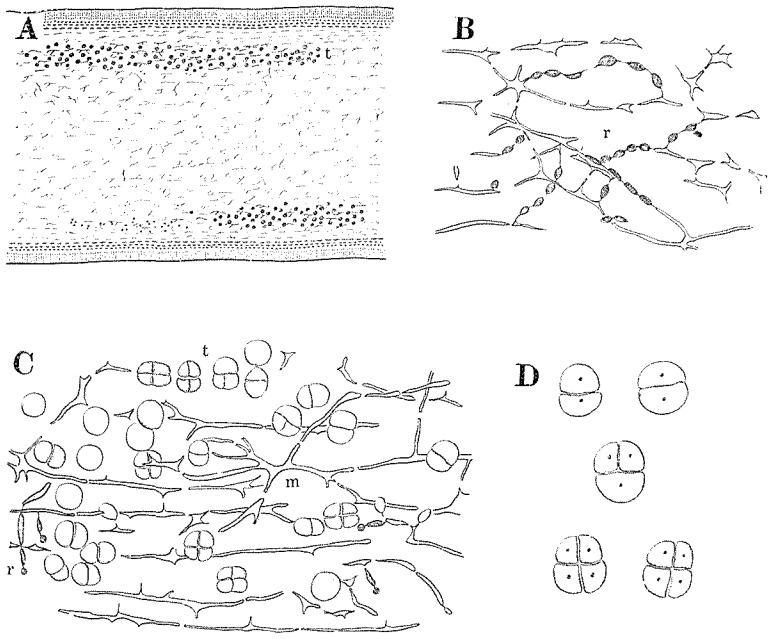


Fig. 43. *Iridaea cornucopiae* POSTELS et RUPRECHT
A. Longitudinal section of thallus with sporangia. × 30.
B. Early development of sporangia. × 180.
C, D. Mature sporangia. C, × 180; D, × 330.
m, medulla; r, rudiment of tetrasporangia; t, tetrasporangia.

The structure of the procarp in this alga is entirely the same as that of *Chondrus* as shown in Fig. 44 (A). The carpogonial branch is composed of three cells. The basal cell of the carpogonial branch is the largest while the carpogonium is the smallest. Furthermore, the carpogonial branch is strongly curved in such a way that the carpogonium becomes to lie close to the supporting (auxiliary) cell. Very regrettably, the connection of the carpogonium and the auxiliary cell was

not observed. The structure and development of the special medullary filaments (Faserhülle) and gonimoblasts in the present alga are similar to those of *Rhodoglossum*. That is, the special medullary filaments originate by the secondary cell division from the hyphae in the vicinity of the auxiliary cell. They become gradu-

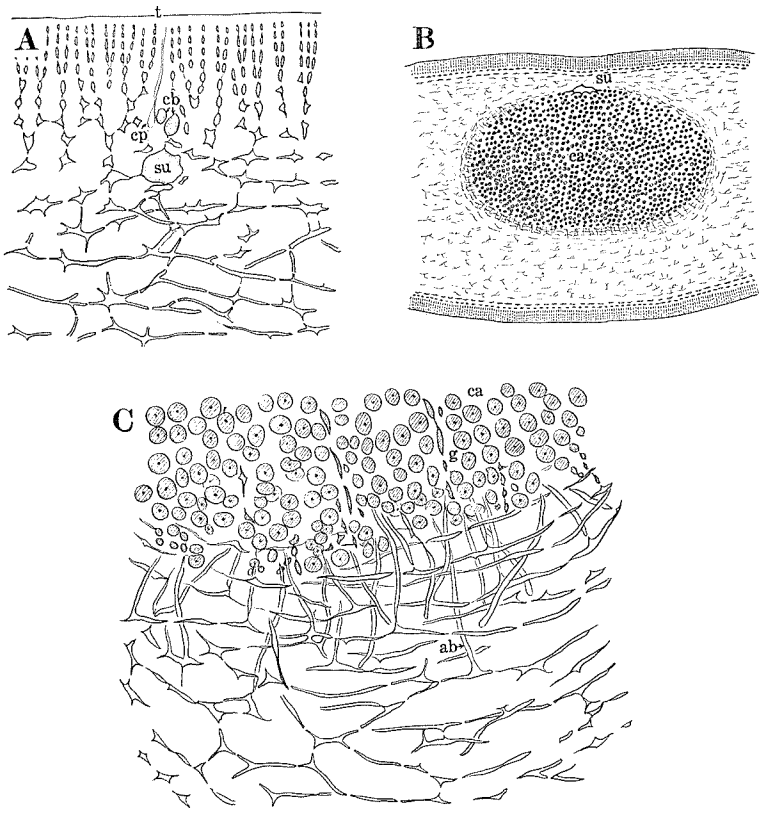


Fig. 44. *Iridaea cornucopiae* POSTELS et RUPRECHT

A. Longitudinal section of thallus with procarp. × 180.
B. Longitudinal section of a young cystocarp. × 30.
C. The same, more highly magnified. × 180.

ab, special absorbent filament; ca, carposporangia; cb, carpogonial branch; cp, carpogonium; g, gonimoblast; su, supporting cell; t, trichogyne.

ally thickened with rich contents. On the other hand, Fig. 44 (C) shows many special absorbent filaments (ab) developing from the gonimoblasts. They connect with the special medullary filaments (Faserhülle) in order to obtain the nutrients. Namely, the nutrition reaches at first the gonimoblast only by way of the auxiliary

cell, however, soon after, through the absorbent filaments, the contents of the special medullary filaments are exhausted for the development of the gonimoblasts. Consequently, the withered medullary cells appear as slender "Faserhülle" on the outermost circumference of cystocarp.

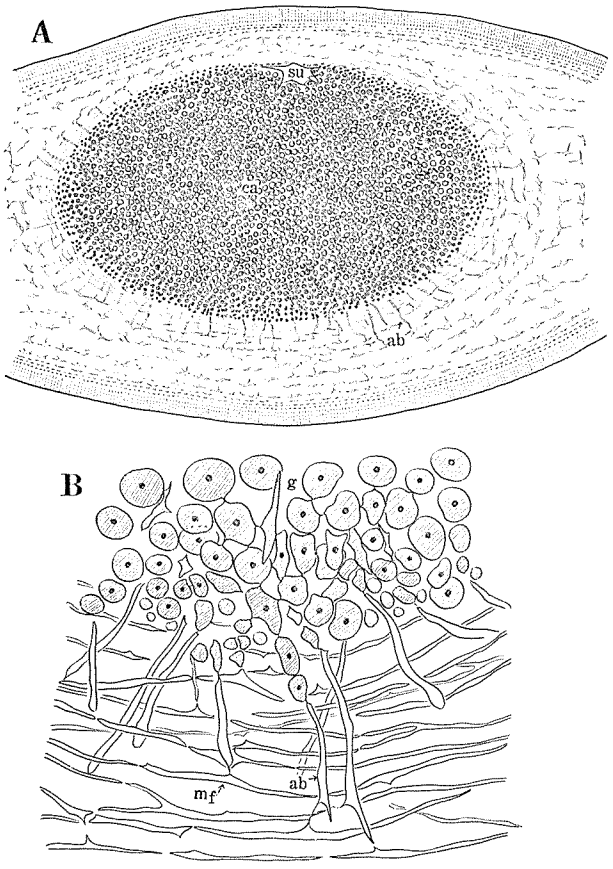


Fig. 45. *Iridaea cornucopiae* POSTELS et RUPRECHT

A. Longitudinal section of thallus with an almost mature cystocarp. × 50.

B. The same, more highly magnified. × 330.

ab, special absorbent filament; ca, carposporangia; g, gonimoblast; mf, special medullary filament (Faserhülle); su, supporting cell.

Nagai described *Iridophycus subdichotomum* in 1941, but according to the writer's opinion, Nagai seems to have laid too much stress on the external appearance of the frond, which is never a matter of specific importance but one generally

due to the habitat. Namely, according to NAGAI's description (1941), *Iridophycus subdichotomum* NAGAI is characteristic in the narrow and 3–5 times repeatedly dichotomous or rarely palmate fronds. In the Herbarium of the Botanical Institute, Faculty of Science, Hokkaido University there is a sheet (including 6 individuals) of *Iridophycus subdichotomum* NAGAI collected from Broughton Bay, Shimushiru Isl. (Kurile) and determined by him. They do not necessarily agree with NAGAI's description. That is, in some materials, the fronds are only once or twice dichotomously divided. Fig. 45 (A) represents an almost mature cystocarp of NAGAI's material in longitudinal section. The development and arrangement of the special medullary cells and the special absorbent filaments of them are not different from those of *Iridaea cornucopiae*.

## *Rhodoglossum*

Key to the species

1. Cystocarps spherical, elevated on both surfaces of the frond. . . *Rh. japonicum*
1. Cystocarps often hemispherical, elevated on one surface of the frond. . . . . *Rh. hemisphaericum*

### ***Rhodoglossum japonicum*** MIKAMI, sp. nov.

Frons caespitosa, cartilaginea, 10–30 cm alta, ex basi parva discoidea assurgens, sursum subito late vel cuneatim expansa, saepe dichotome vel palmatim vel irregulariter divisa; lobis simplicibus vel bifidis, ovatis vel oblongo-ovatis, marginibus integris vel leviter crispatis; cortice e cellulis minutis, sphaericis vel ellipsoideis, ad superficiem perpendiculariter 5–7 ordinatis dispositis; strato subcorticale e cellulis paucis subglobosis 2–3-anticlinis ordinatis; medullis abundantis cellulis libere aperteque anastomosantibus compositis; soris tetrasporangiferis numerosis, ovoideis, ovato-oblongis, cruciatis, 62.5–125 (–155) × 37.5–62.5 $\mu$ in diam.; cystocarpiis numerosis, per totam superficiem frondis disseminatis, sphaericis, in utraque pagina prominentibus, 1–3 mm in diam.; carposporis subglobosis, 20–50 (–65) $\mu$ in diam.; colore coccineo-purpureo; specimina exsiccata chartae imperfecte vel non adhaerenta.

Frond caespitose, cartilaginous, 10–30 cm high, arising from a small discoidal base, abruptly or cuneately expanding upwards, simple or often dichotomously or palmately or irregularly divided; lobes simple or bifid, ovate or oblong-ovate, entire or slightly crispate on margin; cortex composed of 5–7 rows of small, spherical or ellipsoidal cells, diminishing in diameter outwards, arranged closely with their longer axis perpendicular to the surface; subcortical layer rather thin, of 2–3 series of larger subglobose cells, arranged in anticlinal order; medullary layer consisting of somewhat thicker filaments, meshed with the neighbouring cells, often arranged

mostly in vertical direction; tetrasporangial sori scattered on the whole frond except the basal portion, slightly elevated, immersed within the subcortical layer; tetrasporangia transformed from the subcortical cells, ovoid or ovate-oblong, 62.5–125 (–155) × 37.5–62.5 $\mu$ in diam., cruciately divided; cystocarps quite spherical and numerous, densely scattered on the whole frond, making both surfaces of the frond hemispherically elevate, 1–3 mm in diam.; gonimoblast compacted with anastomosing sterile cells; special medullary filaments (Faserhülle) rather few, mainly developed by the secondary cell division of the medullary cells, circularly arranged around the gonimoblast masses; special absorbent filaments developing from the gonimoblast cells present, connected with the special medullary filaments; carpospores subglobose, 20–50 (–65) $\mu$ in diam.; colour crimson purple; specimens imperfectly or not adhering to paper in drying.

The present new species is one of the commonest seaweeds in the northern part of Japan, it was first referred to *Iridaea pulchra* KÜTZING by YENDO (1917), on the basis of the specimens from Hakodate (Hokkaido) and Aomori Pref., etc. *Iridaea pulchra* was established by KÜTZING in 1847 basing on the materials from Kamtschatka. In 1936, however, SETCHELL and GARDNER have transferred it to the genus *Rhodoglossum*, without giving any remarks. So, since his Kurile specimens were referred to *Rhodoglossum pulchrum* (KÜTZ.) S. et G. by NAGAI (1941) it has been passed among us under that name.

At present, the type specimen of *Iridaea pulchra* KÜTZ. is kept in the Rijksherbarium, Leiden, the Netherlands. According to Dr. J. TH. KOSTER, the type of *Iridaea pulchra* KÜTZING is two tiny fragments and a piece on mica. On the sheet belonging to the type in KÜTZING's Herbarium, in KÜTZING's handwriting is written as follows:

> *Iridaea pulchra* KG. Tab. phyc. XVII. 5.
> "Nov. genus *omnium facile pulcherrimum*"
> Kamtschatka. Herb. *Lehmannianum*
> bei Halymenia in Binder
> *Iridaea* no. 1.

Fortunately, the writer has been able to examine both the smallest fragment and the slide of the type specimen kindly loaned from the Rijksherbarium by the kindness of Dr. KOSTER. As far as the writer could ascertain from the type specimen, it agrees, of course, well with the original description and figure of *Iridaea pulchra* KÜTZING. In the writer's opinion, however, the resemblance of the present new species to *Iridaea pulchra* KÜTZ. is merely superficial. Namely, they are readily distinguishable each other by the structure of cystocarp and by the other characters. So far as the writer has studied, the differences between

the above two species appear to consist of the following points:

1. the special medullary filaments present (*Rh. japonicum*) or absent (*Iridaea pulchra*); 2. the absorbent filaments present (*Rh. japonicum*) or absent (*Iridaea pulchra*); 3. the cystocarp verruciform or somewhat papilliform (*Iridaea pulchra*) or quite spherical (*Rh. japonicum*); 4. carpospore 20–50 (–65) $\mu$ in diam. (*Rh. japonicum*) or ca. 10–15 $\mu$ in diam. (*Iridaea pulchra*).

On the other hand, Dr. A. D. ZINOVA kindly wrote to the writer as follows: "We have no specimen of *Rhodoglossum pulchrum* (KÜTZ.) S. et G. from Kamtschatka. I think KÜTZING's fig. c, d on tab. 5 (1867) is not a *Iridaea* or *Rhodoglossum*, but something from *Callymenia*, growing copiously at Kamtschatka. *Iridaea* and especially *Rhodoglossum* are met very rarely in this region. From the genus *Rhodoglossum* we have only one species gathered in Kamtschatka = *Rh. phyllocarpum* (POST. et RUPR.) comb. nov. = *Iridaea phyllocarpa* POST. et RUPR., 1840. In our Herbarium there are one RUPRECHT's specimen with the cystocarps and four specimens gathered at the beginning of the 20th century with the tetraspores, and with the same structure and appearance as *Iridaea phyllocarpa* P. et R." While, *Iridaea phyllocarpa* POST. et RUPR. was treated as a synonym of *Iridaea laminarioides* var. *cornucopiae* J. AG. by YENDO (1917). That is, he says as follows: "*Iridaea phyllocarpa* P. et R. is described from a second-year form of *Iridaea laminarioides* var. *cornucopiae* J. AG. with the older frond withered on the margin and new foliages proliferating from it".

Fortunately, the present writer could examine both a cystocarpic (type specimen) and a tetrasporic of *Iridaea phyllocarpa* P. et R. through the kindness of Dr. A. D. ZINOVA in the Herbarium of the Academy of Sciences in Leningrad. As far as the writer observed, the development of the tetraspore suggests distinctly that the placing of the species under the genus *Rhodoglossum* is quite correct. Namely, in that species, the tetraspores are formed by the direct transformation of the subcortical cells. Accordingly, the writer also holds the same opinion regarding that species (*Rhodoglossum phyllocarpum*) as Dr. A. D. ZINOVA does.

The present new species resembles in some degree *Rh. phyllocarpum* (P. et R.) A. D. ZINOVA from Kamtschatka. The former, however, is sharply distinguished from the latter by the external appearance and other characters. For instance, the frond in the present species is almost wanting in proliferation as far as the writer could examine.

In YENDO's Herbarium of the University of Tokyo there are many specimens which are determined by YENDO himself as *Iridaea cornucopiae* POST. et RUPR. (Collected at Oshoro Bay, April 1910). All of them are to be referred to the present new species. On the other hand, in the Herbarium of Botanical Institute, Faculty of Science, Hokkaido University, the writer has examined a female specimen

of *Rh. pulchrum* f. *luxurians* NAGAI (collected at Paramushiru, Kurile, Aug. 1932; No. 022024) distributed by NAGAI himself. In that specimen the cystocarps are not spherical but somewhat ocellate. In addition, both the special medullary filaments (Faserhülle) and the special absorbent filaments have not been found. Accordingly, it shows a very different habit and the anatomical structure is too peculiar to allow it to be referred even to the genus *Rhodoglossum*. Under the present species two forms are to be distinguished.

Key to the forms

1. Frond simple or 1–2 times dichotomously divided . . . . . f. *japonicum*
1. Frond 3–5 times dichotomously divided. . . . . f. *divergens*

### f. ***japonicum***

Pl. IX; Figs. 46–50

*Iridaea pulchra* YENDO (non KÜTZ.), Mar. Botany, 1911, p. 603, Fig. 169 (Fig. sinistr.); Id., Not. Alg. New. Jap. VI, 1917, p. 81; INAGAKI, Mar. Rhodophyc. Oshoro Bay, 1933, p. 34; KAWABATA, Mar. Alg. Shikotan Isl., 1936, p. 209; OKAMURA, Nippon Kaisoshi, 1936, p. 660; TAKAMATSU, Mar. Alg. Kinkwazan, 1936, p. 65; Id., Mar. Alg. Tsugaru, 1938, p. 51; Id., Mar. Alg. Sanriku, 1938a, p. 124, pl. 16, Fig. 1; Id., Mar. Alg. Japan Sea, 1939, p. 65.

*Rhodoglossum pulchrum* NAGAI (non S. et G.), Mar. Alg. Kurile Isl., II, 1941, p. 193; YAMADA et TANAKA, Mar. Alg. Akkeshi Marine Biological Station, 1944, p. 72; TOKIDA, Mar. Alg. S. Saghalien, 1954, p. 184; HASEGAWA, A List Mar. Alg. Okushiri Isl., 1949, p. 60; KAWASHIMA, A List Mar. Alg. Iwate Pref., II, 1955, p. 32; TOKIDA et MASAKI, Mar. Alg. Oshoro, 1959, p. 187.

*Rhodoglossum pulchrum* (KÜTZ.) S. et G. f. *typicum* NAGAI, Mar. Alg. Kurile Isl., II, 1941, p. 194; TOKIDA, Mar. Alg. S. Saghalien, 1954, p. 185.

Japanese name: Akaba-ginnanso.

Type locality: Oshoro Bay, Shiribeshi Prov.

Locality: Shimofuro, Aomori Pref. (MIKAMI, Aug. 1959); Esashi, Oshima Prov. (YAMADA, NAKAMURA, KARAKAWA, Apr. 1940); Shioya, Shiribeshi Prov. (NAKAMURA, June 1940); Oshoro, Siribeshi Prov. (SEGI, Mar. 1944; MIKAMI, May 1957; MIKAMI, May 1958; MIKAMI, May 1959); Zenibako, Shiribeshi Prov. (MIKAMI, May 1957); Shoya, Hidaka Prov. (MIKAMI, Mar. 1959); Sakagishi, Hidaka Prov. (MIKAMI, Apr. 1958); Aburakoma, Hidaka Prov. (MIKAMI, July 1957); Horoizumi, Hidaka Prov. (MIKAMI, Apr. 1958); Rausu, Nemuro Prov. (TANAKA, July 1936); Shikotan Isl., (NAGAI, without date of collection). Growing on rocks in the littoral belt.

Frond cartilaginous, simple or 1–2 times dichotomously divided; base rotundate with small stipe.

The present forma is chracteristic in the ovate or ovate-elliptic or sometimes 1–2 times dichotomously divided fronds with small stipe. The base of the frond

is narrowly cuneate, generally abruptly expanding upwards into an ovate frond. The bases are orbicular and small callous discs. In longitudinal section they are of parenchymatous structure of firm consistence, being built up of angular cells arranged in somewhat irregular rows. The cortex consists of 5–7 rows of small,

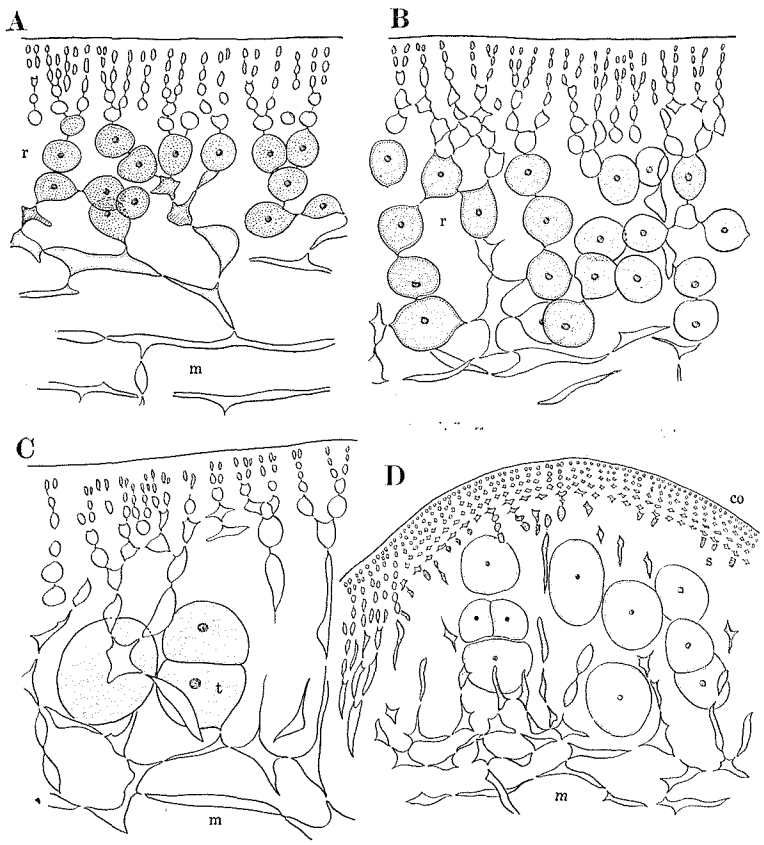


Fig. 46. *Rhodoglossum japonicum* MIKAMI f. *japonicum*
A, B. Early development of sporangia. × 300.
C, D. Further development of sporangia. × 300.
co, cortex; m, medulla; r, rudiment of sporangia; t, tetrasporangia.

spherical or ellipsoidal cells with progressively smaller dimension towards the surface. The subcortical layer is rather thin, and consisting of subglobular cells which are arranged in anticlinal order. The medulla is composed of loose filaments often arranged in vertical direction.

The development of the tetrasporangia was traced as in Fig. 46. Fig. 46 (A, B)

shows the young sporangia which have transformed from the subcortical cells. The tetrasporangial sori are observed being scattered widely on the frond except the basal portion. They are round or ovate in surface view and sometimes become confluent each other. The tetrasporangia are cruciately divided, measuring 62.5–125×37.5–62.5 $\mu$ in diameter. The structure of the procarp is exactly the same as that of *Chondrus*. Namely, it consists of a large supporting (auxiliary) cell and a three-celled carpogonial branch as in Fig. 47 (A). The carpogonial branch is bent characteristically in such a manner that the carpogonium lies lateral to the supporting (auxiliary) cell. The basal cell of the carpogonial branch is the largest while the carpogonium is the smallest. Unfortunately, the fusion of the carpogonium with the auxiliary cell was not observed. Fig. 47 (B) represents the initial development of the gonimoblast (gi). The special medullary filaments (Faserhülle)

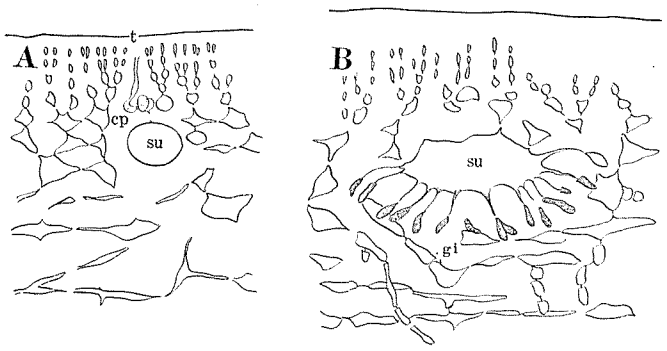


Fig. 47. *Rhodoglossum japonicum* MIKAMI f. *japonicum*
A. Longitudinal section of thallus with procarp. × 340.
B. Formation of gonimoblast-initials. × 340.
cp, carpogonium; gi, gonimoblast-initial;
su, supporting cell; t, trichogyne.

originate by the secondary division from the medullary cells in the vicinity of the auxiliary cell. Thus, the primary gonimoblast with short articulations is surrounded by the special medullary filaments. Shortly afterwards, the long or short special absorbent filaments are sent out from the gonimoblasts.

In succession, they connect with the special medullary filaments. Namely, the nourishment reaches at first the gonimoblast only by way of the auxiliary cell, however, soon after, through the special absorbent filaments the contents of the special medullary cells are exhausted for the development of the primary gonimoblast. Consequently the special medullary cells are withered. So they appear as slender "Faserhülle" on the outermost circumference of cystocarp. As shown in Fig. 48 (B), the special absorbent filaments also attain frequently the subcortex. That

is, the contents of the subcortical cells are also exhausted for the development of the gonimoblast. Thus, the primary gonimoblasts with rich cytoplasm form a network within the younger cystocarp, and some of them are linked by special absorbent

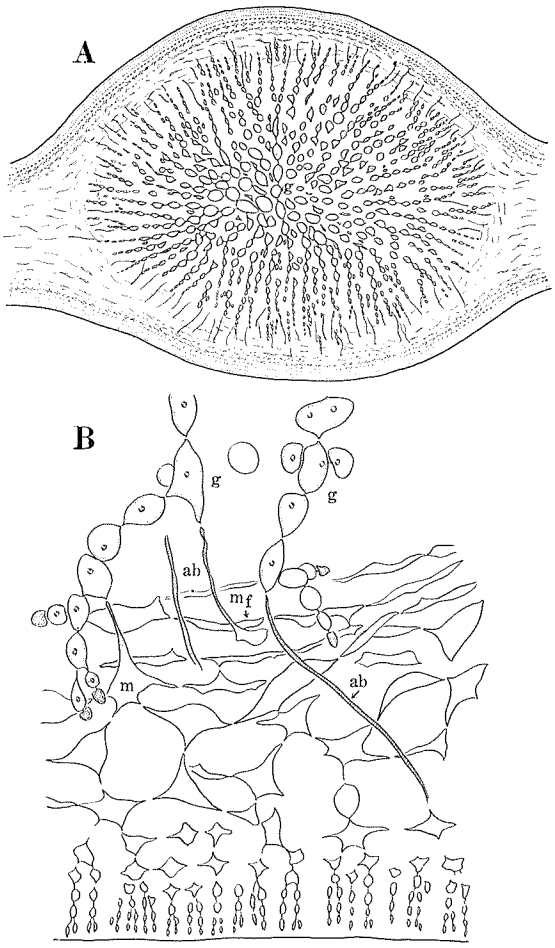


Fig. 48. *Rhodoglossum japonicum* MIKAMI f. *japonicum*
A. Longitudinal section of a young cystocarp. × 55.
B. The same, more highly magnified. × 340.
ab, special absorbent filaments; g, gonimoblast; m, medulla; mf, special medullary filament.

filaments to the subcortex. Finally, the sterile cells of the primary gonimoblast lose most of their contents, as the terminal carposporangia develop. Fig. 49 (A) represents a mature cystocarp. They are quite spherical, and elevated on both surfaces

of the frond. The distribution of the cystocarps are observed being scattered widely on the lobes except the base of the frond. The carpospores are subglobose or spherical, measuring 20–50 (–65) $\mu$ in diameter.

In the material at hand, the carpospore developing in the mature cystocarp could be observed as shown in Fig. 50.

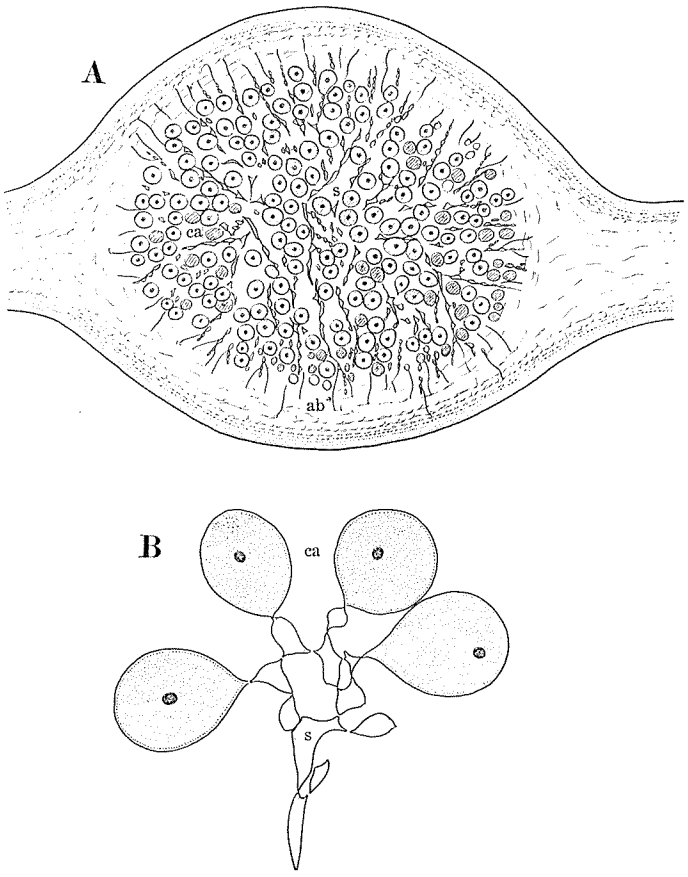


Fig. 49. *Rhodoglossum japonicum* MIKAMI f. *japonicum*

A. Longitudinal section of an almost mature cystocarp. × 55.

B. The same, more highly magnified. × 340.

ab, special absorbent filament; ca, carposporangia; s, sterile gonimoblast.

f. ***divergens*** (NAGAI) MIKAMI, comb. nov.

Pl. X, 1

*Rhodoglossum pulchrum* (KÜTZ.) S. et G. f. *divergens* NAGAI, Mar. Alg. Kurile Isl., 1941, p. 194; TOKIDA, Mar. Alg. S. Saghalien, 1954, p. 185.

Japanese name: Edauchi-ginnan (nom. nov.).

Type locality: Erimo, Hidaka Prov.

Locality: Harutachi, Hidaka Prov. (MIKAMI, Mar. 1952); Ikantai, Hidaka Prov. (MIKAMI, Mar. 1959); Horoizumi, Hidaka Prov. (MIKAMI, Apr. 1958); Aburakoma, Hidaka Prov. (MIKAMI, July 1957); Erimo, Hidaka Prov. (MIKAMI, Aug. 1955); Rebun-iso, Kunashiri Isl., Kuliles (NAGAI, SHIMAMURA, July 1929). Growing on rocks in the littoral belt.

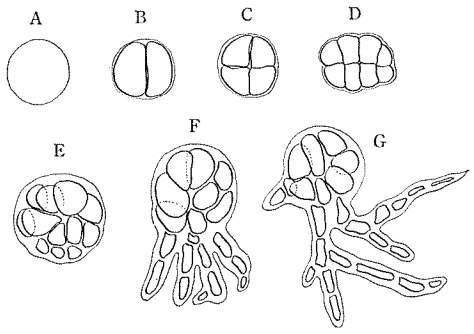


Fig. 50. *Rhodoglossum japonicum* MIKAMI f. *japonicum*
A–G. A series of various stages of the development of germinating carpospores in mother cystocarp. × 330.

Frond cartilaginous, 3–5 times dichotomously divided; base broadly cuneate.

The present forma is commonly found in the south-eastern coast of Hokkaido and the southern Kuriles. It is characteristic in the 3–5 times repeatedly dichotomous fronds. The structure and development of the cystocarp and tetrasporangia in the present forma are quite similar to those of f. *japonicum*.

***Rhodoglossum hemisphaericum*** MIKAMI, sp. nov.

Frons solitaria vel caespitosa, cartilaginea, 10–25 cm alta, e basi parva discoidea assurgens, sursum mox late vel cuneatim expansa, simplex vel dichotome vel palmatim vel irregulariter divisa, interdum parvis prolificationibus ornata in utrisque superficiebus prolifera; marginibus integris vel minutissime crenulatis vel denticulatis; cortice e cellulis minutis, sphaericis vel ellipsoideis, ad superficiem perpendiculariter 4–6 ordinatis dispositis; strato subcorticale e cellulis paucis subglobosis 2–4-anticlinis ordinatis; medulla cellulis rhizoideis crassioribus anastomosantibus

compositis; soris tetrasporiferis parvis, orbiculatis vel ellipticis vel irregularibus, numerosis; tetrasporangiis ovoideis vel ovato-oblongis, cruciatis, 50–62.5×32.5–45 $\mu$ in diam.; cystocarpiis numerosis, per totam superficiem frondis disseminatis, nunc hemisphaericis nunc sphaericis; carposporis ovoideis, oblongis, 25–35 $\mu$ in diam.; colore coccineo-purpureo; specimina exsiccata chartae imperfecte vel non adhaerenta.

Frond solitary or caespitose, cartilaginous, 10–25 cm high, arising from a small discoidal base, soon expanding widely or cuneately upwards, simple or dichotomously or palmately or very irregularly divided, sometimes provided with small proliferations on both surfaces; at margin entire or very minutely crenulate or denticulate; cortex composed of 4–6 rows of small, spherical or ellipsoidal cells, diminishing in diameter outwardly, arranged closely with their longer axis perpendicular to the surfaces; subcortical layer rather thin, consisting of 2–4 series of subglobose, anticlinally arranged cells; medullary layer consisting of somewhat thicker, longitudinally elongated, anastomosing rhizoidal cells; tetrasporangial sori small, circular or elliptical or irregular in outline, scattered on the whole frond except the basal portion, somewhat elevated, and shallowly immersed within the subcortical layer; tetrasporangia transformed from the subcortical cells, ovoid or ovate-oblong, 50–62.5×32.5–45 $\mu$ in diam., cruciately divided; cystocarps numerous, densely scattered on the whole frond, sometimes hemispherically elevated on one side, or sometimes prominent on both surfaces; gonimoblast compacted with anastomosing sterile cells; special medullary filaments (Faserhülle) rather abundant, mainly developed accessorily from the medullary cells in the vicinity of procarp, circularly arranged around the gonimoblast masses; special absorbent filaments connected with the special medullary ones abundant; carpospores ovoid or oblong, 25–35 $\mu$ in diam.; colour crimson purple; specimens imperfectly or not adhering to paper in drying.

The present new species has some resemblance to *Rhodoglossum japonicum* MIKAMI. But it may be readily separated from the latter by its hemispherical cystocarps and often by the existence of small proliferations and denticulations on the margin and surface of the frond. Futhermore the medullary layer is rather thicker than that of *Rhodoglossum japonicum*, and mainly arranged horizontally to the surface of the frond. Two following forms are separable.

Key to the forms

1. Frond dichotomously, palmately or irregularly divided with small proliferations or denticulations . . . . . f. *hemisphaericum*
1. Frond simple or rarely 1–2 times subdichotomously divided with entire margin . . . . . f. *oblongo-ovatum*

### f. ***hemisphaericum***

Pl. X, 2; Figs. 51–53

Japanese name: Ibo-ginnan (nom. nov.).

Type locality: Oshirabetsu, Tokachi Prov., Hokkaido.

Locality: Oshirabetsu, Tokachi Prov. (MIKAMI, July 1960); Izumihara, Tokachi Prov. (MIKAMI, July 1957). Growing on rocks in the littoral belt.

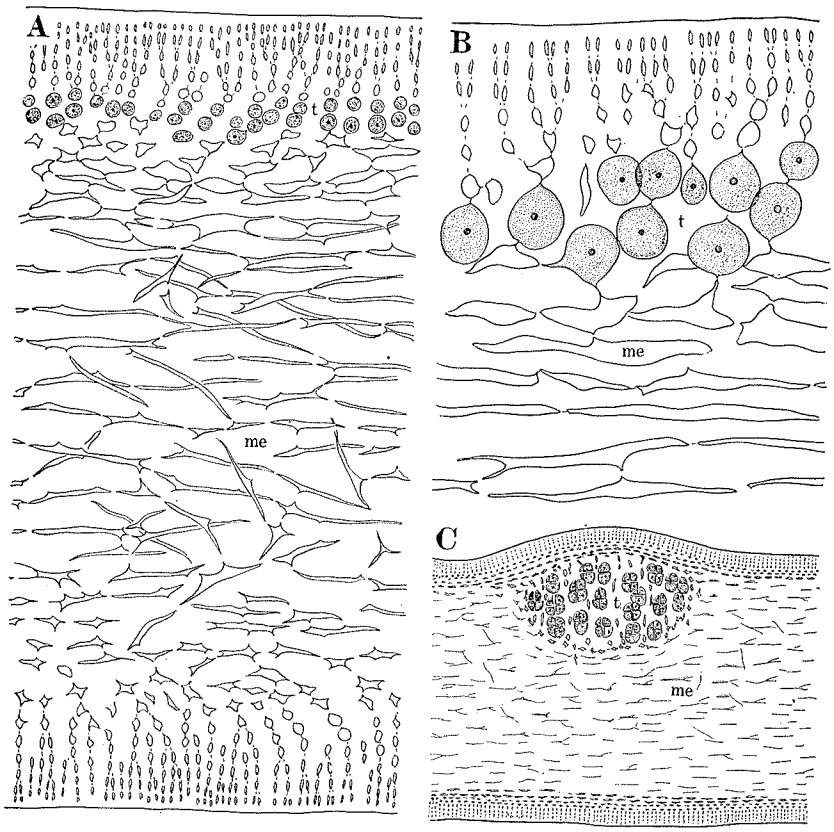


Fig. 51. *Rhodoglossum hemisphaericum* MIKAMI f. *hemisphaericum*

A. Younger tetrasporangia in longitudinal section. × 180.
B. The same, more highly magnified. × 340.
C. Mature sporangia (schematic). × 55.
me, medulla; t, tetrasporangia.

Frond dichotomously, palmately or irregularly divided, with slender stipe; small proliferations or denticulations present

The present forma is characteristic in the irregular or repeatedly dichotomous

or rarely palmate fronds.

The development and arrangement of the tetrasporangia in the present alga are exactly the same as those of *Rh. japonicum*, except the smaller dimensions.

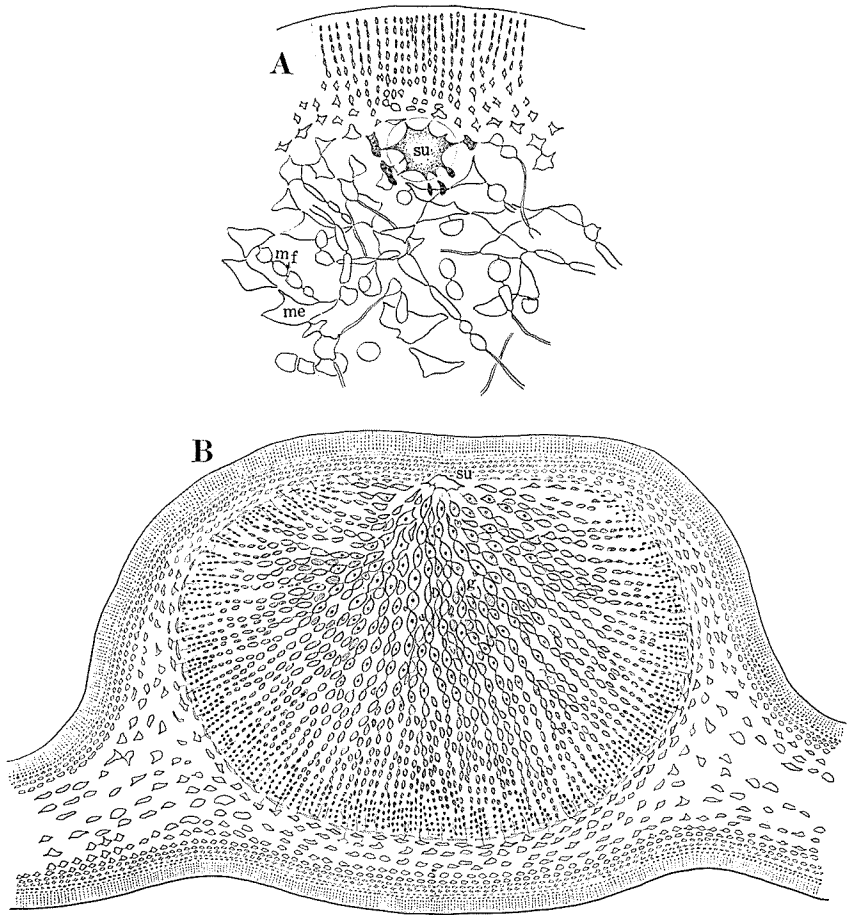


Fig. 52. *Rhodoglossum hemisphaericum* MIKAMI
f. *hemisphaericum*
A. Longitudinal section of thallus with procarp. × 180.
B. Primary gonimoblast in longitudinal section. × 50.
g, gonimoblast; me, medulla; mf, special medullary filament (Faserhülle); su, supporting cell.

The development of the special medullary filaments (Faserhülle) and gonimoblasts are also similar to those of *Rh. japonicum*. However, the special medullary filaments are more abundant in quantity than those of the latter. The special medullary filaments originate accessorily from the medullary cells in the vicinity of the

auxiliary cell as in Fig. 52 (A). Fig. 52 (B) represents the development of the primary gonimoblasts. On the other hand, the numerous special absorbent filaments develop from the gonimoblast tissue. They are connected with the special medullary filaments in order to obtain nutriments, and consequently the special medullary filaments (Faserhülle) become shrinked. Thus, they appear as slender "Faserhülle" on the outermost circumference of cystocarp. Finally, the sterile cells of the

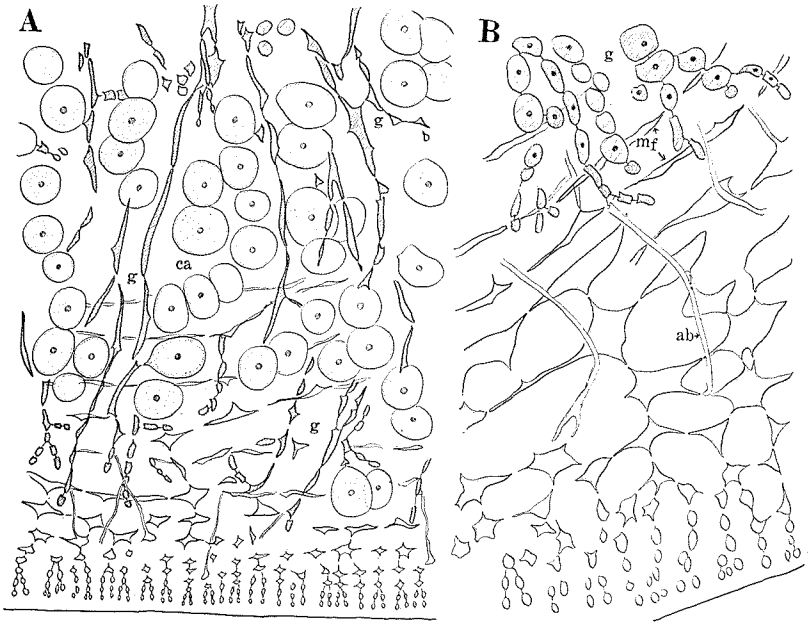


Fig. 53. *Rhodoglossum hemisphaericum* MIKAMI f. *hemishaericum*

A. Longitudinal section of a mature cystocarp. × 180.

B. Primary gonimoblasts and special absorbent filaments in longitudinal section of younger cystocarp. × 340.

ab, special absorbent filament; ca, carposporangia; g, gonimoblast; mf, special medullary filament (Faserhülle).

primary gonimoblast lose most of their contents, as the carposporangia develop. Fig. 53 (A) shows a part of the mature cystocarp. The carposporangia are ovoid or oblong and 25–35 $\mu$ in diameter.

f. ***oblongo-ovatum*** MIKAMI, f. nov.

Pl. XI; Figs. 54-55

Japanese name: Tokachi-ginnan (nom. nov.).

Type locality: Oshirabetsu, Tokachi Prov., Hokkaido.

Locality: Oshirabetsu, Tokachi Prov. (MIKAMI, July 1957). Growing on rocks in the littoral belt.

Frons oblongo-ovata, simplex vel raro semel bisve subdichotome ramosa, marginibus integra.

Frond oblongo-ovate, simple or rarely 1–2 times subdichotomously divided, entire at margin.

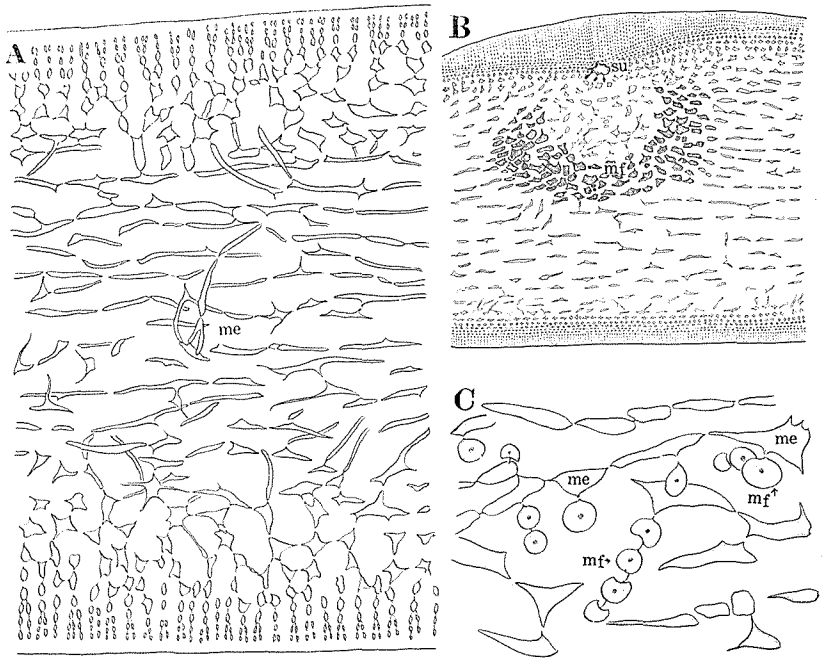


Fig. 54. *Rhodoglossum hemisphaericum* MIKAMI
f. *oblongo-ovatum* MIKAMI

A. Longitudinal section of thallus. × 180.
B. Supporting cell and special medullary filaments. × 50.
C. Origin of "Faserhülle". × 340.
me, medulla; mf, special medullary filaments (Faserhülle); su, supporting cell.

In the present forma the frond is entire at margin and simple or rarely 1–2 times subdichotomously divided. The development of the special medullary filaments (Faserhülle) and the gonimoblasts in the present materials are entirely similar to those of f. *hemisphaericum*. Fig. 54 (B, C) shows the development of "Faserhülle". Namely, the special medullary filaments (Fig. 54, mf) originate accessorily from the medullary cells in the vicinity of the procarp. They gradually enlarge with rich

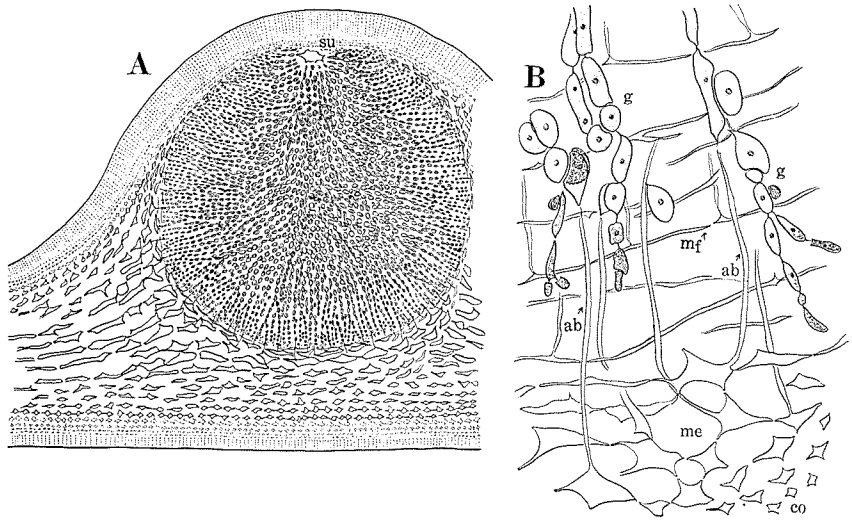


Fig. 55. *Rhodoglossum hemisphaericum* MIKAMI
f. *oblongo-ovatum* MIKAMI

A. Longitudinal section of cystocarp with primary gonimoblasts. × 50.
B. Young gonimoblasts and special absorbent filaments. × 340.
ab, special absorbent filaments; co, cortex; g, gonimoblast; me, medulla; mf, special medullary filaments (Faserhülle); su, supporting cell.

cytoplasm, and communicate with the neighbouring cells. On the other hand, Fig. 55 (B) represents the special absorbent filaments (ab) which developed from the gonimoblast tissue.

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PLATE I

*Ahnfeltia yamadae* (SEGAWA) MIKAMI

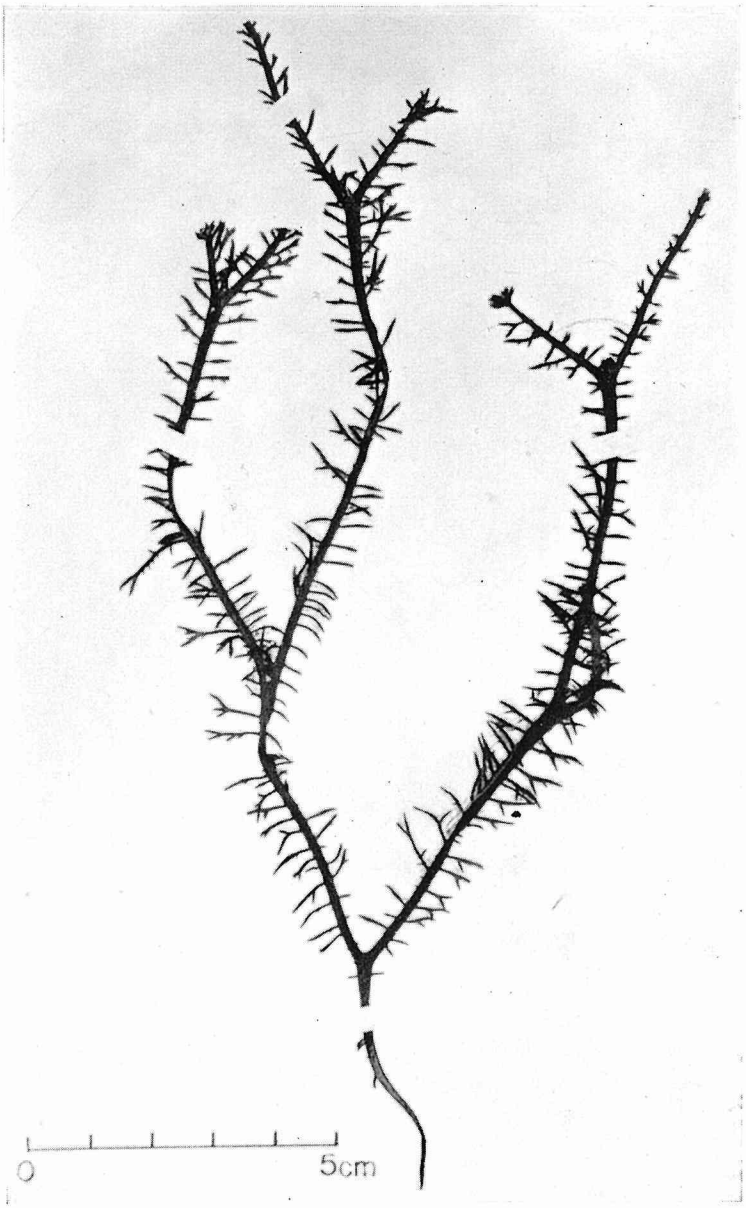
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PLATE II

*Chondrus pinnulatus* (HARVEY) OKAMURA
f. *armatus* (HARVEY) YAMADA et MIKAMI

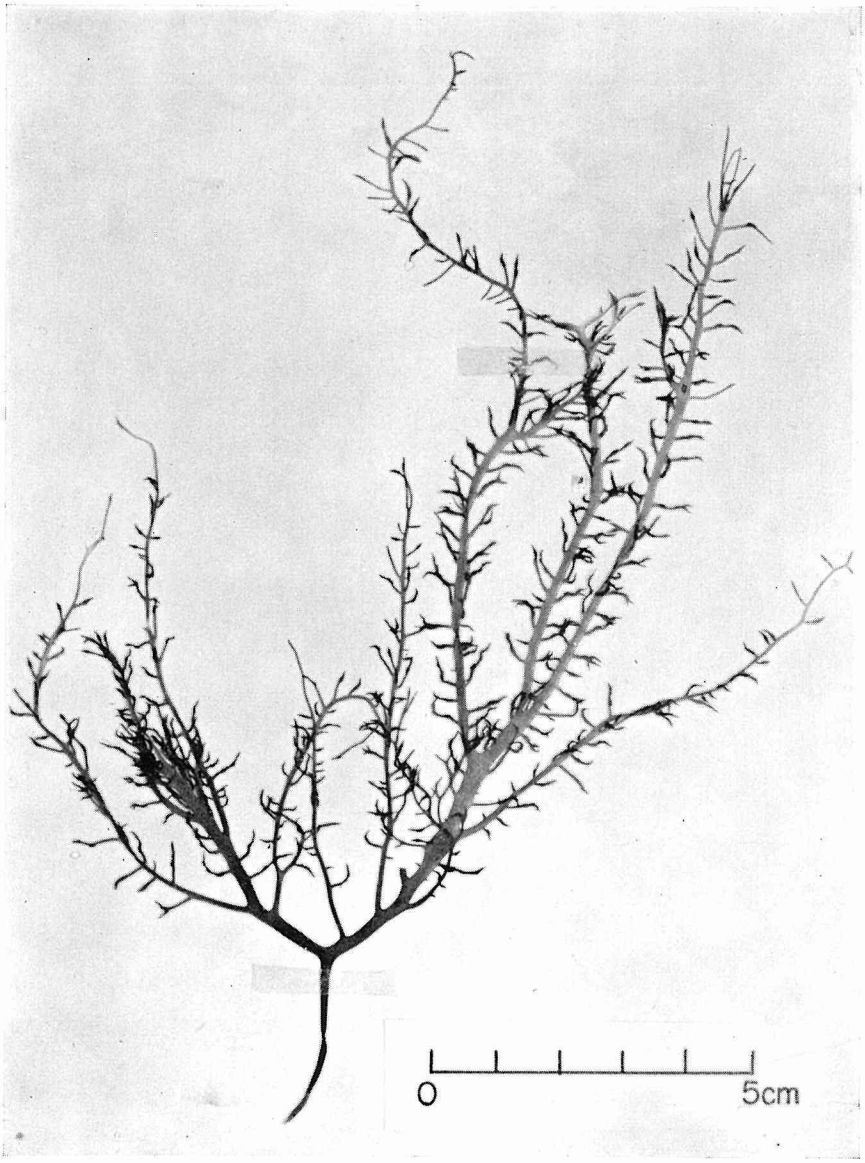
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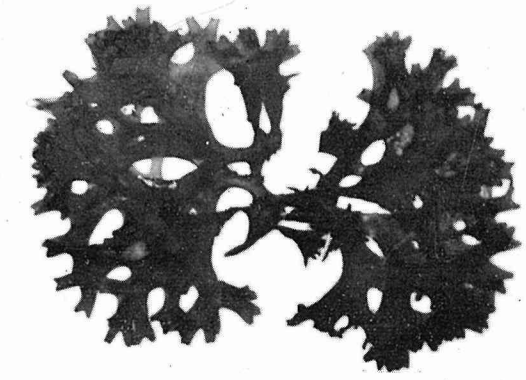
PLATE III

*Chondrus ocellatus* HOLMES

1. f. *parvus* MIKAMI
2. f. *crispoides* MIKAMI × 9/10
3. f. *aequalis* MIKAMI



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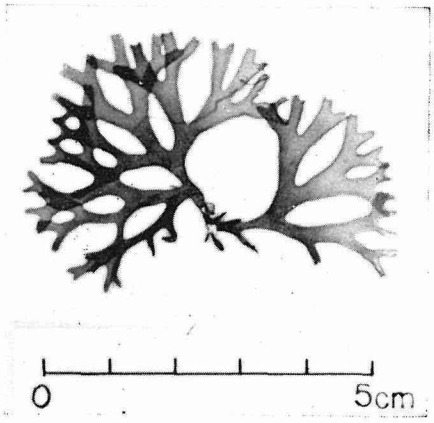


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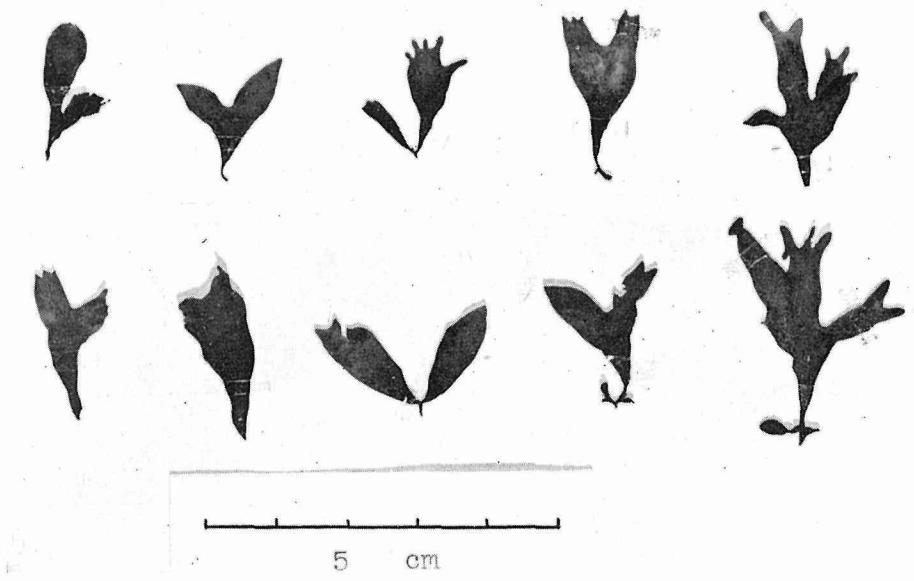
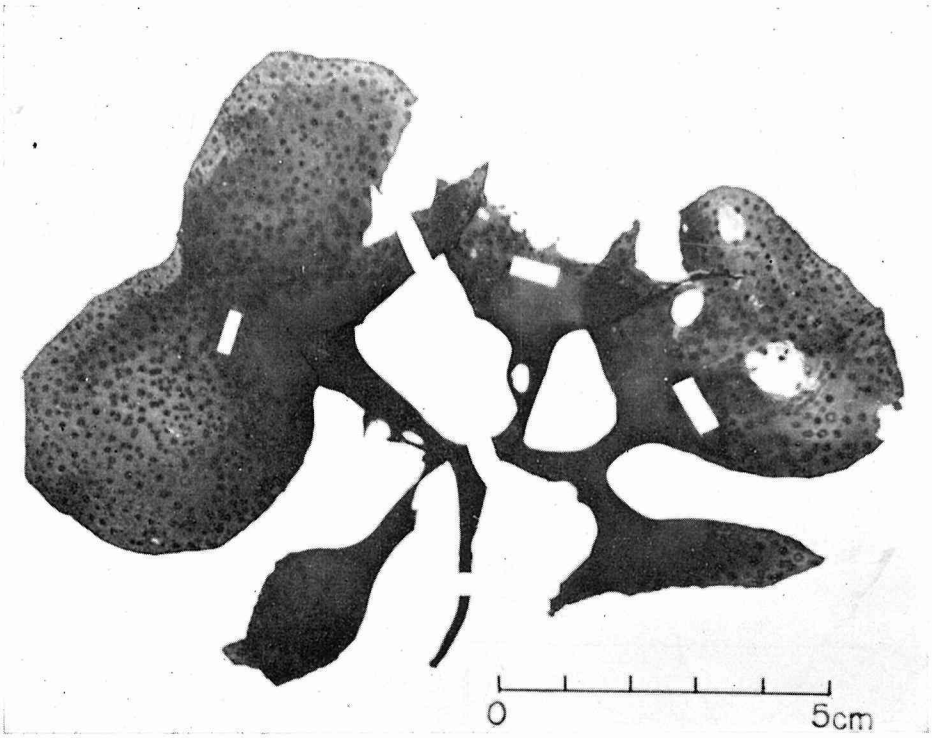



1

PLATE IV

1. *Ahnfeltia gracilis* (YAM.) YAMADA et MIKAMI × 5.5
2. *Chondrus yendoi* YAMADA et MIKAMI
   f. *subdichotomus* MIKAMI

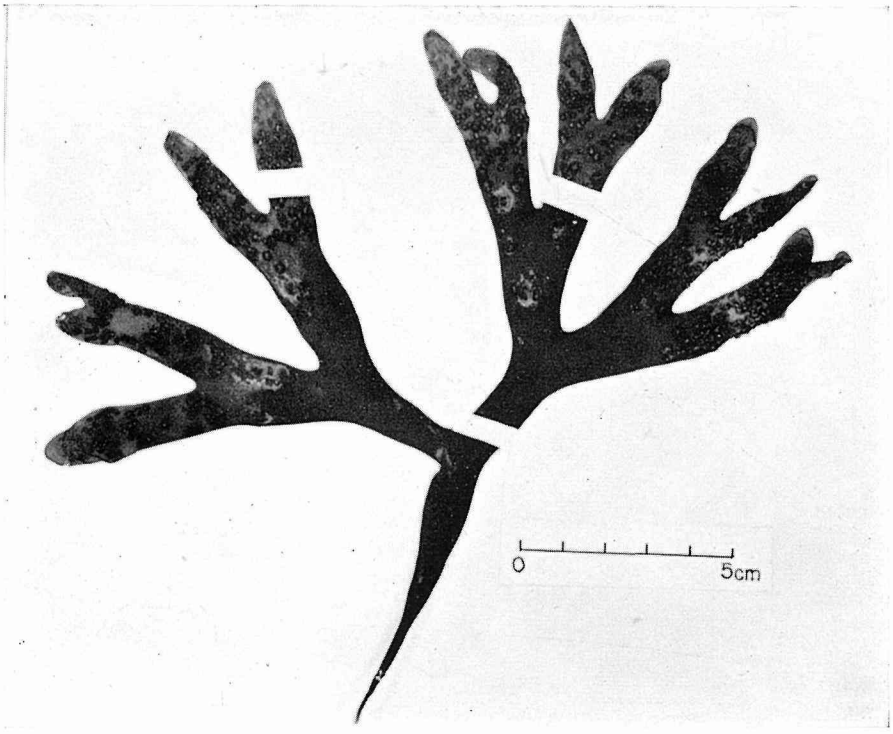
1




2

PLATE V

1. and 2. *Chondrus verrucosus* MIKAMI

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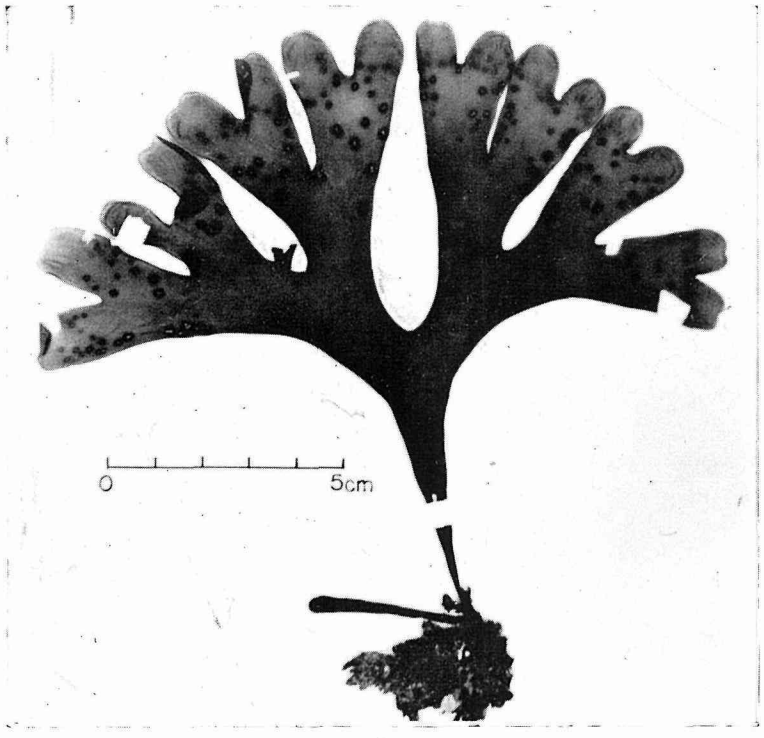


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PLATE VI

*Chondrus giganteus* YENDO

f. *giganteus*

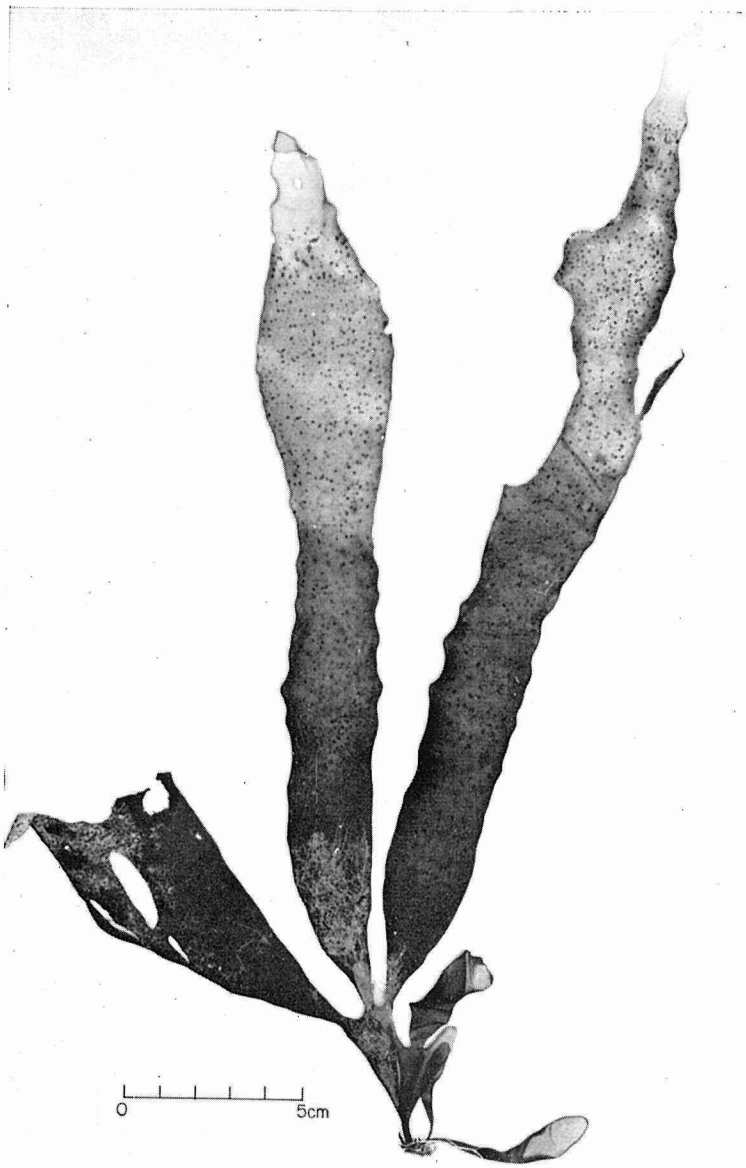
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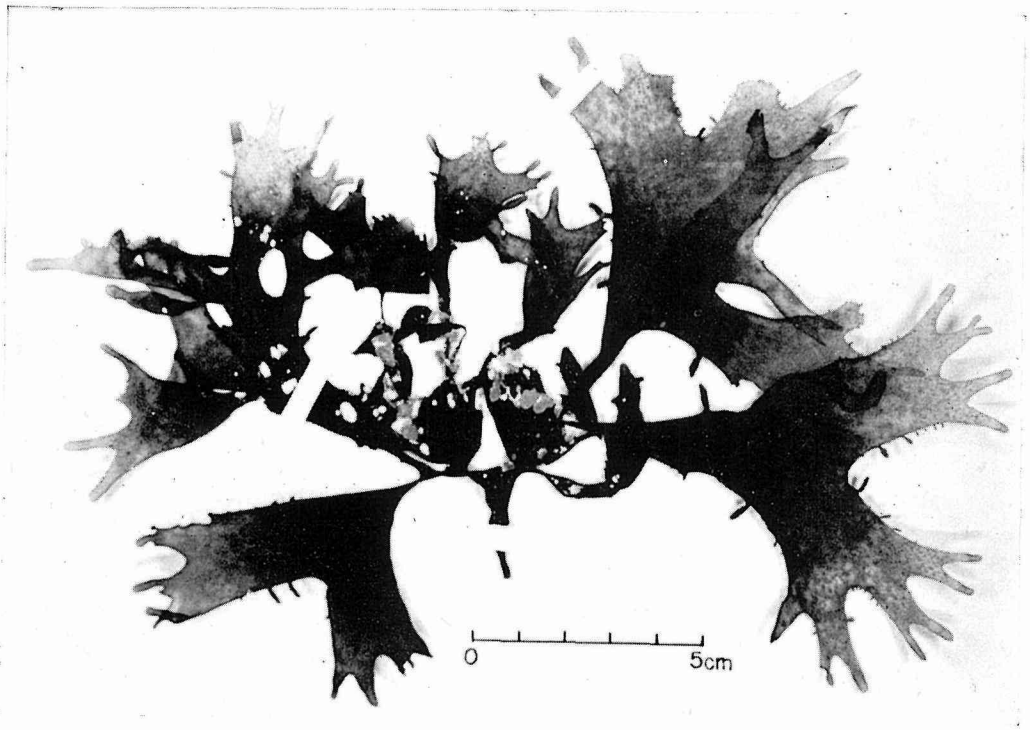
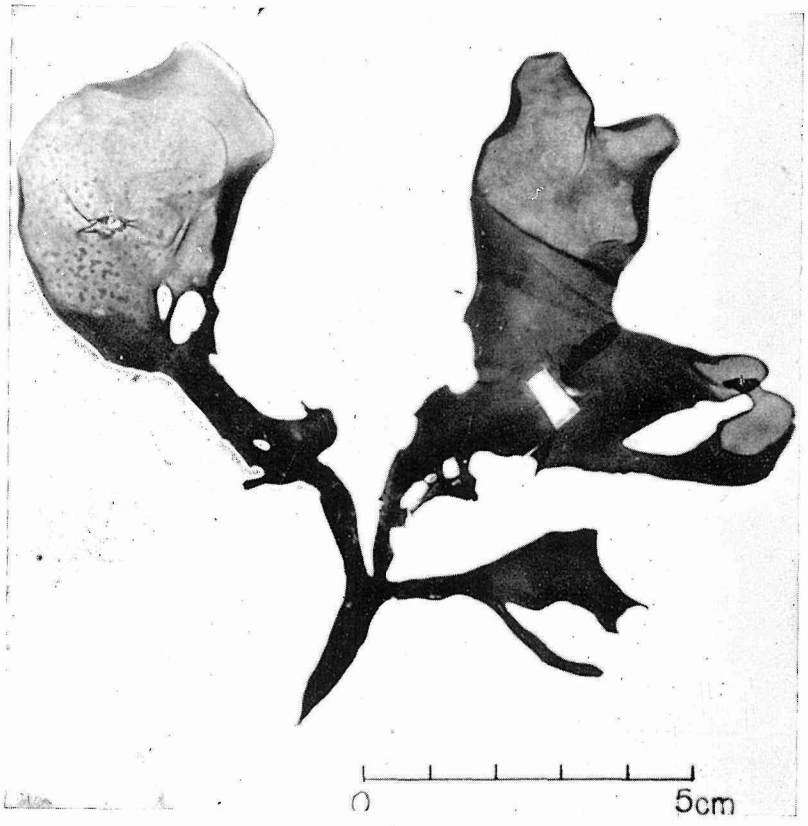
PLATE VII

1. *Chondrus giganteus* YENDO
   f. *flabellatus* MIKAMI

2. *Iridaea cornucopiae* P. et R.




1

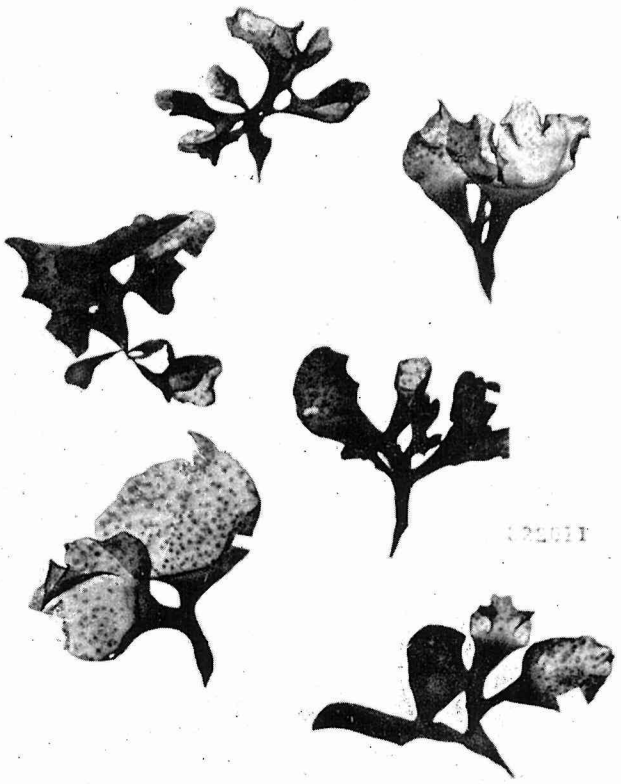



2

PLATE VIII

*Iridaea cornucopiae* P. et R.

The specimens from Shimushir Isl., Kuriles, determined by Prof. M. NAGAI as "*Iridophycus subdichotomum* NAGAI".



Broughton Bay.
on muddy Isl.
[illegible]. M.N.

北海道帝國大學理學部植物學教室

Marine Algae of the Kurile Islands

N. Nagai.

PLATE IX

*Rhodoglossum japonicum* MIKAMI
f. *japonicum*

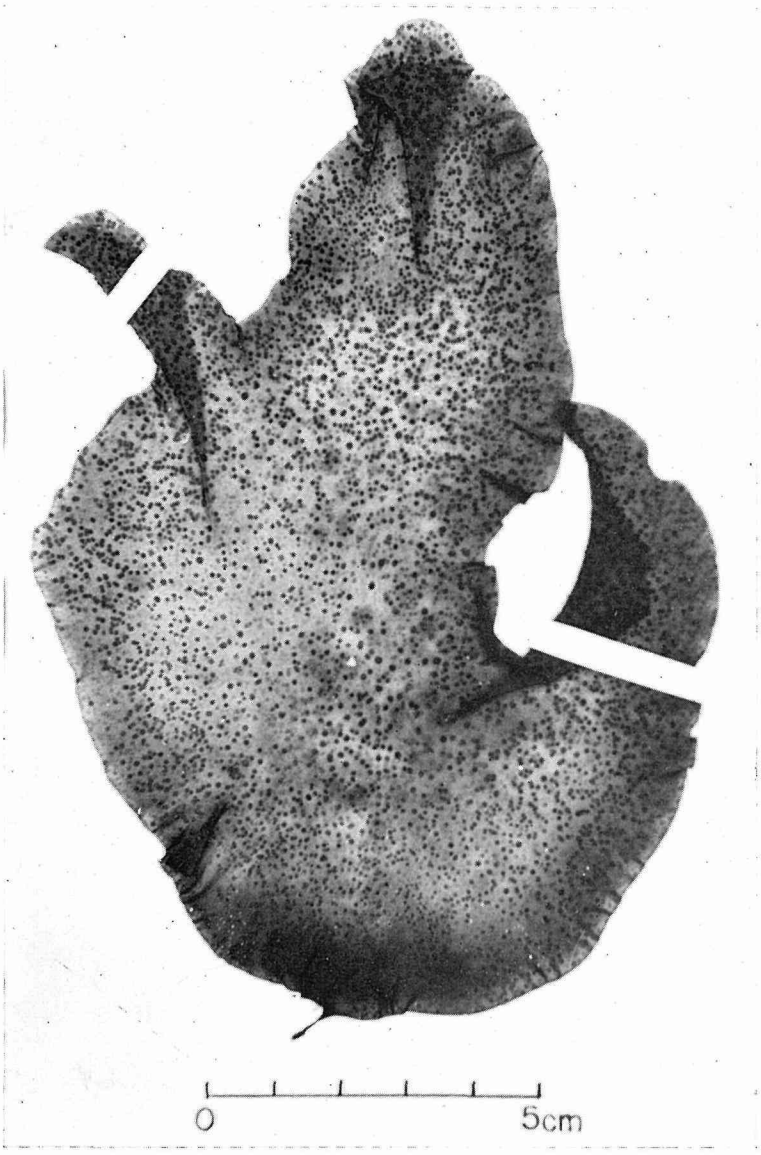
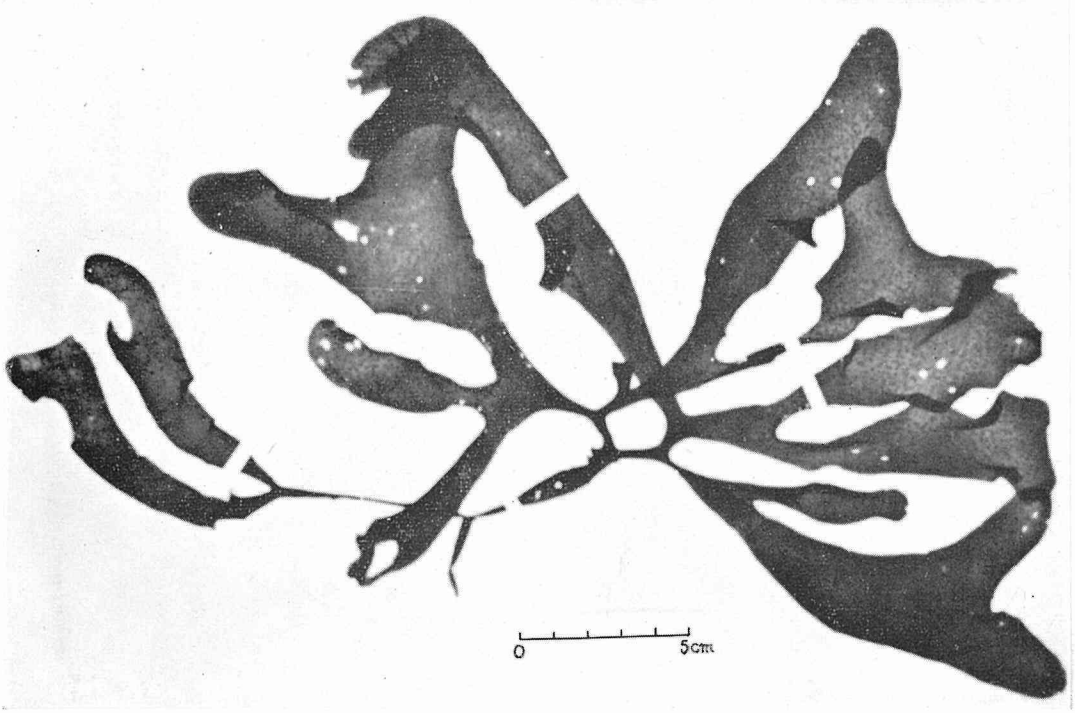

0
5cm

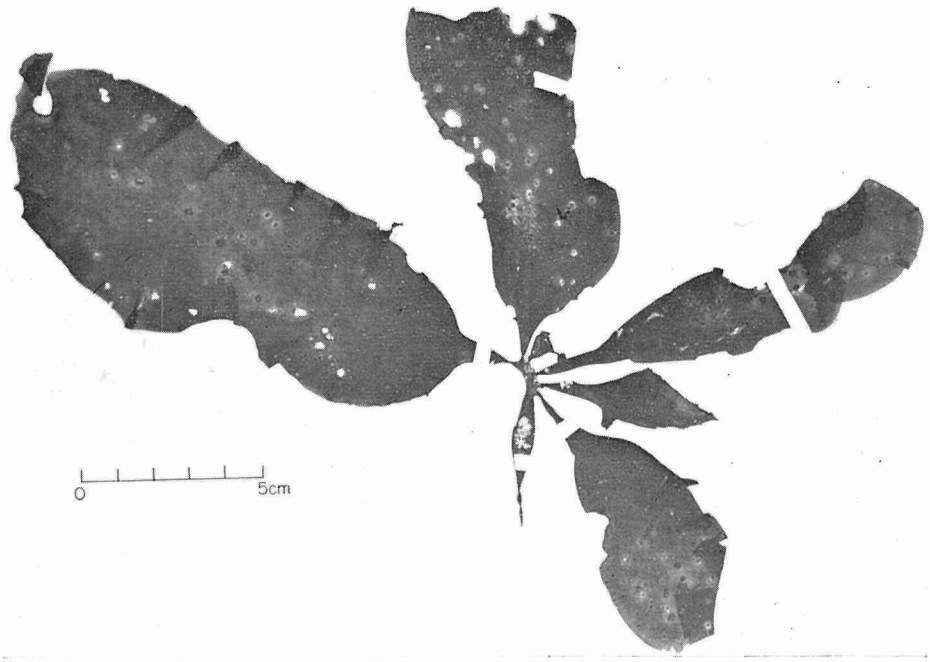
PLATE X

1. *Rhodoglossum japonicum* MIKAMI
   f. *divergens* (NAGAI) MIKAMI

2. *Rhodoglossum hemisphaericum* MIKAMI
   f. *hemisphaericum*



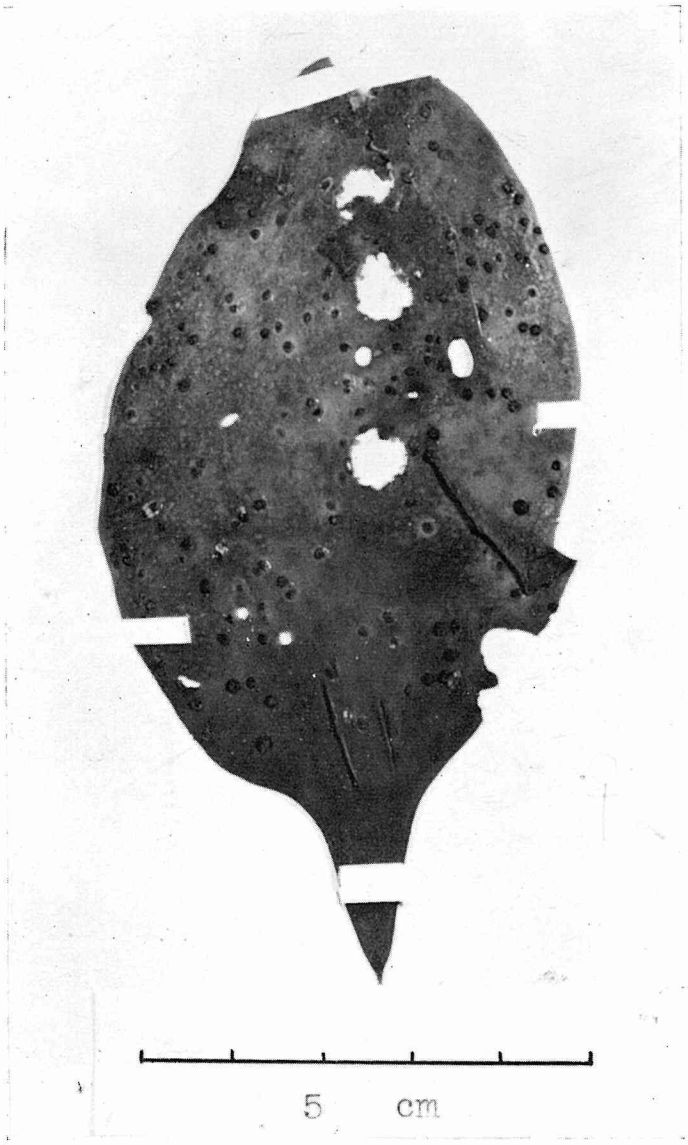

1




2

PLATE XI

*Rhodoglossum hemisphaericum* MIKAMI
f. *oblongo-ovatum* MIKAMI


5 cm