Contributions to the Knowledge of the Chordariales from Japan I

By

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Since 1950 the present writer has been studying systematically the Japanese species of the Order Chordariales under the guidance of Prof. YUKIO YAMADA, in the Institute of Algological Research, Faculty of Science, Hokkaido University. In treating this Order use is made of the inner characters, especially the growing point, the central axis of the frond, the medullary layer and the assimilating filaments, as well as the outer characters. In the present paper five species and five formae from Honshu and Hokkaido are enumerated.

Here the writer wishes to express his hearty thanks to his teacher, Prof. Y. YAMADA for his kind guidance during the course of this work. The writer is also very thankful to Dr. Y. NAKAMURA for his valuable suggestions regarding this study. Sincere thanks are also due to Dr. E. YALE DAWSON in the Allan Hancock Foundation, University of Southern California for the use of the valuable material of the Order Chordariales gathered from various places in America. 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 writer also records his indebtedness to the Ministry of Education for the financial aid for pursuing the present investigation.

Nemacystus decipiens (SURINGAR) KUCKUCK

Figs. 1–3

Fragm. einer Monogr. der Phaeosporeen, 1929, p. 68, Figs. 92–93; *Mesogloia decipiens* SUR., Illustr. des alg. de jap., Mus. bot. de Leyde. Tom I, 1872, p. 75, t. 25; DE TONI, Syll. Alg. III, 1895, p. 428; *Cladosiphon decipiens* OKAM., Algae japonicae exsicc. No. 87; Id., Icon. jap. alg. II, 1912, p. 136, Tab. 89; KYLIN, Phaeophyceenord. Chordar. 1940, p. 46.

Japanese name: *Mozuku.*

Loc.: Enoshima, Sagami Prov.; Toyohama and Morozaki, Owari Prov.; Takeshima and Ikawazu, Mikawa Prov.; Hino-misaki, Izumo Prov.; Sado, Echigo Prov. etc., widely distributed along the Pacific and the Japan Sea coasts of the middle and the southern parts of Honshu, also found along Shikoku and Kyushu coasts. Growing on the fronds of *Sargassum patens* C. AG., *S. piluliferum* C.

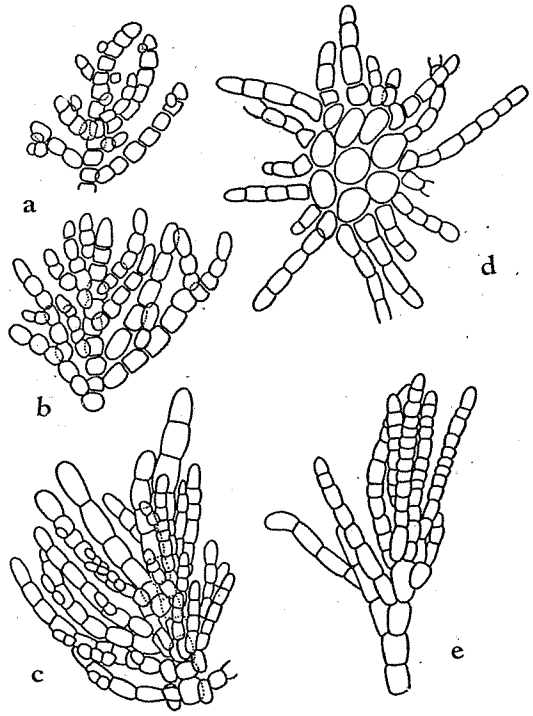

Fig. 1. *Nemacystus decipiens* (SUR.) KCK.
a, b, c. A series of developments of growing points. a, b. × 375, c. × 300.
d. Transverse section of the young frond. × 300.
e. Assimilating filaments with inmatured plurilocular sporangia. × 300.

AG. etc. below the low tide mark.

Frond generally growing on the fronds of several species of *Sargassum*, arising from small discoid base at first, 10–30 cm long, gelatinous, slimy, very lubricous, filiform, somewhat cord-shaped in older or main branches, in age branched several times alternately in various directions, provided with irregularly dichotomous branchlets, especially in younger stage with short, patent or approaching branchlets; branches about 1mm thick in the lower portion of the frond, gradually tapering upwards, usually scattered in the lower portion, but provided with branchlets considerably densely upwards; frond solid or more or less hollow, possessing oblong or elongated medullary cells, the cells 100–180 μ, sometimes 1 mm long, 50–100 μ broad and somewhat loosely arranged; central axis monopodially developed, consisting of a single cell-row; longitudinal growth of the frond performed by the terminal cell of the central axis; rudimental assimilating filaments formed from segment cells of the central filament, the segment cells irregularly shaped, 10 μ in diam.; medullary layer and cortical ones formed through stretching and dividing of the basal cells of the rudimental assimilating filaments, and also cortical layer formed from cell-rows divided from the subbasal cells of the rudimental assimilating filaments; cortical cells fully provided with secondary assimilating filaments and sporangia, so differentiation between the rudimental assimilating filaments and the secondary assimilating ones not found; secondary assimilating filaments simple or sparsely branched, filiform, 120–200 μ long, slightly curved upwards; consisting of about 9 cells or more, cells somewhat swelling in the upper portion; hairs colourless, up to 400 μ long, consisting of elongated cells,

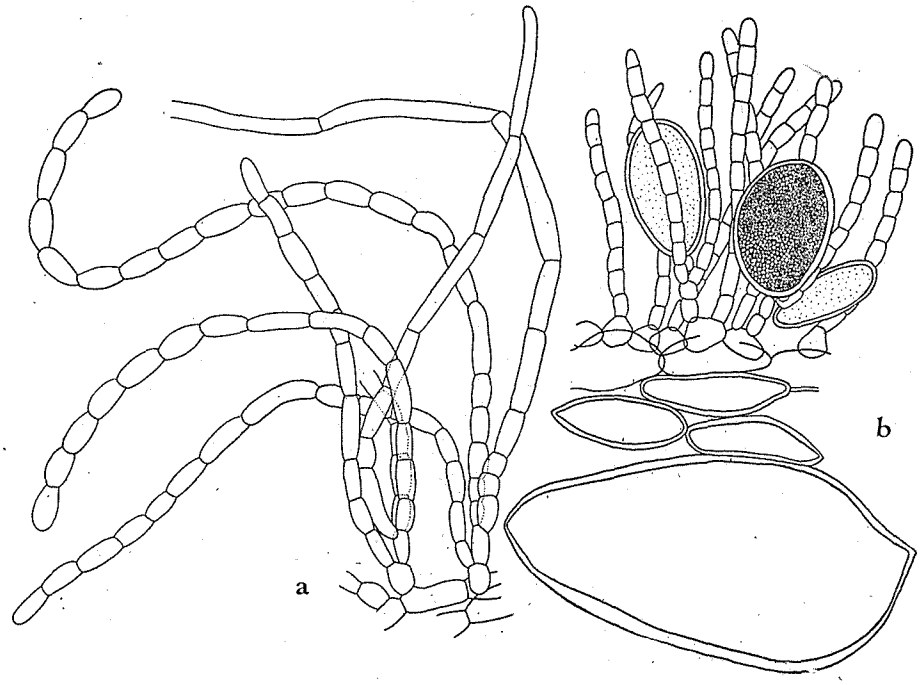

Fig. 2. *Nemacystus decipiens* (SUR.) KCK.
a. Assimilating filaments and hairs. × 200
b. Longitudinal section of the frond with unilocular sporangia. × 200

arising very abundantly from the basal cells or the branches of the assimilating filaments; unilocular sporangia ellipsoid or obovate, 80 μ long, 40–50 μ broad, sessile or with one-celled pedicels on the bases or the lower portions of the assimilating filaments; plurilocular sporangia filiform, gathering tuft-like on the assimilating filaments, composed of one row of cells, transformed from the assimilating filaments; colour brown or light brown, very often becoming dark in age; frond firmly adhering to paper in drying.

Tinocladia crassa (SURINGAR) KYLIN Figs. 4–5

Phaeophyceenord. Chordar., 1940, p. 34, Figs. 17, 18; *Mesogloia crassa* SUR., Illustr. alg. jap. 1872, p. 85, Tab. 10–12; OKAM., Icon. jap. alg. I, 1907, p. 89, Tab. 20, Figs. 1–9; *Eudesme crassa* (SUR.) OKAM., Nippon Kaisoshi, 1936, p. 193, Tab. 100, Figs. 1–5; SEGAWA, Mar. alg. Susaki, 1935, p. 65.

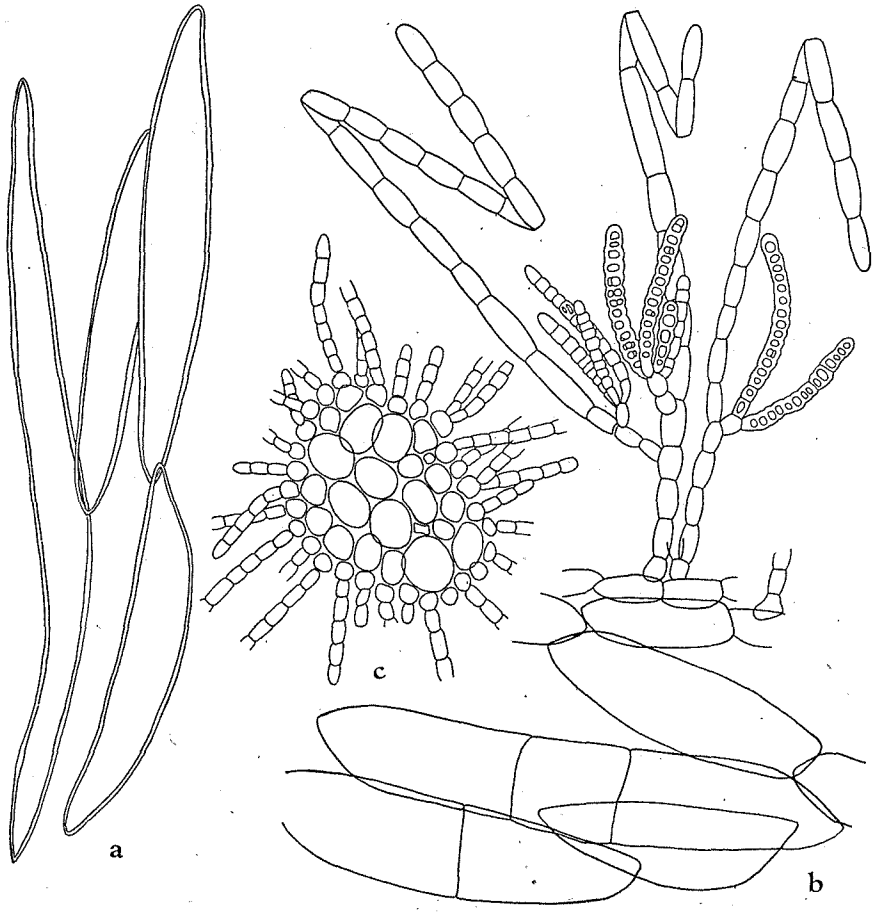

Fig. 3. *Nemacystus decipiens* (SUR.) KCK.

a. Medullary cells with thickening walls. × 67
b. Longitudinal section of the frond with plurilocular sporangia. × 200
c. Transverse section of the branch. × 200

Japanese name: *Futo-mozuku.*

Loc.: Misaki and Enoshima, Sagami Prov.; Toyohama, Onizaki, Ohno, and Asahi-mura, Owari Prov.; Iragozaki and Miyazaki, Mikawa Prov.; Hamajima, Shima Prov.; Kushimoto, Kii Prov.; Kobe, Settsu Prov.; Amakusa, Hizen Prov. Along the Pacific coasts from Iwaki Prov. to the southern part of Honshu, and also from Shikoku and Kyushu. Growing on rocks and stones between tide marks.

Frond solid, columnar, gelatinous, very lubricous, arising from a small disc with an evident principal axis, 10–30cm long, 1–3mm in diam., gradually tapering upwards, irregularly alternately branched in all directions, sometimes, however, provided with a few main branches, when the main branches become longer, the principal axis indistinct; branches scattered or dense, simple, patent, very often provided with sparse branchlets; branches and branchlets more or less tapering to the ends, obtuse at apices; central axis consisting of many central filaments, braided with thinner rhizoidal filaments 100–180μ long, 10μ broad; some apical cells of central filaments growing intercalary, issuing young hairs and assimilating filaments; subcortical layer developed between medullary layer and cortical ones of assimilating filaments, consisting of filaments repeatedly patently or somewhat dichotomously branched; cells of central filaments cylindrical, elongated, 100–180 μ long, 20–40 μ broad; assimilating filaments in the marginal portion of the frond entirely imbedded in gelatinous substance, simple or sparsely branched, more or less curved on the terminal portion, composed of lower cylindrical cells and upper swollen cells; hairs almost colourless, slender, arising from the bases of the assimilating filaments: unilocular sporangia elliptical, about $70 \times 50\,\mu$, borne on the basal cells

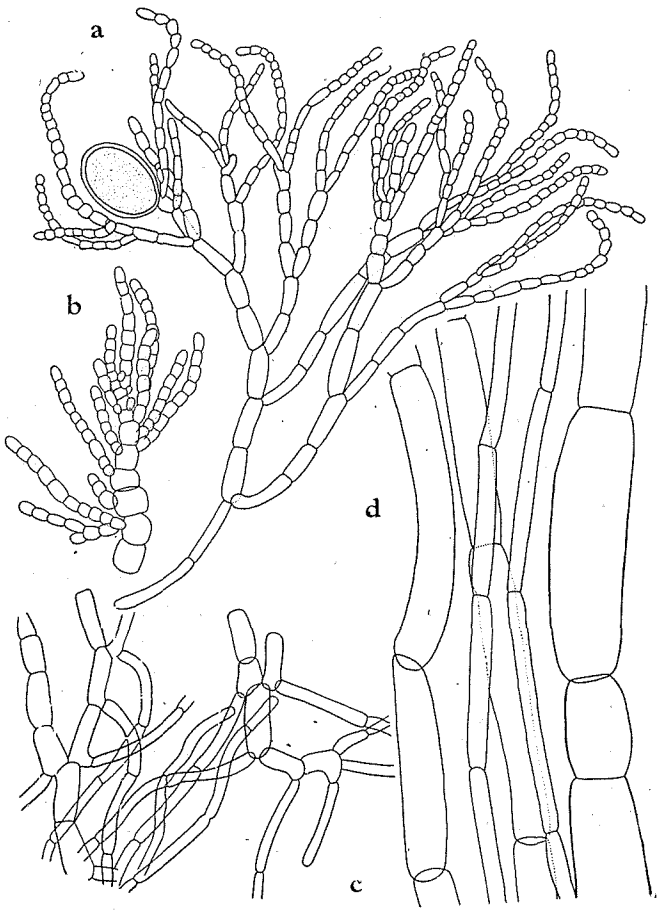

Fig. 4. *Tinocladia crassa* (SUR.) KYLIN
a. Assimilaitng filaments and unilocular sporangium. × 134
b. Growing point. × 300 c. A part of subcortex. × 166
d. Medullary cells. × 200

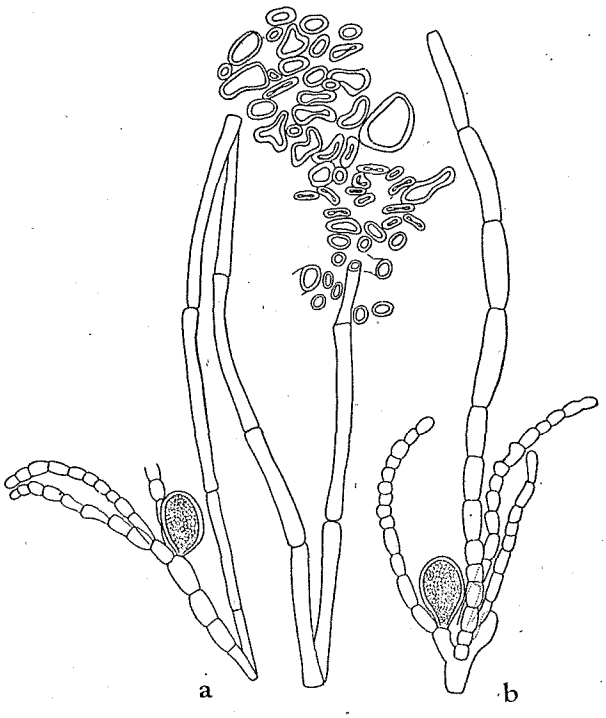

Fig. 5. *Tinocladia crassa* (SUR.) KYLIN

a. Transverse section of the frond with unilocular sporangium. × 200

b. Assimilating filaments, hair and unilocular sporangium. × 200

of the assimilating filaments; plurilocular sporangia unknown; colour yellowish brown, very often dark in age; frond adhering firmly to paper in drying.

The genus *Tinocladia* differs from the genera *Mesogloia* and *Eudesme* in the following respects.

Tinocladia has a sympodial central axis and an evident subcortex, whose cells are radiately arranged between the central axis and the exact assimilating filaments, but in the genus *Mesogloia* the central axis develops monopodially and such a subcortex is not found. In the genus *Eudesme* the subcortex is indistinct and the filaments of the medullary axis are easily longitudinally separated from each other.

The present alga differs from *Tinocladia australis* (HARV.) KYLIN in richer branching and in having narrower branches.

Acrothrix pacifica OKAMURA et YAMADA Fig. 6

YAMADA, Notes on some japan. alg. III, 1932, p. 113, pl. 24, Text-fig. 2; KYLIN, Phaeophyceenord. Chordariales, 1940, p. 45.

Japanese name: *Nise-mozuku.*

Loc.: Abashiri and Utoro, Kitami Prov.; Muroran, Iburi Prov.; Oshoro, Shiribeshi Prov.; Ehima, Mikawa Prov.; Wagu, Shima Prov.; Iyo Prov. Epiphytic on *Chorda Film* LAMOUR. below the low tide mark.

Frond epiphytic, attaching to the host by means of a small disc, growing trichothallically at the apex, cylindrical or slightly compressed, gelatinous, slimy,

very lubricous, solid in the upper portions of branches, hollow in the other portions, 10–20 cm. long, about 0.5 mm in diam., scarcely attaining 1 mm in diam. in the thickest portion, irregularly alternately and repeatedly divaricately branched in all directions without an evident principal axis or sometimes densely provided with many short branchlets, but in older individuals the short branchlets somewhat scattered, central axis possessing a single central filament, growing intercalarly at the apex, transformed into a single hair; apical hair long, colourless, hyaline, always found in the young individuals, but in age disappearing; primary assimilating filaments 2–7-celled, arising below the dividing zone of the growing point, composed of several roundish or ellipsoid cells; medullary layer formed by the division of the central filament and the basal cells of the primary assimilating filaments; subcortex composed of 2–4 cell layers developing by division of the subbasal cells of the primary assimilating filaments; secondary assimilating filaments generally unbranched, club-shaped, arising from the cortical cells, composed of 2–8 cells, 20–150 μ long, constricted at dissepiments, broadened towards the apex, generally somewhat curved; terminal cells of the assimilating filaments ellipsoid, ovate or obovate, 10–20 μ × 8–10 μ; upper cells of the secondary assimilating filaments swollen; hairs arising from the subbasal cells of the primary assimilating filaments and the basal cells of the secondary assimilating filaments, colourless, very long, consisting of cylindrical cells, however in age falling off; unilocular sporangia ovate or pyriform, 30–50 μ × 40–50 μ, sessile, borne on the basal cells of the

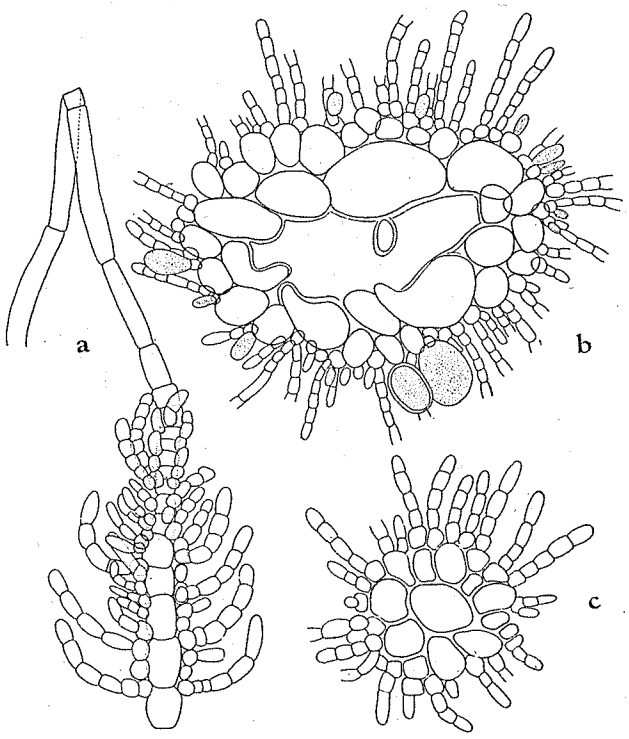

Fig. 6. *Acrothrix pacifica* OKAMURA et YAMADA
a. Growing point. × 300
b. Transverse section of the frond in the middle portion. × 140
c. Transverse section of the young frond. × 140

secondary assimilating filaments; plurilocular sporangia unknown; colour yellow or yellowish brown; frond adhering to paper in drying.

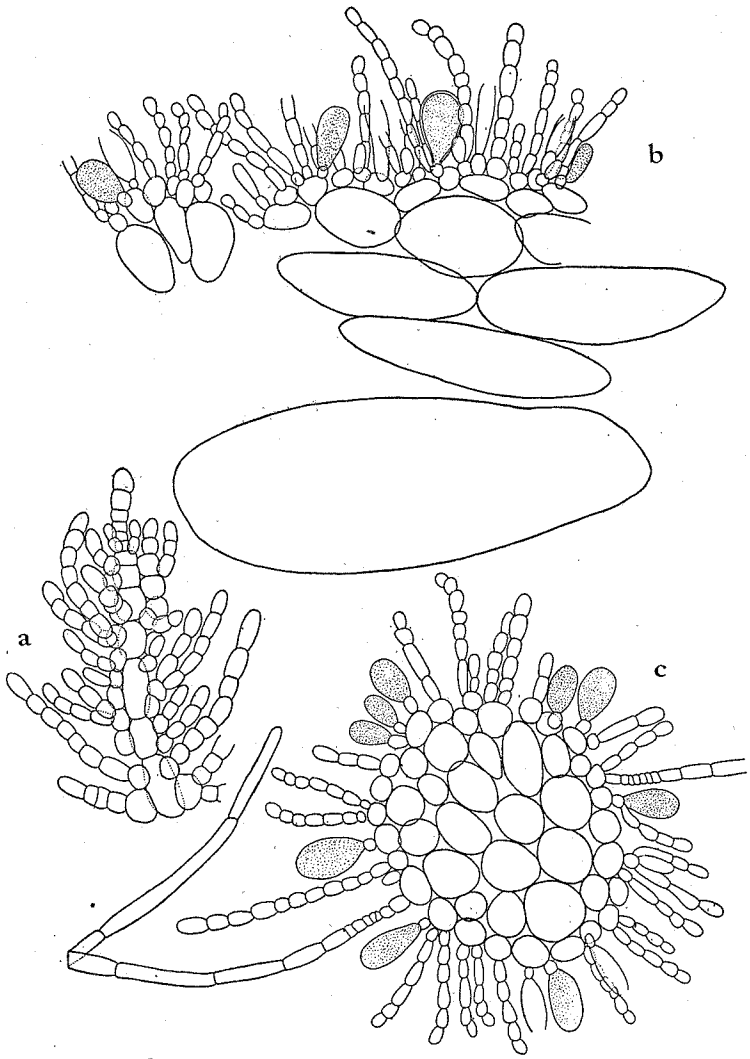

Fig. 7. *Acrothrix pacifica* OKAMURA et YAMADA f. *crassa* INAGAKI
a. Growing point in the older stage. × 300.
b. Longitudinal section of the frond with unilocular sporangia. × 200
c. Transverse section of the frond with hairs and unilocular sporangia. × 200

f. **crassa** INAGAKI f. nov. Fig 7

Japanese name: *Futo-nisemozuku* (nov.)

Loc.: Atsumi peninsula, Mikawa Prov. Growing on stones or epiphytic on *Chorda Filum* LAMX. below the low tide mark.

Frons 8–20 cm longa, diametro 1–1.5 mm superans ad partem principem, axe principale aliquantum distincto, irregulariter alternatim 2es vel 3es ramosa, ramis patentibus ramulosis sparsis ornata.

Frond 8–20 cm long, attaining 1–1.5 mm in diam. in main branches, 2–3 times irregularly alternately branched; principal axis very distinct; branches patent, provided with scattered branchlets.

The new forma is usually epiphytic on *Chorda Filum* LAMX, but sometimes it is found growing on stones.

The branching of this alga is irregularly alternate, sometimes divaricate and in the lower portion of the frond the branchlets are considerably scattering. The frond of this species is somewhat slimy to the touch, but the older frond often adheres slightly to paper in drying.

Sphaerotrichia divaricata (AGARDH) KYLIN Figs. 8–9

Phaeophyceenord. Chordariales, 1940, p. 38, Fig. 20, c, d; *Chordaria divaricata* J. AG. in HARV. Phyc. brit., Vol. 1, 1851, p. 53, Tab. 17; *Mesogloia divaricata* (AG.) KÜTZ., Tab. Phyc., Vol. 8, 1858, Tab. 8; KYLIN, Phaeophyceen schwed. Westk., 1947, p. 58, Figs. B, C.

Frond solitary or tufted, arising from a scutate disc, 5–30 cm high, filiform, somewhat cartilaginous, gelatinous, slippery, hollow, irregularly divaricately, laterally or alternately 1–4 times branched in all directions, provided with a traceable principal axis or divided into a few main branches without a principal axis, sometimes flexuous; branches 0.5–1 mm thick or more, generally thinner in the upper portion of the frond, standing off in the lower portion; upper branches very often spread, especially in younger stage quite densely provided with very short branchlets or rarely elongated ones; ultimate ramuli 1–2 cm long; subcortex composed of 2–3 layers of short irregular cells in younger portion, but in older portion composed of 4–8 layers; medullary layer almost tubular, consisting of large longitudinally elongated parenchymatous cells outside, constructed through the activity of monopodial central filaments; walls of the medullary cells generally thickened; intercalary transversal division occurring in the apical portion of the central axis; the growing point composed of a single or several large and spherical cells; assimilating filaments simple, comparatively short, consisting of 4–6 cells entirely enclosed in gelatinous substance; lower

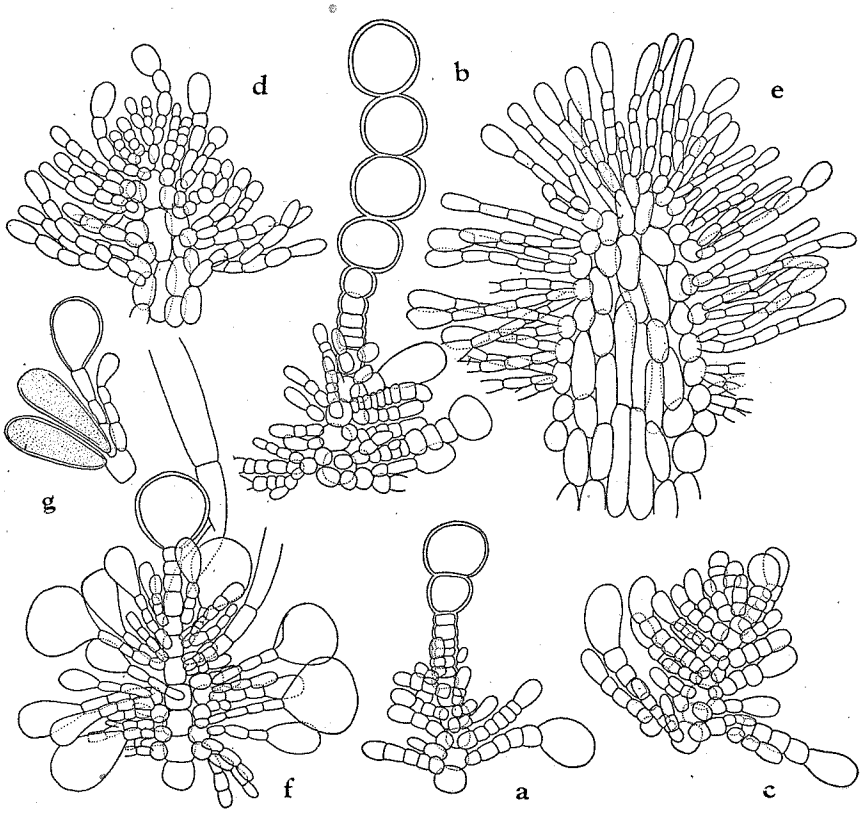

Fig. 8. *Sphaerotrichia divaricata* (AG.) KYLIN
a–e. f. *typica* INAGAKI. Series of developments of the growing points and the apical portions. × 300
f. f. *chordarioids* INAGAKI. Growing point. × 240
g. f. *gracilis* INAGAKI. Unilocular sporangia. × 240

cells cylindrical, 6–8 μ thick, two times longer than the diam.; terminal cells almost spherical or pyriform, 20–25 μ broad; hairs colourless, very long, abundant in the younger portion, but in age falling off; unilocular sporangia borne on the bases of the assimilating filaments, sessile, ovate or pyriform, 120–140 μ long, 25–35 μ broad; plurilocular sporangia unknown; colour brown or light brown, changeable to darkish brown when dried; frond adhering to paper in drying.

The present species answers very well to a sketch of the type specimen of GEPP's Chordaria firma once made by Dr. YAMADA at the British Museum

and also to sketches of the sections of the type specimen made by the kindness of Miss L. M. NEWTON and Miss F. L. B. BROWNE of the same Museum. Thus the writer was able to compare histologically the Japanese specimens with GEPP's type specimen and he recognizes that the latter is the same as *Sphaerotrichia divaricata* (AG.) KYLIN and also as *Chordaria firma* GEPP from our country identified by Dr. OKAMURA.

The present alga is exceedingly variable both in habit and substance being soft or hard according to the localities. Here the writer proposes to distinguish 4 forms of this species as follows:

f. typica INAGAKI f. nov. Figs. 8, a-e, 9

Sphaerotrichia divaricata (AGARDH) KYLIN, Phaeophyceenord. Chordariales, 1940, p. 38, Fig. 20, c, d; *Chordaria Cladosiphon* OKAMURA (non KÜTZING), Icon. Jap. Alg., Vol. III, 1915, p. 188, pl. 144, Figs. 1, 2, 4; pl. 145, Figs. 10–14 (in part); *Sphaerotrichia japonica* KYLIN, Phaeophyceenord. Chordariales, 1940, p. 38; Id., Phaeophyceen schwed. Westk., 1947, p. 58, Fig. B, C; *Chordaria firma* GEPP, Chinese Mar. Alg. (Journ. Bot. Vol. 42, 1904) p. 162, Tab. 460, Figs. 7, 8; OKAMURA, Icon. Jap. Alg., Vol. III, 1915, p. 183, pl. 143, Figs. 1–9, p. 145, Figs. 1–9.

Frons ca 20 cm alta, 1–1.5 mm crassa diametro saepe 2–3 mm ad partem crassissimam, axis principali evidenti vel in ramos paucos divisa, aliquanto densissime 3es raro 4es, vel in aetas sparse ramosa, ramis ultimis 1–2 cm vel plus longis ornata.

Japanese name: *Ishi-mozuku* (*Kusa-mozuku*).

Loc.: Tsushima Prov.; Higo Prov.; Igami, Nagato Prov.; Garo, Inaba Prov.; Ochi-gun, Dogo Prov.; Fukue, Mikawa Prov.; Toyohama and Himaka-Jima, Owari Prov.; Wajima, Noto Prov.; Suezaki and Motoyoshi, Rikuchu Prov.; Nou and Teradomari, Echigo Prov.; Iwai-zaki, Rikuzen Prov.; Ohma, Ishizaki and Fukaura, Mutsu Prov.; Okushiri and Hakodate, Oshima Prov.; Muroran, Iburi Prov.; Cape Soya, Kabuka and Utoro, Kitami Prov.; Oshoro, Shiwoya, Yoichi, Tomari and Otaru, Shiribeshi Prov.; Tomari (Kunashiri). Growing on stones, or epiphytic on *Sargassum confusum* C. Ag., and *Rhodomela larix* (TURN.) C. Ag. below the low tide mark.

Frond about 20 cm high, 1–1.5 mm, very often 2–3 mm in diam. in the thickest portion, provided with an evident principal axis or divided into a few main branches, rather densely, 3 times or rarely 4 times branched; ultimate branchlets 1–2 cm long or more, standing off in age.

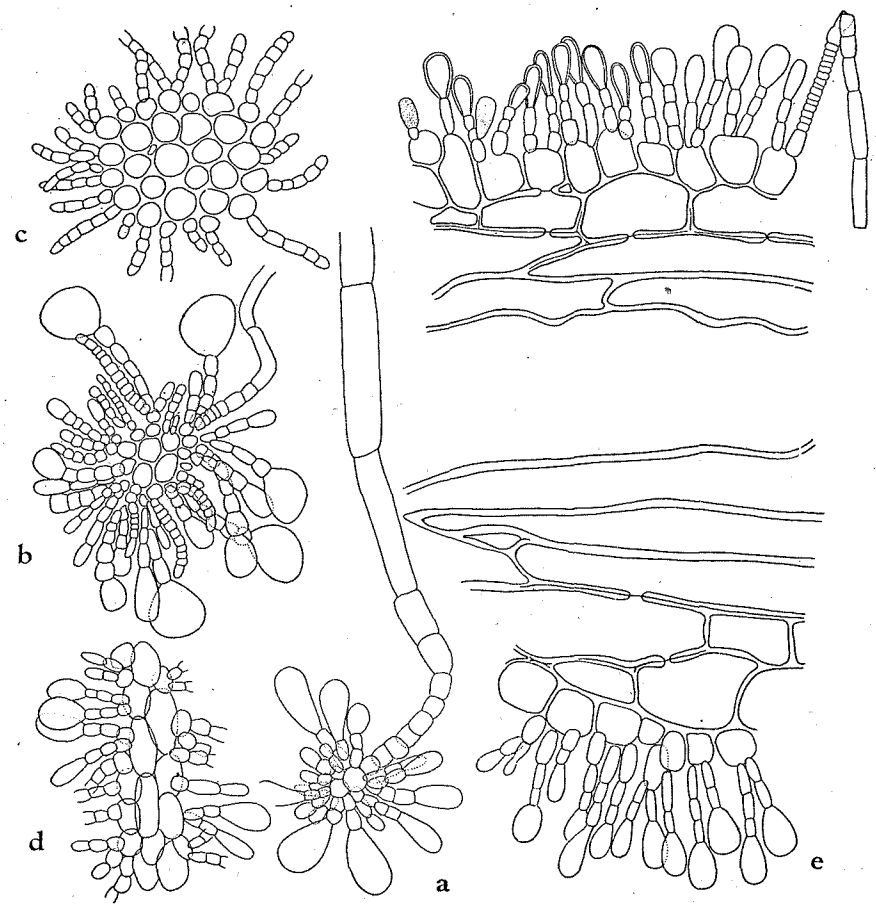

Fig. 9. *Sphaerotrichia divaricata* (AG.) KYLIN f. *typica* INAGAKI

a. Transverse section of the branchlet in the apical portion. × 200
b. Transverse section of the branchlet in the upper portion. × 200
c. Transverse section of the young frond. × 200
d. Longitudinal section of the branchlet in the upper portion. × 160
e. Longitudinal section of the frond with unilocular sporangia in the middle portion. × 134

f. epiphytica INAGAKI. f. nov.

Sphaerotrichia japonica KYLIN, Phaeophyceenord. Chordariales, 1940, p. 38; *Chordaria Cladosiphon* OKAM. (non KÜTZ.) Icon. Jap. Alg. Vol. III, 1951, p. 188, pl. 144, fig. 3 (in part).

Frons epiphytica, 5–15 cm alta, filiformis, gracilis aliquando gracillima, axi

principali evidenti, comparate dense 2–3es ramosa, ramis brevibus 1–10 mm longis ornata.

Japanese name: *Yase-mozuku.*

Loc.: Tomari and Shiwoya, Shiribeshi Prov.; Lake Saroma, Kitami Prov. Epiphytic on *Rhodomela subfusca* (WOODW.) C. AG., *Sargassum confusum* C. AG. and *Phyllospadix Scouleri* HOOK in shallow waters below the low tide mark.

Frond epiphytic, 5–15 cm long, filiform, slender, sometimes exceedingly slenderer, 2–3 times branched, provided with an evident principal axis and 1–10 mm long, comparatively densely issued short branchlets.

f. **chordarioides** (YAMADA) INAGAKI comb. nov. Fig. 8, f.

Sphaerotrichia chordarioides YAMADA, Alg. report Shiretoko Peninsula, Kitami Prov. 1944, p. 167 (in Japanese).

Frons cylindrica, 20–30 cm alta, diametro 1–2 mm, axi principali evidenti, 1–2 es sparse ramosa; ramis ca 10 cm longis ornata.

Japanese name: *Nise-nagamatsumo.*

Loc.: Utoro, Kitami Prov. Growing on stones below the low tide mark to the depth of about 2 fathoms.

Frond cylindrical, 20–30 cm high, 1–2 mm in diam. with an evident principal axis, 1–2 times sparsely branched; branches about 10 cm long.

f. **gracilis** (YAMADA) INAGAKI comb. nov. Fig. 8. g

Sphaerotrichia chordarioides YAMADA var. *gracilis* YAMADA, Alg. report Shiretoko Peninsula, Kitami Prov. 1944, p. 167 (in Japanese).

Frons filiformis, ca 20 cm alta, diam. ca 0.5 mm, axi principali evidenti, aliquantum dense 1–2es ramosa, ramis 5–10 cm longis ornata.

Japanese name: *Hosoba-no-nisenagamatsumo.*

Loc.: Cape Shiretoko, Kitami Prov. Growing on stones below the low tide mark to the depth of 2 fathoms.

Frond filiform, about 20 cm high, 0.5 mm in diam., with an evident principal axis somewhat densely, 1–2 times branched; branches very slender, 5–10 cm. long.

Sauvageaugloia ikomae (NARITA) INAGAKI comb. nov. Fig. 10.

Castagnea ikomae NARITA, Two new mar. alg. Japan Sea. 1936 (Bot. Mag. Tokyo, Vol. 50, No. 595), p 385, Figs. 1–2.

Japanese name: *Kuro-mozuku.*

Loc.: Oh-haneo, Inaba Prov. Growing on stones below the low tide mark.

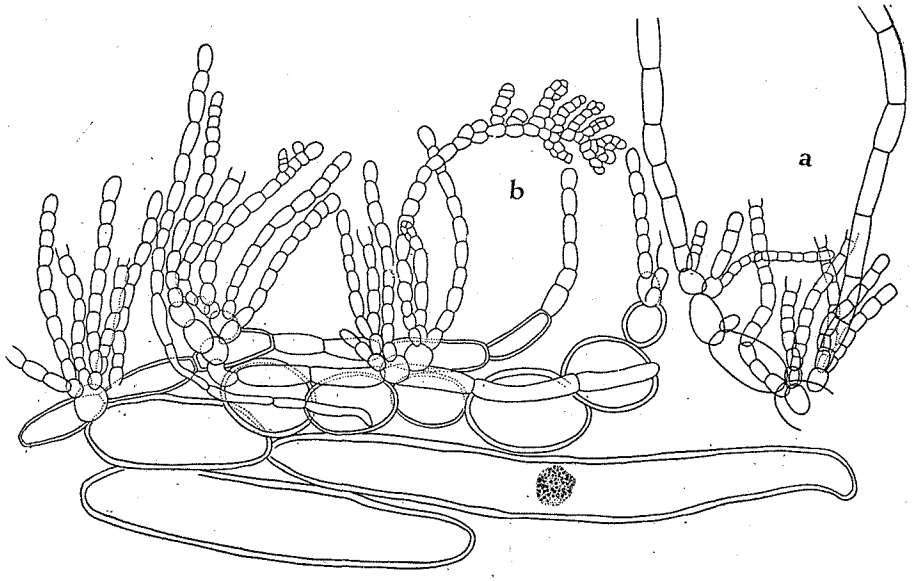

Fig. 10. *Sauvageaugloia ikomae* (NARITA) INAGAKI
a. Apical portion of the frond in age. × 240
b. Longitudinal section of the frond with plurilocular sporangia. × 200

Frond cylindrical, 40–50 cm long, 2–4 mm in diam., caespitose, erect on a small disc, gelatinous or gelatinoso-coriaceous, simple or sometimes irregularly dichotomously branched, obtuse at the apex, scarcely tapering downwards; inner medullary layer hollow in the middle portion, composed of cells extremely elongated longitudinally, the cells 25–50 μ thick, 200–300 μ long, loosely arranged; outer medullary layer composed of ovate or spherical cells, the cells 40–70 μ long, 30–40 μ thick; walls of medullary cells thick as well as subcortical ones; subcortical cells somewhat smaller, spherical, ovate or elongated, very often transformed into rhizoidal filaments creeping on the medullary layer; central axis composed of many sympodial central filaments; assimilating filaments simple, erect or slightly curved, constricted at the joints in the apical portion, but scarcely so in the lower portion, arising tuft-like or dichotomously from the cortical cells, composed of 7–13, sometimes 19 cells, the cells 10–15 μ long, 6–9 μ in diam., arranged in a single row; hairs colourless, very long, consisting of many cylindrical cells, arising from the basal cells of the assimilating filaments; unilocular sporangia unknown; plurilocular sporangia subpinnately branched, transformed from the upper cells of the assimilating filaments; colour brown; frond adhering to paper in drying.

The present alga is very closely related to *Cladosiphon filum* (HARV.) KYLIN, from which it differs in the shorter cells of the assimilating filaments and the subpinnate plurilocular sporangia.