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Notes on Some Japanese Algae III.

By

YUKIO YAMADA

With Plates XXI –XXV.

Monostroma angicava Kjellman

Pl. XXI and XXII.

Alg. of Arctic sea (1883) p. 297, Tab. 29.

From February to April the present species of *Monostroma* is found very commonly and in abundance in Oshoro Bay, where the Biological Station of our University is located. In every characteristic our plant agrees well with the description of *Monostroma angicava* given by Kjellman l.c. At the end of last March I found many specimens of this species producing gametes, and made observation of their conjugation. In the after-noon of the 24th of March, material was collected which was rinsed carefully with clean sea water, and each specimen kept in the glass vats separately. Soon after being placed in vats, all specimens discharged numerous gametes from the yellow upper margin of the frond. They showed positive phototaxis and gathered densely at the side of vats which faced the light. They were all discharged at the same time, making an appearance like a small yellow cloud. I could distinguish two kinds of individuals among the specimens, one discharging smaller gametes, male, while the other to all outer appearances the same were undoubtedly female. The male gametes are long pear shaped, pale green, about $5-6\mu \times 2-3\mu$, provided with two cilia of equal length at the narrow end of the body, one chromatophore and one eye spot. The female ones are also pear shaped, but more rounded than the male ones, provided also with two cilia at the narrow end and one chromatophore and an eye spot. Their size is about $6-7\mu \times 4-5.5\mu$. The cilia of both kinds of gamets are about two times as long as the length of the body itself and because of this, the gametes make very vivid mouvements, especially soon after they have been discharged. In expectation of observing their conjugation, I mixed both kinds of gametes on glass slides under the microscope, but I did not succeed in observing conjugation that night. The

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next morning, however, their conjugation was very easily observed by the same method, but I could not determine what was the cause of the absence of conjugation in the night. They always attach side by side, just like the case of *Enteromorpha intestinalis* reported by Kylin,[1] and I have never observed attachment in any other way. The paired gametes enter into the resting stage after moving about rapidly and irregularly and then came to rest sorrounded by a membrane. Their further development has not been followed. I also mixed gametes of the same kind from one and the same individual or different individuals, but of course no conjugation took place. Whether they develope parthenogenetically or not I have not been able to determine. At any rate it can be said that we have here an evident case of heterogamy. At this time over a hundred specimens were collected, but I could not find any specimen which produced zoospores.

In the Ulvaceae, Hartmann[2] reported in *Enteromorpha* isogamy, while recently heterogamy has been reported by Kylin in *Enteromopha intestinalis*. Carter[3] and Föyn[4] also gave accounts concerning the Ulvaceae in which they stated the dioeciousness of *Monostroma latissima* and *Ulva lactuca* respectively, both recognizing the great variability in the size of gametes. So, we can see that the size of gametes is very unstable here in the Ulvaceae, and the species in question gives another case of heterogamy.

Among specimens there are several ones which are to be referred to as *M. cylindraceum* Kjellm. Both cylindrical and non cylindrical forms are found close together in the same locality, and there are many transitional forms connecting both species.

Vaucheria constricta sp. nov.

Text-fig. 1.

Species halophila. Planta caespitosa, per filamenta rhizoidea adfixa. Frons 1–2 cm alta, 240–300 μ crassa, simplex vel dichotome ramosa,

1) Ueber Heterogamie bei *Enteromorpha intestinalis*. Ber. d. deut. Bot. Ges. Bd. 48 (1930) p. 458.

2) Untersuchungen über die Sexualität und Entwicklung von Algen III. Ueber die Sexualität und den Generationswechsel von *Chaetomorpha* und *Enteromorpha*. Ber. d. deut. Bot. Ges. Bd. 47 (1929) p. 490.

3) Untersuchungen über die Sexualität und Entwicklung von Algen IV. Vorläufige Mitteilung über die Sexualität und den Generationswechsel von *Cladophora* und *Ulva*. L. c. p. 503.

4) An investigation into the cytology and biology of the Ulvaceae. Ann. of Bot. Vol. 40 (1926) p. 665.

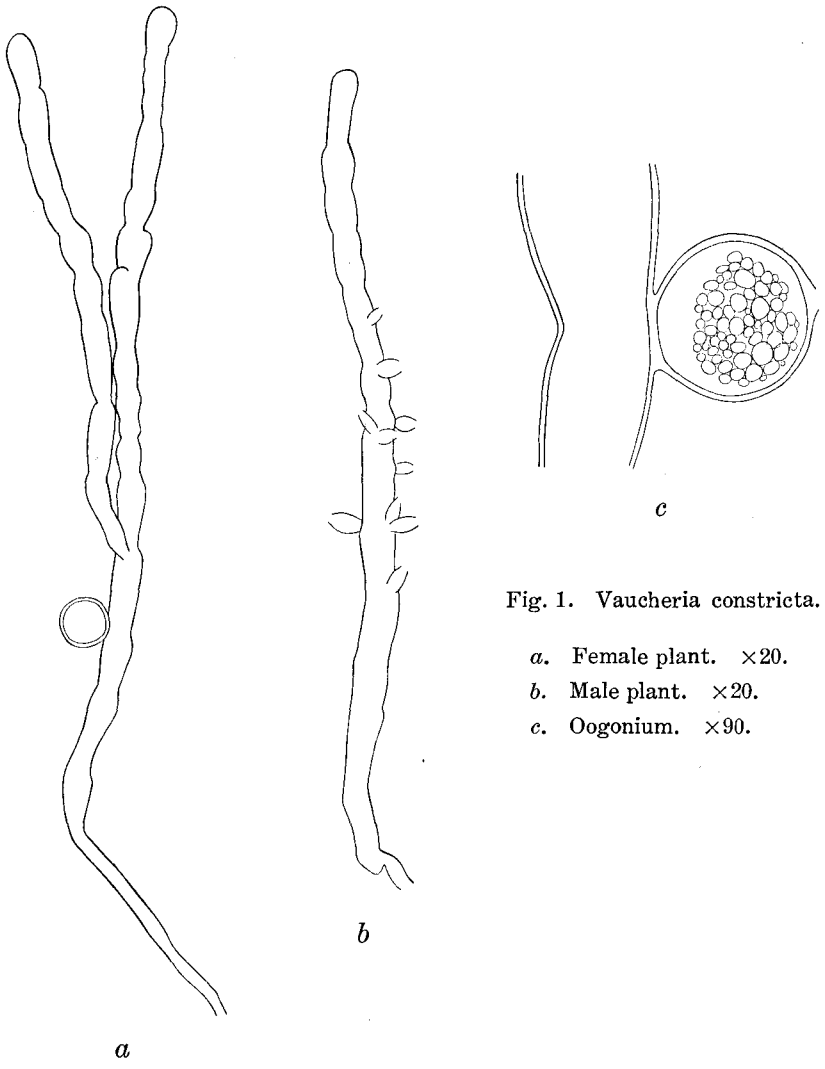


Fig. 1. Vaucheria constricta.

a. Female plant. ×20.
b. Male plant. ×20.
c. Oogonium. ×90.

ramis fastigiatis, hic illic constrictis. Filamenta rhizoidea simplicia vel raro ramosa. Antheridia sessilia, solitaria vel 2–3 aggregata, ovata et erecta, 170–190 μ longa, 70–110 μ lata. Oogonia nunquam terminalia, sessilia, sphaerica, ad apicem ostioli ornata, ca. 240 μ crassa, fulvesentia.

Hab. Riu-kiu. (S. Inoh).

Plants caespitose and attached to the substratum by means of rhizoids (light purple in colour) which come out of the basal part of the frond. The frond is 1–2 cm high and 240–300 μ thick, simple or ramified dichotomously once or twice or rarely three times, upper segments being fastigiate. In every part of the frond there are many light constrictions at the base of branches as well as along parts of the segments, but they are not accompanied with cell wall thickenings. Rhizoids simple or rarely ramified. Antheridia are sessile without an empty cell between them and the frond, solitarly or crowded 2–3 together along the frond and never terminal. They are ovate and straight, 170–190 μ long, 70–100 μ wide. Oogonia sessile and solitarly, occupying the side of segments, spherical, provided with a small ostiole at the top, around 240 μ in diameter, when fertilized they are filled with much oily substance and reddish yellow in colour.

The present species shows some likeness in habit to *Dichotomosiphon*, the frond being composed of the rhizoidal part and the erect dichotomous filaments, and having many constrictions at the base of the branches as well as intermediately, and the oospores being reddish brown in colour. On the other hand, however, there are some differences of great importance between the present species and *D. tuberosus*, the best known species of that genus. In *Vaucheria constricta* oogonia are always on the side of filaments, never being terminal, and at constrictions of filaments there is no thickening of the cell wall.

This is for the first time that a marine species of *Vaucheria* has been reported from Japan.

Striaria attenuata (Agardh) Greville

Pl. XXIII.

Cryptg. Flor. (1830), Syn. p. 44, Tab. 288; Harvey, Phyc. Brit. Vol. 1 (1846), pl. 25; De Toni, Syll. Alg. Vol. 3 (1895), p. 471.

Hab. Wagu, Shima Prov. (K. Inagaki).

It is very interesting to add the present species to our algal list. In spite of the fact that this species is known very commonly from the Atlantic Ocean, and also from the Mediterranean Sea, its occurrence in the Pacific Ocean is very vague. Prof. Setchell[1] seems to doubt its oc-

1) The marine algae of the Pacific coast of North America III. Melanophyceae. Univ. Calif. Pub. Bot. Vol. 8 (1925) p. 529.

currence on the Pacific coast of North America. The Japanese locality for this species is quite isolated. In my herbarium I have compared our specimens with those from Brest, France, which were kindly given me by Dr. G. Hamel in Paris, and also with those collected by myself at Saint-Servan, France, but I have not been able to find sufficient characteristics to separate them from each other.

Acrothrix pacifica Okamura et Yamada sp. nov.

Pl. XXIV. Text-fig. 2.

Frons epiphytica, 10–15 cm longa, cylindrica vel leviter compressa, diametro vix 1 mm superans ad partem crassissimam, iterum atque iterum irregulariter alternatim ramosa; ramis ramulosis brevibus ornatis. Filamenta assimulatoris e 3–8 cellulis composita, ad dissepimenta constricta, saepe curvata, sursum crassioria, cellula terminale ellipsoidea vel ovata vel obovata, $10-23\,\mu \times 8-15\,\mu$. Pili sparsi, ca $10\,\mu$ crassi. Sporangia unilocularia ovata vel piriformia, $30-40\,\mu \times 27-30\,\mu$, ad cellulam basalem filamenti assimulationis sessilia.

Hab. Wagu, Shima Prov. (K. Inagaki).

Frond epiphytic on *Chorda Filum* Lamx., 10–15 cm high, cylindrical or slightly compressed, scarcely attaining 1 mm. in diameter in the thickest portion, irregularly alternately and repeatedly much branched; branches provided with short branchelets. Assimilating filaments composed of 3–8 cells, constricted at dissepiments, broadened upwards, often slightly curved, the terminal cells being ellipsoid, ovate or obovate, $10-23\,\mu \times 8-15\,\mu$, hairs sparsed, around $10\,\mu$ thick. Unilocular sporangia ovate or piriform, $30-40\,\mu \times 27-30\,\mu$, sessile on a basal cell of the assimilating filaments.

The new species clearly shows the generic characteristics of *Acrothrix* having trichothallic growth at the apex of the frond and the same structure of the frond as described by Kylin in *Acrothrix gracilis* Kylin.[1] But the branching of our plant is much denser and more irregular than in the European species as well as the Taylor's species from New England,[2] when we compare our specimens with the photographs of their species.

The occurrence of the present species in Japanese waters is of some interest from the standpoint of distribution, because the genus

1) Studien über die Algenflora der schwedischen Westküste (1907) p. 93.
2) A species of *Acrothrix* on the Massachusetts coast. Amer. Journ. of Bot. Vol. 15 (1928) p. 577.

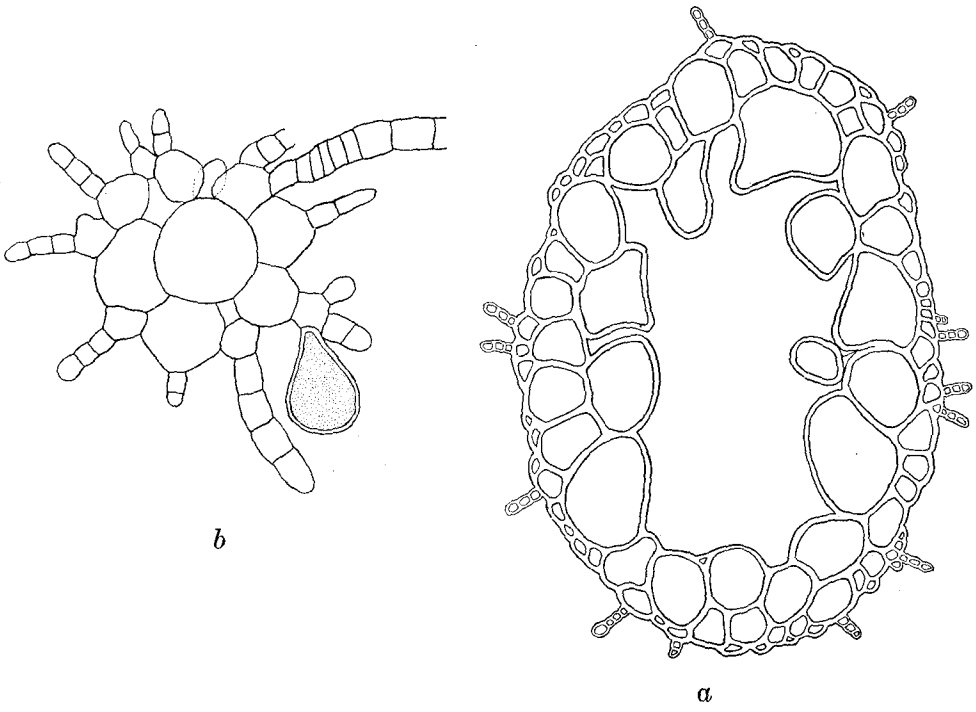


Fig. 2. Acrothrix pacifica.
a. Transverse section of the frond in the middle portion. ×140.
b. Transverse section of the frond near the top. ×420.

Acrothrix has been recorded only from the coasts of the Atlantic Ocean, namely from Bohuslan, Sweden on the European side, and from Woods Hole, New England on the American side.

Rhodochorton affine sp. nov.

Text-fig. 3.

Planta ex filamentis erectis et filamentis rhizoideis basalibus constructa. Filamenta erecta 3–4 mm alta, irregulariter ramosa, ramulis saepe secundis, cellulis cylindricis, ad segmenta principalia ca. 16 μ crassis, 4–6-plo diametro longioribus ; cellulis apicalibus leviter inflatis apice obtusissimis. Filamenta rhizoidea inter utriculis hospitis valde expansa, ramosa, 18–27 μ crassa. Chromatophrum parietale, re-

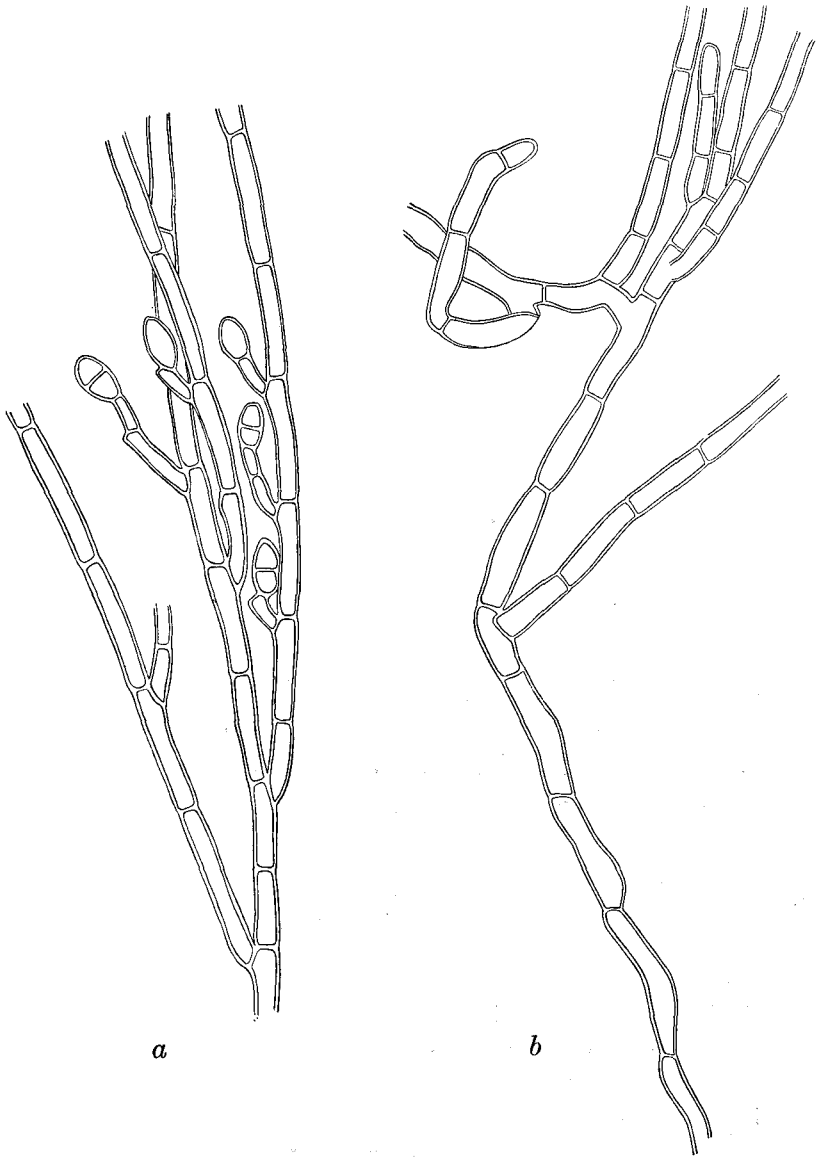


Fig. 3. Rhodochorton affine.

a. Part of frond with sporangia. ×220.

b. Basis of the plant. ×190.

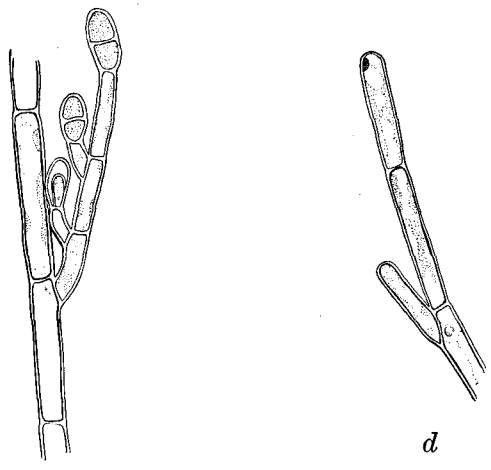


Fig. 3. Rhodochorton affine.

c. Part of frond with sporangia. ×220.
d. Upper end of erect filament. ×220.

ticulatum vel teniatum. Tetrasporangia in ramulo terminalia vel lateralia, ellipsoidea, 30–40 μ longa, 15–20 μ crassa.

Hab. Iragasaki, Owari Prov. (K. Inagaki).

Plants consisting of two parts: erect free assimilating filaments and nearly horizontally creeping filaments growing between the utricles of the host. The free assimilating filaments are about 3 – 4 mm long, arising from the endophytic rhizoid, irregularly branched, branchlets often secund; cells cylindrical, decreasing in size from the base of the filament to the apex, around 16 μ in diameter in the main filaments, 4–6 times as long as diameter; apical cells slightly inflated at the end, obtuse at the apex. Endophytic filaments exceedingly developed, branched, 18–27 μ thick. Chromatophores parietal, reticulate or band-shaped; reproduction by tetraspores, sporangia terminal and lateral on the branchlets, elliptical, 30–40 μ by 15–20 μ.

In habit, *Rhodochorton affine* shows a strong resemblance to *R. rhizoideum* Drew[1] according to the description and figures, and both

1) A revision of the genera *Chantransia*, *Rhodochorton* and *Acrochaetium*. Univ. Calif. Pub. Bot. Vol. 14 (1928) p. 182, pl. 42, Fig. 42–44.

species send the endophytic filaments between the utricles of *Codium* which develope in horizontal direction. Reproductive organ, however, is quite different, the American species having monospores, while ours tetraspores. At one time I doubted if the Japanese species was to be considered as a terasporic form of the American species, but in our species branching is denser than in the other, and the terminal cells of assimilating filaments are slightly inflated.

Gloiopeltis complanata (Harvey) comb. nov.

Syn. *Endocladia complanata* Harvey (non Okamura), Char. of new alg. from Jap. (1854) p. 332.

Syn. *Endotrichia cervicornis* Suringar, Alg. Jap. (1870) p. 34, Tab. 21–22.

Syn. *Gloiopeltis cervicornis* Schmitz, Syst. Uebers. der bisher bekannten Gattungen der Florid. (1889) p. 18; Okamura, Icones of Jap. Alg. vol. 2 (1912) p. 157, pl. 94.

? Syn. *Caulacanthus compressus* Harvey, 1. c. p. 331.

In 1902 Dr. Okamura[1] referred a small plant to which he gave the Japanese name "Iso-danzu" to *Endocladia complanata* Harv. The material on which Harvey's description was based, was collected in the Loo-choo Islands by C. Wright. In his determination, Dr. Okamura could not compare his material with any authentic specimen other than the very short diagnosis of Harvey l.c. Since then "Iso-danzu" has been known to us as *Endocladia complanata* Harv. In the Farlow Herbarium in Cambridge, Mass. and in the Harvey's collection of algae in Dublin, I encountered some specimens named *Endocladia complanata* Harv. which were brought from the type locality, but in structure as well as in habit, they coincide very well with specimens which we call *Gloiopeltis cervicornis* (Suring.) Schm. figured very beautifully in Suringar's Alg. Jap, Plates 21–22 under *Endotrichia cervicornis* Suring.

Together with *Endocladia complanata* Harv. Harvey gave the diagnosis of *Caulacanthus compressus* Harv. which is also a very short one. On the sheet on which the type specimen of this latter species is mounted, there is pasted an annotation label of Prof. K. Yendo who visited Dublin some sixteen years earlier than I did, which reads as follows:

1) Nippon Sorui Meii 1st. Edit. (1902) p. 23.

" The tetrasporangia of this plant are cruciately divided. This is not a generic character of *Caulacanthus*. Although I could not find cystocarps in the specimens, I am strongly tempted to identify this plant with

Gloiopeltis cervicornis Suringar. K. Yendo, 24, Nov. 1913."

In habit the type specimen of this species in Dublin as well as other ones kept in the Farlow Herbarium are slenderer than those of specimens which we call *Gloiopeltis cervicornis* Schm. but in general they are very much alike, so Prof. Yendo's supposition seems to be very probable. However one thing which makes me harbour a slight doubt in putting together *C. compressus* Harv. and *G. complanata* is that the frond of the former is exeedingly soft and decays very easily after being put into fresh water as has also been mentioned by Me. Weber van Bosse.[1)]

Chrysymenia Wrightii (Harvey) comb. nov.

Pl. XXV. Text-fig. 4.

Syn. *Halosaccion Wrightii* Harvey, Char. of new alg. (1859), p. 332. J. Agardh, Epicr. (1876), p. 260; De Toni, Sylloge Alg. Vol. 4 (1897) p. 608.

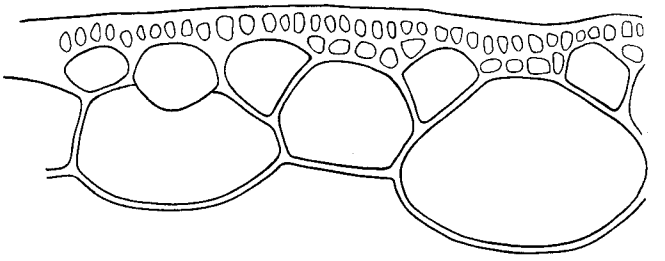
Syn. *Chylocladia Wrightii* Okamura, Nippon Sorui Meii (1916), p. 51.

Syn. *Chrysymenia Enteromorpha* Yendo (non Harvey) Notes on alg. new to Jap. VI. (Tokyo Bot. Mag. vol. 31, 1917) p. 85.

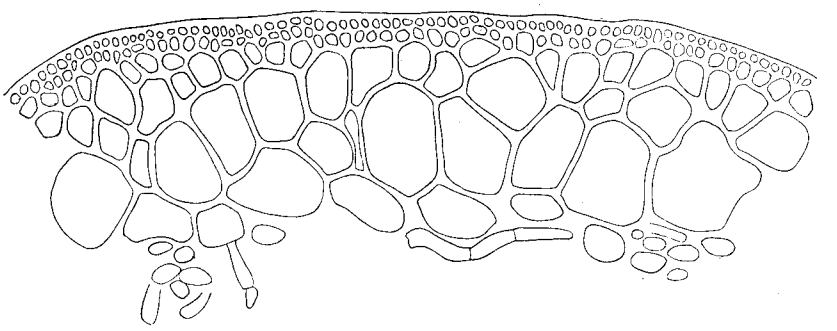
The length of this plant varies usually between 10 cm and 30 cm but it attains rarely 50 cm. In such a large plant the frond becomes nearly 7 mm thick in the lower part. Throughout the whole length the frond is cylindrical, the inside of it making always a central cavity and there are no diaphragms at all. The branching is rather irregular, branches being issued from every side and alternately and this mode of ramification is repeated, so that the whole plant is of a paniculate appearance. Branches as well branchlets are constricted at the base and attenuate toward the end.

Anatomically, near the end of branchlets the frond consists of 1–2 layers of large cells inside and 1–3 layers of small coloured cells. Some

1) Liste des algues de Siboga, II. (1921) p. 222.



a



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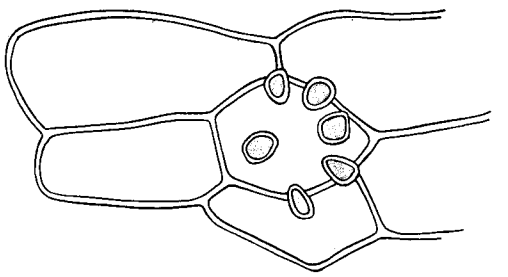


c

Fig. 4. Chrysymenia Wrightii.

a. Longitudinal section of a branchlet near the end. ×450.
b. Transverse section of a brach. ×150.
c. Large cells facing the cavity with gland cells. ×230.

innermost large cells facing the central cavity bear gland cells which are pear shaped and grouped 4–6 or more. In the lower parts of the frond the cell layers making up the wall of the frond becomes thicker and some hyphae-like filaments appear on the cell wall of the innermost large cells. They are running rather irregularly and ramify freely, but in the older parts of the frond they are arranged chiefly longitudinally. Cystocarps are scattered in abundance on branches as well as branchlets, hemisphaerically elevated.

As Yendo notes, the type specimens of *Halosaccion Wrightii* Harv. kept in Dublin are sterile, but comparing our specimens collected by us at Hakodate, the type locality, with them, it seems to be quite safe that they represent one and the same species. This plant seems to grow rather commonly on our coast, from Hokkaidō to the middle part of Honshū on the Pacific side as well as in the Japan sea.

Having made comparative study of our specimens with the authentic specimens of *Chrysymenia Enteromorpha* Harv. Yendo came to the conclusion that both those plants are the same not only generically but also specifically.

I also had the opportunity to see the specimens of *C. Enteromorpha* Harv. in Dublin ; there are only two specimens collected at Key West. Both those specimens are much thicker than our Japanese specimens and at that time I was rather doubtful of Yendo's amalgamation ; they are really very different in habit. Recently I received a copy of 'Die Florideenordnung Rhodymeniales' by Prof. H. Kylin in which the author makes revision on the Rhodymeniales which is very valuable and useful especially for those who are not familiar with the authentic specimens of old species. According to Kylin the old *Chrysymenia* is divided mainly into two genera vid. *Chrysymenia* in a narrow sense and *Cryptarachne* which was elevated to the generic rank by him in order to receive those species which are different chiefly from those of *Chrysymenia* in two respects, namely a flat frond, so that it is not so sack like as in *Chrysymenia*, and the presence of rhizoidal cells inside the cavity between two innermost layers.

Coming back to the Japanese plant, it must be referred at least, to the *Chrysymenia* in the wide sense coinciding with the opinion of Yendo. However in structure it is a little complicated, the frond being cylindrical, nearly sack like, but showing rather rich amount of hyphae-like filaments in the cavity, especially in the lower parts of the frond, as above mentioned. Neither the original description of Harvey on *C. Enteromorpha* from Key West, nor the very precise one of Börgesen

on the West Indian specimens show the presence of the hyphae-like filaments in the cavity inside the frond. When we consider this matter in accompaniment with diversity of superficial characteristics and the very widely separated localities of *C. Enteromorpha* Harv. and the Japanese plant, it seems to me to be far more reasonable to consider them as two different species, than as one.

Lomentaria lubrica (Yendo) comb. nov.

Syn. *Chylocladia lubrica* Yendo, Nov. alg. Jap. Decas I–III. p. 6 (Bot. Mag. Tokyo, Vol. 34, 1920); Yamada, Mar. alg. of Mutsu Bay, II., p. 31, fig. 14 (Sci. rep. Tohoku Imp. Univ. 4 ser. Vol. 3, 1928).

The frond of this plant is always tube like and there is no diaphragm. Long thin rhizodal cells run longitudinally inside the cavity of the frond, and some small gland cells are also met with. Tetraspores are loosely grouped, protruding into the cavity of the frond.

Yendo did not touch on the anatomy of the frond of this plant. Having re-examined my specimens from Mutsu Bay I determined it as *Lomentaria* instead of *Chylocladia*, from the characteristics above mentioned.

Pleonosporium pusillum sp. nov.

Text-fig. 5.

Frons parva, 0.5 cm alta, ecorticata, distiche pinnatim ramosa, flexuosa, ad basin 80–100μ crassa; pinnis simplicibus elongatis ad dissepimentis leviter constrictis, e cellulis cylindricis diametro 1.5–2, raro 3-plo longioribus constitutis, apice obtusis. Sporangia sporas multas contentia, sphaerica, sessilia, saepe in latere superiore ramorum seriata.

Hab. Riu-kiu (S. Inoh).

As the above diagnosis shows, the present plant is very small and delicate, growing among leaves of *Amansia glomerata* together with *Griffithsia* sp. The plants are aespitose, every individual emitting rhizoidal filaments at the base for fixing themselves. They scarcely exceed five millimeters in height, and are ramified distichously pinnately; in the upper part of the frond every cell of the rachis emitting a branch alternately and thus the rachis becoming flexuous. Cells constituting the rachis are completely nude, cylindrical in shape, about

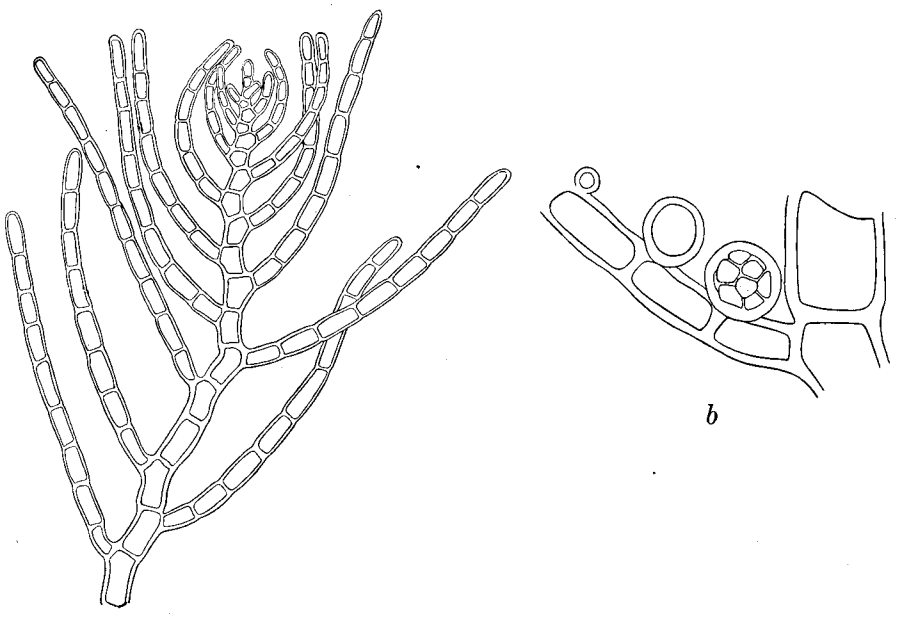


Fig. 5. Pleonosporium pusillum.

a. Upper part of the frond. ×40. *b*. A branch with sporangia. ×70.

80–100μ thick near the base of the frond tapering very gradually upwards, and the width of cells near the end of branches is about 20–25μ. They are 1.5–2, rarely 3 times as long as the diameter. Branches are usually simple, and obtuse at the apex, and very slightly constricted at the dissepiments of the cells. I have not found any branch bearing ramuli. Chromatophores are parietal, and irregularly reticulate. As to the reproductive organs, the present specimens bear only sporangia which contain about 12 spores. The sporangia are spherical, the diameter being about 50–70μ, and they are produced on the branches seriately, often in the lower parts of the frond, and they are always sessile.

Laingia pacifica (Yamada) comb. nov.

Syn. *Pseudophycodrys pacifica* Yamada, Notes on some Jap. alg. I. (1930) p. 32, pl. II, fig. 1

Syn. *Delesseria crassifolia* Okamura (non Ruprecht), Icones of Jap. alg. vol. 4, p. 72, pl. 168.

The cystocarps of the present plant which occur on the small proliferations of the leaves made me doubtful as to its taxonomical position, and not being well informed of the precise condition of cystocarps in *Pseudophycodrys*, I wrote to Prof. H. Kylin in Lund, asking for information. He was kind enough to examine our plant and informed me that it is related most nearly to *Laingia Hookeri* Kylin from Australia.

Monostroma angicava Kjellm.

Slightly reduced.

Plate XXII.

Monostroma angicava Kjellm.

f. *cylindraceum.* × 1.

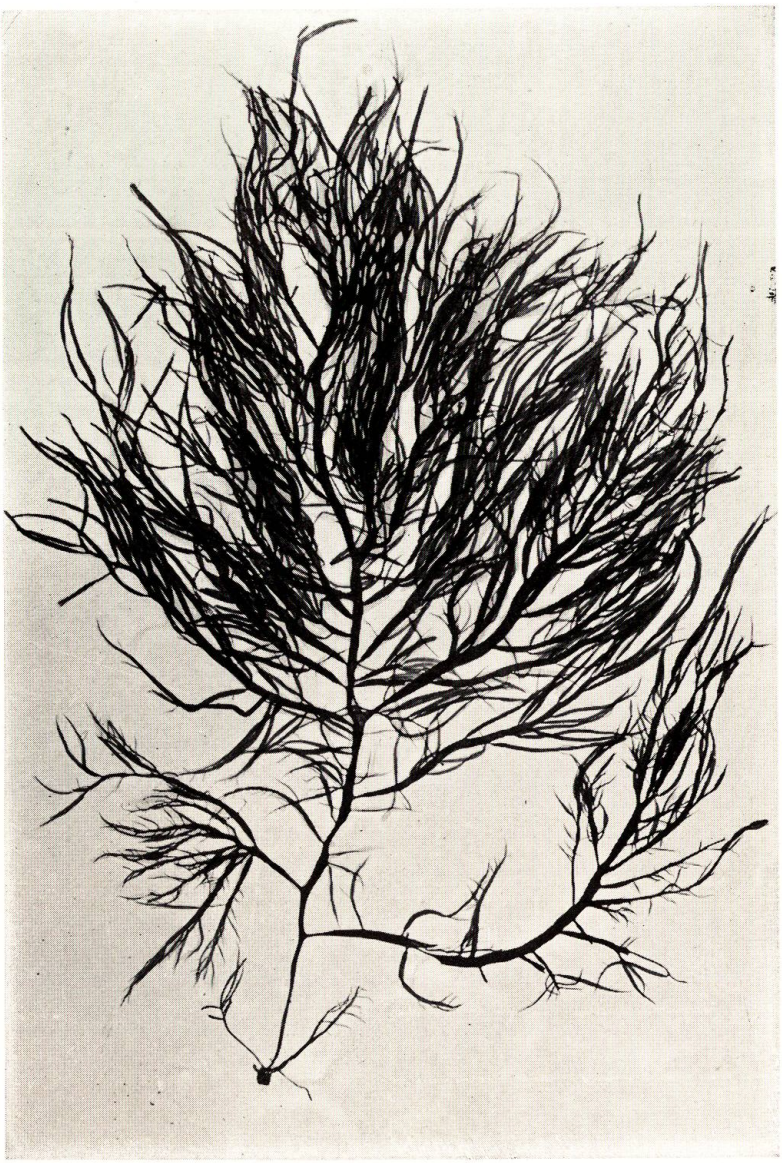
Striaria attenuata (*Ag.*) *Grev.*

Slightly reduced.

Acrothrix pacifica Okam. et Yam.

The type specimen. × 1.

Plate XXV.



Chrysymenia Wrightii (*Harv.*)

×ca. 2/5