The Species of Liagora from Japan

By

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With Plates I–XV.

It has been nearly impossible accurately to determine the species of *Liagora* from the coasts of the country though there are about 10 reported species, because many old species of this genus are known only from short diagnoses, almost all old authors having given no description of anatomical details.

For some years the present writer has been paying special attention to this genus and trying to collect material from as many localities as possible, and he has studied them using mainly those specimens preserved in alcoholic or formalin solutions. Very fortunately in the beginning of last year an opportunity was afforded to the writer to visit again the herbarium of the University of California in Berkeley, where Prof. SETCHELL allowed the study of the rich material there. He also showed photographs of the type specimens of many old species, and even his very valuable notes which he had taken in several herbaria in Europe. Thanks to these facilities the present writer could obtain some ideas on *Liagora,* and consequently could determine at least 14 species from the Japanese coast, which will be enumerated in the following pages.

Before going further an expression of sincerest thanks is due to Prof. W. A. SETCHELL of the University of California, and also to President K. TAKAOKA, and to all my collegues of the Faculty of Science of our University who gave the writer the opportunity of going abroad, and to Mr. T. TANAKA the writer expresses here his best thanks for his assistance, especially in making many drawings.

The expense incurred in collecting a part of the material used for the present study was covered by a grant from the Japan Society for the Promotion of Scientific Research, for which the writer expresses here his best thanks.

Scientific Papers of the Institute of Algological Research, Faculty of Science, Hokkaido Imperial University, Vol. II, No. 1, 1938.

Some Remarks on the Anatomical Details of Liagora.

From the viewpoint of systematics beside others the following characteristics must be taken into consideration: the shape of the assimilatory filaments; the position and the shape of the spermatangia; the position, the shape, the size, and the structure of the carpogonial branches; and the structure of the cystocarps.

1. The assimilatory filaments

As has been noted by former authors there can be distinguished, roughly speaking, two different types of the assimilatory filaments in all species ever described. One of them is the type which is seen in the section Farinosae including *L. farinosa* LAMX., *L. pinnata* HARV., etc. The cells constructing the assimilatory filaments are cylindrical, being not very inflated, though some are slightly barrel-shaped; the diameter of them is rather wide and about the same from the lower part to the end of the assimilatory filaments. The other type is much more common than the former, being found in many other species than *L. farinosa* LAMX. and its allies. In this type the cells of the assimilatory filaments are very different according to their position, usually the lower ones being long and cylindrical, while the upper ones become shorter and rounded, some being elliptical or ovate or nearly spherical. In this type the assimilatory filaments often ramify in nearly corymbose manner in their upper parts.

2. The spermatangia

Two different types, generally speaking, can also be recognised in the spermatangia. In one type the spermatangia are produced around the ultimate cell of the assimilatory filaments, being nearly sessile, and forming densely packed head-like clusters. In some species these clusters are produced around the cells which are located near the third or fourth cells from the top of the assimilatory filaments or on a top of the very short branchlets on these cells. In both these cases the spermatangia which are nearly sessile form a dense cluster. In the other type the spermatangia are produced on the ultimate cells and sometimes also on the penultimate ones, in nearly corymbose manner. It is very interesting to note that the former type is always found in those species which show the assimilatory filaments belonging to the *L. farinosa*-type mentioned above.

3. The carpogonial branches.

We can distinguish also two kinds of carpogonial branches. In the

first type they are evidently lateral on one cell of the assimilatory filaments and mostly curved, while in the other type they are lateral or subterminal or terminal on the assimilatory filaments, and in this case the carpogonial branches are straight or nearly so. This second type is found in the section Mucosae which includes *L. mucosa* HOWE, *L. pedicellata* HOWE, etc. The number of cells constructing the carpogonial branches is usually about four, mostly 3–5, but in some species they are composed of only one or two cells, especially in *L. orientalis* J. AG. where the carpogonial branches are composed of only the carpogonium itself, or they accompany only one hypogynous cell, so that they are composed of only two cells.

4. The cystocarps

After the fertilization takes place the carpogonia are divided into two cells usually by means of a horizontal cell wall, but in *L. orientalis* J. AG. a longitudinal wall occurs instead of a horizontal one. Such a case has been observed by the writer in only this one species. On the other hand in some species the complete cystocarps are covered with involucre-like filaments, while in others these filaments are wanting or nearly so, the cystocarps being nude, especially in the species of the section Mucosae where these filaments scarcely develop.

Taking into consideration the differences of the above mentioned characters it seems to the present writer that all known species of *Liagora* can be divided into the four sections: Orientales, Validae, Farinosae, and Mucosae.

An Analytical Key to the Japanese Species of Liagora

Carpogonial branches very simple, consisting of 1 or 2 cells; cystocarps without involucre; antheridia borne on the top of assimilatory filaments in nearly corymbose manner .....Section **Orientales**
L. orientalis J. AG.

Carpogonial branches not so simple as above, at least consisting of 3 or more cells; cystocarps with or without involucre.

Carpogonial branches subterminal or terminal or lateral; involucre of cystocarps nearly absent; antheridia borne on the top of assimilatory filaments; carpospores comparatively large; frond very soft and lubricous. .....Section **Mucosae**

Carpogonial branches mostly subterminal or terminal and straight. .....*L. mucosissima* YAMADA

Carpogonial branches lateral and slightly curved. .....
.....*L. formosana* YAMADA

Carpogonial branches lateral; involucre of cystocarps present or absent; antheridia borne on the top of assimilatory filaments; frond not so soft and lubricous as above; cells of assimilatory filaments moniliform or nearly so ..... Section **Validae**

Branching monopodial, decussate or somewhat pseudo-dichotomous .....Decussata-group

L. decussata MONT.

Branches dichotomous, with lateral ramelli .....Distenta-group

Frond often canaliculate after drying....*L. Segawai* YAMADA

Frond not as above .....*L. ceranoides* LAMX.

Branches dichotomous, without lateral ramelli .....Valida-group

Branches and branchlets with clear annulations.

Frond low, intricated .....*L. caenomyce* DECNE.

Frond erect, not intricated, often geniculate .....

.....*L. robusta* YAMADA

Frond high, not geniculate .....*L. Boergesenii* YAMADA

Branches and branchlets without clear annulation.

Surface of frond plane or rarely with annulations .....

..... *L. Setchellii* YAMADA

Surface of frond farinose .....*L. japonica* YAMADA

Carpogonial branches lateral; antheridia head-like; cells of assimilatory filaments not moniliform .....Section **Farinosae**

Antheridia produced on top of assimilatory filaments; ultimate ramelli not clavate .....*L. farinosa* LAMX.

Antheridia produced in clusters on cells below the top of assimilatory filaments; ultimate ramelli not clavate ....*L. pinnata* HARV.

Antheridia unknown; ultimate ramelli clavate .....

.....*L. clavata* YAMADA

Section I. **ORIENTALES**

Liagora orientalis J. AGARDH Pl. I, and Text-fig. 1.

Anal. alg., Cont. 3 (1896) p. 99; DE TONI, Syll. alg., vol. 4 (1897) p. 86; YAMADA, Notes on some Japan. alg., V (1933) p. 282.

Japanese name: *Husa-konahada.*

Hab.: Daibanratu, Formosa.

Distr.: Ceylon.

Of this species vegetative characters and antheridia have already been especially mentioned. But by a more careful examination of a piece

that is preserved in alcohol fortunately the carpogonial branches and their development could be observed.

The carpogonial branches in the present specimen are exceedingly peculiar; they are mostly one-celled, being rarely provided with a hypogynous cell, and are very thin. But the trichogynes are comparatively thick and their tops are clearly thickened. The carpogonial branches are born on the shoulder of the cells mostly in the upper portions of the assimilatory

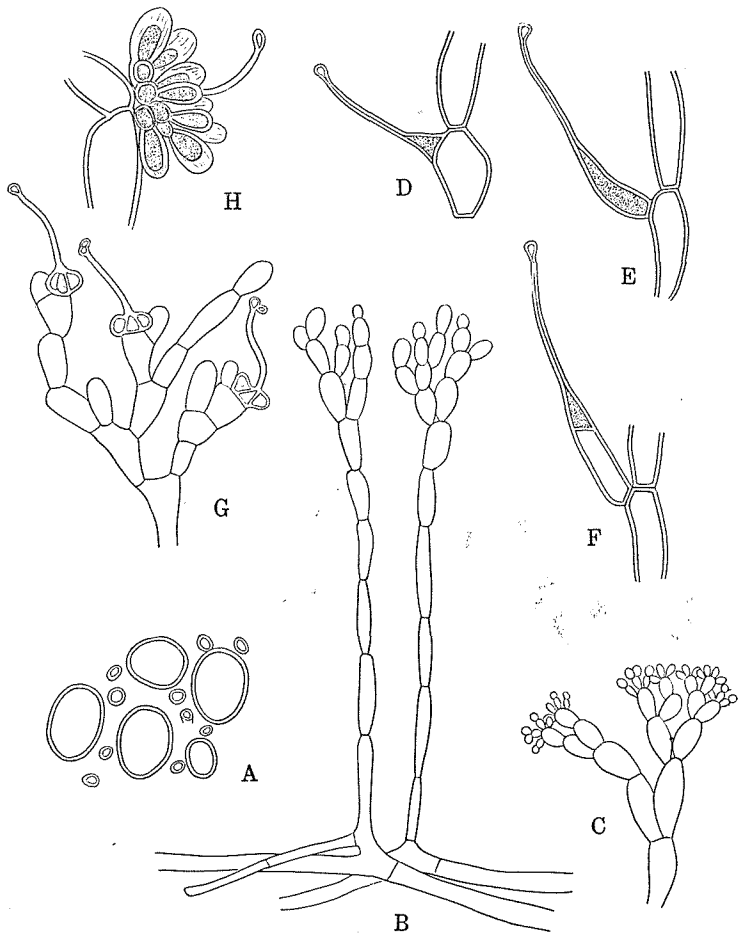

Fig. 1. *L. orientalis* J. Ag. A. Cross-section of the central axis. ×300. B. Assimilatory filaments. ×300. C. Antheridia. ×470. D–F. Three carpogonial branches. ×470. G. Fertilized carpogonia divided with longitudinal walls. ×300. H. Cystocarp. ×470.

filaments. After fertilization the carpogonia are divided by means of longitudinal walls, and at last there are produced many carpospores around the original carpogonia. The carpospores are ellipsoid or long obovoid in shape. They seem to leave their membrane when they become free, and often they give the impression of having been produced in succession inside the old membrane. There are no involuce-like filaments.

In the herbarium of the University of California the writer was able to examine a piece of the specimen which was collected by W. FERGUSON in Ceylon, and is kept in the herbarium of the British Museum under *L. orientalis* J. AG. In the central axis, assimilatory filaments and antheridia this specimen agrees fairly well with the specimen at hand, but very unfortunately neither any carpogonial branch nor cystocarp is to be seen in that piece of FERGUSON's specimen.

The present species seems to be very peculiar among several species of this genus hitherto described by its very simple structure of the carpogonial branches and carpospores, which, of course, should be taken as the primitive characteristics.

Section II. **VALIDAE**

Valida-group

Liagora caenomyce DECAISNE Pl. III, 1, and Text-fig. 2.

Essai sur une classification des algues et mémoire sur corallines (1842) p. 107; DE TONI, Syll. Alg., vol. IV (1897) p. 100; WEBER VAN BOSSE, Liste des alg. du Siboga, vol. 2 (1921) p. 202.

Syn. *L. intricata* BUTTERS, Notes on Spec. of Liag. and Galax. of Centr. Pacif. (1911) p. 167, pl. 24, fig. 6.

Syn. *L. Holstii* ZEH, Neue Art. Gatt. Liagora (Notizbl. königl. bot. Gart. u. Mus. Dahlem, Bd. V, Nr. 49,) p. 272.

?Syn. *L. rugosa* ZANARDINI, in Flora (1851) p. 36, Plant. Mar. Rub. (1858) p. 65, pl. 4, fig. 2.

?Syn. *L. annulata* J. AGARDH, Epicr. (1876) p. 518, Anal. alg., cont. 3 (1896) p. 107; YENDO, Notes on alg. new to Japan, VI (1917) p. 76.

Japanese name: *Hai-konahada.*

Hab.: Formosa: Kaikō; Daibanratu; Kasyōtō; Taitō.
Ryūkyū: Naha; Miyako-zima; Isigaki-zima; Yonakuni-zima.
Ogasawara Islands: Haha-zima.

Distribution: Manila, Philippines; Dutsh East Indies; Friendly

Islands? Red Sea?; Dar-es-Salem.

The fronds of this species are rather small, usually about 3–5 cm high. They are spread on the rock and the branches adhere to each other near the base of the fronds, thus forming a rather dense mass. The branches are dichotomous at short intervals, fastigiate and patent, continuously calcified, in dried specimens transversely rugose, and often divergent and acute at the end.

The assimilatory filaments are rather short, about 200 μ long, about 5 μ thick, ramified dichotomously, and corymbose upwards. They are composed of cylindrical cells near the base, and of obovate or elliptical ones in the upper portion, sending out thin rhizoids from the lower cells. The rhizoids are thin, being only about 3–5 μ in thickness and running usually nearly parallel to the central axis. Neither carpopogonial branches nor antheridia are known.

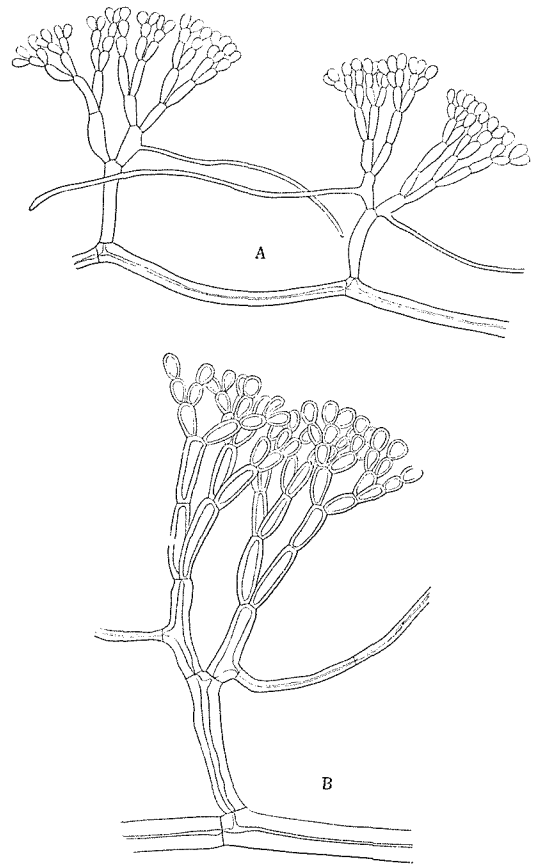

Fig. 2. *L. caenomyce* DECNE.
Assimilatory filaments. A. ×120. B. ×215.

Me. WEBER VAN BOSSE examined the type specimen of this species and the present writer himself has also had the privilege of examining a fragment of the co-type specimen of *L. caenomyce* DECNE. in the herbarium of the University of California by the kindness of Prof. W. A. SETCHELL. The result of the writer's observation coincides very well with the description and figures given by Me. WEBER VAN BOSSE. Judging from these results the specimens at hand seem to agree rather well with this species. But there are some points in which the present specimens and DECAISNE's do not coincide with each other.

After decalcifying DECAISNE's specimen becomes exceedingly soft while those at hand remain rather firm. But this softness of DECAISNE's specimens might be due to the fact that it had been collected nearly 100 years ago. Next, in describing *L. caenomyce* neither DECAISNE nor Me. WEBER VAN BOSSE have stated the adhering of branches in the lower parts of the fronds in their specimens. In this point the present specimens agree very well with BUTTER's description of *L. intricata* BUTT.

Looking at the good agreement of other characteristics, too, it seems to the writer that there is scarecely any doubt about the identity of his specimens with BUTTER's.

L. rugosa ZAN. and *L. annulata* J. AG. were described rather briefly, but they appear to be very nearly related to the present species, though it has not been possible for the writer to examine the type specimens of either species.

The co-type specimen of *L. Holstii* ZEH is preserved in the herbarium of the University of California as No. 409055 which was determined by Dr. O. C. SCHMIDT as *L. rugosa* ZEH. This specimen was collected by HOLST in 1892 at Dar-es-Salem, East Africa, and is marked as No. 1276 which is quoted by ZEH under his original description. The examination of this specimen shows that the habit of the frond, the thick-walled and thin medullary filaments and the shape of the assimilatory filaments agree fairly well with those of the present specimens referred here to *L. caenomyce* DECNE.

Liagora robusta spec. nov. Pl. XII, 1, and Text-figs. 3–4.

Frons calce valde incrustata, caespitosa, ad basim et hic illic calce destituta, quasi articulata, cylindracea, sicco compressiuscula, 5–6 cm alta, 1.5–2.0 mm crassa, repetite dichotome axilibus rotundatis vel irregulariter umbellatim fasciculatimque ramosa, transverse rugosa.

Axis centralis ex filamentis crassis, ca. 20 μ crassis et tenuioribus rhizoideis ca. 5–7 μ crassis composita. Fila corticalia ca. 350 μ longa, quater–sexies dichotome vel trichotome ramosa, cellulis in partibus inferioribus mediisque longissimis, cylindricis, sursum brevioribus, oblongo-cylindricis, cellulis ultimis et saepe penultimis longe ellipsoideis vel obovoideis, cellulis ultimis pilo breve ornatis.

Species monoica. Antheridia in cellulis ultimis filorum corticalium corymbose evoluta. Rami carpogonii ex cellulis tribus compositi, leviter curvati, ca. 13 μ crassi, in cellula filorum corticalium lateraliter dispositi. Cystocarpia fere hemisphaerica ex filis carposporiferis densis composita,

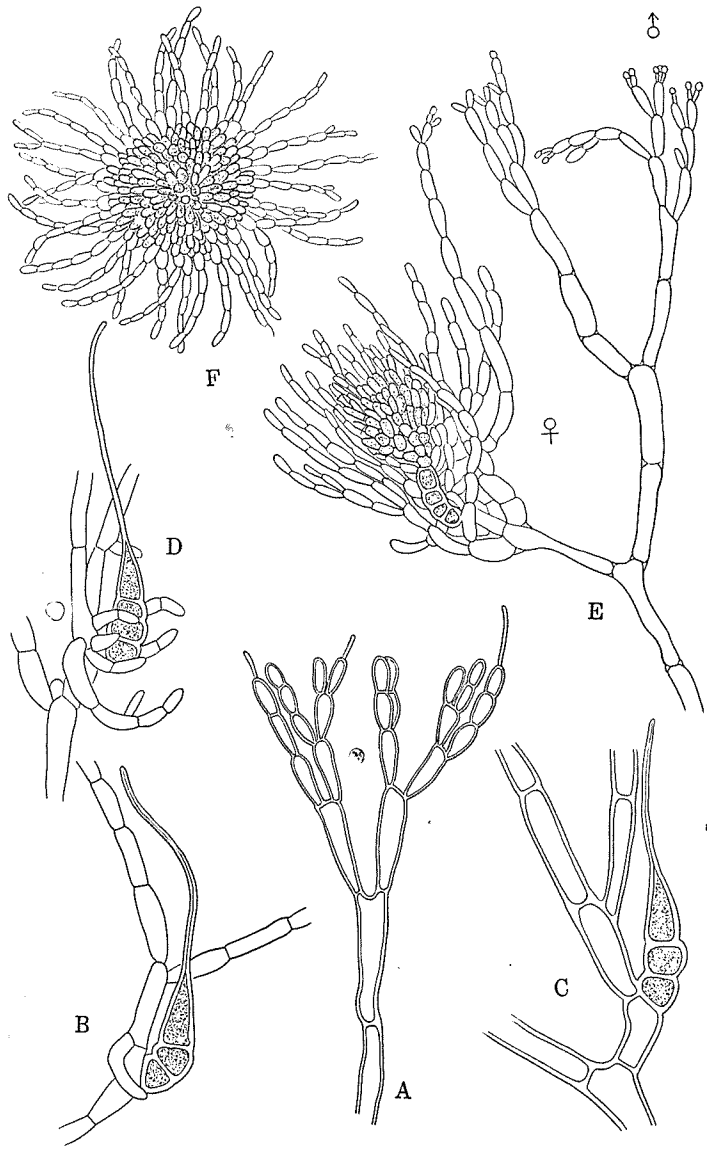

Fig. 3. *L. robusta* YAMADA. A. Assimilatory filament. ×460. B–C. Two carpogonial branches. ×460. D. Carpogonial branch with young involucral filaments. ×460. E. Assimilatory filament bearing a young cystocarp and antheridia. ×280. F. Cystocarp seen from above. ×150.

involucro evoluto. Carpospora longe ellipsoidea vel ellipsoidea vel obovata, parva, ca. 8–12 $\mu \times$ 5–6 μ.

Japanese name: *Tati-konahada.*

Hab.: Titi-zima and Haha-zima, Ogasawara Islands.

Frond strongly incrusted with lime, not soft, not very lubricous except near the apices, caespitose, very often destituting lime at the very base and also here and there, especially near the axils, thus looking as if articulated, cylindrical, but somewhat compressed when dried, about 5–6 cm high, 1.5–2.0 mm thick, repeatedly ramified in dichotomous manner with very wide axil or rarely in irregular umbellate manner, nearly always provided with annular wrinkles.

Central axis composed of rather thin filaments, and thinner rhizoidal ones; cells of filaments nearly cylindrical, about 20 μ thick, those of rhizoidal ones about 5–7 μ thick. Assimilatory filaments about 350 μ long, 4–6 times dichotomous or trichotomous, in the lower and medial parts cells very long, cylindrical, in the upper parts becoming shorter and oblongo-cylindrical, ultimate and often also penultimate cells long ellipsoid or obovoid, ultimate cells often provided with a short hair.

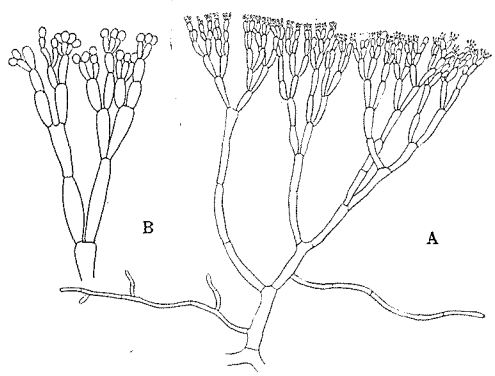

Fig. 4. *L. robusta* YAMADA.
Assimilatory filaments bearing antheridia.
A. ×120. B. ×350.

Species monoicous. Antheridia borne on the ultimate cells of the assimilatory cells, crowded in corymbose manner. Carpogonial branches composed of three cells, slightly curved, about 13 μ wide, lateral on a cell forming the assimilatory filaments. Cystocarps nearly hemispherical, with dense gonimoblasts, provided with a well developed involucral filaments. Involucral filaments long, ramified, their basal cells strongly inflated. Carpospores long ellipsoid or ellipsoid or obovate, small, about 8–12 $\mu \times$ 5–6 μ.

Judging from the description given by GRUNOW, his *L. subarticulata* from Fidschi, of which no opportunity of examining an authentic specimen has jet been afforded to the present writer, seems to have a general habit like the present species. But *L. subarticulata* GRUN. does not seem to show any annular wrinkles which are to be found in almost all specimens at hand.

As to the microscopic characters GRUNOW did not give any information on his species so that the present writer can not ocmpare the present species with his in respect to this point.

Liagora Boergesenii spec. nov. Pl. II, and Text-figs. 5–6.

Frons teres, calce multo incrustata, ca. 6–12 cm alta, exsiccatione fragilissima, sublevis, diam. ca. 1.5 mm, aequicrassa, conspicue annulata, repetite denseque dichotoma, ramis fastigiatis.

Axis centralis ex filamentis 20–30 μ crassis et tenuibus rhizoideis ca. 8 μ crassis composita. Stratum periphericum ex filamentis ca. 400–550 μ longis, quater vel quiquies dichotome ramosis (ramulis ultimis saepe trichotomis et corymbosis) compositum. Cellulae filamentorum longe cylindricae, infra ca. 8–10 μ crassae, sursum breviores, longe ellipsoideae vel obovatae, ca. 6–8 μ crassae.

Rami carpogonii ex tribus cellulis compositi, leviter curvati, ca. 12–15 μ lati. Cystocarpia gonimoblastis densis globosa, filamentis tenuibus sterilibus obtecta. Antheridia ovata vel subglobosa, ca. 3 μ longa, ad apicem filamentorum strati peripherici evoluta.

Japanese name: *Suzi-konahada.*

Hab.: Ryūkyū: Yonakuni-zima.

Formosa: Kasyōtō.

Frond terete, strongly calcified except at very extremity of the ramuli, not strongly lubricous, very brittle when dried, calcification nearly smooth, ca. 6–12 cm high, ca. 1.5 mm thick, nearly equally in thickness throughout the

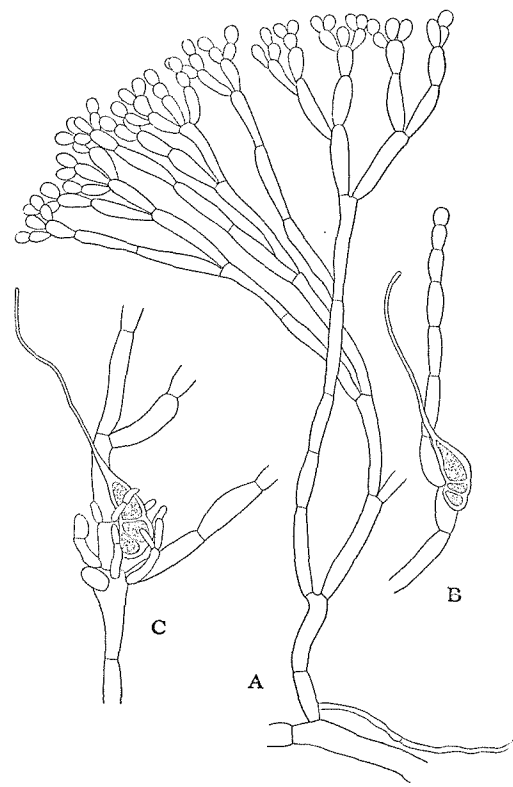

Fig. 5. *L. Boergesenii* YAMADA. A. Assimilatory filament. ×225. B. Carpogonial branch. ×350. C. Carpogonial branch with yonug involucral filaments. ×350.

whole length except near the top of branchlets, usually with clear annulations mostly in the upper part of the frond, but often below, too, repeatedly and densely dichotomous, branches fastigiate.

Central axis composed of longitudinal filaments ca. 20–30 μ thick, mixed with thin rhizoidal filaments ca. 8 μ thick; assimilatory filaments ca. 400–500 μ long, 4–5 times dichotomous (ultimate ramuli often trichotomous and corymbose), composed of long cylindrical, ca. 8–10 μ thick cells below, of shorter and longly ellipsoid or obovate, ca. 6–8 μ thick cells upwards; carpogonial branches 3-celled, somewhat curved, ca. 12–15 μ thick, situated laterally on a cell usually a little above the middle of the assimilatory filaments; cystocarps with dense gonimoblasts, covered with well developed, rather thin involucral filaments, dark red in colour and dot-like seen from the surface of the frond; carpospores longly obovate, ca. 10–15 μ long; antheridia produced on the top of the ultimate ramuli of the assimilating filaments, ovate or subglobose, ca. 3 μ long.

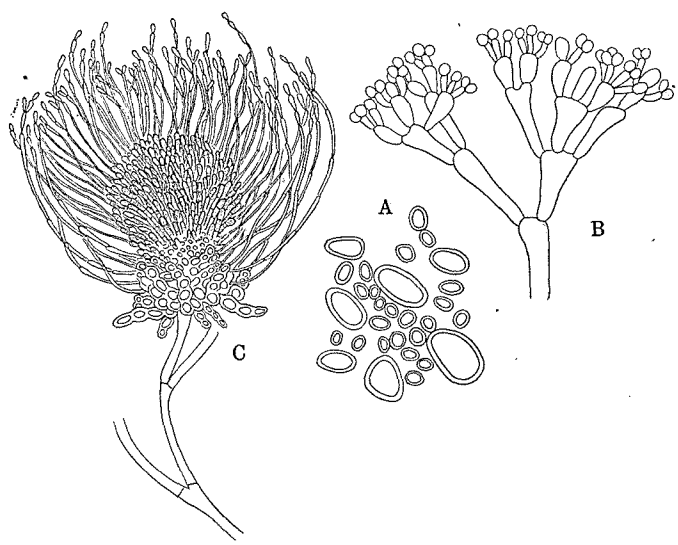

Fig. 6. *L. Boergesenii* YAMADA. A. Cross-section of the central axis. ×290. B. Antheridia. C. Cystocarp. ×150.

The present species resembles *L. valida* HARV. in habit, especially those specimens which show only weak annulations. But there are clear differences between the two species in anatomical characters. The ultimate cells of the assimilatory filaments in *L. valida* HARV. are usually smaller than the penultimate or lower ones, while this is not the case in *L.*

Boergesenii. The differences in the carpogonial branch, the filaments of the involucre, the form of the antheridia etc. help very much in distinguishing one species from the other.

Liagora Setchellii spec. nov. Pl. III, 2, and Text-figs. 7–8.

Frons calce valde incrustata, fragilis, teres, ca. 4–12 cm alta, ca. 1–2 mm crassa, equicrassa, densissime regulariter dichotome ramosa, fastigiata, raro in ramulis ultimis transversim rugosa.

Axis centralis ex filamentis, ca. 15 μ crassis et tenuioribus, ca. 4–6 μ crassis, rhizoideis composita. Fila corticalia ca. 270–400 μ longa, ter–quater dichotome ramosa, cellulis inferne longe cylindraceis, ca. 8–12 μ crassis, sursum brevibus et moniliformibus, superne ovalibus vel ellipsoideis, cellulis ultimis penultimisque minoribus sed variantibus.

Species monoica. Antheridia ad apicem filorum corticalium densissime evoluta. Rami carpogonii ex cellulis 5 vel 4 compositi, leviter curvati, ca. 15 μ crassi, in cellula cylindracea filorum corticalium laterales. Cysto-

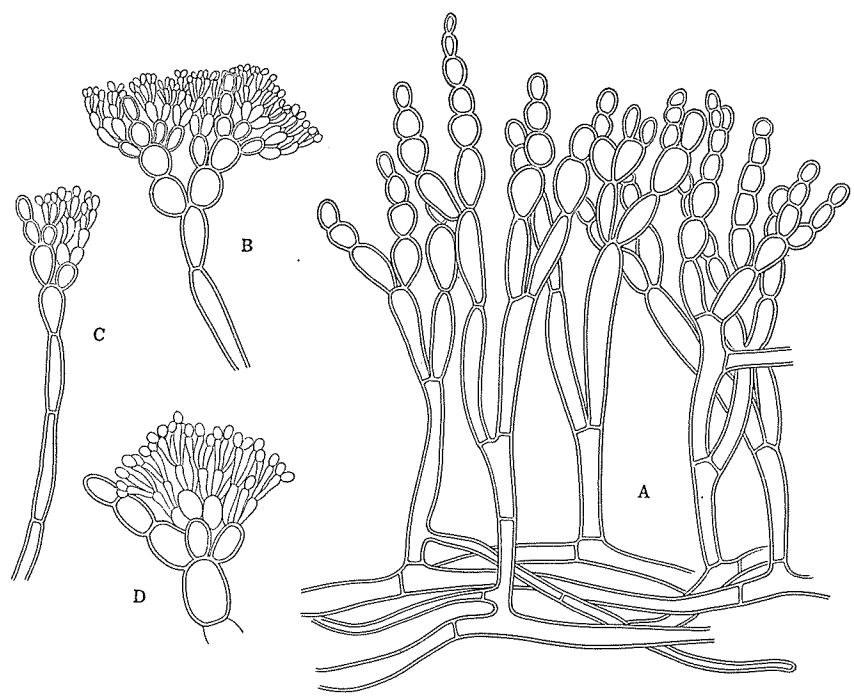

Fig. 7. *L. Setchellii* YAMADA. A. Assimilatory filaments. × 280. B–D. Antheridia. B–C. × 270. D. × 430.

carpia involucris dense obtecta, filamentis involucrorum inferne longe cylindraceis, superne crassioribus clavatisque. Carpospora longe ellipsoidea vel clavata, 20–25 μ longa.

Japanese name: *Isihada.*

Hab.: Ryūkyū: Naha, Miyako-zima, Yonakuni-zima and Isigaki-zima.
Formosa: Kasyōtō.
Ogasawara Islands: Titi-zima.

Frond rather hard, fragile, especially so in dried specimens, not much lubricous, deposited with lime strogly except at apices of the ramuli, terete, about 4–12 cm high, very densely and regularly dichotomous, about 1–2 mm thick, nearly equally thick throughout the whole length, branches usually plane, but rarely annulately wrinkeled near the apices.

Central axis rather compact, consisting of thin, about 15 μ thick, longitudinally running filaments but mixed with rich thinner, about 4–6 μ thick, rhizoidal ones. Assimilatory filaments about 270–400 μ long, usually 3–4 times dichotomously ramified; cells longly cylindrical, about 8–12 μ thick below, becoming shorter and rounded upwards, near the end of filaments oval or elliptical, large ones about 18 μ thick, ultimate and penultimate ones usually with smaller diameter and variable in diameter and shape.

Species monoicous. Antheridia produced at first on a small branchlets issued from the cells near the top of the assimilatory filaments, leaving the main filaments sterile but afterward the sterile main filaments becoming often indiscernible. Spermatia longly obovoid, about 5 μ long, situated on an elongated stalk-like cell. Carpogonial branches 5-celled, but often 4-celled, slightly curved, situated laterally on a cylindrical cell of the assimilatory filaments, about 15 μ thick. Cystocarps covered with a dense involucre; cells of involucre different from those forming sterile assimilatory filaments, thin, longly cylindrical below, becoming thicker and shorter, 4–5 ones near the top barrel-shaped, ultimate ones often conical. Carpospores longly elliptical or clavate, 20–25 μ long, rather few in number.

Sometimes the specimens of this species appear to be dioicous, the antheridia alone being found in some individuals and without cystocarps or vice versa. But in other specimens often both antheridia and cystocarps are found.

The filaments forming the involucre of the cystocarps are very clearly distinguished as mentioned above. They are thin below but upwards they grow remarkably thicker and are divided di-polychotomously, thus

clearly distinguishing themselves from the assimilatory filaments.

L. valida HARV. was described by HARVEY basing on specimens from Sand Key, Florida, but HARVEY has given neither description nor figures of the reproductive organs. Therefore without examining HARVEY's specimens one can not imagine the characters of the antheridia and cystocarps in this species. Very fortunately the present writer has had the privilege of examining some co-type specimens of HARVEY in Dublin and Berkeley. The antheridia abundantly found in those specimens show the characteristics about the same as those in the specimens at hand. On the other hand the cystocarps have not been minutely described by any author except BÖRGESEN who described and deliniated them in the West Indian specimens. Making comparison with those descriptions and figures given by BÖRGESEN with the cystocarps in the present specimens there are so many and important differences that it hardly seems possible to consider our specimens as the same as *L. valida* HARV., although there is great resemblance between the Japanese and the Atlantic specimens.

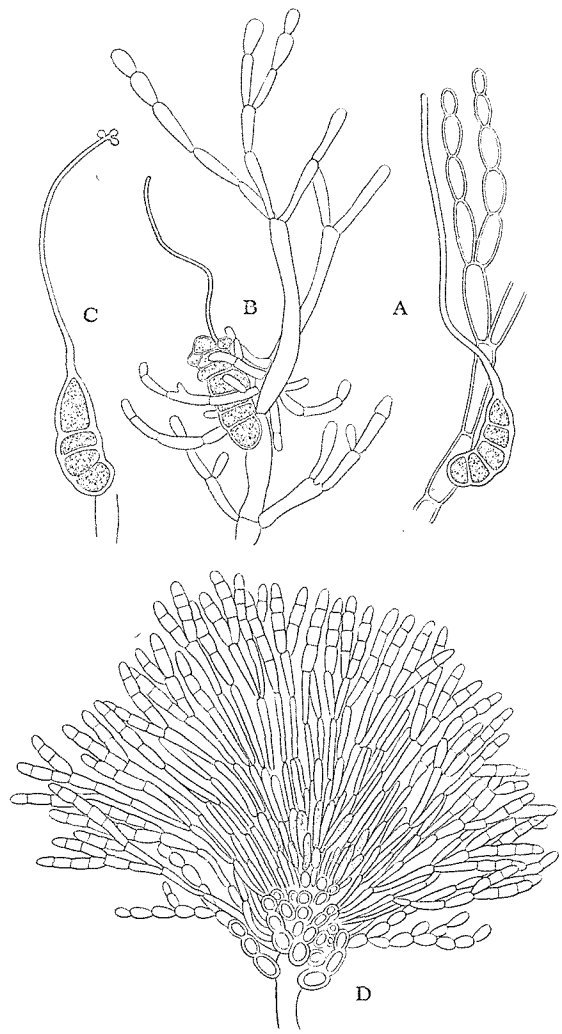

Fig. 8. *L. Setchellii* YAMADA. A, C. Carpogonial branches. × 350. B. Carpogonial branch with young involucral filaments. × 350. D. Cystocarp. × 200.

The present species is distributed very widely in the warmer parts of Japan.

Liagora japonica spec. nov. Pl. IV, and Text-fig. 9–10.

Syn. *L. Cliftoni* YENDO (non J. AGARDH), Notes on alg. new to Japan, V (Bot. Mag. Tokyo, Vol. 30, 1916) p. 254.

Frons mollis, lubrica, teres, sicco compressa vel saepe canaliculata, 5–16 cm alta, 1–3 mm lata, regulariter dichotome ramosa, raro ramulis proliferis ornata; ramis fastigiatis, axilibus latis, in parte obsoleta saepe fasciculatis umbellatisque; crusta calcarea leve, sicco farinosa, interdum interrupta obductis.

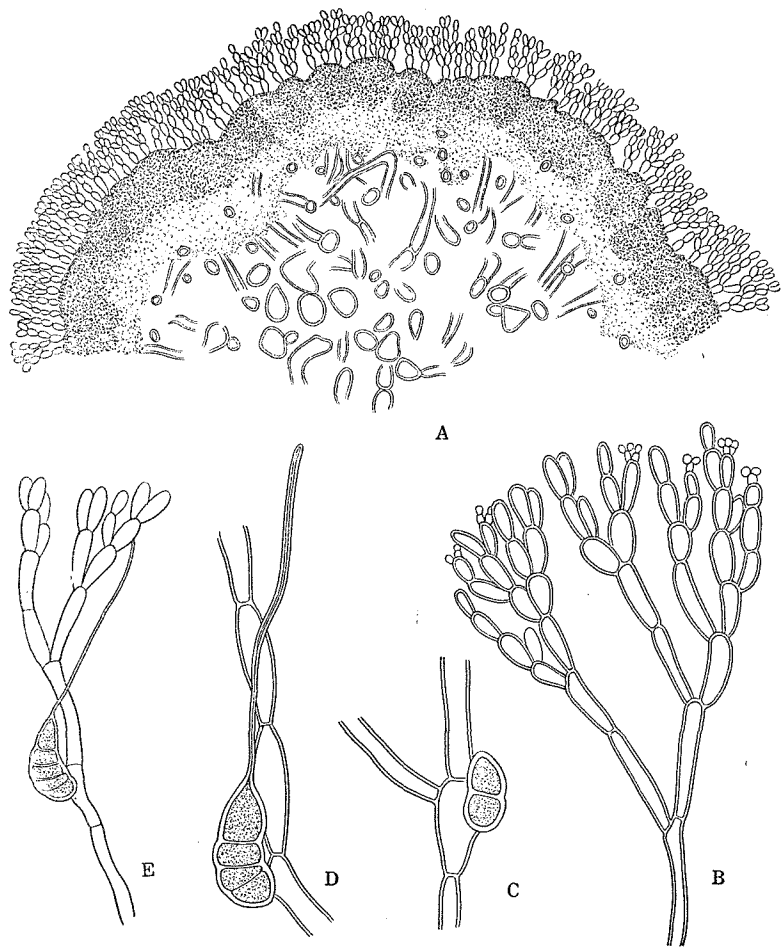

Fig. 9. *L. japonica* YAMADA. A. Cross-section of the frond showing chalk deposit. ×75. B. Assimilatory filament with antheridia? ×280. C. Young carpogonial branch. ×460. D. Four-celled carpogonial branch. ×460. F. Five-celled carpogonial branch. ×280.

Axis centralis laxa, ex filamentis crassioribus, 30–60 μ crassis et tenuioribus, 3–7 μ crassis composita. Fila strati peripherici ca. 200–250 μ longa, infra ex cellulis cylindraceis, ca. 8–10 μ crassis, sursum brevioribus composita; cellulis ultimis obovatis vel longe obovatis, ca. 10–12 μ crassis, pilo destitutis.

Species monoica. Antheridia ad apicem filorum assimilantium laxe corymbosa, 2–3 μ diam. Rami carpogonii ex 5 vel 4 cellulis compositi, 12–15 μ crassi, leviter curvati, ad cellulam in media parte filorum assimilantium lateraliter dispositi. Cystocarpia laxa, filamentis involucris destituta. Carpospora longe ovata vel elliptica, ca. $8\times20\,\mu$ (raro $15\times24\,\mu$) magna.

Japanese name: *Yagore-konahada.*

Hab.: Enosima and Misaki, Sagami Prov.; Iwado, Inaba Prov.

Frond soft, lubricous, terete but compressed and canaliculate when dried, 5–16 cm high, 1–3 mm thick, regularly dichotomous, rarely provided with proliferating ramuli; branches fastigiate, with wide axils, often proliferous and umbellate in obsolate portions; colour usually dirty brownish purple; calcification not very strong, occurring in assimilatory layer alone and not in central axis, sometimes interrupted near the dichotomies of branches.

Central axis very loose, composed of thick filaments measuring about 30–60 μ in diam., near margin mainly of much thinner rhizoidal filaments, about 5–7 μ thick. Assimilatory filaments about 200–250 μ long, composed of cylindrical cells about 8–10 μ thick below, and becoming shorter upwards;

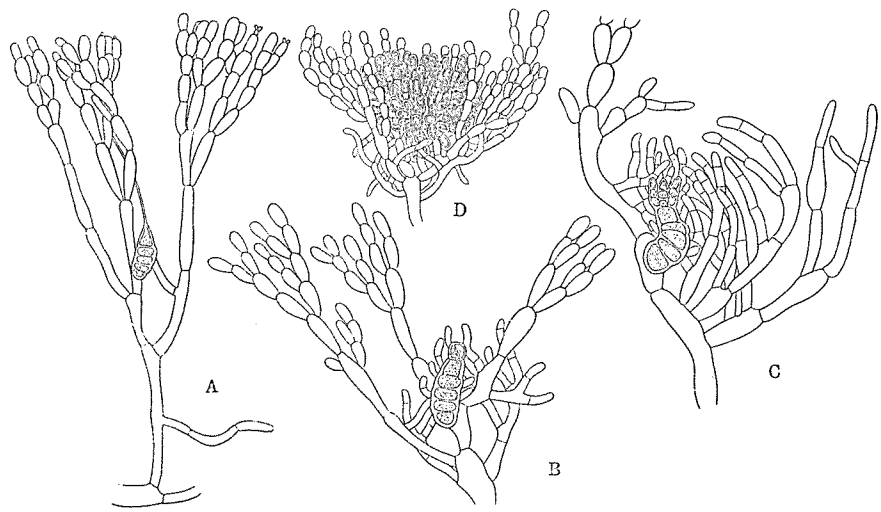

Fig. 10. *L. japonica* YAMADA. Development of cystocarp. A–C. ×225. D. ×125.

near the end composed of obovate or longly obovate cells about 10–12 μ thick; ultimate cells without hairs.

Species monoicous. Antheridia at the top of ultimate cells of the assimilatory filaments, nearly spherical, about 2–3 μ in diam., loose; carpogonial branches composed of 5, rarely 4, cells, slightly curved, 12–15 μ thick, lateral on the nearly middle portion of the assimilatory filaments; cystocarps rather loose, without involucral filaments; carpospores longly ovate or elliptical, about 8 $\mu \times$ 20 μ (rarely 15 $\mu \times$ 24 μ).

The specimens on which this new species is founded are most probably specifically the same as those which YENDO referred to *L. Cliftoni* J. AG. The writer has also collected several specimens at Misaki where YENDO found his specimens, and in identifying YENDO was followed. Having seen however, the type specimen of *Galaxaura Cliftoni* HARV. (=*L. Cliftoni* J. AG.) in the HARVEY Herbarium at Dublin, the writer entertained much doubt about this identification, because HARVEY's specimen is only slightly calcified and shows the velvet-like surface, coinciding well with the figure in Phyc. Austr.

In the material at hand it has fortunately been possible to follow the formation of the cystocarps. The fertilized carpogonia divide once or twice with horizontal walls and then longitudinal walls occur. The fusion of the carpogonium with hypogynous as well as other cells in the carpogonial branch, and also with the supporing cell observed by KYLIN in *L. viscida* AG. can not be seen in this case. In almost all carpogonial branches which already bear many young gonimoblasts the complete walls sorrounding every cell can be very clearly observed. The antheridia are found not in abundance, but rather few in number. They are very small and produced two or three together on a short stalk-cell which occurs on the ultimate cells of the assimilatory filaments.

L. japonica YAM. shows some resemblance to *L. viscida* AG., but the frond of the former is much more robust than that of the latter, and it helps in distinguishing these two species one from the other.

Distenta-group.

Liagora Segawai spec. nov. Pl. V, and Text-figs. 11–12.

Frons mollissima, flaccida, lubrica, calce modeste incrustata, cylindrica, sicco farinacea, complanata, hic illic canaliculata, ca. 1.0–1.5 mm lata ad basin frondis, apicem versus gradatim angusta; ramis principalibus dichotomis, axilibus rotundatis, ramulos pinnatos emittentibus, ramulis

ramellis brevibus prolificantibus patentibus ornatis.

Axis centralis ex filamentis longitudinalibus et filamentis tenuioribus rhizoideis composita, cellulis filamentorum crassioribus oblongo-cylindraceis, ca. 50 μ crassis. Fila corticalia ca. 240 μ longa, quinquies–septies dichotoma, in parte superiore saepe trichotoma et corymbosa; cellulis in parte inferiore longis, oblongo-cylindricis, sursum brevioribus, latioribus, longe ellipsoideis vel longe obovatis, cellulis ultimis penultimisque minoribus, ovatis vel subsphaericis vel ellipsoideis.

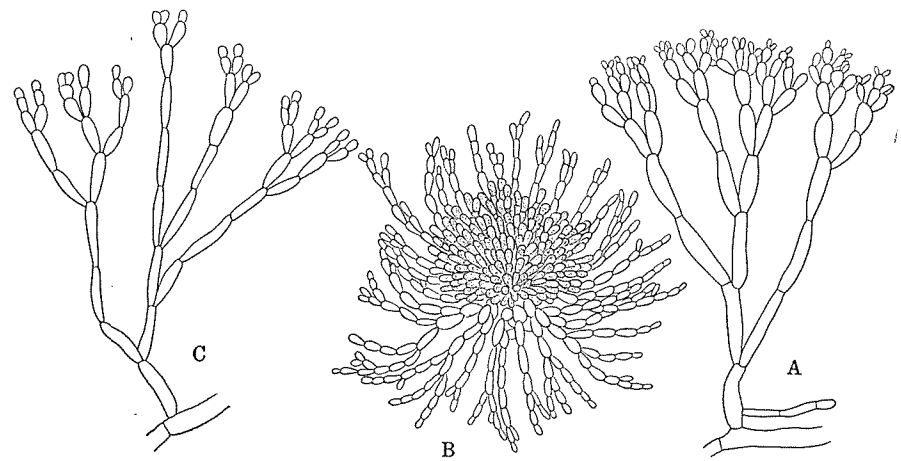

Fig. 11. *L. Segawai* YAMADA.
A, C. Assimilatory filaments. ×260. B. Cystocarp. ×140.

Species dioica? Antheridia ignota. Rami carpogonii ex tribus cellulis compositi, carpogonio majori quam cellulis aliis, curvati, 10–12 μ lati, ad cellulam filorum corticalium lateraliter dispositi. Cystocarpia subhemisphaerica, filamentis involucrorum longis et ramosis ornata. Carpospora longe ellipsoidea vel obovata, parva, ca. 5–7 $\mu \times$ 10–12 μ.

Japanese name: *Mizo-konahada.*

Hab.: Titi-zima, Ogasawara Islands; Okinawa-zima, Ryūkyū.

Frond very soft and flaccid, lubricous, incrusted with lime moderately, finely farinaceus in drying, cylindrical, becoming complanate and here and there canaliculate after drying, about 1–1.5 mm wide near the base of dried specimens, becoming gradually narrower upwards. Main branches dichotomous with wide axils, sending several pinnate branches and branchlets, upper branches sending many patent, proliferating ramuli.

Central axis composed of longitudinal filaments build up with thick (about 50 μ thick), near both ends somewhat thin, cylindrical cells, in the

lower portions of the frond filaments being covered with thinner rhizoidal filaments coming out of the basal portion of the assimilatory filaments. Assimilatory filaments about 240 μ long, 5–7 times dichotomously branched, in the upper portion often trichotomously branched and corymbose. Cells of assimilatory filaments long, oblong-cylindrical in the lower portion, becoming shorter upwards, near the end thicker, long ellipsoid or long obovate, ultimate and penultimate ones smaller, ovate or subspherical or ellipsoid.

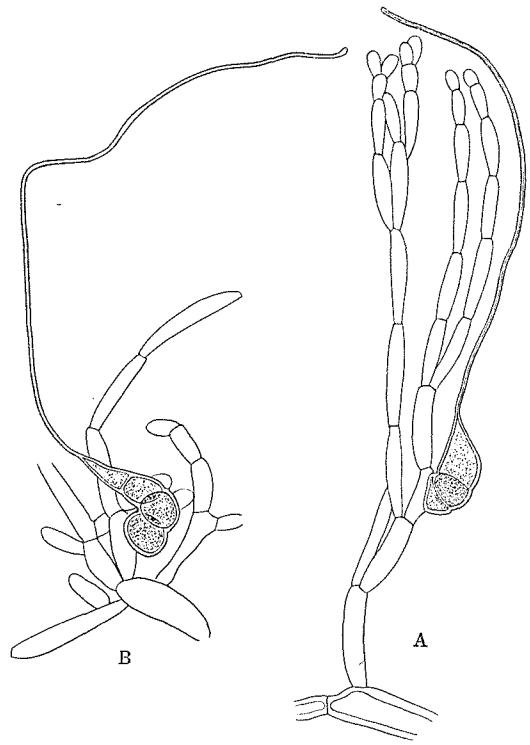

Fig. 12. *L. Segawai* YAMADA. A. Assimilatory filament bearing a carpogonial branch. ×450. B. Fertilised carpogonial branch with young involucral filaments. ×450.

Species dioicous? Antheridia unknown. Carpogonial branches composed of three cells, carpogonia being larger than other cells in the carpogonial branches, curved, about 10–12 μ wide, borne laterally on the assimilatory filaments. Cystocarps subhemispherical, dense, provided with well developed involucral filaments. Carpospores long ellipsoid or obovate, small, 5–7 $\mu \times$ 10–12 μ.

This new species is evidently to be placed in the *Distenta*-group, and seems to be related most nearly to *L. distenta* (MERT.) AG. and *L. Wilsoniana* ZEH. From both species, however, *L. Segawai* is different in respect to the carpogonial branches and the cystocarps. In *L. distenta* AG. the carpogonial branches are composed of four or five cells, and in *L. Wilsoniana* ZEH, of which the writer has examined an authentic specimen, the involucral filaments are not ramified, while in the present species they are much ramified.

Liagora ceranoides LAMOUROUX Pl. VI.

Hist. polyp. corallig. flex. (1816) p. 239; J. AGARDH, Spec. alg., vol. 2

(1852) p. 426, Epicr. (1876) p. 519; HOWE, in BRITTON and MILLSPAUGH'S Bahama Flora (1920) p. 555; BÖRGESEN, Mar. alg. Canary isl., vol. 3 (1927) p. 58.

HOWE and BÖRGESEN consider *L. pulverulenta* J. AG. and *L. leprosa* J. AG. to be the same as *L. ceranoides* LAMX. after having compared the authentic specimens. The first named author considered *L. opposita* J. AG. and *L. Pilgeriana* ZEH also as synonymous to *L. ceranoides* LAMX. As the present writer himself has not had the opportunity of examining any authentic specimens of those five species except *L. Pilgeriana* ZEH, here the opinion of the above named authors will be accepted. But among present rather rich material there seem to be two groups of specimens which are rather easily distinguishable from each other by the difference of general habit, one being referable to *L. pulverulenta* J. AG. and the other to *L. leprosa* J. AG. respectively. As has been noticed by the former authors the specimens belonging to the former group almost always show many short proliferating ramuli, coming out of the branches nearly rectangularly, while those of the latter group do not have any of them, and they are almost always pale in colour. Therefore it seems to the present writer reasonable to distinguish these two forms from each other.

α. **pulverulenta** (AGARDH) comb. nov.

Syn. *L. pulverulenta* C. AGARDH, Spec. alg., vol. 1 (1821) p. 396; J. AGARDH, Spec. alg., vol. 2 (1852) p. 427, Epicr. (1876) p. 516, Anal. alg., cont. 3 (1896) p. 101; KÜTZING, Tab. Phyc., vol. 8 (1858) tab. 89; BUTTERS, Liagora and Galaxaura (Minnesota Bot. Studies, 1911) p. 164; BÖRGESEN, Mag. alg. Dan. West-Ind., vol. 2 (1915) p. 80; WEBER VAN BOSSE, List des alg. du Siboga, vol. 2 (1921) p. 199.

Syn. *L. Pilgeriana* ZEH, Neue Art. Liagora (Notizbl. Königl. Bot. Gart. Berlin, Bd. 5, 1912) p. 272.

Japanese name: *Konahada.*

Hab.: Kyūsyū; Bōkotō, Formosa.

Distr.: West-Indies; Red Sea; Malay Archipelago; Australia?

β. **leprosa** (J. AGARDH) comb. nov.

Syn. *L. leprosa* J. AGARDH, Alg. Liebm. p. 8, Spec. alg., vol. 2 (1852) p. 427, Epicr. (1876) p. 516, Anal. alg., cont. 3 (1896) p. 100; HARVEY, Ner. Bor. Amer., vol. 2 (1853) p. 139, pl. 31 c; YENDO, Notes on alg. new to Japan, VI (Bot. Mag. Tokyo, vol. 30, 1917) p. 75.

Syn. *L. opposita* J. AGARDH, Anal. alg., cont. 3 (1896) p. 100.

Japanese name: *Ao-konahada.*

Hab.: Kyūsyū; Kaikō, Formosa.

Distr.: Atlantic coast of Mexico; Friendly Isl.; Guadeloupe?

Decussata-group

Liagora decussata MONTAGNE Pl. VII, and Text-figs. 13–14.

De plant. cell. nouv., tant indig. exotiq. (Ann. Sic. Nat., Bot., 1849) p. 64; KÜTZING, Spec. alg. (1849) p. 538; J. AGARDH, Spec. alg., vol. 2 (1852) p. 429, Anal. alg., cont. 3 (1896) p. 102; COLLINS, HOLDEN and SETCHELL, Phyc. bor.–Amer., Fasc. 2 (1895) no. 89.

Japanese name: *Kiburi-konahada.*

Hab.: Taitō, Formosa.

Distribution: St. Vincent Island; Guadeloupe Island; Jamaica.

In the outer appearance and anatomical structure of the frond, the antheridia and the cystocarps the specimens at hand agree well with the descriptions given by the former authors, and especially with the specimens of Phyc. bor.-Amer. mentioned obove. This Jamaica specimen in our possession is a male one. The writer has been able to examine the female

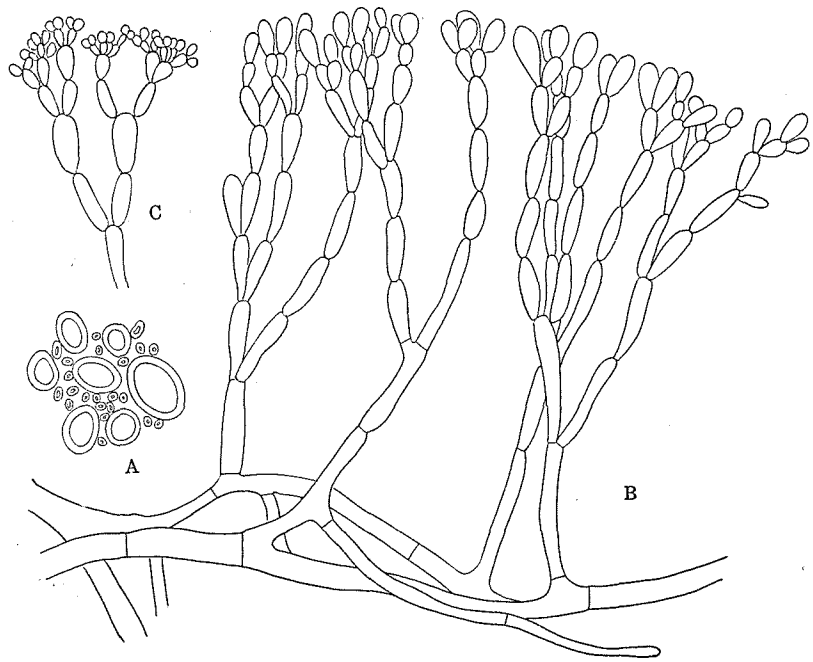

Fig. 13. *L. decussata* MONT. A. Cross-section of central axis. ×150. B. Assimilatory filaments. ×300. C. Antheridia. ×470.

specimen in the copy possessed by Prof. W. A. SETCHELL in the University of California. Furthermore the writer has had the privilege of examining some fragments taken from MONTAGNE's specimens of this species, which also show agreement in anatomical characteristics with the present specimens.

The carpogonial branches of the specimens at hand are rather inconspicuous, being very small. They consist of three, or rarely four cells and are almost always crooked. They are produced in a lower portion of the assimilatory filaments and the trichogynes are also rather short. The mature cystocarps are covered with involucre-like filaments, which are distinctly thinner than the assimilatory filaments. There is always seen a cell-complex at the base of the cystocarps.

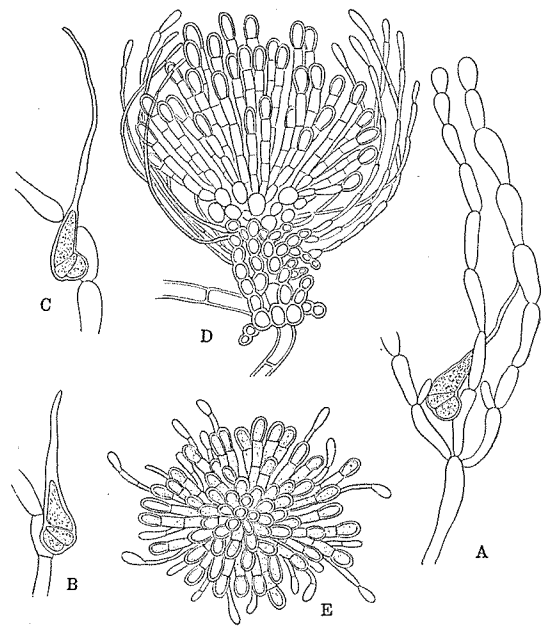

Fig. 14. *L. decussata* MONT. A–C. Carpogonial branches. ×410. D–E. Cystocarps. ×260. E. Seen from above.

The present species has been found only once at the above mentioned locality, growing on rocks in the lower littoral as well as upper sublittoral belts. But the writer recalls also having seen some specimens from Amami-Ōsima which were also to be referred to the present species. Therefore it seems that this species is distributed in the warmer parts of our sees, though it is evidently not a common *Liagora* in our boundaries.

Section III. **FARINOSAE**

Liagora farinosa LAMOUROUX Pl. VIII–X, and Text-figs. 15–16.

Hist. Polyp. (1816) p. 240; HOWE, in BRITTON and MILLSPAUGH's Bahama Flora (1920) p. 554; BÖRGESEN, Mar. alg. Canary Isl., pt. 3 (1927) p. 59.

Syn. *L. hirta* HARVEY et BAILEY, in Proc. Boston Soc. Nat. Hist., vol. 3

(1851) p. 373, Publ. in CHARLES WILKE's U. S. expl. exped., 1844–1874, V. 17, Botany (1847). Section Algae, p. 170.

Syn. *L. elongata* ZANARDINI, Alg. nov. vel minus cognitae in Mar. rub. (Flora 1851) p. 35, Plant. in Mar. rub. hucusque collect. enumer. (1858) p. 66, tab. 4, fig. 1; KÜTZING, Tab. Phyc., vol. 8 (1858) tab. 94; J. AGARDH, Epicr. (1876) p. 516, Anal. alg., cont. 3 (1896) p. 105; BÖRGESEN, Mar. alg. Dan. West-Ind., vol. 2 (1915) p. 67.

Syn. *L. Cheyneana* HARVEY, Some account of mar. bot. of West. Austr. (Transac. Royal Irish Acad., vol. 22, 1855?) p. 552, Alg. Austr. exsicc. no. 352, Phyc. Austr., vol. 3 (1860) tab. 162; J. AGARDH, Epicr. (1876) p. 515, Anal. alg., cont. 3 (1896) p. 105; KÜTZING, Tab. Phyc., vol. 8 (1858) tab. 92; BUTTERS, Notes on spec. of Liag. and Galax. of Centr. Pacif. (1911) p. 173; WEBER VAN BOSSE, Liste des alg. du Siboga, vol. 2 (1921) p. 200.

Syn. *L. lurida* DICKIE, On alg. of Mauritius (Journ. Linn. Soc., Bot., 1873) p. 195.

Syn. *L. crassa* DICKIE, l. c. p. 195.

Syn. *L. Cayohuesonica* MELVILL, Notes on mar. alg. South Carol. and

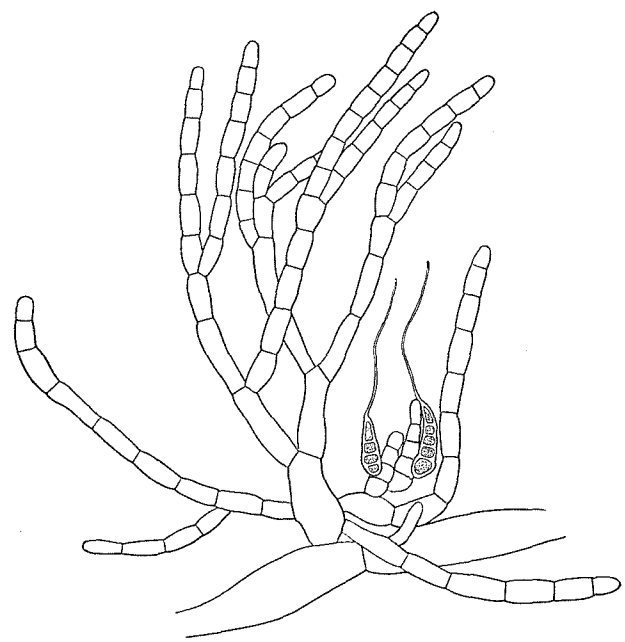

Fig. 15. *L. farinosa* LAMX.
Assimilatory filament bearing two carpogonial branches. ×150.

Florida (Trimen Journ. of Bot., vol. 13, 1875) p. 262.

Syn. *L. farionicolor* MELVILL, l. c. p. 263.

Syn. *L. corymbosa* J. AGARDH, Anal. alg., cont. 3 (1896) p. 104 (fide HOWE and BÖRGESEN) not BUTTERS, l. c. p. 171.

Japanese name: *Ke-konahada.*

Hab.: Japan proper: Kasiwa-zima, Tosa Prov.; Kosiki-zima, Satuma Prov.; Seto, Kii Prov.

Ryūkyū: Naha; Yonakuni-zima.

Formosa: Kaikō; Daibanratu; Kasyōtō.

Distribution: Warmer parts of the Pacific; Red Sea; Canary Isl.; West Indies.

Detailed information on the anatomy of the frond and the antheridia

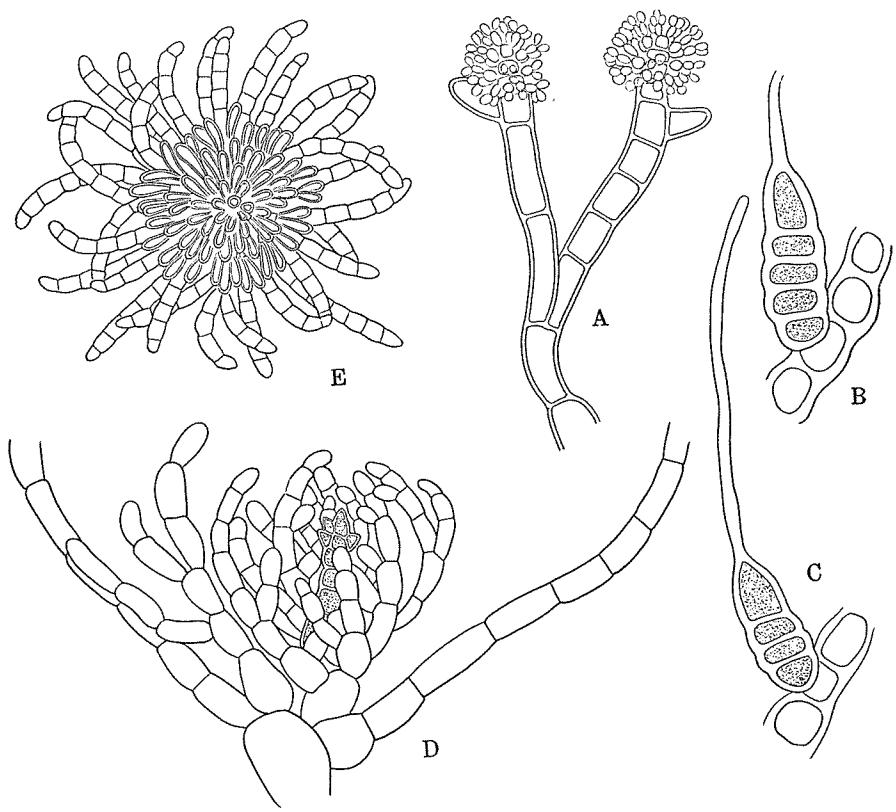

Fig. 16. *L. farinosa* LAMX. A. Antheridia. ×290. B–C. Carpogonial branches. ×470. D. Carpogonial branch with gonimoblasts and young involucral filaments. ×290. E. Cystocarp seen from above. ×155.

of the present species has been given by BÖRGESEN in his West Indian as well as Canary specimens. Me. WEBER VAN BOSSE also reported the carpogonial branch of this species in her New Guinea specimens. The present specimens identified as this species show very good agreement with the descriptions given by the above mentioned phycologists. But there are some minor points observable in the specimens at hand. BÖRGESEN reported that this species is monoeceous, while according to HOWE it is dioeceous. In the present specimens the cystocarps and antheridia are alwasy found in the different individuals. The development of the cystocarps was followed in the Yonakuni specimens. The first stage of the development of the gonimoblasts is given in Fig. 16, D. The cystocarps are surrounded by rather thick involucre-like filaments, which stage has already been deliniated by KÜTZING. In the present specimens the apical cells of the assimilatory filaments are destitute of the hair-like appendages which are found by BÖRGESEN in his specimens.

As seen from the above listed synonyms this very widely distributed species has been described by different authors under different names. HOWE considered *L. elongata* ZAN., *L. Cheyneana* HARV., *L. lurida* DICKIE, *L. crassa* DICKIE, *L. Cayohuesonica* MELV., *L. farionicolor* MELV., and *L. corymbosa* J. AG. p. p. max. as synonymous to *L. farinosa* LAMX. Among these the present writer himself has examined the authentic specimens of *L. Cheyneana* HARV., *L. lurida* DICKIE, *L. crassa* DICKIE, and *L. Cayohuesonica* MELV. and found that HOWE's opinion must be followed.

One more synonym, however, must be added here. That is *L. hirta* HARV. et BAIL. This species was described first in the Proceedings of the Boston Society of Natural History which, according to Prof. SETCHELL, is, together with the descriptions of other species, overlooked by almost all authors. In the herbarium of the University of California there is an authentic specimen of *L. hirta* HARV. et BAIL. which was collected on Tatuila Island and sent to Prof. SETCHELL from the herbarium of J. W. BAILEY, Brown University. In the habit and in the characteristics of the assimilatory filaments this specimen is just like *L. farinosa* LAMX.

Within our boundaries the present species is distributed very widely and in abundance.

f. **pinnatiramosa** f. nov. Pl. X.

Rami conspicue pinnati.

Hab.: Haha-zima and Titi-zima, Ogasawara Islands.

In the mode of ramification this form is quite distinct from the typical

specimens in which the barnches are usually regularly dichotomous. Among the assimilatory filaments there are met with many "monosporangial discs."

Liagora pinnata HARVEY Pl. XI, and Text-figs. 17–18.

Ner. Bor. Amer., part 2 (1853) p. 138, pl. 31, B; J. AGARDH, Epicr. Florid. (1876) p. 517, Anal. alg., Cont. 3 (1896) p. 108; BÖRGESEN, Mar. alg. Dan. West-Ind., vol. 2 (1915) p. 74; YAMADA, Not. on some Japan. alg., V (1933) p. 283.

Japanese name: *Hane-konahada.*

Hab.: Markyoku, Palao Isl.; Pratas Isl.; Titi-zima, Ogasawara Isl.

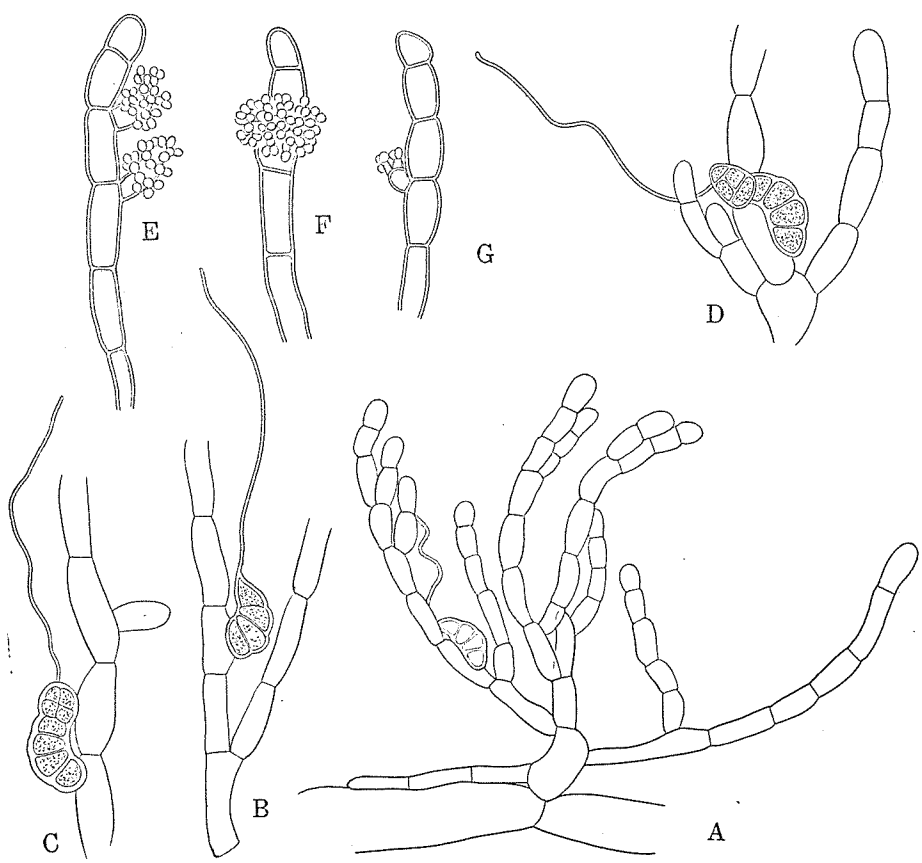

Fig. 17. *L. pinnata* HARV. A. Assimilatory filament bearing a carpogonial branch. ×170. B. Carpogonial branch. ×310. C–D. Development of gonimoblasts. ×310. E–G. Antheridia. ×310.

Distr.: Florida; Jamaica; St. Croix.

The occurrence in the Pacific of this species has been reported by the present writer (l. c.). In this place the locality erroneously reported is to be corrected and there are to be added some antomical details of present specimens from Markyoku, one branch of which is preserved in alcoholic solution, and shows the peculiar character in carpospores.

In the former information (l. c.) Saipan, Marianne Islands was stated as the locality of this species, but it was an error, the correct habitat being Markyoku, Palao Island as stated above.

The habit, the structure of the central axis, of the assimilatory filaments and of the carpogonial branches, the peculiar antheridia, and the development of cystocarps of the present specimen agree fairly well with the very detailed description and figures of *L. pinnata* HARV. given by BÖRGESEN (l. c.). But there is one difference, which should not be overlooked, bewteen the carpospores of the specimens at hand and those of the West Indian ones. That is the formation of "tetraspores" instead of the usual carpospores. Text-fig. 18 shows well a mature cystocarp producing such tetraspores. The contents of the sporangia usually divide cruciately, but of course there often occur some irregularities. For example some sporangia appear to be tetrahedral while others are divided irregularly, producing 5–6 spores.

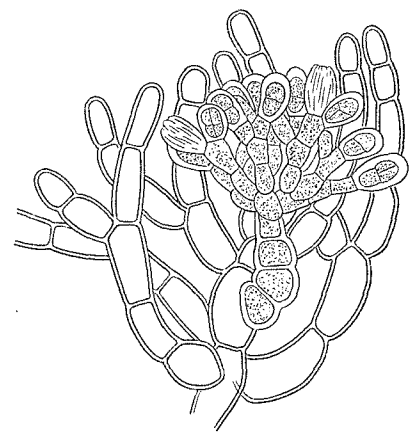

Fig. 18. *L. pinnata* HARV. Cystocarp. ×320.

The tetraspores in *Liagora* were found first by BÖRGESEN in his Canarian species, *L. tetrasporifera,* and he discussed where the nuclear reduction occurs in his species. He also found the tetraspores in D'ARBERT's specimen collected in another season than those of BÖRGESEN, and afterward KYLIN[1] also reported the tetraspores in his French specimen. Those data seem, as already mentioned by BÖRGESEN[2] to show that the formation of tetraspores in *L. tetrasporifera* is a natural future, but not an anomaly. On the contrary

1) H. KYLIN: Ueber die Entwicklungsgeschichte der Florideen (1930) p. 8.

2) F. BÖRGESEN: Marine algae from the Canary Islands, III, Rhodophyceae (1927) p. 47.

the present case seems to be quite different. Because of the coincidence of the specimens at hand in every characteristic with *L. pinnata* HARV. from the Atlantic, there can hardly be any doubt in identifying these specimens with *L. pinnata* HARV., though they show tetraspores which have never been reported in the Atlantic specimens. Therefore the occurrence of the tetraspores in the present specimens may not be taken as a natural feature.

Liagora clavata spec. nov. Pl. XII, 2, and Text-fig. 19.

Frons mollissima, lubrica, crusta calcarea tenue farinosa, in ramos ultimos alveolata, obducta; ca. 10 cm alta, paniculatim ramosa, ramulis ultimis ca. 5–7 mm longis, evidenter clavatis.

Axis centralis ex filamentis cylindricis, ca. 50 μ latis composita. Stratum periphericum ex filamentis ca. 350–450 μ longis, quater–quinquies dichotomis vel raro trichotomis comopsitum. Cellulae filamentorum peripherarum infra cylindricae, elongatae, ca. 10–16 μ latae, sursum breviores crassioresque, doliiformes, ca. 16–22 μ latae.

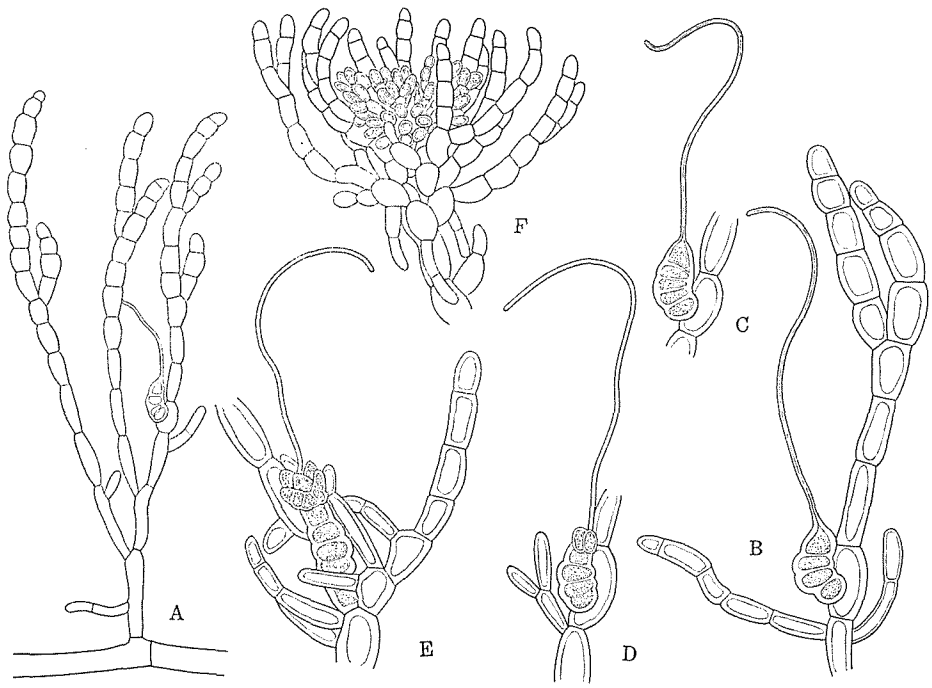

Fig. 19. *L. clavata* YAMADA. A. Assimilatory filament. ×135. B–C. Carpogonial branches. ×250. D–F. Development of gonimoblasts. D. E. ×250. F. ×145.

Species dioica. Rami carpogonii ex cellulis 4 vel 5 compositi, levissime curvati, ca. 18–20 μ crassi. Cystocarpia subhemiglobosa gonimoblastis laxis composita, ca. 100 μ lata, filamentis sterilibus involucrum circumdata. Carpospora obovata, ca. 20–25 μ longa. Antheridia ignota.

Japanese name: *Hukure-konahada.*

Hab.: Miyako-zima, Ryūkyū.

Frond about 11 cm high, very soft, strongly lubricous, weakly calcified; calcification in the ultimate branchlets (in alcohol preserved specimens) clearly alveolate; branches paniculate; ultimate branchlets about 5–7 mm long, evidently clavate in shape, in the upper part very weakly calcified, adhering firmly to paper when dried.

Central axis composed of parallel filaments of long, cylindrical cells with diameter of about 50 μ or a little less; assimilatory filaments about 350–450 μ long, usually 4–5 times dichotomous or rarely trichotomous, branching as often below as above, cells cylindrical, long, about 10–16 μ wide below, shorter and thicker, barrel-shaped, about 16–22 μ broad above, without terminal hairs.

Species dioicous. Carpogonial branches 4-celled or rarely 5-celled, slightly curved, about 20 μ broad, situated on the side of a (often somewhat inflated) cell in the middle portion of the assimilatory filaments. Cystocarps rather loose, subhemiglobose, about 100 μ broad (excepting involucre), with conspicuous involucre consisting of filaments as thick as the assimilatory filaments; carpospores obovate, 20–25 μ long.

There are only three specimens before the writer, which he collected on rocks in the sublittoral belt, about 1–2 fathoms deep. This species seems to belong to the group of *L. farinosa* LAMX., though antheridia are unknown. It can be distinguished from its allied species, especially from *L. pinnata* HARV. by its strong mucosity, by being dioicous and by the clavate ultimate branchlets.

There are abundant "monosporangial discs" among the assimilatory filaments.

Section IV. **MUCOSAE**

Liagora mucosissima spec. nov. Pl. XIII, and Text-fig. 20.

Frons mollissima, flaccida, lubricissima, modeste calce incrustat, ca. 15 cm alta, ca. 1 mm crassa, aequicrassa, ad apicem ramulorum ultimorum attenuata; ramis peniculatis densis, ramulis ultimis vel penultimis brevissimis, apice obtusis vel acutiusculis saepe spineis vel verrucosis.

Axis centralis ex filamentis 60–90 μ crassis et tenuioribus composita. Fila strati peripherici ca. 320 μ longa, ter–sexies dichotome vel raro trichotome ramosa, cellulis basalibus longis cylindraceis, ad dissepimentum constrictis, cellulis superioribus brevioribus moniliformibus, cellulis ultimis vel penultimis ellipticis vel obovoideis vel fere sphaericis, cellulis ultimis saepe pilo clavato ornatis.

Species dioica? Antheridia ignota. Rami carpogonii plerumque ex cellulis 4, sed saepe ex cellulis 5 vel 3 compositi, ca. 20 μ–24 μ crassi, erecti, ad cellulam filamentorum strati peripherici lateraliter vel subterminaliter vel terminaliter dispositi. Cystocarpia fere sphaerica vel hemisphaerica, filamentis involucrorum destituta. Carpospores elliptici vel longe ovoidei vel pyriformes, 46 $\mu \times 24\,\mu$ et ultra.

Japanese name: *Nuruhada.*

Hab.: Miyako-zima, Ryūkyū.

Frond very soft, flaccid, extreemly lubricous, not strongly calcified, about 15 cm high, about 1 mm thick, showing nearly the same thickness throughout whole length except only near the top of ultimate ramuli; branches paniculate, dense, ultimate or penultimate ramuli very short, obtuse or subacute at apex, thorn-like or wart-like.

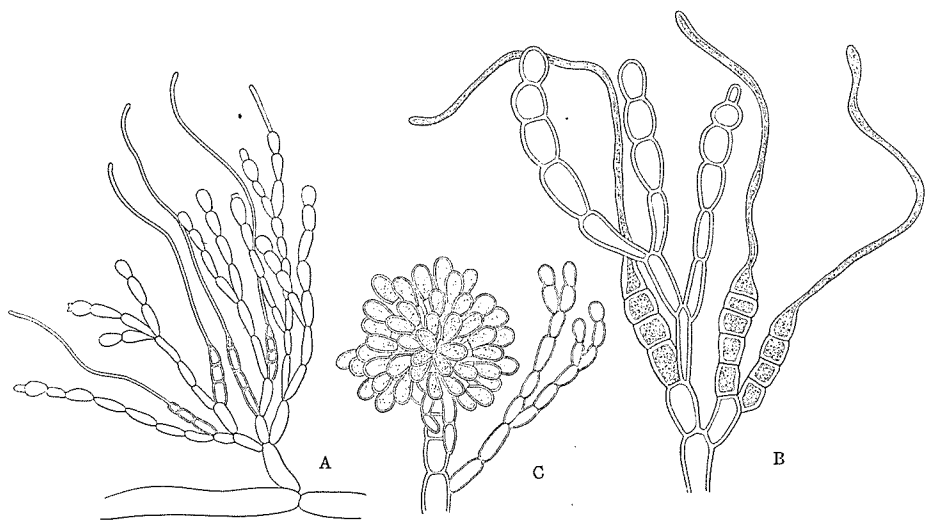

Fig. 20. *L. mucosissima* YAMADA.

A. Assimilatory filament bearing carpogonial branches. ×120.
B. Carpogonial branches. ×220. C. Cystocarp. ×130.

Central axis composed of longitudinal filaments about 60–90 μ thick and thinner ones, but rhizoids wanting in young portions of branchlets. Assimilatory filaments about 320 μ long, 3–6 times dichotomously or rarely trichotomously branched, cells long, somewhat cylindrical, at dissepiments constricted near the base, shorter and moniliform upwards, ultimate or penultimate cells elliptical or obovoid or nearly spherical, ultimate cells often provided with a clavate hair.

Species most probably dioicous. Antheridia unknown. Carpogonial branches composed of mostly four cells, often of three or five cells, about 20 μ thick, straight, lateral or subterminal or terminal on a cell of the assimilatory filaments. Cystocarps nearly spherical or hemispherical, destituting of involucral filaments, only providing with a few short descending rhizoidal filaments. Carpospores elliptical or long ovoid or pyriform, 46 $\mu \times 24\,\mu$ or slightly larger.

The new species very much resembles *L. mucosa* HOWE and *L. pedicellata* HOWE from the Bahamas in strong mucosity, paniculate branching, lateral or subterminal or terminal carpogonial branches and large spored, nude cystocarps which are provided with only a few short descending rhizoidal filaments. But in detail there are several constant differences between the present species and *L. pedicellata* HOWE to which *L. mucosissima* is related most nearly. According to HOWE *L. pedicellata* HOWE is monoicous while no antheridium is to be found in the specimens at hand though carpogonial branches as well as cystocarps are found very commonly in them. Further in HOWE's specimens the carpogonial branches are provided with the usually long pedicel cell, but such a long pedicel cell can not be distinguished in the present specimens.

Liagora formosana spec. nov. Pl. XIV–XV, and Text-figs. 21–22.

Frons mollissima, flaccida, mucosissima, 15 cm alta, paniculatim ramosa, ramulis ultimis apice obtusis, calce leve, sicco pulverulenta obducta.

Axis centralis in ramulis ex filamentis diam. 10–20 μ crassis, in inferioribus partibus frondis ex filamentis magis crassioribus, diam. 50–80 μ crassis et tenuioribus, ca. 8–12 μ crassis intermixtis, composita. Stratum periphericum ex filamentis, ca. 350–500 μ longis compositum. Filamenta starati peripherici quater vel quinquies dichotoma, infra vix divisa, ex cellulis elongatis, cylindraceis, 3–6 μ crassis, sursum saepe dichotoma, ex cellulis brevioribus ovatisque, $15 \times 10\,\mu$ composita; cellulis ultimis interdum pilis coronatis.

Species dioica. Antheridia in cellulis ultimis filorum assimilantium

evoluta. Rami carpogonii ex 2–3 cellulis compositi, ca. 10–16 μ crassi, leviter curvati, ad cellulam inflatam in parte inferiore filorum assimilantium lateraliter dispositi. Cystocarpia densa, hemiglobosa, ca. 90–160 μ crassa, involucris imperfectis.

Japanese name: *Sima-konahada.*

Hab.: Taitō, Formosa. (Washed ashore).

Frond very soft, flaccid, strongly lubricous, 15 cm high, paniculately branched, with obtuse ultimate branchlets; calcification not strong, pulverulente when dried. Central axis composed of long cylindrical cells with diameter of 10–20 μ in branchlets, in the lower portion of the frond of thicker (50–80 μ thick) filaments and thinner, about 8–12 μ, thick ones; assimilatory filaments about 350–500 μ long, 4–5 times dichotomous, usually not branched and cells long, nearly cylindrical, 3–6 μ thick below, often dichotomous, cells short and ovate, about 15×10 μ above, ultimate cells bearing sometimes hairs or often short young hairs.

Plant dioicous. Antheridia crowded on the ultimate cells of the assimilatory filaments; carpogonial branches situated laterally on a usually inflated cell in the lower portion of the assimilatory filaments, composed of 2–3 cells, curved, about 10–16 μ broad; cystocarps compact, hemiglobose, about 90–160 μ broad, involucre-like filaments

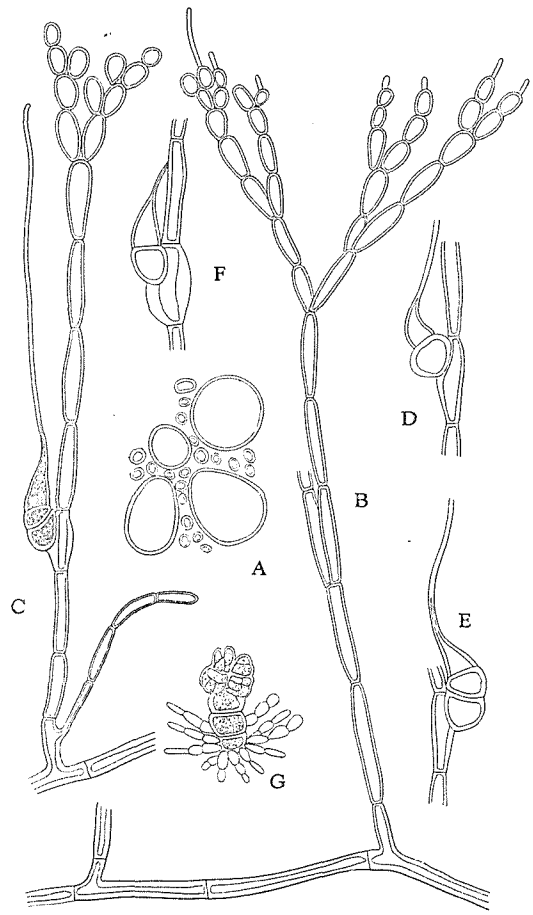

Fig. 21. *L. formosana* YAMADA. A. Cross-section of central axis. ×230. B. Assimilatory filament. ×230. C. Assimilatory filament bearing a carpogonial branch. ×230. D–F. Carpogonial branches. ×230. G. Development of gonimoblasts. ×360.

imperfect, composed of appressed-decurrent and pendent or slightly ascending short rhrizoidal filaments; carpospores ovate, about 8μ long.

Very unfortunately only two specimens of this species which were found washed ashore were collected. But it is very evident that the present species is allied to *L. mucosa* HOWE, and it appears to come very nearly to *L. mucosa* HOWE, but it differs from this Bahama species by its less-celled carpogonial branch, its smaller carpospores, its longer assimilatory filaments etc.

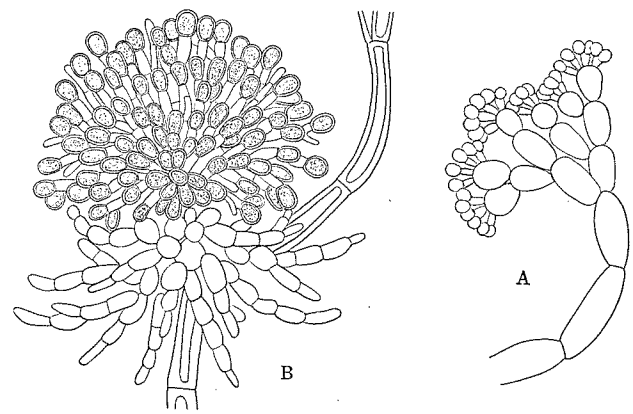

Fig. 22. *L. formosana* YAMADA.
A. Antheridia. ×470. B. Cystocarp. ×300.

PLATE I

PLATE 1

Liagora orientalis J. Ag. × ⅔

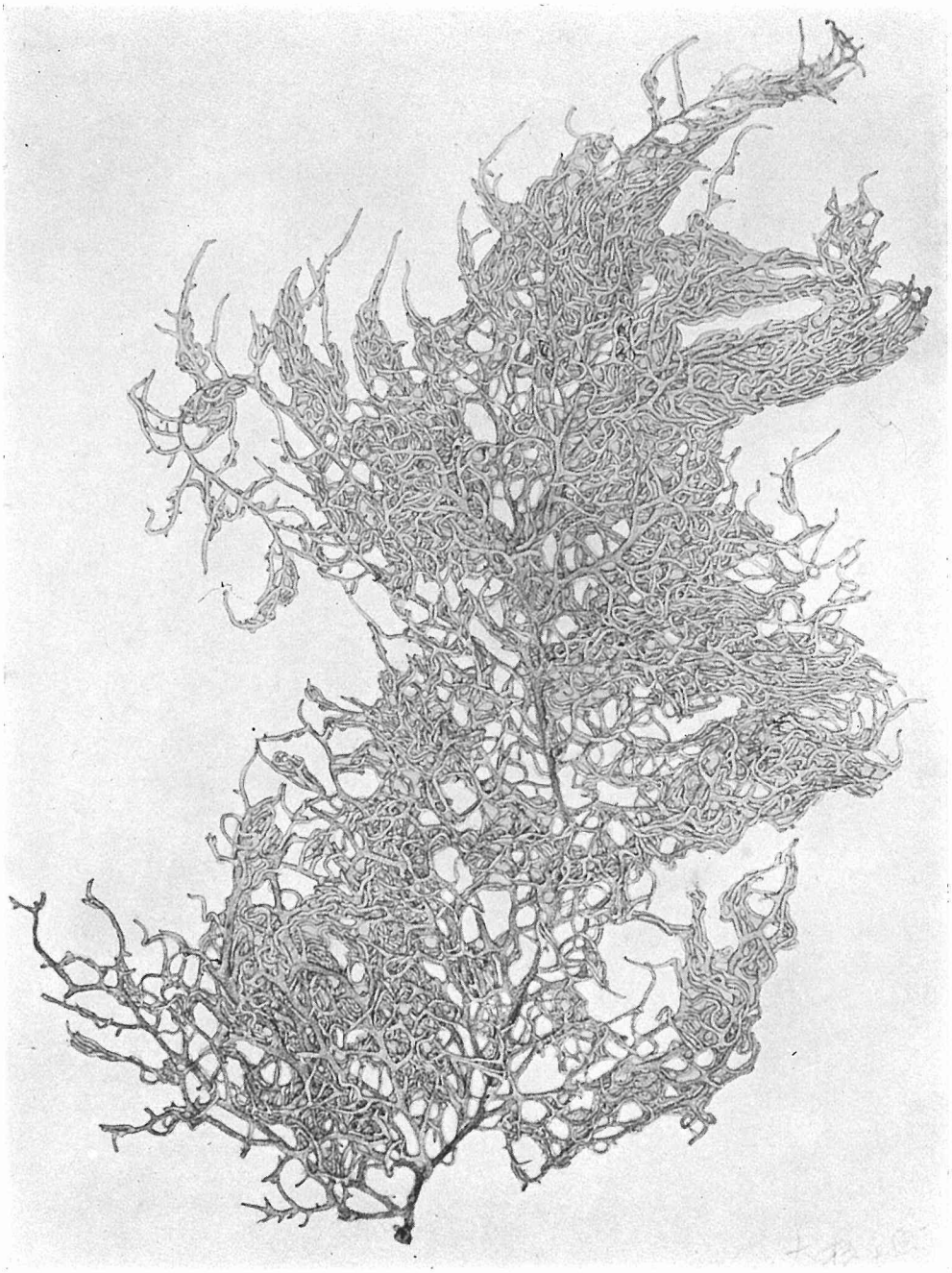

PLATE II

PLATE 2

Liagora Boergesenii YAMADA ×1

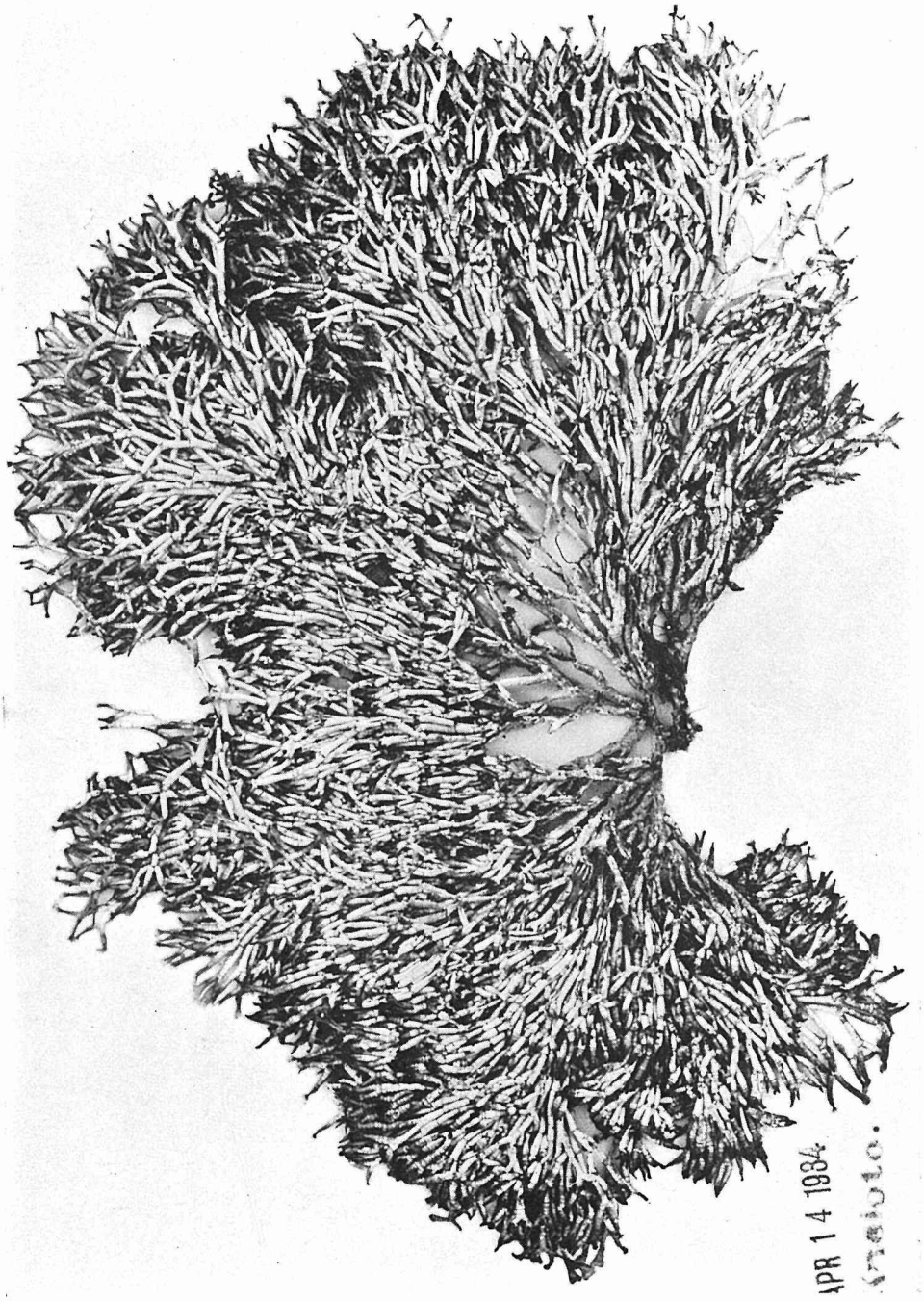
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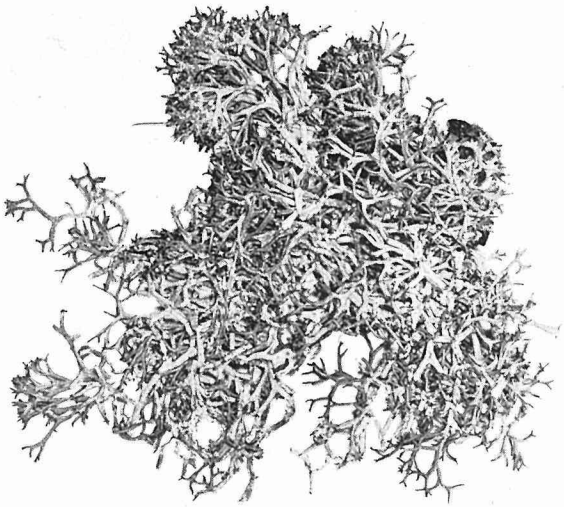
PLATE III

PLATE 3

1. *Liagora caenomyce* DECNE. ×1
2. *Liagora Setchellii* YAMADA ×1



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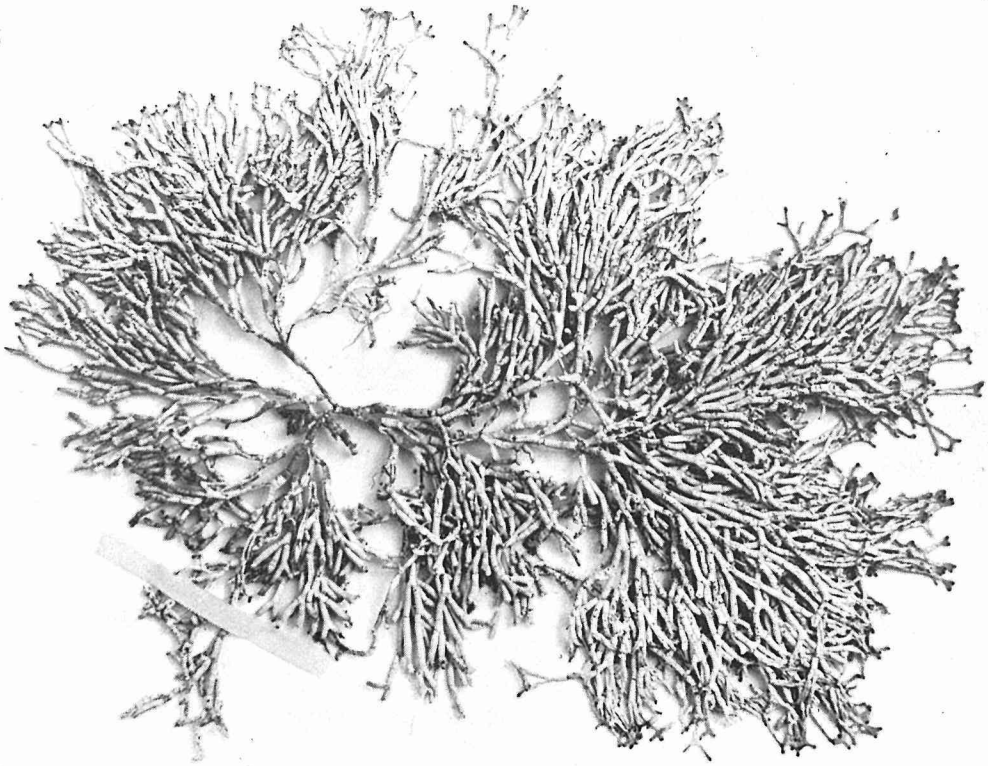

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PLATE IV

PLATE 4

Liagora japonica YAMADA. Slightly reduced.

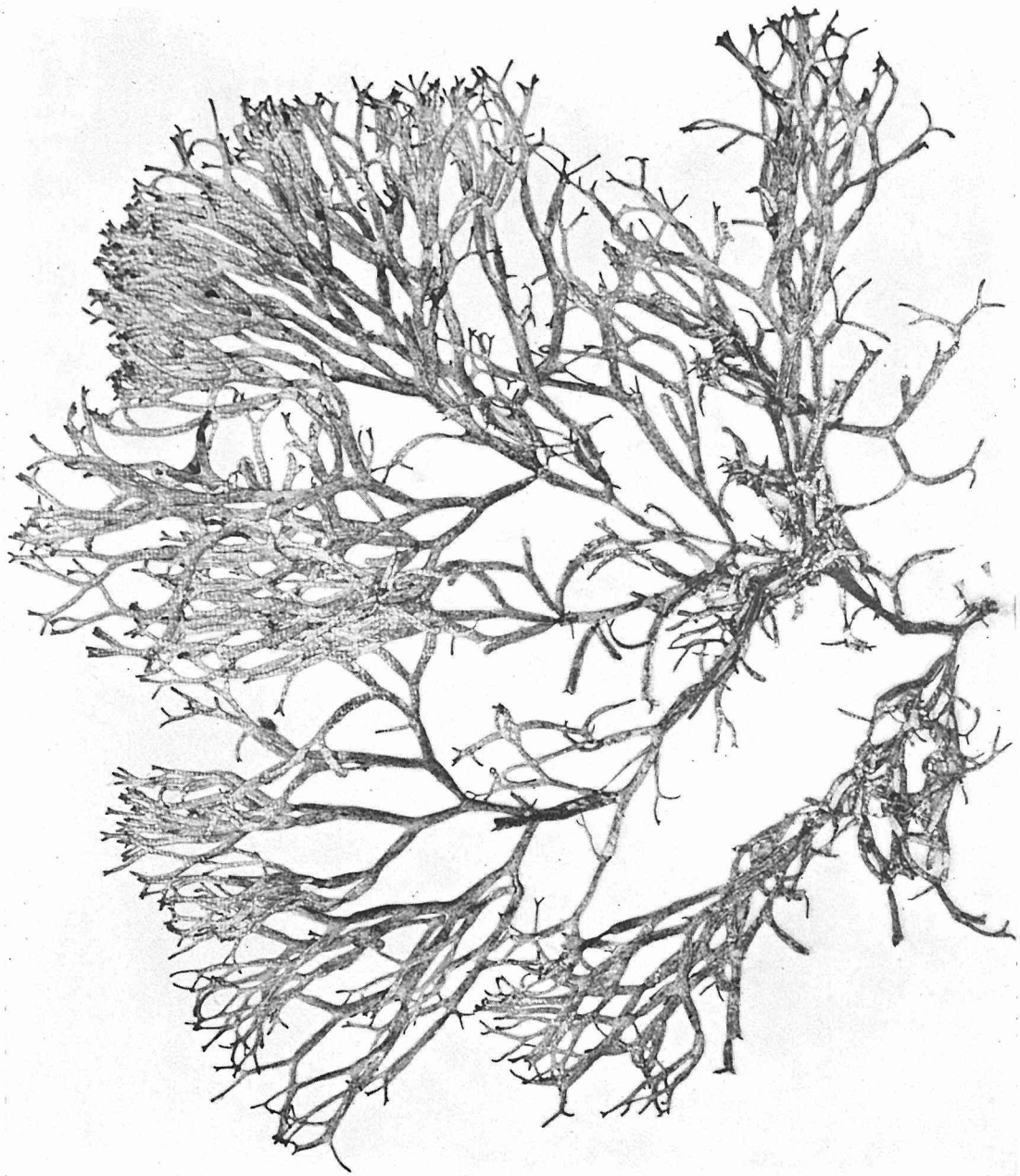

PLATE V

PLATE 5

Liagora Segawai YAMADA ×1

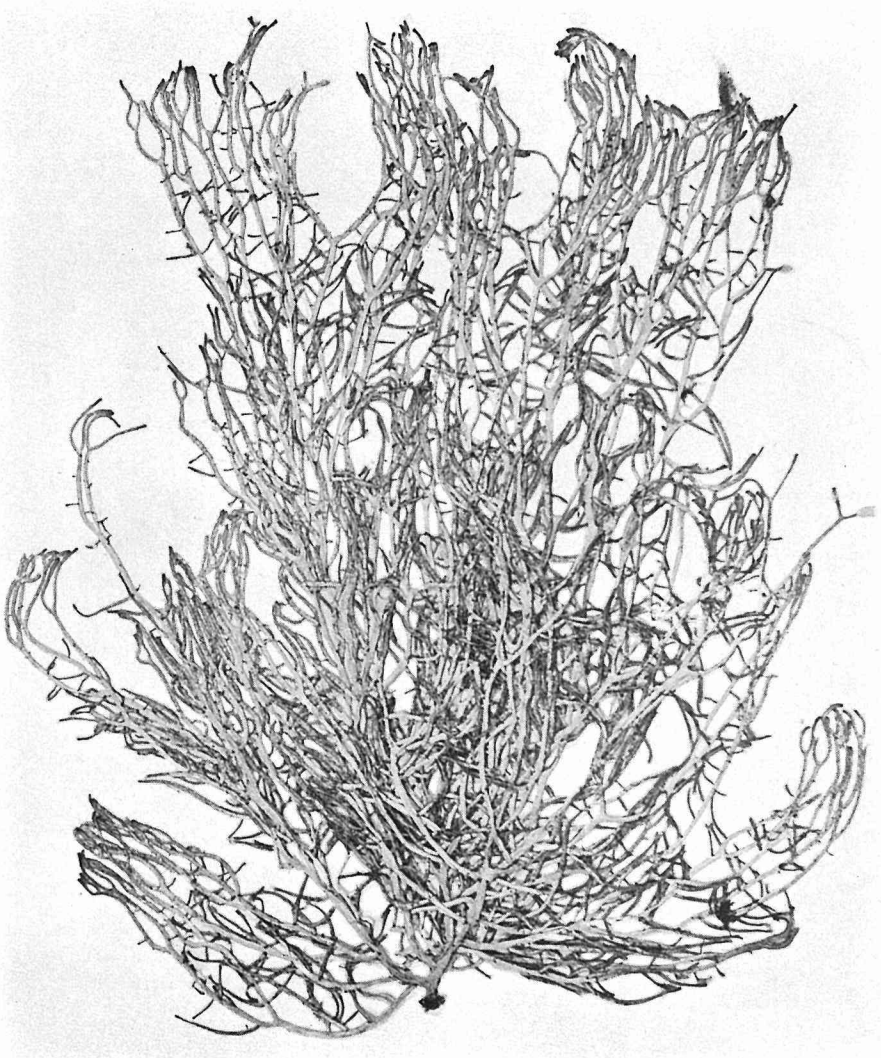

PLATE VI

PLATE 6

Liagora ceranoides LAMX. f. *pulverulenta* YAMADA ×1

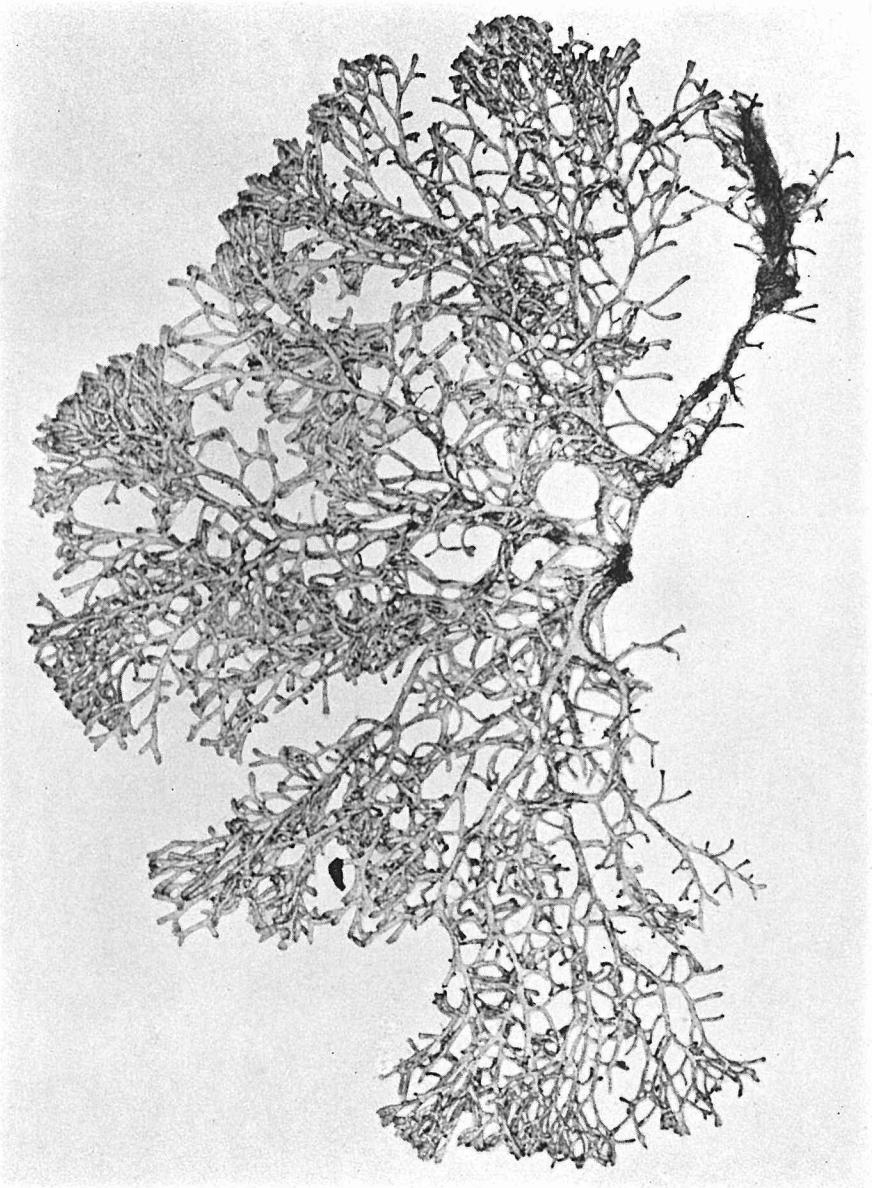

PLATE VII

PLATE 7

Liagora decussata MONT. × ¾

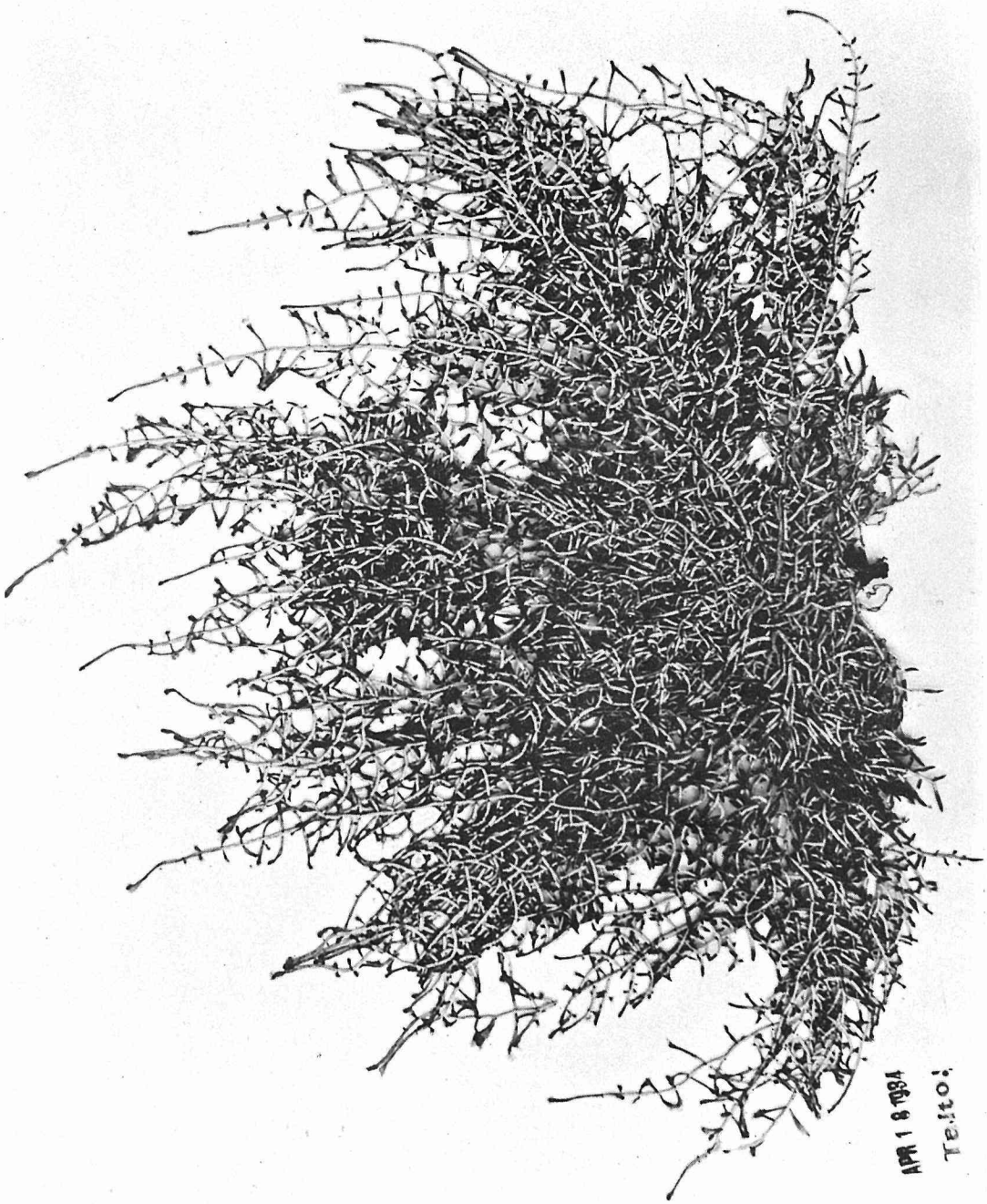
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PLATE VIII

PLATE 8

Liagora farinosa LAMX. ×1

The specimen from Kaikō, Formosa, which coincides with *L. elongata* ZANARD.

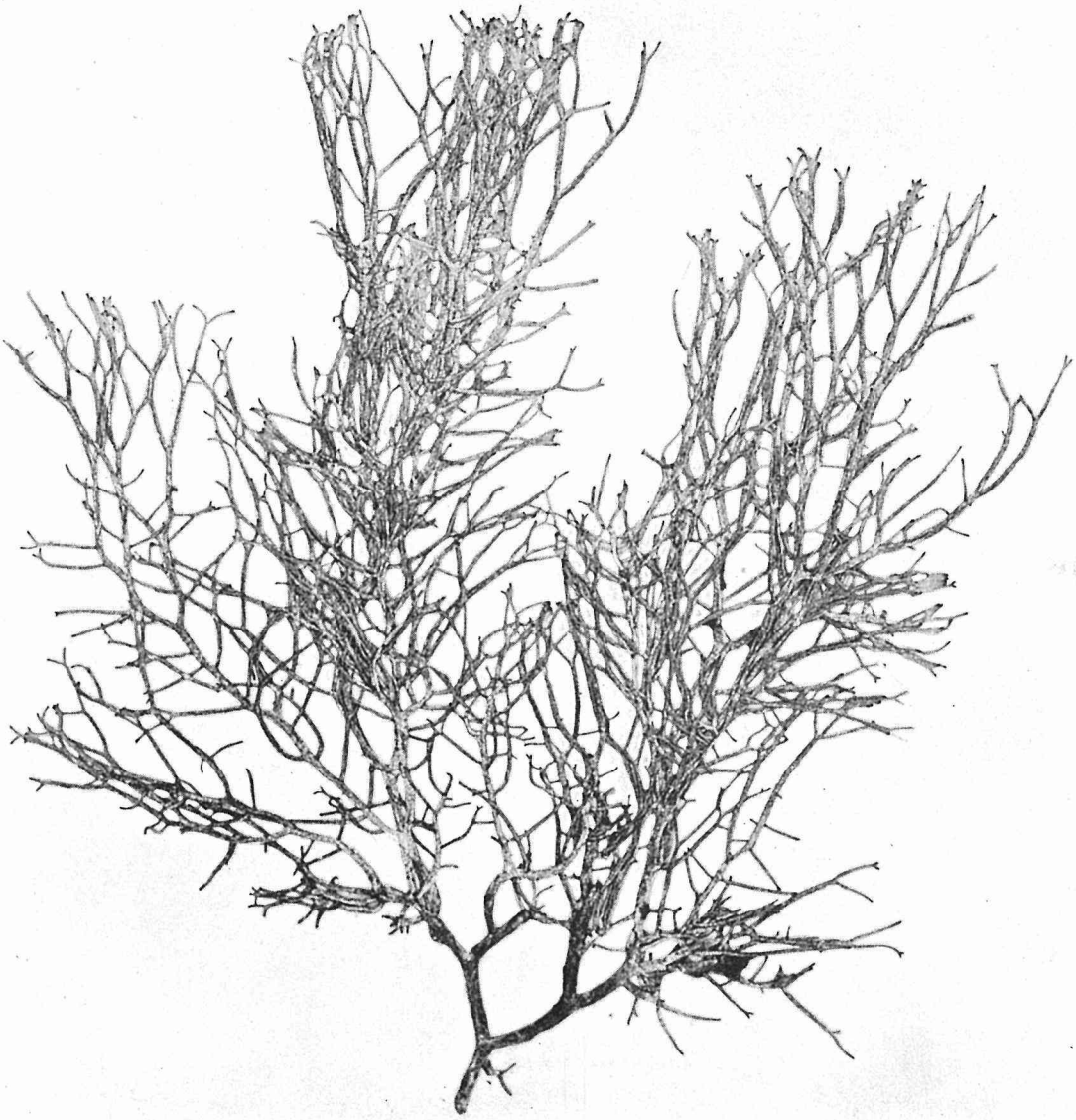


PLATE IX

PLATE 9

Liagora farinosa LAMX. ×1

The specimen from Daibanratu, Formosa, which concides with *L. Cheyneana* HARV.

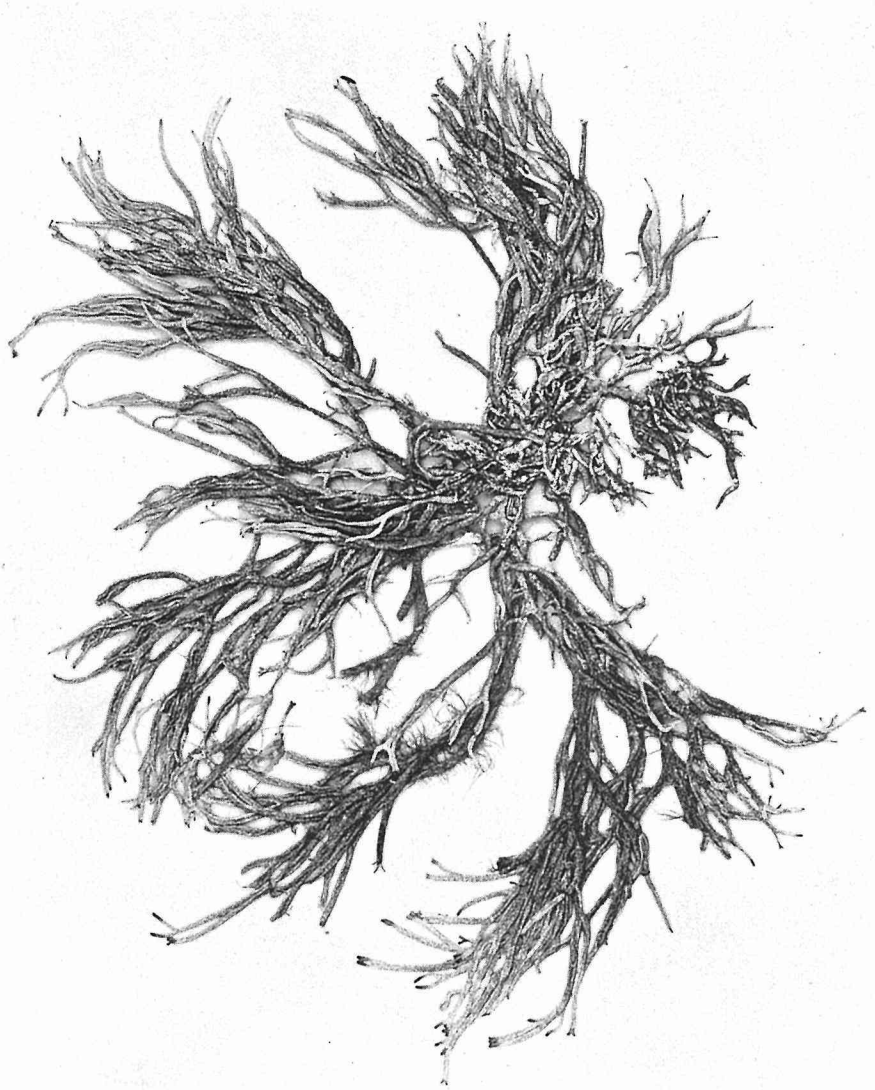


PLATE X

PLATE 10

Liagora farinosa LAMX. f. *pinnatiramosa* YAMADA ×6/7

PLATE XI

PLATE 11

Liagora pinnata HARV. ×1

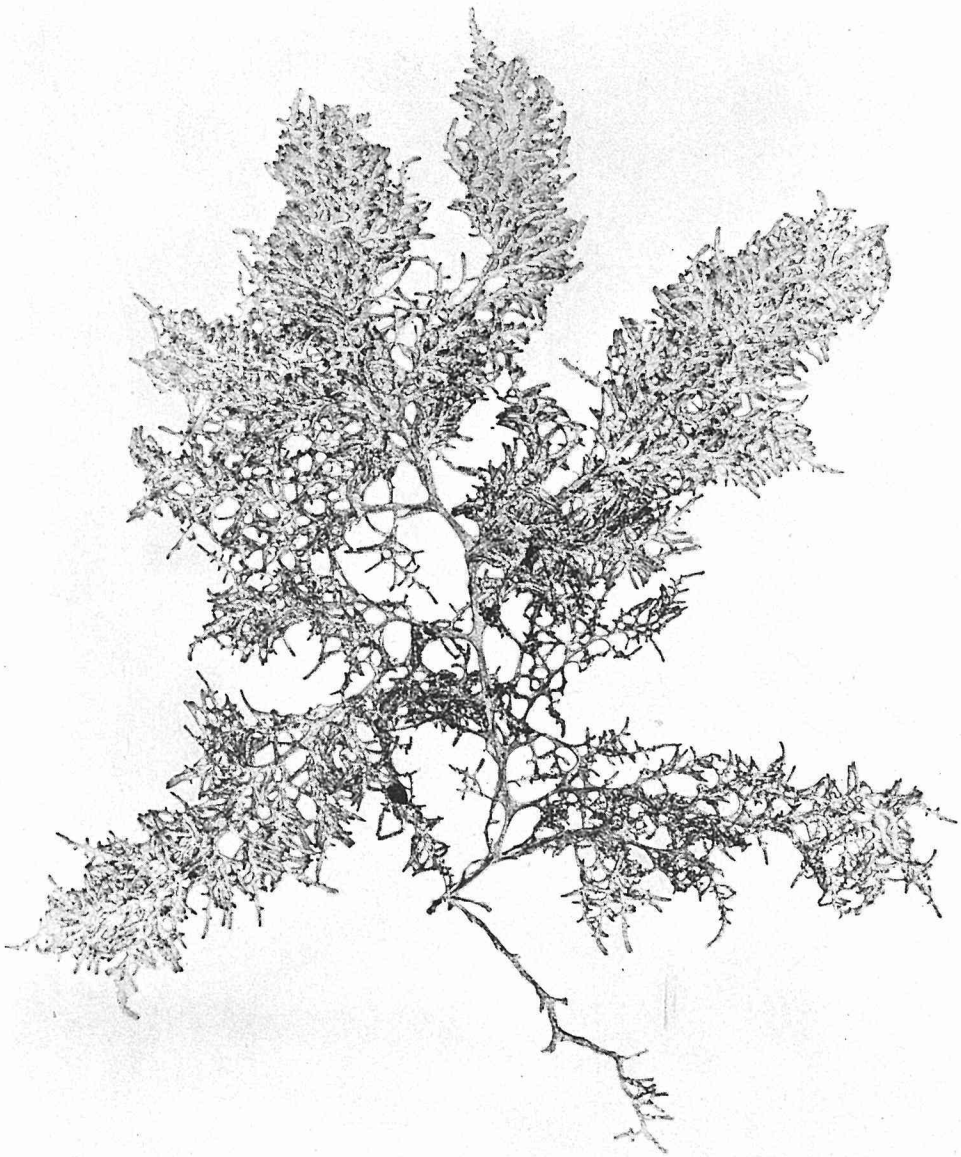
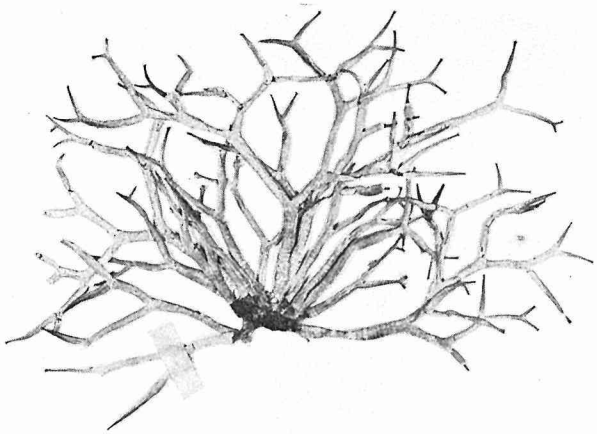


PLATE XII

PLATE 12

1. *Liagora robusta* YAMADA ×1
2. *Liagora clavata* YAMADA ×1



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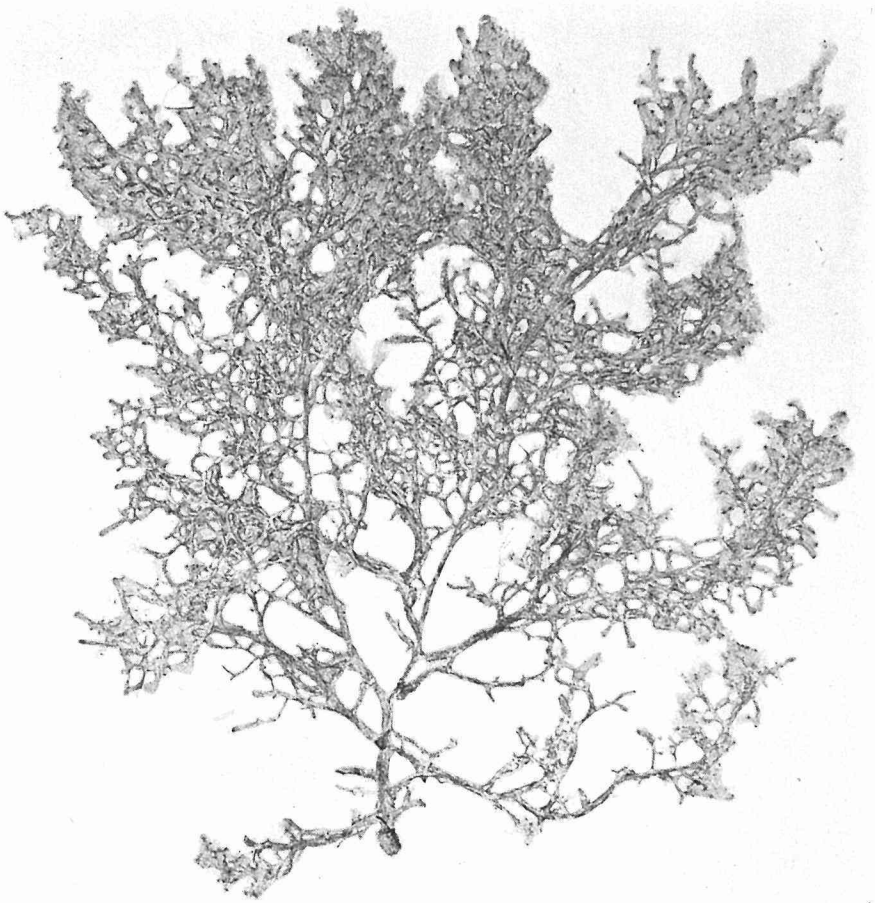

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PLATE XIII

PLATE 13

Liagora mucosissima YAMADA ×1

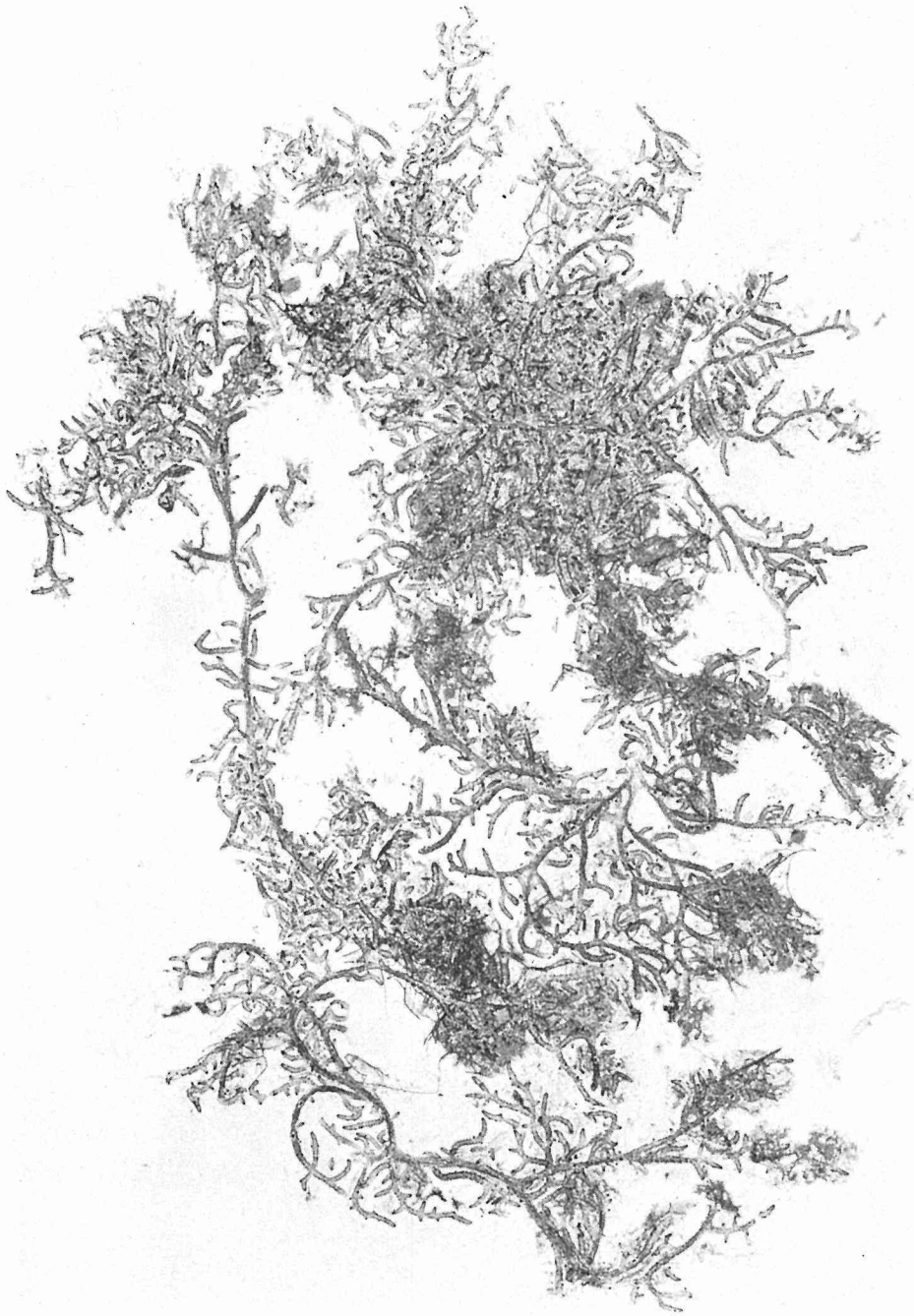

PLATE XIV

PLATE 14

Liagora formosana YAMADA ♀ × ¾

PLATE XV

PLATE 15

Liagora formosana YAMADA ♂ ×1