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The Genus *Galaxaura* from Japan

By

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With Plates XXXIV–XLV.

After the establishment of the genus *Galaxaura* by LAMOUROUX (1812) it was divided into three sections by DECAISNE in 1842, namely, *Dichotomaria*, *Eugalaxaura* and *Microthoe*. Afterward J. G. AGARDH divided the genus into four sections, enumerating eight species and five doubtful ones in his “*Epicrisis*”. These four sections are *Alysium*, *Eugalaxaura*, *Microthoe*, and *Dichotomaria*. The first monographic work, “*Floridé-slägtet Galaxaura*” was done by KJELLMAN in 1900, in which he divided the genus into nine sections (*Rhodura*, *Microthoe*, *Papulifer*, *Eugalaxaura*, *Heterotrichum*, *Brachycladia*, *Vepreculae*, *Laevifrons*, and *Dichotomaria*) and enumerated 62 species. Of these nine sections, five were established by KJELLMAN. The section “*Brachycladia*” was considered by SONDER as an independent genus and this view is adopted by DE TONI in his “*Sylloge Algarum*, Vol. 4”.

In 1917 HOWE¹⁾ reported that the “*Cameratae*” structure pointed out by KJELLMAN is characteristic of the tetrasporic individuals of *G. obtusata* LAMX., while the “*Spissae*” structure is constant to the sexual ones of the same species. Next year, HOWE²⁾ again reported that similar relations existed between several other pairs of groups hitherto considered by KJELLMAN to be independent sections and species. For instance the species of section “*Vepreculae*” of KJELLMAN represent the sexual plants, and those of section “*Brachycladia*” the tetrasporic plants of the corresponding species. And group *Rhodura* is made up of tetrasporic plants whose corresponding male and female plants are to be found in groups *Microthoe* and *Eugalaxaura* of KJELLMAN.

Of course cultural demonstrations are needed in order to settle the

1) M. A. HOWE, A note on the structural dimorphism of sexual and tetrasporic plants of *Galaxaura obtusata*. Bull. Torr. Bot. Club. Vol. 43, 1917.

2) M. A. HOWE, Further notes on the structural dimorphism of sexual and tetrasporic plants in the genus *Galaxaura*. Brook. Bot. Gard. Memoirs, Vol. 1, 1918.

question definitely, but nevertheless HOWE's supposition seems to the writer very convincing, from having already observed the structural dimorphism of the sexual and tetrasporic plants of *G. falcata* KJELLM., *G. papillata* KJELLM. and others. But at present in treating this genus it is almost impossible to establish a new classification instead of KJELLMAN's one. Therefore in the present paper the writer has for convenience followed KJELLMAN's monograph in enumerating 23 Japanese species.

The present study was carried out under the guidance of Prof. Y. YAMADA as a graduation thesis. The material used for the study belongs mostly to the herbarium of Prof. YAMADA many items of which have been compared by him with the type specimens of KJELLMAN preserved in Upsala, with the herbarium of the late Dr. K. OKAMURA and the present writer's own collection.

The writer wishes to offer his best thanks to his teacher, Prof. Y. YAMADA of the Botanical Institute of Hokkaido Imperial University, who gave most valuable suggestions and kind encouragement. Thanks are also due to the late Dr. K. OKAMURA, who gave permission to examine his herbarium and allowed me the writer to use his libraries.

Key to the Sections and Species

Section 1. *Rhodura* KJELLMAN

Frond cylindrical, villous, hirtous throughout the whole length; medullary tissue consisting of rather thin (colourless) filaments, entangled loosely in an irregular manner; assimilating layer composed of long and short assimilating filaments; only tetrasporangia known.

1. Frond with only long assimilating filaments.....*G. rudis* KJELLM.
2. Frond with long and short assimilating filaments.
 - A. Long and short assimilating filaments in obvious alternating transverse zones*G. subverticillata* KJELLM.
 - B. Long and short assimilating filaments evenly distributed over the whole surface of the frond.
 - a. Apical cells of the short assimilating filaments larger than the basal ones*G. fasciculata* KJELLM.
 - b. Apical cells of the short assimilating filaments smaller than the basal ones.
 - i. Short assimilating filaments composed of 2-3 cells; long assimilating filaments not branching*G. fruticulosa* KJELLM.
 - ii. Short assimilating filaments usually composed of 2 cells only; long assimilating filaments often branching.....*G. delabida* KJELLM.

Section 2. **Microthoe** DCsNE.

Thallus terete throughout the whole length, but often complanate above; medullary tissue consisting of dichotomously branched, loosely entangled filament; assimilating layer forming a compact parenchymatous tissue, composed of 3-4 layers of cells; epidermal cells flattened, often bearing assimilating filaments; only sexual organs known.

1. Frond glabrous, assimilating filaments usually wanting; central axis quite free from lime *G. pacifica* TANAKA
2. Frond almost glabrous, assimilating filaments very short and scarce and not evenly distributed *G. glabriuscula* KJELLM.
3. Assimilating filaments evenly distributed over the whole surface excepting only upper complanate portion.
 - a. Branches subregularly dichotomous or often umbellate; internode rather short *G. cuculligera* KJELLM.
 - b. Branches regularly dichotomous or very rarely umbellate; internode rather long, and diameter of segments nearly equal *G. elongata* J. AG.

Section 3. **Papulifer** KJELLM.

Frond cylindrical, regularly dichotomous, often tapering toward the apex; central axis consisting of rather thick, loosely entangled filaments, quite free from lime; cortical layer consisting of loose parenchymatous tissue composed of 3 layers, cells of outermost layer obconical or pyramidal in shape, bearing single or two rounded papillae. *G. papillata* KJELLM.

Section 4. **Eugalaxaura** DCsNE.

Frond fragile, glabrous, furcate and decompound with proliferations; assimilating layer consisting of separable, moniliform cells; assimilating filaments wanting; central axis consists of loosely entangled filaments; only sexual organs known *G. fastigiata* DCsNE.

Section 5. **Brachycladia** SONDER

Frond regularly dichotomous, usually complanate, stipitate; stipe terete; assimilating layer consisting of parenchymatous cells connected closely with each other; assimilating filaments commonly long elliptical or obovoid in shape (very rarely cylindrical), provided with well developed chromatophores; tetrasporangia on the assimilating filaments with short stalk.

- A. Frond divided into subcylindrical stipe and complanate leaves ARBORESCENTES
 1. Terminal cells of assimilating filaments commonly rounded.
 - a. Arborescent, stipe long, branching at narrow angle *G. falcata* KJELLM.
 - b. Frutescent, stipe short, branching at broad angle *G. arborea* KJELLM.

2. Terminal cells of assimilating filaments usually apiculate.....*G. apiculata* KJELLM.
- B. Stalk and leaves not clearly distinguishable, lower portion of the leaves subtereteFRUTICULOSAE
.....*G. clavigera* KJELLM.

Section 6. *Vepreculae* KJELLM.

Frond complanate or subcomplanate, regularly dichotomous; stipitate; stipe terete; assimilating tissue consisting of compact parenchymatous layer bearing one-celled (very rarely 2–3 celled) free assimilating papillae; only sexual organs known.

1. Frond almost cylindrical, often articulate.....*G. articulata* TANAKA
2. Frond complanate or subcanaliculate.
 - a. Branches irregularly dichotomous or sympodial*G. Kjellmanii* WEBER VAN BOSSE
 - b. Branches regularly dichotomous.
 1. Arborescent, stipe long, each epidermal cell always bearing a papillose process*G. hystrix* KJELLM.
 2. Arborescent, internodes rather long, epidermal cells wanting papillose process excepting near the opening of the antheridial conceptacle*G. elegans* TANAKA
 3. Internode rather short, very wide (3–4 mm)*G. latifolia* TANAKA
 4. Frutescent, stipe short, epidermal cells not always bearing a papillose process*G. veprecula* KJELLM.

Section 7. *Dichotomaria* DCNE.

Frond terete, caulescent, regularly dichotomous, distinctly articulate; segments swollen; cortex consisting of a parenchymatous layer and assimilating filaments; medullary tissue consisting of rather thin entangling filaments.

1. Assimilating filaments consisting of funnel-shaped epidermal cells and cylindrical stalk cellsCAMERATAE
.....*G. robusta* KJELLM.
2. Assimilating filaments consisting of two parenchymatous layers.....SPISSAE
.....*G. obtusata* (SOLAND.) LAMX.

Enumeration of Species

Galaxaura rudis KJELLMAN

Pl. XXXIV, fig. 1, and Text-figs. 1–2.

Floridé-släktet *Galaxaura* (1900), p. 43, tab. 2, figs. 1–9, tab. 20, fig. 11; DE TONI, Syll. alg., vol. 6 (1924), p. 109; OKAMURA, On the mar. alg. from Kôtôsho (Bull. of the Biogeogr. Soc. of Japan, vol. 2, 1931), p. 109.

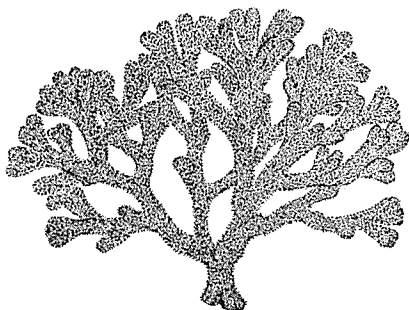


Fig. 1. *Galaxaura rudis* KJELLM.
×1.

Frond cylindrical, 2–4 cm high, 1.3 mm in diameter (not counting assimilating filaments), conspicuously villous, caespitose, more or less irregularly dichotomous or rarely umbellate; segments 2–4 mm long, obtuse at the apex; medullary filaments running very loosely, about $13\text{--}18\mu$ thick; supporting cells at the periphery not well developed or wanting; assimilating layer consisting of only long filaments, encrusted with lime; filaments about 2.5 mm long, composed of usually more than 15 cells and often ramified; all cells of filaments almost similar, about 55μ long and $18\text{--}21\mu$ broad, having well developed chromatophores. Colour reddish brown but dark reddish brown when dried.

Japanese name. *Husa-garagara*.

Hab. Kôtôsyô, Kwasyôto, Formosa. Growing on rocks near the low-tide mark.

Distrib. Friendly Islands, Pacific Ocean.

Recently OKAMURA reported the occurrence of this species in Kôtôsyô, Formosa, but he did not touch the anatomy of the frond of this plant. Our plant agrees very well with the description of KJELLMAN (l. c.) in habit. But in them the supporting cells are very small or sometimes wanting, and the basal cells of the assimilating filaments are smaller than those in KJELLMAN's figures. Otherwise, however, the specimens at hand show

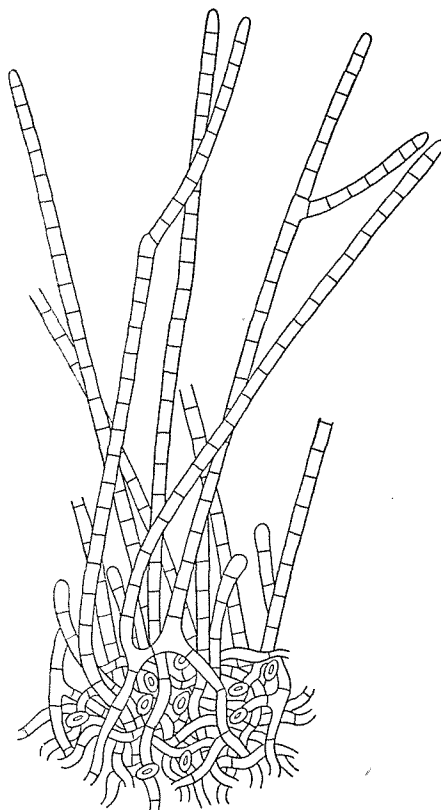


Fig. 2. *Galaxaura rudis* KJELLM.
Transverse section of the frond. ×75.

so close affinity that they have to be considered identical with *G. rudis* KJELLMAN.

Galaxaura subverticillata KJELLMAN

Pl. XXXIV, fig. 2, and Text-figs. 3-4.

l. c., p. 48, tab. 3, figs. 12-14, tab. 20, fig. 17; BÖRGESSEN, Mar. alg. of the Danish West Ind., vol. 2 (1916), p. 92, fig. 97; HOWE, in Britton and MILLSPAUGH's Bahama fl. (1920), p. 558; DE TONI, l. c., p. 113.

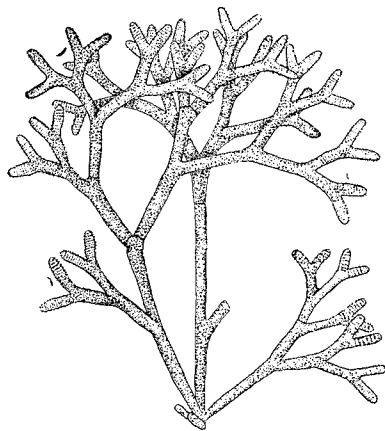


Fig. 3. *Galaxaura subverticillata* KJELLM. $\times$ ca. 1.

Frond 3-5 cm high, coarse, cushion-shaped, regularly dichotomous; internodes cylindrical, 0.8-1.5 mm in diameter, of variable length but usually short, seldom exceeding 1 cm, often constricted at the base; medullary filaments about $12-18\mu$ thick, ramifying rarely, entangled in an irregular manner; supporting cells at the periphery well developed, quadrangular, about 40μ in diameter; both long and short assimilating filaments alternately verticillate, especially at the upper part of the frond; short assimilating filaments usually consisting of 2-3 cells; basal cells largest, obovoid or ellipsoid, $45-55\mu$ long and $25-35\mu$ broad; apical cells also obovoid, $17-22\mu$ in diameter; basal cells of long assimilating filaments similar to those of the short ones; cells of long filaments cylindrical, having chromatophores, about 15μ thick and 30μ long. Colour grayish

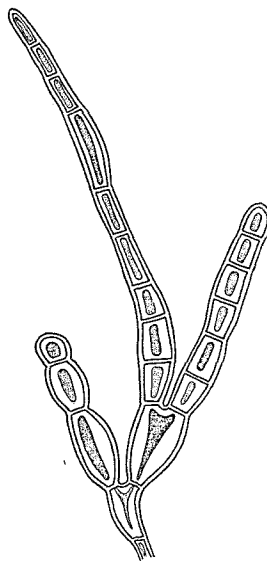


Fig. 4.

Galaxaura subverticillata KJELLM.
Long and short assimilating filaments issued from the same supporting Cell. $\times 217$.

olive-green with a reddish tinge especially in the younger parts of the frond.

Japanese name. *Sima-garagara*.

Hab. Sato, Kosiki-zima.

Distrib. Florida; West Indies; Pacific Ocean.

The present species very closely resembles *G. fruticulosa* KJELLM., but in external appearance it differs from the latter (only) in its alternately verticillate arrangement of the assimilating filaments, especially in the upper part of the branches. This character serves to distinguish separate the present species from other species of the section *Rhodura*. Short assimilating filaments usually consist of three cells but sometimes of two, and resemble those of *G. fruticulosa* KJELLMAN. In the present specimens the basal cells of the filaments are not so large as those of the specimens from Florida and the West Indies.

Galaxaura fasciculata KJELLMAN

Pl. XXXIV, fig. 3, and Text-figs. 5-6.

l. c., p. 53, tab. 5, figs. 1-9, tab. 20, fig. 14; WEBER VAN BOSSE, Liste des alg. du Siboga, vol. 2 (1921), p. 211; DE TONI, l. c., p. 115.

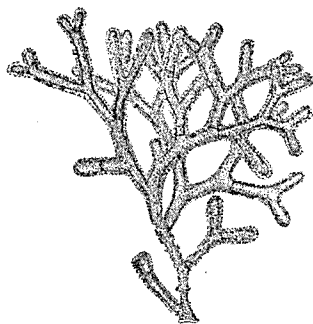


Fig. 5. *Galaxaura fasciculata* KJELLM. $\times 1$.

Frond 5-12 cm high, 2 mm thick, villous, caespitose, regularly dichotomous, forming a large dense tuft, attaching to the substratum by means of a broad disc; internodes cylindrical, 1-2 cm long, but variable in length, 1 mm

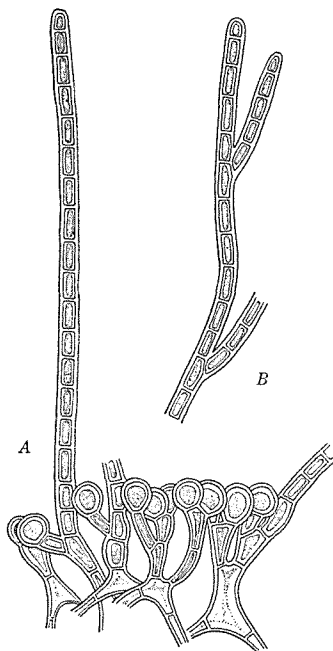


Fig. 6. *Galaxaura fasciculata* KJELLM.

A. Transverse section of the frond. $\times 125$.

B. Branching of the assimilating filament. $\times 125$.

wide except hairs; hairs evenly distributed over the whole surface of the frond, giving it a felted appearance; medullary tissue consisting of rather thin-walled filaments, whose diameter is about 10μ ; assimilating tissue dense, about 120μ thick, encrusted with lime; supporting cells of the assimilating filaments polygonal, not well developed; short assimilating filaments consisting of two or three cells, increasing rapidly in size upwards; basal-cells cylindrical or elliptical, about 36μ long and 18μ broad; terminal cells almost globose or depressed globose, about $30\text{--}42\mu$ in diameter, scarcely connected with each other; long assimilating filaments reaching a length of about 1 mm and often branching, composed of 12–35 cells. Colour light reddish brown or olive-green with a more or less reddish tinge.

Japanese name. *Birôdo-garagara*.

Hab. Kôtôsyô, Kwasyôto, Formosa; Titi-zima, Haha-zima, Bonin Islands; Korrôr, Palao Islands. Growing on rocks in quiet places.

Distrib. Malay Archipelago; Indian Ocean.

Galaxaura fruticulosa KJELLMAN

Pl. XXXV, fig. 2, and Text-figs. 7–8.

l. c., p. 51, tab. 4, figs. 4–16, tab. 20, fig. 19; DE TONI, l. c., p. 115.

Frond caespitose, loosely fruticulose, tenacious, villous, 3–8 cm high, $850\mu\text{--}1\text{ mm}$ wide, cylindrical, irregularly subdichotomous or corymbose, attached to the substratum by means of a large disc; internodes vary

between 0.5–1.5 cm in length, obtuse at the apex, often constricted at the base; central axis consisting of loosely entangled filaments, whose diameter is $8\text{--}15\mu$; supporting cells at the periphery well developed, irregularly trigonal or quadrate, $40\text{--}48\mu$ in diameter; peripheral tissue consisting of short and long assimilating filaments, about 150μ thick, encrusted with lime; short assimilating filaments consisting of three cells but rarely two cells only, slightly decreasing in diameter upwards; basal cells largest, elliptical or ovate, about $36\text{--}50\mu$ long, 25--

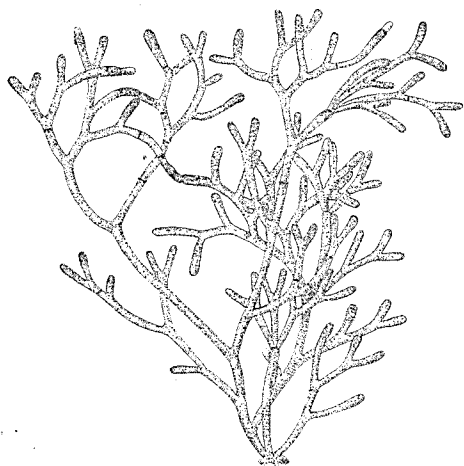


Fig. 7. *Galaxaura fruticulosa* KJELLM.
× 1.

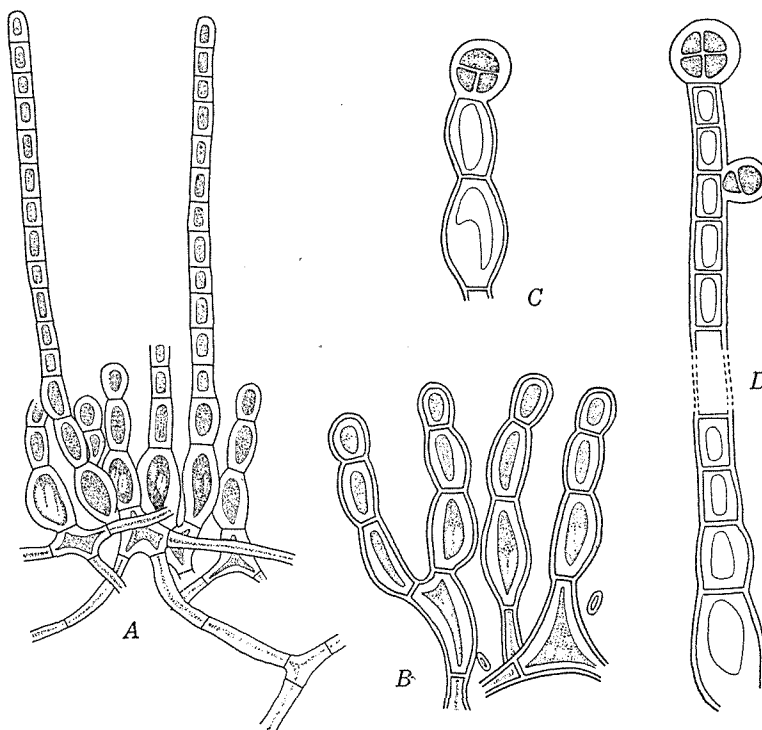


Fig. 8. *Galaxaura fruticulosa* KJELLM.

A. Transverse section of the frond. $\times 165$.

B. Short assimilating filaments. $\times 310$.

C. D. Assimilating filament with tetrasporangia. $\times 310$.

36μ broad; apical cells smallest, spherical, about 32μ in diameter; long assimilating filaments cylindrical, composed of about 14 cells or more, not ramified; tetrasporangia mostly elliptical or spherical, $24-30\mu$ in diameter, sessile, cruciately divided, produced terminally or laterally on the assimilating filaments. Colour dark reddish brown or reddish brown.

Japanese name. *Mosa-garagara*.

Hab. Cape Nomo, Hizen Prov.; Hutae, Amakusa; Makurazaki, Satuma Prov.; Gotô Islands. Growing on rocks near the low-tide mark. Tetrasporangia in late summer.

Distrib. Endemic.

The present species seems to be distributed rather widely in the southwestern sea. Our numerous specimens agree well with the description of this species illustrated by KJELLMAN except for the fact that the individual cells of the short assimilating filaments are unequal in diameter.

Galaxaura delabida KJELLMAN

Pl. XXXV, fig. 1, and Text-figs. 9–10.

l. c., p. 49, tab. 3, figs. 15–23. tab. 20, fig. 12; BÖRGESEN, Mar. alg. of the Danish West Ind., vol. 2 (1916), p. 100; DE TONI, l. c., p. 114.

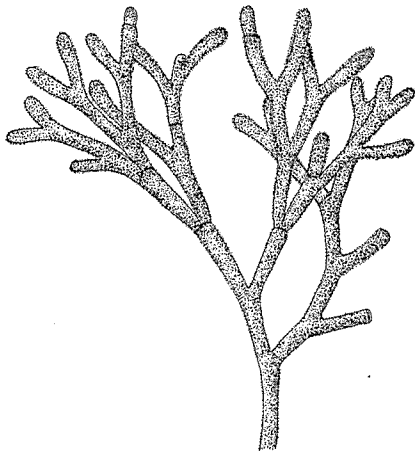


Fig. 9. *Galaxaura delabida* KJELLM.
Part of a plant. $\times$ ca. 2.

Frond about 4 cm high, 1.5 mm wide, fragile, articulate, villous, irregularly dichotomous, arising from a large basal disc, strongly encrusted with lime; internodes 2–5 mm long, but variable in length, cylindrical, obtuse at the apex; medullary filaments running very loosely, about 6–18 μ thick; supporting cells usually not developed; short assimilating filaments consisting of almost two cells only, but rarely three; basal cells largest, elliptical or pyriform, 40–48 μ long and 30–36 μ broad; terminal cells ovoid or semi-globose, about 24 μ in diameter; long assimilating filaments reaching a length of about 900 μ , often branching. Colour dark reddish brown.

Japanese name. *Moture-garagara*.

Hab. Titi-zima, Bonin Islands.

Distrib. St. Thomas, Atlantic Ocean.

A few specimens from the Bonin Islands may be identified with the present species which is apparently near to *G. fruticulosa* KJELLM., but it differs from the latter in the short assimilating filaments and supporting cells.

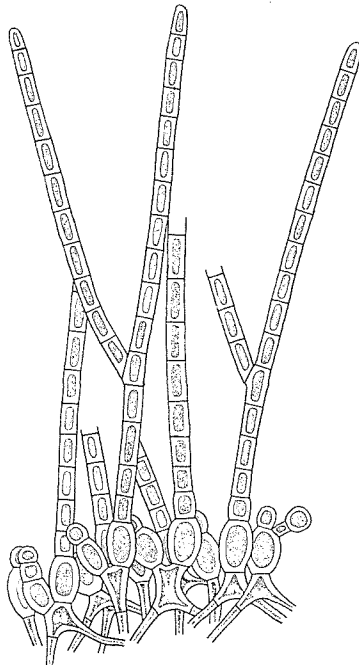


Fig. 10. *Galaxaura delabida* KJELLM.
Transverse section of the frond. $\times$ 117.

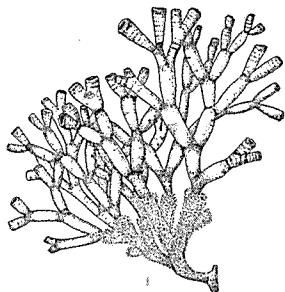


Fig. 11. *Galaxaura pacifica*
TANAKA $\times 1$.

***Galaxaura pacifica* TANAKA**

Text-fig. 11.

Four new species of *Galax.* from Japan (Sci. Pap. Instit. of Algolog. Research, Fac. of Sci., Hokkaido Imp. Univ., vol. 1, no. 1, 1935), p. 55, pl. 17, fig. 2, text-figs. 5-6.

Japanese name. *Tyabo-garagara*.

Hab. Haha-zima, Bonin Islands; Garanbi, Formosa.

***Galaxaura glabriuscula* KJELLMAN**

Pl. XXXVII, fig. 1, and Text-figs. 12-13.

l. c., p. 56, tab. 7, figs. 1-2, tab. 20, fig. 26; BUTTERS, *Liagora* and *Galaxaura* (Minnesota Bot. Stud. 1911), p. 175; DE TONI, l. c., p. 117.

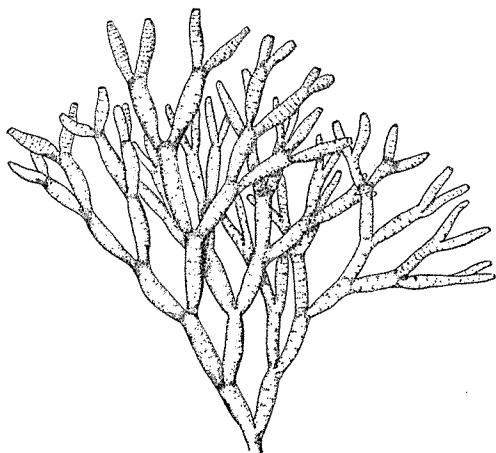


Fig. 12. *Galaxaura glabriuscula* KJELLM.
Part of a plant. $\times$ ca. 1.5.

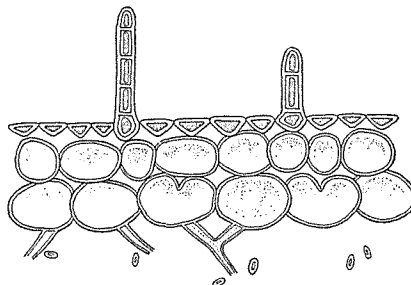


Fig. 13.
Galaxaura glabriuscula KJELLM.
Transverse section of the frond in the
lower portion. $\times 217$.

Frond about 6 cm high, 1.5-2 mm broad, regularly dichotomous, subglabrous, fragile; internodes more or less distended, sometimes articulate, subcomplanate, with dense transverse annulations upwards; lower internodes obconical, villous, 4-7 mm long; peripheral tissue consisting of about 3 layers of cells, subparenchymatous, strongly encrusted with lime; innermost cells largest, oblong-oval or cylindrical and often lobed; epidermal cells about 18μ high, 20μ broad in cross section, lens-like or hemispherical, pentagonal or hexagonal when seen from above, containing well developed

chromatophores; assimilating filaments very scarce excepting only lowest branches, straight, up to 200μ in length, 18μ thick. Colour yellowish white or reddish yellow.

Japanese name. *Tuya-garagara*.

Hab. Haha-zima, Bonin Islands.

Distrib. Tahiti, Pacific Ocean; Hawaiian Islands.

The present species agrees well with the illustration of KJELLMAN (l. c.). The segments are not cylindrical but somewhat subdistended. In our specimens the annulations, though very faint, count about 20 in 10 mm.

***Galaxaura cuculligera* KJELLMAN**

Pl. XXXVI, fig. 1, and Text-figs. 14–15.

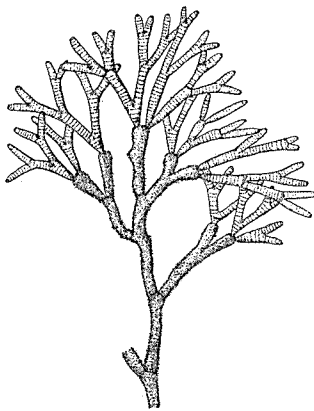


Fig. 14.
Galaxaura cuculligera KJELLM.
Part of a plant. $\times 1$.

l. c., p. 58, tab. 6, figs. 22–30, tab. 20, fig. 30; WEBER VAN BOSSE, Liste des algues du Siboga, vol. 2 (1921), p. 212; BUTTERS, l. c., p. 178; DE TONI, l. c., p. 120.

Frond about 5 cm high, 1.5 mm wide, stipitate, umbellate, with very short proliferations, membranaceous; upper internodes glabrous, densely annulate, somewhat collapsed; lower internodes densely villous, subcylindrical, with almost inconspicuous joints; peripheral tissue consisting of 3 layers of cells, subparenchymatic, encrusted with lime; cells of the innermost layer largest, $45\text{--}60\mu$ long and about 32μ broad, often lobed; epidermal cells lens-like or hemispherical in

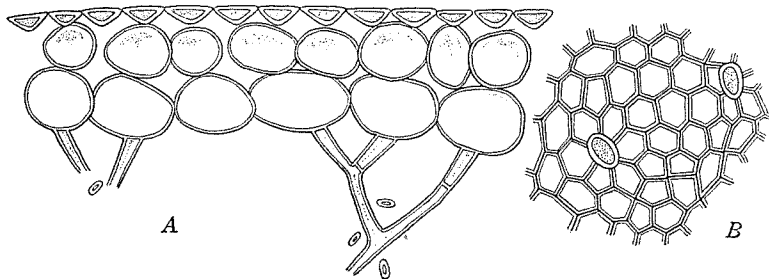


Fig. 15. *Galaxaura cuculligera* KJELLM.
A. Transverse section of the frond in the upper portion. $\times 290$.
B. Epidermal cells seen from above. $\times 290$.

cross section, pentagonal-septagonal in surface view, $18-25\mu$ in diameter, often mixed with abortive cells; peripheral filaments persistent, not arranged in any conspicuous order, rarely branched, the branches either similar, straight, sub-attenuated, short, or one branch straight, the other rhizoidal-like, much elongated. Colour light red or reddish green.

Japanese name. *Tukusi-garagara*.

Hab. Gotô Islands; Imuta, Kosiki-zima; Nomazaki, Satuma Prov.

Distrib. Hawaiian Islands; Malay Archipelago.

The outer appearance of the present species is characteristic on account of the umbellate ramification, and upper portion of the frond is somewhat complanated and shows clearly transverse annulations. In the present specimens the annulations count 25 in 10 mm at the upper portion.

***Galaxaura elongata* J. AGARDH**

Pl. XXXVIII, and Text-figs. 16-17.

Epier. (1876), p. 529; KJELLM., l. c., p. 56, tab. 7, figs. 6-12; WEBER VAN BOSSE, Liste des algues du Siboga, vol. 2 (1921), p. 212; YENDO, Notes on alg. new to Japan, V (B.M.T. vol. XXX, 1916), p. 254; DE TONI, l. c., p. 113.

Frond about 4-8 cm high, 1.5-2 mm wide, regularly dichotomous but very rarely umbellate, not articulated, attached to the substratum by means of a large disc; upper internodes glabrous, smooth and densely rugulose, membranaceous, subcomplanate; lower internodes villous with faint transverse annulations, cylindrical, medullary tissue consisting of loosely entangled filaments, with diameter of $8-12\mu$, encrusted with lime; assimilating layer consisting of 3-4 layers of cells, subparenchymatous, about 70μ thick, strongly encrusted with lime; innermost cells largest, oblong-ovate, about 36μ long and about 30μ broad, often lobed; uppermost cells containing well developed chromatophores, lens-like or hemispherical, about 18μ high and about 24μ broad in cross section, pentagonal or hexagonal when seen from surface; assimilating filaments persistent, straight, elongated; antheridial conceptacles nearly spherical opening through the wall of the frond, mostly with a diameter of about 250μ . Colour a pretty reddish brown or yellowish green.

Japanese name. *Naga-garagara*.

Hab. Garanbi, Kôtôsyô, Kwasyôto, Formosa. Growing on rocks in calm places in the lower littoral belt. Antheridia in spring.

Distrib. Friendly Islands; New Holland; Malay Archipelago.

As already mentioned by YENDO, the present species resembles the

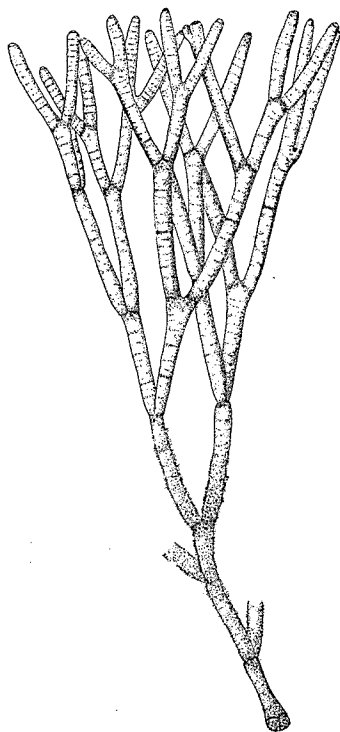


Fig. 16.
Galaxaura elongata J. Ag.
× ca. 1.5.

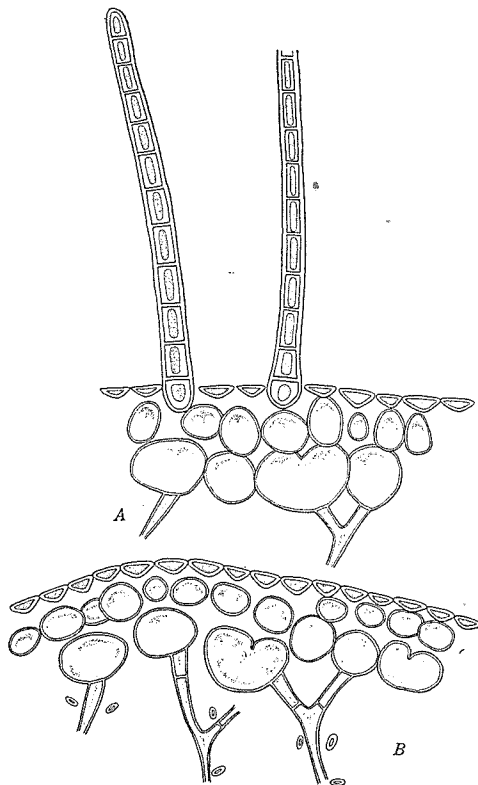


Fig. 17. *Galaxaura elongata* J. Ag.
A. Transverse section of the frond in the lower portion. ×215.
B. Transverse section of the frond in the upper portion. ×215.

elongated form of *Galaxaura cuculligera* KJELLM. in its general appearance.

The diameter of internodes is almost homogeneous through the whole length of the frond.

***Galaxaura papillata* KJELLMAN**

Pl. XXXVI, fig. 2, and Text-figs. 18–19.

l. c., p. 59, tab. 7, figs. 13–19, tab. 20, fig. 37; DE TONI, l. c., p. 121.

Frond loosely caespitose, 3–8 cm high, 5–9 times regularly dichotomous, often articulate, shortly stipitate; stipe almost terete, villous, consisting of numerous rhizoidal filaments; segments nearly cylindrical, 0.8–1.5 mm in

diameter and 4–15 mm long but variable in length, acute at the apex; central axis almost free from lime; medullary filaments 12–18 μ thick, entangled in an irregular manner, outsides making a loose parenchymatous

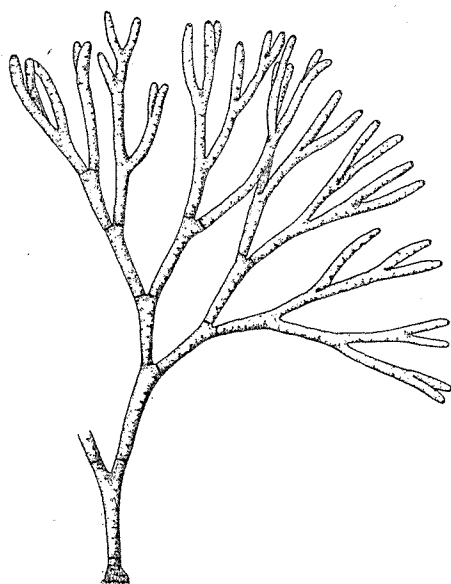


Fig. 18. *Galaxaura papillata* KJELLM.
× ca. 1.5.

tissue, encrusted with lime; cells of innermost layer largest, oblong-ovate, about 60 μ in diameter; intermediate cells ovate and often lobed, about 40 μ long and about 25 μ broad; peripheral loosely packed cells obconical or pyramidal, about 20 μ high and 18 μ broad, having well developed chromatophores, bearing single (25–30 μ long and about 21 μ broad) or double (50–70 μ long and 18 μ broad) clavate, briefly rounded papillae; antheridial conceptacles usually nearly spherical or rarely pyriform, densely scattered in the upper portion of the frond, 200–250 μ in diameter; tetrasporangia about 38 μ in diameter, obovate or nearly spherical, cruciately divid-

ed, on the epidermal cells together with two papillae. Colour purplish brown or greenish purple.

Japanese name. *Papira-garagara*.

Hab. Kusimoto, Kii Prov.; Cape Muroto, Tosa Prov.; Hukue, Gotô Islands; Tomioka, Amakusa; Cape Nomo, Hizen Prov.; Imuta, Kosiki-zima. Growing in calm places in the lower littoral belt. Antheridia in spring, while tetrasporangia in late summer.

Distrib. Endemic.

A large collection of *Galaxaura* from the southwestern parts of Japan upon which the writer based his examination contains two forms of the present species. These two forms may be considered as sexual and tetrasporic plants. The sexual plant is diagnosed to have always one papillose process on each epidermal cell. This papilla is 25–30 μ long and about 21 μ broad and contains well developed chromatophores. The tetrasporic plant is often found growing together with the above described sexual ones and these two forms cannot be distinguished by habit. As to the anatomical

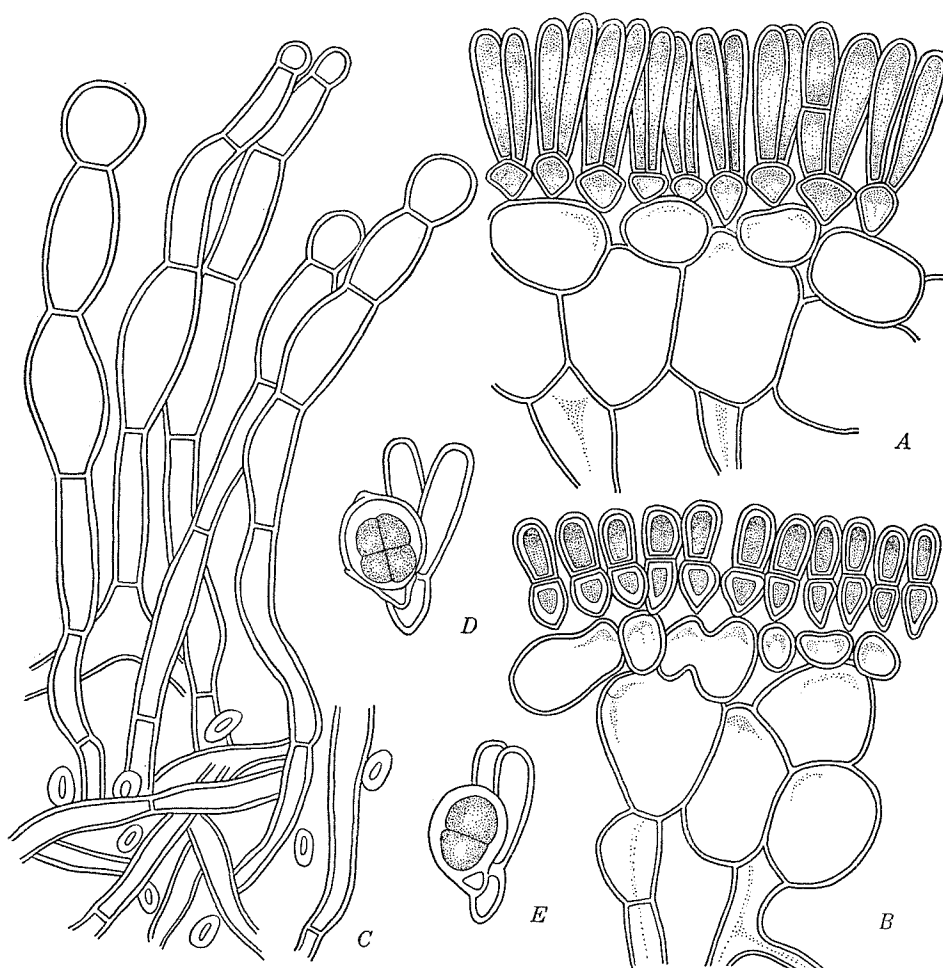


Fig. 19. *Galazaura papillata* KJELLM.

- A. Transverse section through the frond of the tetrasporic plant. $\times 285$.
- B. Transverse section through the frond of the sexual plant. $\times 285$.
- C. Part of the cross section of the stipe. $\times 285$.
- D. E. Epidermal cell with tetrasporangium. $\times 285$.

character of the tetrasporic plants, however, each epidermal cell always bears two (rarely three), long-elliptical papillose processes. These processes are $50-70\mu$ long and about 18μ broad, and contain chromatophores but not so remarkable as sexual ones. Very rarely they are 2-celled. This character, therefore, serves in differentiating the sexual plant from the

tetrasporic ones. The present species is one of those, which demonstrate well in this genus the structural dimorphism of sexual and tetrasporic plants.

***Galaxaura fastigiata* DECAISNE**

Pl. XXXVII, fig. 2, and Text-figs. 20-21.

Sur les Corallines (1842), p. 16; J. AGARDH, Spec. alg. (1876), p. 527; DE TONI, Syll. alg., vol. 4 (1897), p. 116; KJELLM., l. c., p. 64, tab. 9, figs. 1-3, tab. 20, fig. 4; WEBER VAN BOSSE, Liste des alg. du Siboga, vol. 2 (1921), p. 213; OKAMURA, On the mar. alg. from Kôtôsho (Bull. of the Biogeogr. Soc. of Japan, vol. 2, 1931), p. 109.

Syn. *Galaxaura Schimperi* DCSE., l. c., p. 116; KJELLMAN, l. c., p. 61, tab. 7, figs. 19-20, tab. 8, figs. 16-22, tab. 20, figs. 1-2.

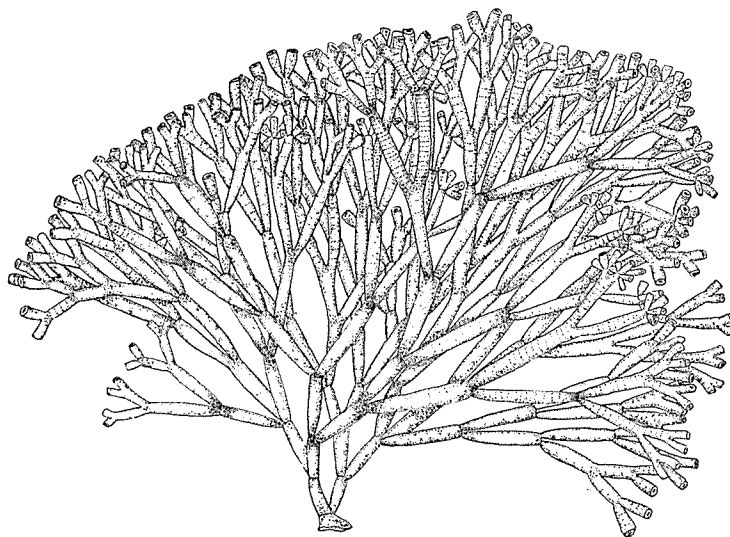


Fig. 20. *Galaxaura fastigiata* DCSE. $\times$ ca. 1.

Frond fragile, very smooth, but above densely or inconspicuously annulately rugose, thickened towards the apex, loosely corymbose or almost semiglobose, loosely equally furcate, decompound with proliferations from the apices, or sometimes from the geniculi; axils wide; internodes cylindraceous or somewhat distended, long obconical; assimilating layer consisting of loosely moniliform cells, encrusted with lime; cells of the innermost layer obovoid or ovoid, $25-36\mu$ in diameter; uppermost cells obconical or semiglobose, $8-14\mu$ in diameter; central portion consisting of very loosely entangled filaments, running in the mucilaginous substance;

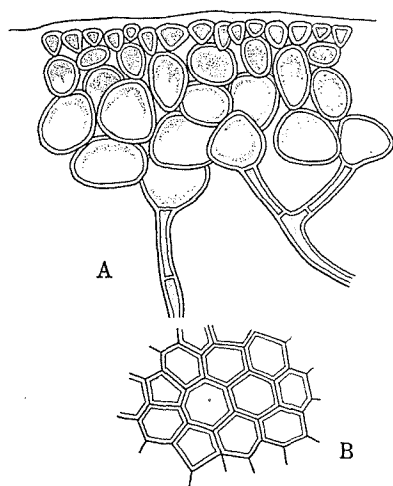


Fig. 21. *Galaxaura fastigiata* DCSNE.

A. Transverse section of the frond.
× 290.

B. Epidermal cells seen from above.
× 470.

cystocarps almost spherical, scattered in the upper portion, opening through the wall of the frond, 250–400 μ in diameter; antheridial conceptacles also nearly spherical or elliptical, 200–250 μ in diameter. Colour yellowish green or reddish pink or sometimes greenish red.

Japanese name. *Garagara*.

Hab. Ryûkyû; Formosa; Bonin Islands; Micronesian Islands. Along the Pacific coast from Micronesian Islands to Awa Province. Along the Japan sea, southern parts from Toyama Bay.

Distrib. Philippin Islands; New Caledonia; Polynesia; Malay Archipelago; Red Sea.

This is a very common species of

Galaxaura in the warmer parts of Japan.

The external appearance of abundant specimens of this species at hand shows a very wide range of variation. This variation is no doubt largely due to the external conditions of individuals. Some specimens from the Micronesian Islands may be taken as *G. fastigiata* DCSNE., but some from Amakusa, as *G. Schimperii* DCSNE. It is very probable that these plants have been passing under these specific names among phycologists. According to KJELLMAN, in general appearance of the frond and measurements of internodes, both species have their own peculiarities. But as far as the present writer could ascertain these two species are not distinguished in habit and structure one from the other. The differences between both species which were mentioned by KJELLMAN and others appear to be entirely a matter of individual variations. Therefore they are combined here under the specific name, *G. fastigiata* DECNE.

Galaxaura falcata KJELLMAN

Pl. XXXIX, and Text-figs. 22–23.

l. c., p. 73, tab. 11, figs. 12–31, tab. 12, figs. 1–4, tab. 20, fig. 33.

Frond about 10 cm high, regularly dichotomous with narrow angle, long stipitate; stipe cylindrical, about 3 cm high, verticillately villous, consisting of rhizoidal filaments; internodes subcanaliculate with faint trans-

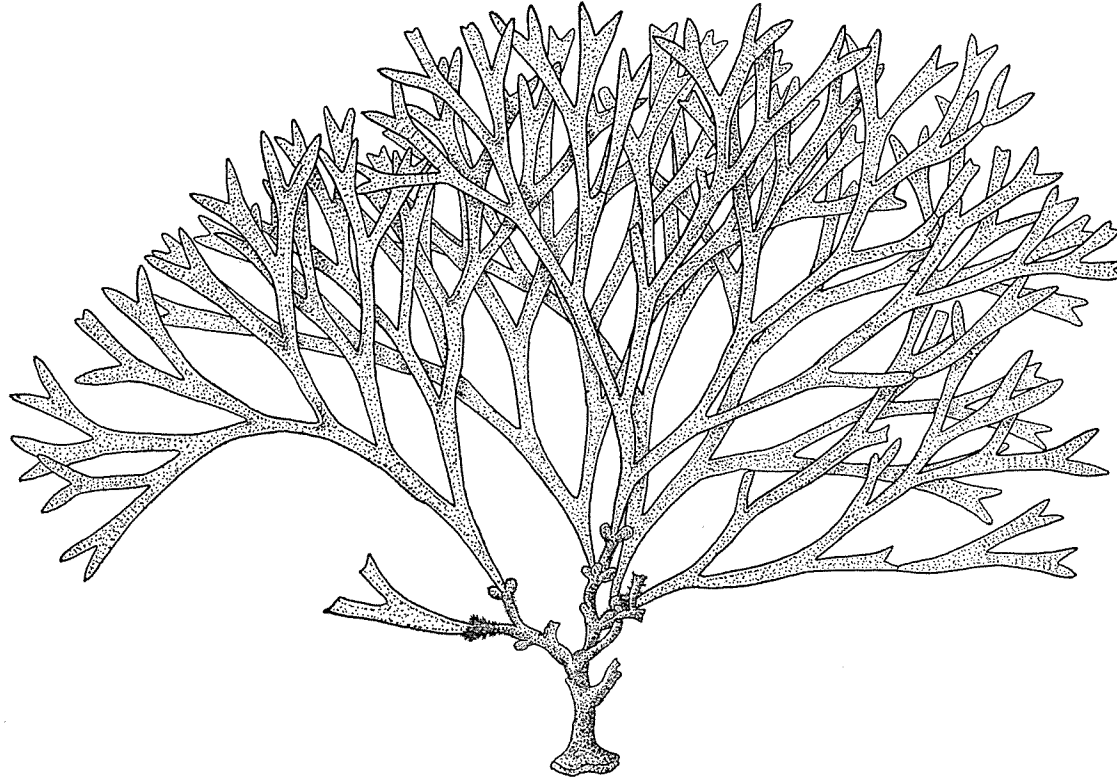


Fig. 22. *Galaxaura falcata* KJELLM. $\times$ ca. 1.

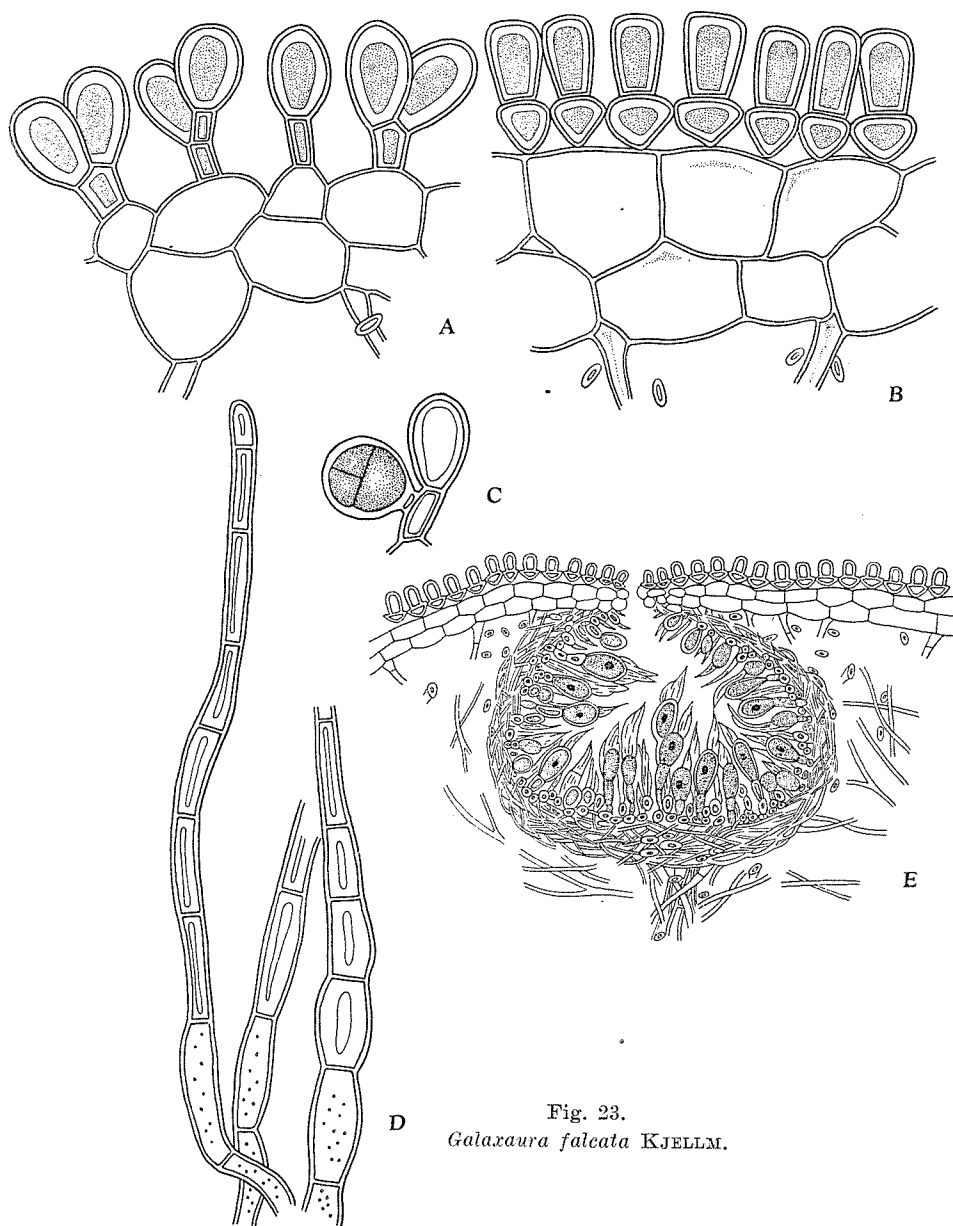


Fig. 23.
Galaxaura falcata KJELLM.

- A. Transverse section through the frond of the tetrasporic plant. $\times 390$.
- B. Transverse section through the frond of the sexual plant. $\times 390$.
- C. Assimilating filament with tetrasporangium. $\times 390$.
- D. Periferic filaments of the stipe. $\times 237$.
- E. Cross section of a cystocarp. $\times 125$.

verse striations, wider at the distal end than in the proximal end, 0.7–2 cm long, about 3 mm wide, about 350μ thick. Colour reddish brown or deep greenish brown.

Anatomical structure of the tetrasporic plants: Medullary filaments running very loosely, about 18μ thick; parenchymatous tissue consisting of 2–3 layers of cells; cells of the innermost layer largest, $55\text{--}75\mu$ broad, $30\text{--}36\mu$ long; assimilating filaments having mostly a unicellular pedicel; terminal cells commonly cylindraceous, elliptical or obovoidal globose, $36\text{--}50\mu$ long, $30\text{--}36\mu$ broad, containing well developed chromatophores, almost rounded at the apex but very rarely apiculate; tetrasporangia nearly globose or subglobose, $27\text{--}40\mu$ in diameter, cruciately divided, borne on the assimilating filaments with short pedicel.

Anatomical structure of the sexual plants: Medullary filaments running in an irregular manner, $18\text{--}25\mu$ thick; peripheral tissue consisting of 3 layers of cells, parenchymatous, about 84μ thick; cells of the innermost layer almost quadrate in cross section, $54\text{--}66\mu$ broad, $30\text{--}42\mu$ long; peripheral packed cells obconical or pyramidal, about 18μ high, 22μ wide in cross section, having well developed chromatophores, bearing papillae; papillae about 36μ long and $20\text{--}25\mu$ broad, having chromatophores; antheridial conceptacles nearly spherical or rarely elliptical, $250\mu \times 300\mu$ — $300\mu \times 320\mu$, densely scattered in the upper portion of the frond; cystocarps also nearly spherical, $250\text{--}280\mu$ in diameter; cystocarps and antheridia on different individuals.

Japanese name. *Hira-garagara*.

Hab. Susaki, Awa Prov.; Enosima, Sagami Prov.; Koza, Kii Prov.; Cape Muroto, Tosa Prov.; Gogosima, Iyo Prov. Growing on rocks, stones in the sublittoral zone. Tetrasporangia in late summer, while cystocarps and antheridia in spring.

Distrib. Endemic.

The sexual plant of this species is quite different from the tetrasporic ones in anatomical structure, though they cannot be distinguished by habit, and often grow together in the same places. The inner structure of the sexual plant of the species reminds one very much of what is found in the section *Papulifer*. Among the species in this genus the present one gives one of the most representative examples of structural dimorphism.

Galaxaura arborea KJELLMAN

Pl. XL, and Text-figs. 24–25.

l. c., p. 72, tab. II, figs. 1–11, tab. 20, fig. 39; BUTTERS, l. c., p. 180; YENDO,

Notes on alg. new to Japan, VIII (B.M.T. vol. XXXII, 1918), p. 65.

Frond frutescent, about 8 cm high, regularly dichotomous, with wide angle, subcanaliculate, short stipitate; stipe cylindrical, verticillately villous, consisting of numerous rhizoidal cells; internodes 1.5–2 mm wide, 3–8 mm long, about 200μ thick, with clear transverse striations; parenchy-

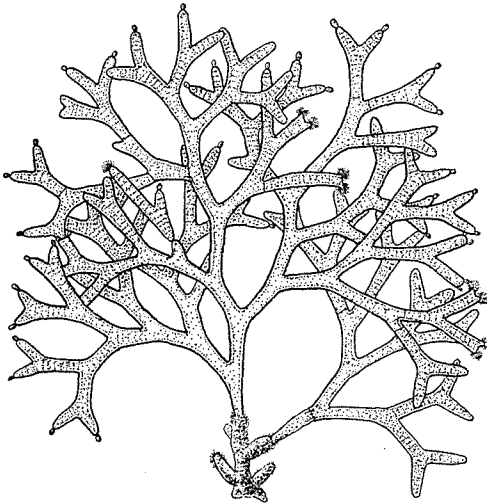


Fig. 24. *Galaxaura arborea* KJELLM. $\times 1$.

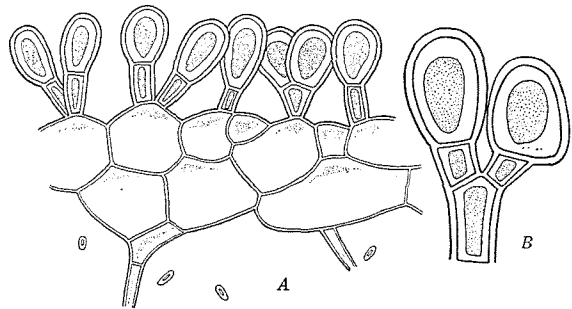


Fig. 25. *Galaxaura arborea* KJELLM.

A. Transverse section of the frond. $\times 215$.
B. Assimilating filament. $\times 350$.

matous tissue consisting of 2–3 layers of cells; assimilating filaments having mostly a unicellular pedicel, terminal cells almost cylindraceous or obovoid, $36\text{--}45\mu$ long and $25\text{--}30\mu$ broad, containing well developed chromatophores. Colour grayish green or light reddish brown.

Japanese name. *Hosoba-garagara*.

Hab. Simidu, Tosa Prov.; Hutae, Amakusa; Kosiki-zima; Ryûkyû.

Distrib. Australia; Hawaiian Islands.

***Galaxaura apiculata* KJELLMAN**

Pl. XLI, fig. 2, and Text-figs. 26–27.

l. c., p. 74, tab. 12, figs. 13–26, tab. 20, fig. 36.

Frond arborescent, 3–8 cm high, regularly dichotomous with narrow angle, long stipitate; stipe cylindrical, villous, consisting of rhizoidal filaments; internodes subcanaliculate, with faint transverse striations, 4–20 mm long, 1.5–2 mm wide, $450\text{--}500\mu$ thick, slightly wider at the distal end than at the proximal; cells of innermost layer about $60\text{--}75\mu$ wide, $35\text{--}60\mu$ high; assimilating filaments having mostly a unicellular pedicel; terminal

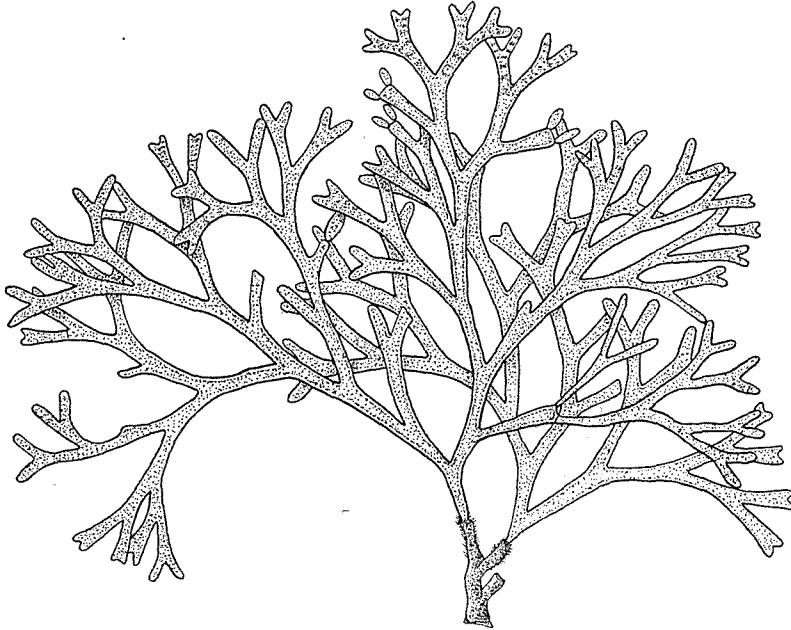


Fig. 26. *Galaxaura apiculata* KJELLM. $\times$ ca. 1.

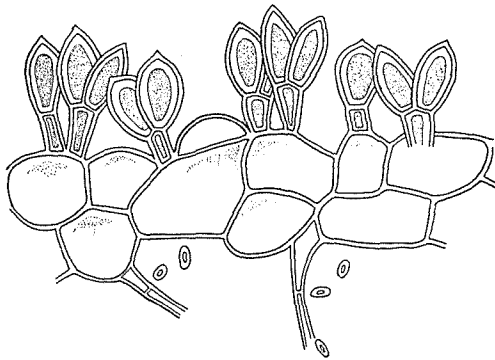


Fig. 27. *Galaxaura apiculata* KJELLM.
Transverse section of the frond. $\times$ 245.

cells almost long elliptical or obovoidal globose, $18-25\mu$ wide, $35-42\mu$ long, almost apiculate at the apex but rarely rounded; reproductive organ unknown. Colour reddish brown or deep reddish brown.

Japanese name. *Gibôsi-garagara*.

Hab. Cape Nomo, Iki, Hi-zen Prov.; Amakusa.

Distrib. Endemic.

The present species is allied to *G. falcata* KJELLMAN and *G. hystrix* KJELLM. in its general appearance, from which, however, it differs in its anatomical structure.

***Galaxaura clavigera* KJELLMAN**

Pl. XLI, fig. 1, and Text-figs. 28-29.

l. c., p. 76, tab. 13, figs. 1-13, tab. 20, fig. 25; WEBER VAN BOSSE, l. c., p. 216;

OKAMURA, On the mar. alg. from Kôtôsho (Bull. of the Biogeogr. Soc. of Japan, vol. 2, 1931), p. 109.

Frond 3–10 cm high, regularly dichotomous, long stipitate; stipe cylindrical, villous, consisting of rhizoidal filaments; lower portion of the leaves terete or subterete, without clear distinction from stipe; internodes subcanaliculate, with faint transverse striations, about 5 mm long and 1.5–2 mm wide, about 480μ thick; medullary filaments about

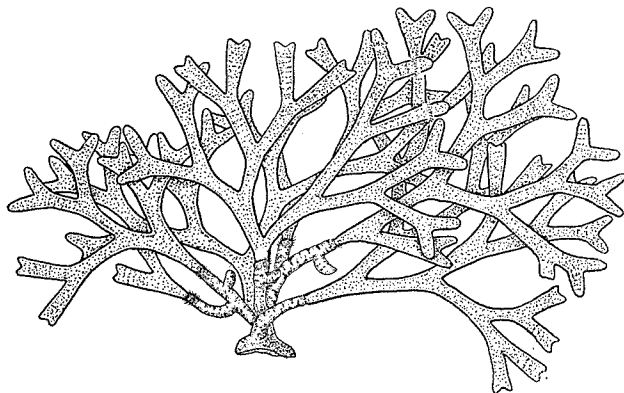


Fig. 28. *Galaxaura clavigera* KJELLM. $\times 1$.

12μ thick, running in an irregular manner; parenchymatous tissue consisting of 2–3 layers of cells; assimilating filaments having almost a unicellular pedicel; terminal cells almost long elliptical or obovoid, containing well developed chromatophores, $36\text{--}54\mu$ long, $20\text{--}25\mu$ wide, rounded at the apex but rarely apiculate; tetrasporangia mostly spherical, $26\text{--}36\mu$ in diameter, cruciately divided, borne laterally on the stalk cells of assimilating filaments with a short pedicel. Colour grayish green or light reddish brown.

Japanese name. *Atuba-garagara*.

Hab. Ryûkyû; Haha-zima, Titi-zima, Bonin Islands; Kôtôsyô, Kwas-yôto, Formosa. Growing on rocks in lower littoral belt. Tetrasporangia in late summer.

Distrib. Indian Ocean; East Africa; Malay Archipelago.

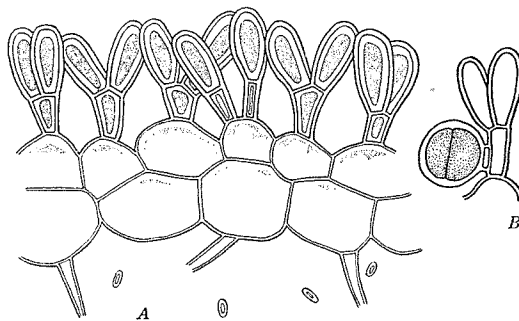


Fig. 29. *Galaxaura clavigera* KJELLM.

A. Transverse section of the frond. $\times 205$.

B. Assimilating filament with tetrasporangium. $\times 205$.

***Galaxaura articulata* TANAKA**

Four new species of *Galax.* from Japan (Sci. Pap. Instit. of Algolog. Research, Fac. of Sci., Hokkaido Imp. Univ., vol. 1, no. 1, 1935), p. 51, pl. 17, fig. 1, text-figs. 1-2.

Japanese name. *Kuda-garagara*.

Hab. Haha-zima, Bonin Islands.

***Galaxaura Kjellmanii* WEBER VAN BOSSE**

Pl. XLII, and Text-figs. 30-31.

Liste des alg. du Siboga, vol. 2 (1921), p. 217, fig. 66; DE TONI, l. c., p. 139.

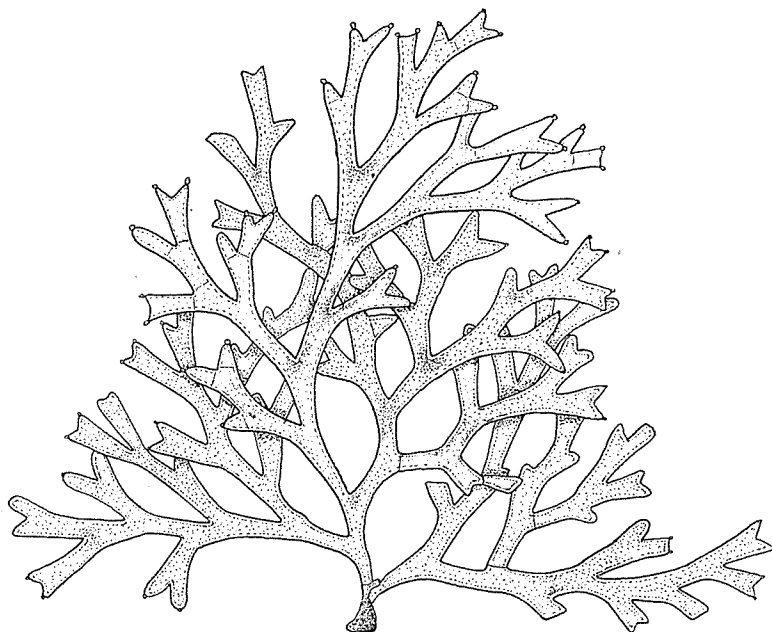


Fig. 30. *Galaxaura Kjellmanii* WEBER VAN BOSSE $\times 1$.

Frond 5-8 cm high, 2.5-3 mm wide, fragile, often subcanaliculate, articulate, irregularly subdichotomous or sympodial, short stipitate; stipe cylindrical, villous, consisting of numerous rhizoidal filaments; peripheral tissue consisting of 2-3 layers of cells, subparenchymatous, 88-105 μ thick excepting papillae, encrusted with lime; cells of innermost layer largest, rounded polygonal, about 45 μ broad, 25-30 μ high; those of next layer spherical, about 36 μ in diameter; epidermal cells closely united, rounded

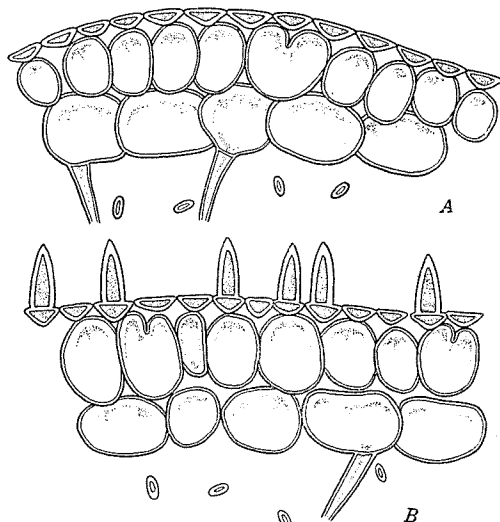


Fig. 31.

Galaxaura Kjellmanii WEBER VAN BOSSE

- A. Transverse section of the frond in the upper portion. $\times 255$.
 B. Transverse section of the frond in the lower portion. $\times 255$.

is, however, different in frond structure. The general character of the plant, habit, especially mode of branching, etc. agree well with the descriptions of *G. Kjellmanii* WEBER VAN BOSSE given in WEBER's work (l.c.).

Galaxaura hystrix KJELLMAN

Pl. XLIII, fig. 2, and Text-figs. 32-33.

l. c., p. 79, tab. 16, figs. 1-10, tab. 20, fig. 34, BUTTERS, *Liagora* and *Galaxaura* (Minnesota Bot. Stud. 1911), p. 175; DE TONI, l. c., p. 137.

Frond arborescent, 3-8 cm high, subcanaliculate, regularly dichotomous with narrow angle, long stipitate; stipe verticillately villous, consisting of rhizoidal filaments; internodes very faintly transversely annulate, 5-20 mm long, 1.5-3 mm wide, 450-500 μ thick, cuneate or linear cuneate; peripheral tissue consisting of 3 layers of cells, subparenchymatous, about 84 μ thick with exception of papillae; cells of innermost layer largest, rounded polygonal, about 35 μ broad, about 25 μ high; those of middle layer spherical or elliptical, about 30 μ in diameter, often lobed; epidermal cells lens-like in cross section, containing well developed chromatophores, always bearing a papilla; papillae clavate, briefly api-

trigonal in cross section, pentagonal-septagonal in surface view, containing well developed chromatophores, those of the upper portion of the frond often bearing single papilla; papillae clavate, briefly apiculate, about 30 μ long and about 12 μ wide. Colour yellowish green or greenish white.

Japanese name. *Samehada-garagara*.

Hab. Susaki, Tosa Prov.; Seto, Kii Prov.

Distrib. Sulu Islands, Malay Archipelago.

As it seems from the illustration this species has a very close external resemblance to *G. angustifrons* KJELLM., which

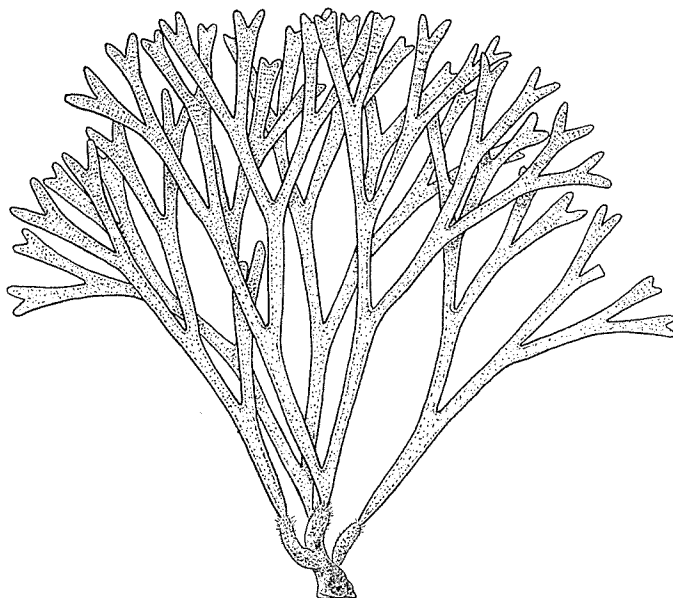


Fig. 32. *Galaxaura hystrix* KJELLM. $\times$ ca. 1.

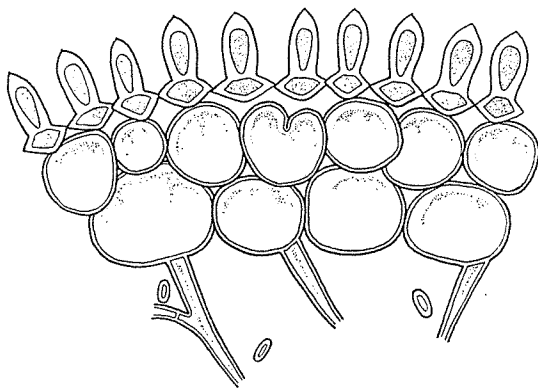


Fig. 33. *Galaxaura hystrix* KJELLM.
Transverse section of the frond. $\times$ 290.

culate, $25-30\mu$ long, $14-16\mu$ wide; antheridial conceptacles nearly spherical or ovate, $200-300\mu$ in diameter, scattered on the upper portion of the frond. Colour reddish brown or deep reddish brown.

Japanese name. *Hera-gata-garagara*.

Hab. Cape Nomo, Hizen Prov.; Tomioka, Amakusa; Gotô Islands. Growing in quiet places in lower

littoral zone. Antheridia in spring.

Distrib. Endemic.

***Galaxaura elegans* TANAKA**

Text-fig. 34.

Four new species of *Galax.* from Japan (Sci. Pap. Instit. of Algolog.

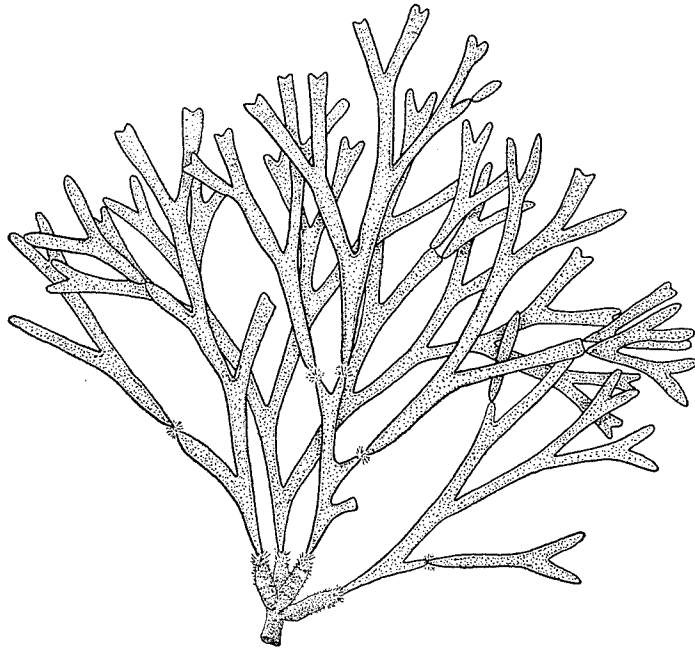


Fig. 34. *Galaxaura elegans* TANAKA $\times$ ca. 1.

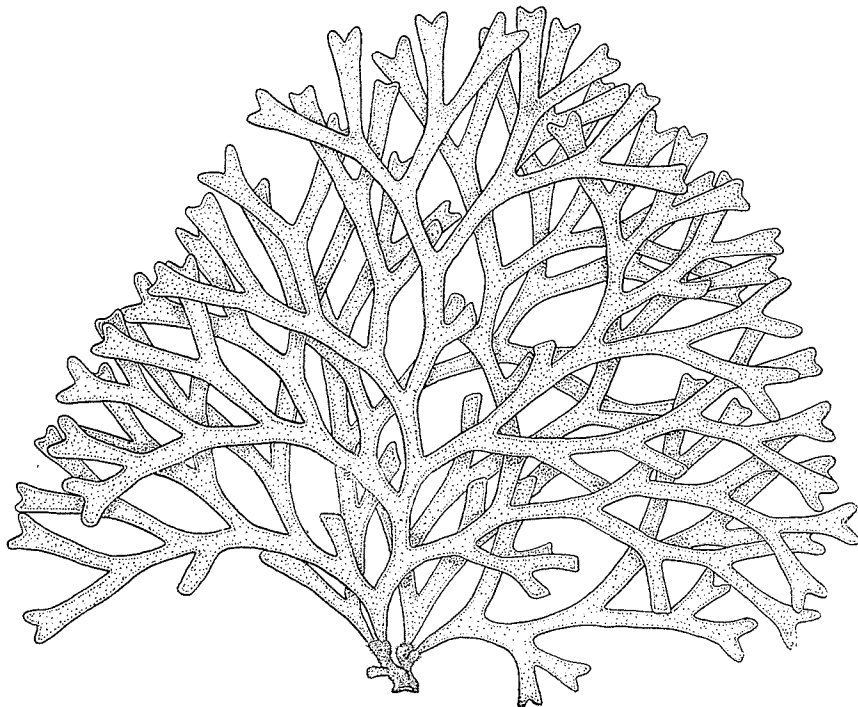


Fig. 35. *Galaxaura latifolia* TANAKA $\times$ 1.

Research, Fac. of Sci., Hokkaido Imp. Univ., vol. 1, no. 1, 1935), p. 52, pl. 17, fig. 3, text-fig. 3.

Japanese name. *Hime-garagara*.

Hab. Garanbi, Formosa.

***Galaxaura latifolia* TANAKA**

Text-fig. 35.

Four new species of *Galax.* from Japan (Sci. Pap. Instit. of Algolog. Research, Fac. of Sci., Hokkaido Imp. Univ., vol. 1, no. 1, 1935), p. 54, pl. 18, text-fig. 4.

Japanese name. *Hiroha-garagara*.

Hab. Kelung, Dairi, Formosa.

***Galaxaura veprecula* KJELLMAN**

Pl. XLIII, fig. 1, and Text-figs. 36-37.

l. c., p. 80, tab. 16, figs. 17-33, tab. 20, fig. 20; YENDO, Notes on alg. new to Japan, VIII (B.M.T. vol. XXXII, 1918), p. 66; DE TONI, l. c., p. 137.

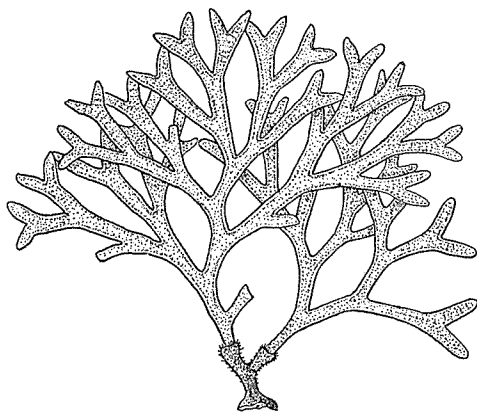


Fig. 36. *Galaxaura veprecula* KJELLM.
slightly reduced.

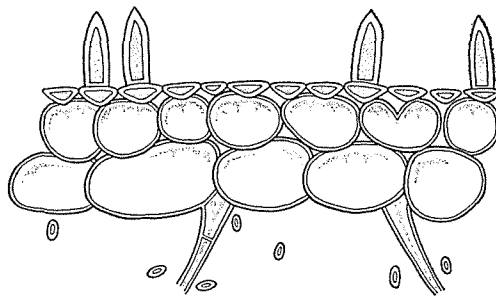


Fig. 37. *Galaxaura veprecula* KJELLM.
Transverse section of the frond. $\times 225$.

Frond frutescent, 4-10 cm high, regularly dichotomous with wide angle, shortly stipitate; stipe terete, villous, consisting of numerous rhizoidal filaments; internodes rather short, faintly transversely striate, somewhat canaliculate, 4-8 mm long, 1.5-2 mm wide, 250-300 μ thick; medullary filaments about 15 μ thick, running very loosely; peripheral tissue consisting of three layers of cells, subparenchymatous, 75 μ thick excepting papillae; cells of innermost layer largest, rounded polygonal, about 35 μ

broad, 25μ high; those of the middle layer almost spherical, often lobed, about 30μ in diameter; epidermal cells rounded trigonal in transverse section, pentagonal or hexagonal when seen from above, often bearing single papilla; papillae calvate, apiculate or rounded at the apex, $25\text{--}30\mu$ long, about 15μ broad. Colour grayish green or light reddish brown.

Japanese name. *Usuba-garagara*.

Hab. Ryûkyû; Kôtôsyô, Kwasyôto, Formosa.

Distrib. Madagascar.

According to YENDO, the present species has a close affinity to *G. hystrix* KJELLM., and the latter is diagnosed to have a papillose process on each epidermal cell, while the present one has the papillae only scatteringly. Other characters pointed out by KJELLMAN as the distinctions between the two species are rather unreliable. On repeated examinations of numerous specimens from southern Japan, the present writer has ascertained that this species, as YENDO has noted, differs from *G. hystrix* KJELLM. in its papillose processes which are not on each epidermal cell. But in the general appearance of the frond and the measurements of segments both clearly have their own peculiarities.

Galaxaura robusta KJELLMAN

Pl. XLIV, and Text-figs. 38–39.

l. c., p. 85, tab. 18, figs. 19–32, tab. 20, fig. 42; HEYDRICH, Einige Alg. von den Loochoo- oder Riu-Kiu-Inseln (Ber. d. Deut. Bot. Gesel. Bd. XXV, 1907), p. 103; WEBER VAN BOSSE, l. c., p. 219.

Frond 4–10 cm high, 6–12 times regularly dichotomous, fragile, shortly stipitate, articulate; segments 7–15 mm long, 3.5–4 mm wide, obovoid or elliptical obovoid; medullary filaments $14\text{--}25\mu$ thick, running very loosely; cortex consisting of only one parenchymatous layer and of two assimilating layers; cells of parenchymatous layer, colourless, quadrate or rounded, $78\text{--}120\mu$ broad, $46\text{--}60\mu$ high; assimilating layers consisting of epidermal cells and its stalk cells; cells of epidermal layer funnel-shaped or broadly obconical, containing well developed chromatophores, contracting at their edges, $31\text{--}36\mu$ broad, about 18μ high, pentagonal-septagonal in surface view; stalk cells cylindraceous, narrowly funnel-shaped, separated from each other and encrusted with lime there. Colour a pretty light rose; reproductive organ unknown.

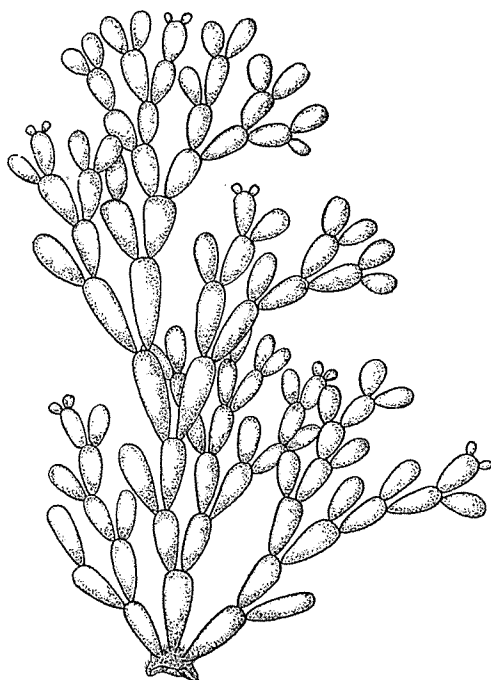


Fig. 38. *Galaxaura robusta* KJELLM.
× 3/4.

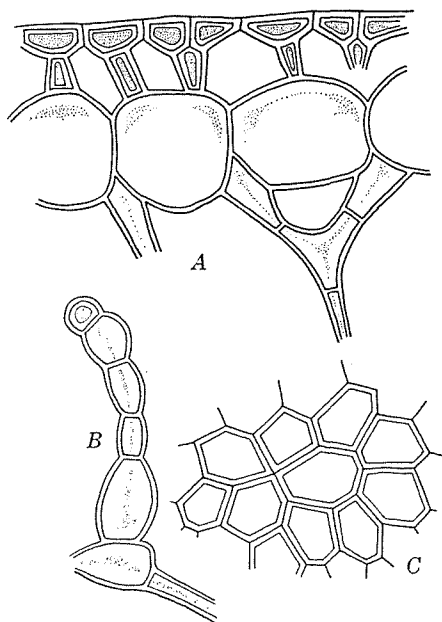


Fig. 39. *Galaxaura robusta* KJELLM.
A. Transverse section of the frond. × 290.
B. A periferic filament of the stipe. × 290.
C. Epidermal cells seen from surface. × 290.

Japanese name. *Zyuzu-garagara*.

Hab. Makurazaki, Satuma Prov.; Ryûkyû; Garanbi, Kwasyôto, Formosa. Growing on rocks near the lower littoral zone.

Distrib. Indian Ocean; Madagascar; Malay Archipelago.

This species is allied to *G. obtusata* LAMX. in its general appearance, from which, however, it differs in its heavier encrustation of lime and entirely fragile surface. Very unfortunately the writer has not yet seen any reproductive organ.

***Galaxaura obtusata* (SOLANDER) LAMOUROUX**

Pl. XLV, and Text-figs. 40-41.

Hist. Polyp. fléx. (1816), p. 262; KÜTZING, Spec. alg. (1849), p. 529; Id., Tab. Phyc., vol. 8 (1858), t. 35; J. AGARDH, Epier. (1876), p. 525; HEYDRICH, Beitr. zur Kenntn. d. Algenf. von Ostasien (Hedwigia, 1894), p. 292; DE TONI, Syll. alg., vol. 4 (1897), p. 110; KJELLM., l. c., p. 88; HOWE, in Britton and MILLSPAUGH's Bahama flora (1920), p. 559; WEBER VAN

BOSSE, l. c., p. 220; BÖRGESSEN, Mar. alg. from the Canary Isl., vol. 3 (1927), p. 78; YAMADA, Notes on some Japan. alg., IV (Journ. Fac. Sci. Hokkaido Imp. Univ. Ser. V. vol. 2, 1932), p. 274, pl. 7.

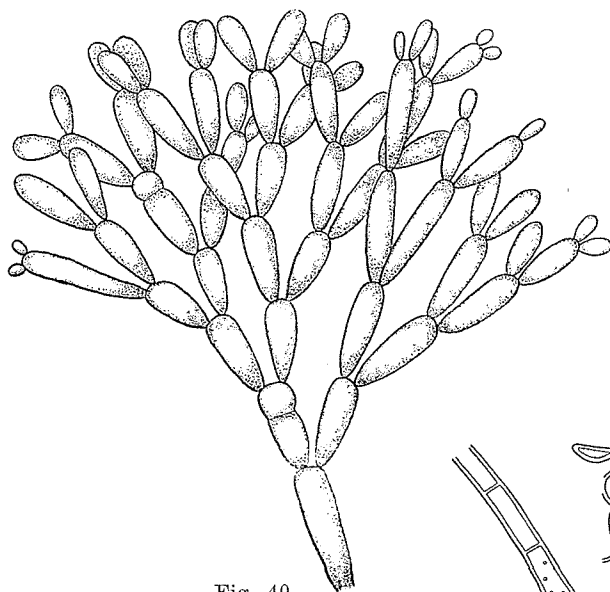


Fig. 40.
Galaxaura obtusata (Soland.) LAMX.
Part of a plant. $\times$ ca. 1.

Frond 7–20 cm high, 6–15 times regularly dichotomous, articulate, shortly stipitate; stipe almost terete, hirtous, consisting of numerous rhizoidal filaments; segments 2–3 mm wide and usually 2–5 times as long as the width, obovoid or ellipsoidal obovoid; central axis consisting of loose slender filaments, running in the mucilaginous substance; cortex consisting of one parenchymatous layer and two assimilating layers; cells of the parenchymatous

layer colourless, quadrate, $20\text{--}25\mu$ high, $35\text{--}60\mu$ broad; epidermal cells of assimilating layers lens-like in cross section, usually pentagonal or hexagonal in surface view; basal cells of assimilating layer ovoid or hemispherical,

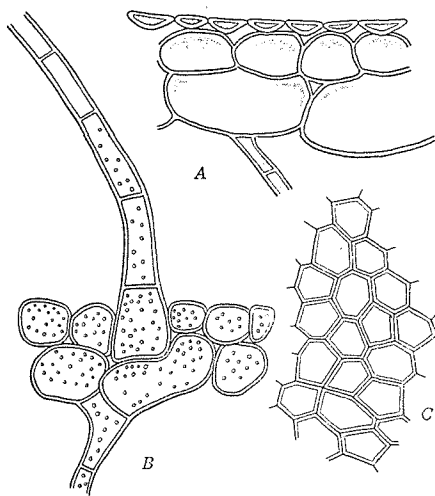


Fig. 41.
Galaxaura obtusata (Soland.) LAMX.
A. Transverse section of the frond.
 $\times 215$.
B. Cross section of the stipe. $\times 215$.
C. Epidermal cells seen from surface.
 $\times 215$.

set closely to each other, not much encrusted with lime; cystocarps nearly spherical, scattered in the upper portion of the frond, about $400\mu \times 450\mu$ — $450\mu \times 530\mu$ in size. Colour rose or light red.

Japanese name. *Hukuro-garagara*.

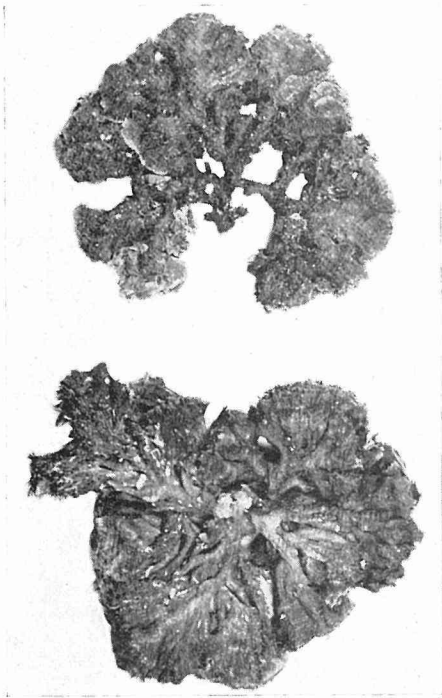
Hab. Wagu, Sima Prov.; Kusi, Satuma Prov.; Ryûkyû; Kwasyôto, Garanbi, Formosa. Growing in quiet places in the lower littoral belt. Cystocarps in spring.

Distrib. West Indies; Florida; Pacific Ocean; Malay Archipelago; Polynesia; Australia.

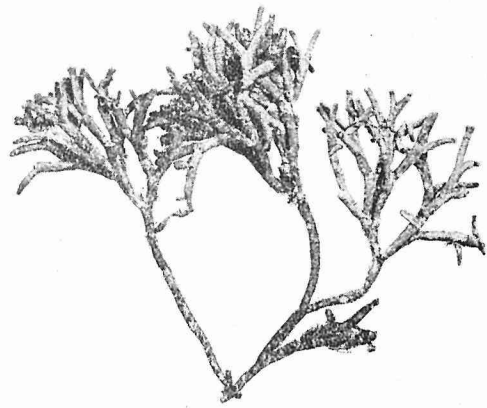
PLATE XXXIV

PLATE 34

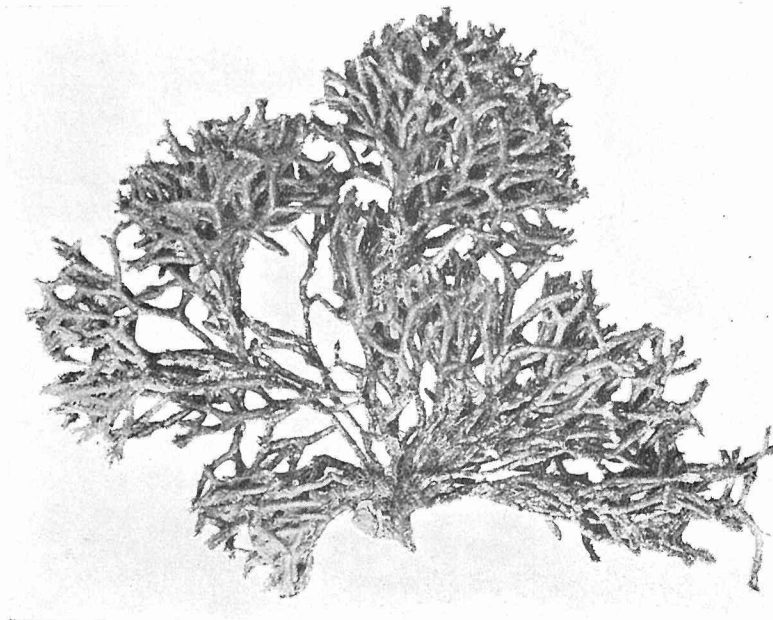
1. *Galaxaura rudis* KJELLM. ×1
2. *Galaxaura subverticillata* KJELLM. ×1
3. *Galaxaura fasciculata* KJELLM. ×1



1



2



3

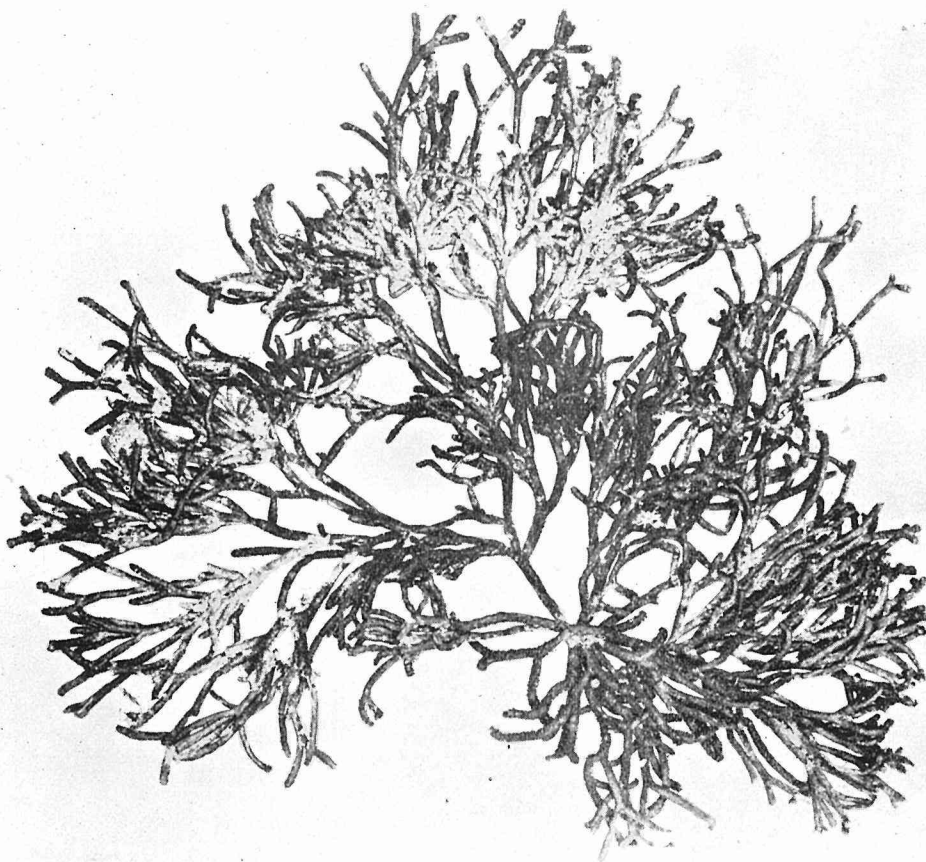
PLATE XXXV

PLATE 35

1. *Galazaura delabida* KJELLM. ×1
2. *Galazaura fruticulosa* KJELLM. ×1



1

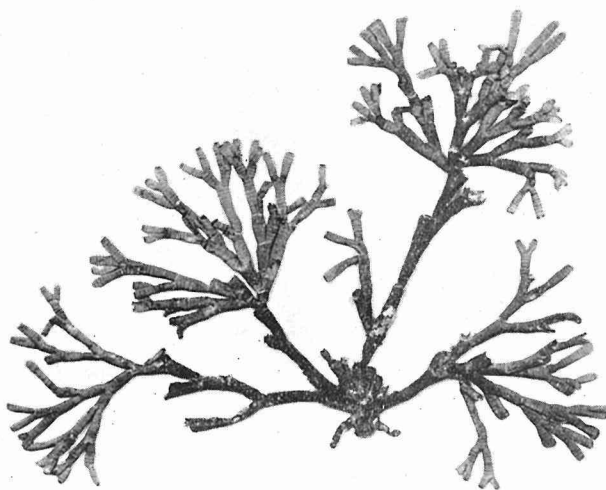


2

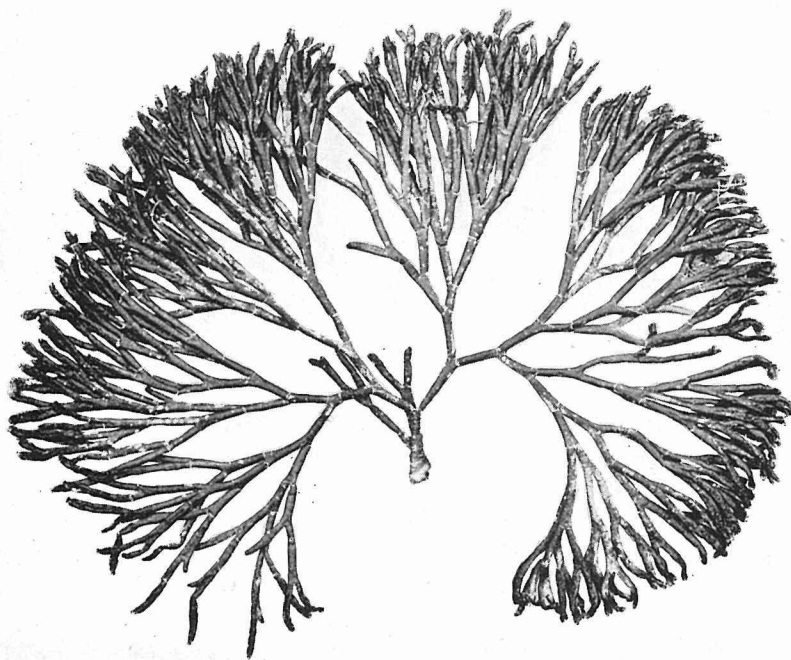
PLATE XXXVI

PLATE 36

1. *Galaxaura cuculligera* KJELLM. × 1
2. *Galaxaura papillata* KJELLM. × 1



1

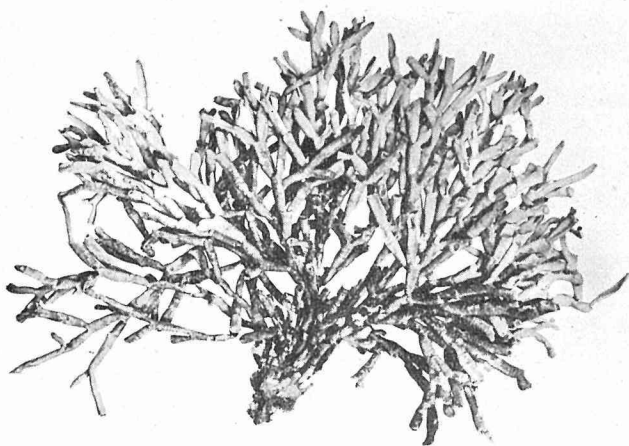


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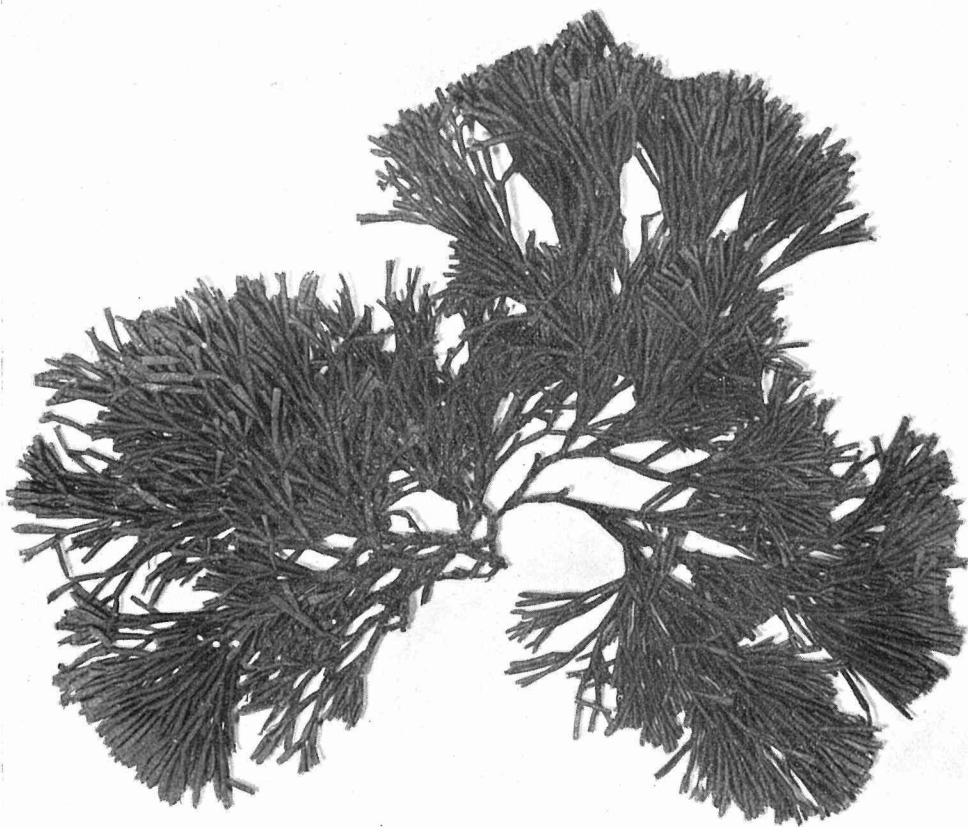
PLATE XXXVII

PLATE 37

1. *Galaxaura glabriuscula* KJELLM. ×1
2. *Galaxaura fastigiata* DCNE. ×1



1



2

PLATE XXXVIII

PLATE 38

Galaxaura elongata J. Ag. × ca. 1

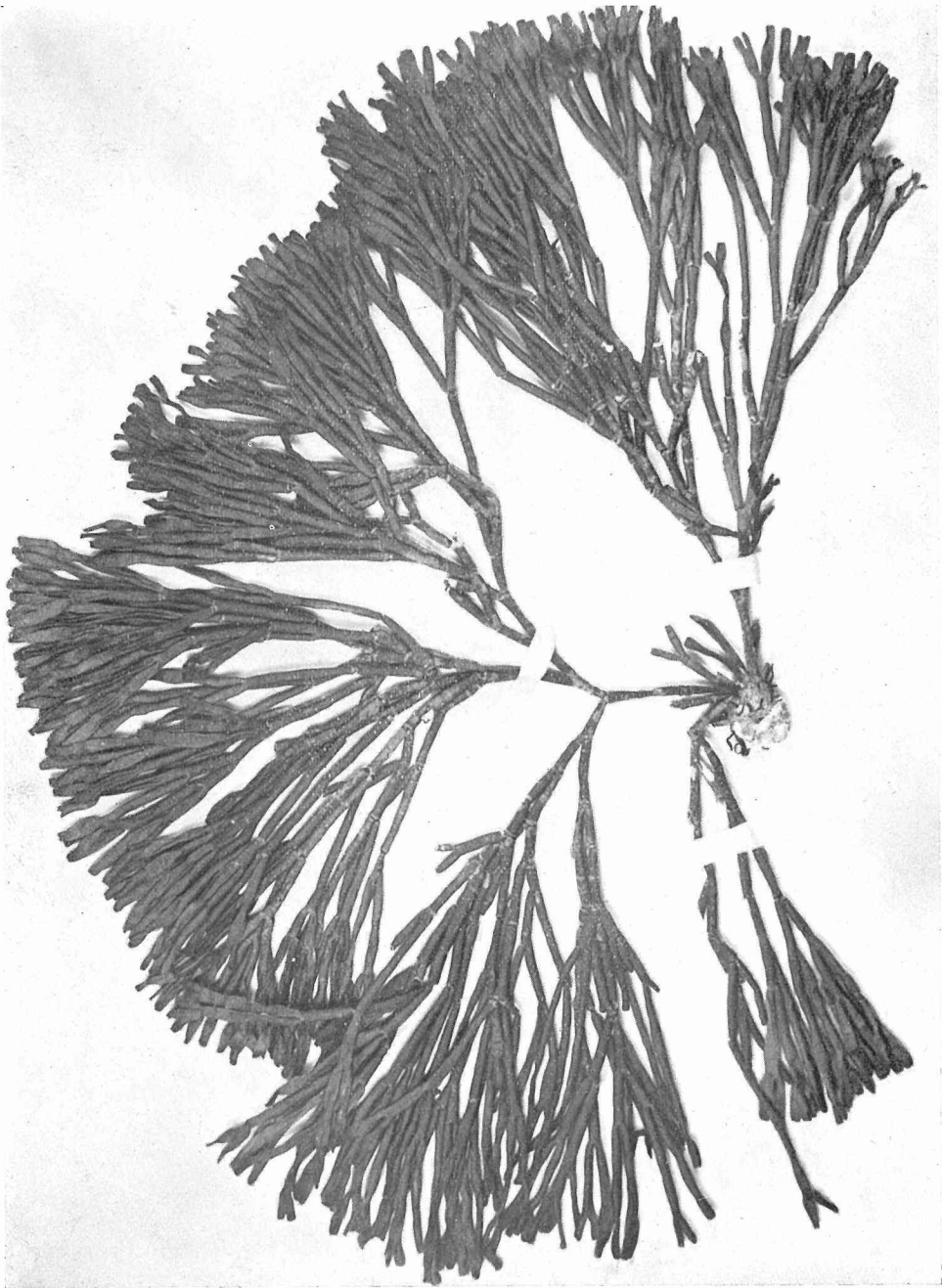


PLATE XXXIX

PLATE 39

Galaxaura falcata KJELLM. × ca. 1

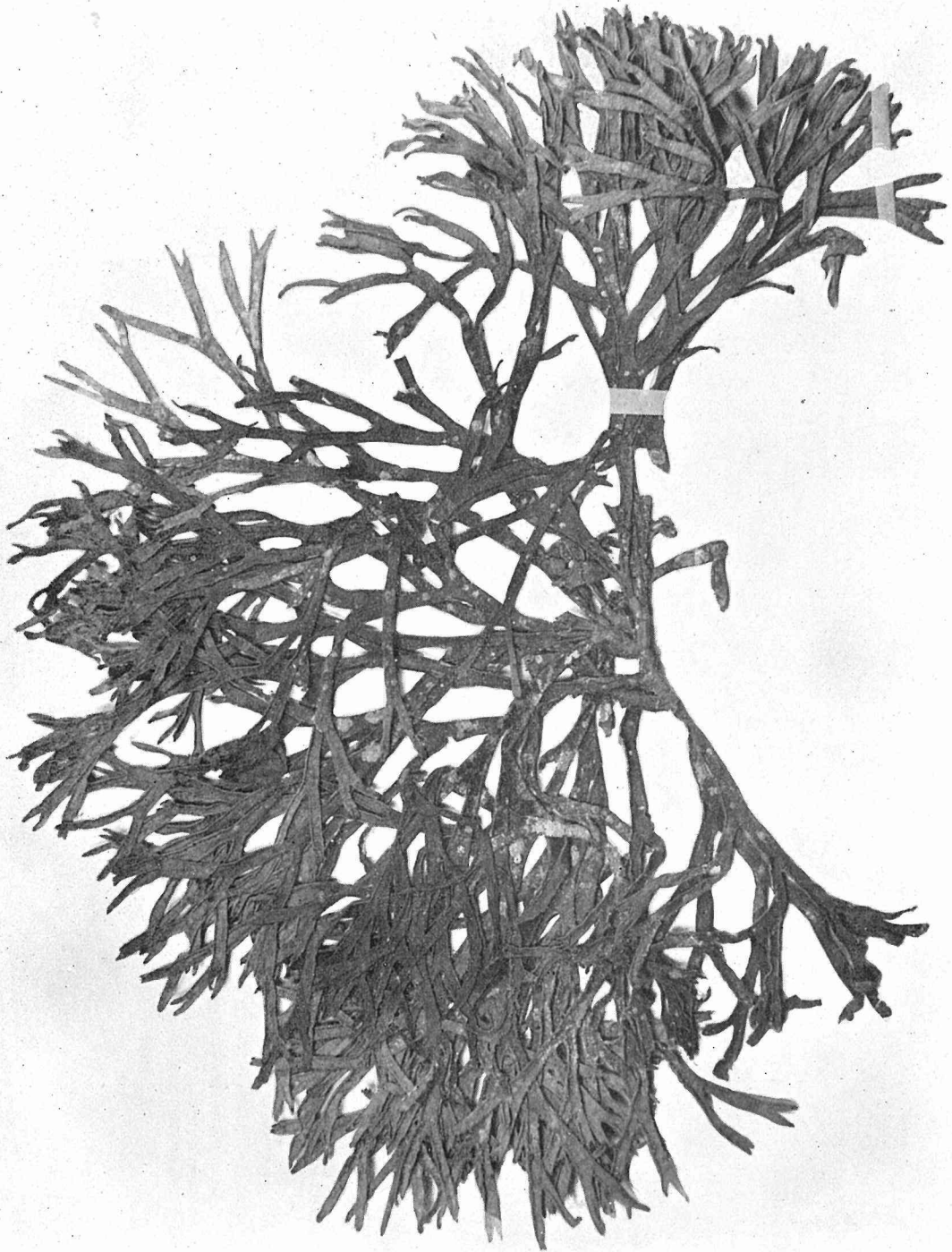


PLATE XL

PLATE 40

Galaxaura arborea KJELLM. ×1

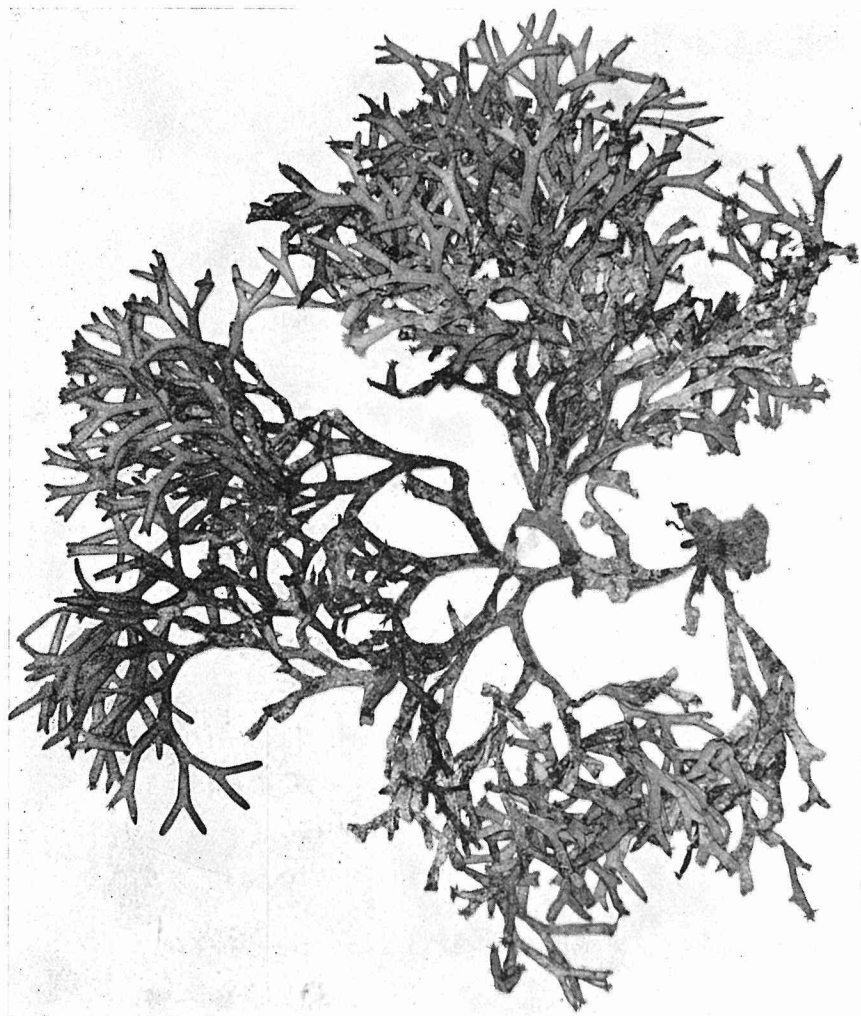
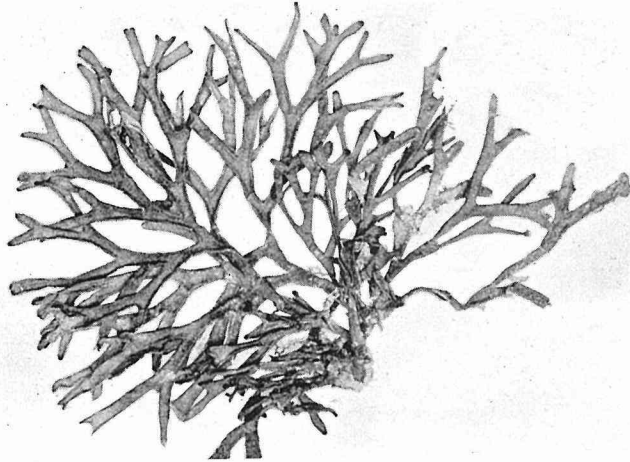


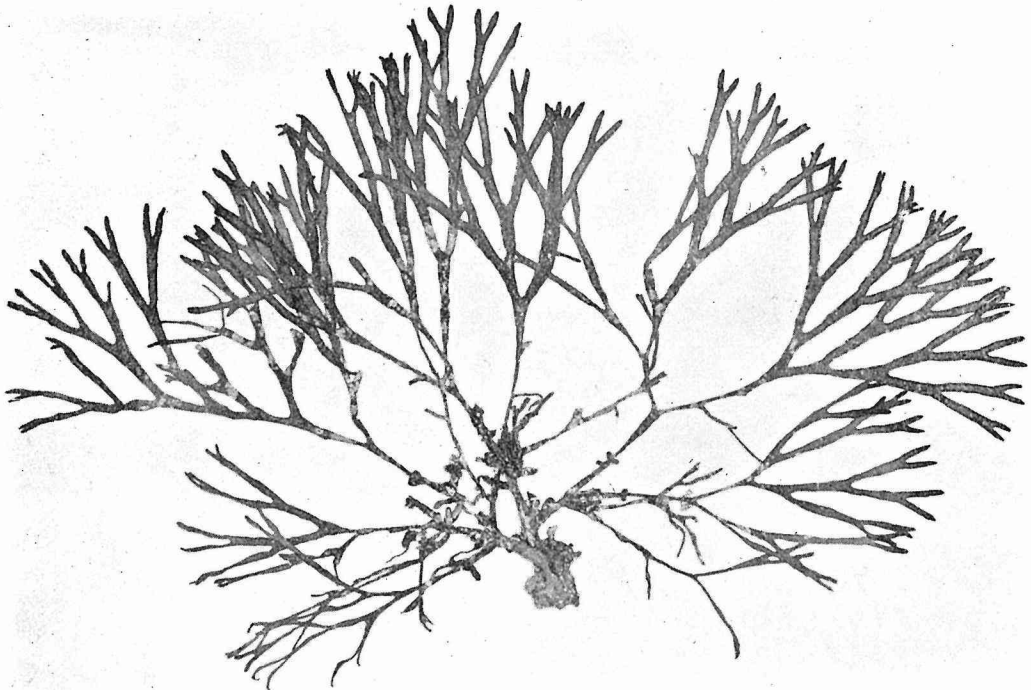
PLATE XLI

PLATE 41

1. *Galaxaura clavigera* KJELLM. ×1
2. *Galaxaura apiculata* KJELLM. Slightly reduced.



1



2

PLATE XLII

PLATE 42

Galaxaura Kjellmanii WEBER VAN BOSSE × 1

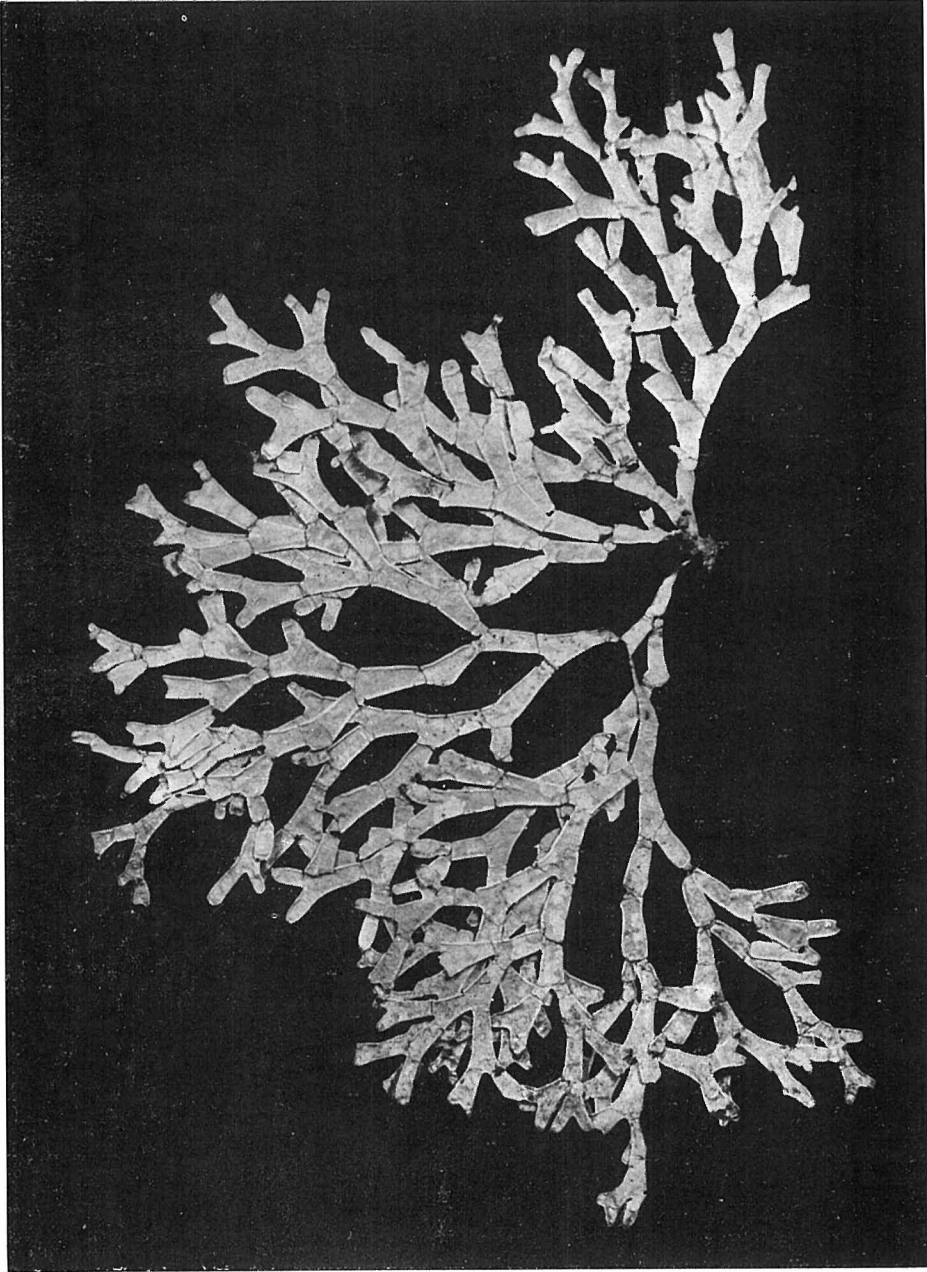
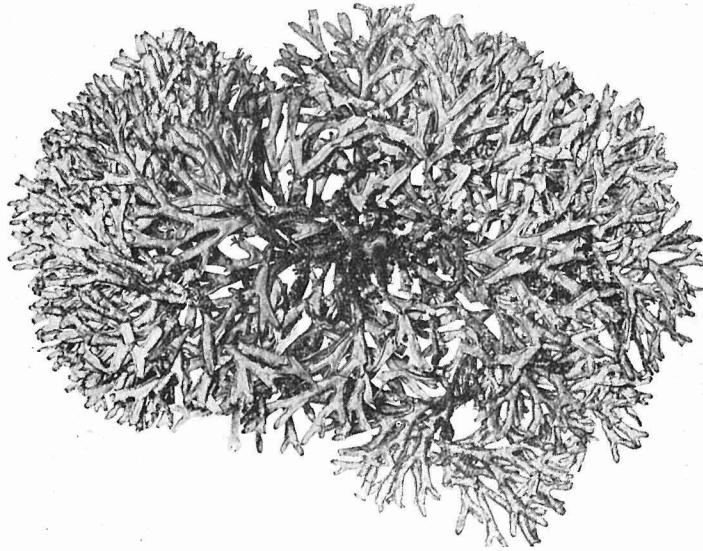


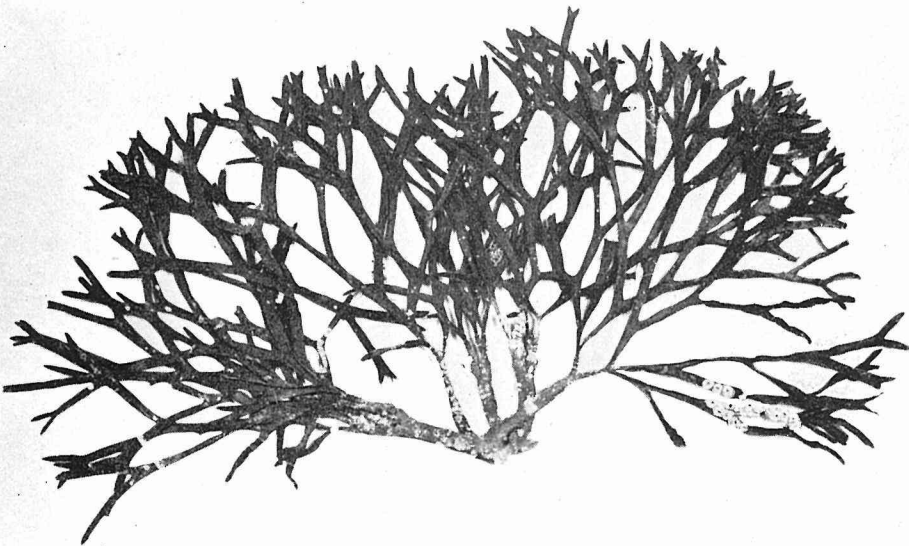
PLATE XLIII

PLATE 43

1. *Galaxaura veprecula* KJELLM. ×1
2. *Galaxaura hystrix* KJELLM. ×1



1



2

PLATE XLIV

PLATE 44

Galaxaura robusta KJELLM. ×1

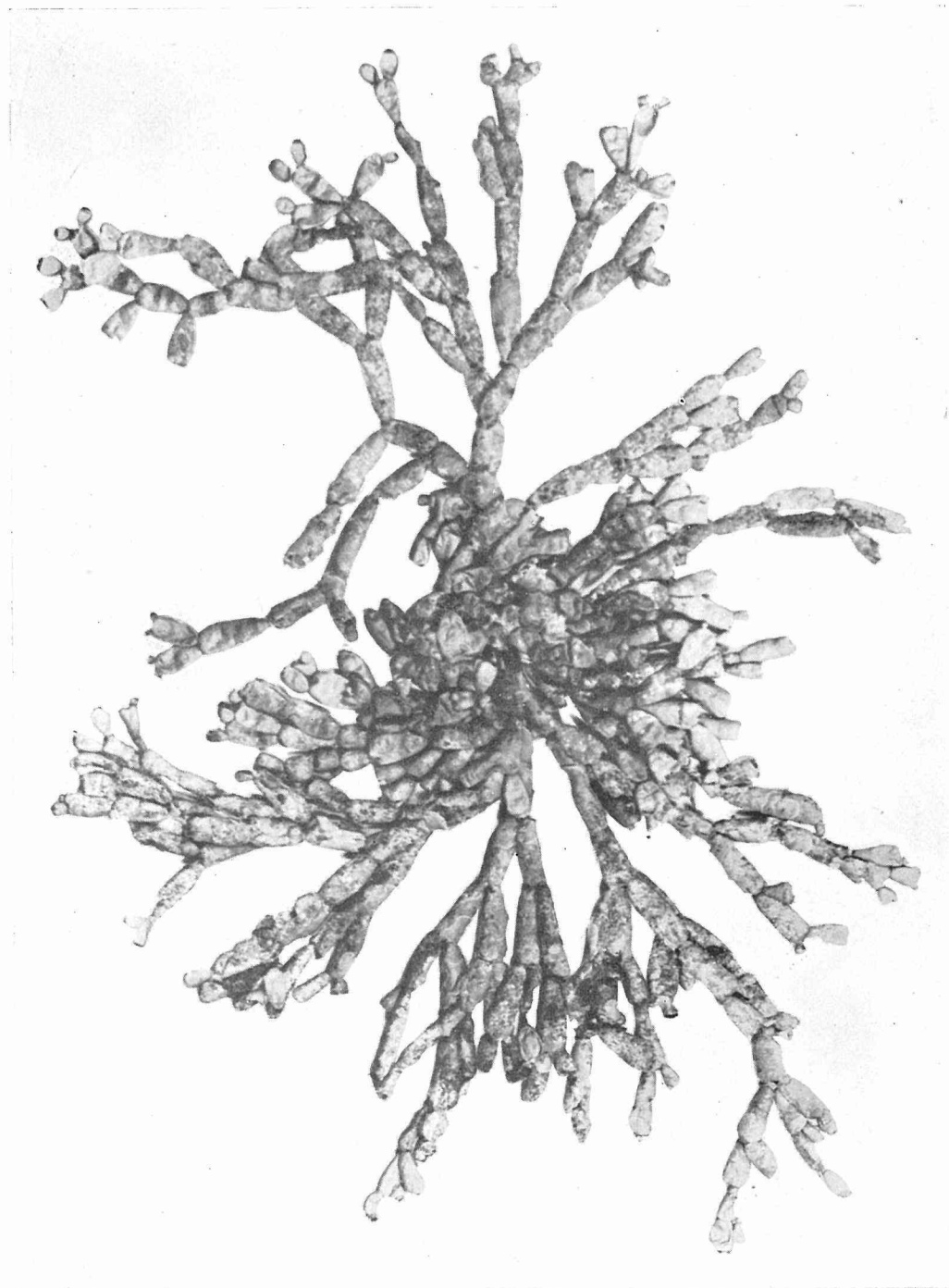


PLATE XLV

PLATE 45

Galaxaura obtusata (Soland.) LAMX. ×1

