

Some Noteworthy Species of *Galaxaura* (Chaetangiaceae, Rhodophyta) from Fiji

Hiroshi ITONO*

Abstract

Five species of the genus *Galaxaura* are described. They are *Galaxaura subfruticulosa* CHOU, *Galaxaura stupocaula* KJELLMAN, *Galaxaura glabriuscula* KJELLMAN, *Galaxaura ventricosa* KJELLMAN and *Galaxaura rugosa* (ELLIS et SOLANDER) LAMOUREUX. The former four species are reported here for the first time from Fiji and the latter one is suggested to occur in the Fijian waters.

Introduction

Galaxaura is a common genus on tropical and subtropical areas of the world. Since many of this genus sometimes present formidable taxonomic problems, the species of *Galaxaura* in the tropical and subtropical oceans have been inadequately known despite of several recent publications have made noteworthy contribution to our knowledge of the tropical Indo-Pacific species of *Galaxaura* (Kjellman, 1900; Weber V. Bosse, 1921; Boergesen, 1942, 1949; Chou, 1945, 1947; Womersley & Bailey, 1970; Itono, 1980). Past records (Grunow, 1873; Chapman, 1971, 1977) indicate that nine species of *Galaxaura* have been reported from Fiji. They are *G. fasciculata* KJELLMAN, *G. fastigiata* DECAISNE, *G. hystrix* KJELLMAN, *G. lapidescens* (ELLIS et SOLANDER) LAMOUREUX, *G. marginata* (ELLIS et SOLANDER) LAMOUREUX, *G. obtusata* (ELLIS et SOLANDER) LAMOUREUX, *G. robusta* KJELLMAN, *G. rugosa* (ELLIS et SOLANDER) LAMOUREUX and *G. striata* KJELLMAN. Of these nine species, Chapman (1971) excluded *G. lapidescens* and *G. rugosa* from the list of the Fijian marine algae due to the possible misidentification by Grunow (1873). As the major ground for such conclusion Chapman considered that these two species were the non-Pacific entities.

Recent collections of marine algae obtained by diving have revealed four species of *Galaxaura* new to the Fijian waters and one species, *G. rugosa*, to be a possible

* Department of Biology, Faculty of Science, Kagoshima University, Kagoshima 890, Japan

inhabitant in the Fijian waters. This paper provides an annotated list of these species. The study was based on the specimens which were collected on 1-7-'82 from Ndravuni, Kadavu Islands, during my stay in that island as a member of the Kagoshima University-University of the South Pacific joint scientific research project to Fiji.

Taxonomic Account

Key to the species.

1. Plants with branches terete throughout2.
1. Plants with branches complanate at least above4.
2. Epidermal layer absent ; free assimilatory filaments of two types, evenly distributed over the thalus surfaces*Galaxaura subfruticulosa*
2. Epidermal layer well developed3.
3. Branches smooth above*Galaxaura glabriuscula*
3. Branches conspicuously annulate rugose*Galaxaura rugosa*
4. Inner cortex outwardly supporting slender stalk cells each with one to two distal globose cells with occasional apiculate tips*Galaxaura stupocaula*
4. Inner cortex bearing on the outer side one layer of small depressed cells forming continuous epidermis, spinulose cells only on the thickened thallus margins.....
.....*Galaxaura ventricosa*

1. *Galaxaura subfruticulosa* CHOU ex Taylor

Fig. 1

1945 : 140 ; Chou, 1945 : 41, pl. 2 fig. 6. pl. 8 fig. 2 ; Dawson, 1952 : 52, pl. 20 fig. 1 ; Svedelius, 1953 : 51, figs. 43-47 ; Itono, 1977 : 4, fig. 4 ; 1980 : 5, fig. 3. Kjellman, 1900 : 51 ; Tanaka, 1936 : 148 ; Tseng, 1941 : 87 (as *Galaxaura fruticulosa* KJELLMAN).

Plants loosely fruticulent, up to 6 cm tall, the branches spreading, terete ; branching subdichotomous or corymbose, the internodes 3-11 mm long, 1-1.2 mm in diameter ; medullary filaments 12-17 μ m in diameter, loosely entangled, bearing assimilatory layer outwardly ; encrusted with more or less heavy lime deposits ; supporting cells of free assimilatory filaments at the periphery well developed, each supporting cell provided with 1-2 assimilatory filaments ; free assimilatory filaments of short and long types intermixed, both with subcylindrical basal cells ; short assimilatory filaments consisting of three cells but rarely of two cells, moniliform, terminal cells not exceedingly inflated, mostly decreasing slightly in diameter upwards, 20 μ m in diameter, slightly constricted at the dissepiments, unbranched or once branched at the basal parts.

Distribution : Pacific Mexico, Hawaiian Islands, Mariana Islands, Pratas Island, Hong Kong, southern parts of Japan, Fiji.

In habit, the thalli of the present Fijian specimens are closely similar to those of

G. subfruticulosa from the southern parts of Japan and from Micronesia. The species, with extended assimilatory filaments on the thallus surface, frequently show troublesome difficulties in their identification. However, many features of the present Fijian specimens fundamentally agree with the characteristics proposed by Chou (1945 : 140) in the type description of *G. subfruticulosa* and I regard the present Fijian species as *G. subfruticulosa*. It has generally accepted that *G. subfruticulosa* provides wide but discontinuous distribution in the tropical and subtropical parts of the north Pacific, and the present report of *G. subfruticulosa* from the Fijian waters extends its distributional range to the Southern Hemisphere.

2. *Galaxaura glabriuscula* KJELLMAN

Fig. 2

1900 : 56, pl. 7 figs. 1-2, pl. 20 fig. 26 ; Butters, 1911 : 175 ; Tanaka, 1936 : 151, figs. 12-13, pl. 37 fig. 1 ; Chou, 1947 : 11, pl. 4 figs. 14-24, pl. 10 fig. 1 ; Svedelius, 1953 : 10, figs. 4-13 ; Itono, 1977 : 9 figs. 12, 31 ; 1980 : 10, fig. 9.

Plants bushy, 7 cm tall, attached by small discoid holdfast ; branching subdichotomous, branches terete, glabrous above and villous below ; segments 1-1.5 mm in diameter, 4-11 mm long ; free assimilatory filaments evenly distributed in the lower half of the fronds, slightly stiff and thus easily fractured, unbranched, 18 μm in diameter, cells about two times as long as broad ; medulla traversed by few loosely entangled filaments of 10-15 μm in diameter ; cortical tissues parenchymatous, tristromatic, about 70 μm thick ; cells of the innermost layer the largest, subglobose or compressed oblong ; cells of the intermediate layer smaller, subglobose, more or less loosely arranged ; cells of the outermost layer forming epidermis, closely arranged, angular in surface view, 15-25 μm in diameter, semilunate in section, 10-15 μm thick ; hair-bearing epidermal cells slightly raised above the surrounding epidermal cells, circular in surface view.

Distribution : Tahiti, Mariana Islands, Hawaiian Islands, Bonin Islands, southern parts of Japan, Indonesia, Fiji.

G. glabriuscula, type from Tahiti, resembles closely in its external features to *G. squalida* KJELLMAN which is originally known from St Croix, Virgin Island in the Atlantic Ocean. The latter species has, thus far, been described from the tropical Indian and Pacific Oceans, such as Ceylon, Philippines, Solomon Islands and Tahiti, and is thought to be a representatives either in the Indo-Pacific or Atlantic Oceans.

In distinguishing *G. glabriuscula* from *G. squalida*, Chou (1947) paid attention to the size of epidermal cells, lobed cortical cells, frequency of the extended assimilatory filaments on the thallus surface and the presence of the yellow pigments in the chromatophores in the former species. According to the Chou's circumscription the present Fijian specimens agree well with *G. glabriuscula*. However, these criteria as used by Chou in separating these two species seem to have insufficient importance in the taxonomy of the *Galaxaura* since many of these features are the unstable structures being influenced by circumstantial conditions. From occurrence and form, *G. gla-*

briuscula and *G. squalida* could possibly be the same species. A precise study of further collections of these two species would help in assessing their relationship and I provisionally assign the present Fijian species to *G. glabriuscula*.

3. *Galaxaura rugosa* (ELLIS et SOLANDER) LAMOUROUX

Fig. 3

Kjellman, 1900: 55; Boergensen, 1916: 100, figs. 105-106; Chou, 1947: 13, pl. 4 figs. 12-13, pl. 10 fig. 2; Svedelius, 1953: 18, figs. 14-17; Taylor, 1960: 340; Itono, 1980: 11, fig. 10

Plants up to 5.5 cm tall, branching regularly dichotomous, attached by discoid holdfast; branches terete, glabrous above and villous at the base, continuous or constricted at the nodes, distinctly annulate-rugose; segments 1-1.2 mm in diameter, 3-6 mm long; free assimilatory filaments only at the base, 14-21 μm in diameter, unbranched; medulla traversed by few loosely entangled filaments, 7-13 μm in diameter; cortical tissue parenchymatous, tristromatic, about 65 μm thick; cells of the innermost layer the largest, frequently lobed, subglobose; others globose or subglobose, smaller than the innermost ones; cells of the outermost layer angular in surface view, containing well-developed chromatophores.

Distribution: Jamaica, Bahamas, Florida, Virgin Islands, Mauritius, Philippine Islands, Caroline Islands, Mariana Islands, Hawaiian Islands, Fiji.

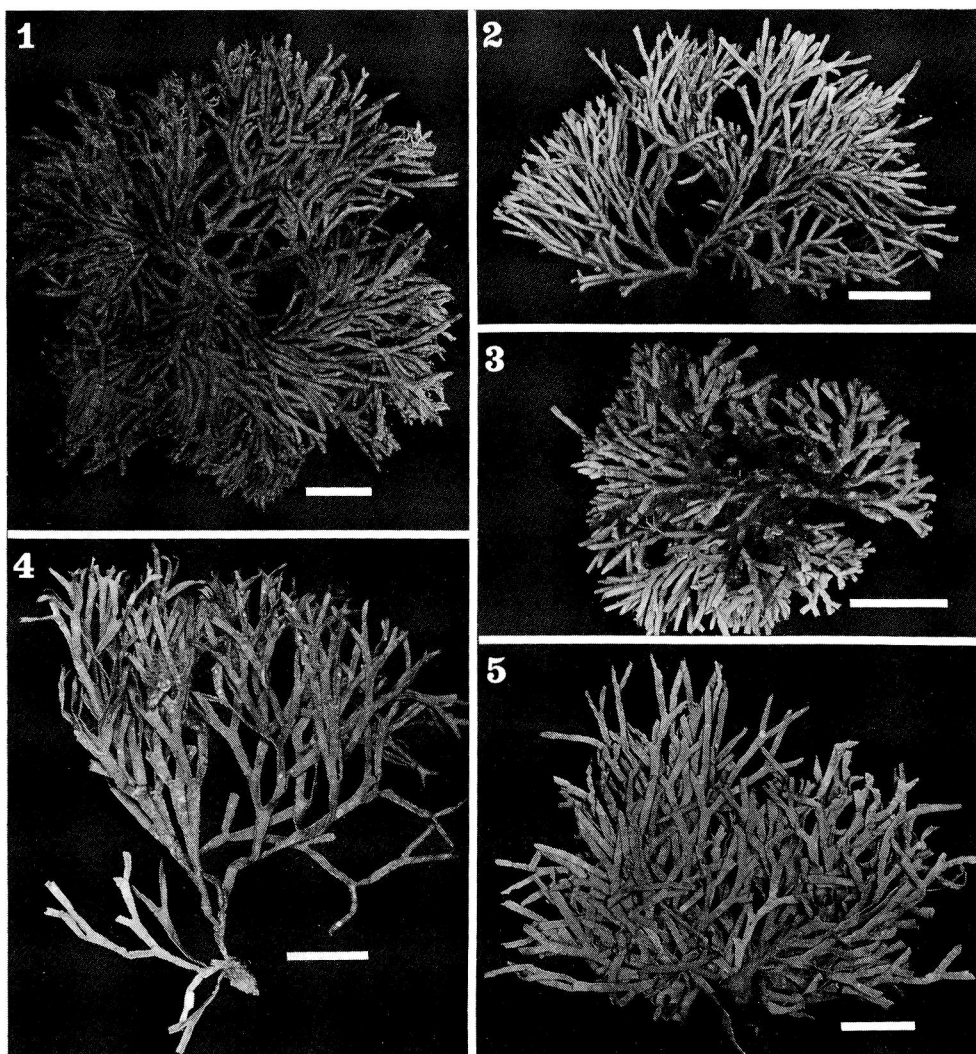
G. rugosa was already recorded by Grunow (1873) from the Fijian waters. However, Chapman (1971) was of the opinion to exclude this species from the Fijian floristic list, since *G. rugosa* was known only from outside the Pacific suggesting misidentification by Grunow. Chou (1947) was the second author who recorded the occurrence of *G. rugosa* from the Pacific. In her description of *G. rugosa*, Chou compared the specimens from the Philippine Islands with *G. elongata*, a species similar to *G. rugosa* but is limited to the Pacific Ocean, and, despite of such comparison, several features of her specimens agree more closely to *G. rugosa* than to *G. elongata*. Subsequently, *G. rugosa* has been recorded from some localities in the Indo-Pacific Oceans, and it is suggested that *G. rugosa* should be a more or less common inhabitant of the Atlantic and Indo-Pacific Oceans.

The plants from Fiji agree well with the descriptions and drawings made by Boergesen (1916), Chou (1947) and Svedelius (1953), and the species from Fiji should be referred to *G. rugosa*, suggesting Grunow's identification of this species is thus feasible.

4. *Galaxaura stupocaula* KJELLMAN

Fig. 4

1900: 75, pl. 14 figs. 1-9, pl. 20 fig. 28, as *G. stupocaulon*; Tanaka, 1936: 161, figs. 24-25, pl. 40 as *G. arborea*; Chou, 1945: 49, pl. 5 figs. 10-12, pl. 11 fig. 1, as *G. stupicaulis*; Svedelius, 1953: 72, figs. 61-64; Itono, 1977: 18, figs. 21, 39, as *G. arborea*.



Figs. 1-5. Habit of plants. Fig. 1. *Galaxaura subfruticulosa* CHOU; Fig. 2. *Galaxaura glabriuscula* KJELLMAN; Fig. 3. *Galaxaura rugosa* (ELLIS et SOLANDER) LAMOUREUX; Fig. 4. *Galaxaura stupocaula* KJELLMAN; Fig. 5. *Galaxaura ventricosa* KJELLMAN. (Scale: 2 cm).

Plants up to 10 cm tall, the branches smooth, frequently with faint transverse striations near the tips of branches, flattened, regularly dichotomous with narrow angles, 1.5-2.5 mm broad, the segments 7-14 mm long, about 380-450 μm thick, canaliculate when dried; lower parts of the fronds subterete without clear distinction from the stipe; stipe cylindrical, villous consisting of rhizoidal filaments, attached by a rather large, discoid holdfast; medullary filaments 5-10 μm in diameter, running irregularly; inner cortex composed of pseudoparenchymatous layer of large, nearly colorless cells, subglobose or compressed, bearing on the outer side 1-2 cylindrical or cuneate-cylindrical stalk cells, these simple or once forked and bearing one to two distal cells of highly variable forms, some obovoid, subglobose, semi-lunate in section

and frequently provided with spines on the distal cells produced mostly on the thickened margins.

Distribution : Brazil, Hawaiian Islands, Philippine Islands, Hong Kong, southern parts of Japan, Fiji.

Three specimens had been collected from the Fijian waters and on examining the external morphological features of these specimens it becomes evident that these specimens should be allied either to *G. clavigera* or *G. apiculata* in the section Brachycladia in their dichotomous branching manner with narrow angles. *G. apiculata* has been recorded from the restricted areas around its type locality and is characterized by having apiculate epidermal cells. Occasional production of the apiculate cells in *G. clavigera* has been recorded by Tanaka (1936) and Itono (1977) and if such characteristic is stressed in the classification of these species the present Fijian species may merge either in *G. apiculata* or in *G. clavigera*. In the Fijian specimens apiculate cells are mostly confined to the thickened margins which may sometimes be entirely lacking such cells. Such condition is seen in *G. marginata* (Boergesen, 1916 ; Itono, 1980) and *G. mauiana* (Svedelius, 1953) and occasional production of the apiculate cells in these species are probably affected by ecological conditions or by the stages of the thallus development. The appearance of lower stem-like portion of the present Fijian species is, however, differ significantly from either those of *G. apiculata* or *G. clavigera*.

The appearance of the lower stem-like portion of the Fijian specimens is more or less enlarged resembling to those of *G. arborea* from Japan. *G. arborea* has been recorded from some of the restricted areas such as southern parts of Japan (Tanaka, 1936 ; Itono, 1977), Philippines (Chou, 1945) and Hawaiian Islands (Butters, 1911), but the species recorded from these areas were considered by Svedelius (1953) to be allied close to *G. stupocaula*. The opinion proposed by Svedelius seems feasible and the binominal *G. arborea* should be excluded from the floristic lists of the Pacific Ocean in the Northern Hemisphere. Thus, the species formerly considered to be *G. arborea* should be merged under *G. stupocaula*.

Occasional production of the apiculate cells as can be seen in the present Fijian specimens has not been recorded in the past reports on *G. stupocaula*. The present Fijian materials were collected from about 10 m deep in the lagoon and such occasional production of the apiculate cells may be affected by ecological condition such as weak wave actions. Until further precise accounts on the occasional apiculate-cell production becomes clear, I would suggest to name the present Fijian species as *G. stupocaula*.

5. *Galaxaura ventricosa* KJELLMAN

Fig. 5

1900 : 81, pl. 16 figs. 11-16, pl. 20 fig. 24 ; Taylor, 1945 : 143 ; Chou, 1947 : 18, pl. 6 figs. 9-12, pl. 12 fig. 2 ; Womersley & Bailey, 1970 : 304 ; Itono, 1977 : 23, figs. 26-27, 45, pl. 1-2 ; 1980 : 17, fig. 13.

Plants bushy, up to about 8 cm tall, attached by stem-like holdfast ; stems terete

and villous, 10 mm long and 8 mm broad ; branches smooth, glabrous, flattened, about 1.5-2.5 mm broad, regularly dichotomously branched with narrow angles, segments 6-13 mm long, slightly canaliculate when dried, at the thickened margins 300-360 μm thick (except spinulose cells); medulla consisting of loose filaments measuring 5-18 μm in diameter ; inner cortex composed of a parenchymatous layer usually three cell layers thick of large, nearly colorless oval cells, cells of the innermost layer the largest, frequently lobed ; epidermal cells polygonal in surface view, 35-60 μm in diameter, closely adhering laterally, in section semilunate, up to 13 μm thick ; spinulose cells columnar, 13-18 μm in diameter and up to 48 μm long, mostly produced on the thickened margins.

Distribution : Tropical eastern Atlantic, Pacific Mexico, southern parts of Japan, Mariana Islands, Solomon Islands, Fiji.

Kjellman (1900) placed four species under the section *Vepreculae*. This section is characterized by the species having epidermal cells with papillae. After the publication of the monograph on *Galaxaura* by Kjellman, eight species of the section *Vepreculae* have been described. They are *G. occidentalis* (Boergesen, 1916), *G. articulata*, *G. latifolia*, *G. elegans* (Tanaka, 1935), *G. yaeyamensis* (Tanaka, 1960), *G. kjellmanii*, *G. sibogae* (W. V. Bosse, 1921) and *G. vietnamensis* (Dawson, 1954). Of these, *G. articulata* was thought to be synonymous to *G. infirma* by Svedelius (1953) and *G. yaeyamensis* was treated as synonymous to *G. ventricosa* by the present author (Itono, 1977). Thus, ten species in all should be included under the section *Vepreculae* and among these species the present Fijian species should be allied under the binomial *G. ventricosa* by having spinulose cells on the epidermal cells of the thickened margins.

Unlike to the specimens of *G. ventricosa* from Micronesia (Itono, 1980), the present Fijian species is distinct by having narrow angle of the branching and is more closely related to *G. hystrix* from Hawaii (Svedelius, 1953) in its external morphology. Svedelius (1953) was of the opinion that the branching and growth habit were of greater significance in the identification of the *Galaxaura* species, but in the present study I would suggest that the present Fijian specimens should be referred to *G. ventricosa* based on the presence of spinulose cells only around the thickened margins of the frond until taxonomic implication of the branching and growth habit, as well as the presence and location of the spinulose cells, becomes clear.

In its external morphology, the present Fijian specimens of *G. ventricosa* are quite identical with those of *G. stupocaula* described before in the present paper and it is almost impossible to separate these two unless internal structures are observed. *G. ventricosa* was collected together with *G. stupocaula*, and although only sterile specimens were collected these two are possibly the same species each representing a different stage of generation.

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