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STUDIES ON THE MARINE ALGAL FLORA OF VENEZUELA. V. *PSEUDOGLOIOPHLOEA HALLIAE*[1,2]

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SUMMARY

Details of structure and reproduction, particularly pre- and postfertilization development, are given for the first time in Pseudogloiophloea halliae. *In general, the author's observations agree with what is known for most species of the genus. Some remarks on the identity of 3 species of* Pseudogloiophloea *in the tropical and subtropical American Atlantic shores are also included.*

INTRODUCTION

Pseudogloiophloea (Nemaliales, Chaetangiaceae) contains forms that are erect and fleshy with a cylindrical, generally dichotomously branched thallus. The genus has a wide, but isolated distribution in tropical and temperate waters. In the tropical and subtropical western Atlantic, 3 species have been recorded: *P. halliae* (Setchell) Joly *et* Cordeiro-Marino, *P. caribaea* (Taylor) Joly *et* Cordeiro-Marino (*11*), and *P. braziliensis* Joly *et* Cordeiro-Marino (*5*). Of these, *P. halliae* is a little known species of which very few specimens have been collected. The first specimens were collected by G. A. Hall at St. Lucie, Florida, in 1899. The species was given a valid description by Setchell (*8*). The second collection was a small piece collected by Gisela Muscus de Falcón in Venezuela and examined by Taylor (personal communication; see also *11*). The ontogeny of the carposporophyte of *Pseudogloiophloea* has been described for *P. capensis* (*9*), *P. fascicularis* (*3*), *P. confusa* (*7*), and *P. okamurai* (*2*). In *P. braziliensis* only the structure of the carpogonial branch has been described (*5*). Details of sexual reproduction have not been studied in any of the warm water American Atlantic species of *Pseudogloiophloea*. Abundant fertile material of *P. halliae* was obtained in eastern Venezuela and was used for the present study.

MATERIAL AND METHODS

Abundant, quite fresh material was found washed ashore on a beach near Juan Griego, Margarita Island, eastern Venezuela on June 5, 1968. Formalin-preserved material was stained with 1% aqueous aniline blue for 24 hr, the excess stain washed off with distilled water, the material chopped into small pieces, and then squashed. However, for some anatomical details, portions of stained material were cut with a freezing microtome (25 μm thick). All sections were mounted in glycerine.

RESULTS

The alga grows to a height of 20 cm from a small discoid base. The thallus has a fleshy consistency, is dark brown below, reddish brown in the terminal branches, about 1 mm in diameter in the basal portion, and up to 2.5 mm in diameter in the apical parts. Branching is essentially dichotomous with narrow angles, and the distance between dichotomies varies from 0.4 (Fig. 1) to 4 cm (Fig. 2) The Venezuelan material was also compared with a photograph of the lectotype of *Pseudogloiophloea halliae* (Fig. 9) kept in the herbarium of the University of California, Berkeley (UC 177646). In general appearance, mode of branching, and diameter of branches, the Venezuelan plants agreed well with the lectotype photograph. A fragment of the lectotype in the herbarium of the University of California was not sectioned for comparison because of its small size. However, Setchell's (*8*) figure shows that the specimen is representative of the genus *Pseudogloiophloea*. The anatomy of *Pseudogloiophloea halliae* was described adequately by Setchell (*8*) and need not be redescribed here.

Carpogonial branches are initiated in the apical region and generally in the region of a basal dichotomy of the cortical filaments, where utricular differentiation is not yet detectable (Fig. 3). The carpongonial branch initial divides by 2 transverse divisions resulting in a branch consisting of a carpogonium, a hypogynous cell, and a basal cell (Fig. 6). The trichogyne of the mature carpogonium projects beyond the surface of the thallus.

Before fertilization, the hypogynous cell cuts off laterally 2 secondary cells, on opposite sides (Fig. 6, 4). One of these derivatives cuts off another cell laterally, resulting in 4 hypogynous cells which are arranged in a row (Fig. 7) or cruciately. The basal cell forms a few, short, small-celled sterile filaments (Fig. 4).

After fertilization, the 4 hypogynous cells remain distinct, without fusing (Fig. 7), although there may

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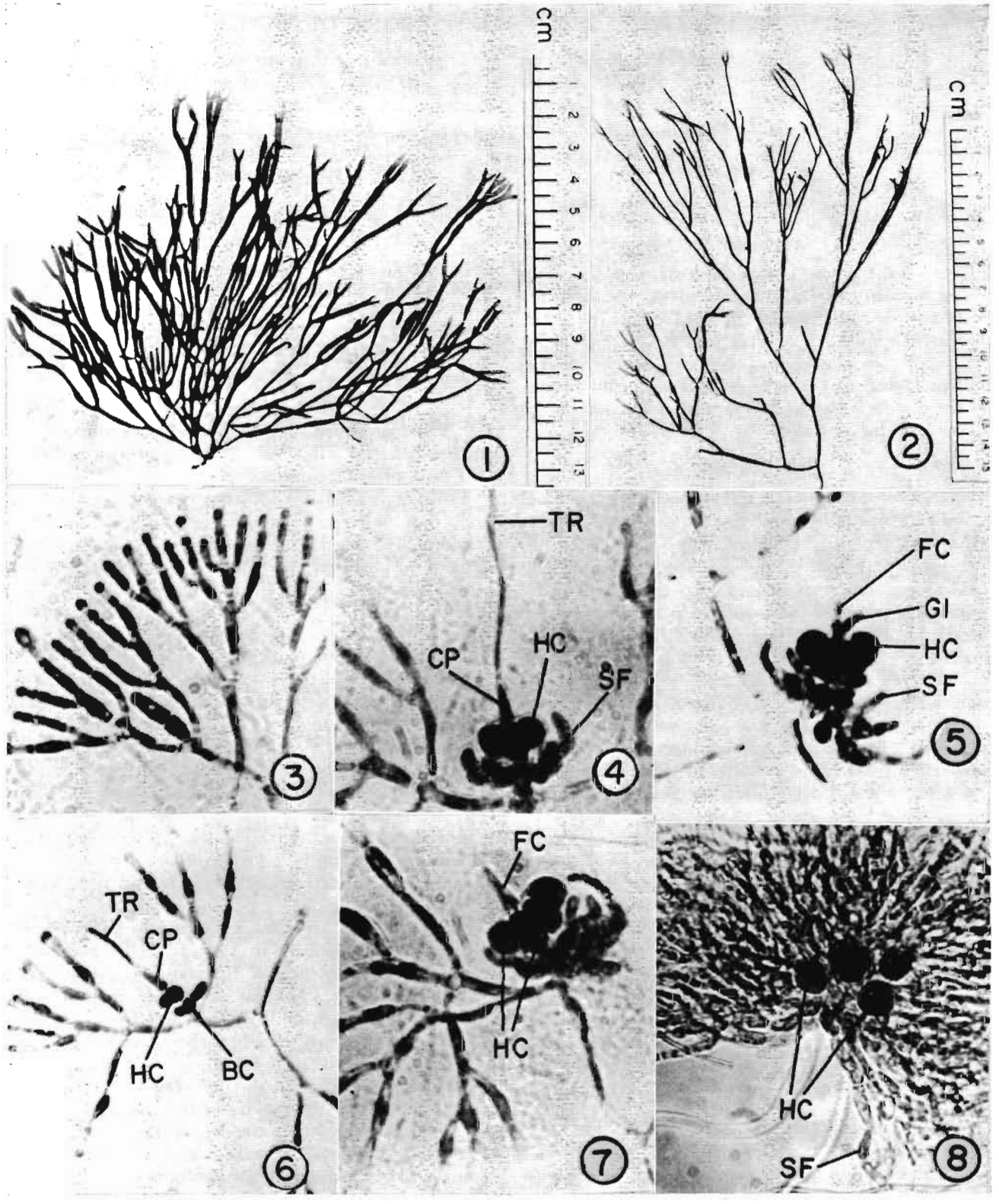

NOTE: *CP* = carpogonium; *TR* = trichogyne; *HC* = hypogynous cell; *SF* = sterile filament; *FC* = fertilized carpogonium; *GI* = gonimoblast initial; *BC* = basal cell.

FIG. 1. Habit of an abundantly branched specimen.
FIG. 2. Habit of a sparsely branched plant.
FIG. 3, 4, 6. Stages in the development of a carpogonial branch. × 780.
FIG. 5. Origin of the gonimoblast initial from the base of the fertilized carpogonium. × 857.

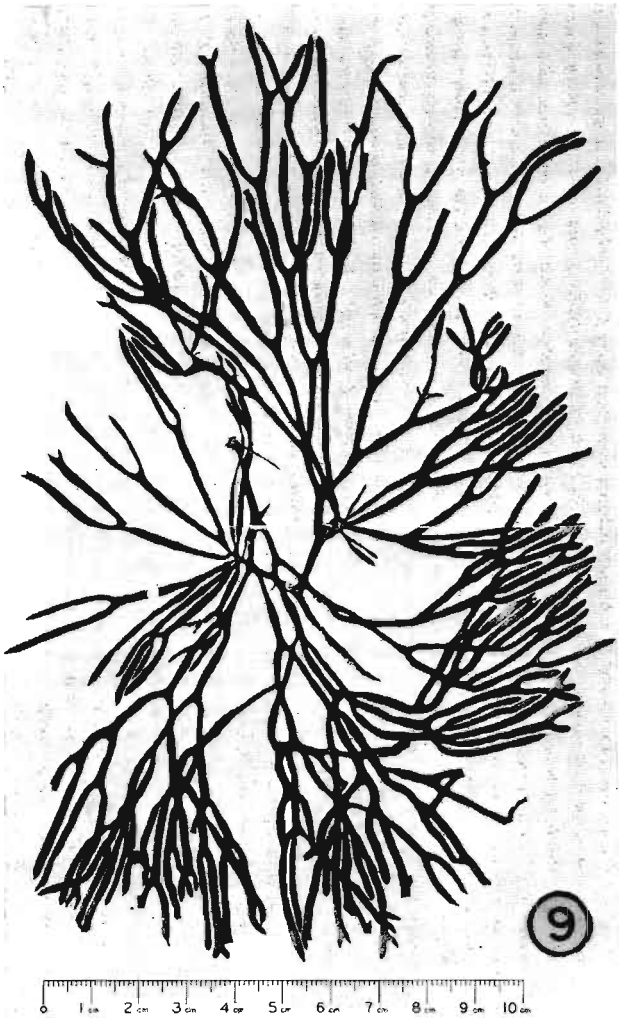

FIG. 9. Photograph of lectotype of *Pseudogloiophloea halliae* (UC 177646).

be a slight to prominent enlargement of pit connections. The gonimoblast initial is cut off from the base of the fertilized carpogonium (Fig. 5) and gives rise to branched gonimoblast filaments. Carposporangia are formed in small chains from the tips of the gonimoblast filaments. The sterile filaments derived from the basal cell form a pericarp around the carposporophyte. Even in advanced stages of carposporophyte formation, the 4 hypogynous cells remain distinct (Fig. 8). Young developing cystocarps, which occur in the first few millimeters below the growing point, are conical, 80–120 μm in diameter and 120–175 μm long. Mature cystocarps, observable 10 cm below the growing point, are 120–200 (240) μm in diameter and 250–300 μm long.

The gametophytes of *Pseudogloiophloea halliae* are monoecious. Spermatangia occur as scattered, irregular patches on the thallus surface. As in *P. confusa* (*7*), some of the pigmented cells between the utricles give rise to small spermatangial filaments, made up of 2–3 cells, the terminal cell of which produces a group of spermatangia. The spermatangia, when still attached, are slightly elongated, nearly colorless, and about 2.0 μm in diameter. Ramus (*7*) is of the opinion that in *P. confusa* the terminal cells separate from the filaments and function as spermatia.

DISCUSSION

Setchell (*8*), when describing *Pseudogloiophloea halliae*, mentioned that the cystocarps were 100–118 μm in diameter and 66–88 μm long. Taylor (*11*), probably by oversight, gave the measurements as 66–88 μm in diameter and 100–118 μm long. In the material from Venezuela studied by the writer the mature cystocarps measure as much as 120–240 μm in diameter and 250–300 μm in length. According to Taylor (*11*), the axial strand of *P. halliae* is obscure. However, the Venezuelan plants of *P. halliae* studied by the writer show a prominent axial strand when viewed externally and in section.

In having 3-celled carpogonial branches and by the formation of sterile filaments from the basal cell of the carpogonial branch, *Pseudogloiophloea halliae* is very similar to *P. capensis* (*9*), *P. fascicularis* (*3*), *P. confusa* (*7*), and *P. okamurai* (*2*). In all these species the hypogynous cell divides longitudinally to form a group of 4 cells before fertilization. *Pseudogloiophloea braziliensis* is very peculiar in having a 4–5-celled carpogonial branch and in not forming either a group of 4 hypogynous cells or sterile filaments from the first cell of the carpogonial branch [see Joly *et al.* (*5*), pl. VI. Fig. 4]. Since *P. braziliensis* closely resembles all the other species of the genus in thallus structure, a detailed study of pre- and postfertilization development of this species is called for.

In *Pseudogloiophloea confusa* the hypogynous cell and its 3 derivatives fuse after fertilization to form 2 fusion cells (*7*). However, in *P. halliae*, as in *P. okamurai* (*2*), no such fusion occurs, although there may be a slight to prominent widening of pit connections between the cells. *Pseudogloiophloea halliae* resembles *P. confusa* (*7*) and *P. okamurai* (*2*) in that the gonimoblast initial arises from the fertilized carpogonium. In *P. capensis* (*9*) and *P. fascicularis* (*3*), the gonimoblast initial arises from the hypogynous cell. All the species of *Pseudogloiophloea* in which

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FIG. 7. Fertilized carpogonium with 4 hypogynous cells. × 857.

FIG. 8. Basal part of a young cystocarp showing 4 hypogynous cells. × 857. Note in this figure, as also in Fig. 7, there is no fusion among hypogynous cells.

the early development of the gonimoblast has been studied are uniform in that there is only one initial produced—an advanced feature among members of Chaetangiaceae, according to Chiang (*1*).

Pseudogloiophloea is represented in the tropical and subtropical western Atlantic by 3 species: *P. halliae* and *P. caribaea* from the Caribbean Sea (*10,11*) and *P. braziliensis* from northern Brazil (*5*). In the present state of our knowledge, it appears that *P. braziliensis* is easily distinguished from the other 2 species essentially by thallus diameter of 2–3 mm, invisible central axis, and dioecious sexual plants.

As shown earlier in this paper, axial strands are evident in *Pseudogloiophloea halliae*, and cystocarp size range of *P. halliae* includes that of *P. caribaea* also. *Pseudogloiophloea caribaea*, originally described from Hispaniola (*10*), has also been recorded recently from Venezuela (*4*). Examination of 3 herbarium specimens of this species in our Herbarium showed that the Venezuelan plants are up to 10 cm long, segments (dry) 0.5 mm in diameter at the base and up to 2 mm in diameter at the apex, 4–8 times dichotomously branched with intervals varying from 1 to 2 cm, resembling *P. halliae*. Hence, these 2 species, in the opinion of the author, appear to be somewhat indistinguishable (see also *6*). Taylor (*10*, p. 149), when describing *P. caribaea* and discussing its affinity with *P. halliae*, remarked that ". . . it is not inconceivable that the variations are within the range of one species, but, with only two collections known, that can hardly be established." Until a complete study of the ecotypic variations of *Pseudogloiophloea* is made in the Caribbean Sea, together with examination of topotype materials, it is best to consider *P. halliae* and *P. caribaea* as independent species.

The author's attention was drawn by G. F. Papenfuss to the fact that in the eastern Atlantic *Pseudogloiophloea verae* (Dickinson) Papenfuss (*6*) is known from Ghana. *P. verae* resembles the 2 large western Atlantic species *P. halliae* and *P. braziliensis* in general appearance, thallus size, and width of segments. The author has also examined 2 herbarium specimens (UC 104584, 104585) and fertile liquid material of *P. verae* collected by Ted Papenfuss on November 1961 from 1 mi east of Tema, eastern region, Ghana. Externally the resemblance of *P. verae* to *P. halliae* is particularly striking. However, *P. verae* appears to be different from *P. halliae* by being dioecious and having smaller cystocarps. Both *P. verae* and *P. braziliensis* are dioecious. Again the cystocarp size appears to distinguish the 2 species, *ie*, those of *P. verae* are 200–230 μm long and 130–150 μm in diameter and those of *P. braziliensis* are 304–323 μm long and 235–258 μm in diameter.

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