THE SEXUAL FEMALE PLANTS OF **GRIFFITHSIA TENUIS** C. AGARDH

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Griffithsia tenuis is a wide spread plant; it has been reported previously from various parts of the world: Mediterranean Sea, Canary Islands, Caribbean Sea, northeastern coast of North America, Japan, China, Viet Nam, Australia and India. The reports, so far as I have been able to find are concerned mainly with sterile, male or tetrasporic plants. The female plant has been found very seldomly and the few reports only mention scattered filaments found among other algae.

For this reason, apparently, there is no description of the female plant and the development of the carpogenic branch of this distinctive species, apart from the very fragmentary notes given by Askenasy (1888, p. 36-37) based upon one cystocarpic plant found by him, and the statement by Collins & Hervey (1917, p. 135) when they say that the cystocarps are characteristic of the genus *Griffithsia*. Okamura (1933) published few remarks on the shape and position of the cystocarp and figures also a mature (?) cystocarp. Nothing was added by Feldmann-Mazoyer (1940) in her valuable work. Abbot's (1946) treatment of the genus *Griffithsia* in Hawaii contains a few remarks on the origin of the auxiliary cell and carpospores in plants she attributed to this species, which I will discuss later.

Tseng (1942) reports the present species from China; he gives also a good illustration of the characteristic branching habit (l.c. p. 107, fig. 1). The tetrasporangia and the antheridial stands are well known. In connection with this statement cf. Askenasy (l.c. p. 36-37 pl. 9, figs. 1 and 4 — under *G. thyrsigera* (Thwaites).

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Askenasi; Preda (1908, p. 152); Collins & Hervey (1.c. p. 135 pl. 6, figs. 38-39); Börgesen (1920, p. 462-464, fig. 423; 1930, p. 31 and 1931, p. 11-12); Okamura (1.c. p. 2-3 pl. 302, figs. 1-6, pl. 303, figs. 4-7); Feldmann-Mazoyer (1.c. p. 411-412, fig. 161); Dawson (1954, p. 450, fig. 56 e). For complete bibliographical reference for this species see especially Okamura (1.c.), Feldmann-Mazoyer (1.c.) and Börgesen's papers quoted above.

Description of the plant

The most typical feature of this species is the peculiar manner of branching, which was long ago noted (cf. Askenasy, 1.c.); later the discovery of tetrasporic plants provided a very good character for identification purposes, since the arrangement of the tetrasporangia characteristic of *G. tenuis* is not found in any other species of the genus. It will be convenient to describe briefly the manner of branching and the position of the tetrasporangia. New branches always arise from the proximal part of any adult vegetative cell instead of, as is usual in related forms, being formed from the distal end of the cell. The branching is not frequent, as has already been noted by Börgesen (1920, 1931). The tetrasporangia occur upon unicellular pedicels, each of which bear one tetrasporangium. They are placed near the tips of the vegetative branches, and make a dense ring at or a little below the whorls of trichoblasts. The number of tetrasporangia has been reported variously from different regions where the plant has been found — 5 to 8 on the Mediterranean Sea, or up to 15 in the Caribbean area, for instance. The Brazilian plants commonly bear 8 tetrasporangia in each ring.

The female plants also provide very good and reliable characteristics for identification, since the position and structure of the female organs are also very distinctive. The future fertile branch can easily be recognized at the apex of a vegetative system by the relatively small apical cell (as compared with the apical cells of the neighboring vegetative branches) — see Plate I, figs. 1 and 2. As a matter of fact the fertile branch arises terminally as in *G. corallina* reported by Kylin (1916) and only later will it be displaced to a lateral position by the development of one lateral branch from the cell immediately below. This false lateral position is later

strongly marked by the growing apex. To my opinion this is what happens in this species and not what Abbot (l.c. p. 442) stated.

Development of fertile branches

The material I have, enables me to present a description of the development of the fertile branch. The earliest stage observed is that represented in fig. 1. The future carpogonium-bearing branch has 3 cells, as in *G. corallina* (see Kylin 1916) it is distinguished from the vegetative branches by its small apical cell and denser cytoplasmic contents. It is evident now that the fourth cell immediately below the fertile branch gives off the lateral branch which will replace later the growing apex. A following stage is found in fig. 2, where the lateral branch already has 2 cells (one is a nearly normal sized apical cell); the fertile branch presents, in addition to another cell, the first pericentral (cut off from the middle one — the central cell), the following modifications: The lower cell, which is destined to become the future stalk cell of the cystocarp and the middle cell have greatly increased in size. The lower cell (future stalk cell) will remain undivided until fertilization takes place and after a while it will form at the distal end eight cells (in Brazilian plants) which will later produce the envoloping threads of the cystocarp. It is to be noted that the fertile branch still retains its terminal position. No evident modification is seen in the apical cell, which apparently remains undivided throughout the whole process as in *G. corallina* (see Kylin 1916). In the next (fig. 3) as well as in the following figures only the fertile branch is represented. In fig. 3 the fertile branch has 5 cells, the fifth cell (the small one at the upper right of the figure), will be the first cell of the carpogenic branch. Fig. 4 shows a later stage, where it is possible to name each cell involved: the stalk cell (stk), the central cell (cc), the supporting cell (su), derived from the central cell, another pericentral cell (pc) and the apical cell initial (seen also at fig. 5). The pericentral cell (pc) — the proximal one seen at the upper left corner of the figure — which in *G. corallina* and *G. metcalfii* produces another carpogenic branch (see Kylin 1916 and Tseng 1942) is here apparently non functional. The carpogenic branch, cut off from the supporting cell, is found in

the process of formation (with 3 cells). Fig. 5 shows a complete carpogenic branch with 4 cells. Note the increase in size of the stalk cell. Figs. 6 and 7 show the earlier and nearly mature enveloping threads surrounding the developing carpospores. Fig. 8 represents the fully grown enveloping threads. The gonimoblast and carpospores are not shown in figs. 7 and 8. Ripe carpospores are shown in fig. 9 (seen from above). Figs. 10 and 11 represent the typical lateral branching, young and old respectively, found at the basal part of the plant. The new lateral branch arises at the proximal end of the vegetative cells. In none of the drawings are the trichoblasts shown which were present around the young terminal parts.

I shall point out that this terminal position of the fertile branch is also found in *G. globulifera* Harvey*, so thoroughly described by Lewis (1909, under *G. bornetiana* Farlow); the existence of only one carpogenic branch plus the special fruit envelope, approximates the present species to the well known *G. barbata* (Smith) C. Agardh. Cf. Börgesen (1920, p. 464-465, fig. 424, 1930, p. 32-34) and Feldmann-Mazoyer (l.c. p. 408-410, figs. 159-160), where a complete bibliography concerning this species is given.

I am inclined to accept Abbott's report of *G. tenuis* from Hawaii with certain restrictions. Her description, remarks and drawing of the species mentioned above are somewhat in discordance with the original concept of that species, as accepted by Börgesen (1920 and 1931), Okamura (1933), Feldmann-Mazoyer (1940) and Tseng (1942). From some remarks in her paper it is possible to infer that she was dealing, perhaps, with a mixture of related species. This doubt arises as a consequence of her statement (l.c. p. 442) that she found only in one, out of the several collections listed, typical material of *Griffithsia tenuis*. Furthermore, her remarks that the "... persistent dichotomous branching of the Hawaiian specimens is a very misleading character since *Griffithsia tenuis* of other writers is taxonomically characterized by having lateral, secund branches", and "... Hawaiian specimens appear to be more narrow in the size of the cells and have smaller tetraspores than

* *G. globulifera* Harvey in Kützing, Tab. Phyc. 12: 10, pl. 30, figs. a-d 1862.

the Atlantic and China specimens". Again, her drawings of the tetrasporangia (her pl. 3, figs. 1 and 4) and the enveloping threads of the cystocarp (her pl. 3, fig. 6) do not agree with the illustrations given by the authors already cited. In addition to the non-typical habit of branching shown in figs. 1 and 4, her figs. 6 and 7 are somewhat discordant from the published figure of Okamura (1933, pl. 302, fig. 6).

The tetrasporic and the antheridial branches are in our species clearly unbranched, a condition which we can assume as more specialized than the branched type found in both structures in *G. barbata*. The similarities between the development of the carpogenic branch and the final structure of the ripe cystocarp point towards a possible line of evolution from an ancestor like *G. barbata* to *G. tenuis* in which we find specialization in that the tetrasporangial and spermatangial structures are not borne on the basal cells of trichoblasts, but terminate short stalklike branchlets which do not continue into trichoblasts. Here they are performing only one specific rôle: reproduction.

The species referred to above has been colleted with tetrasporangia, cystocarps and antheridia, each found on different plants, during April and July. It is abundant in shallow water on leaves of an unidentified Monocotyledonous plant growing on muddy bottom at S. Sebastião and Ilhabela on the coast of the State of São Paulo, Brazil. This is the first record of this species from Brazil (cf. Taylor, 1931) and the South Atlantic generally.

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RESUMO

O presente trabalho descreve em detalhe a diferenciação do ramo fertil e a formação do ramo carpogonial (procarpio) em uma espécie do gênero *Griffithsia* (Ceramiales), estruturas essas até agora nunca observadas. Após uma revisão da bibliografia, o autor discute e critica interpretações anteriores, terminando com uma breve discussão sôbre a possível posição filogenética da presente espécie dentro do gênero *Griffithsia*. Esta é a primeira referência que se faz da ocorrência de *Griffithsia tenuis* no Brasil e no Atlântico Sul em geral. Uma prancha com numerosos desenhos originais completa o trabalho.

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PLATE I

Griffithsia tenuis C. Agardh

Fig. 1 and 2. Two very young fertile branches. Note its terminal position and the beginning of the lateral branching. No trichoblasts were drawn. In fig. 2 the first pericentral is already formed.

Fig. 3 and 4. In fig. 3 the second pericentral is clearly seen. In fig. 4 the developing 3-celled carpogonial branch, and the sterile cell are shown at the upper right corner.

Fig. 5. Mature carpogonial branch (procarp) with its four cells. Note the increase in size of the future stalk cell.

Fig. 6 and 7. Very young and developing cystocarp. Fig. 7 shows enveloping threads and stalk cell only.

Fig. 8. Mature ring of enveloping threads.

Fig. 9. Three ripe carpospores seen from above.

Fig. 10 and 11. Young and old lateral branches, respectively. Note the proximal position of each branch, a characteristic feature of this species.

Fig. 12. Diagram showing the position and the relation of the carpogonial branch.

All drawings were made from formalin preserved material.

In all drawings:

ap, apical cell; *pc,* pericentral cell; *cc,* central cell; *stk* stalk cell; *st,* sterile cell; *su,* supporting cell; *cb,* carpogonial branch.

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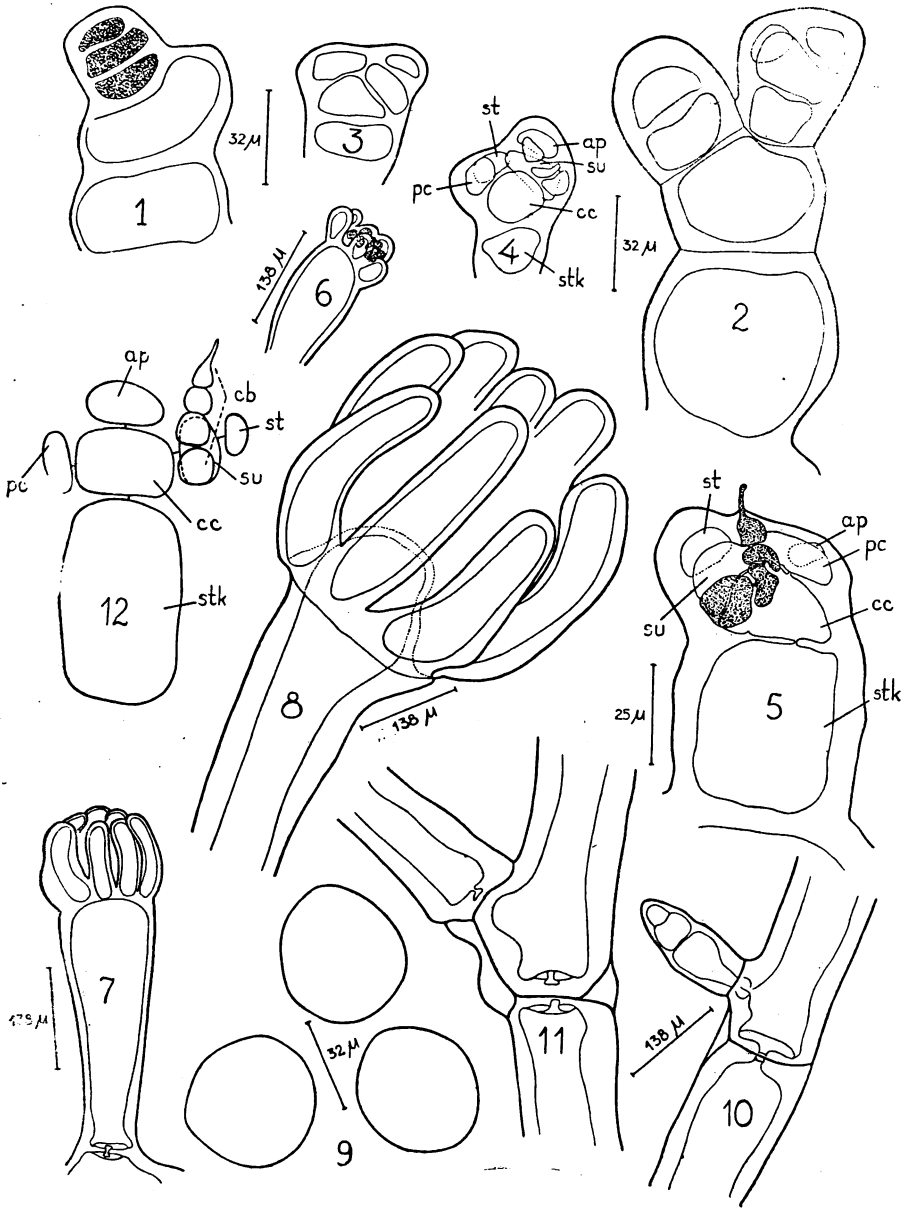
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