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TAXONOMY OF THE ECONOMICALLY IMPORTANT SEAWEEDS OF VENEZUELA: 1 GRACILARIA: G. LACINULATA (VAHL) HOWE PROX.

E.K. GANESAN

Instituto Oceanográfico, Universidad de Oriente, Cumaná, Venezuela.

ABSTRACT: A taxonomic list of economically important (gel-forming) marine algae (agarophytes, carrageenophytes and alginophytes) and the quantity of phycocolloids (agar and alginic acid) imported in Venezuela between1978-1987 are given. As a begining on the morphology and taxonomy of this group of algae, the author's observations on a *Gracilaria* species occurring in the Gulf of Cariaco in eastern Venezuela are described and illustrated. This species would appear to belong to *G. foliifera* var. *foliifera* (Taylor, 1960). However, on the basis of recent published information on the compressed, di-trichotomously branched species from the eastern Atlantic, the Venezuelan material is tentatively referred to *G. lacinulata* (Vahl) Howe, a species described based on material collected from the U.S. Virgin Islands. The present study also highlighted the need to have more critical information both in the field collected and cultured material from different geographical areas on species with supposedly wide latitudinal distribution.

RESUMEN: Se señalan una lista taxonómica de algas marinas economicamente importantes (agarofitas, carrageenofitas y alginofitas productoras de gel) y las cantidades de ficocoloides importadas en Venezuela entre los años 1978-1987. Como el inicio de una investigación sobre la morfología y taxonomía de estos grupos de algas de interés comercial, el presente trabajo trata de una especie de *Gracilaria*, aparentemente subtidal, del Golfo de Cariaco en el oriente venezolano. Siguiendo la clave y la descripción dadas por Taylor (1960), este material parecería pertenecer a *G. follifera* var. *foliifera*. No obstante, de acuerdo con los trabajos publicados recientemente sobre las especies comprimidas y ramificadas di-tricotomicamente en el atlántico oriental, el material venezolano se asigna tentativamente a *G. lacinulata* (Vahl) Howe, una especie descrita de material recolectado en las Islas Vírgenes, EE.UU. en el mar caribe. Dado que *G. lacinulata* es tambien reportada desde Filipinas, el presente trabajo pone de relieve la necesidad de tener informaciones adicionales mas críticas no solo de materiales del campo, sino también de cultivos de las especies que presuntamente tienen una amplia distribución latitudinal.

INTRODUCTION

About 67 distinct forms (specific and infraspecific entities and barring Uncertain Records and genera of lesser importance because of low percentage of gel yield) of economically important marine red (agarophytes and carrageenophytes) and brown (alginophytes) algae are reported hitherto from Venezuela (Ganesan, 1989). These taxa are distributed among the following 10 genera: *Agardhiella* - 3; *Gelidium* -5; *Gelidiella* -2; *Gigartina*- 2; *Gracilaria*-23; *Hypnea*- 4; *Meristiella*-3; *Pterocladia*-3; *Sargassum*- 20 and *Turbinaria*- 2 (Table 1).

On the basis of data published by "Estadísticas del Comercio Exterior de Venezuela", (Statistics on Venezuelan Foreign Trade) the quantity of agar and alginic acid and their value (in Bs., and US$) for a 10 year period (1978 to 1987) are shown in Figs. 1-3. As would be evident from Fig. 1, quantity of alginic acid imported was always greater than agar, and in 1987 import of this product was nearly 4.6 times greater than agar.

Richardson (1958, 1959) was probably the first author to compile information on a scientific basis concerning the utilization of marine algae in the

TABLE.1. Taxonomic List of gel yielding marine algae (Agarophytes, Carrageenophytes and Alginophytes) of potential economic importance recorded from Venezuela.* (based on Ganesan, 1989 and later publications)

AGARDHIELLA Schmitz (Solieriaceae, Rhodophyta)
1. *A. ramosissima* (Harvey) Kylin
2. *A. ramosissima* var. *harveyana* J. Agardh
3. *A. subulata* (C. Agardh) Kraft & Wynne

GELIDIUM Lamouroux (Gelidiaceae, Rhodophyta)
4. *Gelidium americanum* (W.R. Taylor) Santelices
5. *G. floridanum* W. R. Taylor
6. *G. microdonticum* W. R. Taylor
7. *G. pusillum* (Stackhouse) Le Jolis
8. *G. pusillum* var. *conchicola* J. Agardh

GELIDIELLA J. Feldmann & Hamel (Gelidiellaceae, Rhodophyta)
9. *Gelidiella acerosa* (Forsskal) J. Feldmann & Hamel
10. *G. trinitatensis* W. R. Taylor

GIGARTINA Stackhouse (Gigartinaceae, Rhodophyta)
11. *Gigartina acicularis* (Roth) Lamouroux
12. *G. teedii* (Roth) Lamouroux

GRACILARIA Greville (Gracilariaceae, Rhodophyta)
13. *G. albornozii* (Rodriguez) Ganesan
(= *Polycavernosa albornozii* Rodriquez)
(= *Hydropuntia albornozii* (Rodriguez) Wynne)
14. *G. bursa-pastoris* (S.G. Gmelin) Silva
15. *G. cervicornis* (Turner) J. Agardh
16. *G. cornea* J. Agardh
(= *Polycavernosa debilis* (Forsskal) Fredericq & Norris)
(= *Hydropuntia cornea*) J. Agardh Wynne)
17. *G. corymbiata* (Rodriguez) Ganesan
(= *Polycavernosa corymbiata* Rodriguez)
(= *Hydropuntia corymbiata* (Rodriguez) Wynne)
18. *G. crassissima* P. & H. Crouan ex J. Agardh
(= *Polycavernosa crassissima* (P. & H. Crouan) Fredericq & J. Norris)
(= *Hydropuntia crossissima* (P. & H. Crouan) Wynne)
19. *G. cuneata* J. E. Areschoug
20. *G. curtissiae* J. Agardh
21. *G. cylindrica* Borgesen
22. *G. damaecornis* J. Agardh
23. *G. domingensis* (Kuetzing) Sonder ex Dickie
24. *G. lacinulata* (Vahl) Howe
25. *G. lemaneiformis* (Bory de St. Vincent) Greville
(= *Gracilaria sjoestedtii* Kylin)
(= *Gracilariopsis sjoestedii* (Kylin) Dawson)
(= *Gracilariopsis lemaneiformis* (Bory) Dawson, Acleto & Foldvik)
26. *G. mammillaris* (Montagne) Howe
27. *G. occidentalis* (Borgesen) Bodard
28. *G. ornata* J. E. Areschoug
29. *G. pausiramosa* (Rodriguez) comb. nov.
(Basionym: *Polycavernosa pausiramosa* Rodríguez. Ernstia 56:1, figs. 1-3, 1989)
30. *G. tenuifrons* C.J. Bird & Oliveira
(= *Gracilariopsis tenuifrons* (C.J.Bird & Oliveira) Fredericq & Hommersand)
31. *G. tepocensis* (Dawson) Dawson
32. *G. textorii* (Suringer) De Toni
33. *G. tikvahiae* McLachlan
(= *G. foliifera* (Forsskal) Borgesen var. *angustissima* (Harvey) W. R. Taylor).
34. *G. venezuelensis* W. R. Taylor
35. *G. verrucosa* (Hudson) Papenfuss

HYPNEA Lamouroux (Hypneaceae, Rhodophyta)
36. *H. cervicornis* J. Agardh
37. *H. cornuta* (Kuetzing) J. Agardh
38. *H. musciformis* (Wulfen) Lamouroux
39. *H. spinella* (C. Agardh) Kuetzing

MERISTIELLA Cheney (Solieriaceae, Rhodophyta)
40. *M. echinocarpa* (Areschoug) Cheney & Gabrielson
41. *M. gelidium* (J. Agardh) Cheney & Gabrielson
42. *M. schrammii* (P. & H. Crouan) Cheney & Gabrielson

PTEROCLADIA J. Agardh (Gelidiaceae, Rhodophyta)
43. *P. bartlettii* W. R. Taylor
44. *P. capillacea* (S.G. Gmelin) Bornet & Thuret
45. *P. media* Dawson

SARGASSUM C. Agardh (Sargassaceae, Phaeophyceae)
46. *Sargassum acinarium* (Linnaeus) C. Agardh
47. *S. bermudense* Grunow
48. *S. cymosum* C. Agardh
49. *S. desfontainesi* (Turner) C. Agardh
50. *S. filipendula* C. Agardh
51. *S. filipendula* var. *montagnei* (Bailey) Grunow
52. *S. filipendula* var. *pinnatum* Grunow
53. *S. furcatum* Kuetzing
54. *S. hystrix* J. Agardh
55. *S. hystrix* var. *buxifolium* (Chauvin) J. Agardh
56. *S. hystrix* var. *spinulosum* (Kuetzing) Grunow
57. *S. platycarpum* Montagne
58. *S. polyceratium* Montagne
59. *S. polyceratium* var. *ovatum* (Collins) W. R. Taylor
60. *S. pteropleuron* Grunow
61. *S. ramifolium* Kuetzing
62. *S. rigidulum* Kuetzing
63. *S. stenophyllum* Martius
64. *S. vulgare* C. Agardh
65. *S. vulgare* var. *foliossimum* (Lamouroux) C. Agardh

TURBINARIA Lamouroux (Sargassaceae, Phaeophyceae)
66. *Turbinaria tricostata* Barton
67. *Turbinaria turbinata* (Linnaeus) Kuntze

* Note: The above list does not include Uncertain or Doubtful Records, taxa identified only up to the generic level or species of genera of lesser commercial importance with low yield of their gels. Additionally, some of the species (e.g. *Gelidium microdonticum*, *G. pusillum* var. *conchicola*) because of their very small size (up to a few mm long) are also not commercially feasible.

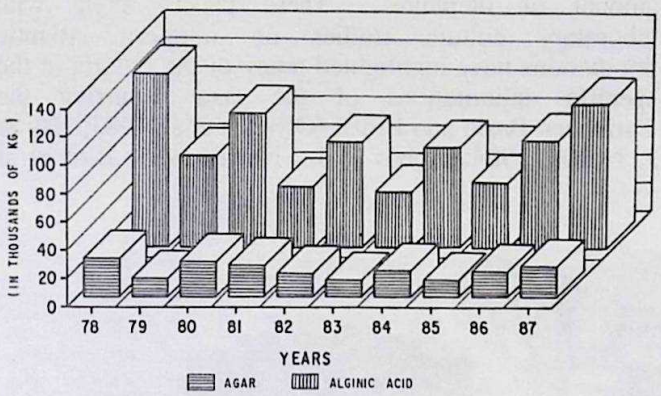


Fig. 1.- Quantity thousands of Kg. of Phycocolloids (Agar & Alginic Acid) imported in Venezuela for a ten year period (1978-1987).

Caribbean. Subsequently, several authors (Diaz-Piferrer & Caballer,1964; 1967; Goldstein, 1973; Michanek, 1975; Ortiz & Almodovar, 1982) have also contributed to this topic for this area. More recently, Barbaroux *et al* (1984), Smith *et al* (1984) & Smith (1986) have published on mass cultivation of *Gracilaria* species (Sea Moss) with a possible industrial exploitation in places like St. Lucia, West Indies.

In Venezuela, detailed studies relating to the utilization of marine algae (see Ganesan, 1989 for citation of earlier literature) has begun very recently . However several important aspects like (i) range of morphological variation in different populations (ii) critical reproductive details (iii) seasonal abundance and reproduction in natural beds (iv) growth rates, production and yield both in the field and in the laboratory under defined conditions and (v) chemical studies which are vital for any large scale cultivation and explotation, are known only for many of the taxa occurring in Venezuela (see however Lemus & Aponte, 1987; Velasquez *et al*., 1988; Aponte & Lemus, 1989).

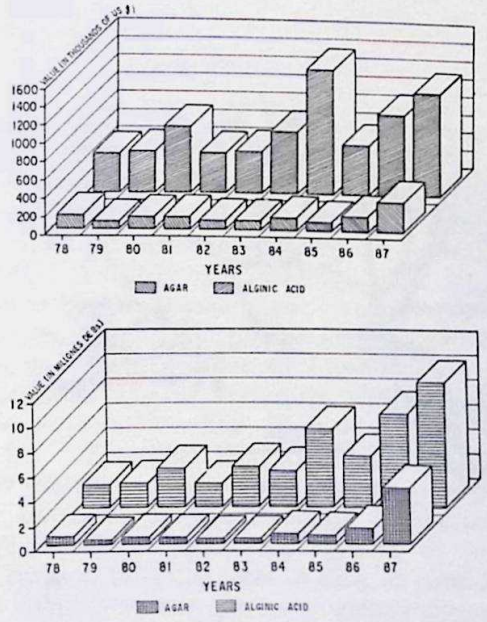
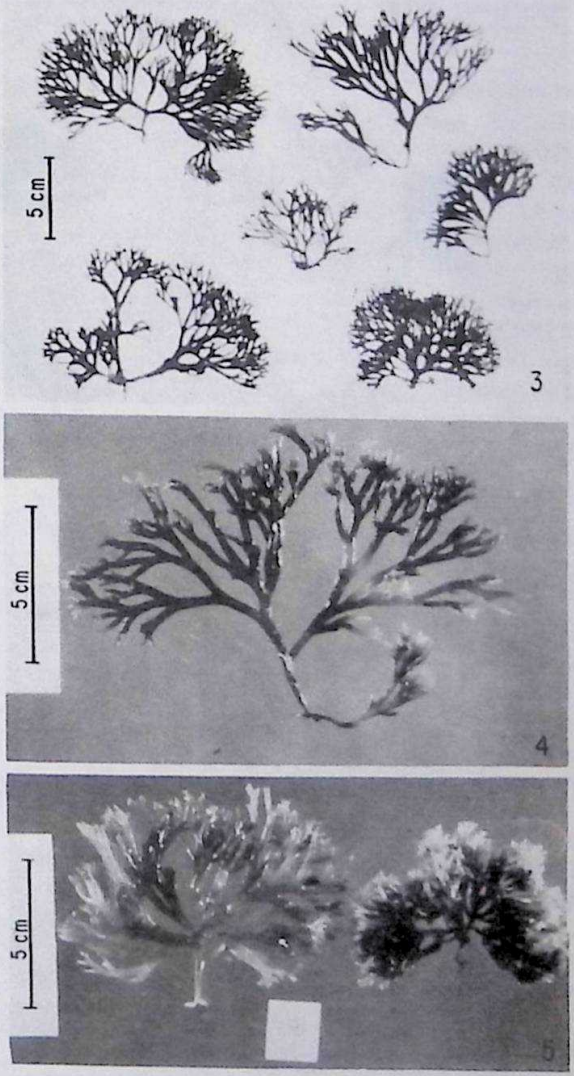
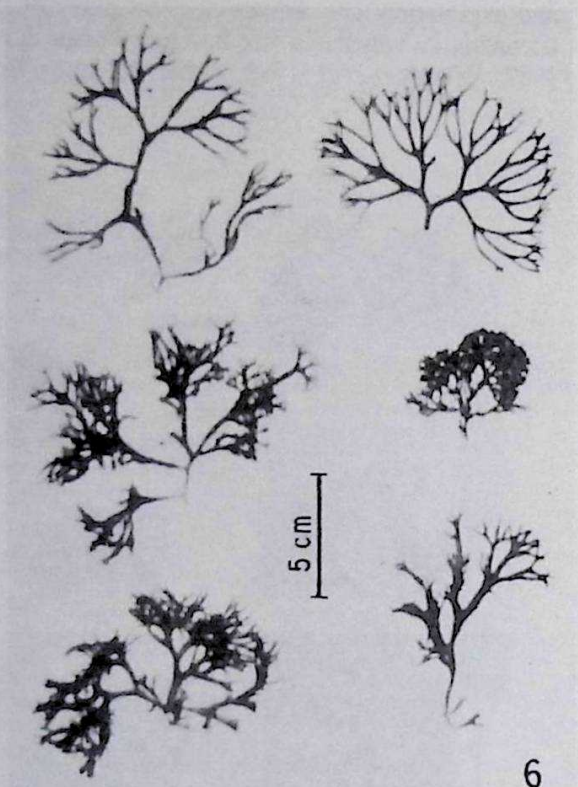


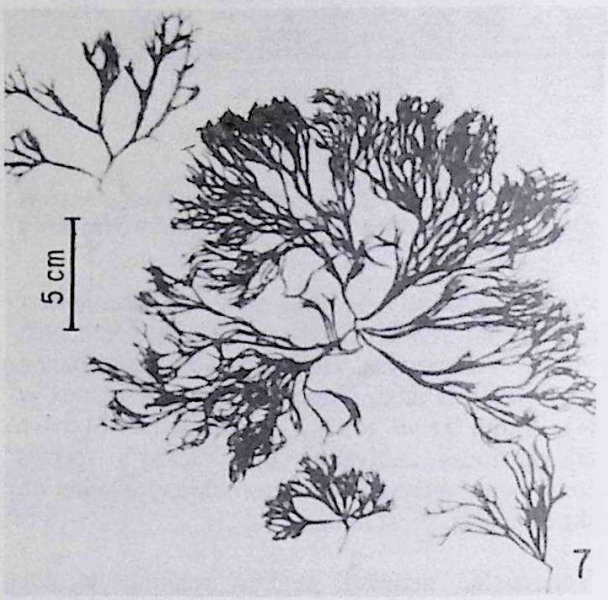
Fig. 2.- Values in US $ (above) and in Bolivars (below) for the phycocolloids (Agar and Alginic acid) imported in Venezuela for a 10 year period (1978-1987).

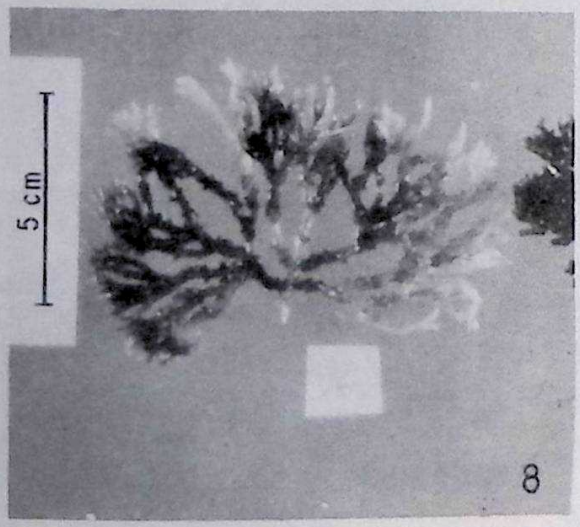


Figs. 3-5.- *Gracilaria lacinulata* (Vahd) Howe prox. Fig. 3. Habit of several herbarium mounted specimens. Figs. 4-5. Hab. of 3 formalin preserved specimens.

Of the various economically important red algal genera, *Gracilaria* (Gracilariales, Rhodophyta) with approximately 100-160 species (Guiry & Freamhainn (1986) has received the largest universal attention in recent years from different geographical latitudes, and there exists currently on a world basis a vast amount of literature. These papers along with laboratory culture studies on northern Atlantic populations have highlighted many of the criteria in the specific delimitations of the taxa occurring the Caribbean Basin and Brazil (Oliveira et al, 1983; Hay & J. Norris, 1984; Abbot & J. Norris 1985; Bird et al







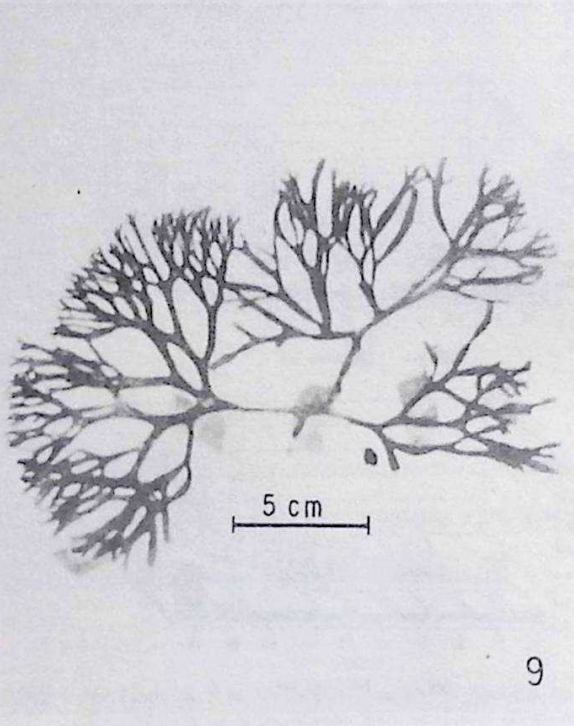


Fig. 6-9.- *Gracilaria lacinulata* (Vahl) Howe prox. Figs. 6-7. Several dried specimens showing the range of morphological variations. Fig. 8. A liquid preserved female specimen. Fig. 9 Habit. of *G. mamillaris* from Isla Coche (leg. R. Cantillo. 21. viii. 63).

1986; Abbott, 1988). As a begining on the taxonomy of this algal group, the author presents in this paper his observations on a species tentatively assigned to *Gracilaria lacinulata* (Vahl) Howe prox.

MATERIALS AND METHODS

Materials were collected during March, April and July 1989 from Golfo de Cariaco between Monumento de Cumaná and Playa Barbudo (near Pesquerias) from washed ashore material. During days of strong winds, considerable quantity was washed ashore. This area is highly polluted by discharges of domestic seawage and a fish processing plant.

Standard methods of preservation (herbarium mounts and liquid preserved in 5 % seawater formalin) were used for numerous specimens to learn the range of morphological variations. Many specimens did not adhere well to the herbarium paper. Both hand sections and freezing microtome sections (20-30 µm) thick were made. Sections were mounted in 80 % Corn Syrup (Karo) after staining them in aqueous aniline blue and acidified with dilute HCL. Voucher specimens of both dry and liquid preserved are deposited in the Herbarium of the Institute of Oceanography. For comparative studies, other specimens preserved from the same herbarium were also examined.

OBSERVATIONS

As stated earlier, all the collections were made from cast ashore material indicating an essentially subtidal habitat. Plants grow up to a maximum height of 15 cm long with mostly a dark brown to nearly black color. Freshly collected plants had a soft or firmly fleshy consistency. A narrow subcylindrical stipe upto 3 cm long was evident in several plants. Branching is mostly dichotomous in the same plane and at more frequent intervals in the upper portions (Figs. 3-5). However, trichotomy and irregular branching with several small marginal proliferations (Fig. 6) were also frequently observed. Excepting the stipe and the ultimate branches, thallus in most parts is generally compressed with an ovoid or ellipsoidal outline in transections. Although herbarium specimens because of pressing would appear to be in the form of delicate strap-shaped ribbons, liquid preserved specimens clearly showed that they are not markedly compressed to give the aspect of strap shaped ribbons. Thallus width varied between 2-6 mm. Branches of the last order generally narrow into an acute point, simple or variously cleft (Fig. 4). In other words, in the populations I examined, the ultimate segments are not broadly expanded with rounded or obtuse ends. The range of variations in thallus morphology is shown in Figs. 3-8.

Thallus structure is typically gracilarioid (Fig. 10). In sterile parts the outer or external cortex is thin generally made of a single layer of small anticlinally elongated cells. The subcortex is made of up 2-3 layers of colorless cells, while the medulla of large, colorless, polygonal or rounded cells contitute the major part of the tissue. In mature sterile parts, thallus width in transections varied from 800-1,500 µm. Hair cells from the surface cortical cells were not observed either in living or preserved specimens.

In contrast to the sterile plants, where the outermost cortical cells occur as a continuous layer, spermatangial plants present a net-like appearance enclosing slightly refringent or whitish areas contituting the spermatangial sori (Fig. 11). In transections, these sori are present in the form of small, superficial conceptacles or cavities with the cells of the lateral walls of the crypts characteristically elongated (Fig. 13). Spermatangia are produced only from the floor of these crypts. Since the many spermatangial conceptacles I have examined were restricted to the outer cortex without forming deep cavities, I am referring the Venezuelan male plants of *G. mammillaris* to the "*textorii*" type (Yamamoto, 1978).

Female plants showed numerous cystocarps on both surfaces and the thallus margins scattered irregulary throughout a few cms below the apex and above the stipe. Developing and mature cystocarps project markedly on the thallus surface with a hemispherical outline and about 1 mm broad. In liquid preserved specimens, many of the mature cystocarps showed the characteristic small projection or protuberance (mammillate) in the ostiole portion of the cystocarp. It should be pointed out that this mammillate nature, a characteristic attributed to *G. mammillaris*, was not consistently present in all the cystocarps. In transections, the sterile central gonimoblast parenchyma was made up of large colorless cells forming a column (Figs. 15-16) without ramification. From the periphery of this gonimoblast parenchyma, small, branched gonimoblast filaments interspersed with long and irregularly terminally lobed absorbing filaments connecting to the pericarp were observed (Fig. 17).

Formation of tetrasporangia was observed throughout the thallus surface right from a few cm

below the apex and a few cm above the stipe. In surface view, both the initials and mature tetrasporangia were seen dispersed irregularly among the surface cortical cells (Fig. 14). In transection (Fig. 12), tetrasporangia were elongate up to 30 µm long and 15 µm broad and irregularly cruciately divided. In comparison to the sterile portions of the thallus, tetrasporangia forming areas are more thick with several layers of cortical cells (cf. Figs. 10, 12).

DISCUSSION

Nearly 30 years ago, Taylor (1960), summarized in the following words the problems and remedies for the identification of *Gracilaria* species in the tropical and subtropical western Atlantic ocean. "The species in the genus are notoriously variable. Some of those recorded in our area are hard to distinguish, the early descriptions not covering the same characters in comparable terms.

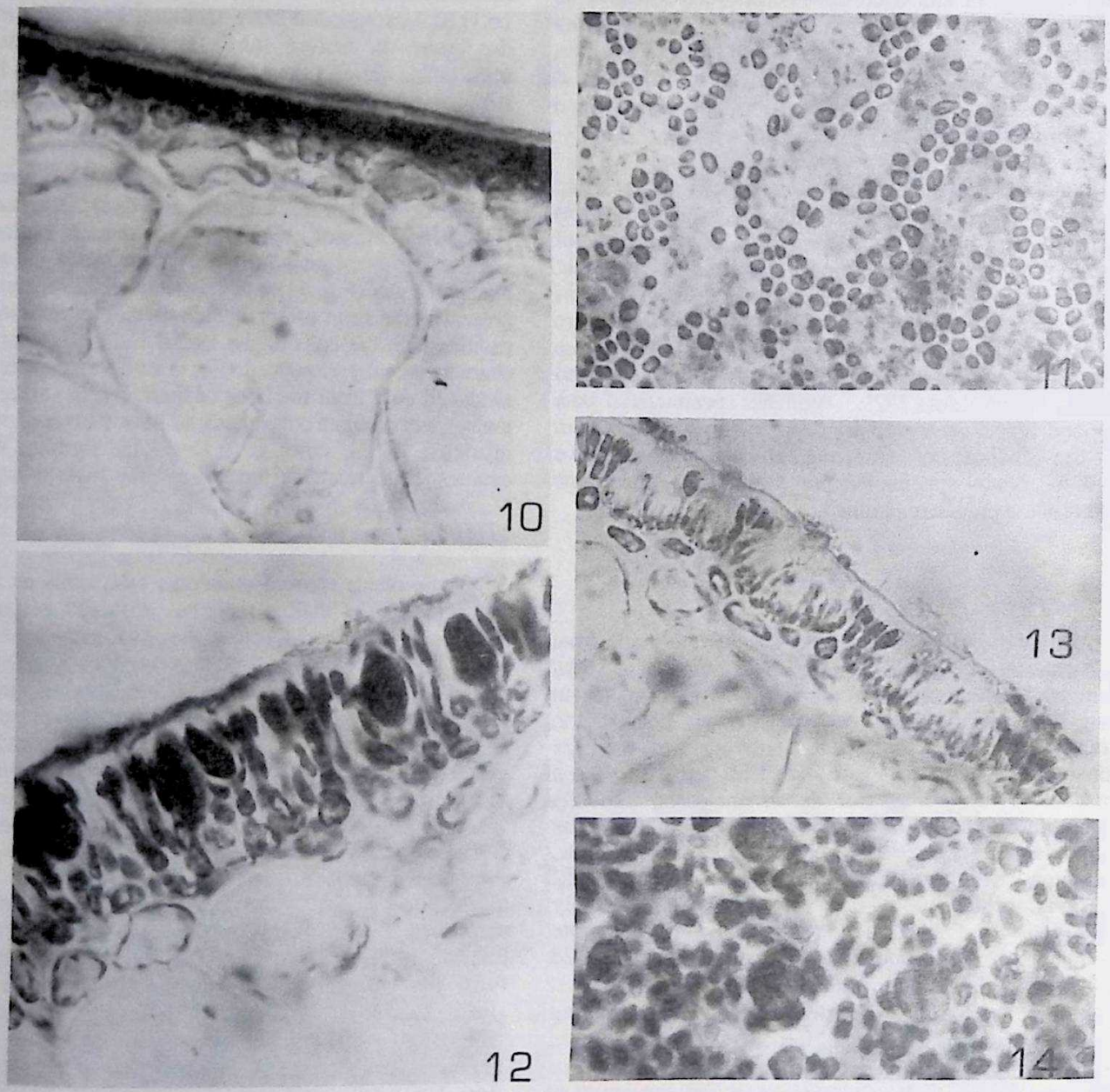


Fig. 10-14.- *Gracilaria lacinulata* (Vahl) Howe prox. Fig. 10. T.S. of sterile part of the thallus. Fig. 11. Surface view of spermatangial sori. Fig. 12. T.S. of a tetrasporic thallus. Fig. 13. T.S. of male thallus showing the "textorii" type of spermatangial formation. Fig. 14. Surface view of tetrasporic thallus showing intials and mature sporangia.

and they are so scarce in collections that preparation of good descriptions is not yet possible. So far as possible one should secure a large series of specimens from a population from all variations of habitat and in the most mature stages of growth before identification is attempted. Identification of individual specimens is often impossible, and when there is any suspicion that the plants are fragmentary or that they were dwarfed or otherwise modified by exceptional circumstances under which they grew, it should not be attempted". With publications of such recent critical studies (Bird & McLachlan, 1982; 1984; Oliveria *et al.*, 1983; Abbott & Norris, 1985; Fredericq & J. Norris, 1985; Bird *et al.*, 1986; Bird & Oliveria, 1986; Fredericq & Hommersand,1989 a, 1989 b), various aspects like reproductive morphology, confiable taxonomic criteria for specific delimitations, interspecific affinities and nomenclatural considerations are becoming increasingly transparent.

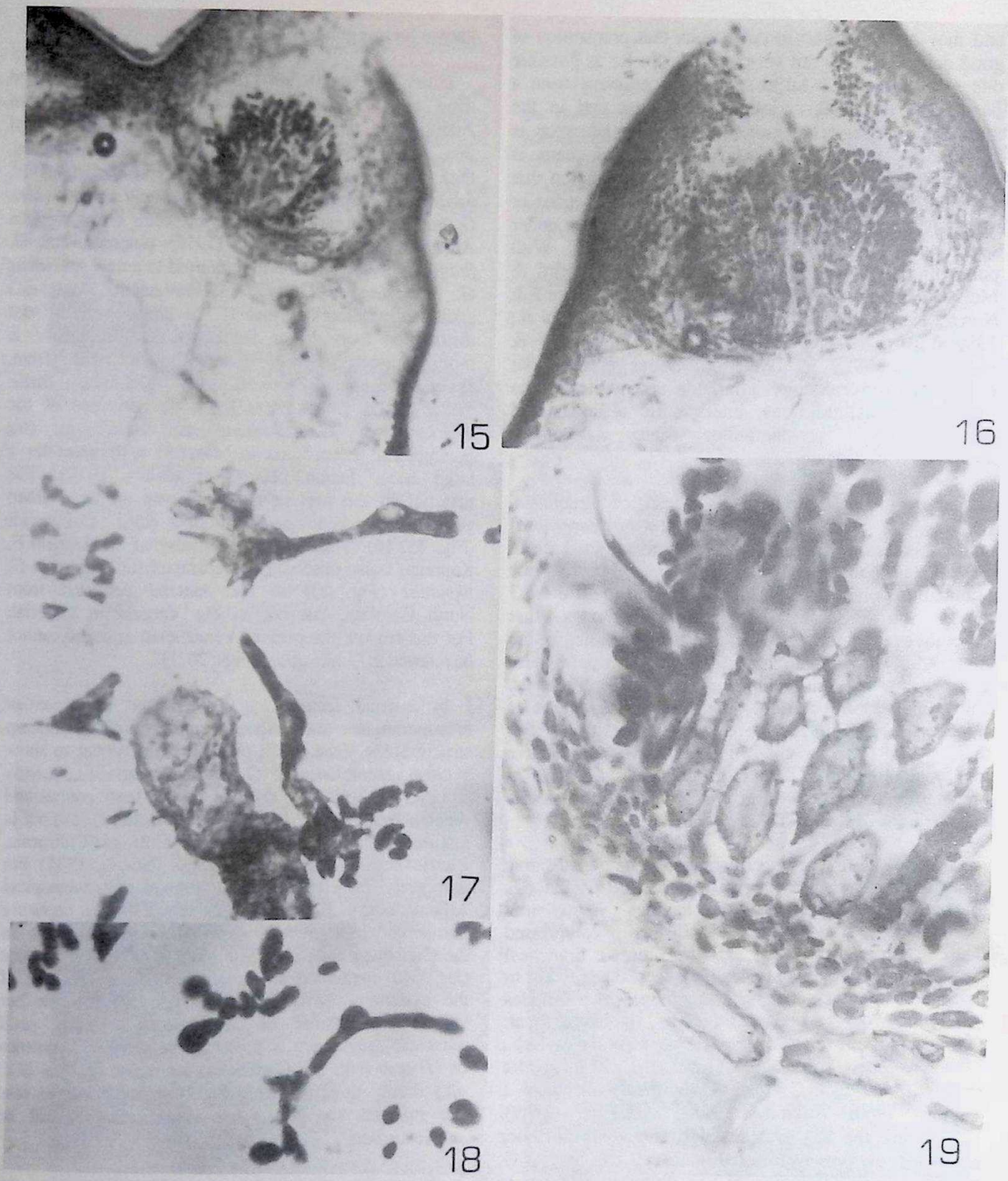
As shown in Table 1, 23 species of *Gracilaria*, (including 4 species of *Hydropuntia*(= *Polycavernosa*) and 2 species of *Gracilariopsis*) are reported so far from Venezuela (Ganesan, 1989). It is evident from the publications on several species attributed to all these 3 genera in different geographical latitudes that vegetative anatomical characteristics are basically the same and the fundamental differences between these genera are only in their reproductive morphologies. Until intergeneric culture studies between species of *Gracilaria, Gracilariopsis* and *Hydropuntia* establish that they are not interfertile (reproductive incompatability) and hence generically distinct, I prefer to consider *Gracilaria* in a broad sense to incluse both *Gracilarioposis* and *Hydropuntia*.

On the basis of spermatangial and cystocarpic characteristics, the Venezuelan material clearly belongs to *Gracilaria sensu stricto*. By having narrow (not more than 10 mm broad) and distinctly compressed thalli (excepting the stipe and the ultimate branches) with di-trichotomous branches in several degrees but in the same plane, they belong to a group, which includes *G. foliifera* (Forsskal) Borgesen (including var. *foliifera* and var. *angustissima* (Harvey) W.R. Taylor) , *G. mammillaris* (Montagne) Howe and *G. lacinulata* (Vahl) Howe and *G. textorii* (Suringar) De Toni (Taylor, 1960; Norris, 1985, Ganesan, 1989). Following the key and description given by Taylor (loc. cit.), the present material could be assigned to *G. foliifera* (Forsskal) Borgesen var. *foliifera* (and not to var. *angustissima* (Harvey) W.R. Taylor). A detailed discussion on the specific identity of the Venezuelan material is given below in the light of information known for this group of species.

Guiry & Freamhainn (1985) presented evidence to show that *G. foliifera* does not occur in the western Atlantic and that this name be applied solely to Red Sea, Arabian and Indian Ocean material. Additionally, they also suggested that the species known as *G. foliifera* in eastern Atlantic coasts should be known as *G. multipartita* and doubted its presence in the western Atlantic. McLachlan earlier (1979) proposed that *G. foliifera* var. *angustissima* be referred to a new species as *G. tikvahiae*. Guiry & Freamhainn (*loc. cit.*) additionally remarked that *G. tikvahiae* with its vast distribution from Nova Scotia to the Caribbean is morphologically a very variable species with terete, slightly flattened or distintly flattened thalli. Whatever be the external form, the structure of the cystocarp of *G. tikvahiae* is distinct in that gonimoblast parenchyma is branched with generally a large basal fusion cell (MacLachlan, 1979). The material in the present study showed an unbranched gonimoblast parenchyma without a basal fusion cell (Fig. 15, 16). Thanks to the courtesy of Dr. Donald F. Kapraun, I also observed this characteristic feature in *G. tikvahiae* (Fig. 23) in the material collected from North Carolina, but not in the Venezuelan material. For this reason, the present Venezuelan material cannot be referred to *G. tikvahiae*. (Figs. 20-23).

In external features, as also in the formation of tetrasporangia and spermatangia and cystocarp structure, the Venezuelan plants would appear to show a close resemblance to *G. textorii*, a species recently reported by Rodriguez de Rios (1986) from central and western Venezuela. It is well known that G. *textorii* is reported more frequently from Gulf of California, Pacific Mexico, Japan and China (Norris, 1985) but unreported hitherto from the tropical and subtropical Atlantic ocean. It is well documented in the literature that some pacific members are known to be present in the Caribbean and *vice versa*. But in *G. textorii*, Norris (*loc. cit.*) mentioned a large fusion cell at the base of the cystocarp, a feature not shown by Rios in her venezuelan material of "*G. textorii*". Hence, unitl unrefutable evidence is presented to show the presence of *G. texorii* in the Caribbean, the report of Rios (*loc. cit.*) should be considered highly questionable, as also the material she based her identification should be reinvestigated.

Originally described from Martinique in the Caribbean (Montagne, 1842), *Gracilaria mammillaris* has a wide distribution from North Carolina (Schneider & Searles, 1973; Schneider, 1975) to Brazil (Taylor,

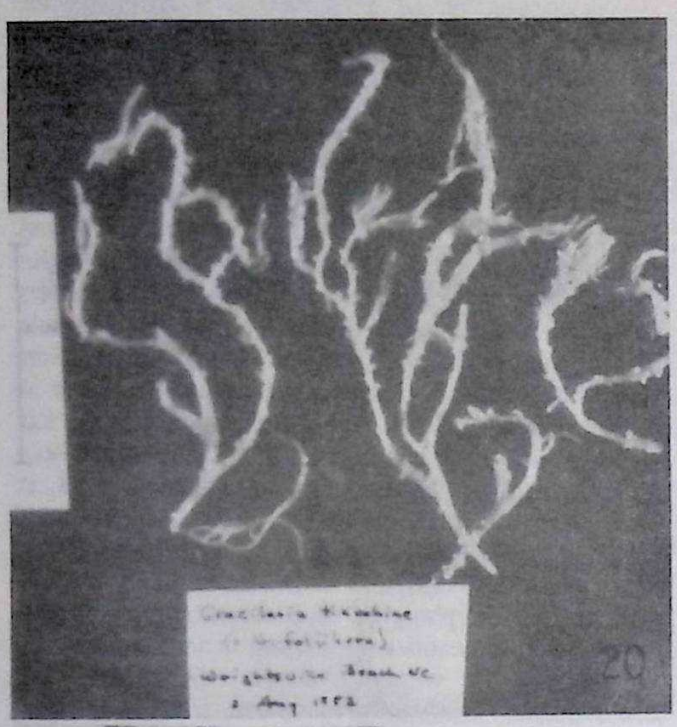


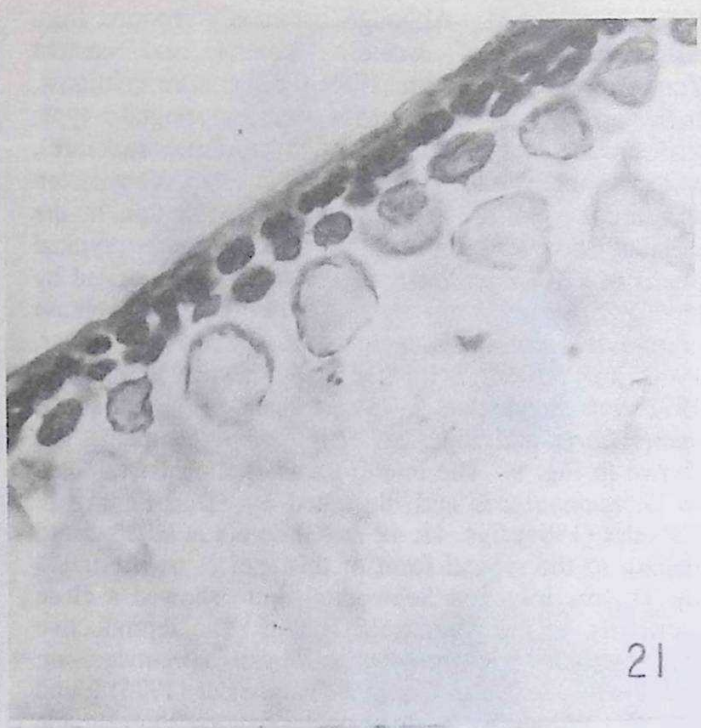
Figs. 15-19.- *Gracilaria lacinulata* (Vahl) Howe prox. Figs. 15-16. T.S. of two cystocarps showing the columnar unbranched nature of gonimoblast parenchyma. Figs. 17-18. Part of a squahed preparation showing the large and irregulary branched absorbing filaments and the small branched gonimoblast filament. Fig. 19 Base of cystocarp enlarged th show the large polygonal cells forming the gonimoblast parenchyma and an absorbing filament at left.

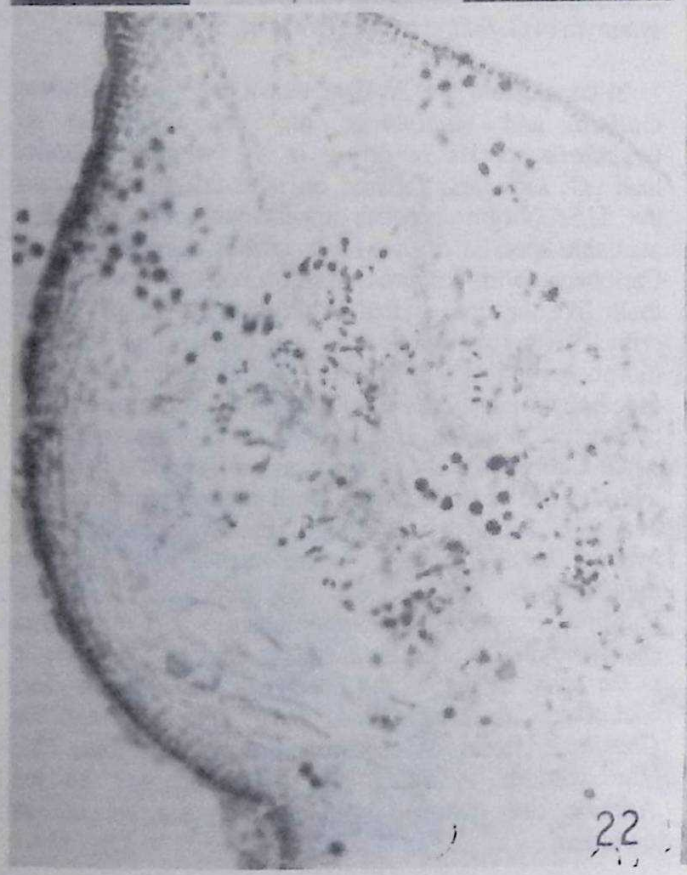
1960; Joly, 1965). Although commonly reported from different parts of western, central and eastern Venezuela (see Ganesan, 1989 for literature citations), critical reproductive details (spermatangial type, tetrasporangial formation and cystocarpic structure), were not well documented in the Venezuelan specimens. Within the range of distribution in the tropical and subtropical western Atlantic, typical plants of *G. mammillaris* are generally characterized by having generally strap shaped thin blades with obtuse or rounded terminal segments (for figures see Taylor, 1960; Joly, 1965; Schnetter & Schnetter, 1967; Rios, 1972 and Schneider, 1975). Plants identified as *G. mammillaris* and reported from eastern Venezuela are shown in Fig. 9. The Puerto Rican specimens attributed to *G. mammillaris* and illustrated by Diaz-Piferrer & Caballer (1964; figs. 41, 42 & 43) do not at all appear to belong to the typical form of this speices as illustrated by Taylor, Joly and Schneider, but showed a close similarity to the Venezuelan plants. The reproductive characteristics of the Puerto Rican specimens are unknown. In North Carolina, Schneider (1975) found *G. mammilaris* to be a variable species showing the existence of two different (typical and atypical) morphological entities, which induced him to suggest "whether the atypical plants could represent a new variety of *G. mammillaris*, or possibly a new species, requires further investigation". Only a critical study of type material of *G. mammillaris* and specimens collected from the type locality would establish the precise morphological and reproductive attributes of this species i.e., thin, strap shaped narrow blades or thick broad foliose fronds and more importantly establish whether spermatangial formation is of the "*verrucosa*" or "*textorii*" type. Bird & McLachlan (1984) had already pointed out the anamolies in the report of "*textorii*" type in North Carolina material (Schneider, 1975) and "*verrucosa*" type in the Cuban material (Dawson, 1962). Currently, most authors in the tropical and subtropical western Atlantic consider *G. mammillaris* to possess generally strap shaped narrow blades with mostly dichotomous branching in wide angles and with obtuse or emarginate terminal segments, features not present in the several Venezuelan specimens examined by me. Hence, these plants are not referred to *G. mammillaris*.

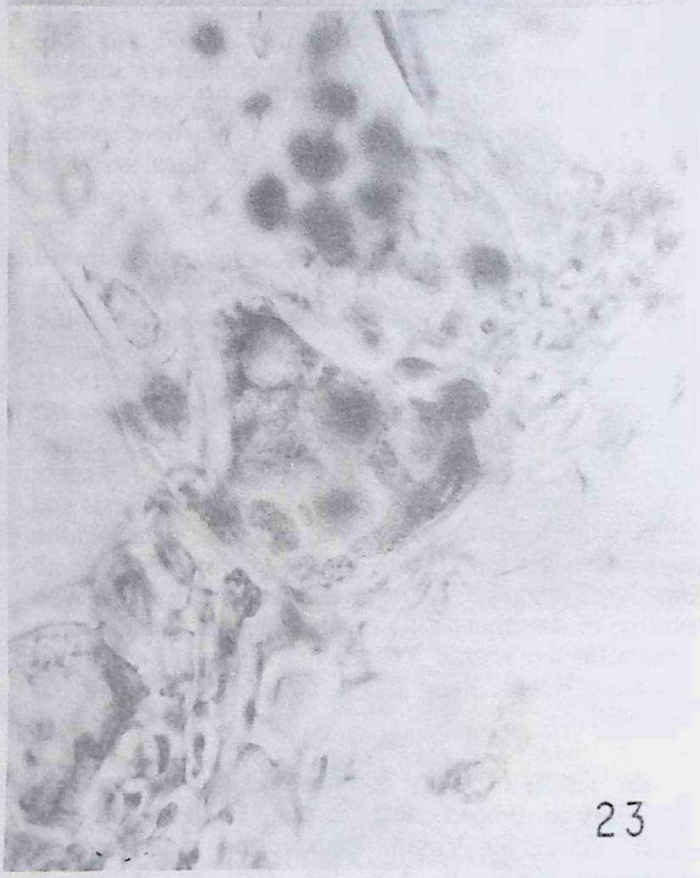
The results of Guiry & Freamhainn (1986) made it necessary to propose that the name *G. lacinulata* (type from the U.S. Virgin Islands and illustrated by Borgesen, 1913, p. 379, fig. 366) be applied to *Gracilaria* species with flattened and di-trichotomously branched thalli passing under the name *G. foliifera* in the Caribbean (Ganesan, 1989). The circumscription of *G. lacinulata* as it occurs in the tropical and subtropical western Atlantic is also not clear. Kim & Humm (1965) remarked "As a result of a number of years of collecting and studying the algae of the southeastern coast of the United States and the West Indies, the writers are of the opinion that *G. foliifera* and *G. lacinulata* are different species. *G. lacinulatula* is always more extensively and consistently flattened, has distinctly narrower angles in the branches, is limited to oceanic habitats, occurs only from North Carolina southward, and is some shade of red in color. *G. foliifera* occurs from New Hampshire to the tropics, is most commonly flound in protected waters (bays, sounds, estuaries, coves), has wider angles in the branches, is usually much less flattened than *G. lacinulata* or not flattened at all, is olive green to dark purple in color, and tolerates salinities from a few parts per thousand to full sea water" (see also Hoyt, 1920). Hence, it is unclear whether two morphotypes of a single species or two different specific entities are passing under the name *G. lacinulata* in the western Atlantic. *G. lacinulata* is also reported from the Philippines, but treated as a synonym of *G. foliifera* (see Silva *et al*, 1987).

In conclusion, it is evident that if the specific names *foliifera* and *multipartita* are not applicable to *Gracilaria* species occurring in the western Atlantic, than *G. lacinulata* (based on material collected from the U.S. Virgin Islands) appears to be the earlier available specific epithet for a species occurring in the Caribbean with compressed di-trichotmously branched thalli like the one studied in the present paper. More critical information on the range of thallus morphology in relation to ecological preferences, and especially type of spermatangial formation and cystocarpic structure in *G. lacinulata* as it occurs in the wider Caribbean and nearby areas are needed whether it includes one or two species. Until such informations are available, I prefer to assign tentatively the present material to *G. lacinulata sensu auct.* Finally mention may also be made that *G. lacinulata* from the Philippines should be evaluated in detailed morphological and culture studies to know whether it is the same or not as the Caribbean *G. lacinulata*, for, McLachlan & Bird (1984) have suggested that the *Gracilaria* floras of certain geographical regions like "the western Atlantic, eastern Pacific and eastern Atlantic are distinct, with few if any species in common".









Figs. 20-23.- *Gracilaria tikvahiae* McLachlan from North Carolina. Fig. 20. Habit. of female plants. Note the sparse branching at long intervals and the pronunced tips of the cystocarps. Fig. 21. T.S. of sterile thallus. Fig. 22. T.S. of a cystocarp. Note the irregularly branched gonimoblast parenchyma (compare with figs. 15 & 16). Fig. 23. Base of cystocarp engarged show a prominent fusion cell.

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