Bol. Inst. Oceanogr. Univ. Oriente, 24 (1-2): 237-246 (1985); 6 lams.

STUDIES ON THE MARINE ALGAL FLORA OF VENEZUELA VIII. 4 NEW ADDITIONS

E. K. GANESAN[1], OLGA DE ALFONZO[2], MIRELLA APONTE[1] & ANGEL GONZÁLEZ[3]

Instituto Oceanográfico, Universidad de Oriente, Cumaná, Venezuela[1]

Facultad de Humanidades y Educación, Universidad del Zulia, Maracaibo, Venezuela[2]

Jardín Botánico, Instituto Nacional de Parques (INPARQUES), Caracas, Venezuela[3]

ABSTRACT: The present paper deals with our observations on 4 new additions to the Venezuelan marine algal flora. Collections of these species were made from the coastal waters of eastern and western Venezuela. The 4 new additions are *Ulva reticulata* Forsskal (Ulvaceae) of Chlorophyta, *Botryocladia shanksii* Dawson (Rhodymeniaceae), *Callithamnion uruguayense* Taylor (Ceramiaceae) and *Taenioma perpusillum* (J. Ag.) J. Ag. (Delesseriaceae) of Rhodophyta. Of these, *U. reticulata* constitutes apparently a new addition to the western Atlantic, since all the earlier records are from the Red Sea, Japan and India. Morphological and anatomical aspects of the Venezuelan specimens are described and illustrated. Aspects relating to their distribution in the Caribbean Sea and adjacent areas as well as affinities with related species are discussed briefly.

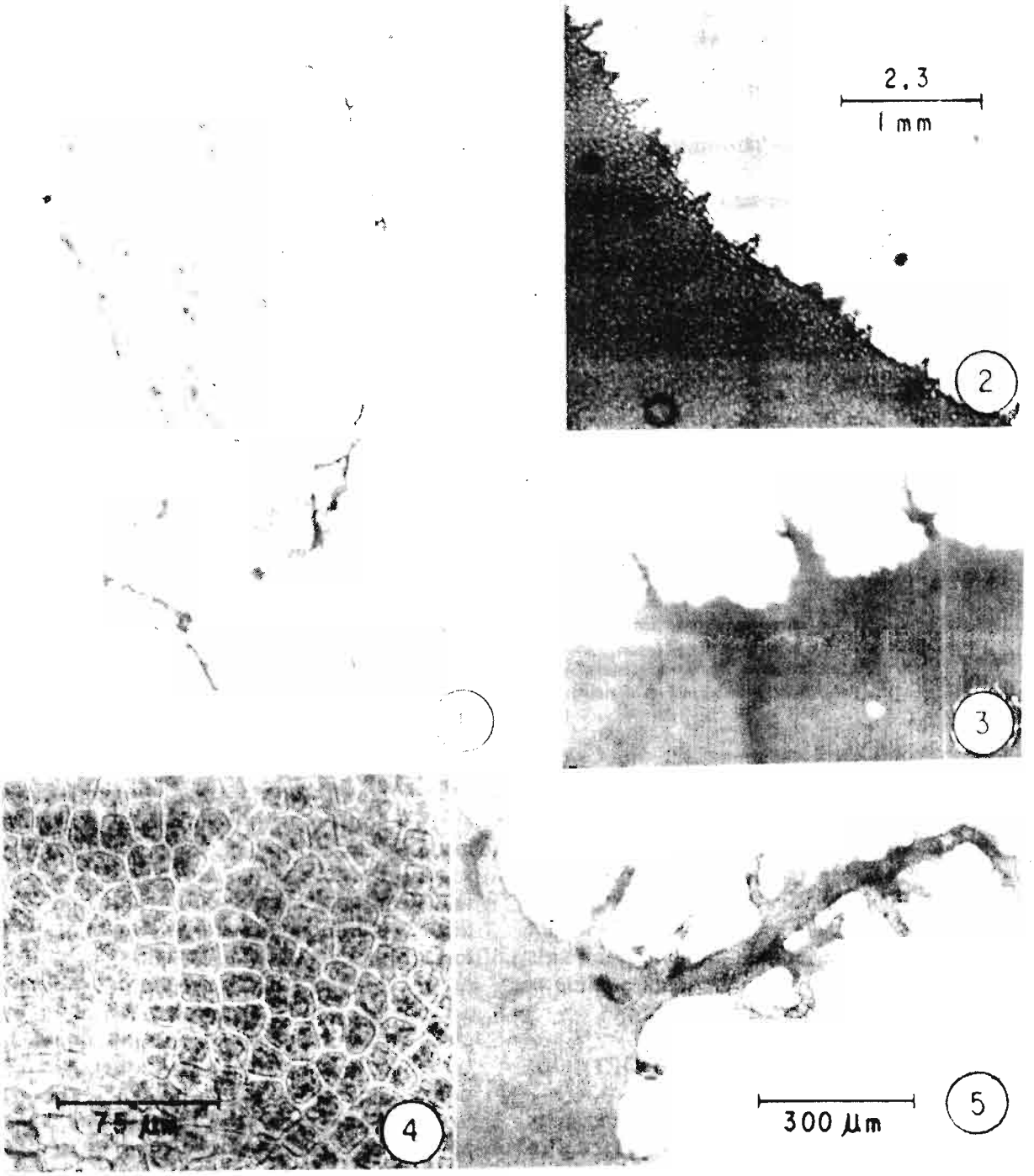
RESUMEN: El presente trabajo muestra observaciones sobre 4 nuevas adiciones de algas marinas para la flora costera venezolana. Se hicieron colecciones de estas especies tanto en la costa oriental y occidental del país. Los 4 nuevos registros están representados por *Ulva reticulata Forskal* (Ulvaceae) Chlorophyta; *Botryocladia shanksii* Dawson (Rhodymeniaceae); *Callithamnion uruguayense* Taylor (Ceramiaceae) y *Taenioma perpusillum* (J. Ag.) J. Ag. (Delesseriaceae) pertenecientes a la División Rhodophyta. De estas especies, *Ulva reticulata* constituye aparentemente un nuevo registro para el Atlántico occidental, puesto que todos los registros anteriores han sido referidos del Mar Rojo, Japón e India. Se describen e ilustran los aspectos morfológicos y anatómicos de las nuevas adiciones, así como también aspectos relacionados con la distribución tanto en el Mar Caribe y áreas adyacentes. Se discuten brevemente las afinidades con las especies relacionadas.

INTRODUCTION

Continued collections and study of marine algae from the different coastal waters of eastern and western Venezuela have revealed the ocurrence of several species which have not been previously reported for this country. The present paper deals with our observations on 4 such species.

MATERIALS AND METHODS

The 6 collection sites reported in the paper are shown in the map. Both 4% formalin preserved and herbarium material were studied following standard procedures for the study of marine benthic algae. For the small filamentous forms, whole mounts of small portions of thalli were made. Freezing microtome sections (25-35 μm thick) were made of larger thalli. All material was stained in 1% aqueous aniline blue, acidified with dilute HCl and mounted in Karo syrup Photomicrographs were made with the aid of a Zeiss MC 63 automatic photomicrographic apparatus. Voucher specimens of the 4 species are deposited in the Herbarium, Departamento de Biología Marina, Instituto Oceanográfico, Universidad de Oriente, Cumaná, Venezuela. For each taxon, references to papers which were consulted for identification purposes, description and illustration based on the Venezuelan specimens are given.



Figs. 1-5. *Ulva reticulata.* Fig. 1. Habit. to show the reticulate frond. Figs. 2, 3, 5. Margins of 3 fronds to show variations in the marginal microscopic teeth. Fig. 4. Surface view of thallus to show cell arranmient.

RESULTS AND DISCUSSION

CHLOROPHYTA

ULVALES

ULVACEAE

Ulva reticulata Forsskal (Figs. 1-8).

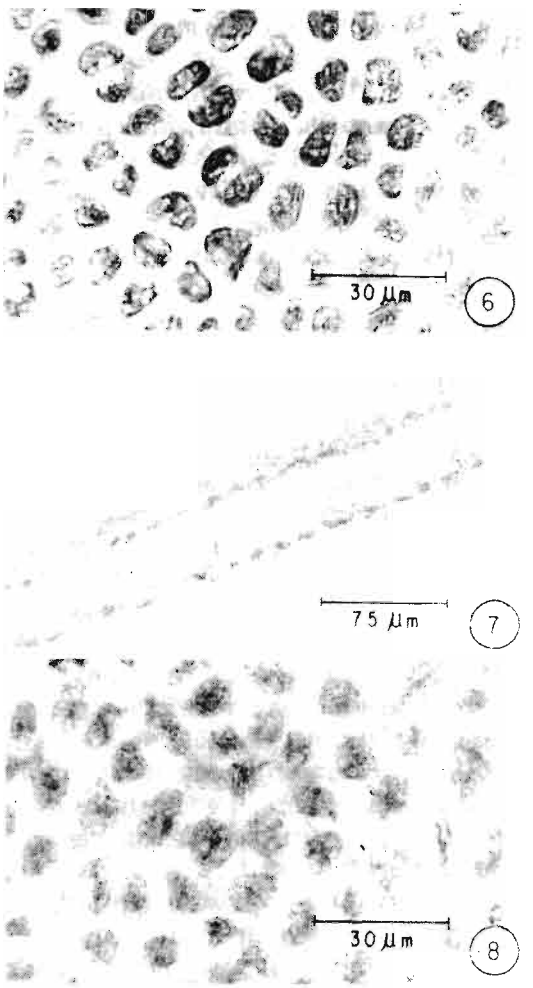
Srinivasan, 1969, p. 50, Lám. L., Papenfuss, 1968, p. 12, Nasr, 1947, p. 22, BΦrgesen, 1953. p. 9, Okamura, 1909, p. 183, Lam. C., Kützing, 1861, VI, tab. 29.

Plants cast ashore or forming large floating masses along the shore, individual fronds delicate, expanded, foliaceous, and irregularly lobed without a distinguishable basal part or stipe, fronds up to 50 cm or more, dark green when fresh and becoming pale and not adhering well to herbarium paper on drying; each frond characteristically with numerous variously shaped and sized perforations giving the alga a reticulate appearance; margins of thalli generally with numerous minute microscopic simple or branched teeth-like projections: cells in surface view not arranged in any regular fashion, more or less rectangular or oval in shape; 12-26 μm broad in maximun diameter, distromatic, cells in section squarish or more vertically elongated, plastid occupying one end of cell with 1-4 (5) pyrenoids; reproduction not observed.

Distribution in Venezuela:

Cumaná (Playa Los Bordones; EKG, 20. iii 80), Isla de Margarita (Pampatar & Porlamar; MA-BV. 56: 29. i. 83; 244: 7. i. 84; MA. 374: 3. ii. 84). Washed ashore or floating.

Remarks: So far, all our collections are based on floating or washed ashore collections, suggesting an essentially deep water habitat for this species. Also, when present, the alga occurs in large quantities. Originally described from the Red Sea (see PAPENFUSS 1968) this species has an ample geographic distribution being reported from Japan, India, Australia and the Pacific coast of



Figs. 6-8. *Ulva reticulata*. Figs. 6, 8. Cells in surface view. Fig. 8. To show pyrenoids. Fig. 7. Transection of thallus.

America (BΦRGESEN, 1935; NASR, 1947), but not so far from the Atlantic ocean. In several features, i. e., regularly perforate thallus and becoming pale in colour and not adhering well to pe per on drying, marginal microscopic teeth and the form and arrangement of vegetative cells, the Venezuelan material we studied agreed well with description and figures given by OKAMURA (1909), SRINIVASAN (1969) and KÜTZING (1861). However, mention should also be made to the

very close similiarity between *U. reticulata* and *U. profunda Taylor* (1928, 1960), known so far only from the original collection from deep waters (15-67 m) of Florida. Judging from Taylor's description and figures (TAYLOR, *loc. cit.)*, *U. profunda* appears to lack the characteristic marginal microscopic teeth and the cells in section are generally broader than long (see TAYLOR, 1928, pl. 3, figs. 16, 17). Also, TAYLOR (1960) reports that each chloroplast in *U. profunda* has one or rarely 2 pyrenoids, while in our material of *Ulva reticulata pyrenoids* varied from 1-5 for each chloroplast. Additionally, cells of the fronds of *U. reticulata* are 12-26 μm, broad, while in *U. profunda* they are larger, being 18-36 μm, and cells in transections of the thallus in the latter species are generally quadrate or taller than broad (see Fig. 7). However, in view of the high polymorphism shown by the members of the genus *Ulva*, it is desirable to examine more ample collections of *U. profunda* and compare them with *U. reticulata* to establish the status of *U. profunda* as an autonomous species. It may be pointed out here that this alga has been collected commonly only in recent years from the coastal waters of eastern Venezuela. This fact, along with the lack of records of this species in the herbarium of the Institute of Oceanography by earlier investigators, who have made extensive collections from this area strongly suggest that *U. reticulata* is probably a very recent introduction to the Venezuelan waters.

RHODOPHYTA
RHODYMENIALES
RHODYMENIACEAE
Botryocladia shanksii DAWSON
(Figs. 9 - 13)

Norris & Bucher, 1928, p. 200, Schnetter, 1977, p. 79, figs. 8-11, Ríos, 1972, p. 280, Lam. 23, fig. 51 (as *B. occidentalis* (Børgesen) Kylin), Díaz-Piferrer, 1970, p. 30, figs. 7 & 8. Dawson, 1962a, p. 385, pl. 1, fig. A, pl. 2, figs. A, B, pl. 5, fig. B.

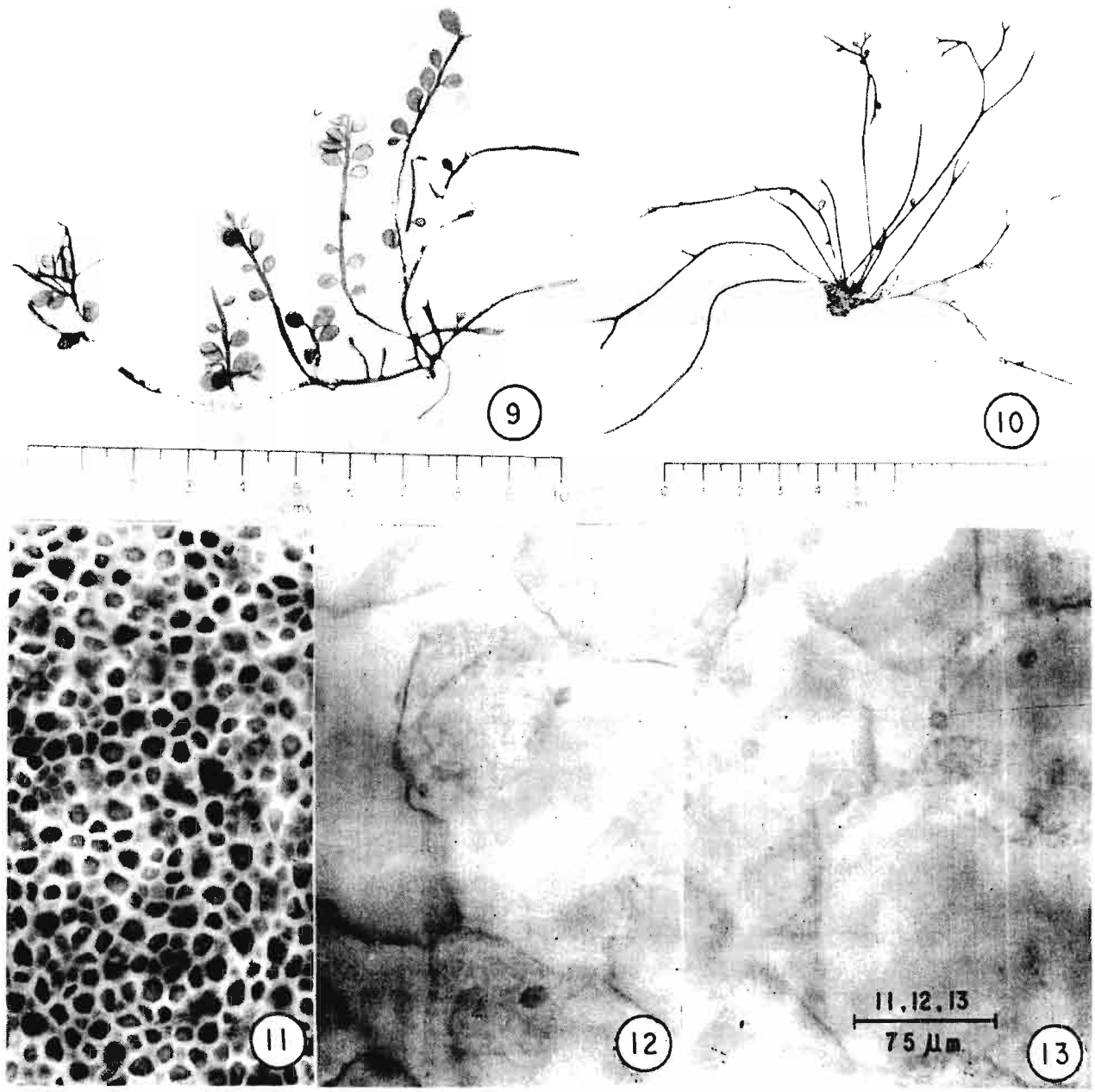
Plants up to 10 cm tall with several long sparsely and irregulary branched erect axes arising from a discoid base, erect axis about 1 mm broad; vesicles generally pyriform with a very small indistinct stalk, about 2-5 mm long and 2-4 mm broad, distribution of vesicles, on the axes without any order; frequently erect axes with very few small bladders or axes even completely naked; structurally the outer wall of the vesicle continous, made up of relatively large closely packed cells; inner layer of large colourless polygonal cells; gland cells not very abundant, but characteristically 1-2 gland cells mounted on special irregularly lobed or rounded cells in the inner polygonal layer.

Distribution in Venezuela:

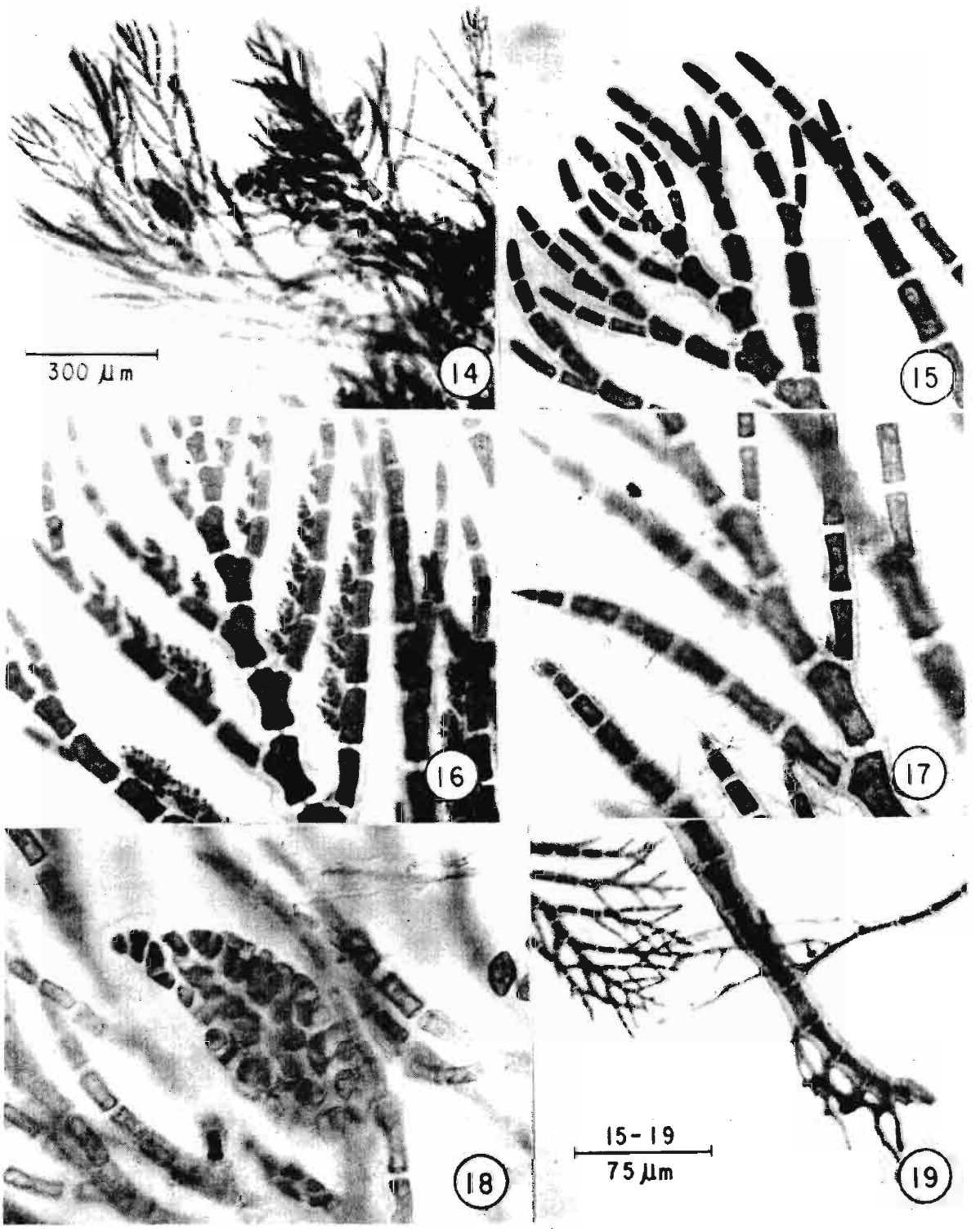
Puerto Cumarebo (AG. 13A: 16.xi.65), La Vela de Coro (OA. 347: 1247: 10.vi.72), Tocopero (BR. 2848, Mary N° 6), Estado Falcón. Drift or in shallow coastal waters.

Remarks: Originally described from the Atlantic side of Costa Rica and Barbados (DAWSON, 1962), this species is also reported subsequently from Puerto Rico (DIAZ-PIFERRER, 1970), Atlantic coast of Colombia (SCHNETTER, 1977) and more recently from Belize (NORRIS & BUCHER, 1982). The Venezuelan specimens agree well with description and figures given by these authors.

Despite being an apparently widely distributed species in the different parts of the Caribbean Sea, fertile plants of *B. shanksii*, like *B. occidentalis* (BØRGESEN) KYLIN, are unknown so far. Plants of *B. shanksii* with numerous pyriform vesicles may sometimes show a striking similarity to *B. occidentalis*. The two species, however, are very different in gland cell arrangement. For example, in *B. occidentalis*, gland cells are borne directly on the inner large medullary cells (see SCHNETTER, 1977, p. 78, figs. 13, 14), while in *B. shanksii*, they are borne on separate cells on the large inner cells (SCHNETTER, *loc. cit)*. It appears that a



Figs. 9-13. *Botryocladia shanksii*. Figs. 9, 10. Habit of two plants. Fig. 11. External layer of a vesicle in surface view. Figs. 12, 13. Disposition of gland cells borne on special, cells of the medullary layer.



Figs. 14-19. *Callithamnion uruguayense*. Fig. 14. Upper portion of a plant. Fig. 15. Apex showing the characteristic distichous branching. Note the cells in the apex with obtuse ends. fig. 16. Part of a spermatangial plant. Fig. 17. A lateral to show curved out and pointed tip lateral. Fig. 18. Mature cystocarp. Fig. 19. Basal portion to show rhizoids.

specimen misidentified as *B. occidentalis* by RIOS (1972) from Cumarebo, Edo. Falcon is referable to *B. shanksii*. RIOS *(loc. cit.)* did not refer to gland cell arrangement in her material. An examination of her specimen showed gland cell arrangement characteristic of *B. shanksii* and hence her report of *"B. occidentalis"* is included here under *B. shanksii*.

CERAMIALES
CERAMIACEAE
Callithamnion uruguayense TAYLOR
(Figs. 14-19)

Taylor, 1939, p. 150, pl. 3, fig. 1, pl. 6, figs. 1-4, pl. 7, fig. 1, Joly, 1957, p. 145, pl. XVII, figs. 1, 1a; 2-2f; 3-3a, Taylor, 1960, p. 506. pl. 41, figs. 5-7, Joly, 1963, p. 200, pl. XXXV, figs. 272-475, Oliveira-Filho, 1969, p. 64, pl. XVII, figs. 96-97, Cordiero-Marino, 1972, p. 303, pl. 60.

Plants soft, small and bushy up to 3 cm high, main filament covered in the basal parts by many long, branched rhizoids not covering the main axis; primary branching in the basal part irregular, but in the upper parts regularly distichous, lateral branches curved outwards and frequently terminating in acute tips, while in the more terminal parts branch tips obtuse; cells multinucleate; spermatangia formed abundantly in rows on the adaxial side of lateral branches in the apex; cystocarps few and isolated, elongate or lung-shaped apparently without special sterile cells, all cells of the gonimoblat filaments maturing to carpospores; tetrasporangia not observed.

Distribution in Venezuela:

Isla de Margarita (El Farallón; EKG. 84-10. vii.84). Subtidal on coarse algae and other objects.

Remarks: Excepting for the shape of the cystocarps, the Venezuelan material agreed well in general with the description and figures given by the various authors for this species. It appears that the shape of the cystocarps apparently is variable, for TAYLOR (1960); OLIVEIRA-FILHO (1969) described them as bilobed, each portion as oval, while JOLY (1965) reports mature cystocarps as globose, frequently covered by sterile branches. However, by the regular distichous branching, acute apices of the curved out laterals and the formation of the spermatangia, *C. uruguayense* is easily distinguished from the other 2 *Callithamnion* species recorded so far from Venezuela (GANESAN, 1978). *C. uruguayense appears to have* a wide distribution in the western Atlantic being recorded from Cuba, Brazil and Uruguay (TAYLOR, 1960).

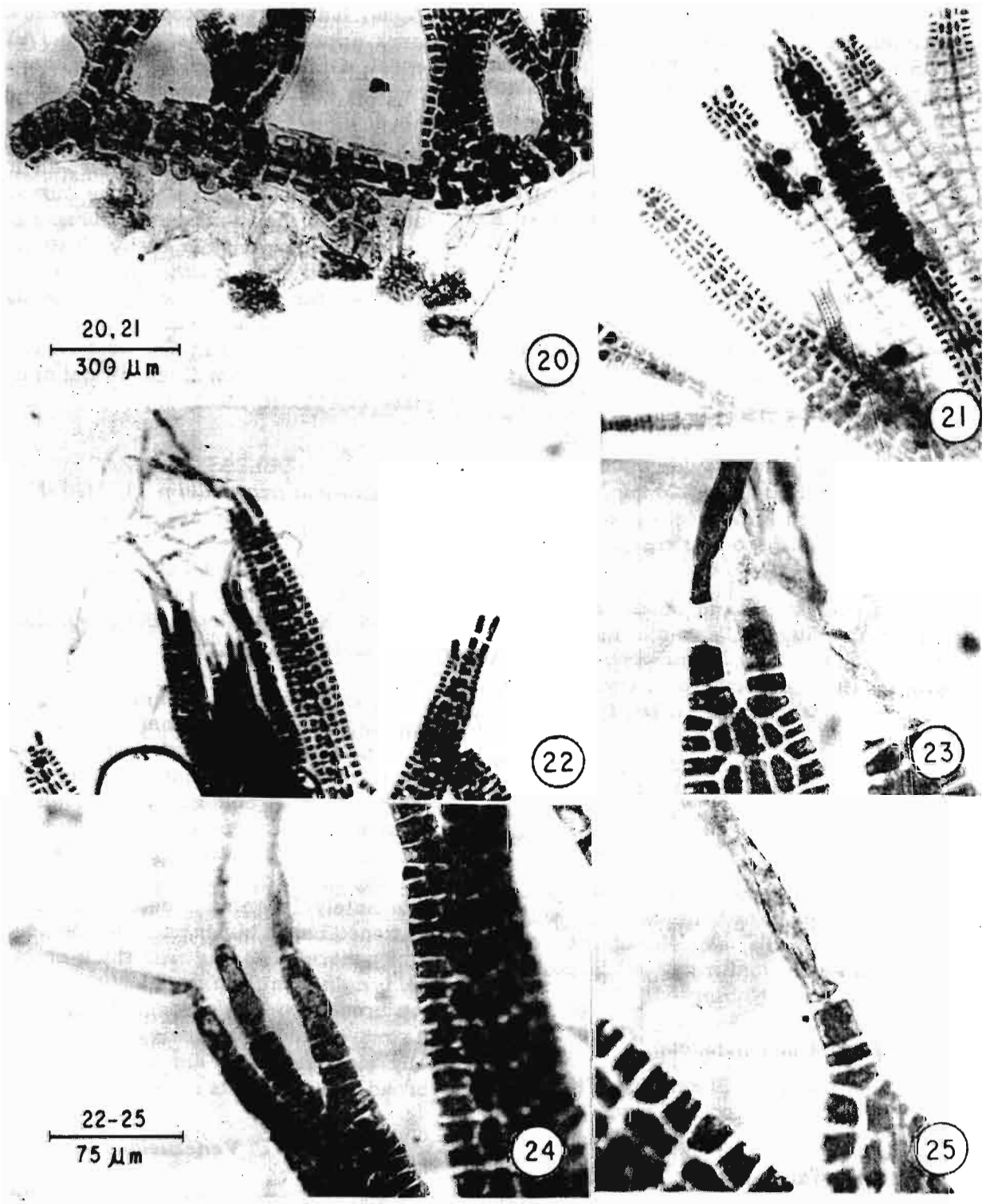
DELESSERIACEAE
Taenioma perpusillum (J. AG.) J. AG.
(Figs. 20-25)

Taylor, 1960, p. 549, Joly *et al.*, 1963, p. 15, pl. VI, figs. 1-4, Joly, 1965, p. 213, pl. 45; figs. 564-567, Oliveira-Filho, 1969, p. 93. Cordeiro-Marino, 1972, p. 332, pl. 66.

Plants minute, 2-4 mm high, delicate, entangled with other smaller algae; decumbent; postrate axes cylindrical; polysiphonous and ecorticate with many slender or thick, long and short endogenous rhizoids arising from one of the pericentral cells; postrate axis 140-200 μm thick, several erect axes arising dorsally and divided irregularly alternately few times; erect axes distinctly flattened in the upper parts, 90-150 μm broad and generally ending in 3 thick or rarely 2 or 1 hair; tetrasporangial stichidia 125-150 μm broad; 600-700 μm long tetrasporangia in 2 rows; mature tetrasporangia oval or laterally elongate 45-60 μm long and 40-55 μm broad. Sexual plants not observed.

Distribution in Venezuela:

Cabo San Román, Estado Falcón (E. 2968), on mangrove roots mixed with other small algae.



Figs. 20-25. *Taenioma perpusillum*. Fig. 20. Part of a creeping axis with several ventral rhizoids and dorsal erect axes. Fig. 21. Mature tetrasporangial stichidia. Note the 2 stichidia at right with empty sporangia. Figs. 22, 24. Apex of determinate branchlets with 3 hairs. Fig. 23. Apex with 2 hairs. Fig. 25. Apex with only one hair.

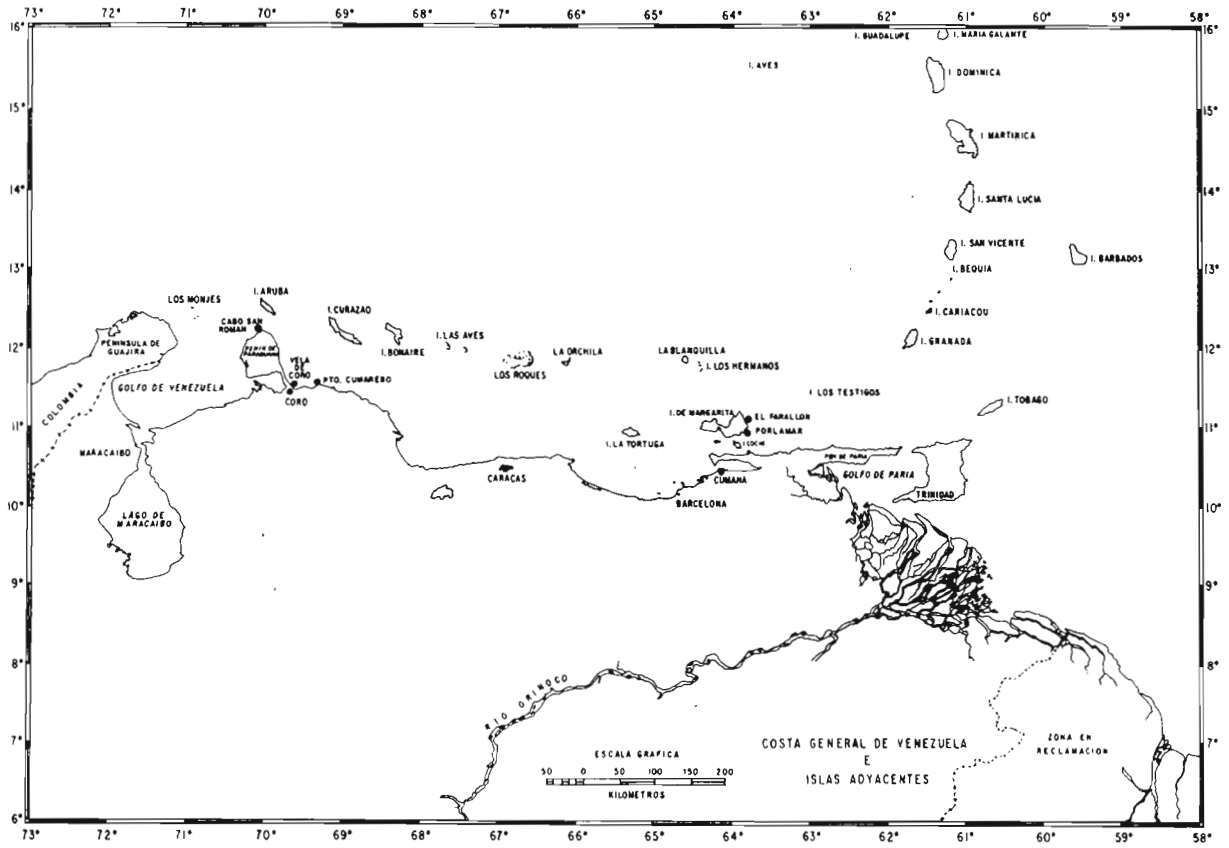


Fig. 26. Map, showing the 6 collection sites of the algae reported in this paper.

Remarks: 3 species of *Taenioma* are currently known. These are *T. dotyii* Hollenberg recorded so far only from Hawaii, and *T. perpusillum* (J. AG.) J. AG., and *T. nanum* (KÜTZING) PAPENFUSS which have a wide geographical distribution in the Pacific, Indian and Atlantic ocean. Of these, only the last mentioned species is recorded hitherto for Venezuela (GANESAN & LEMUS, 1969). All these 3 species are minute plants of a few mm height and share several features in common, but are distinguished essentially on the basis of terminal hairs present on the erect branchlets (see HOLLENBERG, 1967). The number of such hairs, however, is not always consistent and hence the validity of such a differentiating characteristic, especially between *T. perpusillum* and *T. nanum* had been repeatedly questioned by various authors (DAWSON, 1962b; HOLLENBERG, 1967; GANESAN & LEMUS 1969 and NORRIS & BUCHER 1982). HOLLENBERG *(loc. cit.)* in particular questioned whether *T. nanum* merits specific rank. DESIKACHARY and BALAKRISHNAN (1957) had earlier shown for the Indian ocean material that the basic anatomical features and the branching pattern are indentical in these 2 taxa. A comparison between the form and size of the 3 types of reproductive organs of these 2 species on the basis of data given for the Brazilian plants by JOLY (1963) also did not show any significant differences, excepting for the spermantangial stichidia of *T. nanum*, which are noticeably smaller (450-505 μm long and 150-210 μm broad) than *T. perpusillum* (900-1200 μm long and 300-360 μm broad). We did not observe sexual plants in Venezuelan material. It may be pointed out that statistical analysis on the number of terminal hairs in a predetermined number of specimens

using a test of significance such as a one-way ANOVA or a biochemical taxonomic study like the starch gel electrophoresis to show the banding pattern of the prcteins would probably give some new information to this problem.

ACKNOWLEDGEMENTS

Grateful thanks are extended to Consejo de Investigación, Universidad de Oriente, (Project CI 5-019-00242/84), for financial assistance to one of us (EKG), and to present this paper in the Venezuelan Annual Science Convention, (AsoVAC), held at Merida between 17-22, November 1985. We are also thankful to Dr. JOHN WEST, Dept. of Botany, Univ. of California, Berkeley, California, USA, for reviewing and correcting the manuscript and to Sr. RAMON VARGAS for the photographic help.

REFERENCES

BORGESEN, F. 1935. A list of marine algae from Bombay. *Biol. Medd. KCH.* 12 (2): 1-64, pls. X.

CORDEIRO-MARINO, M. 1972. *Rodoficeas Marihnas do Estado de Santa Catalina.* Doctoral Thesis. Univ. Sao Paulo, Brazil, 491 p., 92 pls.

DAWSON, E. Y. 1962a. Additions to the marine flora of Costa Rica and Nicaragua. *Pac. Nat.* 3: 375-395.

DAWSON, E. Y. 1962b. Marine red algae of Pacific Mexico. Part. 7 Cermiales: Ceramiaceae, Delesseriaceae. *Allan Hancock Pacif. Exped.* 26 (1): 1-206, 1-50, pls.

DESIKACHARY, T. V. & M. S. BALAKRISHNAN. 1957. *Taenioma* J. Ag. from India. *Proc. Indian Acad. Sci. Sect. B.* 46: 336-345.

DÍAZ-PIFERRER, M. 1970. Adiciones a la flora marina de Venezuela. *Carib. J. Sci.* 10 (3-4): 159-193, 60 figs.

GANESAN, E. K. 1978. *Reseña histórica, catálogo, bibliografía y distribución de las macroalgas y fanerógamas marinas citadas para Venezuela.* 226 p., 16 lams. Univ. de Oriente Instituto Oceanográfico. Trabajo de Ascenso.

———— & A. J. LEMUS. 1969. Notes on Venezuelan Marine Algae. I. On the ocurrence of the red algal genus TAENIOMA J. Ag. in Venezuela. *Nov. Hedw.* 18: 765-767, 5 figs.

HOLLENBERG, G. J. 1967. New marine algae from the central tropical Pacific ocean. *Amer. J. Bot.* 54 (10): 1198-1203. 10 figs.

JOLY, A. B. 1957. Contribuicao ao conhecimiento da flora ficologica marinha da baia da Santos e arredores. *Bol. Fac. Fil. Cienc. Letr. Univ. S. Paulo. Bot.* 14: 1-196 + 1 map. 19 pranches.

————, M. CORDEIRO, M. L. MENDOZA, N. YAMAGUISHI & Y. UGADIM. 1963. Aditions to the marine flora of Brazil. III. *Ibid.*, 20: 41-53.

————. 1965. Flora marinha do litoral norte do estado de Sao Paulo en regiones circunviznihas. *Ibid.*, 21: 1-393.

KÜTZING, F. T. 1861. *Tabulae phycologicae,* order Abbildungen dertange. 11: 30 p., 100 pls., (Vol. 6, Tab. 29).

NASR, A. H. 1974. Synopsis of the marine algae of the Egyptian red sea coast. *Bull. Fac. Sci.* 26: 155, 14 lams.

NORRIS, J. & K. E. BUCHER. 1982. Marine algae and seagrasses from Carrie Bow Cay, Belize. In: Rützler, K. & MaCintyre. I. G. (Eds.) Atlantic Barrier reef ecosystem at Carrie Bow Cay, Belize. I. Structure and communities. *Smithsonian Contr. Mar. Sci.* 12: 167-223.

OKAMURA, K. R. 1909. *Icones of Japanese algae.* Vol. II. Nº 34, 1. Chome Handa Jinbocho Chiyodaku, Tokyo, Japan, 191 p.

OLIVEIRA-FILHO, E. 1969. Algas marinhas do sul do Estado do Espiritu Santo (Brazil) 1. Ceramiales. *Bot.* 26 *U.S.P. Fac. Cienc. e Let. Bot.* 343., 209 p.

PAPENFUSS, G. F. 1968. A history, catalogue and bibliography of red sea benthic algae. *Isr Jour. Bot.* 17: 1-118 p.

RIOS, N. DE 1972. Contribución al estudio sistemático de las algas macroscópicas de la costa de Venezuela. *Act. Bot. Venez.* 7 (1-4): 219-324, 42 lams.

SCHNETTER, R. 1977. Notás sobre las especies del Caribe del género *Botryocladia* (Rhodymeniales, Rhodophyceae) con referencia especial a los taxa de la costa Atlántica de Colombia. *An. Inst. Inv. Mar. Bertin* 9: 73-80, 15 figs.

SRINIVASAN K. S. 1969. *Phycologia Indica* (Icones of Indian Marina Algae). Vol. 1. 52 p.

TAYLOR, W. R. 1928. *The marine algae of Florida with special reference to the Dry Tortugas.* 220 p.

————. 1939. Algae collected by Hassler, Albatross and Schmitt expeditions. II. Marine algae from Uruguay, Argentina, the Falkland Islands an the strait of Magellan. *Paper Michigan Acad. Sci. Ser.* 24 (1): 127-164. 7 pls. (1938).

————. 1960 *Marine algae of the eastern tropical and subtropical coasts of the Americas.* xi + 870 pp., 14 text photos, 80 pls., Ann Arbor.

(Manuscrito recibido el 26 de noviembre de 1985)