

ADDITIONS TO THE MARINE FLORA OF COSTA RICA AND NICARAGUA¹

By

E. YALE DAWSON

Only seven papers have appeared to date in which Costa Rican seaweeds have been considered (Taylor 1933, 1945, 1960; Dawson 1949, 1957, 1960; Dawson & Beaudette 1960). All of these have been published since 1933 and only two of them are floristic accounts dealing especially with Costa Rica. The combined efforts on the Pacific coast have resulted heretofore in the recording of 127 species of brown, green, red and blue-green algae, a number to be considered fairly representative of the flora. Collections on the Atlantic coast have been meager, however, and the latest compilation (Taylor 1960) accounts only 61 species in that area.

During the summer of 1962, in connection with second annual Advanced Seminar in Tropical Biology at the University of Costa Rica, the writer had opportunity for fairly extensive field work, especially on the Atlantic coast, and this has resulted in the present report which greatly expands the list of marine plants from that region, to 196 species, and adds 15 more from the Pacific.

The Nicaraguan flora is still poorly known. The 24 species reported here were obtained by Mr. Robert A. Rasmussen mainly on a lava reef at Masachapa southwest of Managua, December 1961, and provide a modest representation of the open coast flora. Only six marine plants have previously been reported from this nation.

The Pacific coast of Costa Rica is much more varied and extensive than the Atlantic, and it has been collected more widely in both the intertidal and the subtidal. Notwithstanding this, we find not only a significantly larger number of species in the Atlantic flora, but a much greater abundance of marine plant life generally. Several opportunities to visit and compare alternately both coasts during the past summer have led to considerations of some of the reasons for the striking poverty of the Pacific coast seaweed flora as compared to that of the Atlantic.

The most widely influencing factor is that of tides which seems to have not only pronounced direct effects on the flora, but to account for the major physiographic differences in the character of the shore. The Atlantic tides are of low amplitude (scarcely 3 feet) and are of a mixed diurnal character in which only one "low tide" occurs daily. The Pacific

¹This work has carried out with support of the National Science Foundation through grant G-21977 to the University of Southern California, and the Office of Naval Research through contract Nonr 3096(00) with the Beaudette Foundation for Biological Research. Reproduction in whole or in part is permitted for any purposes of the United States government.

tides, on the other hand, are of high amplitude (8-10 feet) and are semi-diurnal with a marked low occurring twice daily.

Under warm-tropical conditions of high water temperature various species of coralline algae of the genera *Porolithon*, *Goniolithon*, *Lithophyllum*, etc., combine growth forces with numerous calcareous animals, especially corals, to form "coral" reefs. Growth of these reefs is primarily controlled by the cementing action of the calcareous algae on the reef margin, and these algae are characteristically inhabitants of highly oxygenated waters (apparently due to high oxygen requirements for dark-hour respiration). Furthermore, these calcareous algae are not at all resistant to desiccation and require constant wetting by surf and spray for survival. Accordingly, it is only under tropical conditions of low tidal amplitude, by which both continuous oxygenation and continuous wetting are provided, that these plants can grow, and hence, can produce "coral" reefs.

The Atlantic coast of Costa Rica is dominated by sand beaches that stretch monotonously along most of the shore, but toward the southeast, beginning at Rio Moin, relatively recent uplifts of old calcareous strata have provided small areas for the development of coral and coralline reefs, and these, especially at Puerto Limon and in the vicinity of Puerto Vargas, provide environments favorable to a great diversity of tropical marine algae and a number of marine flowering plants.

On the Pacific coast this is not the case. Although there are greatly varied coastal configurations providing bays, estuaries, gulfs, headlands, offshore rocks and islands, there are no calcareous reefs, and the algal flora, by and large, is exceedingly impoverished. The high tidal amplitude prohibits the development of the fringing reef with its many favorable algal habitats, and further provides for such intense insolation and desiccation during periods of low water that almost nothing survives intertidally except in the shade of overhanging trees near low tide level. The frequent extensive exposure also makes the algae subject to unfavorable fresh water influence during the rainy season, and the height of high water in conjunction with the low transparency of the water during this season of heavy sediment run-off provides unfavorable conditions of illumination for all but a few tolerant species.

To these and other factors must be added the broad effect of relatively low-nutrient and relatively high-nutrient waters on the opposite continental shores. It is now established that the clockwise and counter-clockwise circulation, respectively, in the northern and southern hemispheres in the ocean basins and the movement of higher nutrient deep waters toward the surface in the central equatorial regions of these basins provides for generally higher nutrient values in tropical waters on the west sides of the oceans than on the east sides. This seems clearly reflected in the Pacific by the richer floras of Indonesia and southeast Asia as compared with the impoverished floras of Central America, and in the Atlantic by the

relatively rich Caribbean flora as compared to that of tropical central west Africa, although that region is not well known.

The most generally reduced algal flora ever encountered by the writer occurs in the vicinity of Punta Catedral on the central Pacific Costa Rican coast. There, a marvelously varied rocky shore occurs, replete with headlands, offshore rocks, islands, bays and coves of striking beauty. One can compare the physiography favorably with that of the Monterey Peninsula in California where one of the richest algal floras of the world lives. However, this most promising of shore areas, as viewed from a distance, proved to be an algal desert in which only the most meager assortment of plants occurred at lowest tide levels, and then only in certain limited and protected small areas. Where one might have expected a hundred species, we found hardly more than a dozen.

Such species-poor floras have been observed by the writer widely along Pacific tropical America from the Perlas Islands in Panamá to Mazatlán, Sinaloa, Mexico. Throughout this whole region seaweeds are conspicuously absent or reduced, especially intertidally, and nowhere do calcareous coral-coraline reefs occur as they do in the opposite Atlantic or at the same latitude westward in the Pacific. That the reef-building algae can occur and build under favorable tide conditions is shown by the presence of reef-type *Porolithon castellum* at Isla Caño, Costa Rica. Subtidal reef formations are present in that locality but neither break into the intertidal zone nor keep sufficiently ahead of solution to allow extensive development.

The Latin diagnoses were prepared by Dr. Hannah Croasdale.

Thanks are due to Dr. Erika Post and Dr. Francis Drenet for identifications of material.

The Costa Rican collections reported here were obtained by the writer with the help of Dr. Ward Rudersdorf, Mr. Oren Lackey, Mr. Sherman Hoslett and others. They are cited by field collection numbers the data for which follow.

- 24001-24095, 24216a. Vicinity of Puerto Limon, Atlantic coast, June 27, 1962. Mainly intertidal collections about 1 mile north of the hospital.
- 24096-24113. Same area, July 7, 1962.
- 24114-24139. Puerto Limon, intertidal reef in sheltered bay immediately south of the hospital, July 7.
- 24140-24196. Portete, a sheltered bay north of Puerto Limon, July 12.
- 24196a-24197. Rio Moin mouth, a brackish intertidal locality at the Northern Railway bridge north of Puerto Limon, July 12.
- 24199-24216. Puerto Limon, bay reef just south of the hospital, July 12.
- 24217-24273. Puerto Vargas, Atlantic coast. Collections from intertidal reef to -6 feet. 0.2 miles north of the landing, July 13.

- 24274-24299. Playa Manuel Garcia, south of Punta Catedral, near Punta Quepos, Pacific Coast. Intertidal rocky shore and adjoining mangroves. July 21.
- 24300a-24310a. Punta Quepos, Pacific coast. A heavily surf-beaten point, July 20.
- 24300-24323. Mata Limon, south shore of Golfo de Nicoya, Pacific coast. Rocky shore in sand beach area, July 19.
24324. Mangrove estuary adjoining above locality, July 19.
- 24325-24344. Portete, near Puerto Limon, Atlantic coast. Sheltered bay, August 4.
- 24345-24356. South of Portete, near Puerto Limon. Surfey shore at edge of narrow reef, August 4.
- 24357-24366; 24370-24382. Isla Uvita, off Puerto Limon. Fringing reef at low tide, August 3.
- 24368-24369. Limon Harbor sea wall, August 3.

The Nicaraguan collections were made at two Pacific coast localities of one of which Mr. Rasmussen says, "The first few [field trips in Nicaragua] were very unproductive. Our only real success was at Masachapa. There is a good lava outflow and reef effect there. Collecting conditions were quite good except for the turbulence and turbidity. I was unable to work the outer edges of the outflow. The area is probably a good source for future collections." The content of this small collection suggests that this reef may be one of the richest intertidal collecting localities along Pacific Central America.

- 22754-22773. Masachapa, Pacific Nicaragua, on a lava reef and point with lava sand beach, December 22, 1961.
- 22774-22775. Poneloya, Pacific Nicaragua, on a rocky point south of the Hotel Lacayo, December 19, 1961.

The nomenclature as to the Atlantic flora, with a few exceptions, follows Taylor 1960. For literature pertaining to the Pacific flora one may refer to Dawson 1957, 1961, 1961a.

Sets of specimens are deposited in the herbaria of the Allan Hancock Foundation, University of Southern California, and of the Department of Botany, University of Costa Rica.

SYSTEMATIC LIST

ATLANTIC COSTA RICA

The following annotated list includes all recognized records of benthic marine plants for this area known to the writer. Plants newly reported are marked with an asterisk.

Ulva fasciata Delile 24200

Ulva lactuca L. 24130, 24144

* *Enteromorpha lingulata* J. Ag. 24172, 24254, 24327

* *Enteromorpha kylinii* Bliding 24333, with clearly distinct multiple pyrenoids.

- * *Enteromorpha chaetomorphoides* Børg. 24344b
- Enteromorpha flexuosa* (Wulf.) C. Ag. reported by Taylor, but not again detected.
- Chaetomorpha media* (Ag.) Kütz. 24055, 24202
- Chaetomorpha linum* (Müller) Kütz. 24372
- *? *Chaetomorpha indica* Kütz. 24332a
- Chaetomorpha gracilis* Kütz. reported by Taylor, but not again detected.
- * *Rhizoclonium kernerii* Stockm. 24263
- * *Rhizoclonium hookeri* Kütz. 24012, 24201
- * *Rhizoclonium tortuosum* Kütz. 24021 (mixed with *Jania* and *Cladophoropsis*); 24234a (mixed with *R. kockianum*)
- * *Rhizoclonium kockianum* Kütz. 24234 (mixed with *R. tortuosum*)
- * *Cladophora fascicularis* (Mert.) Kütz. 24147, 24182, 24245, 24325
- * *Neomeris annulata* Dickie 24249
- * *Acetabularia calyculus* Quoy & Gaimard 24141
- * *Acetabularia farlowii* Solms-Laubach 24142
- * *Valoniopsis ventricosa* J. Ag. 24013, 24237
- * *Ernodesmis verticillata* (Kütz.) Børg. 24150
- * *Dictyosphaeria cavernosa* (Forssk.) Børk. 24223, 24242
- * *Struvea anastomosans* (Harv.) Picc. 24216a
- * *Cladophoropsis membranacea* (Ag.) Børg. 24010, 24040, 24170, 24340
- * *Anadyomene stellata* (Wulf.) Ag. 24115, 24222
- * *Bryopsis plumosa* (Huds.) Ag. 24032, 24074, 24097, 24327, 24382
- *? *Bryopsis pennata* var. *lepricuri* (Kütz.) Collins & Hervey 24098 This material is irregular, but apparently distinct in habit from typical *B. plumosa*.
- * *Pseudobryopsis longipedicellata* Blomquist & Díaz-Piferrer 24198, det. Díaz-Piferrer, a second Caribbean locality for this rare species recently described from Puerto Rico. Note, however, that Taylor (1962) has placed this species in synonymy under *Trichosolon duchassaingii* (J. Ag.) Tayl.
- * *Boodleopsis pusilla* (Collins) Taylor 24160 (on shaded mud); 24340 (with *Cladophoropsis membranacea* in a mat on shaded mud)
- * *Caulerpa verticillata* J. Ag. 24258
- Caulerpa racemosa* var. *uvifera* (Turn.) Weber van Bosse 24049, 24177
- Caulerpa racemosa* var. *occidentalis* (J. Ag.) Børg. 24191
- Caulerpa sertularioides* f. *longiseta* (Bory) Svedel. 24031, 24083, 24192, 24223a
- Caulerpa vickersiae* Børg 24072b
- * *Avrainvillea rawsonii* (Dickie) Howe 24042, 24165, 24271
- * *Avrainvillea longicaulis* (Kütz.) Murray & Boodle 24220
- * *Penicillus capitatus* Lamx. 24219
- * *Codium intertextum* Collins & Hervey 24259
- Codium isthmocladum* Vickers 24146, 24227
- Codium decortcatum* (Woodw.) Howe Reported by Silva (1960) from

San Lucas, but not again detected.

- * *Halimeda tuna* (Ellis & Sol.) Lamx. 24257
- Halimeda opuntia* (L.) Lamx. 24041, 24058, 24082
- * *Vaucheria dichotoma* (L.) Ag. 24185, 24332, forming extensive fine, fuzzy patches on the silt bottom of Portete Bay at depths of 8-15 feet.
- * *Giffordia duchassaingiana* (Grun.) Tayl. 24064, 24184
- *? *Giffordia conifera* (Børg.) Tayl. 24255
- *? *Giffordia mitchellae* (Harv.) Hamel 24255
- * *Giffordia rallsiae* (Vick.) Tayl. 24063
- * *Bachelotia fulvescens* (Born.) Kuck. 24354
- Ectocarpus breviararticulatus* J. Ag. 24357
- Sphacelaria furcigera* Kütz. 24027a, 24228
- Spatoglossum schroederi* (Mert.) Kütz. 24368
- * *Padina vickersiae* Hoyt 24153
- Padina gymnospora* (Kütz.) Vick. 24154, 24240
- Dictyopteris delicatula* Lamx. 24009, 24122, 24204, 24369
- * *Dictyota divaricata* Lamx. 24051, 24188, 24236
- * *Dictyota crenulata* J. Ag. 24050, 24181 Taylor (1960) described *Dictyota jamaicensis* with the comment "These plants seem rather large for *D. crenulata* as found on the western coast of Mexico, though not dissimilar in some respects." To my experience they are not particularly large, and I find no satisfactory distinctions in support of a separate species.
- * *Dictyota bartayresii* Lamx. 24134
- * *Dictyota dichotoma* (Huds.) Lamx. 24238
- * *Dictyota dentata* Lamx. 24260
- * *Dictyota ciliolata* Kütz. 24346
- Pocockiella variegata* (Lamx.) Papenf. 24149, 24256 These are exceedingly luxuriant, large examples as compared to Pacific specimens, and are even somewhat stipitate at times.
- * *Colpomenia sinuosa* (Roth) Derbès & Sol. 24243
- * *Sargassum polyceratum* var. *ovatum* (Collins) Tayl. 24001
- * *Sargassum filipendula* Ag. 24239
- Sargassum vulgare* Ag. Reported by Taylor, but not again detected.
- Sargassum hystrix* J. Ag. Reported by Taylor, but not again detected.
- Sargassum fluitans* Børg. Reported by Taylor, but not again detected.
- * *Goniotrichum alsidii* (Zanard.) Howe 24142a, on *Acetabularia*
- * *Erythrotrichia carnea* (Dillw.) J. Ag. 24183
- * *Erythrocladia subintegra* Rosenv. 24337
- * *Acrochaetium phacclorhizum* Børg. 24228, on *Codium*
- * *Acrochaetium dufourii* Collins 24072a, on *Dictyota*
- * *Acrochaetium seriatum* Børg. 24027c, 24183
- * *Liagora valida* Harv. 24378
- Galaxaura cylindrica* (Ellis & Sol.) Lamx. Reported by Taylor, but not again detected.

- * *Galaxaura squalida* Kjellm. 24048, 24225
- Galaxaura oblongata* (Ellis & Sol.) Lamx. 24180, 24190
- Galaxaura marginata* (Ellis & Sol.) Lamx. 24068, 24244
- * *Galaxaura rugosa* (Ellis & Sol.) Lamx. 24070
- * *Galaxaura lapidescens* (Ellis & Sol.) Lamx. 24224
- Gelidium pusillum* (Stackh.) Le Jolis 24027, 24374
- * *Gelidium crinale* (Turn.) Lamx. 24089, 24101
- * *Gelidium microdentatum* Daws. 24112, 24151, 24351

These three collections are in excellent agreement with the type of this species recently described from San Blas, Pacific Mexico, and also represented by a collection from Malpelo Island in the Gulf of Panama. The range extension into the Atlantic seems improbable, but the fact that these small gelidia are often either overlooked, or lumped indiscriminately under *G. pusillum*, suggests that a broad tropical range may be recognized for this distinctive, but apparently uncommon little plant.

**Pterocladia melanoidea* (Born.) comb. nov. (Plate I, Fig. B)

Gelidium melanoideum Schousboe, ex Bornet 1892, p. 269

As Taylor (1945) pointed out, this is the only species of *Gelidium* in which the tetrasporangia are arranged in decussate rows and "one anticipates that it will be shown to be a *Pterocladia* when cystocarps are found." Since that time the writer has had experience with several small species of *Pterocladia* in some of which cystocarps have been found, and in which the arrangement of the tetrasporangia in decussate rows is characteristic. For this reason and because of the form of the thallus and arrangement of rhizines in the central medulla it seems so probable that this may indeed be a *Pterocladia*, that it is more appropriate to treat the plant under that genus.

Two forms are present in the Costa Rican collections: numbers 24021, 24036 and 24090 from the vicinity of Puerto Limon are apparently sterile, but agree vegetatively with *Gelidium melanoideum* var. *filamentosum* Schousboe ex Bornet 1892, p. 270 (see Feldmann & Hamel 1936, p. 110, fig. 17) = *Pterocladia melanoidea* var. *filamentosa* (Born.) comb. nov. These are also vegetatively similar to *Pterocladia mcNabbiana* Daws. from Pacific Central America, although the tetrasporangia in that species are not at all in decussate rows in the stichidia. Numbers 24355 from Portete, 24090a from Puerto Limon, and 24373 from Isla Uvita are like *Gelidium melanoideum* var. *gracile* Feldmann & Hamel 1936, p. 111 = *Pterocladia melanoidea* var. *gracilis* (Feldm. & Hamel) comb. nov., and the latter of these specimens is in good tetrasporic condition.

Pterocladia americana Tayl. 24128, 24207

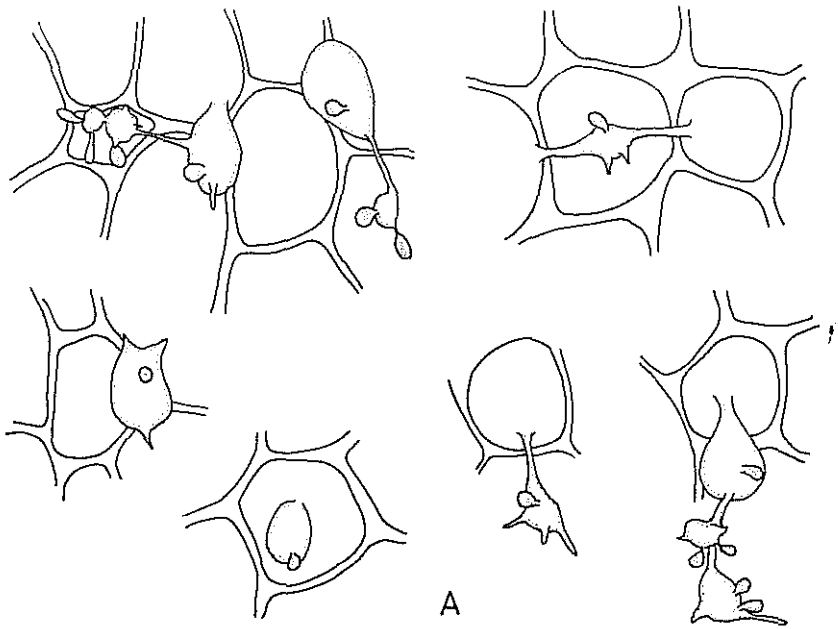
Pterocladia pinnata (Huds.) Papenf. 24127

* *Pterocladia bartlettii* Tayl. 24342

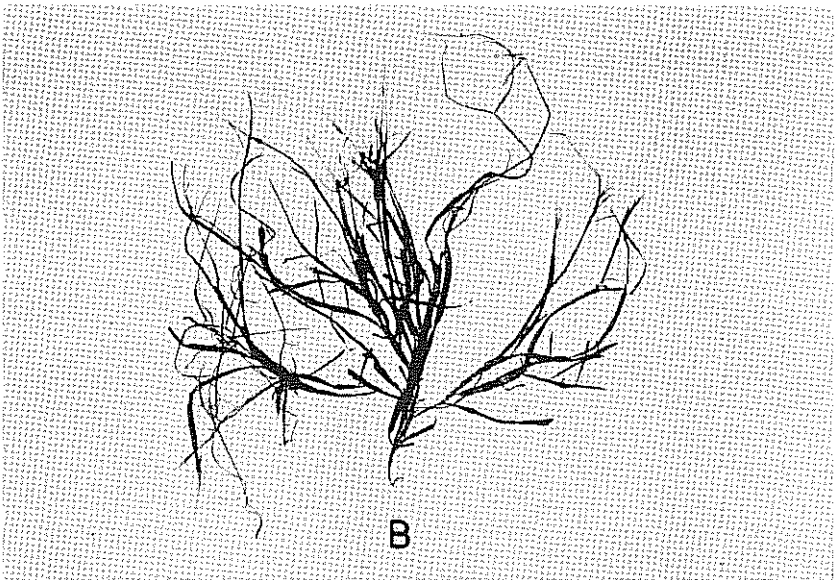
Gelidiella acerosa (Forssk.) Feldm. & Hamel 24019, 24085, 24156

Gelidiella trinitatensis Tayl. 24095

* *Hildenbrandia prototypus* Nardo 24080



A



B

PLATE 1

Fig. A. *Botryocladia shanksii* sp. nov. Several variations in gland cells and bearing cells in the type material, X 210. Fig. B. *Pterocladia melanoidea* (Born.) Daws. from Puerto Limon, X 1.

- Ochtodes secundiramea* (Mont.) Howe 24003, 24187a, 24096, 24370
- * *Cruoriella dubyi* (Cr. & Cr.) Schm. 24140a
- Peyssonelia rubra* (Grev.) J. Ag. 24074, 24140, 24148 The material from a deeply shaded, quiet tidal channel at Portete is exceedingly luxuriant and the blades are for the most part free from the substrate.
- Fosliella farinosa* (Lamx.) Howe 24084
- Dermatolithon pustulatum* (Lamx.) Fosl. 24211a, on *Gracilaria*
- Goniolithon boergesenii* Fosl. Reported by Taylor, but not again detected.
- * *Lithophyllum trichotomum* (Heydr.) Lemoine 24218 This species, first described from the southern Gulf of California, has been shown by Dawson (1960) to have a broad distribution along Pacific America from the Revillagigedo Archipelago and Panama to the Galapagos Archipelago. This is the first recognition of its occurrence in the Atlantic.
- * *Lithophyllum munitum* Fosl. & Howe 24217, tetrasporic, with low, domoid conceptacles about 600 μ in diam.
- * *Lithophyllum crosium* Fosl. 24376, tetrasporic
- * *Lithothamnium incertum* Fosl. 24014, 24264, tetrasporic
- * *Lithothamnium mesomorphum* Fosl. 24343
- * *Heteroderma* sp. near *H. subtilissima* (Fosl.) Fosl. 24194, on *Halophila* with tetrasporangial conceptacles 90-175 μ in diam.
- * *Heteroderma minutula* (Fosl.) Fosl. 24353
- * *Heteroderma lejolisii* (Rosanoff) Fosl. 24221
- * *Amphiroa tribulus* (Ellis & Sol.) Lamx. 24231a
- * *Amphiroa hancockii* Tayl. 24231
- Amphiroa fragilissima* (L.) Lamx. 24018, 24060
- * *Amphiroa rigida* var. *antillana* Børg. 24272
- * *Corallina officinalis* L. 24124
- * *Jania tenella* Kütz. 24062
- Jania capillacea* Harv. 24052
- Grateloupia filicina* (Wulf.) Ag. 24056, 24114, 24171, 24203 Both a slender and a broad form are present depending upon the degree of turbulence and insolation.
- Grateloupia dichotoma* J. Ag. Reported by Taylor, but not again detected.
- * *Halymenia duchassaingii* (J. Ag.) Kylin 24195, solitary at a depth of 12 feet. This is apparently a rare plant known heretofore only from Guadeloupe.
- * *Cryptonemia luxurians* (Mert.) J. Ag. 24199
- * *Cryptonemia crenulata* J. Ag. 24248
- Agardhiella tenera* (J. Ag.) Schm. 24336
- * *Eucheuma schrammii* (Crouan & Crouan) J. Ag. 24268, cystocarpic, similar to the Guadeloupe type, but the ultimate segments more reduced and spinosely branched.
- * *Hypnea cervicornis* J. Ag. 24126, juvenile

Hypnea spinella Kütz. 24037, 24106, 24129, 24330, 24313

Hypnea musciformis (Wulf.) Lamx. 24002, 24136

Catenella impudica (Mont.) J. Ag. Reported by Taylor, but not again detected.

- * *Gelidiopsis scoparia* (Mont. & Mill.) Schm. 24205, 24213, tetrasporangial, identical in every respect, including the flat, heart-shaped stichida, with Børgesen's Mauritius material (type from Reunion).

Gelidiopsis planicaulis (Tayl.) Tayl. Reported by Taylor, but not again detected.

Gelidiopsis intricata (Ag.) Vickers Reported by Taylor, but not again detected.

- * *Gigartina acicularis* (Wulf.) Lamx. 24145

- * *Gracilaria cuneata* Aresch. 24341 (Plate 3, Fig. A) This agrees adequately with the original description of the type of this rare species from Pernambuco, Brazil. Taylor reports it also from Venezuela. The cuneate, membranous blades (to a short stipe) and the more or less undulate margins appear to be distinctive, but reproductive material needs to be studied.

- * *Gracilaria ornata* Aresch. 24226 (Plate 3, Fig. B)

- * *Gracilaria jolifera* (Forssk.) Borg. 24250, 24252 These tetrasporic and cystocarpic plants are identical with my number 7616, May 19, 1949, from Tarifa, Cuba, identified by W. R. Taylor. That Cuban collection includes male plants showing the spermatangia in deep pits. The cystocarpic plants show the abundant nutritive filaments from the gonimoblast characteristic of *Gracilaria*.

Gracilaria ferox J. Ag. 24008, 24121, 24253

- * *Gracilaria mammillaris* (Mont.) Howe 24061, 24119, 24178, 24339. My number 7770 from Matanzas, Cuba, identified by Taylor, is identical with these and includes male plants with spermatangia in deep, open pits.

- * *Gracilaria* sp. 24211, 24118 These materials represent a species very near, but distinct from *G. mammillaris*. It is a crisper, harsher plant which grows often in the same area, nearly side by side, but is readily distinguished in the field. Only sterile plants were found.

- * *Gracilaria crassissima* Crouan & Crouan, ex J. Ag. 24366, 24261 (Plate 4, Fig. B.) Two distinctive forms are present here, the former, a plant corresponding with what Collins and Hervey described as *G. horizontalis* with creeping, rhizomatous, anastomosed branches. The latter is a widely forked plant tending to be a little less prostrate, but having a single discoid attachment. It was found at 3-4 ft. depths, while number 24366 was intertidal. Spermatangia in 24261 are borne in deep, narrow-necked, conceptacular pockets about 80 μ deep, 45 μ wide. In both, the central medullary cells are of mixed large and small sizes quite unlike the usual condition in *Gracilaria*. Examination of the cystocarpic plants is especially needed here.

* *Gracilaria cylindrica* Børg. 24251, tetrasporic. This plant is strongly suspected to be a species of *Gracilariopsis*.

*? *Gracilaria cervicornis* J. Ag. 24344

Gracilaria dominguensis Sonder Taylor reports this, but no corresponding material has been recognized. It has been treated by other authors as a variety of *G. cervicornis*.

* *Gracilaria* sp. cf. *G. verrucosa* (Huds.) Papenf. 24176, 24335 The cystocarps of these plants are peculiar in that apparently characteristic nutritive filaments connect the gonimoblast to the pericarp, but the gonimoblast is exceedingly broad as in *Gracilariopsis*. Spermatangia occur in conceptacular pits of rather irregular size (45-75 μ deep) quite similar to the condition in *Gracilaria verrucosa*. A close study of the development of the cystocarp is called for here to provide an interpretation of the anomalies.

* *Gracilariopsis sjoestedtii* (Kylin) Daws. 24152, all fertile phases.
Botryocladia occidentalis (Børg.) Kylin 24247

**Botryocladia shanksii* sp. nov.

Plate 1, Fig. A; Plate 2, Fig. A-B; Plate 5, Fig. B

Thalli to about 7 cm. high, loosely, stiffly bushy, consisting of several to many cylindrical, irregularly dichotomous solid axes from a discoid holdfast, the axes 1.0-1.5 mm. in diameter, branched somewhat divaricately at intervals of 5-20 mm., provided sparsely in upper parts, and here and there below, with small, hollow, pyriform vesicular branches 2.5-4 mm. long; vesicles with the outer wall layer complete; gland cells solitary or in small groups, borne on specialized cells of irregular form from the inner wall surface; bearing cells of varied shape and size (10-30 μ), simple or compound, sessile or pedicellate, usually with several stellate processes some of which may expand at the end into a secondary bearing cell and others extend as a filament to attach again to the vesicle wall; reproduction not seen.

Thalli usque ad c. 7 cm. alt., laxe rigide fruticosi, ex axibus aliquot vel multis, cylindricis firmis irregulariter dichotomis, ab haptère discoideo enascentibus, constantes; axes 1.0-1.5 mm. diam., intervalis 5-20 mm. aliquantum divaricate ramosi, ramis 2.5-4 mm. long. parvis cavis pyriformibus vesicularibus, superioribus in partibus sparse, infra hic illic praediti; membranae stratum exterius vesiculae perfectum; glandicellulae singulares aut parce aggregatae, in cellulis propriis forma irregularibus, e superficie membranae interioris enascentibus, portatae; cellulae ferentes forma magitudineque (10-30 μ) variantes, simplices aut compositae, sessiles aut pedicellatae, aliquot processibus stellatis plerumque praeditae; nonnulli horum processuum in cellulam ferentem secundariam terminali in parte interdum expansi, alii ut filamentum, membranae vesiculae denuo se affigens, interdum extensi; reproductio non visa.

TYPE: Holotype is E. Y. Dawson 24206, July 12, 1962, in Herb. Allan Hancock Foundation.

TYPE LOCALITY: In a shaded crack in the narrow, fringing reef at -1.0 ft. tide level on the bayshore at Puerto Limon, Atlantic Costa Rica, adjacent to the hospital area.

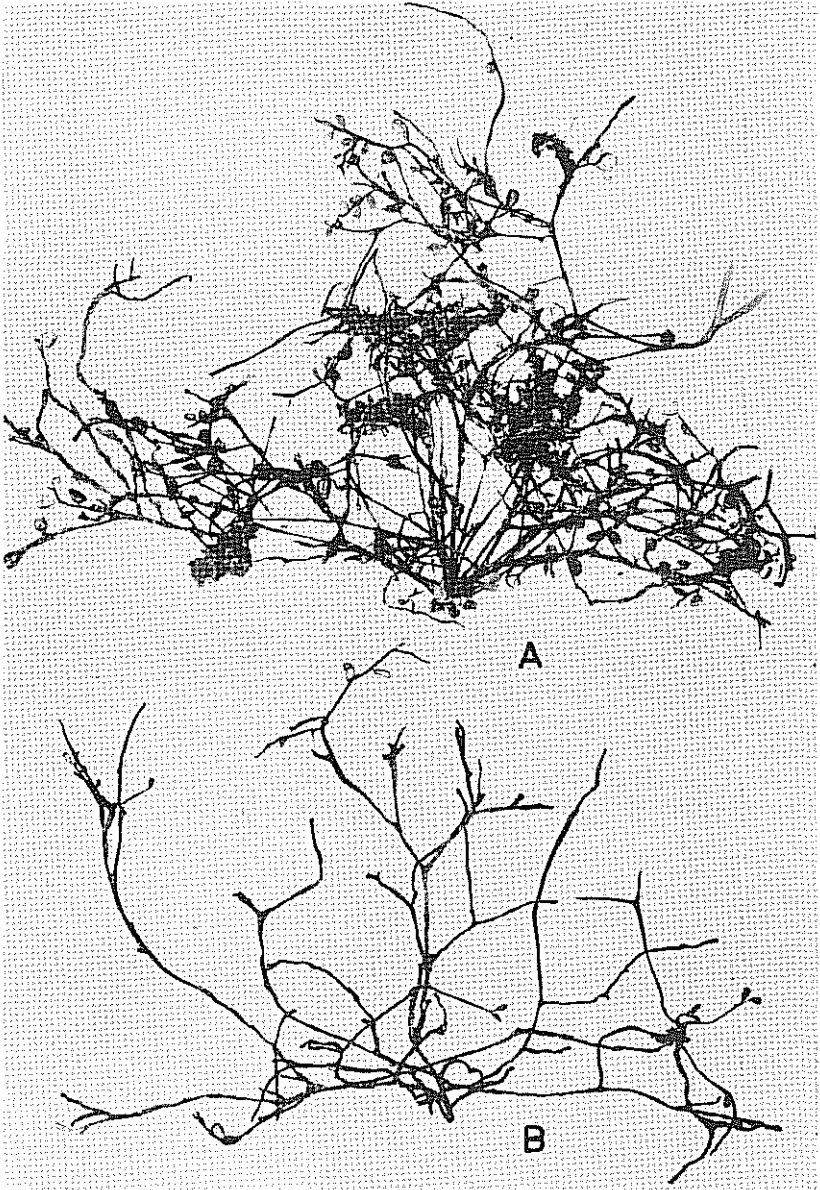


PLATE 2

Botryocladia shanksii sp. nov. Dry specimens from the type locality showing variation in vesicle frequency, X 1.

ADDITIONAL MATERIAL: Dawson 24117, from the same general area and habitat, July 7. Also representative is a specimen from the collections of Anna Vickers labeled "Chryssymenia uvaria J. Ag., Barbados (Hiver 1898-99) R 25 Fev. 99" mounted in a book of 39 algal specimens entitled in script "Barbadian algae, souvenir from Anna Vickers to Miss E. Balls in remembrance of our excursions on the beach" in the library of E. Yale Dawson. This material is a little coarser than the Costa Rican type and with somewhat more numerous vesicles, but with the same peculiar gland cells.

This species is especially distinctive in its stiff, bushy habit, its branching and sparse small vesicles, and in the production of gland cells from stellate or ramified bearing cells. It seems to fall in G. Feldmann's (1944) synoptic key nearest to *B. madagascariensis* G. Feldm. and shows some resemblances also to the more recently described *B. neushulii* Daws. It is named in honored memory of Dr. Royal E. Shanks, companion botanist and friend, who died in the sea at Puerto Limon while studying algae a few days after this new plant was discovered.

* *Gymnothamnion elegans* (Schousb., in C. Ag.) J. Ag. 24214a

Wrangelia argus Mont. 24059, 24099

* *Antithamnion lherminieri* (Cr. & Cr.) Nasr. (*A. antillarum* Borg.) 24075, 24079, 24081, 24361, 24381.

* *Antithamnion* sp. 24215 This is tetrasporic material of the "*Antithamnion* spec." of Borgesen 1917, fig. 217. It shows much resemblance to *A. lherminieri*, but lacks gland cells. It may be only a variant, since the sporangia appear to be borne in the same manner.

* *Antithamnion butleriae* Collins 24168, on a nullipore.

* *Ceramium fastigiatum* (Roth) Harv. The forma *fastigiatum* occurs under nos. 24147a and 24173; the forma *flaccida* H. E. Peters occurs under nos. 24143 and 24326.

* *Ceramium gracillimum* var. *byssoides* (Harv.) G. Mazoyer 24022. Taylor treats this as *C. byssoides* Harv.

* *Ceramium leuzelbergii* Schm. 24190a, on *Galaxaura*. The cystocarpic and tetrasporic material appears to be in complete agreement with this small plant known heretofore only from Brazil.

* *Ceramium diaphanum* (Lightf.) Roth 24133

Ceramium subtile J. Ag. Reported by Taylor, but not again detected.

* *Ceramium cruciatum* Collins & Hervey 24120, 24125

Centrocerus clavulatum (Ag.) Mont. 24004, 24057, 24235

Spyridia filamentosa (Wulf.) Harv. 24033, 24091

* *Spermothamnion speluncarum* (Collins & Hervey) Howe 24352

* *Griffithsia tenuis* C. Ag. 24044

* *Tiffaniella saccorhiza* (Setch. & Gard.) Doty & Meñez 24228, on *Codium*

Acanthophora spicifera (Vahl) Børg. 24034, 24189, 24230

Acanthophora muscoides (L.) Bory Reported by Taylor, but not again detected.

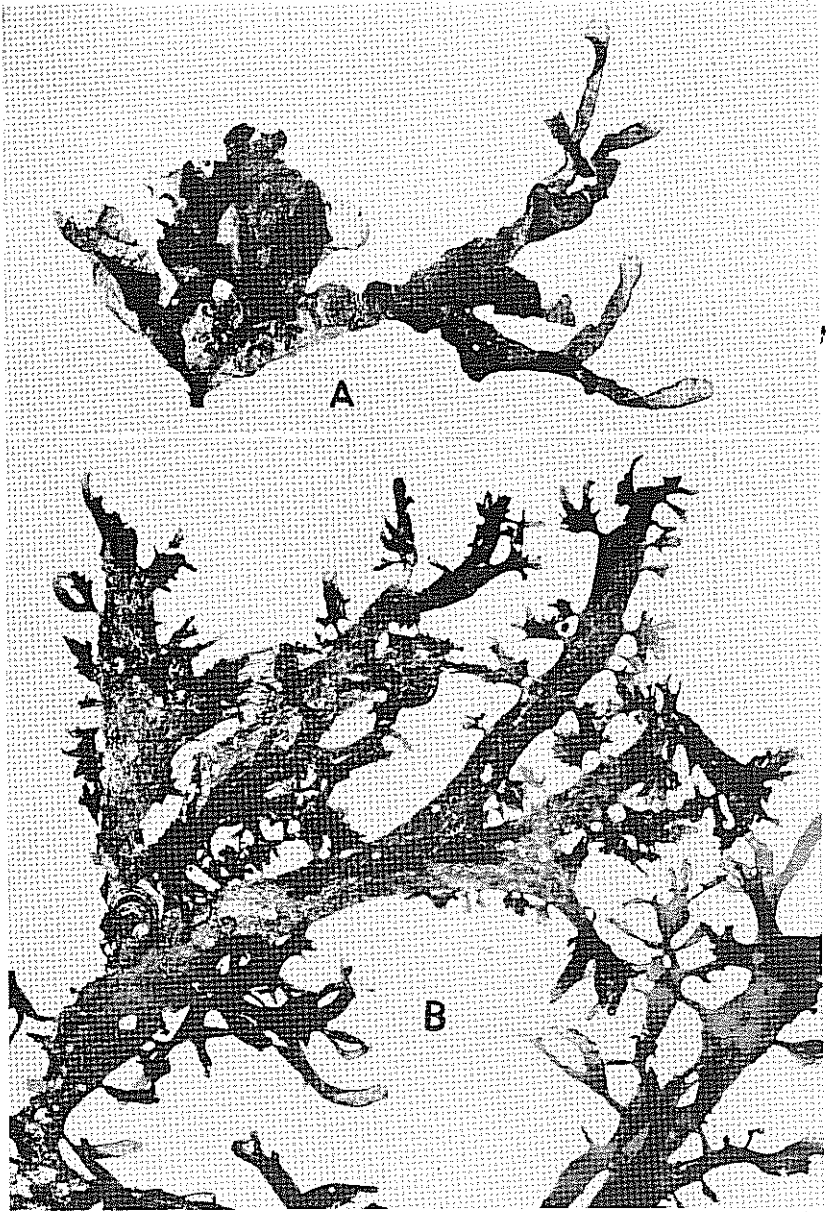


PLATE 3

Fig. A. *Gracilaria cuneata* Aresch. A small specimen (D. 24341) from Portete, Costa Rica, showing undulate blades, X 1. Fig. B. *Gracilaria ornata* Aresch. Part of an ample specimen from D. 24226 showing proliferous marginal branchlets, X 1.

- * *Caloglossa stipitata* Post² 24163. det. by E. Post.
Bryothamnion triquetrum (Gmel.) Howe 24030
Bryothamnion seaforthii (Turn.) Kütz 24116, 24157
- * *Polysiphonia howei* Hollenb. 24159, 24113, 24007, 24011 Commonly encountered at high levels in shaded places near or with the *Bostychieum*.
- * *Lophosiphonia* sp. near *L. villum* (J. Ag.) Setch. & Gard. 24356, with four pericentral cells.
Polysiphonia ferculacea Suhr 24100, 24349
- *? *Polysiphonia subtilissima* Mont. 24125a Spermatangia in this specimen are cylindrical, on the basal cell of trichoblasts, with one sterile terminal cell.
- * *Polysiphonia macrocarpa* Harv. 24255b
- * *Digenia simplex* (Wulf.) Ag. 24267
- * *Bostrychia binderi* Harv. 24005, 24111, 24212, 24158, 24362, det E. Post All on shaded rock substrates under shoreside trees.
- * *Bostrychia radicans* Mont. 24197, det E. Post
Bostrychia tenella (Vahl) J. Ag. Reported by Taylor, but not again detected.
Bostrychia rivularis Harv. Reported by Taylor, but not again detected.
Laurencia papillosa (Forssk.) Grev. 24035
Laurencia scoparia J. Ag. 24045
Laurencia microcladia Kütz. Reported by Taylor, but not again detected.
Laurencia intricata Lamx. Reported by Taylor, but not again detected.
- * *Laurencia corallopsis* (Mont.) Howe 24210, 24233
- * *Laurencia obtusa* (Huds.) Lamx. 24208, 24262, 24365a, 24046
- * *Laurencia sinicola* Setch. & Gard. 24137, 24365 It is surprising to find this small, distinctive plant in the Atlantic flora since it has been presumed to be a northeast Pacific endemic.
- * *Chondria dasyphylla* (Wood.) Ag. 24348
- * *Chondria polyrhiza* Collins & Hervey 24046a
- * *Chondria tenuissima* (Gooden. & Wood.) Ag. 24246
- * *Chondria floridana* (Collins) Howe 24328, intertidal in a shaded place; solitary.

The following blue-green algae have been identified by Francis Drouet and are deposited in his herbarium at the Philadelphia Academy of Sciences.

²Dr. Post reports in a personal communication that she has detected this species in a collection from the Pacific Coast of northern South America: W. R. Taylor 490, partim., Feb. 11, 1934, on *Rhizophora*, roots, Bahía San Francisco, Esmeraldas, Ecuador.

- * *Calothrix pilosa* Harv. 24006, 24108
 - * *Calothrix crustacea* Schousb. & Thur. 24078
 - * *Schizothrix calcicola* (Ag.) Gom. 24078a, 24027
 - * *Lyngbya majuscula* (Dillw.) Harv. 24024, 24092
 - * *Lyngbya sordida* (Zanard.) Gom. 24103, 24179, 24138
 - * *Oscillatoria corallinae* (Kütz.) Gom. 24062
 - * *Symploca hydnoides* Kütz. 24069, 24102, 24161
 - * *Symploca hydnoides* var. *fasciculata* (Kütz.) Gom. 24162
 - * *Brachytrichia quoyi* (Ag.) Born. & Flah. 24229
 - * *Microcoleus chthonoplastes* (Mert.) Zanard. 24241
 - * *Phormidium crosbyanum* Tild. 24371
- Flowering plants
- * *Thalassia testudinum* König 24087, 24266
 - * *Halophila baillonis* Asch. 24193, forming a lawn on the bottom of Portete Bay in about 8-12 feet of water.
 - * *Ruppia maritima* L. 24196a
 - * *Syringodium filiforme* Kütz. 24265

PACIFIC COSTA RICA

All of the following are new records for this region.

- Rhizoclonium kernerii* Stockm. 24282
- Cladophoropsis peruviana* Howe Lackey, L-1, Punta Morales, Golfo de Nicoya, July 1962.
- Chaetomorpha javanica* Kütz. 24285, 24322
- Galaxaura arborea* Kjellm. 24300
- Dermatolithon canescens* (Fosl.) Fosl. ? 24323
- Amphiroa foliacea* Lamx. 24305a, depauperate
- Hypnea cervicornis* J. Ag. 24308
- Gelidiopsis intricatus* (Ag.) Vickers 24306, 24309, 24276, Two sets of tetrasporic plants occur. The stichidium in one is conical-clavate, about 0.8 mm. in diameter, 2.0 mm. long from a slender stalk (250 μ diam.). The other is subcylindric-clavate, of the same size. This character of the fertile plants has not heretofore been reported for this species generally known along the Pacific Coast as *Gelidiopsis tenuis* Setch. & Gard., and enables us to reduce *G. tenuis* under *G. intricatus* inasmuch as neither the stichidia nor sterile structure are adequately distinctive (see Dawson 1954, fig. 34, a-d).
- Catenella opuntia* Grev. 24304a, det. E. Post
- Griiffithsia ovalis* Harv. 24312, tetrasporic; also a collection by Sherman Hoslett, 7/20/62, from Punta Quepos.
- Polysiphonia ferulacea* Suhr 24292
- Polysiphonia howei* Hollenb. 24287, 24310a, 24317
- Bostrychia calliptera* (Mont.) Mont. 24281a, det. E. Post
- Bostrychia tenella* J. Ag. 24281, det. E. Post
- Schizothrix calcicola* (Ag.) Gom. 24288, det. F. Drouet

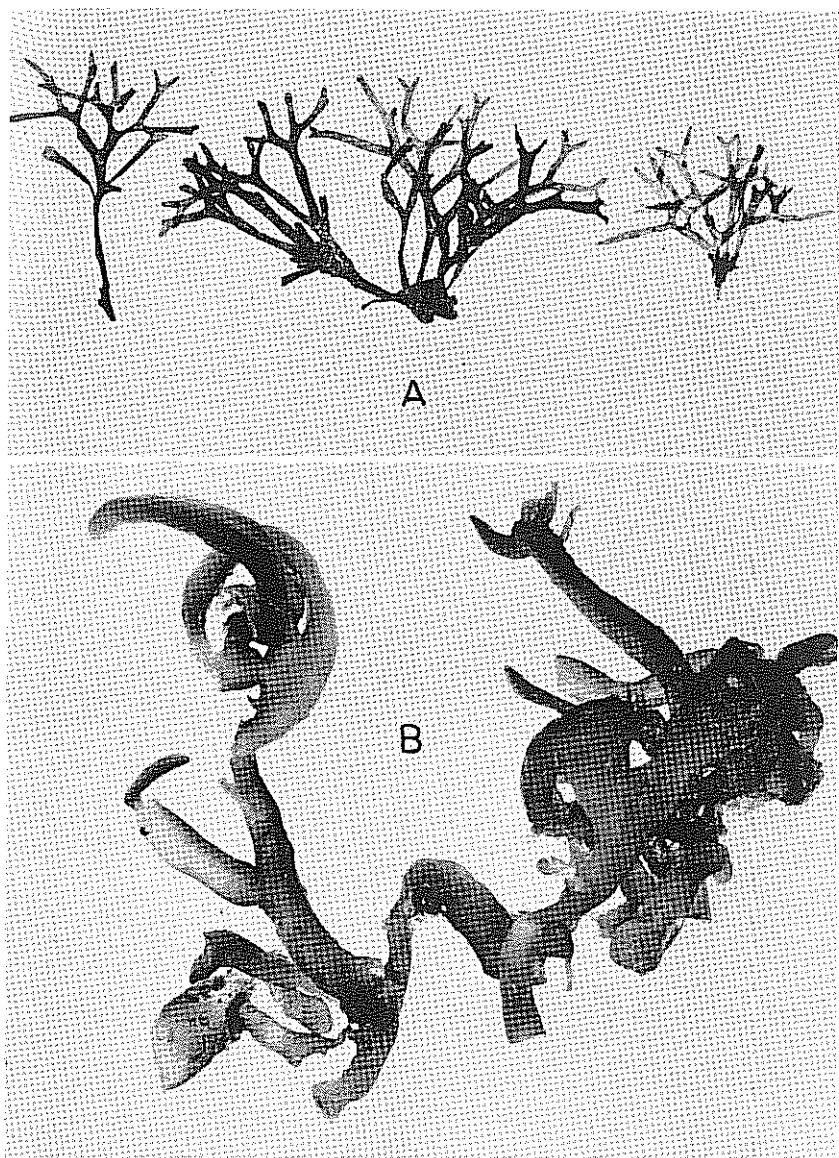


PLATE 4

Fig. A. *Polyopes clarionensis* S. & G. Three specimens from Masachapa, Nicaragua (D. 22761), X 1. Fig. B. *Gracilaria crassissima* Cr. & Cr., ex. J. Ag. A liquid-preserved specimen from Isla Uvita, near Limon, Costa Rica (D. 24366), X 1.5.

PACIFIC NICARAGUA

All of the following are new records for Nicaragua. The only species heretofore identified from this country (vicinity of Corinto Harbor) are *Wurdemannia miniata*, *Caulerpa sertularioides* and *Diplanthera dawsonii* den Hartog (1960).

Monostroma ecuadoreana Tayl. 22762 This material seems quite like the type. Initial saccate parts split open and become widely expanded and ruffled. This confirms the occurrence in Central America suggested in 1957 by doubtful Costa Rican specimens.

Chaetomorpha antennina (Bory) Kütz. 22774

Struvea unastomosans (Harv.) Picc. 22775

Halimeda discoidea Dec'ne 22757

Codium geppii O. C. Schmidt 22769

***Dictyota stolonifera* sp. nov.**

Plate 5, Fig. A

Thalli 4-6 cm. tall, consisting of one to several flabellate blades from a primary discoid holdfast; blades stipitate; stipe and blade bases stupose, provided with several or many linear, simple or occasionally pinnate, compressed, spreading stolons; blades somewhat irregularly dichotomous at intervals of 5-8 mm., the segments 3-4 mm. broad, marginally entire, not terminally reduced, characteristically showing concentric growth bands 600-1200 μ wide; oogonia in scattered, elliptical sori 200-400 μ in diam.; sporangia scattered, solitary or aggregated in small groups, about 70 μ in diam.

Thalli 4-6 cm. alt., ex una vel aliquot laminis flabellatis, ab habere primario discoideo enascentibus, constantes; laminae stipitatae; bases stipitis laminarumque stuposae, aliquot aut multis stolonibus linearibus compressis patentibus simplicibus aut interdum pinnatis praeditae; laminae intervallis 5-8 mm. satis irregulariter dichotomae, segmentis 3-4 mm. lat., in margine integris, extrema in parte non reductis, taenias incrementi concentricas 600-1200 μ lat. proprie praebentibus; oogonia in soris sparsis ellipticis 200-400 μ diam.; sporangia sparsa, singularia aut parce aggregata, c. 70 μ diam.

TYPE: Robert Rasmussen 12/22/61 (E. Y. Dawson 22767), in Herb. Allan Hancock Foundation.

TYPE LOCALITY: Intertidal lava reef at Masachapa, Nicaragua.

ADDITIONAL MATERIAL: E. Y. Dawson 24295, rocky shore, Playa Manuel Garcia, near Punta Cathedral south of Punta Quepos, Pacific Costa Rica, July 21, 1962.

This small species resembles *Dictyota flabellata* from farther north along the Pacific coast, but is well distinguished by the consistent production of linear stolons from the slender stipe and primary blade base, and by the banded blades (somewhat iridescent in life.) *D. radicans* from New Zealand is similarly stoloniferous, but is a much larger plant with long segments and reduced apices.

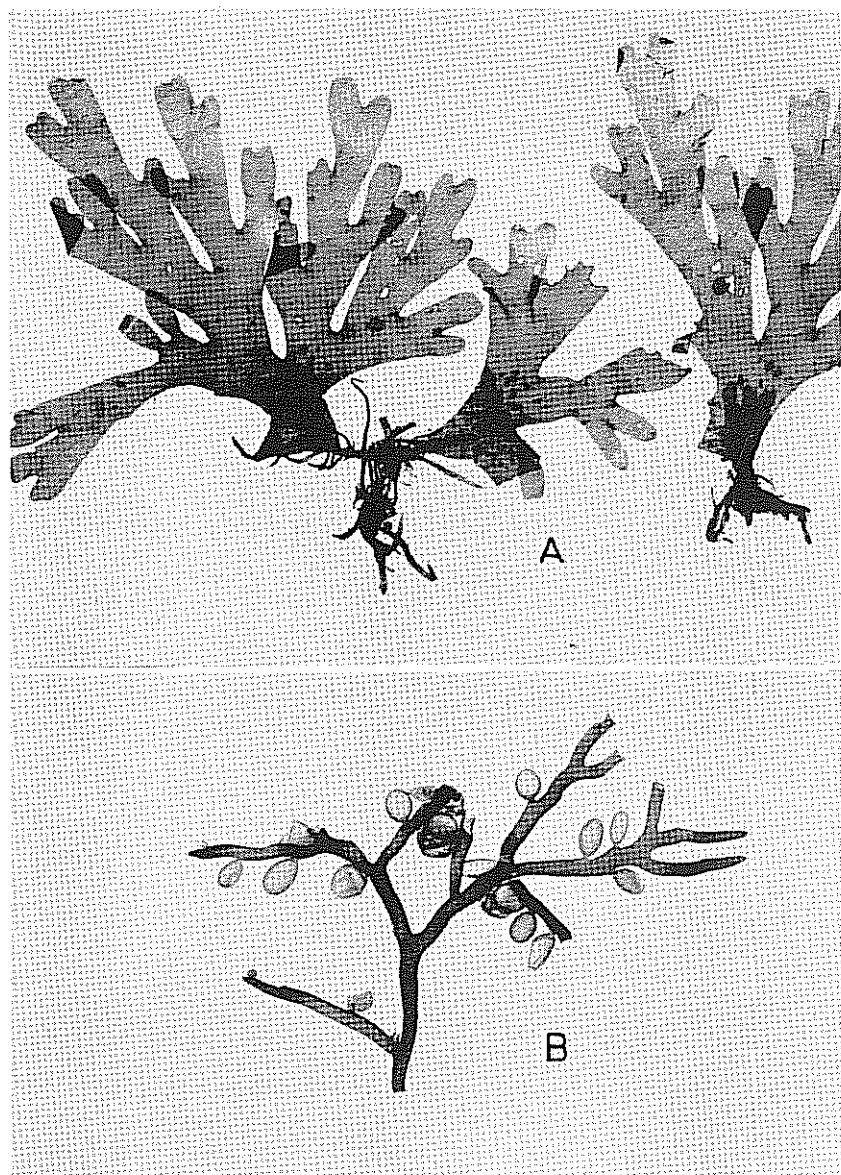


PLATE 5

Fig A. *Dictyota stolonifera* sp. nov. Two specimens from the type collection (Rasmussen 12/22/61) showing stolons and concentric banding of the blades, X 1.5.
Fig. B. *Botryocladia shanksii* sp. nov. Portion of a liquid-preserved specimen from the type collection, X 1.5.

Pocockiella variegata (Lamx.) Papenf. 22771b

Padina durvillaei Bory 22763

Padina caulescens Thivy 22763a

Spatoglossum howellii Setch. & Gard. 22766

Sargassum camouii Dawson 22764 This plant, with firm conical holdfast, agrees well with this Gulf of California species, but probably is represented by one or more other specific names which may be revealed as studies of Galapagos and other South America sargassa are studied in the field and matched with fragmentary types.

Sargassum liebmannii J. Ag. 22765 This corresponds with Costa Rican material recently reported. The well-developed stoloniferous base and sparse or absent cryptostomata ally these plants with the Gulf of California *S. brandegeei* and *S. herporhizum*.

Acrochaetium variabile (Drew) G. M. Smith 22772, luxuriant material on old, very large *Padina durvillaei*, essentially identical with Drew's specimens on Laminariaceae in California.

Galaxaura spatulata Kjellm. 22755, somewhat depauperate material compared with Taylor's luxuriant Galapagos specimens.

Galaxaura fastigiata Dec'ne 22768 This material has been compared with Taylor 485 from Esmeraldas, Ecuador, and found to agree. This eliminates from the Pacific coast flora the record of *G. oblongata* (Taylor 1945) which appears generally to be an Atlantic Caribbean plant.

Gelidium sclerophyllum Tayl. 22758, luxuriant tetrasporic specimens

?*Polyopes clarionensis* Setch. & Gard. 22761 (Plate 4, Fig. A) This material is somewhat larger, coarser and more ample than the type (3.5 cm. tall and 200 μ thick). Structurally it shows the same tissue organization of a cortex composed of anticlinal filaments grading into larger and more rotund subcortical cells and thence to a filamentous medulla. However, the filamentous medulla in the new material is confined to the central $\frac{1}{5}$ or $\frac{1}{6}$ of the thickness of the blade, rather than the central $\frac{1}{3}$. In this respect the plants are more like *P. bushiae*. The type is also more densely branched, especially from the lower, subcylindrical portions, and presents a different aspect of habit. Considering all these differences, one suspects that we may be dealing with a separate species of *Polyopes*, possibly more closely allied with *P. bushiae*, but since the Nicaraguan material is sterile and since specimens closely matching the type of *P. clarionensis* have not been recollected in Mexico or Central America, it seems best to illustrate the new specimen and refer it here. The larger, luxuriant specimens from Hawaii assigned by the writer to this species in 1954 should be compared in future studies of these plants.

Jania tenella var. *zaciae* Daws. 22761

Amphiroa dimorpha Lem. 22771

- Amphiroa taylorii* Daws. 22771a, good material of the coarser form of the species known previously from Mexico and Costa Rica.
Lithothamnium californicum Fosl. 22773 The specimen shows the large conceptacles and essentially smooth surface of this species known hitherto only from as far south as southern Baja California.
Gelidiopsis variabilis (Grev.) Schm. 22760
Hypnea pannosa J. Ag. 22756
Spyridia filamentosa (Wulf.) Harv. 22754

Literature Cited

- Bornet, E.
 1892. Les algues de P.-K.-A. Schousboe . . . Mém. Soc. Nat. Sci. nat. et math. de Cherbourg 28: 165-376.
- Borgesen, F.
 1915-20. The marine algae of the Danish West Indies. Rhodophyceae with addenda . . . Dansk Bot. Ark. 3:369-540.
- Dawson, E. Y.
 1949. Studies of northeast Pacific Gracilariaceae. A. Hancock Found., Occ. Papers (7): 1-104.
 1954. Marine red algae of Pacific Mexico. Part 2. Cryptonemiales (cont.). A. Hancock Pacific Exped. 17(2): 241-397.
 1957. Marine algae of the Pacific Costa Rican gulfs. Los Angeles Co. Mus. Contr. Sci. (15): 1-28.
 1960. New records of marine algae from Pacific Mexico and Central America. Pacific Nat. 1(20): 31-52.
 1961. A guide to the literature and distributions of Pacific benthic algae from Alaska to the Galapagos Islands. Pacific Sci. 15(3): 370-461.
 1961a. Plantas marinas de la zona de las mareas de El Salvador. Pacific Nat. 2(8): 389-461.
- Dawson, E. Y. & P. T. Beaudette
 1960. Field notes from the 1959 eastern Pacific cruise of the Stella Polaris. Pacific Nat. 1(13): 1-24.
- den Hartog, C.
 1960. New sea grasses from Pacific Central America. Pacific Nat. 1(15): 1-8.
- Feldmann, Geneviève
 1944. Révision du genre Botryocladia Kylin (Rhodophycées-Rhodymeniaceés) Bull. Soc. d'Hist. Nat de l'Afrique du Nord 35: 49-61.
- Feldmann, J. & G. Hamel
 1936. Floridées de France, VII. Gelidiales. Rev. Algol. 9(1): 85-140.
- Taylor, W. R.
 1933. Notes on algae from the tropical Atlantic Ocean, II. Papers Mich. Acad. Sci., Arts and Lett. 17: 395-407.
 1945. Pacific marine algae of the Allan Hancock Pacific Expeditions to the Galapagos Islands. A. Hancock Pacific Exped. 12: 1-528.
 1960. Marine algae of the eastern tropical and subtropical coasts of the Americas. xii+870 pp. Univ. Michigan Press.
 1962. A note on Bryopsis in the West Indies. Phycologia 2(1): 24-28.
- Vickers, Anna & Mary Shaw
 1908. Phycologia Barbadosensis. Pt. 1, Chlorophyceae; Pt. 2, Phaeophyceae. 44 pp., 84 pls. Paris.