Los Angeles County Museum

CONTRIBUTIONS IN SCIENCE

ıber 15 October 31, 1957

MARINE ALGAE FROM THE PACIFIC COSTA RICAN GULFS

By E. Yale Dawson[1]

The marine flora of Pacific Costa Rica was virtually unknown until W. R. Taylor (1945) reported 47 species from collections made by the Allan Hancock expeditions of 1934 and 1939 to the Galapagos Islands. Apart from this report, only three other species are recorded from Costa Rica from among several other papers, namely, Grunow (1915-16), Setchell (1937), Dawson (1944, 1949 and 1953), Post (1955) and Drouet and Daily (1956). Most of the known collections came from three localities: Puerto Parker, Puerto Culebra and outer Golfo Dulce. Those from the latter area, and one from Golfo de Nicoya, are listed again in the systematic part of this paper. The other reported collections, from north to south, are:

Bahía Salinas

Enteromorpha lingulata J. Ag.
Ulva lactuca L.
Colpomenia ramosa Taylor

Puerto Parker and vicinity

Enteromorpha flexuosa (Wulfen) J. Ag.
Enteromorpha lingulata J. Ag.
Colpomenia sinuosa (Roth) Derbès & Solier (drift)
Colpomenia ramosa Taylor
Sargassum liebmannii J. Ag.
Bangia fuscopurpurea (Dillw.) Lyngb.
Acrochaetium penetrale (Drew) Taylor, prox.
Hildenbrandia prototypus Nardo
Gracilaria crockeri Dawson (dredged)

---

[1] Research Associate.

Gracilaria costaricensis Dawson (dredged)
Ceramium personatum Setch. & Gard., prox.
Entophysalis deusta Drouet & Daily
Lyngbya semiplena Gomont

Bahía Playa Blanca

Polysiphonia bifurcata Hollenberg (dredged)

Vicinity of Puerto Culebra

Enteromorpha lingulata J. Ag.
Rhizoclonium lubricum Setch. & Gard.
Dictyota flabellata (Collins) Setch. & Gard. (dredged)
Dictyota crenulata J. Ag.
Scinaia complanata (Collins) Cotton (dredged)
Scinaia johnstoniae Setchell (dredged)
Lithothamnium validum Foslie (dredged)
Sarcodiotheca ecuadoreana Taylor (dredged)
Gracilaria crockeri Dawson (dredged)
Gracilariopsis costaricensis Dawson (dredged)
Gracilariopsis panamensis (Taylor) Dawson (dredged)
Hypoglossum abyssicolum Taylor (dredged)
Chondria californica (Collins) Kylin (dredged)
Chondria platyclada Taylor (dredged)

Bahía Brasilito

Entophysalis deusta Drouet & Daily

Bahía Piedra de Blanca

Jania tenella var. *zacae* Dawson

Although these fifty species would seem to constitute a fair indication of the general nature of the marine flora, especially as contrasted to the almost total lack of marine algal information for all the other Central American republics as well as Pacific Colombia, the writer believed that an appreciable increase in our knowledge of the marine vegetation of the region could be obtained even during a single visit to the country. Accordingly, he accepted enthusiastically an invitation from Mr. Maurice A. Machris to go there during June of 1957 to conduct an initial survey in the Golfo de Nicoya and the Golfo Dulce. The present paper records the results of that brief exploratory trip.

In addition to the generous support provided by Mr. Machris, the writer wishes to thank several others who contributed to the success of the work by providing personal assistance or in furnishing information, namely, Mr. John McNabb, Señor Guido Contreras, Señor Hernán Sobrado, Dr. Milner B. Schaefer, Dr. Gerald V. Howard, and the staff of the United Fruit Company's office at Golfito.

COLLECTION STATIONS

Station 1: Puntarenas Peninsula, Golfo de Nicoya, June 6, 1957. Nos. 16690-16693. Except for scant *Enteromorpha* on a log buried in sand, and a bit of *Sargassum* in the beach flotsam, this shore was desolate of algae. The stones of an artificial rock dike on the polluted estuary on the north side of the peninsula yielded depauperate *Spyridia* and colonial pennate diatoms at about ½ m. above mean low tide level.

Station 2: Just inside Bahía Ballena from Punta Piedra Amarilla on the outer Peninsula de Nicoya, Golfo de Nicoya, June 7. Nos. 16694-16729, from about low water level to minus 2 m.; Nos. 16730-16751, at 1½ to 2½ m. above mean low water. This station was reached by walking around the southwest side of the bay from Tambor. The tidal amplitude is great, but rainfall is heavy and insolation intense so that almost nothing occurs at high levels except where protected by overhanging trees. Several species were obtained in such situations, but on rocks exposed to the sun Cyanophyta, (mainly *Isactis plana*) and some *Hildenbrandia* began to appear only at levels of less than two meters above low water. At the end of Punta Piedra Amarilla everything was subject to spray and surf mist at lower intertidal levels and the rocks were covered by a slippery brown cyanophyte layer. Except for a very scant growth in shallow pools and a fringe of crustose lithothamnioid in the surge zone around most of the rocks, erect algae were essentially absent from all areas above mean low water level. At depths of ½ to 2 meters a heavy *Sargassum* and *Padina* flora, with some *Dictyota* and occasionally well developed *Digenia* and *Galaxaura*, dominated a loose turf of various small species on the submerged rocks. The water was dirty from leaves and humus discharged into the bay from heavy recent rain wash.

Station 3: Rocky shore nearest Tambor on the south side of Bahía Ballena, Golfo de Nicoya, June 8. Nos. 16752-16762b. Collections were made from depths of ½ to 1 meter below mean low water. The flora was poor and the rocks covered chiefly by hydroids and bryozoans. The water was extremely opaque from plankton and debris.

Station 4: North side of Bahía Ballena, Golfo de Nicoya, within 500 meters east of Pochote, June 8. The first material (Nos. 16763-16765) came from under trees, some of them mangroves, just outside the estuary where the shade permitted growth that is otherwise restricted by the intense insolation. From there a small point extends out a short distance and Nos. 16766-16777 were collected in high seepages in the sand and in drainage pools. The principal collections (Nos. 16778-

16803a) were from a lagoon just beyond and sheltered by a natural rock breakwater formed by the next rocky point in the sequence. This lagoon is shallow, apparently not much exceeding 2 meters in depth at low water, and is bottomed by dead coral fragments. The beach sand is white from this coral material, unlike the blacker sand on the opposite side of the bay. The circulation is counter clockwise in Bahía Ballena, for the water in this lagoon was comparatively clear, and free of river debris unlike the situation on the other side where the river just above Tambor carries a great amount of silt and organic detritus into the bay and piles up driftwood in front of Tambor. The algae of this lagoon were dominated by *Padina* in scattered clumps to about 25 cm. high. All the other growth was small. An occasional clump of *Amphiroa,* a little *Liagora,* and a cover of very small species appeared on the dead coral. At the end of the natural breakwater a considerable surge occurs, as well as a small amount of surf. Under the influence of these, *Sargassum* occurs just as it did on the other side of the bay, in clumps about 25 cm. high. Quite considerable masses of *Spyridia* were on the bottom here, but other species were inconspicuous. The extreme proverty of Siphonocladales was striking. The only *Caulerpa* seen was markedly dwarfed. On such an apparently favorable bottom many other things were expected to occur, and would have been found in other parts of the tropical Pacific, but for reasons not yet fully understood were absent here.

Station 5: On a submerged rock about 50 meters off shore near Punta Voladera, Golfo Dulce, about 1 km. outside of Golfito Harbor entrance, June 13. Nos. 16804-16814. This rock is exposed somewhat less than 1 meter at low water. Except for a peculiar plant-like ctenophore bryozoan which resembles a *Laurencia* in habit and color, this rock was covered largely by a thin *Jania-Gelidium* turf of diminutive species.

Station 6: Inside and near the southeast end of Golfito Harbor, Golfo Dulce, June 13, (on rocks and mangrove, Nos. 16815-16821; on a sunken steel ship, Nos. 16822-16825). The water here was mucky, and plants were extremely scant. Tube worms and ctenophore bryozoans were dominant. Pollution was evident.

Station 7: On the mud flats at the civil town of Golfito, Golfo Dulce, June 14. Nos. 16826-16827; 16834-16835. *Spyridia* was in fairly good development on shell fragments.

Station 8: On rocks and fallen trees in the middle intertidal zone near El Atrocho, south of Golfito, Golfo Dulce, June 13. Nos. 16828-16832.

Station 9: On the legs of the light tower at the entrance to Golfito Harbor, Golfo Dulce, June 14. No. 16833. A heavy growth of a plant-like ctenophore bryozoan covered the steel legs. Several minute red algal epizoans occurred on it.

Station 10: On mud flats opposite the hospital at the Bananera Company town, inner harbor of Golfito, Golfo Dulce, June 16. Nos. 16836-16847.

Station 11: On the rocky shore of a rapid drop-off just northwest of Punta Galardo, Golfo Dulce, in 1 meter of water at low tide, June 14. Nos. 16848-16853. Although there was some surge and surf, and the bottom appeared to be favorable for abundant algal growth, almost nothing was visible except a few depauperate specimens of *Padina.*

Station 12: Bahía de los Guabos, innermost Golfo Dulce, June 15. Nos. 16854-16871. The collections were made from rocks and dead coral in 1-3 meters at low water. Visibility was about 3 meters in the calm, very warm water. The flora consisted of a continuous short turf 1-3 cm. thick. The largest plants were *Galaxaura* and *Caulerpa,* but none of these exceeded eight centimeters in height. All else was short, covered with fine silt, and of monotonously brown color. Very few living corals were visible although much of the substrate was of dead coral masses and fragments.

Station 13: On a solitary rock 200 meters off the end of Punta Galardo, Golfo Dulce, June 14. Nos. 16872-16887. This rock is subject to complete submergence at high water and to drying on top at low water. The area exposed is about 10 square meters. No growth of larger algae was observed, although considerable clumps of *Cladophoropsis* and *Amphiroa* occurred. Except for these and the conspicuous ubiquitous ctenophore bryozoan mentioned above, the rock surface was covered by a short turf mostly 1 cm. tall or less and by some thin patches of crustose algae. Articulated corallines were conspicuous but very small in size.

ECOLOGY

It may be seen from these notes and the systematic account to follow that the marine algal flora of the Costa Rican gulfs is a poor one, both in number of species and in the stature of the plants. Indeed, in the writer's experience in the tropical Pacific he has never found an area of such varied exposures and of such diversified and favorable substrates for algal attachment in which the algal population is so poorly developed. A full explanation of the reasons for this is not yet possible, but the observations to date clearly reveal several factors which are limiting. Most conspicuous among these are the exceptionally and consistently high water temperatures throughout the Golfo de Nicoya and Golfo Dulce. These high values, which for Puntarenas, Golfo de Nicoya, are outlined in Table 1, p. 26, together with the low circulation and limited to negligible surf agitation in these protected gulfs, greatly limits the availability of respiratory oxygen for the plants and probably are in large part responsible for the impoverished character of the sublittoral flora. It was notable at Bahía Ballena how the size and density of the *Sargassum* and *Padina* growths were favored by the increased exposure to agitation near Punta Piedra Amarilla.

Another restricting factor is the consistently heavy rainfall (some 280 inches annually in the Golfo Dulce) which causes reduced salinity from runoff and seepage in many inshore areas and introduces unfavorable quantities of sedimentary debris into the shore waters. This heavy and regular rainfall probably accounts for the dirth of intertidal species which, because of the tidal amplitude (to about 3 meters) and frequent exposure to drenchings with rainwater, are unable to survive above the level of mean low water. Species which might tolerate these salinity changes are further restricted by the excessive dryness, light and heat during daytime periods of exposure to intense insolation.

It remains to be seen from further explorations along the exposed, open shores of Costa Rica how rich and diversified a flora may yet be found. The abundance of rocks, islets and magnificent reefs suggest from the air that for the most part only the lesser species have been found and that a thorough survey of the outer coasts by skin diving may reveal a flora more in accord with those of other tropical Pacific areas.

SYSTEMATIC LIST

In citing specimens, the prefix "D." is given to designate the writer's field collection numbers. A complete set of these cited specimens is deposited in the herbarium of the Los Angeles County Museum. Collections by others are indicated by the full name. Those of W. R. Taylor are located in the Herbarium of the Allan Hancock Foundation and at the University of Michigan.

The literature citations are incomplete and somewhat arbitrary, but in general represent those found to be pertinent in making the determinations of these collections.

The Latin diagnoseis of new species were prepared by Dr. Hannah Croasdale.

CHLOROPHYTA

Monostroma sp. cf. *M. ecuadoreanum* Taylor 1945:40 Fig. 1.

D. 16839 agrees in size, thickness of blade, etc., with Taylor's Ecuadorean type, but does not show particularly rectangular cells in transection. The material is scant and only 1 cm. tall, so cannot be identified with certainty. Taylor's type has not previously been illustrated.

Enteromorpha lingulata J. Agardh

D. 16690. This material is apparently like that reported by Taylor (1945:39) from three Costa Rican localities outside the gulfs.

Enteromorpha compressa (L.) Grev. forma. Dawson 1956:27, fig. 1.

D. 16846 is small and not well developed. It is referred to this widespread species in *sens. lat.*

Cladophoropsis sundanensis Reinbold; Dawson 1956:30, figs. 8 a-b.

D. 16767.

Cladophoropsis gracillima Dawson 1950a: 149, figs. 12-13.

D. 16793; D. 16834. These are essentially identical with the Mexican type except that the filaments tend to be slightly larger (80-120 μ, or up to 130 μ in diameter).

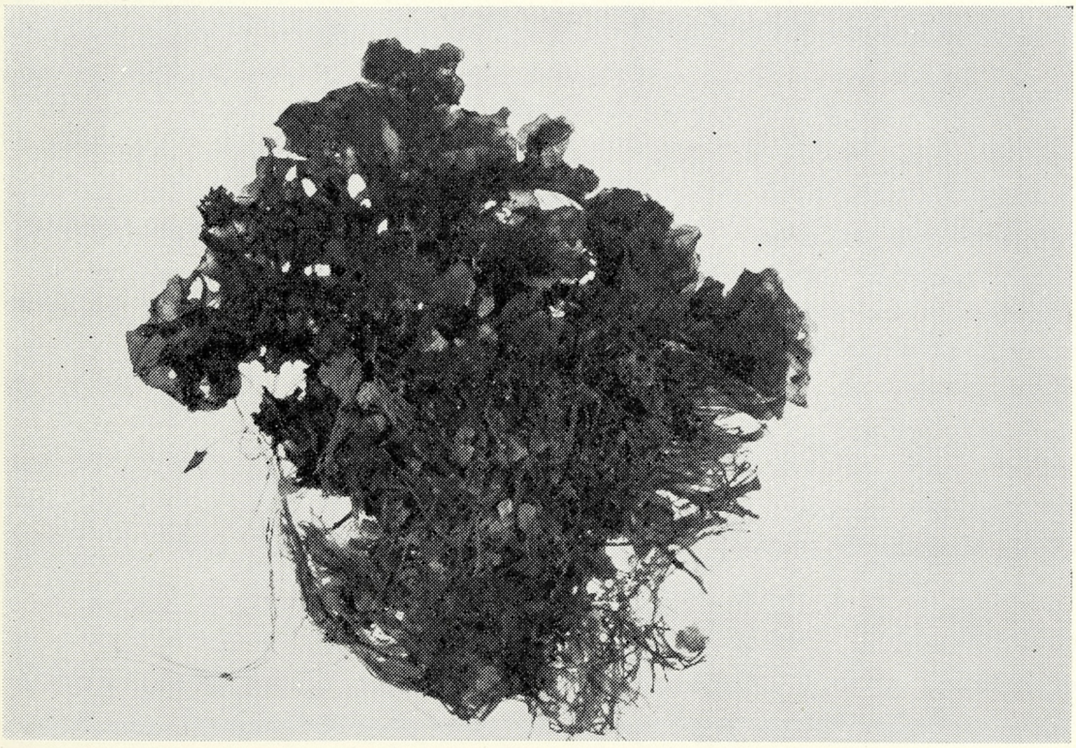

Fig. 1. *Monostroma ecuadoreanum* Taylor. The type specimen, x 2.

D. 16876 is near this species, but is too large in diameter in many parts to fit well within its presently recognized circumscription. It has no fibulae, although the branching above in some parts, is struvioid. It is possibly a distinct species, but the material does not seem to warrant description at this time. It differs from *C. gracillima* not only in its greater diameter of some parts, but in the opposite branching of outermost vegetative parts.

Boodlea siamensis Reinbold; Börgesen 1913:49, fig. 34.

D. 16819 is in good agreement with Börgesen's figures of West Indian specimens. *D. 16825* may be this same, but the upper branching seems too regularly opposite for satisfactory comparison. The plant forms a well developed mat.

Struvea anastomosans (Harvey) Piccone & Grunow, ex Piccone; Egerod 1952:: 359, pl. 31, fig. 4 a-h.

D. 16799 and *D. 16813* are small and rather ill developed from turf mixtures, but their better parts seem to place them here without much question.

Willeella mexicana Dawson 1950: 151, fig. 11.

D. 16871 is represented by a single plant 2½ cm. tall, somewhat ill developed, but seemingly identical with the type which came from near Guaymas in the Gulf of California.

Cladophora prolifera (Roth) Kützing; Vickers 1908: 18, pl. 12; Taylor 1945:57.

D. 16700, D. 16751 are small plants to 2 cm. tall. *D. 16758a* is more slender and lax than *16700,* but structurally similar. *Taylor 39-108* (part) in tufts of *Galaxaura,* Golfo Dulce, 3/26/39.

Cladophora rudolphiana (Agardh) Kützing

D. 16740. Branches remote; main axes 84 μ in diameter; ultimate branches 20-30 μ in diameter; cells 5-7 diameters long.

Cladophora socialis Kützing; Dawson 1954a: 387, fig. 7e (as *Cladophora patentiramea* f. *longiarticulata*).

D. 16765 is a form with very long cells, often 10-15 (or 20-25) diameters long. Börgesen (1946: 28) has discussed this species in connection with *Cladophora patentiramea* var. *longiarticulata* Reinbold, and var. *hawaiiana* Brand, and pointed out that both are probably long-celled forms of *C. socialis* Kütz.

Bryopsis pennata Lamouroux; Egerod 1952: 370, fig. 7.

D. 16751a; D. 16758. These specimens are present in small amount but seem clearly to represent a form of this widespread tropical species.

Caulerpa racemosa var. *peltata* (Lamouroux) Eubank 1946: 421, fig. 2 r-s.

This species is well represented in the collections, but in no instance were specimens of really characteristic development seen. *D. 16809* and *D. 16856* are both small, scrubby plants; *D. 16792* is depauperate; *D. 16798* is a small, highly stoloniferous form.

Codium sp.

D. 16644, around the base of *Sargassum.*

Chlorodesmis hildebrandtii A. Gepp and Ethel Gepp 1911: 16, 137, fig. 74-75.

D. 16703; D. 16805.

Halimeda discoidea Decaisne; Egerod 1952: 398, pl. 38, fig. 19 b-d; Taylor 1945: 73.

D. 16707; D. 16801; D. 16754. These represent a small form with utricles only 35-45 μ in diameter. The plants are all short and were nowhere seen in luxuriant development. *Taylor 39-96,* in rock crevices and lower tide pools, Golfo Dulce, 3/26/39.

PHAEOPHYTA

Sphacelaria novae-hollandiae G. Sonder; Dawson 1954a; 400, fig. 14g.

D. 16865 has only a few propagulae, but these are identical with those in the writer's Viêt Nam collections cited above. The species has been reported on the Pacific Coast only from Isla Guadalupe, Mexico.

Sphacelaria furcigera Kützing; Dawson 1954a: 400, fig. 14h.

D. 16697b, D. 16699, D. 16720, D. 16786. Some of these are richly developed with abundant propagulae. They seem to be in best condition on older stipe parts of *Sargassum.*

Dictyota divaricata Lamouroux; Taylor 1928: pl. 16, fig. 6-9.

D. 16857 seems to be a form of this widespread tropical species known from several localities in southern Mexico.

Dictyota sp. cf. *D. friabilis* Setchell 1926;91, pl. 13, fig. 4-7, pl. 20, fig. 1; Dawson 1954a: 401, fig. 16a-b.

D. 16701 is a prostrate to spreading small plant from a central attachment. Its many rhizoids on the undersides and very short segments

Fig. 2. *Padina crispata* Thivy. The three small specimens are from the type collection. The larger example is from the writer's collection at Bahía Ballena, Golfo de Nicoya. Reduced x 0.7.

are noteable. It has a greenish irridescence in life. Study of many collections of small dictyotae from diverse parts of the tropical Pacific is needed to establish the specific limits of *D. friabilis* and related species. Two other collections of a different small *Dictyota* are present from the Gulf of Nicoya, *D. 16724* and *D. 16788*, representing a pinnate-proliferous small plant of unknown identity.

Dictyopteris repens (Okamura) Börgesen 1924:265, fig. 13.

D. 16697d; D. 16787a. Not previously reported from the Pacific Coast.

Pocockiella variegata (Lamouroux) Papenfuss 1943: 467, fig. 1-14.

D. 16702 and *D. 16868* are small but characteristic specimens. The former is fertile.

Padina durvillaei Bory; Setchell & Gardner 1925: pl. 93; Taylor 1945: 101.

D. 16704. The material is depauperate compared to the luxuriant specimens from Pacific Mexico. It shows a very light calcification in concentric lines on the lower surfaces. *Taylor 39-101,* infrequent in rock crevices near entrance to Golfo Dulce, 3/26/39.

Padina crispata Thivy, in Taylor 1945: 100. Fig. 2.

D. 16783; D. 16723; D. 16848 are all apparently identical with the type which, however, is not, because of its ill developed nature, characteristic of the species. It came from rocks near the entrance of Golfo Dulce, *Taylor 39-100,* 3/26/39, and was probably collected at a relatively high level where the plants are of scrubby development. The figures show the extent of development of plants in luxuriant condition at a depth of 1-2 meters below mean low water in the Gulf of Nicoya. At Bahía Ballena this species seemed to dominate considerable areas at this depth and, except for *Sargassum liebmannii,* is the species present in largest quantity of any in the Costa Rican gulfs. The dark, non-calcified upper surfaces, the chalky, rather heavily calcified lower surfaces and rather small segments are distinctive.

Padina caulescens Thivy, in Taylor 1945:99. Fig. 3.

D. 16723a has a well developed, branched, stupose stipe and thin, lightly calcified blades like this species described from Isla María Magdalena, Las Tres Marías, Mexico. The type has never been illustrated.

Chnoospora implexa Hering, ex J. Agardh; Dawson 1954a:404, fig. 20a-b.

Fig. 3. *Padina caulescens* Thivy, from the type collection, approximately natural size.

D. 16727 is a rather poor, depauperate example of this distinctive species hitherto unreported for the Pacific Coast of North America.

Sargassum liebmannii J. Agardh; Setchell 1937:130, pl. 28, fig. 1-3; Taylor 1945:119, pl. 29.

D. 16705; D. 16691; D. 16785. All of these are characteristic examples of this species which would seem to be the only one present in the Costa Rican gulfs. Taylor (1945) does not record it from Costa Rica, but his specimen 39-102 from Golfo Dulce cited under *Sargassum brandegeei* is this plant rather than the Gulf of California species. Setchell (1937) reports *S. liebmannii* from the Gulf of Nicoya as well as from two other localities to the north. Grunow (1915:398) describes *S. liebmannii* var. *nicoyana* from the Gulf of Nicoya, of which Setchell says: This "is probably an antheridial plant of quiet waters with thinner, more punctate leaves and less spinulose receptacles."

RHODOPHYTA

Goniotrichum elegans (Chauvin) Zanardini. Tanaka 1952:5, fig. 2-3, (as *Goniotrichum alsidii).*

D. 16833b.

Erythrotrichia carnea (Dillwyn) J. Agardh; Tanaka 1952:14, fig. 7A-E.

D. 16808a; D. 16833a.

Liagora valida Harvey; Taylor 1945:135.

Taylor 39-94, scarce in tide pools near the entrance to Golfo Dulce, 3/26/39. Not again collected.

Liagora ceranoides Lamouroux

D. 16782. These small, sterile plants only 2 cm. tall are best referred to the *Liagora ceranoides* complex, although with some doubt.

Galaxaura filamentosa Chou, in Taylor 1945:139; Chou 1945:39, pl. 1, fig. 1-6, pl. 6, fig. 1.

D. 16854 occurred in abundance as short, rather corymbose, spongy tufts, mostly in shaded places under cliffs in quiet water. *Taylor 39-93,* frequent on intertidal rocks on the western side of Golfo Dulce near near the entrance, 3/26/39. Also reported from Puerto Culebra.

Galaxaura ramulosa Kjellmann; Chou 1945: 44, pl. 2, fig. 3-5, pl. 7, fig. 1.

D. 16855 is represented by a single rather poor plant, but it is much like Taylor's specimen *34-505* cited and illustrated by Chou from nearby Jicarita Island, Panama.

Galaxaura stupocaula; Chou 1945: 49, pl. 5, fig. 10-12, pl. 11, fig. 1; Svedelius 1953:72, fig. 61-64; Taylor 1945:141.

D. 16698; D. 16794a, both intermixed with *Galaxaura veprecula. Taylor 39-90A; Taylor 39-91A; Taylor 39-92A,* from tide pools near the entrance of Golfo Dulce, 3/26/39.

Galaxaura veprecula; Chou 1947; 16, pl. 6, fig. 1-8, pl. 12. fig. 1; Taylor 1945:143.

D. 16696; D. 16794. The plants of both these collections were abundant and intermixed with *G. stupicaula* just as were *Taylor 39-90B, Taylor 39-91B,* and *Taylor 39-92B,* from tide pools near the entrance to Golfo Dulce, 3/26/39.

Gelidium sclerophyllum Taylor 1945:156, pl. 5, fig. 13, pl. 13, fig. 2.

Taylor 39-99, stunted, on under sides of rocks near entrance to Golfo Dulce, 3/26/39. Not again collected.

Gelidium pusillum (Stackhouse) LeJolis; Taylor 1945:152; Dawson 1944:258, pl. 42, fig. 1-6.

D. 16853; D. 16717; D. 16810. The latter two collections are of a form approaching *G. pusillum* var. *pacificum* Taylor. *D. 16821* is an extremely small form, yet with clearly evident rhizines. *Taylor 39-111* is a somewhat narrow form, abundant on rock much mixed with sand, Golfo Dulce, 3/26/39. *J. T. Howell 783, J. T. Howell 779a* and *Carroll W. Dodge n.n.* in the Herbarium of the University of California, Berkeley, are from the vicinity of Golfo de Nicoya.

Pterocladia mcnabbiana sp. nov. Fig. 4C-D.

Thalli pumili, tegetes in saxis conchisque formantes, ad 2 cm. altitudine e stolonibus ramosis subcylindricis c. 100 μ diametro constantes; stolonibus ad substratum crebro affixis, ramos erectos aut decumbentes, simplices aut parce pinnatos efficientibus, ramis partim subcylindricis ac stoloniferis, partim complanatis, c. 60-80 μ crass., ligulatis atque 0.35-0.65 mm. latis, extrema in parte, autem, in extensiones longas flagellatas subcylindricas productis. Cortex externus e strato uno cellularum minorum 3-6 μ diam., cortex internus e strato uno vel partim duobus 8-12 μ diam. constans; medulla angusta, 22-25 μ lat., rhizinas sparsas 8 vel plures per 100 μ includens; regio subcorticalis admodum sine rhizinis; tetrasporangia in ramis stichideis planis, ellipticis extrema in parte expansis producta; cystocarpi antheridiaque non visa.

Thalli dwarf, mat-forming on rocks or shells, reaching 2 cm. tall, consisting of ramified, subcylindrical stolon parts about 100 μ in diameter attached at frequent intervals to the substrate and giving rise to erect or decumbent, simple or sparingly pinnate branches, these branches in part subcylindrical, stoloniferous, and in part flattened, about 60-80 μ thick, ligulate and 0.35-0.65 mm. wide, but produced terminally into long, flagellate, subcylindrical extensions; outer cortex of 1 layer of small cells 3-6 μ in diameter; inner cortex of 1 or partially 2 layers of cells 8-12 μ in diameter; medulla narrow, 22-25 μ wide with rhizines scattered through it, sometimes as few as 8 per 100 μ, sometimes more abundant; subcortical area essentially without rhizines; tetrasporangia borne in terminally expanded, flat, elliptical, stichidial branches; cystocarps and antheridia not seen.

TYPE: *Dawson 16822,* forming small mats on the iron hull of a sunken ship, inner Golfito Bay, southwest of the civil town, Golfo Dulce, June 13, 1957.

ADDITIONAL MATERIAL: *D. 16859a, D. 16861.*

All of these collections came from extremely warm, sheltered areas of inner Golfo Dulce. They show considerable variability, but are especially marked by the dimorphism of the branches which are in part strongly flattened, and in part cylindrical and filamentous. In these respects it is reminiscent of other *Pterocladia* species such as *P. pyramidale* of Pacific Mexico and the United States. It is similar in size to both *P. parva* Dawson and *P. musciformis* Taylor, but in these the erect parts are consistently flat and lack the flagellate terminal extensions so prominent in *P. mcnabbiana.* It shows some resemblance to the stoloniferous form of *P. nana* Okamura of Japan and Formosa, but is smaller and lacks the prominent, close pinnate branching of that species. The fertile fragments of a small *Pterocladia* recognized by the writer from stomach contents of Palmyra Island fishes (Dawson, Aleem & Halstead 1955, p. 16) may be related here.

Inasmuch as cystocarps are not yet known, the position in *Pterocladia* rather than *Gelidium* must be provisional despite the evidence from vegetative parts.

The species is named for Mr. John McNabb of Los Angeles, California.

Pterocladia musciformis Taylor 1945:159. Fig. 4A.

Taylor 39-106 (TYPE), abundant on rocks much admixed with sand, associated with *Centroceras clavulatum* and *Gelidium pusillum* near the entrance of Golfo Dulce, 3/26/39. A specimen from the original collection has not heretofore been illustrated, and no new material has been found.

Gelidiopsis tenuis Setchell & Gardner 1924:749, pl. 22, fig. 2.
D. 16762; D. 16858.

Wurdemannia miniata (Lmk. & DC.) Feldmann & Hamel 1934:544, fig. 9-11.
D. 16741; D. 16749c; D. 16857a. This species is generally mixed in

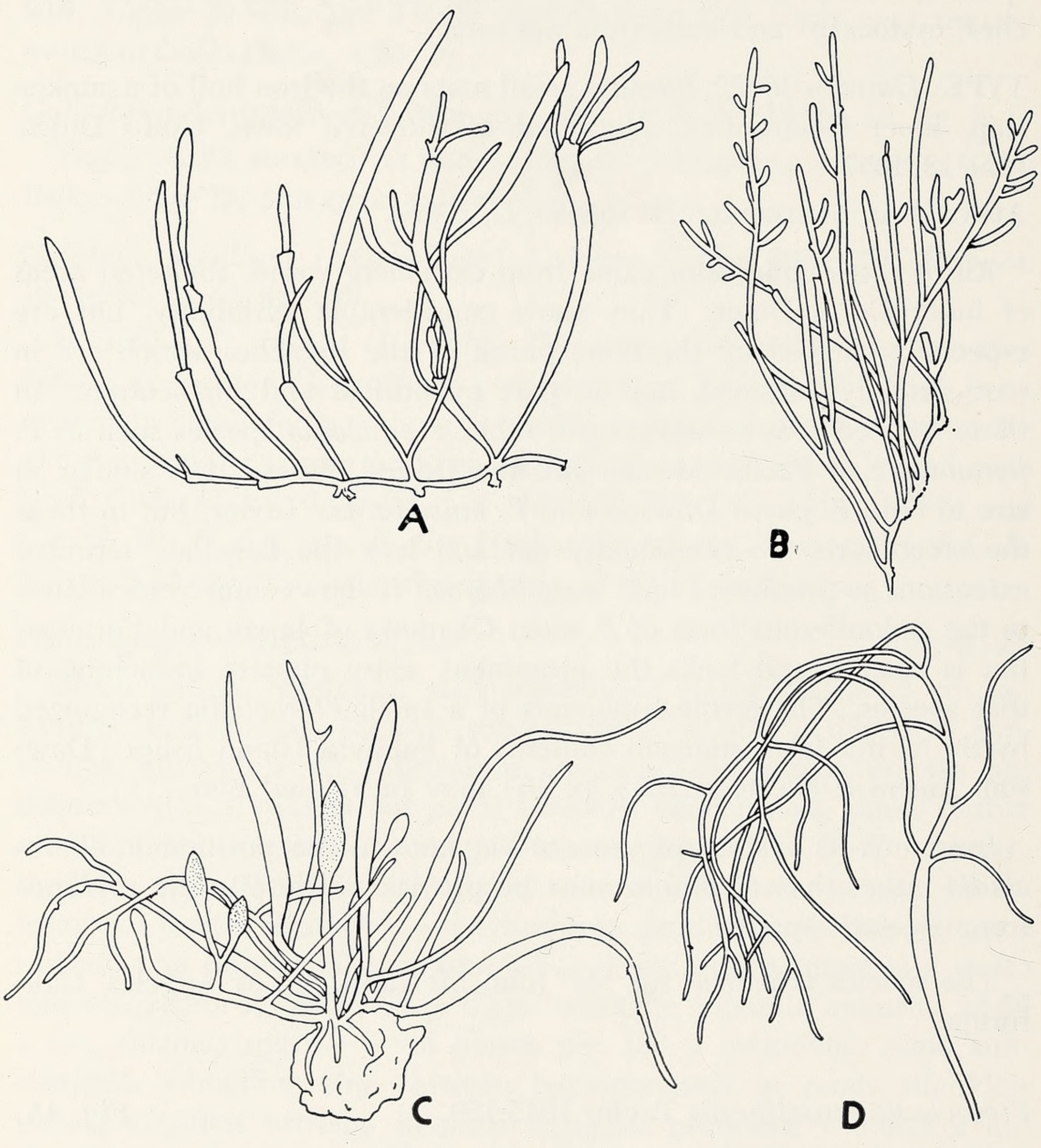

Fig. 4. A. *Pterocladia musciformis* Taylor, from the type collection, x 6.5. B. *Gelidiella machrisiana* Dawson, from the type collection, X 5. C-D. *Pterocladia mcnabbiana* Dawson, from the type collection, X 6.5.

turf with other small species. *Taylor 39-107*, below overhanging rocks near the entrance to Golfo Dulce, 3/26/39.

Gelidiella tenuissima Feldmann & Hamel

D. 16760; D. 16873?. The latter collection, growing on a chiton, seems to be almost intermediate between *G. tenuissima* and *G. myrioclada* Börgesen, but may best be referred to the former. It has tetrasporangial stichidia formed on short-stipitate branchlets. No terminal stichidia were observed.

Gelidiella machrisiana sp. nov. Fig. 4B.

Thalli penicillatim crebro fruticulosi, c. 1 cm. altitudine, e partibus repentibus cylindricis, ramos erectos efficientibus, constantes; rami erecti percurrentes compressi ad complanatos, primum simplices, deinde dimidiis in superioribus parce alterni pinnatim subdistiche breviter ramosi; ramis erectis 150-160 μ lat., 75-90 μ crass., ramis secondariis plerumque minoribus quam 1 mm. long., ad bases quasi contractis; apices subacuti, cellula apicali manifesta; transsectio structuram solidam uniformem cellularum parvarum satis isodiametricarum, cellulis extrorsus 5.5-6 μ diam., introrsus 7-8 μ diam., praebens; reproductio non visa.

Thalli densely tufted, about 1 cm. tall, consisting of subcylindrical, creeping parts giving rise to erect, compressed to flattened percurrent branches which are at first simple, then sparingly alternately, pinnately, subdistichously short-branched in their upper halves; erect branches 150-160 μ wide, 75-90 μ thick, the secondary branchlets mostly less than 1 mm. long, somewhat contracted at their bases; apices subacute, the apical cell prominent; transection showing a solid, uniform structure of small, more or less isodiametrical cells 5.5-6.0 μ in diameter toward the outside, 7-8 μ in diameter toward the center; reproduction not seen.

TYPE: *Dawson 16745*, on a shell fragment in a rock crevice about 1.5 m. above mean low water level, rocky shore on the southwest side of Bahía Ballena, Golfo de Nicoya, June 7, 1957.

The compressed to flattened percurrent, erect branches with their fairly regular alternate, distichous pinnae in the distal half are distinctive of this plant which seems amply different, despite the absence of reproductive material, from other species of *Gelidiella* heretofore described.

Caulacanthus sp. aff. *C. indicus* Weber van Bosse.

D. 16812 is sterile and poorly developed in a *Jania* turf so that it can be referred here only in doubt. The branches vary from 50 to 120 μ in diameter and, thus, tend to be somewhat larger than those of *C. indicus*, although the form and the presence of attachment discs correspond.

Hildenbrandia prototypus Nardo; Dawson 1953:95, pl. 7, fig. 4.

D. 16731; D. 16766; D. 16815; D. 16828.

Cruoriella fissurata Dawson 1953: 109, pl. 7, fig. 6, p. 24, fig. 1.

D. 16849 seems to be identical with the type from Cabeza Ballena, Baja California, Mexico. The species has been reported from as far south as Acapulco, Mexico.

Cruoriopsis mexicana Dawson 1953:99, pl. 10, fig. 11-14.

D. 16883. This material, in a mixture scraped from a rock, is tetrasporangial and is identical with the type described from Islas Los Coronados off northwesternmost Mexico. This represents the second collection of this species and a significant extension of range.

Peyssonelia conchicola Piccone & Grunow; Dawson 1953:105, pl. 11, fig. 12-13.

D. 16850 agrees with a specimen of this plant collected by the writer from Cape San Lucas, Baja California, Mexico and cited above.

Lithothamnium sp. cf. *L. heteromorphum* (Foslie) Foslie; Foslie 1929: 42, pl. 12, fig. 20.

D. 16695; D. 16778.

Lithophyllum sp. cf. *L. decipiens* (Foslie) Foslie; Mason 1953:338, pl. 40.

D. 16780.

Dermatolithon canescens (Foslie) Foslie; Dawson 1955:274.

D. 16754a; D. 16870. These are in good agreement with this species. The tetrasporangial conceptacles are 240-300 (325) μ in diameter; the hypothallus cells are 40-50 μ long. It has not previously been reported from the eastern Pacific.

Amphiroa beauvoisii Lamouroux; Hamel & Lemoine 1953: 42, pl. 5, fig. 1, 7, text fig. 7.

D. 16708 and *D. 16814* have four tiers of cells in the genicula. Their intergenicular medullas have in part exactly the pattern shown by Hamel and Lemoine, and in part 2-3 long cell-tiers alternating with 1 short. *D. 16867* has four tiers of cells in the genicula, but in the intergenicular medulla 4-5 tiers of long cells alternate with 1 short. *D. 16781* is more divergent in genicular structure with 6-7 tiers of cells, all of about the same length, but, despite this, it seems to agree with the other specimens, all of which best fall under this species.

Amphiroa taylorii Dawson 1953:138, pl. 26, fig. 1.

D. 16874 agrees well with the type from Isla Socorro, Mexico. *D. 16790* is also typical of the species in size, irregular diameter, genicula, size of conceptacles, branching habit, etc., but the presence of frequent discoid attachments between branches in the clumps were not previously noted in this species. The constrictions at the genicula are not as prominent either as in the type, and the density of the clumps is greater. Nevertheless, there are not sufficient apparent differences from *A. taylorii* to merit a separate taxonomic designation at this time. *D. 16709* seems to be a slender, lax form of this species. The genicula in the liquid preserved specimens are more prominent than in *D. 16790*, perhaps because of some decalcifying action of the formalin.

Amphiroa dimorpha Lemoine 1929:76, pl. 3, fig. 3-4, p. 4, fig. 6, text fig. 33. Taylor 1945:192, pl. 54 (as *Amphiroa polymorpha*).

Taylor 39-116B, mixed with *Amphiroa annulata* from tide pools near the entrance of Golfo Dulce, 3/26/39, has shown upon reexamination to be unlike the type of *A. polymorpha* and to be referable instead to *A. dimorpha.* The segments in part reach 2.5 mm. in width, but the material is not luxuriantly developed.

Amphiroa minutissima Taylor 1945:186, pl. 46, fig. 1.

Taylor 39-116C (TYPE), rare, littoral, Golfo Dulce, 3/26/39. Not again collected.

Amphiroa annulata Lemoine 1929:78, fig. 34, pl. 4, fig. 1; Taylor 1945: 188.

Taylor 39-116A, stunted, in tide pools near the entrance to Golfo Dulce, 3/26/39.

Amphiroa sp. cf. *A. annulata* var. *pinnata* Dawson 1953:137.

D. 16885. The unizonal genicula, size and habit are of *A. annulata*, but the suppression of dichotomous branching, the inconspicuous annulations, and short segments represent minor differences from the type of this species from the Galapagos Archipelago and seem to relate this collection more with the Mexican var. *pinnata.*

Jania tenella var. *tenella* Kützing; Dawson 1953:120, pl. 9, fig. 3.

D. 16802; D. 16787, close to this form; *D. 16875,* a slender form with ungulate tips.

Jania tenella var. *zacae* Dawson 1953:121, pl. 8, fig. 3, pl. 31, fig. 1.

D. 16718, growing on *Sargassum,* agrees well with the type from Bahía Piedra de Blanca, Costa Rica.

Jania capillacea Harvey; Dawson 1953:116, pl. 9, fig. 1.

D. 16748; D. 16757; D. 16808; D. 16852; D. 16859. These plants are common in the short turfs covering many sublittoral rocks. They are decussately branched and have segments 60-110 μ in diameter.

Jania longiarthra Dawson 1953:119, pl. 9, fig. 4, pl. 27, fig. 4.

D. 16755 compares favorably with this species known on the Pacific American coast from southern Baja California and from Sonora, Mexico.

Hypnea pannosa J. Agardh; Taylor 1945:227, pl. 71, fig. 2.

D. 16715; D. 16803.

Hypnea esperi Bory; Dawson 1954a: 436, fig. 46h-j.

D. 16762a, small amount in mixture; *D. 16787c,* tetrasporangial; *D. 16795,* tetrasporangial.

Hypnea sp.

D. 16864 is mostly of small diameter corresponding with *H. esperi,* but some main branches approach the size of *H. cervicornis* J. Ag. The habit suggests *H. cervicornis* as found by the writer in Viêt Nam on similar gravel and shell fragments.

Gracilaria crispata Setchell & Gardner 1924:753, pl. 22, fig. 7-10, pl. 44a; Dawson 1949b:26, pl. 8, fig. 4, pl. 9, fig. 4-10, pl. 10, fig. 5-7.

D. 16710 is a small fragment only, but is characteristic of this species and identical with material collected by Taylor, March 26, 1939, under number *39-105* from tide pools and friable rocks on the western side of the bay near the entrance of Golfo Dulce. The specimen was labeled "*?Rhodymenia californica* Kylin," but was not cited in publication.

?Gracilariopsis costaricensis Dawson 1949b:46, pl. 18, fig. 7-8, pl. 19, fig. 1, 2, 8.

D. 16844 is scant and sterile, so the determination is doubtful. The type of this species was dredged in Bahía Santa Elena.

Champia parvula (C. Agardh) Harvey; Dawson 1954a:443, fig. 52c.

D. 16703a, fragments only.

Antithamnion breviramosus Dawson var. *breviramosus*, Dawson 1949a: 14, fig. 28, 57.

D. 16806a.

Spyridia filamentosa (Wulfen) Harvey; Dawson 1954a:444, fig. 54i.

D. 16692 (small and poorly developed); *D. 16750; D. 16789; D. 16824; D. 16826; D. 16835.*

Pleonosporium globuliferum Levring 1941:647, fig. 19A-D.

D. 16729. This shows good agreement in size, morphology, and in the often incurved tips, but the decending rhizoids were not seen, and the plant seems to be out of its proper temperature range here. Nevertheless, the correspondence is so close that it seems best to refer this collection to the Juan Fernandez Island species.

Ceramium equisetoides Dawson 1944:320, pl. 51, fig. 1; Dawson 1950b: 128.

D. 16716b contains tetrasporangial and antheridial specimens.

Ceramium gracillimum var. *byssoideum* (Harvey) G. Mazoyer; Dawson 1954a:448, fig. 55e, f.

D. 16804c; D. 16866; D. 16756. The latter material, growing on a hydroid, contains antheridial, cystocarpic, and tetrasporangial plants. The tetrasporangia tend to be solitary and adaxial, but some range toward a whorled condition. These agree essentially with the plants treated by Dawson (1950b) as *C. masonii* Dawson and subsequently reduced. No gland cells are conspicuously evident. *D. 16759* has a stronger tendency to whorled tetrasporangia than does *D. 16756.*

Ceramium nakamurai Dawson 1954b:6. *Ceramium equisetoides* Nakamura 1950:157, fig. 1-2, non Dawson.

D. 16746 is tetrasporic and in excellent agreement with the Formosa type. The only apparent difference is the somewhat shorter nodal bands. *D. 16749b* is probably the same.

Ceramium marshallense Dawson 1957a:120, fig. 27a-b.

D. 16716a. The material is sterile but vegetatively seems to match well.

Ceramium mazatlanense Dawson 1950b:130, pl. 2, fig. 14-15.

D. 16841, tetrasporangial and cystocarpic; *D. 16843,* excellent tetrasporangial material in good agreement with this species.

Ceramium taylorii Dawson 1950b:127, pl. 2, fig. 13, pl. 4, fig. 31-33.

D. 16796 is sterile, but easily recognized as this species by its vegetative characters.

Ceramium vagabunde Dawson 1957a:121, fig. 27e; Dawson 1954b:6, pl. 4, fig. 2 (as *Ceramium* sp.).

D. 16808b, tetrasporangial plants creeping through *Jania* clumps.

Centroceras clavulatum (Agardh) Montagne; Smith 1944:328, pl. 84, fig. 5-6.

D. 16762b. This species is also mentioned by Taylor (1945:159) as occurring near the entrance of Golfo Dulce.

Cryptopleura sp.?

D. 16711 is too scant for identification, but seems to be this genus. When more material is available it should be compared with *Hymenena decumbens* Levring (1941).

Caloglossa leprieurii (Montagne) J. Agardh; Post 1943:127, fig. 3a-d.

D. 16838 seems to correspond well with *C. leprieurii* var. *hookeri* as illustrated by Post (1943:fig. 3a-d).

Dasya sp.

D. 16706a; D. 16728. These small, sterile plants, mostly under 1 cm. tall, do not seem to belong to any species previously recorded from the Pacific Coast, but are not adequate for description at this time. Their relatively coarse, corticated axes and short, spirally arranged pseudolaterals seem to relate them to *Dasya californica* Gardner, but the non-ascending character of these, their acute tips and shorter cells are different.

Heterosiphonia wurdemannii var. *laxa* Börgesen 1915-20:326, fig. 327; Dawson 1956:57, fig. 60.

D. 16697a; 16712; 16760a.

Polysiphonia mollis Hooker & Harvey; Cribb 1956:131, pl. 4, fig. 1-4, pl. 5, fig. 1-5.

D. 16716; D. 16725; D. 16749; D. 16800. This species is known in the literature as *P. snyderae* Kylin and as *P. tongatensis* Harvey.

Polysiphonia subtilissima Montagne; Tseng 1944b:70, pl. 1.

D. 16716c; D. 16721a; D. 16749a; D. 16797; D. 16869.

Digenia simplex (Wulfen) Agardh; Taylor 1945:297.

D. 16722 is luxuriantly developed; *D. 16862* is dwarfed. *Taylor 39-95*, common in tide pools near the entrance of Golfo Dulce, 3/26/39.

Lophosiphonia scopulorum (Harvey) Womersley; Cribb 1956:141. Dawson 1956:59, fig. 64; Taylor 1945:304 (as *Lophosiphonia villum*).

D. 16879, tetrasporangial. *Taylor 39-115,* forming mats attached to rocks in the deeper tide pools near the entrance to Golfo Dulce, 3/26/39.

Lophosiphonia reptabunda (Suhr) Cribb 1956:140, pl. 4, fig. 6-8.

D. 16738; D. 16739, tetrasporangial; *D. 16747; D. 16832.* These are apparently in satisfactory agreement with this species which is widely known in the literature as *Lophosiphonia obscura.*

Bostrychia simpliciuscula Harvey, ex J. Agardh; Tseng 1943:173, pl. 2, fig. 6-7.

D. 16764 is morphologically in good agreement with this species and from a characteristic habitat.

Bostrychia radicans (Montagne) Montagne.

D. 16817; D. 16818, D. 16831, tetrasporangial. These are like the photographs by Post (1955:353, pl. 15, fig. 1-2) of Nayarit, Mexico and El Salvador specimens identified as *B. radicans* f. *moniliforme.*

Bostrychia binderi Harvey; Tseng 1943:177, pl. 1, fig. 7-8; Post 1955: 359-361.

Taylor 39-98, from high cliff faces, but within reach of splash of waves, near the entrance to Golfo Dulce, 3/26/39. This was identified by Tseng in Taylor (1945:306) as *Bostrychia tenella,* but Post (1955) has reexamined the collection and called it *B. binderi.*

Herposiphonia secunda (Agardh) Ambronn; Börgesen 1930:111, fig. 45.

D. 16697c; D. 16706; D. 16721; D. 16791; D. 16803a; D. 16807; D. 16811.

Herposiphonia tenella (Agardh) Ambronn; Dawson 1954:452, fig. 59a.

D. 16726; D. 16761, both on *Padina.*

Herposiphonia subdisticha Okamura 1915, Icones III:199, pl. 146, fig. 11-18; Dawson 1944:334, pl. 49, fig. 2.

D. 16714.

?*Chondria lancifolia* Okamura 1934, Icones VII:43, pl. 323, fig. 1-10; Tseng 1945:166, pl. 2, fig. 5-7; Dawson 1957b:8.

D. 16710; D. 16713. These plants are very small, but seem well developed and very much like the Alijos Rocks, Mexico, material cited above. They are in good agreement with the species as illustrated by Tseng as a small form of *C. lancifolia,* but the size difference of both his and ours from the larger Japanese specimens is great. It is now considered probable that two different species may be involved, but more ample comparative collections are needed. The relationship of the structurally similar, but much larger sublittoral *C. platyclada* Taylor also needs clarification by additional Costa Rican collections.

Chondria repens Börgesen 1924:300, fig. 40; Dawson 1954:460, fig. 62d-e.

D. 16878 is a well developed specimen with erect, sterile parts to 1 cm. long and about 250 μ in diameter. Some tetrasporangia are present. It is somewhat more lax in sterile parts than is Börgesen's Easter Island type, but is otherwise in good agreement.

CYANOPHYTA[2]

Entophysalis conferta (Kützing) Drouet & Daily
D. 16763; D. 16768, both with *Lyngbya aestuarii.*

Calothrix crustacea Thuret
D. 16735 (with some *Hydrocoleum lyngbyaceum*); *D. 16743*

Calothrix pilosa Harvey
D. 16737

Isactis plana (Harvey) Thuret
D. 16730; D. 16733; D. 16734; D. 16872 (with *Lyngbya confervoides*)

Plectonema norvegicum Gomont
D. 16829

Symploca hydnoides Kützing
D. 16744

Hydrocoleum lyngbyaceum Kützing
D. 16735

Hydrocoleum glutinosum (Agardh) Gomont
D. 16827 (?;trichomes out of sheath); *D. 16830*

Amphithrix violacea (Kützing) Bornet & Flahault
D. 16732

Lyngbya gracilis (Meneghini) Rabenhorst
D. 16742, with *Lyngbya sordida*

[2] Determinations by Francis Drouet, and a set of specimens deposited at the Chicago Natural History Museum.

Lyngbya aestuarii (Mertens) Liebman

D. 16763; D. 16768 (both with *Entophysalis conferta*); *D. 16769* (with *Lyngbya semiplena*); *D. 16836; D. 16837.*

Lyngbya sordida (Zanardini) Gomont

D. 16742, with *Lyngbya gracilis*

Lyngbya semiplena (Agardh) J. Agardh

D. 16769, with *Lyngbya aestuarii*

Lyngbya confervoides Agardh

D. 16872, with *Isactis plana*

SUMMARY AND CONCLUSIONS

The collections here enumerated represent 108 species of which 14 are Cyanophyta, 16 Chlorophyta, 11 Phaeophyta, and 67 Rhodophyta. Apart from the Cyanophyta 51 species are of wide tropical or cosmopolitan distribution, while only six are, to this writing, known only from Costa Rica. Nineteen species, most of them of otherwise wide tropical distribution, are reported here for the first time from the Pacific Coast of North America, and 14 species previously known elsewhere along Pacific North America only from one or two collections are here given significant range extensions on this coast. Of particular significance are the following characteristics of the marine flora of the Costa Rican gulfs.

1. A generally poor diversity of species.

2. The presence of only a few species more than 2-3 cm. tall.

3. An apparent absence of marine phanerogams.

4. An extreme paucity of calcareous green algae and other members of the Siphonocladales.

5. The virtual absence of an intertidal algal flora except for Cyanophyta and members of the bostrychietum.

6. An extreme paucity of coral and of the vegetation usually associated with coral in the tropical Pacific.

TABLE 1

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1956 mean		83.2	82.4	83.6	84.2	82.5	82.9	82.8	82.1	81.8	79.3	80.9
1957 mean	81.5	81.3	82.3	83.8	85.4	85.4	85.2					
1956 max.		84.2	84.3	85.4	85.4	84.0	83.3	83.5	83.9	83.7	81.5	82.4
1957 max.	82.6	83.3	85.2	86.2	86.5	86.4	86.2					
1956 min.		82.4	79.3	81.2	82.8	81.2	80.7	81.7	80.3	79.6	77.8	79.5
1957 min.	80.2	78.2	78.8	80.2	84.2	84.1	84.4					

Surface water temperatures in Fahrenheit, Puntarenas Pier, Golfo de Nicoya. Monthly maxima and minima are taken from daily averages of eight readings from a recording thermograph at 3-hour intervals. Means are obtained by averaging these daily figures. Inasmuch as the bulb was located at a point 2 meters below mean low water, these values do not represent maxima for the immediate surface waters, especially in shoal areas such as those of Stations 6 and 12 in the Golfo Dulce where surface temperatures may commonly reach 95°F.

LITERATURE CITED

Börgesen, F.

1915-20. The marine algae of the Danish West Indies. Pt. 3. Rhodophyceae. Dansk Bot. Arkiv 3(1):1-504, 435 figs.

1924. Marine algae from Easter Island. In, C. Skottsberg, The natural history of Juan Fernandez and Easter Island 2(9):247-309. Almqvist & Wiksells, Uppsala.

1930. Marine algae from the Canary Islands . . . III. Rhodophyceae, Pt. III, Ceramiales. Danske Vidensk. Selsk. Biol. Meddel. 9(1):1-159, 59 figs.

1946. Some marine algae from Mauritius. An additional list of species to Part I. Chlorophyceae. Ibid. 20(6):1-64, 27 figs.

Chou, Ruth

1945. Pacific species of *Galaxaura*. I. Asexual types. Michigan Acad. Sci., Arts and Letters, Papers 30(1944):35-55, 11 pls.

1947. Pacific species of *Galaxaura*. II. Sexual types. Ibid. 31(1945):3-24, 13 pls.

Cribb, A. B.

1956. Records of marine algae from southeastern Queensland -II. *Polysiphonia* and *Lophosiphonia*. Univ. Queensland Papers, Dept. Bot. 3(16):131-147, 5 pls.

Dawson, E. Y.

1944. The marine algae of the Gulf of California. Allan Hancock Pacific Exped. 3(10):189-454, 47 pls.

1949a. Contributions toward a marine flora of the southern California Channel Islands, I-III. Allan Hancock Found. Publ., Occ. Papers (8):1-57, 15 pls.

1949b. Studies of northeast Pacific Gracilariaceae. Ibid. (9):1-105, 25 pls.

1950a. Notes on Pacific Coast Marine algae IV. Amer. Jour. Bot. 37(2): 149-158, fig. 1-29.

1950b. A review of *Ceramium* along the Pacific Coast of North America . . . Farlowia 4(1):113-138, 4 pls.

1953. Marine red algae of Pacific Mexico. Part I. Bangiales to Corallinaceae subf. Corallinoideae. Allan Hancock Pacific Exped. 17(1): 1-239, 33 pls.

1954a. Marine plants in the vicinity of the Institut Océanographique de Nhatrang, Viêt Nam. Pacific Sci. 8(4):373-469, 1 map, 63 figs.

1954b. The marine flora of Isla San Benedicto following the volcanic eruption of 1952-1953. Allan Hancock Found. Publ., Occ. Paper (16):1-13, 5 pls.

1955. A preliminary working key to the living species of *Dermatolithon*. pp. 271-277, in Essays in the natural sciences in honor of Captain Allan Hancock . . . Univ. Southern Calif. Press, Los Angeles.

1956. Some marine algae of the southern Marshall Islands. Pacific Sci. 10(1):25-66, 66 figs.

1957a. An annotated list of marine algae from Eniwetok Atoll, Marshall Islands. Ibid. 11(1):92-132, 33 figs.

1957b. Notes on eastern Pacific insular marine algae. Los Angeles Co. Mus. Contr. Sci. (8):1-8, 4 figs.

Dawson, E. Y., A. A. Aleem & B. W. Halstead

1955. Marine algae from Palmyra Island with special reference to the feeding habits and toxicology of reef fishes. Allan Hancock Found. Publ., Occ. Paper 17:1-39.

Egerod, Lois

1952. An analysis of the siphonous Chlorophycophyta . . . Calif. Univ., Pubs., Bot. 25:325-454, 14 pls.

Eubank, Lois

1946. Hawaiian representatives of the genus *Caulerpa*. Calif. Univ., Pubs., Bot. 18:409-432, 1 pl.

Feldmann, J. & G. Hamel

1934. Observations sur quelques Gelidiacées. Rev. Gén. de Bot. 46(1934): 528-550, 11 figs.

Foslie, M. H.

1929. Contributions to a monograph of the Lithothamnia. 60 pp., 75 pls. Aktietrykkeriet, Trondhjem.

Gepp, A. & Ethel Gepp

1911. Codiaceae of the Siboga Expedition. Siboga Expeditie, Monogr. 62. 150 pps., 22 pls. E. J. Brill, Leiden.

Grunow, A.

1915-16. Additamenta ad cognitionem Sargassorum. K. K. Zoolog.-Bot. Gesell., Verhandl. Wien 65:329-448; 66:1-48, 136-185.

Hamel, G. & Mme. P. Lemoine

1953. Corallinacées de France et d'Afrique du Nord. Mus. Natl. d'Hist. Nat. Paris, Arch. vii, 1:17-136, frontespiece and 23 pls., 83 text figs.

Lemoine, Mme. P.

1929. Les Corallinacées de l'Archipel des Galapagos et du Golfe de Panama. Mus. Natl. d'Hist. Nat., Paris, Arch. vi, 4:37-88, 4 pls., 35 text figs.

Levring, T.

1941. Die Meeresalgen der Juan Fernandez Inseln. In, C. Skottsberg, The natural history of Juan Fernandez and Easter Island 2(22):601-670, 5 pls. Almqvist & Wiksells, Uppsala.

Nakamura, Y.

1950. New ceramiums and campylaephoras from Japan. Hokkaido Univ., Inst. Alg. Res., Sci. Papers 3(2):155-172, 7 figs.

Okamura, K.

1915. Icones of Japanese algae 3:1-218, pls. 101-150. Tokyo.

1934. Icones of Japanese algae 7:1-79, pls. 301-345. Tokyo.

Papenfuss, G. F.

1943. Notes on algal nomenclature II. *Gymnosorus* J. Agardh. Amer. Jour. Bot. 30: 463-468, 15 figs.

Post, Erika

1943. Zur Morphologie und Okologie von Caloglossa. . . Archiv für Protistenkunde 96(2):123-220, 40 figs., 2 charts.

1955. Weitere Daten zur Verbreitung des Bostrychietum IV. Ibid., 100(3): 351-377, pls. 11-15.

Setchell, W. A.

1926. Tahitian algae . . . Calif. Univ. Publ., Bot. 12(5):61-142, 16 pls.

1937. The Templeton Crocker Expedition of the California Academy of Sciences, 1932. Number 34. Report on the Sargassums. Calif. Acad. Sci., Proc. iv, 22(5):127-158, 7 pls.

Setchell, W. A. et N. L. Gardner

1924. The marine algae. Expedition of the California Academy of Sciences to the Gulf of California in 1921. Calif. Acad. Sci., Proc. iv, 12:695-949, 77 pls.

1925. The marine algae of the Pacific Coast of North America. Part 3. Melanophyceae. Calif. Univ., Pubs., Bot. 8:383-898, 74 pls.

Smith, G. M.

1944. Marine algae of the Monterey Peninsula, California. 622 pp., 98 pls. Stanford Univ. Press, Stanford, Calif.

Svedelius, N.

1953. Critical studies on some species of *Galaxaura* from Hawaii. K. Vetensk.-Soc. i Upsala iv. 15(9):1-92, 70 figs.

Tanaka, T.

1952. The systematic study of Japanese Protoflorideae. Kagoshima Univ., Faculty Fish., Mem. 2(2):1-92, 23 pls.

Taylor, W. R.

1928. Marine algae of Florida with special reference to the Dry Tortugas. Carnegie Inst. Wash., Pub. 25(pub.379):1-219, 37 pls.

1945. Pacific marine algae of the Allan Hancock Expeditions to the Galapagos Islands. Allan Hancock Pacific Exped. 12:i-iv, 1-528, 3 figs., 100 pls.

Tseng, C. K.

1943. Marine algae of Hong Kong. III. The genus *Bostrychia.* Michigan Acad. Sci., Arts and Letters, Papers 28:165-183, 3 pls.

1944. Marine algae of Hong Kong. VI. The genus *Polysiphonia.* Ibid. 29:67-82, 4 pls.

1945. New and unrecorded marine algae of Hong Kong. Ibid. 30:157-171, 2 pls.

Vickers, Anna & Mary Helen Shaw

1908. Phycologica Barbadensis . . . 44 pp., 93 pls. Paul Klinksiek, Paris.