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# Observations on the Offshore Benthic Flora in the Gulf of Mexico off Pinellas County, Florida[1]

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The Floridian Plateau is that projection of North America which separates the deep water of the Atlantic Ocean from the deep water of the Gulf of Mexico (Vaughan, 1910). According to Cooke (1945) the Plateau includes both the State of Florida and an equally great or greater area that lies submerged in water less than 50 fathoms deep. Gunter (1929) called this submerged portion the Florida Shelf. The shelf width in the vicinity of Pinellas County is approximately 105 miles. The offshore slope is gradual in certain areas and at a distance of 40 miles offshore in the Gulf of Mexico the bottom may be under approximately 100 feet of water.

The present report contains a discussion of the benthic algal flora collected 9 - 20 miles offshore at depths from 35 - 60 feet. It is not known if attached algae occur to the offshore edge of the shelf, however, the fact that they are found so far offshore is significant. It is probable that algal growth will be found at distances further offshore and in water deeper than investigated at the present.

Several papers contain information on the marine algae of the Gulf coast of Florida. These are: Taylor (1928, 1936, 1954, 1954a), Nielsen and Madsen (1949, 1949a), Madsen and Nielsen (1950), Humm (1953), and Earle (1956). Humm (1956) listed algal records from inshore and offshore waters in an unpublished general check-list of the St. Georges Sound-Apalachee Bay region in northwest Florida. Excepting Humm (1956) and Taylor (1928), all the other papers cited here concern work confined to bay and close-shore waters.

*Acknowledgments.*—Sincere appreciation is accorded to Dr. H. J. Humm, Duke University, who identified *Halymenia pseudofloresia* and to Dr. G. J. Hollenberg, Hopkins Marine Station, for the identification of *Lophosiphonia scopulorum.* We thank Dr. P. C. Silva, University of Illinois, for the identification of material of *Codium.* The senior author is responsible for all other specific determinations. Dr. Robert N. Ginsburg, Shell Development Company geologist, kindly examined samples of the reef limestone. Appreciation is expressed for the use of unpublished water temperature data to the St. Petersburg Field Station, U.S. Fish and Wildlife Service. Mr. Bill May, Director, and Mr. John Finucane were most generous in allowing the use of this information. Dr. R. T. Kirk, St. Petersburg optometrist, kindly allowed us to use his boat for the purpose of our collecting.

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[2] Contribution No. 43.

## METHODS AND MATERIALS

The reef areas were located with the aid of a fathometer. SCUBA-type diving equipment was used in collecting, and thus we believe that adequate sampling was made at most stations. The first few collections are doubtfully representative as the perfection of the use of the diving gear was of prime concern. Algae collected by the junior author were incidental to the collection of fishes, but usually a concerted effort was made to obtain a thorough sample. The importance of the use of SCUBA equipment cannot be overemphasized, for it represents the contrast between visual observation and the aimless wanderings of the collecting dredge. Collection periods of one-half hour to two hours were allowed with the use of the diving equipment.

A small chipping hammer was used at times to aid in the removal of the more firmly attached plants. While in the water the collected algae were retained in a small-mesh nylon bag. Preservation was made in ten per cent formalin upon return to the boat.

Eight collections were made in 35 - 40 feet depths and 12 in 45 - 60 feet depths during a one year period. The collections have been lumped into these two depth ranges, owing to the assemblage of plants found in each. It is possible that further study will reveal a "continuum" of plant distribution from shallower depths to the deeper depths rather than the sharp difference in floral composition that is now evident.

Upon return to the laboratory the algae were identified and mounted on herbarium sheets for permanent retention in the Laboratory's herbarium. Thirty of the microscopic forms were unfortunately discarded after the identification (footnoted in Table II).

## DESCRIPTION OF THE HABITAT

Most of the stations were located 240° (magnetic) off Johns Pass, Madeira Beach. Some stations were made at 230°, 235° and 245° off Johns Pass, and one station was located 70° off the southern tip of Egmont Key, approximately 9 miles offshore. The 35 - 40 feet depths were located approximately 9 - 12 miles offshore, and the 45 - 60 feet depths were located approximately 13 - 20 miles offshore.

Three types of substrates were encountered. The first, a flat, shelly and sandy bottom, was generally unproductive, but this bottom type at one location at a depth of 40 feet was found to support a network of *Caulerpa sertularioides*. Collecting was not done on this type of bottom, owing to its general unproductiveness. The second type substrate, an artificial one, consisted of the metallic wrecks of ships. This type was observed to be receptive to algal colonization, and macroscopic red algae were much more abundant on these structures than on rocky reefs. The third type substrate, limestone reefs with heavy incrustations, supported an abundant and varied algal flora. These reefs rise on the average from three to four feet above the rubble and sandy bottom. Most of the collections were made on these reefs. Dr. Robert N.

Ginsburg described a sample of this limestone as a dolomitic calcarenite, possibly of Tertiary age. The area covered by individual reefs varied from a few hundred square feet to an estimated several thousand square feet.

The reefs occur in depths from about 15 feet at one-half mile offshore to a depth and distance as yet undetermined. Operators of fishing party boats report the sporadic occurrence of reef type silhouettes on their fathometers to distances of at least 50 miles out. Jordan (1952) reported a distinctive reef formation 100 miles northwest of Tampa Bay in depths of 18 - 30 fathoms. It is possible that these reefs are an extension of the same formations which we studied.

The reefs in the 15 feet depths were not studied because the turbidity of the water limited visibility to but a few feet or less.

The area surrounding those reefs studied was always covered by a very fine silt which was easily disturbed and would obscure the area, requiring several minutes to clear. This silt was more abundant at the shallower depths. Rubble of shell and pieces of limestone surrounded the reefs. A very soapy type limestone was once noticed under this rubble.

A portion of the material incrusting a reef was examined in the laboratory. The structure was found to consist of an unknown black organic crust overlying a pink crust of *Lithothamnion syntrophicum* which was in cystocarpic state. This algal crust was solid but was also present as flecks to a depth of 4 mm from the surface. Other organic material found in the upper 4 mm were: filamentous red and blue-green algae, bryozoans, and worm tubes. In some parts the rock was riddled by the tubes of polychaetous annelids and pholadids. Major incrusting forms on the reefs also included the mollusks *Arca* and *Spondylus,* and a number of alcyonarians and small hard corals.

Bottom detritus was dissolved in nitric acid. A residue remained which consisted of sand-like particles 105 - 210$\mu$ in diameter, with a few particles ranging from 1300 - 1400$\mu$ in diameter. A very minute portion of the residue appeared to be organic in nature.

Although no Secchi disc readings were made, it was observed that the water was always much clearer in the 45 - 60 feet depths than in the 35 - 40 feet depths. This is related to the more abundant accumulation of silt around the reefs in the shallower depths and the fact that deeper waters are less subject to turbulence. Lateral visibility in the shallower depths was estimated to be about 10 - 20 feet. Once during a period of 20 mph northwest winds visibility was less than one foot on the bottom at 35 feet. In depths of 45 - 60 feet the lateral visibility was about 35 - 40 feet and never was as poor as in the 35 - 40 feet depths.

The St. Petersburg Field Station, U. S. Fish and Wildlife Service, initiated monthly hydrographic sampling stations in the Gulf of Mexico west of Egmont Key in October, 1958. Egmont Key is approximately 11 miles south of Johns Pass. Both surface and bottom temperatures, taken during the study, were generously contributed for use in this paper. During the period of October, 1958, through September, 1959, the month of coldest water was January. In this month the surface reading was 13.7°C. and 15.8°C. in approximately 35 feet of water, 10 miles west of Egmont Key; at 20 miles west of the Key, in approximately 55 feet of water in January, 1959, the surface reading was 15.2°C. and 16.5°C. at the bottom. The warmest month was July, 1959. At 10 miles offshore the surface reading was 30.6°C. and was 30.6°C. in 35 feet of water; at 20 miles offshore the surface reading was 30.2°C. and 30.1°C. in 55 feet of water. The most conspicuous element in this data is the lack of differential between surface and bottom temperatures in both depths throughout the year. The temperatures were taken in the field by a Whitney Thermistor, a continuous recording device. Because of the lack of information on bottom water temperatures in the Gulf of Mexico, the temperatures recorded for the two above described locations will be listed in Table I.

A surface current of about 2 mph was usually present in the area studied. When present the direction of the current was always toward the north.

## RESULTS

The species list and data are given in Table II. The following abbreviations are used to denote abundance: V — very common, U — uncommon, C—common, R— rare. A blank in this column indicates that no observations were made.

All plants were either attached to the bottom, to other algae, or occurred entangled among other algae.

A total of 158 taxa of algae were obtained. Of these, eight were

TABLE I.—Water temperatures (unpublished data from St. Petersburg Field Station, U.S. Fish and Wildlife Service)

| | 35 feet deep | | 55 feet deep | |
|---|---|---|---|---|
| Date | Surface | Bottom | Surface | Bottom |
| Oct. 1958 | 29.0 | 29.0 | 29.0 | 29.0 |
| Nov. 1958 | 23.0 | 23.0 | 24.5 | 25.1 |
| Dec. 1958 | 21.5 | 21.9 | 22.3 | 22.6 |
| Jan. 1959 | 13.7 | 15.8 | 15.2 | 16.5 |
| Feb. 1959 | 19.4 | 19.0 | 21.0 | 17.0 |
| Mar. 1959 | 18.7 | 18.7 | 20.4 | 20.1 |
| Apr. 1959 | 20.7 | 20.0 | 20.1 | 19.4 |
| May 1959 | 23.9 | 23.6 | 23.9 | 22.0 |
| Jun. 1959 | 27.9 | 27.8 | 27.5 | 26.6 |
| Jul. 1959 | 30.6 | 30.6 | 30.2 | 30.1 |
| Aug. 1959 | 28.9 | 28.9 | 29.4 | 29.8 |
| Sep. 1959 | 27.9 | 28.1 | 28.1 | 27.8 |

identified only to genus and one only to the family because the specimens lacked critical taxonomic characters.

Ninety-five taxa were found at the 35 - 40 feet stations, of which seven were identified only to genus. One hundred and eleven taxa were found at the 45 - 60 feet stations of which six were identified only to genus and one only to the family.

Species found only on the metal wrecks are footnoted in Table II. *Caulerpa sertularioides* was found on sand on June 18, 1958. All other collections came from the limestone reefs.

TABLE II.—Species list

| Species | Depth —feet | Date | Abundance | Epiphyte | Reproductive state |
|---|---|---|---|---|---|
| *CYANOPHYCEAE* | | | | | |
| *Anacystis marina* Dr. & Daily[1] | 55-60 | 5-X-58 | R | * | |
| **Calothrix pilosa* Harv.[3] | 40 | 7-XII-58 | U | * | |
| **Hydrocoleum penicillatum* Taylor[2] | 50 | 2-V-59 | C | * | |
| *Lyngbya confervoides* C. Ag.[2] | 60 | 9-VIII-58 | | * | |
| *L. gracilis* (Menegh.) Rab. | 35 | 8-II-59 | C | * | |
| | 55 | 31-I-59 | V | * | |
| | 55-60 | 5-X-58 | V | * | |
| *L. majuscula* Harv.[2] | 35 | 17-VIII-58 | | * | |
| | 55 | 7-X-58 | | * | |
| | 55-60 | 21-X-58 | V | * | |
| **L. meneghiniana* Kutz. Gom. | 38 | 14-II-58 | C | * | |
| *L. mittsii* Phillips | 40 | 7-XII-58 | V | * | |
| **L. rosea* Taylor[3] | 60 | 9-IX-58 | | * | |
| *L. sordida* (Zanard.) Gom. | 35 | 3-I-59 | C | * | |
| | 35 | 8-II-59 | U | * | |
| | 38 | 14-II-59 | U | * | |
| | 40 | 7-XII-58 | U | * | |
| *L. sordida* fa. *bostrychicola* (Crouan) Gom.[1] | 55-60 | 5-X-58 | U | * | |
| *Mastigocoleus testarum* Lagerheim[2] | 38 | 14-II-59 | V | | |
| | 55 | 31-I-59 | U | | |
| *Microcoleus chthonoplastes* (Fl. Dan.) Thur. | 40 | 7-XII-58 | U | * | |
| *Phormidium papyraceum* (C. Ag.) Gom. | 50 | 2-V-59 | C | * | |
| *P. submembranaceum* (Ard. et Straff.) Gom.[3] | 45-50 | 23-XI-58 | U | * | |
| *Plectonema nostocorum* Born. | 38 | 14-II-59 | V | * | |
| | 40 | 7-XII-58 | V | * | |
| | 55-60 | 5-X-58 | C | * | |

TABLE II.—(continued)

| Species | Depth —feet | Date | Abundance | Epiphyte | Reproductive state |
|---|---|---|---|---|---|
| *Skujaella thiebautii* DeToni[3] | 45 | 29-VI-58 | C | | |
| *Spirulina subsalsa* Oerstedt fa. *oceanica* (Crouan) Gom.[1, 2] | 55-60 | 5-X-58 | U | * | |
| *CHLOROPHYCEAE* | | | | | |
| *Acetabularia crenulata* Lamx.[2] | 40 | 18-VI-58 | | | |
| **Avrainvillea asarifolia* Børgs.[1] | 55-60 | 5-X-58 | | | |
| **A. nigricans* Decaisne | 55 | 7-IX-58 | | | |
| **Bryopsis plumosa* (Huds.) C. Ag. | 35 | 7-II-59 | R | * | |
| *Caulerpa crassifolia* (C. Ag.) J. Ag. fa. *mexicana* (Sonder) J. Ag. | 38 | 14-II-59 | U | | |
| | 45 | 29-VI-58 | | | |
| *C. crassifolia* (C. Ag.) J. Ag. fa. *typica* (Weber) Børgs. | 40 | 7-XII-58 | | | |
| | 55 | 7-IX-59 | | | |
| | 55-60 | 5-X-58 | | | |
| *C. cupressoides* (West) C. Ag. var. *elegans* (Crouan) Weber | 45-50 | 23-XI-58 | U | | |
| *C. paspaloides* (Bory) Grev. var. *typica* Weber. | 35 | 13-VII-58 | | | |
| *C. peltata* (Turn.) Lamx. | 60 | 19-VIII-58 | | | |
| | 55 | 7-IX-58 | | | |
| | 55-60 | 21-IX-58 | | | |
| | 55-60 | 5-X-58 | | | |
| *C. prolifera* (Førsskal) Lamx. | 35 | 13-VII-58 | | | |
| *C. sertularioides* (Gmel.) Howe | 40 | 18-VI-58 | | | |
| | 35 | 13-VII-58 | | | |
| | 39 | 19-XI-58 | V | | |
| | 40 | 7-XII-58 | U | | |
| | 55 | 31-I-59 | | | |
| | 60 | 9-VIII-58 | | | |
| | 55 | 7-IX-58 | | | |
| | 55-60 | 5-X-58 | | | |
| *C. sertularioides* (Gmel.) Howe fa. *brevipes* (J. Ag.) Sved. | 38 | 19-II-59 | U | | |

TABLE II.—(continued)

| Species | Depth —feet | Date | Abundance | Epiphyte | Reproductive state |
|---|---|---|---|---|---|
| *C. sertularioides* (Gmel.) Howe fa. *longipes* (C. Ag.) Collins | 38 | 19-II-59 | U | | |
| | 50 | 2-V-59 | R | | |
| **Cladophora glaucescens* (Griff.) Harv. | 35 | 13-VII-58 | | * | |
| *Codium isthmocladum* Vick. | 35 | 8-II-59 | | | |
| | 38 | 19-II-59 | V | | |
| | 35 | 17-VIII-58 | | | |
| | 39 | 9-XI-58 | R | | Gametangia |
| | 40 | 7-XII-58 | U | | Gametangia |
| | 55 | 31-I-59 | R | | |
| | 50 | 2-V-59 | U | | |
| | 60 | 9-VIII-58 | | * | |
| | 55 | 7-IX-58 | | | |
| | 55-60 | 21-IX-58 | | | |
| | 55-60 | 5-X-58 | | * | |
| **C. repens* ? (Crouan) Vick | 35 | 8-II-59 | | | |
| | 60 | 25-IV-59 | R | | |
| | 50 | 2-V-59 | R | | |
| *C. taylori* Silva | 35 | 8-II-59 | | | |
| | 35 | 13-VII-58 | | | |
| | 35 | 17-VIII-58 | | | |
| **Derbesia vaucheriaeformis* (Harv.) J. Ag.[1] | 35 | 17-VIII-58 | U | * | |
| *Entocladia wittrockii* Wille | 40 | 7-XII-58 | V | * | |
| **Ernodesmus verticillata* (Kutz.) Børgs.[2,3] | 40 | 7-XII-58 | R | * | |
| *Halimeda discoidea* Decaisne | 55 | 7-IX-58 | | | |
| **H. opuntia* (L.) Lamx. var. *typica* Barton | 40 | 18-VI-58 | | | |
| | 55 | 27-IV-58 | U | | |
| **H. scabra* Howe | 35 | 13-VII-58 | | | |
| | 39 | 9-XI-58 | C | | |
| | 40 | 7-XII-58 | V | | |
| | 55 | 31-I-59 | V | | |
| | 58 | 9-IV-59 | V | | |
| | 60 | 25-IV-58 | V | | |
| | 55 | 27-IV-58 | C | | |
| | 50 | 2-V-59 | V | | |
| | 48 | 24-V-59 | V | | |
| | 60 | 9-VIII-58 | C | | Sporangia |
| | 55 | 7-IX-58 | | | |
| | 55-60 | 5-X-58 | | | |
| | 45-50 | 23-XI-58 | V | | |

TABLE II.—(continued)

| Species | Depth —feet | Date | Abundance | Epiphyte | Reproductive state |
|---|---|---|---|---|---|
| *Penicillus capitatus* Lamarck[2] | 60 | 9-VIII-58 | | | |
| | 55 | 7-IX-58 | | | |
| Unidentified species of Chaetophoraceae[4] | 55 | 27-IV-58 | U | | |
| **Rhipocephalus oblongus* (Decaisne) Kutz.[2] | 40 | 18-VI-58 | | | |
| | 60 | 9-VIII-58 | | | |
| | 55-60 | 5-X-58 | | | |
| **R. phoenix* (E. & S.) Kutz. fa. *typicus* Gepp. | 55 | 31-I-59 | | | |
| | 58 | 9-IV-59 | C | | |
| | 60 | 25-IV-58 | V | | |
| | 50 | 2-V-59 | V | | |
| | 48 | 24-V-59 | V | | |
| | 45 | 29-VI-58 | | | |
| | 55 | 7-IX-58 | | | |
| | 45-50 | 23-XI-58 | | | |
| *Rhizoclonium kerneri* Stockmayer | 35 | 8-II-59 | R | * | |
| | 55 | 31-I-59 | C | * | |
| | 60 | 25-IV-59 | R | * | |
| *Udotea conglutinata* (Solander) Lamx. | 40 | 18-VI-58 | | | |
| | 35 | 13-VII-58 | | | |
| | 50 | 2-V-59 | U | | |
| | 48 | 24-V-59 | U | | |
| | 60 | 9-VIII-58 | | | |
| | 55 | 7-IX-58 | | | |
| *U. flabellum* (E. & S.) Howe | 58 | 11-IV-59 | U | | |
| | 55 | 7-IX-58 | | | |
| | 55-60 | 5-X-58 | | | |
| **U. spinulosa* Howe | 50 | 2-V-59 | U | | |
| **Valonia macrophysa* Kutz. | 60 | 25-IV-59 | U | | |
| | 55-60 | 5-X-58 | | | |
| *PHAEOPHYCEAE* | | | | | |
| *Dictyopteris delicatula* Lamx.[1, 2, 3] | 55-60 | 5-X-58 | R | | |
| *Dictyota cervicornis* Kutz. | 55 | 7-IX-58 | R | | |
| | 55-60 | 5-X-58 | R | | |
| *D. dichotoma* (Huds.) Lamx. | 50 | 2-V-59 | R | | Tetrasporic |
| | 60 | 9-VIII-58 | | | |
| **D. divaricata* Lamx. | 55-60 | 21-IX-58 | R | | |
| | 45-50 | 23-XI-58 | C | * | |

TABLE II.—(continued)

| Species | Depth —feet | Date | Abundance | Epiphyte | Reproductive state |
|---|---|---|---|---|---|
| *Dictyota* sp. | 35 | 13-VII-58 | R | * | |
| | 55 | 7-IX-58 | R | | |
| **Dilophus alternans* J. Ag.[3] | 40 | 7-XII-58 | R | | |
| *Ectocarpus duchassaingianus* Grun.[2] | 40 | 18-VI-58 | | * | Pleurilocular sporangia |
| *Ectocarpus* sp. | 40 | 18-VI-58 | V | | |
| | 45 | 24-VI-58 | V | | |
| **Eudesme howei* Taylor[3] | 40 | 18-VI-58 | | * | Sporangia |
| *E. zosterae* (J. Ag.) Kylin[3] | 50 | 2-V-59 | R | * | |
| *Padina vickersiae* Hoyt[3] | 40 | 18-VI-58 | | | Antheridia & oogonia |
| *Sargassum filipendula* C. Ag. | 35 | 3-I-59 | V | | |
| | 35 | 8-II-59 | C | | |
| | 38 | 14-II-59 | V | | |
| | 39 | 9-XI-58 | V | | |
| | 40 | 7-XII-58 | U | | |
| | 55 | 21-I-59 | U | | |
| | 55 | 27-IV-58 | C | | |
| | 58 | 11-IV-59 | C | | |
| | 50 | 2-V-59 | V | | |
| *S. filipendula* C. Ag. var. *montagnei* (Bailey) Coll. & Hervey | 35 | 8-II-59 | U | | |
| *S. hystrix* J. Ag. var. *buxifolium* (Chauvin) J. Ag. | 60 | 9-VIII-58 | | | |
| | 55-60 | 21-IX-58 | | | |
| *S. lendigerum?* (L.) C. Ag. | 58 | 11-IV-59 | U | | |
| | 55-60 | 5-X-58 | | | |
| **S. vulgare* C. Ag. | 45-50 | 23-XI-58 | U | | |
| **Spatoglossum schroederi* (Mart.) J. Ag. | 35 | 14-II-59 | U | | |
| | 38 | 14-II-59 | U | | |
| *Sphacelaria furcigera* Kutz.[3] | 45-50 | 23-XI-58 | U | | |
| *RHODOPHYCEAE* | | | | | |
| *Acrochaetium avrainvilleae* Børgs. | 40 | 7-XII-58 | V | * | Monospores |
| *A. flexuosum* Vick. | 35 | 3-I-59 | C | * | Monospores |
| *A. netrocarpum* Børgs. | 40 | 18-VI-58 | | * | |
| *A. phacelorhizum* Børgs.[3] | 55 | 31-I-59 | U | * | |
| *A. seriatum* Børgs.[3] | 35 | 8-II-59 | V | * | Monospores |
| | 38 | 14-II-59 | C | * | Monospores |
| *A. unipes* Børgs. | 55 | 27-IV-58 | U | * | Monospores |

TABLE II.—(continued)

| Species | Depth —feet | Date | Abundance | Epiphyte | Reproductive state |
|---|---|---|---|---|---|
| *Acrochaetium* sp. | 35 | 13-VII-58 | | * | |
| | 60 | 25-IV-59 | C | * | |
| | 50 | 2-V-59 | C | * | |
| | 45 | 29-VI-58 | | * | |
| *Acrochaetium* sp. | 50 | 2-V-59 | C | * | |
| *Agardhiella tenera* (J. Ag.) Schmitz | 38 | 14-II-59 | C | | |
| | 35 | 13-VII-58 | | | |
| | 35 | 17-VIII-58 | | | |
| | 39 | 9-XI-58 | | | |
| **Amphiroa fragilissima* (L.) Lamx. | 55 | 7-IX-58 | | | Cystocarpic |
| **A. rigida* Lamx. var. *antillana* Børgs. | 60 | 9-VIII-58 | | | |
| *Botryocladia occidentalis* (Børgs.) Kylin | 38 | 14-II-59 | U | | |
| | 35 | 17-VIII-58 | | | |
| | 39 | 9-XI-58 | U | | Cystocarpic |
| | 40 | 7-XII-58 | | | |
| | 48 | 14-V-59 | U | | |
| | 55-60 | 5-X-58 | C | | |
| *Callithamnion byssoides* Arnott[3] | 35 | 3-I-59 | C | * | |
| | 48 | 31-I-59 | U | * | |
| *C. cordatum* ? Børgs.[1, 3] | 55-60 | 5-X-58 | | * | |
| *C. roseum* (Roth.) Harv.[3] | 55-60 | 21-IX-58 | | * | |
| *Callithamnion* sp. | 35 | 17-VIII-58 | | * | |
| | 55 | 7-IX-58 | | * | |
| *Ceramium byssoideum* Harv.[2] | 40 | 7-XII-58 | V | * | |
| *C. codii* (Richards) Mazoyer | 35 | 3-I-59 | U | * | |
| | 39 | 9-XI-58 | C | * | |
| | 40 | 7-XII-58 | C | * | Tetrasporic |
| | 55 | 31-I-59 | U-C | * | |
| | 60 | 25-IV-59 | C | * | |
| | 50 | 2-V-59 | V | * | Tetrasporic |
| **C. corniculatum* Mont. | 39 | 9-XI-58 | C | * | |
| | 55-60 | 5-X-58 | V | * | |
| *C. deslongchampsii* Chauvin[3] | 45 | 29-VI-58 | | * | |
| *C. fastigiatum* (Roth) Harv. fa. *flaccidum* H. G. Petersen | 40 | 18-VI-58 | | * | Tetrasporic |
| **C. floridanum* J. Ag. | 55-60 | 21-IX-58 | | * | |
| *C. subtile* J. Ag.[2, 3] | 55 | 31-I-59 | C | * | |

TABLE II.—(continued)

| Species | Depth —feet | Date | Abundance | Epiphyte | Reproductive state |
|---|---|---|---|---|---|
| *C. tenuissimum* (Lyngbye) J. Ag. | 35 | 3-I-59 | R | * | |
| | 38 | 14-II-59 | V | * | Tetrasporic |
| | 40 | 18-VI-58 | | * | Tetrasporic |
| | 35 | 13-VII-58 | | * | |
| | 55 | 31-I-59 | C | * | |
| | 50 | 2-V-59 | U | * | |
| | 48 | 24-V-59 | U | * | |
| | 60 | 9-VIII-58 | | * | |
| | 55 | 7-IX-58 | V | * | |
| *Champia parvula* (C. Ag.) Harv. | 35 | 3-I-59 | | * | |
| | 35 | 8-II-59 | R | * | |
| | 40 | 18-VI-58 | | * | |
| | 35 | 17-VIII-58 | U | * | |
| | 39 | 9-XI-58 | | * | |
| | 40 | 7-XII-58 | U | * | |
| | 50 | 2-V-59 | R | * | |
| | 60 | 9-VIII-58 | | * | Cystocarpic |
| | 55 | 7-IX-58 | | * | |
| *Chondria dasyphylla* (Woodward) C. Ag.[2, 3] | 40 | 18-VI-58 | | | Cystocarpic |
| *Chrysymenia enteromorpha* Harv. | 50 | 2-V-59 | R | | |
| *Crouania attenuata* (Bonne.) J. Ag. | 35 | 3-I-59 | U | * | Tetrasporic |
| | 60 | 9-VIII-58 | | * | Cystocarpic, antheridial |
| | 55 | 7-IX-58 | | * | Tetrasporic |
| *Dasyopsis antillarum* Howe[3] | 38 | 14-II-59 | R | | Tetrasporic |
| *Digenia simplex* (Wulf.) C. Ag.[2] | 60 | 25-IX-59 | U | | |
| **Dudresnaya caribaea* (J. Ag.) Setch.[3] | 40 | 18-VI-58 | | * | Cystocarpic |
| *Erythrocladia subintegra* Rosenvinge | 38 | 14-II-59 | C | * | |
| | 40 | 7-XII-58 | C | * | |
| | 55-60 | 5-X-58 | C | * | |
| *Erythrotrichia carnea* (Dillw.) J. Ag. | 35 | 3-I-59 | R | * | |
| | 35 | 8-II-59 | R | * | |
| | 38 | 14-II-59 | C | * | |
| | 40 | 18-VI-58 | | * | |
| | 35 | 13-VII-58 | | * | |
| | 40 | 7-XII-58 | R | * | |

TABLE II.—(continued)

| Species | Depth —feet | Date | Abundance | Epiphyte | Reproductive state |
|---|---|---|---|---|---|
| | 60 | 25-IV-59 | U | * | |
| | 55 | 27-IV-58 | C | * | |
| | 50 | 2-V-59 | U | * | |
| *Eucheuma ancanthocladum* (Harv.) J. Ag. | 35 | 13-VII-58 | | | |
| **E. isiforme* (C. Ag.) J. Ag. | 35 | 8-II-59 | C | | Cystocarpic |
| | 38 | 14-II-59 | U | | |
| | 35 | 17-VIII-58 | | | |
| | 39 | 9-XI-58 | R | | |
| | 40 | 7-XII-58 | U | | |
| | 55-60 | 21-IX-58 | | | |
| | 55-60 | 5-X-58 | | | |
| | 45-50 | 23-XI-58 | | | |
| *Fosliella farinosa* (Lamx.) Howe var. *solmsiana* (Falkenberg) Taylor[1, 2] | 55-60 | 5-X-58 | V | * | |
| *F. lejolisii* (Rosanoff) Howe | 35 | 3-I-59 | V | * | Cystocarpic |
| | 35 | 8-II-59 | V | * | |
| | 38 | 14-II-59 | V | * | Cystocarpic |
| | 40 | 18-VI-58 | | * | |
| | 39 | 9-XI-58 | | * | Cystocarpic |
| | 40 | 7-XII-58 | C | * | |
| | 55 | 31-I-59 | V | * | |
| | 60 | 25-IV-59 | V | * | |
| | 50 | 2-V-59 | V | * | |
| | 60 | 9-VIII-58 | | * | |
| | 55 | 7-IX-58 | | * | |
| | 45-50 | 23-XI-58 | V | * | Cystocarpic |
| *Gelidium pusillum* (Stackhouse) LeJolis[1, 2, 3] | 55-60 | 5-X-58 | | | |
| *Goniolithon decutescens* (Heydrich) Foslie[2] | 60 | 9-VIII-58 | | | |
| **G. solubile* Foslie & Howe[2] | 35 | 8-II-59 | C | | |
| | 50 | 2-V-59 | V | | Cystocarpic |
| *Goniotrichum alsidii* (Zanard.) Howe | 38 | 14-II-59 | R | * | |
| | 50 | 2-V-59 | C | * | |
| **Gracilaria bursa-pastoris* (Gmel.) Silva | 40 | 7-XII-58 | U | | Cystocarpic |
| **G. cervicornis* (Turn.) J. Ag.[1] | 55-60 | 5-X-58 | C | | Cystocarpic, tetrasporic |
| *G. cornea* J. Ag.[2] | 60 | 9-VIII-58 | | | |
| | 55 | 7-IX-58 | | | |

TABLE II.—(continued)

| Species | Depth —feet | Date | Abundance | Epiphyte | Reproductive state |
|---|---|---|---|---|---|
| **G. curtissiae* J. Ag. | 60 | 9-VIII-58 | | | |
| **G. cylindrica* Børgs.[1] | 55-60 | 5-X-58 | | | |
| *G. ferox* J. Ag. | 38 | 14-II-59 | U | | |
| | 40 | 7-XII-58 | U | | |
| | 55-60 | 5-X-58 | V | | Cystocarpic |
| **G. mamillaris* | | | | | |
| (Mont.) Howe | 35 | 17-VIII-58 | | | |
| | 40 | 7-XII-58 | U | | |
| *G. verrucosa* | | | | | |
| (Huds.) Papenf. | 35 | 13-VII-58 | | | |
| *Gracilaria* sp. | 38 | 14-II-59 | | | |
| **Griffithsia* | | | | | |
| *globulifera* Harv. | 35 | 3-I-59 | R | * | |
| | 35 | 8-II-59 | U | * | |
| | 40 | 7-XII-58 | R | * | |
| | 60 | 9-VIII-58 | | * | Tetrasporic |
| | 55 | 7-IX-58 | | * | Tetrasporic |
| | 45-50 | 23-XI-58 | R | * | |
| *Grinnellia americana* | | | | | |
| (C. Ag.) Harv. var. | | | | | |
| *caribaea* Taylor | 38 | 14-II-59 | C | | Tetrasporic |
| *Halymenia agardhii* DeToni | 35 | 13-VII-58 | | | |
| *H. floresia* | | | | | |
| (Clemente) C. Ag. | 35 | 13-VII-58 | | | |
| | 60 | 9-VIII-58 | | | |
| | 55 | 7-IX-58 | | | |
| *H. gelinaria* | 55-60 | 21-IX-58 | | | |
| Collins & Howe | 39 | 9-XI-58 | R | | |
| | 40 | 7-XII-58 | R | | |
| | 55-60 | 21-IX-58 | | | Cystocarpic |
| *H. pseudofloresia* | | | | | |
| Collins & Howe | 38 | 14-II-59 | U | | |
| | 35 | 13-VII-58 | | | |
| | 55-60 | 5-X-58 | C | | |
| **Hildenbrandtia* | | | | | |
| *prototypus* Nardo[2] | 60 | 25-IV-59 | C | | |
| | 55-60 | 5-X-58 | V | | |
| **Hypoglossum tenui-* | | | | | |
| *folium* (Harv.) J. Ag. | 60 | 9-VIII-58 | | | Tetrasporic |
| **Jania adhaerens* Lamx. | 40 | 18-VI-58 | | * | Cystocarpic |
| | 60 | 25-IV-59 | U | | |
| | 60 | 9-VIII-58 | | * | Cystocarpic |
| *J. capillacea* Harv.[3] | 40 | 7-XII-58 | C | * | |
| *J. pumila* Lamx.[2, 3] | 40 | 7-XII-58 | C | * | |
| *Laurencia gemmifera* | | | | | |
| Harv. | 50 | 2-V-59 | | * | Tetrasporic |
| | 60 | 9-VIII-58 | | | |

TABLE II.—(continued)

| Species | Depth —feet | Date | Abundance | Epiphyte | Reproductive state |
|---|---|---|---|---|---|
| *L. intricata* Lamx. | 55 | 7-IX-58 | | | |
| *L. obtusa* (Huds.) Lamx. | 55 | 31-I-59 | | | |
| **L. papillosa* (Førsskal) Grev.[2] | 38 | 14-II-59 | R | | |
| | 60 | 25-IV-59 | C | | |
| | 55 | 27-IV-58 | R | | |
| *L. poitei* (Lamx.) Howe | 40 | 18-VI-58 | | | |
| | 40 | 7-XII-58 | U | | |
| | 50 | 2-V-59 | U | | Tetrasporic |
| | 45 | 29-VI-58 | | | |
| | 60 | 9-VIII-58 | | | |
| *Laurencia* sp. | 35 | 8-II-59 | R | * | |
| | 35 | 13-VII-58 | R | * | |
| *Lithothamnion occidentale* Foslie | 60 | 25-IV-59 | C | | |
| **L. syntrophicum* Foslie | 38 | 14-II-59 | V | | Cystocarpic |
| | 60 | 25-IV-59 | C | | Tetrasporic |
| *Lophosiphonia scopulorum* (Harv.) Womersley | 40 | 7-XII-58 | U | * | Cystocarpic |
| **Melobesia membranacea* (Esper) Lamx. | 55 | 31-I-59 | C | | |
| | 55 | 27-IV-58 | U | | |
| **Meristotheca duchassaignii* J. Ag.[1] | 35 | 17-VIII-58 | | | |
| *Mesothamnion caribaeum* Børgs.[3] | 40 | 7-XII-58 | R | * | |
| *Peyssonnelia rubra* (Grev.) J. Ag. | 38 | 14-II-59 | U | | |
| | 55 | 7-IX-59 | | | |
| *Polysiphonia binneyi* Harv. | 35 | 13-VII-58 | | | Tetrasporic |
| | 55 | 7-IX-58 | | * | Cystocarpic |
| **P. denudata* (Dillwyn) Kutz.[3] | 45 | 29-VI-58 | | * | |
| **P. gorgoniae* Harv.[3] | 55 | 31-I-59 | U | * | Cystocarpic |
| **P. hapalacantha* Harv.[3] | 40 | 18-VI-58 | | | |
| *P. havanensis* Mont. | 55-60 | 21-IX-58 | | * | |
| | 45-50 | 23-XI-58 | | * | |
| *P. howei* Hollenberg | 60 | 9-VIII-58 | | * | Cystocarpic |
| *P. macrocarpa* Harv.[2] | 35 | 6-I-59 | U | * | |
| | 35 | 8-II-59 | R | * | |
| | 38 | 14-II-59 | U | * | |
| | 40 | 7-XII-58 | U | * | |

TABLE II.—(continued)

| Species | Depth —feet | Date | Abundance | Epiphyte | Reproductive state |
|---|---|---|---|---|---|
| *Polysiphonia* sp. | 35 | 13-VII-58 | | | Tetrasporic |
| *Rhabdonia ramosis-* | 60 | 9-VIII-58 | | * | |
| *sima* (Harv.) J. Ag. | 40 | 7-XII-58 | U | | Cystocarpic |
| | 55-60 | 21-IX-58 | | | |
| *Scinaia complanata* (Collins) Cotton | | | | | |
| var. *intermedia* Børgs. | 38 | 14-II-59 | R | | Cystocarpic |
| | 40 | 18-VI-58 | | | Cystocarpic |
| **Seirospora* | | | | | |
| *occidentalis* Børgs[1, 3] | 55-60 | 5-X-58 | | * | Cystocarpic |
| *Spermothamnion gorgoneum* | | | | | |
| (Mont.) Born.[2] | 39 | 9-XI-58 | V | * | Polyspores |
| **S. investiens* | | | | | |
| (Crouan) Vick. | 60 | 9-VIII-58 | | * | |
| | 55 | 7-IX-58 | | * | |
| **S. investiens* (Crouan) Vick. | | | | | |
| var. *cidaricola* Børgs. | 50 | 2-V-59 | V | * | |
| *Spyridia fila-* | | | | | |
| *mentosa* (Wulf.) Harv. | 35 | 3-I-59 | R | * | |
| | 35 | 13-VII-58 | | | |
| | 39 | 9-XI-58 | | | |
| | 60 | 9-VIII-58 | | * | Cystocarpic |
| | 55 | 7-IX-58 | V | | |
| | 55-60 | 21-IX-58 | | | |
| *Wurdemannia miniata* (Drap.) Feldmann | | | | | |
| & Hamel | 55-60 | 5-X-58 | | | |

* Not previously reported north of the Dry Tortugas on the Florida Gulf coast.
[1] Species found only on metal wrecks.
[2] Species found only in very shallow water at the Dry Tortugas [as reported by Taylor (1928)].
[3] Species not in herbarium.
[4] Material examined by Dr. H. J. Humm. The plant does not have setae. Dr. Humm stated that each cell is extended on the top side into a peak or point. No confidence is placed on identification beyond the family.

## DISCUSSION

A very interesting algal association was noted in the 45 - 60 feet depths where a vast carpet of *Halimeda scabra,* composed of plants two to three inches tall, was found on the reefs. *Rhipocephalus phoenix typicus* was usually associated with the *Halimeda,* but was not as abundant. *Sargassum filipendula* was also abundant, not on the reef, but on the detritus-covered hard bottom surrounding it. These attached *Sargassum* plants, mostly from two to three feet high, occurred one plant every square meter over very large areas, but on several occasions no plants were found. This association was not seen in the 35 - 40 feet depths. *Sargassum filipendula* was found at 5 of the 8 stations in 35 - 40 feet and is considered to be a characteristic plant of these shallower depths. *Halimeda scabra* was found in only 3 of the 8 collections in this depth range and was abundant at only one of these. *Rhipocephalus phoenix* was not found at the 35 - 40 feet depths, but *R. oblongus* occurred in one collection in which it was associated with *Halimeda opuntia typica*.

Several species of *Goniolithon* and *Lithothamnion* were occasionally observed as large knobby growths on the rocky reefs. It is believed that these crustaceous coralline algae are probably an important constituent of the reef flora, however, due to the lack of attention to these algae, we cannot elaborate on this.

Despite the fact that most collections were made on the limestone reefs, several species of Codiaceous green algae with rhizoidal systems were found, often in great abundance. Plants of *Halimeda scabra* and *Udotea flabellum* were attached directly to the hard rock surface. The other species of this group, *viz.*, *Caulerpa* spp., *Halimeda* spp., *Rhipocephalus* spp., *Udotea* spp., *Penicillus capitatus,* and *Avrainvillea* spp., had extremely fine shell detritus and sand grains bound up in the rhizoids. The reef surface was never smooth, but was extremely pitted and craggy. Detritus and sand evidently collected in the rock depressions and potholes, and these algae which are anchored by rhizoids probably invaded the reefs by growing in the detritus filled depressions.

A large number of algal species were found at the 35 - 40 feet depths, but excepting *Sargassum filipendula,* none seemed particularly conspicuous. Once during a storm, vast amounts of *S. filipendula* were found floating on the surface over 35 feet of water. These plants had holdfasts and were in a fresh condition. Reefs were present on the bottom in the vicinity of this floating mass, and it is possible that the rough water may have torn the plants loose from the bottom.

Many more species of red algae were found in the 35 - 40 feet depths than any other group; however, of the macroscopic algae no group appeared to be dominant at a particular station. The epiphytic flora in the 35 - 40 feet depths was a major constituent of the species. Three species of macroscopic algae supported most of these epiphytes: *Halimeda scabra, Sargassum filipendula,* and *Codium isthmocladum,* none of which are red algae.

In contrast to the 35 - 40 feet depths is the 45 - 60 feet range in which *Halimeda, Rhipocephalus,* and *Sargassum* usually dominated the algal biomass present on the rocky reefs. This excludes consideration of the encrusting coralline red algae. In terms of biomass the macroscopic reds were very scarce. Species-wise the red algae comprised over half the total.

On two occasions the junior author collected on metal shipwrecks. One wreck was at a depth of 32 - 35 feet and the other was at 60 feet. Although portions of these wrecks rose as much as 20 feet off the bottom, only the algae within two or three feet of the bottom were collected. At both stations the red algae appeared to comprise the major portion of the algal biomass. *Sargassum* was not present about the shallower wreck and only sparse plants of *S. lendigerum* were present around the deeper one. The holdfast type base of the macroscopic red algae appears to be better suited for colonization on hard surfaces such as metal than does the rhizoid type base of the Codiaceous green algae. Wherever ship wrecks are found in the shallow waters of the Gulf of Mexico, red algae should be expected to prevail.

Eleven species are newly reported for Florida. These are: *Sargassum lendigerum* (?), *Acrochaetium avrainvilleae, A. netrocarpum, A. phacelorhizum, A. seriatum, A. unipes, Callithamnion cordatum, C. roseum, Ceramium codii, Mesothamnion caribaeum,* and *Lophosiphonia scopulorum.* Forty-seven species (marked by an asterisk in Table II) have not been previously reported north of the Dry Tortugas on the Florida Gulf coast and thus represent northward range extensions.

TABLE III.—Synopsis of species

| Depth Range (Feet) | 35-40 | | 45-60 |
|---|---|---|---|
| Total taxa of Cyanophyceae | 9 | | 13 |
| Total taxa of Chlorophyceae | 21 | | 23 |
| Total taxa of Phaeophyceae | 9 | | 12 |
| Total taxa of Rhodophyceae | 56 | | 63 |
| TOTAL | 95 | | 111 |
| Taxa not found at other depth range | 47 | | 63 |
| Taxa found at both depth ranges | | 48 | |
| Taxa of Rhodophyceae not found at other depth range | 27 | | 34 |
| Taxa of Rhodophyceae found at both depth ranges | | 29 | |
| Taxa of epiphytes not found at other depth range | 27* | | 31* |
| Taxa of epiphytes found at both depth ranges | | 19 | |
| Per cent of taxa which were rhodophycean epiphytes | 31 | | 31 |
| Per cent of epiphytes which were Rhodophyceae | 63 | | 68 |

* Four taxa were found in both depth ranges, one was an epiphyte in the 35-40 feet range only, and three were epiphytes in the 45-60 feet range only.

A summary of much of the information obtained in the present study is contained in Table III. The most obvious and interesting conclusion is that despite the differences, species-wise, between the two depth ranges considered, the composition of the algal flora is essentially the same in both. That is, both the ratios of the major algal groupings (Classes) and the ratios of the epiphytes remain constant.

In Table IV we have grouped data reported by Taylor (1928) for comparison with similar data in our Table III. It can be seen that the Tortugas algae also hold, at least in the shallower depths comparable to ours, a more or less constant relationship between the various groupings, though not of the same ratios as ours. These constant relationships at the different depths, although including different species, seem to denote that they are more than just a function of the number of possible species. The factors which might regulate these relationships are unknown to us.

More extensive collecting must be done in order to reveal possible seasonal variation in plant abundance and/or occurrence. The records collected thus far do not indicate such variation.

Taylor (*op. cit.*) recorded only 60 per cent of the taxa listed in Table II from the Dry Tortugas. It is interesting to note that 28 of the taxa we list (footnoted in Table II) were found by Taylor only in much shallower water. It has been the junior author's experience with fishes that several species found locally only in deep water are recorded from very shallow depths at Tortugas. Taylor emphasized the biomass dominance of the green algae in depths comparable to ours, but called attention to the fact that the number (taxa) of red algae greatly exceeded the number of green algae. Our findings are in accord with his.

## SUMMARY

Marine algae were collected on limestone reefs in water 35 - 60 feet deep in the Gulf of Mexico off Pinellas County, Florida, over a period of one year. SCUBA type diving equipment was used.

Two depth ranges were chosen, owing to the assemblage of plants found in each. The first was 35 - 40 feet, and the second was 45 - 60 feet. Ninety-five taxa were found in 35 - 40 feet in eight collections. One hundred and eleven taxa were found in 45 - 60 feet in twelve collections. A total of 158 taxa of plants were found during the study.

TABLE IV.—Comparative data on depth from Dry Tortugas (extracted from Taylor, 1928, Table 6)

| Depth (meters) | 3.1 | 9.2 | 18.3 | 36.6 | 55 | 73.2 | 91.5 |
|---|---|---|---|---|---|---|---|
| Total taxa of Cyanophyceae | 2 | 3 | 3 | 3 | – | – | – |
| Total taxa of Chlorophyceae | 27 | 34 | 24 | 17 | 13 | 10 | 9 |
| Total taxa of Phaeophyceae | 14 | 17 | 16 | 6 | 1 | 1 | 1 |
| Total taxa of Rhodophyceae | 52 | 56 | 46 | 24 | 7 | 3 | – |

The red algae, though high in species numbers, were small in biomass in both depths. However, when metal wrecks were encountered, it was observed that the biomass of red algae was large. *Sargassum filipendula,* owing to the regularity with which it was found in 35 - 40 feet, is considered a characteristic plant in this depth range. No other algal complex or species was observed to dominate on the reefs in this depth.

Vast carpets of *Halimeda scabra* were observed at most of the 45 - 60 feet stations. This species was observed to be characteristic of this depth. *Rhipocephalus phoenix* and *Sargassum filipendula* were often associated with *Halimeda.*

The epiphytic flora, a large percentage of which were red algae, accounted for nearly one-half of the total number of species found.

Eleven species are newly reported for the state, and 47 represent northward range extensions from the Dry Tortugas.

On the basis of this study and comparison with the results of Taylor's (1928) work at the Dry Tortugas, a more or less constant relationship between the various algal groupings can be seen. Although different species are included in the two areas, those relationships seem to denote that they are more than just a function of the number of possible species. The factors which might regulate these relationships are unknown to us.

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