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A RECORD OF BENTHIC MARINE ALGAE FROM JOHNSTON ATOLL

by Richard G. Buggeln and Roy T. Tsuda

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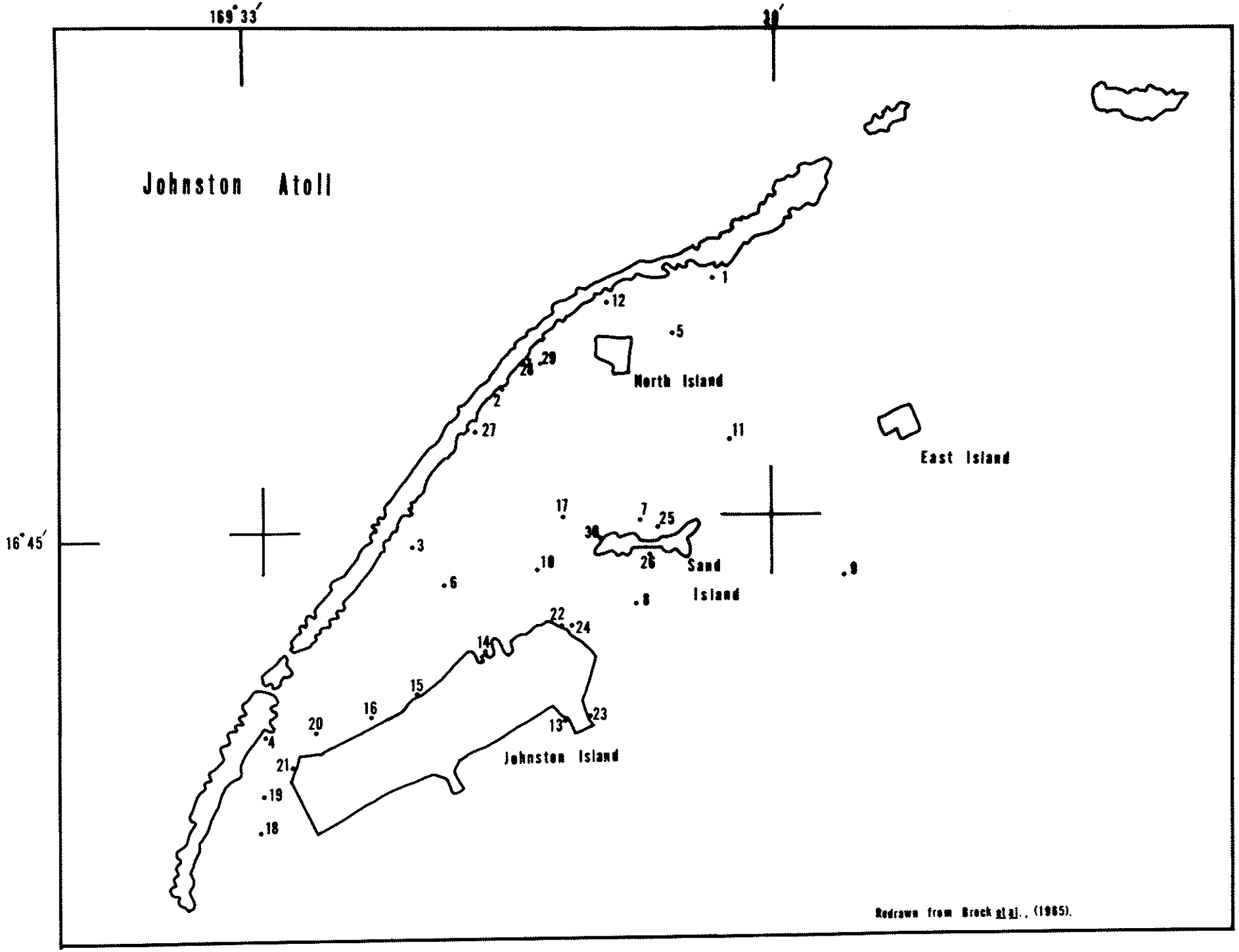
169° 33′
Johnston Atoll
16° 45′
North Island
East Island
Sand Island
Johnston Island
Redrawn from Brock et al., (1965).

A RECORD OF BENTHIC MARINE ALGAE FROM JOHNSTON ATOLL

by Richard G. Buggeln[2/] and Roy T. Tsuda[3/]

A record of the genera of benthic marine algae was compiled as a part of a study of the effects of dredging on the marine environment on Johnston Atoll (Brock, et al., 1966). The preliminary species list (Buggeln & Tsuda, 1966) has been supplemented with collections made during a trip to Johnston Atoll, June 14-24, 1966, sponsored by the Department of Radiation Biology, University of Washington, Seattle. There appears to be no published account of the marine algae from Johnston Atoll, save for Halimeda tuna (Ell. & Sol.) Lamx. cited in Moul (1964). The present listing is conspicuously incomplete in some areas (e.g., the Melobesioid algae) and subsequent collections will necessitate additional entries as well as amendments to this list. Knowledge of the flora from this isolated atoll may serve to link other tropical and sub-tropical Pacific atolls whose floras have been reported (see Tsuda, 1966) with the major Hawaiian archipelago to the north.

Acknowledgments

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Drs. Maxwell S. Doty and Albert J. Bernatowicz, both of the University of Hawaii and Dr. Richard E. Norris of the University of Washington. Special thanks are given to specialists who aided in some of the determinations: Dr. E. Yale Dawson (Dasya, Callithamnion); Dr. W. Jan Newhouse, University of Hawaii (Cyanophyta); and Dr. George Hollenberg, Emeritus, University of Redlands, who incorporated our collections of Polysiphonia and Herposiphonia into a monograph of these genera from the central Pacific Ocean. Lastly, we greatly appreciate the effort shown by the collectors whose names appear throughout a following section, "Description of Stations."

Description of Johnston Atoll

"Johnston Atoll is located at 16° 15' N. Lat. and 169° 30' W. Long. It is 450 miles southwest of the nearest island in the Hawaiian chain, 700 miles northwest of the nearest of the Line Islands, and 1300 miles east of the Marshall Islands" (Gosline, 1955).

The extensive reef area has its long axis oriented in a northeast-southwest direction which essentially places the shoal parallel to the prevailing northeast trade winds. The shoal area which is approximately nine to ten miles long and seven to eight miles wide can be separated into three major regions: 1) the marginal reef, a narrow stip, frequently awash, which forms part of the northern, all of the northwestern, and part of the eastern boundary of the shoal; 2) the land masses, the natural islets of Johnston and Sand Islands and the two recently man-made islets called North and East Islands; and 3) the shoal, the extensive submerged coral area behind the marginal reef and surrounding the islets (Brock, et al., 1965).

Description of Stations

A very brief description of the stations from which the collections were made is given below. The location of each station is also indicated on the accompanying map of Johnston Atoll (Figure 1).* The collection numbers are part of a continuous series initiated by one of us (RT). The collection will be deposited in the herbarium of Dr. Maxwell S. Doty, Department of Botany, University of Hawaii, Honolulu, Hawaii 96822.

Station 1 - Algae growing on living Porolithon and Acropora** (1-3 meters depth) just inside the seaward reef, northeast of North Island. August 17, 1965. Collected by R. G. Buggeln and A. E. Murchison. (RT #1021-1070).

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*Adapted from Brock et. al., (1965).

**Zoocorals whose apices are inhabited by the living polyps are here referred to as "living" coral. (The algae only grow on the basal exoskeleton which is non-living). We distinguish this latter habitat from that (i.e., "dead coral") in which all of the living tissue has been killed and therefore one finds algae growing on the outermost tips of the exoskeleton.

Station 2 - Algae growing on well-developed coral heads (1-5 meters depth) in an are 25-30 meters inside the marginal reef, opposite and north of Johnston Island. August 19, 1965. Collected by R. G. Buggeln. (RT #1071-1101).

Station 3 - (A) - Algae growing on living Porolithon and Pocillopora were collected (2-3 meters depth) from the top of a large coral knoll about 5 meters in height in an area opposite and north of Johnston Island. August 20, 1965. Collected by A. E. Murchison. (RT #1102-1134).
(B) - Algae were collected from the lower 2 meters of the same coral knoll and were found mainly on dead** Pocillopora. August 20, 1965. Collected by A. E. Murchison (RT #1135-1144).

Station 4 - Algae collected on dead Pocillopora in turbid water (1 meter depth) just inside the seaward reef in an area northwest of the southwest end of Johnston Island. August 20, 1965. Collected by R. G. Buggeln. (RT #1145-1162).

Station 5 - (A) - Algae were collected on living Porolithon and Pocillopora (2 meters depth) in an area approximately 750 meters due east of the north end of North Island. August 18, 1965. Collected by R. G. Buggeln. (RT #1163-1185).
(B) - Algae collected on a silt-rubble bottom partially composed of small cobbles and dead Pocillopora fragments in about 15 meters of water. August 18, 1965. Collected by W. F. Van Heukelem. (RT #1186-1196).

Station 6 - (A) - Algae collected from the top 4 meters of a reef (along a mostly vertical transect) in an area north of Johnston Island. August 20, 1965. Collected by R. G. Buggeln. (RT #1197-1221).
(B) - Algae collected from dead Pocillopora near the bottom portion of the reef (7 meters depth) along the transect. August 20, 1965. Collected by A. E. Murchison. (RT #1222-1234).

Station 7 - Algae collected from dead coral (1-3 meters depth) in an area north of Sand Island. August 18, 1965. Collected by R. G. Buggeln. (RT #1235-1255).

Station 8 - (A) - Algae growing mainly on dead Pocillopora (2-4 meters depth) in an area south of Sand Island. August 18, 1965. Collected by R. G. Buggeln. (RT #1256-1269).
(B) - Algae collected on dead Pocillopora from the top of a coral head (1 meter depth). August 21, 1965. Collected by W. F. Van Heukelem. (RT #1270-1275).

Station 9 - Algae growing mainly on dead Pocillopora (2-3 meters depth) in an area about two miles east of Johnston Island. August 19, 1965. Collected by R. G. Buggeln. (RT #1275-1281).

Station 10 -(A) - Algae collected from a transect line on the bottom of a dredged channel (12-13 meters depth) composed of silt and small cobbles in an area west of Sand Island. August 19, 1965. Collected by A. E. Murchison. (RT #1282-1288).
(B) - Algae growing mainly on dead Pocillopora (4-13 meters depth) collected from the sides and bottom of the ship channel. August 19, 1965. Collected by D. Knowles. (RT #1289-1297).
(C) - Additional collections made at random on the bottom of the ship channel (12-13 meters depth). August 19, 1965. Collected by W. F. Van Heukelem. (RT #1298-1300).

Station 11 -(A) - Algae growing mainly on dead Pocillopora on the side of the ship channel (2-4 meters depth) in an area southwest of East Island. August 19, 1965. Collected by R. G. Buggeln. (RT #1301-1315).
(B) - Additional collections from the side of the ship channel were made between 3-5 meters depth. August 19, 1965. Collected by W. F. Van Heukelem. (RT #1316-1321).
(C) - Algae collected from the bottom of a generally barren channel area (6 meters depth). August 19, 1965. Collected by A. E. Murchison. (RT #1322-1326).

Station 12 -Algae collected from the top of the marginal reef bench (awash during all tidal periods) in an area north of North Island. August 22, 1965. Collected by R. G. Buggeln. (RT #1327-1343).

Station 13 -Algae collected from concrete blocks and scrap metal in the littoral zone on the southeast side of Johnston Island. December 19, 1965. Collected by R. T. Tsuda and R. G. Buggeln. (RT #1346-1348).

Station 14 -Algae collected from the concrete landing ramp in the littoral zone on the northwest shore of Johnston Island. December 21, 1965. Collected by R. G. Buggeln. (RT #1349-1350).

Station 15 -Algae growing on coral rubble in the littoral zone along the northwest shore of Johnston Island. July 15 and 19, 1966. Collected by R. G. Buggeln and Dr. Allyn H. Seymour. (RT #1462-1472).

Station 16 -Algae collected from the top of a submerged coral head (1-2 meters depth) 3-4 meters off the northwest shore of North Island. July 16, 1966. Collected by R. G. Buggeln. (RT #1473-1496).

Station 17 -Floating gelatinous masses collected in the ship channel opposite Sand Island, between North and Johnston Islands. July 16, 1966. Collected by R. G. Buggeln. (RT #1497).

Station 18 - Algae growing on a floating channel marker at the southwest end of Johnston Island. July 16, 1966. Collected by R. G. Buggeln. (RT #1498-1502).

Station 19 - Algae floating in the ship channel near the southwest end of Johnston Island. July 16, 1966. Collected by R. G. Buggeln. (RT #1504;1542).

Station 20 - Algae collected from the top of a coral head (1 meter depth) 100 meters from shore near the southwest end of Johnston Island opposite the break in the marginal reef. July 16, 1966. Collected by Dr. E. E. Held, J. S. Isakson, and R. G. Buggeln. (RT #1503; 1505; 1598-1611).

Station 21 - Algae growing on coral fragments in the littoral zone along the southwest shore of Johnston Island. July 17, 1966. Collected by R. G. Buggeln. (RT #1531-1541).

Station 22 - Algae collected near shore (1 meter depth) along the northeast shore of Johnston Island, opposite Sand Island. July 18, 1966. Collected by J. Isakson and R. G. Buggeln. (RT #1543-1546).

Station 23 - Algae growing in the littoral zone along the northeast side of the northernmost jetty on the southeast side of Johnston Island. July 18, 1966. Collected by J. Isakson and R. G. Buggeln. (RT #1547-1567).

Station 24 - Algae collected (1-2 meters depth) from the ridges of coral heads which abut the beach at the northeast end of Johnston Island. July 18, 1966. Collected by R. G. Buggeln. (RT #1568-1581).

Station 25 - Mats of algae growing in 3 meters of water, 30 meters off the north shore of Sand Island. July 20, 1966. Collected by R. G. Buggeln. (RT #1582).

Station 26 - Algae collected from a sandy bottom (1 meter depth) 50 meters from the south shore of the isthmus which separates the two larger land masses of Sand Island. July 20, 1966. Collected by J. S. Isakson and R. G. Buggeln. (RT #1583-1591).

Station 27 - Algae collected (1-2 meters depth) 75 meters inside the marginal reef and 2,000 meters southwest of North Island. July 22, 1966. Collected by R. G. Buggeln. (RT #1612-1634).

Station 28 - Algae collected on the marginal reef (awash here during all tidal periods) 1,000 meters southwest of North Island. July 22, 1966. Collected by R. G. Buggeln. (RT #1635-1662).

Station 29 - Algae collected (1-2 meters depth) 75 meters inside the marginal reef and 1,000 meters southwest of North Island. July 22, 1966. Collected by P. R. Olson. (RT #1663-1670).

Station 30 - Algae growing on coral rubble in the littoral zone near the western end of Sand Island. July 20, 1966. Collected by R. G. Buggeln. (RT #1593-1597).

Systematic list

The following is an annotated list of the marine benthic algae collected on Johnston Atoll. Some of the determinations, especially in the Rhodophyta, should be considered tentative until further study can be made on additional material. Much of the difficulty in identification can be attributed to the herbivorous predators. Certain algae are heavily grazed and fragmentary collections prevent positive identification in many cases.

CYANOPHYTA

Anacystis dimidiata (Kütz.) Drouet and Daily, 1956: 70.
Stations: 7 (RT #1235), 10a (RT #1284).
These cells are interspersed among the filaments of Schizothrix calcicola (Ag.) Gomont.

Entophysalis deusta Drouet and Daily, 1956: 193, Fig. 191.
Stations: 14 (RT #1350), 15 (RT #1465a), 24 (RT #1569b).
This species occurs as a dark green coating on coral and is mixed with Calothrix scopulorum Born. and Flah.

Schizothrix calcicola (Ag.) Gomont, 1892: 15, 307; Drouet, 1963: 275.
Stations: 1 (RT #1057), 2 (RT #1096), 3a (RT #1127a), 5a (RT #1183), 6b (RT #1222), 7 (RT #1235), 10a (RT #1284), 11a (RT #1305), 11c (RT #1326b), 15 (RT #1465d), 17 (RT #1497), 20 (RT #1514b), 21 (RT #1541a), 22 (RT #1546b), 24 (RT #1569c), 26 (RT #1591), 28 (RT #1643).
These collections appear as large gelatinous mats, thin sheets, or large clumps which are often greenish-white or red in color. The trichomes are about 1μ in diameter; the individual cells are 1-3μ long.

Hydrocoleum lyngbyaceum Gomont, 1892: 15, 337; Umezaki, 1961: 27.
Stations: 21 (RT #1540), 28 (RT #1655), 30 (RT #1594).

Microcoleus chthonoplastes Gomont, 1892: 15, 353; Tilden, 1910: 155.
Stations: 3a (RT #1111), 5a (RT #1183), 6b (RT #1230), 7 (RT #1235), 11a (RT #1306).
The bundles of trichomes are within large single sheaths; the individual trichomes are about 1.5 to 3.5μ in diameter.

Microcoleus tenerrimus Gomont, 1892: 15, 355; Tilden, 1910: 155.
Stations: 16 (RT #1494), 27 (RT #1634).

Microcoleus vaginatus Gomont, 1892: 15, 355, Drouet, 1962: 204.
Station: 4 (RT #1149).

Lyngbia aestuarii Gomont, 1892 :15, 127; Tilden, 1910: 120.
Stations: 7 (RT #1235), 20 (RT #1514a), 28 (RT #1651).
These filaments are intermixed with Schizothrix calcicola (Ag.) Gomont. The trichomes are 6-7μ in diameter; the sheathes measure 2.5μ in thickness.

Lyngbya confervoides Gomont, 1892: 16, 136; Tilden, 1910: 119.
Stations: 7 (RT #1246).

Lyngbya lutea Gomont, 1893: 16, 141; Tilden, 1910: 114.
Station: 6b (RT #1230).
The collection consists of a few filaments and the determination is tentative.

Lyngbya majuscula Gomont, 1893 :16, 131; Tilden, 1910: 123.
Stations: 1 (RT #1049a), 6b (RT #1225b), 7 (RT #1251b), 10a (RT #1284), 10b (RT #1289), 11a (RT #1360), 11b (RT #1321), 11c (RT #1326a), 20 (RT #1606), 25 (RT #1582).
All of the collections appear as dark green, tangled filaments. A thick colorless sheath surrounds the trichomes; the latter are 22-30μ in diameter.

Spirulina tenerrima Gomont, 1893: 16, 252; Tilden, 1910: 88.
Stations: 6b (RT #1222), 21 (RT #1541c).
A few of these spiral filaments are mixed with Schizothrix calcicola (Ag.) Gomont. The trichomes are about 6μ in diameter. The width of the spirals is about 1.5μ; the distance between turns is about 1μ.

Symploca atlantica Gomont, 1893: 16, 109; Tilden, 1910: 129.
Stations: 22 (RT #1543), 28 (RT #1655).

Oscillatoria nigroviridis Gomont, 1893: 16, 217; Tilden, 1910: 69.
Station: 14 (RT #1349b).
This species is epiphytic on Sphacelaria novaehollandiae Sonder. The trichomes are about 12μ in diameter.

Phormidium submembranaceum Gomont, 1893: 16, 180; Tilden, 1910: 104.
Stations: 1 (RT #1047), 2 (RT #1096), 5b (RT #1190), 10b (RT #1292), 11b (RT #1320), 12 (RT #1331), 24 (RT #1569a).

Hormothamnion enteromorphoides Bornet and Flahault, 1888: 260; Tilden, 1910: 205.
Stations: 8b (RT #1272), 11b (RT #1321), 21 (RT #1531).
The mass of entangled filaments is greenish-white in color. The individual trichomes are about 5μ in diameter with intercalary heterocysts present.

Calothrix crustacea Bornet and Flahault, 1886: 359; Tilden, 1910: 264.
Stations: 7 (RT #1251b), 11a (RT #1308), 11b (RT #1321), 11c (RT #1325a).
In these collections, the species is associated with Lyngbya majuscula Gomont. The unbranched trichomes are 8-12μ in diameter with numerous heterocysts present.

Calothrix scopulorum Bornet and Flahault, 1886: 353; Tilden, 1910: 258.
Stations: 1 (RT #1047), 2 (RT #1055), 3a (RT #1127a), 4 (RT #1148), 6a (RT #1200), 6b (RT #1228b), 7 (RT #1246), 8a (RT #1261), 14 (RT #1350), 15 (RT #1465b), 18 (RT #1501), 21 (RT #1541b).

The majority of the collections is found to encrust coral. Each tapering trichome consists of a single enlarged basal heterocyst. The cells of the trichomes are 5-10μ in diameter at the base and a distinct sheath is present. In his revision of the genus, Fan (1956) treats this entity as Calothrix confervicola (Roth) Agardh.

Isactis plana Bornet and Flahault, 1886: 344; Tilden, 1910: 281.
Stations: 15 (RT #1465c), 21 (RT #1536), 22 (RT #1546), 23 (RT #1559), 24 (RT #1576), 27 (RT #1622), 28 (RT #1641a), 30 (RT #1593).

CHLOROPHYTA

Palmogloea protuberans (Sm. & Sew.) Kützing, 1843: 176.
Station: 24 (RT #1568).
Cells are about 5μ in diameter and irregular in shape.

Enteromorpha kylinii Bliding, 1948: 1; Bliding, 1963: 103.
Station: 13 (RT #1347).
The thalli are 45-210μ in diameter with branching, when present, only near the base. The cells, arranged in longitudinal but not in transverse rows, are usually rectangular but at times polygonal in shape and about 17μ long and 10μ wide. Two or more pyrenoids are present in each cell.

Cladophora crystallina (Roth) Kützing, 1845: 213; Dawson, 1956: 33.
Stations: 1 (RT #1048), 3a (RT #1144), 4 (RT #1154b), 5a (RT #1184b), 18 (RT #1499).
The filaments are about 1 cm high. The basal cells are about 90μ in diameter and the ultimate branches taper to about 60 in diameter. The pectinate branching as well as the enlarged basal portion are very characteristic of this species.

Cladophoropsis sp.
Station: 28 (RT #1648).
This single, small, matted specimen has filaments about 75μ wide.

Valonia ventricosa J. Ag., 1887: 96; Egerod, 1952: 347.
Station: 5a (RT #1169).
This collection consists of a single vesicle, 1 cm in diameter.

Dictyosphaeria versluysii Weber-van Bosse, 1905: 114; Egerod, 1952: 351.
Stations: 1 (RT #1023), 2 (RT #1098), 3a (RT #1122), 5a (RT #1181), 6a (RT #1212), 7 (RT #1250), 8a (RT #1257), 9 (RT #1274), 11a (RT #1310), 12 (RT #1344), 16 (RT #1481), 20 (RT #1513), 23 (RT #1548), 24 (RT #1570), 27 (RT #1619), 28 (RT #1644), 29 (RT #1667).
These solid, irregularly shaped, pseudoparenchymatous thalli range from 5 to 50 mm in breadth. The individual vesicles are approximately 1 mm in diameter; spinous trabeculae are present.

Boodlea composita (Harvey) Brand, 1904: 187; Egerod, 1952: 362.
Station: 1 (RT #1041).
This collection consists of a small spongiose mass about 1 cm in diameter.

Microdictyon setchellianum Howe, 1934: 38; Setchell, 1929: 553; Egerod, 1952: 366.
Stations: 2 (RT #1097), 3a (RT #1129), 5a (RT #1173), 7 (RT #1245), 12 (RT #1327), 27 (RT #1616), 28 (RT #1645), 29 (RT #1668).
Most of the specimens were immature, ranging from 20 mm to 5 cm in breadth. The cell walls, about 25μ in thickness, distinguish the species from M. okamurai Setchell which is said to have a thinner cell wall.

Derbesia marina (Lyngbye) Solier, 1847: 158; Dawson, 1956: 34.
Station: 19 (RT #1504 & 1542).

Derbesia sp.
Stations: 10a (RT #1286), 10b (RT #1293a).
This species occurs in mats throughout Station 10. The filaments are about 15 cm long and dichotomously branched. The diameter of the filaments is about 37μ. Since all of the collections are sterile, we are tentatively placing these specimens in this genus.

Caulerpa ambigua Okam., 1897: 4.
Stations: 4 (RT #1152), 7 (RT #1249), 8a (RT #1260a, 1260b), 16 (RT #1488), 20 (RT #1509).
All of the collections are about 2 mm high with distichously arranged ramuli. The ramuli in specimen RT #1206b are branched in a verticillate manner.

Caulerpa racemosa var. macrophysa (Kütz.) Taylor, 1928: 101; Eubank, 1946: 420.
Station: 5a (RT #1170).
The stolons are about 3.5 cm long and the ramuli about 1.5 cm high.

Caulerpa urvilliana Montagne, 1845: 21; Taylor, 1950: 60.
Stations: 1 (RT #1021), 8a (RT #1263), 8b (RT #1270), 12 (RT #1345), 26 (RT #1583), 28 (RT #1636).
These collections consist of rather large specimens with stolons up to 40 cm in length; two forms of this species are present in our collections.

Bryopsis pennata Lamx., 1809: 134; Egerod, 1852: 370.
Stations: 1 (RT #1044a), 2 (RT #1087), 4 (RT #1154a), 5a (RT #1184c), 6a (RT #1215), 7 (RT #1237), 8a (RT #1266), 10a (RT #1283), 10c (RT #1299), 13 (RT #1348), 16 (RT #1478), 20 (RT #1522 & 1601), 23 (RT #1553), 27 (RT #1626), 28 (RT #1650).

Two morphological forms exist in these collections. The first is similar to the description and illustration in Egerod (1952) while the other form has long branches, distichously arranged, at the upper portion of the main axis.

Pseudochlorodesmis parva Gilbert, 1962: 141.
Stations: 2 (RT #1089), 12 (RT #1337).

The above collections appear as green felt on corals and attain a height of 5 mm. These siphonaceous filaments are erect and branch only once at the upper portion. The filaments are about 21μ wide and the rhizoids are conspicuously beaded. The following collections are tentatively placed here: (RT #1477), (RT #1508), and (RT #1562). These are from stations: 16, 20, and 23, respectively.

Codium arabicum KUtz., 1856: 35, Egerod, 1952: 382.
Station: 2 (RT #1075).

This unbranched mass of utricles measures about 1 cm in breadth. The utricles are long and clavate and measure up to 900μ in length with the width varying from 150μ at the base to 225μ above. Secondary and tertiary utricles are very common.

Codium sp.
Stations: 1 (RT #1035), 2 (RT #1073), 3a (RT #1127b), 5a (RT #1174), 15 (RT #1463), 16 (RT #1496), 23 (RT #1556), 24 (RT #1572), 27 (RT #1613).

The collections of branched fragments range from 5-20 mm in length. The medullary filaments are about 30μ in diameter. The utricles are approximately 375μ in length and 255μ in width and appear slightly oblong in shape. Secondary utricles are present in specimen RT #1035. Although fragmentary, the specimens have characteristics of C. edule Silva.

Halimeda discoidea Decaisne, 1842: 91; Hillis, 1959: 352.
Stations: 1 (RT #1022a), 3a (RT #1102), 6a (RT #1213), 16 (RT #1474), 28 (RT #1635), 29 (RT #1663).

This species is characterized by its inflated secondary utricles.

Halimeda tuna (Ellis and Solander) Lamx., 1812: 186; Hillis, 1959: 342.
Stations: 1 (RT #1022b), 12 (RT #1343).

All of our collections of Halimeda were rather similar in external appearance, therefore anatomical characteristics, i.e., size and shape of the utricles, etc., are the bases for our decisions.

Aside from the specimens cited above, a very immature thallus consisting of only two segments was collected at Station 2 (RT #1083).

Acetabularia clavata Yamada, 1934: 57; Egerod, 1952: 413.
Stations: 20 (RT #1611), 24 (RT #1581).

Acetabularia mobii Solms-Laubach, 1895: 30; Egerod, 1952: 411.
Stations: 2 (RT #1076a), 4 (RT #1145), 5a (RT #1164), 5b (RT #1192), 6a (RT #1209), 20 (RT #1523), 23 (RT #1565a), 27 (RT #1620).
These "umbrella-shaped" thalli are 4-6 mm high with the disc about 1.5 mm in diameter. Each corona knob may have 3-6 sterile hairs.

Acetabularia tsengiana Egerod, 1952: 414.
Station: 23 (RT #1565b).

Acetabularia sp.
Stations: 2 (RT #1076), 30 (RT #1597).
These specimens are 3-6 mm high and bear five very inflated gametangial rays; the disc is about 1.5 mm in diameter.

CHRYSOPHYTA

Ostreobium reineckei Bornet, in Reinbold, 1896: 269; Dawson, 1954: 396.
Stations: 16 (RT #1484), 23 (RT #1563).
This minute filamentous alga is embedded in coral and gives a greenish tinge to the peripheral matrix. Although we only record this alga from two stations, it (or another species) is probably ubiquitous along with Entophysalis deusta Drouet and Daily.

PHAEOPHYTA

Ectocarpus breviarticulatus J. Ag., 1847: 7; Boergesen, 1914: 17; Dawson, 1954: 398.
Stations: 13 (RT #1346), 18 (RT #1500), 23 (RT #1564).
These spongiose clumps are about 2 cm long. The hook-like branches, characteristic of this species, contribute to the interwoven appearance. The semi-oval plurilocular sporangia are about 42μ long and 36μ wide and are supported by short pedicels approximately 25μ long and 10μ wide.

Ectocarpus indicus Sonder, in Zollinger, 1854: 3, Boergesen, 1941: 16.
Stations: 2 (RT #1084), 3a (RT #1116), 4 (RT #1147), 5a (RT #1176), 6a (RT #1211), 7 (RT #1238), 12 (RT #1336), 16 (RT #1590), 21 (RT #1539), 22 (RT #1544), 24 (RT #1580a).
The above collections are placed in this taxon although some of them may be referrable to Ectocarpus mitchellae Harvey. The filaments are 5 mm high and about 17μ wide. The oblong plurilocular sporangia occurring on these specimens range from 70-240μ in length and are about 25μ wide.

Ectocarpus irregularis Kützing, 1845: 234; Dawson, 1954: 398.
Station: 15 (RT #1467).

Ectocarpus sp.
Station: 10c (RT #1298).

The cells of the filaments are about 20μ wide and 20-40μ long. The pyriform plurilocular organs are about 38μ long and 32μ wide at the base.

Sphacelaria furcigera Kützing, 1855 (Tab. Phyc. 5); Boergesen, 1941: 46.
Stations: 5b (RT #1189), 24 (RT #1580).

This species is characterized by its Y-shaped propagulae. The filaments are about 5 mm high and 30μ wide.

Sphacelaria novaehollandiae Sonder, 1845: 50; Boergesen, 1941: 45.
Stations: 2 (RT #1088), 3b (RT #1142), 5a (RT #1179), 7 (RT #1254), 9 (RT #1277), 14 (RT #1349), 28 (RT #1652).

All of the specimens cited above have propagulae which are characteristic of this species.

Many of our Sphacelaria collections are sterile and application of a specific epithet is difficult. The following sterile specimens are recorded with their locations: 1 (RT #1033), 3a (RT #1113), 6a (RT #1218), 6b (RT #1223), 8a (RT #1267), 10b (RT #1291), 11a (RT #1311), 11b (RT #1316), 11c (RT #1324), 12 (RT #1333), 16 (RT #1486), 20 (RT #1600), 22 (RT #1545), 24 (RT #1575), 29 (RT #1666), 30 (RT #1595).

Sphacelaria tribuloides Meneghini, 1840: 2; Boergesen, 1941: 41.
Station: 15 (RT #1470).

Dictyota sp.
Stations: 1 (RT #1038), 3a (RT #1123), 20 (RT #1520), 27 (RT #1633).

These specimens are mere fragments (5 mm long) and specific determination is not possible.

Pocockiella variegata (Lamx.) Papenfuss, 1943: 467.
Stations: 1 (RT #1027), 2 (RT #1077), 3a (RT #1124), 3b (RT #1141), 4 (RT #1151, 5a (RT #1178), 5b (RT #1186), 6a (RT #1199), 4 (RT #1151), 5a (RT #1178), 5b (RT #1186), 6a (RT #1199 #1199), 6b (RT #1234), 9 (RT #1273), 10b (RT #1296), 12 (RT #1340), 16 (RT #1472), 20 (RT #1507), 23 (RT #1552), 27 (RT #1662), 29 (RT #1670).

These collections consist of thalli up to several centimeters in breadth. At times this species could be seen growing as a collar around living corals with the basal portion of the thallus firmly attached to exoskeleton subtending the living apex. Frequently this alga acts as a substratum for other filamentous species.

RHODOPHYTA

Asterocystis ornata (Ag.) Hamel, 1924: 451; Dawson, 1954: 411.
Station: 6a (RT #1203).

This species is usually found as an epiphyte on larger filamentous algae; it is encountered at many stations.

Goniotrichum alsidii (Zanardini) Howe, 1920: 553; Taylor, 1960: 288.
Station: 11b (RT #1319).

These fine golden-colored filaments are epizoic on Pennaria. The dense habit obscures the basal portion of the alga. The gelatinous branches are up to 25μ in diameter with the cells 9μ wide and 9-14μ in length. The specimens appear to be in agreement with Taylor's description.

Erythrotrichia sp.
Station: 6a (RT #1198).

One or more species of these tiny epiphytes are commonly found on larger algae.

Gelidium crinale var. perpusillum Piccone and Grunow, in Piccone, 1884b: 317; Dawson, 1954: 421.
Stations: 3a (RT #1128), 3b (RT #1136), 5b (RT #1169), 11a (RT #1304), 11c (RT #1323), 16 (RT #1491), 20 (RT #1602b), 23 (RT #1551), 26 (RT #1587).

The habit and apical cell represented in Dawson's figure are characteristic of these collections.

Gelidium pusillum (Stackh.) Le Jolis, 1864: 139; Dawson, 1954: 420; var. pusillum Dawson, 1961: 434.
Stations: 3a (RT #1131), 5a (RT #1182), 6a (RT #1216), 7 (RT #1243), 8a (RT #1262), 14 (RT #1464), 20 (RT #1602a), 21 (RT #1534a), 26 (RT #1856).

One or more erect flattened blades about 5 mm in length arise at "nodes" from a prostrate axis. The rhizoidal holdfasts occur at varying intervals along the prostrate axis. Tetrahedral tetraspores are borne on the erect axis or on short lateral blades (RT #1131).

Wurdemania sp.
Stations: 1 (RT #1034), 4 (RT #1155b), 8a (RT #1258), 20 (RT #1511a), 24 (RT #1577), 28 (RT #1659).

These collections are tentatively placed in this genus. The habit of the collections is lax. There is no apical cell present and the medulla is multiaxial. Without fertile material, some difficulty arises in distinguishing members of Wurdemania from Gelidiopsis.

Jania capillacea Harvey, 1853: 84; Dawson, 1954: 432.
Stations: 1 (RT #1028), 3a (RT #1118a), 3b (RT #1135), 4 (RT #1146b), 6a (RT #1200a), 7 (RT #1252a), 8a (RT #1286a), 9 (RT #1276), 10b (RT #1294a), 11a (RT #1308), 12a (RT #1330), 20 (RT #1519b), 23 (RT #1566a), 26 (RT #1585b).

This small alga is often encountered. The diameter of the axes ranges from 35 to 65μ.

Jania decussato-dichotoma (Yendo) Yendo, 1905: 37; Dawson, 1956: 49.
Stations: 2 (RT #1092b), 3a (RT #1118b), 4 (RT #1156b), 6a (RT #1200b), 20 (RT #1519a), 23 (RT #1566b), 26 (RT #1585a), 27 (RT #1625), 28 (RT #1660a).

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This alga is characterized by its small size and decussate branching pattern. The diameter of the branches ranges from 100 to 110μ. The alga is frequently associated with J. capillacea.

Amphiroa sp.
Stations: 1 (RT #1025a), 3a (RT #1118c).
This short, articulated coralline is 1 - 1.5 cm in height and 0.1 cm wide with conspicuous nodal constrictions between heavily calcified internodes. Several short laterals are present.

Hypnea esperi Bory, 1829: 157; Boergesen, 1920: 306; Dawson, 1954: 436.
Stations: 1 (RT #1053-cystocarpic), 2 (RT #1079), 3a (RT #1115-cystocarpic), 3b (RT #1138-cystocarpic), 4 (RT #1153-cystocarpic), 5a (RT #1177-tetrasporic and cystocarpic), 6a (RT #1198a), 7 (RT #1255-tetrasporic), 8a (RT #1258-tetrasporic), 16 (RT #1489-tetrasporic), 20 (RT #1528), 23 (RT #1547-tetrasporic), 24 (RT #1570), 28 (RT #1640a).
These small laxly clumped collections (branches not anastomosing with each other) agree with the descriptions and figures in Boergesen and Dawson.

Lomentaria hakodatensis Yendo, 1920: 6; Dawson, 1956: 52; (Lomentaria sinensis Howe, 1924: 139).
Stations: 1 (RT #1037b-tetrasporic, 1059b-tetrasporic and some cystocarpic), 7 (RT #1236b), 8a (RT #1264-tetrasporic), 21 (RT #1538).
This alga is characterized by the creeping prostate habit and terete, indeterminate axes which often anastomose with other axes or attach to the substratum. Erect, nonbranching axes bear the tetrasporangia. Fragmentary collections recorded at stations 20 and 28 may be referred to this taxon.

Champia parvula (Ag.) Harvey, 1853: 76; Dawson, 1954: 432.
Stations: 1 (RT #1052-cystocarpic), 2 (RT #1071).
These specimens are entangled with Hypnea esperi Bory and are frequently attached to the latter and to sand grains. The largest specimen is 70.5 mm.

Antithamnion antillarum Boergesen, 1917: 226; Taylor, 1960: 499.
Stations: 1 (RT #1024-tetrasporic), 2 (RT #1089b), 6a (RT #1198c), 7 (RT #1236a), 16 (RT #1493-tetrasporic).
Our material fits the description in Taylor quite well.

Callithamnion marshallensis Dawson, 1957: 118.
Stations: 12a (RT #1335-tetrasporic), 16 (RT #1475), 23 (RT #1567b), 29 (RT #1661a).

Callithamnion sp.
Station: 4 (RT #1160a).

Centroceras apiculatum Yamada, 1944: 42; Dawson, 1956: 55.
Stations: 1 (RT #1049-tetrasporic), 2 (RT #1078), 3a (RT #1109), 3b (RT #1139), 4 (RT #1146a), 5a (RT #1167a-tetrasporic),

6a (RT #1206), 7 (RT #1252b), 8a (RT #1268a), 9 (RT #1279), 16 (RT #1473e), 20 (RT #1510), 23 (RT #1550b), 24 (RT #1573), 27 (RT #1612), 28 (RT #1639), 30 (RT #1588).

This species is a conspicuous element in many of the collections.

Centroceras clavulatum (Ag.) Montagne, in Durieu, 1846: 140; Dawson, 154: 446.

Stations: 1 (RT #1028b), 9 (RT #1281c), 10a (RT #1285), 10b (RT #1294b), 11b (RT #1317), 20 (RT #1610), 30 (RT #1584c).

This species is not as common as C. apiculatum Yamada but is easily recognized by the presence of short spines at the apical terminus of each cortical band.

Crouania minutissima Yamada, 1944: 41; Dawson, 1956: 55.

Station: 29 (RT #1660b).

Ceramium affine Setchell and Gardner, 1930: 172; var. originale Dawson, 1950: 132.

Stations: 2 (RT #1089a), 3a (RT #1104), 4 (RT #1140a-tetrasporic), 5b (RT #1191a), 6a (RT #1259b), 9 (RT #1281b), 11b (RT #1318-cystocarpic), 23 (RT #1557b), 26 (RT #1584a), 27 (RT #1646b).

This species is commonly encountered as a small fragment in many of the collections. Its thin diameter, long internodes, and characteristic cortication are distinctive features.

Ceramium fimbriatum Setchell & Gardner, 1924: 777; Dawson, 1950: 123.

Station: 28 (RT #1646).

A single small specimen is tentatively placed in this taxon.

Ceramium gracillimum var. byssoideum (Harv.) G. Mazoyer, 1938: 323; Dawson, 1954: 448, figs. 55, e-f.

Stations: 1 (RT #1032-tetrasporic), 3a (RT #1158), 7 (RT #1240), 8a (RT #1259a), 8b (RT #1271), 9 (RT #1281a-cystocarpic), 11b (RT #1319a), 12a (RT #1328-tetrasporic), 16 (RT #1482b), 20 (RT #1515a), 21 (RT #1532a), 24 (RT #1571), 27 (RT #1623), 28 (RT #1646).

The characteristic nodal cortication--the cortical bands divided with the lower third composed of transversely elongated cells--is an obvious feature of this fairly common species.

Ceramium huysmansii Weber van Bosse, 1932: 322; Dawson, 1954: 446; Ceramiella huysmansii Boergesen, 1953: 47.

Stations: 1 (RT #1034a-cystocarpic), 2 (RT #1100), 3a (RT #1118d), 3b (RT #1139b), 4 (RT #1157), 5b (RT #1188b), 6a (RT #1220c), 16 (RT #1487b).

The generic name, Ceramiella, has been proposed for this taxon in recognition of its characteristic cortication which entirely covers the central axial cells.

Ceramium maryae Weber van Bosse, 1923: 324; Dawson, 1954: 448.

Station: 12a (RT #1328b).

A single specimen is tentatively placed in this taxon.

Ceramium vagabunde Dawson, 1957a: 121; Dawson, 1962: 66.
Stations: 1 (RT #1032c), 5a (RT #1167b-tetrasporic), 11a (RT #1313a), 12a (RT #1328c).
This material seems to fit the description and figures in Dawson with regard to cortication.

Ceramium zacae Setchell & Gardner, 1937: 89; Dawson, 1950: 134.
Stations: 20 (RT #1512 and 1582b), 23 (RT #1550a), 26 (RT #1584b), 27 (RT #1632).

Ceramium sp.
Stations: 3a (RT #1104a), 5b (RT #1188a).

Crouania minutissima Yamada, 1944: 41; Dawson, 1956: 55.
Stations: 29 (RT #1660b).

Griffithsia metcalfii Tseng, 1942: 11, Abbott, 1946: 440; Dawson, 1954: 450.
Stations: 5b (RT #1191b), 6b (RT #1227-spermatangial and cystocarpic specimens).
The habit and tetrasporangial clusters agree with Abbott's description and figures.

Griffithsia ovalis Harvey, 1862: 203; Abbott, 1946: 2.
Station: 1 (RT #1054-tetrasporic).
This single fertile specimen is placed in this taxon because the involucral cells appear to arise from the main filament and not from the tetrasporangial branch as in G. metcalfii.

Griffithsia tenuis C. Agardh, 1828: 131; Abbott, 1946: 441, Dawson, 1954: 450.
Stations: 1 (RT #1044-tetrasporic), 4 (RT #1150c), 6a (RT #1204b), 16 (RT #1482a-cystocarpic), 20 (RT #1511a), 27 (RT #1624), 28 (RT #1649).
The vegetative cells are 60-100μ wide and 3-5(9) times as long as wide. There are no involucral cells substending the tetraspores which are clustered at the apex of short vegetative cells. The material agrees more closely with the taxon as described sensu Abbott than sensu Tseng (1942).

Griffithsia sp.
Station: 7 (RT #1242b).
The small collection from this station is most likely referable to one of the taxa above but it was too fragmentary for specific determination.

Dasya adherens Yamada, 1944: 31.
Stations: 3a (RT #1125), 28 (1647b-tetrasporic).

Dasya sinicola (S. & G.) Dawson var. sinicola Dawson, 1963: 408.
Stations: 1 (RT #1053b, 1056a, and 1058), 3b (RT #1135), 27 (1631a), 28 (1647a-tetrasporic).

Dasya sp.
Stations: 5a (RT #1185a), 8a (RT #1265), 12a (RT #1332).
The specimens appear to be juvenile stages of much larger forms.

Taenioma macrourum Thuret, in Bornet and Thuret, 1876: 69; Papenfuss, 1944: 1943.
Stations: 2 (RT #1093), 3a (RT #1107t), 5a (RT #1172), 17 (RT #1480).
The presence of two apical hairs distinguishes this species from T. perpusillum which has three.
Dr. G. J. Hollenberg (personal communication) has informed us that while sorting through the collections of Polysiphonia from this atoll, he came across several specimens of Taenioma which had both two and three apical hairs on different axes of a single specimen.

Caloglossa leprieurii (Montagne) J. Ag., 1876: 499; Post, 1936: 49, Dawson, 1956: 57.
Stations: 6a (RT #1205), 6b (RT #1224).
These tiny prostrate blades are attached to the substratum by rhizoidal outgrowths from the mid-rib. The erect blades usually arise from the mid-rib near a holdfast. The material is sterile.

Heterosiphonia wurdemanii var. laxa Boergesen, 1915-20: 326; Taylor, 1960: 565-6.
Stations: 1 (RT #1042), 3a (RT #1107a), 5a (RT #1171), 28 (RT #1647c-tetrasporic).

Herposiphonia spp.
Stations: 1 (RT #1060), 2 (RT #1090), 3a (RT #1104b), 5a (RT #1180), 6b (RT #1226), 7 (RT #1239), 27 (RT #1628), 28 (RT #1638), 20 (RT #1525).
These collections as well as the Polysiphonias have been identified by Dr. G. J. Hollenberg and are being treated separately in a monograph currently in preparation.

Polysiphonia spp.
Stations: 1 (RT #1061), 2 (RT #1080), 3b (RT #1139), 5a (RT #1185b), 6a (RT #1214), 7 (RT #1247), 9 (RT #1275), 10a (RT #1282), 10c (RT #1300), 11a (RT #1302), 11c (RT #1322), 12a (RT #1329), 16 (RT #1468), 17 (RT #1473a & 1497), 18 (RT #1503), 20 (RT #1524 & 1526), 21 (RT #1535), 23 (RT #1616).

Laurencia sp.
Stations: 1 (RT #1030b), 2 (RT #1081), 3a (RT #1106), 3b (RT #1137), 5a (RT #1166), 6a (RT #1207), 8a (RT #1269a), 12 (RT #1334), 17 (RT #1473d), 23 (RT #1549), 29 (RT #1669a).
Feeding herbivores leave nothing but the basal portions for collectors! "Undisturbed" material is needed before identifications can be attempted.

Chondria repens Boergesen, 1924: 300; Tanaka, 1963: 66.
Stations: 1 (RT #1030-tetrasporic), 2 (RT #1074), 3a (RT #1106), 5a (RT #1195), 6a (RT #1204c-tetrasporic), 28 (RT #1657), 29 (RT #1669-tetrasporic).

The habit of this alga and the morphological features of the tetrasporangia agree in detail with Tanaka's description and figures.

SELECTED BIBLIOGRAPHY

Abbott, I. A. 1946. The genus Griffithsia (Rhodophyceae) in Hawaii. Farlowia 2(4): 439-453.

Bliding, C. 1963. A critical survey of European taxa in Ulvales. Opera Botanica 8(3): 160 pp.

Boergesen, F. 1914. The marine algae of the Danish West Indies. Pt. 2. Phaeophyceae. Dansk Bot. Arkiv. 2(2): 157-224.

_____. 1915-1920. The marine algae of the Danish West Indies. Pt. 3. Rhodophyceae. Dansk Bot. Arkiv. 3(1): 1-504.

_____. 1941. Some marine algae from Mauritius. II. Phaeophyceae. K. Danske Vidensk. Selsk., Biol. Meddel. 16(3): 1-81, 8 pls.

_____. 1953. Some marine algae from Mauritius. V. K. Dansk Vidensk. Selsk., Biol. Meddel. 21(9): 1-62.

Brock, V. E., R. S. Jones and P. Helfrich. 1965. An ecological reconnaissance of Johnston Island and the effects of dredging. Hawaii Marine Laboratory Technical Report No. 5. University of Hawaii, Honolulu, Hawaii. 90 pp.

_____, W. Van Heukelem, & P. Helfrich. 1966. An ecological reconnaissance of Johnston Island and the effects of dredging. (Second Annual Report). Hawaii Institute of Marine Biology Technical Report No. 11. University of Hawaii, Honolulu. 56 pp.

Buggeln, R. G., & R. T. Tsuda. 1966. A preliminary marine algal flora from selected habitats on Johnston Atoll. Hawaii Institute of Marine Biology Technical Report No. 9. University of Hawaii, Honolulu. 29 pp.

Dawson, E. Y. 1950. A review of Ceramium along the Pacific Coast of North America with special reference to its Mexican representatives. Farlowia 4(1): 113-138.

_____. 1954. Marine plants in the vicinity of the Institute Océanographique de Nha Trang, Viet Nam. Pacific Sci. 8(4): 373-469, 1 map, 63 figs.

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

Dawson, E. Y. 1957. An annotated list of marine algae from Eniwetok Atoll, Marshall Islands. Pacific Sci. 11(1): 92-132, 31 figs.

_____. 1961. Plantas marinas de la zona de las mareas de El Salvador. Pacific Nat. 2(8): 288-461.

_____. 1962. Marine red algae of Pacific Mexico. Pt. 7. Ceramiales: Ceramiaceae, Delesseriaceae. Univ. So. Calif. Press 26(1): 1-106.

_____. 1963. Marine algae of Pacific Mexico. Pt. 8. Ceramiales: Dasyaceae, Rhodomelaceae. Nova Hedwigia 6(3/4): 401-481.

Drouet, F. 1962. Gomont's ecophenes of the blue-green alga, Microcoleus vaginatus (Oscillatoriaceae). Proc. Acad. Nat. Sci., Phil. 114(6): 191-205.

_____. 1963. Ecophenes of Schizothrix calcicola. Proc. Acad. Nat. Sci., Phil. 115(9): 261-281.

_____, and W. A. Daily. 1956. Revision of the coccoid Myxophyceae. Butler Univ. Bot. Studies, XII: 218 pp.

Egerod, L. E. 1952. An analysis of the siphonous Chlorophycophyta. Univ. Calif. Publ. Bot. 25(5): 325-454, 23 figs., 14 pls.

Eubank, L. L. 1946. Hawaiian representatives of the genus Caulerpa. Univ. Calif. Publ. Bot. 18(18): 409-432, 2 figs.

Fan, K. C. 1956. Revision of Calothrix Ag. I. Delineation of species. Rev. Algol. N. S. 2(3): 154-178.

Gilbert, W. J. 1962. Contribution to the marine Chlorophyta of Hawaii, I. Pacific Sci. 16(1): 135-444, 8 figs.

Gosline, W. A. 1955. The inshore fish fauna of Johnston Island, a central Pacific atoll. Pac. Sci. 9: 442-480.

Hillis, L. W. 1959. A revision of the genus Halimeda. Inst. Mar. Sci. VI: 321-403, 12 pl.

Howe, M. A. 1924. Chinese marine algae. Torrey Bot. Club Bull. 51: 133-144, 2 pls.

Kützing, F. T. 1843. Phycologia generalis. 458 pp., 80 pls. F. A. Brockhaus, Leipzig.

Moul, E. T. 1964. New records of Halimeda and Udotea for the Pacific area. Atoll Res. Bull. (106): 10 pp.

Okamura, K. 1897. On the algae of Ogasawara-jima (Bonin Isls.) Bot. Mag. Tokyo 11(119-120): 1-16.

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

_____. 1944. Structure and taxonomy of Taenioma, including a discussion of the phylogeny of the Ceramiales. Madrono 7(3): 193-214.

Post, E. 1936. Systematische und pflanzengographische Notizen zur Bostrichia-Caloglossa-Assoziation. Rev. Algologique 9(1-2): 1-84, 4 figs.

Tanaka, T. 1963. Studies on some marine algae from Southern Japan. IV. Mem. Fac. Fish., Kagoshima Univ. 12(1): 66-67.

Taylor, W. R. 1950. Plants of Bikini and other Northern Marshall Islands. Univ. Mich. Press. xv + 227 pp., 79 pls.

_____. 1960. Marine algae of the eastern tropical and subtropical coasts of the Americas. Univ. Mich. Press. ix + 870 pp., 14 figs., 80 pls.

Tilden, J. 1910. Minnesota algae. Vol. I. Report of the Survey, Botanical Series, VIII. Minneapolis, Minnesota. iv + 319 pp., 20 pls.

Tseng, C. K. 1942. On some Chinese species of Griffithsia. Mich. Acad. Sci., Arts and Letters, Papers 27: 111-116.

Tsuda, R. T. 1966. Preliminary bibliography on the marine benthic algae in the Central Pacific, Polynesia and Micronesia. Hawaii Institute of Marine Biology Technical Report No. 10. University of Hawaii, Honolulu. 13 pp.

Umezaki, I. 1961. The marine blue-green algae of Japan. Mem. Coll. Agr., Kyoto Univ. 83: 1-149.

Weber van Bosse, A. 1923. Liste des algues du Siboga. Seconde partie, Ceramiales, pp. 311-392, pls. 9-10. Siboga Expeditie Monog. 59. E. J. Brill, Leiden.

Yamada, Y. 1941. Notes on Japanese algae IX. Sci. Pap. Inst. Algol. Res., Fac. Sci. Hokkaido Imp. Univ. 2(2): 195-215.

_____. 1944. A list of the marine algae from the atoll of Ant. Sci. Pap. Inst. Algol. Res., Fac. Sci., Hokkaido Univ. 3(1): 1-10.

Yendo, K. 1920. Novae algae Japonicae. Bot. Mag. (Tokyo) 34: 1-12.