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Marine Algae of the Smithsonian-Bredin Expedition to the Society and Tuamotu Islands[1]

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ABSTRACT: Short lists of the marine algae collected by the Smithsonian-Bredin Expedition to the Society and Tuamotu Islands are given. A detailed discussion and description of *Giffordia indica* (Sond.) Papenf. & Chihara is given.

THE UNITED STATES NATIONAL MUSEUM has well earned its success in supplementing its budget-financed field study expeditions with support from private sponsors, whereby great enrichment of our national collections has resulted. One of these was the Smithsonian-Bredin Expedition of April and May 1957 to the Tuamotu Archipelago and the Society Islands (specifically the Îles sous le Vent and Moorea), French mandates just north of the Tropic of Capricorn in the southern Pacific Ocean. The generous sponsor, J. Bruce Bredin of Wilmington, Delaware has also supported work in the Atlantic, such as his 1960 expedition to Yucatan (Taylor, 1972: 34).

The marine algae collected were few, but not without interest, for there is singularly little known of the marine vegetation of either of these Pacific island groups. They figure in the report of "Captain Beechey's Voyage...in H.M.S. Blossom" (Hooker and Arnott, 1841: 77), in a general review by von Martens (1866: 1) and in Svedelius's important phytogeographic paper (1924: 1). Mme. Weber-van Bosse's Tahiti paper (1910: 1) should bear directly, since Tahiti is very near Moorea, but only one of the localities, Tearei (as Tearia), suggests Tahiti, while two, the village Rikitea and the Île Taravai, appear on maps of the Gambier Islands far away at the southeast end of the Tuamotu Archipelago. Only *Caulerpa racemosa* appears both in her short list and in this one. Butters (1911: 161) mentions two *Liagora*s from Tahiti, and Brand (1911*a*: 138; 1911*b*: 611) cites species in *Chlorodesmis* and *Boodlea*. I included *Turbinaria* records in reviewing that genus (Taylor, 1964: 475). Setchell (1926: 61), also dealing with Tahiti, gives us the chief, though surely very incomplete, source of information on the algae of the area and, like myself, he found difficulty with the Weber localities. General features of the vegetation on Raroia in the Tuamotus are alluded to by Doty and Morrison (1954) and by Guilcher, Denizot, and Berthois (1966: 851) as being present on Mopelia Atoll in the Society Islands, but they deal primarily with the crustose lithothamnia of the reef, which are entirely lacking from the Smithsonian-Bredin collections. There are in fact, numerous papers mentioning algal components of the reef structure, but they do not have comprehensive taxonomic coverage.

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SOCIETY ISLANDS

The expedition with which this paper is concerned made algal collections in two regions in the group. At Moorea, 10 miles northwest of the better-known Tahiti, particularly on the reef at Pointe Hauré (or Hauru) on the northeast corner of the island, on Toatane Reef west of the entrance to Paopao Bay (Cook Bay), and

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a little to the east, but west of Irihonu Pass at Maharépa Bay on 8–10 May 1957. Other collections had been made at Huahiné about 100 miles to the west in the Leeward Group, specifically on the northern island Huahiné Nui, north of Baie Fare between Pointe Teffaao (or Teffaar) and Pointe Teopape (or Teopapa) (2 May), and along the outer reef south of Passe Avamoa near the bay and village of Fare (3 May). Still earlier, good samples were retained from gatherings made on Bora Bora Island, taken from the lagoon side of the ocean reef west of Motu Tapu (25 April).

Chlorophyceae

Dictyosphaeria cavernosa (Forssk.) Børg. Bora Bora Island, Motu Tapu, Station 62-57.

Boodlea composita (Harv.) Brand. Bora Bora Island, Motu Tapu, Station 62-57, a poor fragmentary sample. Huahiné Nui, Passe Avamoa, Station 95-57.

Caulerpa pickeringii Harv. & Bail. Moorea Island, Maharépa Bay, Station 116-57. This was a generous collection of a plant not commonly reported. Its habit is quite different from that of other *Caulerpa*s. It forms close colonies with sparingly branched erect axes a very few centimeters tall. These resemble those of a small *Codium*, having the same texture, but *Codium*s do not commonly form dense plant carpets. The ramelli are so very densely crowded that the surface appears quite continuous, but on dissection the typical detailed structure with trabeculae characteristic of the genus is evident.

Caulerpa racemosa (Forssk.) J. Ag. Bora Bora Island, Motu Tapu, Station 62-57, in a dwarf form.

Chlorodesmis comosa Harv. & Bail. Bora Bora Island, Motu Tapu, Station 62-57. Moorea Island, Pointe Hauré, Station 105-57.

Phaeophyceae

Ectocarpus breviarticulatus J. Ag. Moorea Island, Toatane Reef, Station 103-57. Huahiné Nui Island north of Baie Fare, Station 90-57. The plants from Huahiné Island bore plurilocular gametangia in abundance.

Turbinaria condensata Sond. Bora Bora Island, Motu Tapu, Station 62-57. Moorea Island, Pointe Hauré, Station 105-57.

Rhodophyceae

Gelidiella acerosa (Forssk.) Børg. Bora Bora Island, Motu Tapu, Station 62-57.

Jania pumila Lamx., *prox.* Moorea Island, Pointe Hauré, on *Turbinaria*, Station 105-57.

Jania rubens Lamx. Bora Bora Island, Motu Tapu, Station 62-57. Huahiné Nui, Passe Avamoa, Station 95-57.

Amphiroa rigida Lamx. Huahiné Nui, Passe Avamoa, Station 95-57. There were very few instances of femur-ended segments in this material.

Hypnea pannosa J. Ag., *prox.* Bora Bora Island, Motu Tapu, Station 62-57.

TUAMOTU ISLANDS

This archipelago extends in a southeasterly direction for a great distance from those islands north of the Society group where this expedition made its algal collections. Makatea Island is perhaps the closest, and the algae were collected north of the pier in Temao Harbor on 16 April 1957. Tikahau Island is just a little to the east. The material available came from a depth of 15 m on a patch of reef in the lagoon south of the deep water pass, at Mareva anchorage on 12 April. A third sample came from the lagoon shore of Maiai Islet at Tikahau on 13 April.

Ulva rigida C. Ag. Makatea Island, Temao Harbor, Station 37-57.

Microdictyon okamurai Setch. Tikahau, Maiai Islet, Station 26–57.

Cladophoropsis sundanensis Reinb. Makatea Island, Temao Harbor, Station 37-57.

Halimeda opuntia (L.) Lamx., f. *elongata* (Bart.) Bart. Tikahau, Mareva anchorage, Station 18-57.

Halimeda lacunalis W. R. Taylor. Tikahau, Mareva anchorage, Station 18-57.

Phaeophyceae

Ectocarpus breviarticulatus J. Ag. Makatea Island, Temao Harbor, Station 37–57.

Giffordia indica (Sond.) Papenf. & Chihara.

Under one name or another *Ectocarpus indicus* Sonder (1854: 3, from Bima Bay on the north coast of Sumbawa Island near the eastern end)

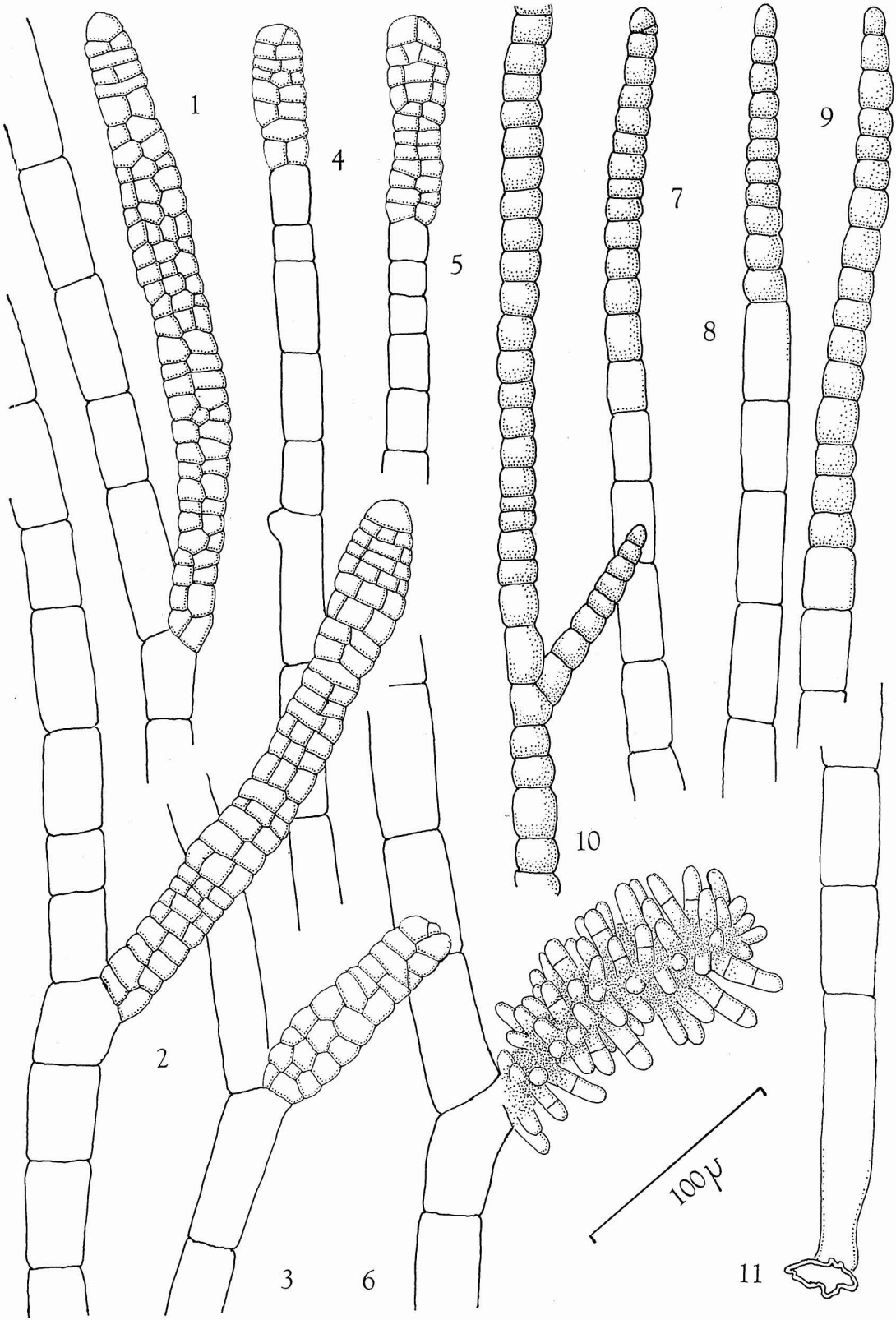
is recognized to be a widespread and important alga of the western Pacific and Indian oceans. Unfortunately, it seems generally to have been reported very casually, without thorough accompanying description or figures and has been associated in synonymy with various other entities. Askenasy (1888: 19, 20, pl. 5, fig. 2, 10) quoted from the original description where the gametangia are said to be secund, which certainly has not generally been an emphasized feature, but the statement may have affected Setchell's interpretation. The figure of *E. indicus* which Mme. Weber-van Bosse (1913: 130) provided from Sonder material shows plurilocular gametangia erect on the ascending filaments, not secund near the bases of lateral branchlets, and, admitting that the plant she figured was very small, the branching is erect, nothing like the figures given by Setchell (1924: 169). Børgesen (1937: 4) suggested that *E. indicus* was only a form of *E. duchassaingianus* Grunow. Still later (1941: 16) he discussed *E. indicus* at length and in this case reduced *E. duchassaingianus* to synonymy under *E. indicus*, which Dawson (1956: 43) accepted. However, his figures resemble *E. mitchellae* somewhat, and my own (Taylor, 1928, pl. 14, fig. 11) of *E. duchassaingianus* are not entirely convincing, when it is considered synonymous with *E. indicus*. Similarly Okamura's figure (1936: 137) suggests *E. mitchellae*.[3] Trono (1969: 25) reported very small plants somewhat similar to those of Mme. Weber-van Bosse from the Caroline Islands, but with unexpectedly short plurilocular gametangia. Womersley and Bailey (1970: 288) on examination of Sonder material found that the figure given by Setchell did not at all agree with the type, but rather with *Giffordia mitchellae* (Harv.) Hamel, which is quite my impression from Setchell's figure and from material I have seen. Womersley and Bailey refer *indica* to Hamel's genus *Feldmannia*, a genus for which I see no particular need. Like Børgesen, Trono, and Papenfuss, Womersley and Bailey (1969: 437) reduced *duchassaingianus* to synonymy under *indica* without giving many supporting data.

[3] In Kuckuck's reliquae (1963) he is seemingly clear as to *E. duchassaingianus* but he had not come to a final decision on its relations with *E. indicus* and *E. amicorum* Harv.

Since I have recognized *E. duchassaingianus* (Taylor, 1960: 207 as *Giffordia duchassaingiana*) from numerous Atlantic and Caribbean stations, I have been able to make measurements of filaments and of plurilocular gametangia from these and from the several Pacific stations represented in the Michigan collections. The average maximum filament diameter for the Atlantic-Caribbean material I find to be 29 μm, the largest gametangia to average 23.5 μm in diameter and 156 μm in length, with an extreme of 248 μm. The gametangia do not, then, often reach extreme lengths. While minor differences seem to appear in some specimens they do not seem constant, and so it appears that on the present evidence I must accept *Giffordia indica* (Sonder) Papenfuss & Chihara (Papenfuss 1968: 30) over *E. duchassaingianus*.

This leads to a consideration of the Tuamotu material brought back by this expedition. It was generous in quantity, but not well-enough preserved to show the chromatophores. The lower parts were heavily infiltrated with calcareous mud and probably little effort had been made to get any creeping parts or initial organs of attachment (Fig. 1—*11*) to the underlying coral rock, so these were very scarce and of limited value. Nevertheless the material justified extended study and comparison with other Pacific and Atlantic materials available.

A condensed description based strictly on the Tuamotu material would be as follows: *G. indica* (Sonder) Papenfuss & Chihara: Plants crowded colonial, 2–5 cm tall, the bases somewhat decumbent and entangled, the erect filaments loosely and repeatedly alternately branched, for the most part 18–26 μm diameter, the cells cylindrical, 1.25–2.50 diameters long, somewhat more slender toward the tips where 10–12 μm diameter, 30–70 μm long; extensive regions, apical and intercalary, including axes with branchlets, composed of short cells distinctly turgid and with very dense contents, not differing greatly from adjacent regions in diameter, but the cells only half as long, or barely as long, as broad (Fig. 1—*7–10*); plurilocular gametangia scattered along the filaments (Fig. 1—*1–3*), ascending to erect, sessile, or rarely on 1–2-stalk cells, occasionally terminating a branchlet (Fig. 1—*4–5*), subcylindrical or a little clavate, blunt at the tips, 11–31 μm di-


1
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ameter, 75–260 μm long, with loculi about 7.5–8.0 μm diameter. TUAMOTU ISLANDS, Tikahau Atoll, Maiai Island, along the shore on the lagoon side. Collected Smithsonian-Bredin Expedition, Station 26–57, 13 April 1957.

Sonder's diagnosis (1854: 3; Anon., 1855: 44) does not provide detailed measurements of the plants. Askenasy does, and both in filament diameter and plurilocular gametangial dimensions the figures are considerably below the average. Børgesen (1914: 159, under *E. duchassaingianus*) cites dimensions comparable with those from the Pacific, as does Jaasund (1969: 256) from Tanzania and Nasr (1947: 64) from the Red Sea. I have mentioned the measurements I have averaged from Bermudian and West Indian Atlantic material, but did not note unilocular sporangia there myself. Børgesen did, and reports them as reaching 70 μm diameter and 110 μm in length. I did see them, together with pluriloculars, in material from Hawaii (collector Doty, no. 19280), where they were smaller, only 26 μm diameter and 85 μm in length. The materials available to me from the Marshall Islands, Caroline Islands, and Singapore in structural dimensions are within the range I find from the Tuamotus. Mme. Weber-van Bosse (1913: 130) reports similar filament diameters, but longer (to 300 μm) pluriloculars, while her measurements of unilocular sporangia agree with those of Børgesen, rather than what I found in Hawaiian material. On examining a small portion of her Makassar material (no. 936,303-77) I found the larger unilocular sporangia often to be a little obovate, and to reach 39–47 μm in diameter, 85–125 μm in length, but none to approach the diameter of 60 μm which she cites.

Opportunity to examine *E. indicus* material in the Rijksherbarium, Leiden, including that formerly in the possession of Mme. Anna Weber-van Bosse, served importantly to extend my familiarity with the species. Some clearly showed the short entangled basal holdfast filaments. A Sonder type specimen included was well over 4 cm tall, indicating that she had at least one well-developed plant to study, not simply minute ones as inferred by Setchell. The largest filaments in Leiden specimens reached 34–39 μm in diameter. The plurilocular gametangia generally ranged in diameter from 21–36 μm and in length to 200–300 μm, but in the material of the type collection from the island of Sumbawa, near Pulu Kambing, in Bima Bay (Zollinger no. 3428), it commonly exceeded 300 μm and actually reached 403 μm. The Tuamotu material is, then, on all accounts of quite conservative dimensions. One should note that in one Leiden specimen from the Celebes the gametangia seemed mature, but were only one–two cells and to 16 μm in diameter, while to 170 μm in length, which suggests dimorphism among the plurilocular plants.

The largest plurilocular gametangia seem to occur in the upper central parts of the tufts: those formed early near the base matured while relatively small, whereas those near the filament tips were immature. A peculiarity found in the Tuamotu material concerned these plurilocular gametangia. In numerous instances near the bases of the filament tufts these proliferated freely (Fig. 1—*6*), but the individual outgrowths were not seen to exceed three–five cells in length. Their propagative potential in a soft, sandy, or muddy environment is, however, evident.

The matter of the reputed growth zones calls for some comment. In most ectocarpi familiar to me these are of modest extent, usually basal to terminal "hairs." In *G. indica* they are very long, even several scores of cells, and there seems to be no distinctive point in the series where particularly short cells initiate activity. The cells are half as long as broad or subequal, in some collections very turgid and very dense of content (as in the Tuamotu material), but in others less distinctive. These series may be terminal (Fig. 1—*7–9*), where they are relatively short, or intercalary and more often long, including lateral branchlets themselves similarly distinctive (Fig. 1—*10*). Instances were seen where small branch systems of many divisions were completely in this state.

FIG. 1. *Giffordia indica*. *1–3*, Plurilocular gametangia lateral on leading axes; *4*, *5*, plurilocular gametangia terminal on branchlets; *6*, plurilocular gametangium with the loculi germinating to filaments *in situ* instead of producing swarmers; *7–10*, terminal and intercalary filament areas considered to be growth zones; *11*, an initial hapteron.

Chnoospora minima (Her.) Papenfuss. Makatea Island, Temao Harbor, Station 37-57.

Turbinaria condensata Sond. Makatea Island, Temao Harbor, Station 37-57.

Rhodophyceae

Pterocladia nana Okam., *prox.* Makatea Island, Temao Harbor, Station 37–57.

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