

**NOTES ON PLANTS OF THE GENUS CAULERPA
IN THE HERBARIUM OF MAXWELL S. DOTY
AT THE UNIVERSITY OF HAWAII**

by Wm. Randolph Taylor¹

In 1966 on the invitation of Professor Maxwell S. Doty I spent several weeks at the University of Hawaii to review his holdings of certain algal genera, particularly those of *Caulerpa* (Chlorophyceae-Siphonales), and especially the Pacific specimens.^{2,3} In view was the rectification of the determinations, where necessary, and the organization of the genus as represented in the collection from a single viewpoint. This I did at that time, but because of other work in hand was unable to consider preparing a report for publication.

More recently, pressed to make such a report, I sent for and received the more troublesome part of the material on loan, and have

¹ Department of Botany, University of Michigan.

² This study while in Honolulu was conducted under an Atomic Energy Commission Contract no. AT(O4-3)-235 to Prof. Maxwell S. Doty, and later continued at the University of Michigan under Nat. Sci. Found. grant GB-3186 in part, for which help the writer is most thankful.

³ The last names of the principal collectors of the materials reported in this paper are associated with the collection number in each case, but in order that their identity may be more accurately defined their initials where available are given in the following list:

Alcala, A.C.; Almazan, M.; Alvarez, V.; Buggeln, R.; Cooper, J.; Doty, M.S.; Engard, C.J.; Fong, E.; Gilmartin, M.; Hair, L.E.; Halstead, B.; Hastings, C.F.; Horwitz, L.; King, J.E.; Kraft, G.T.; Littler, M.M.; Long, C.R.; Matsui, T.; Meñez, E.G.; Newhouse, G.; Pages, P.; Randall, J.; Rogers, D.P.; Sachet, M.-H.; Santos, G.A.; Seiburth, J.; Soegiarto, A.; Sorokin, Y.; Stone, B.C.; Strasburg, D.W.; Trono Jr., G.C.; Tsuda, R.; Velasquez, G.T.; Villaroya, M.L.; Wainwright, S.A.; Wreede, R.E. de.

gone over it again. On the basis of my 1966 notes, review of material accessioned since then, and reconsideration of the specimens loaned in 1972 I present here a list of representative western and central Pacific *Caulerpa* material in that herbarium, excluding Japan, Australia and New Zealand. This is probably the largest representation of that genus from the area in any herbarium. Because of the very great duplication of specimens from certain localities I only cite a few examples from each, but attempt to include all significant places which could be located geographically.

When I agreed to go over the great bulk of material again and to prepare this report I was unaware that G.C. Trono had (1968) published on the Caroline Islands material, or was later to publish (Trono 1972a, b; 1973) on Philippine material, leading to great duplication of effort without commensurate yield of new data. However, since this present paper covers the central and western Pacific (south of Japan, north or east of Australia) in general, and since the citation again of Caroline Island and Philippine specimens could be kept to a minimum, it seems wise to include them where necessary to complete the tale of Honolulu holdings.

It does not seem needful to review here the literature on Pacific green algae, as this is not an historical paper. Nor is it a summation of all accounts of *Caulerpa* in the western Pacific. Necessarily the basis for any account of the genus is the monograph by Mme Anna A. Weber-van Bosse (1898). Mention of the genus occurs in many of the more general papers. A good deal of this literature has already been brought together, in Okamura (1916), Taylor (1950, 1966), May (1953, 1966a, b), and Dawson (1956, 1957), while Gilbert has also listed it (1959) and Abbott (1961), Trono (1968) and Womersley and Bailey (1970) have extended it still further.

Nor can too detailed conclusions be drawn respecting the geographical ranges of the species listed. For this all other major herbaria concerned with the area should be consulted. Nevertheless very many extensions of range are involved, and we do get some idea of what species are commonest throughout the central and western Pacific. It is clear that *Caulerpa lentillifera*, *C. mexicana*, *C. peltata*, *C. racemosa* in particular, *C. serrulata* and *C. urvilliana* are by far the commonest. The substantial representation of the very small *C. ambigua* about Hawaii probably reflects the closer observation possible from a well-equipped scientific center. Other small species seldom mentioned, like *C. elongata*, *C. webbiana* and smaller forms of *C. fastigiata* probably have been missed by reason of a lack of close search.

Some species are nearly ubiquitous in the subtropics and tropics around the world, and in this we could include, with others, *C. cupressoides*, *C. racemosa* and *C. sertularioides*. On the other hand *C. lentillifera* does not come into the Atlantic flora, though found from the Marshall Islands to the Red Sea, paralleling *C. urvilliana*

ranging from the Line Islands west to Mauritius, absent from the Atlantic. Disproportionate abundance is suggested in some cases, for *C. serrulata* seems to be far more abundant in Pacific collections than West Indian, though found in both oceans, while the reverse seems to be the case with *C. cupressoides*.

Less familiar species are harder to evaluate as to range. They may have a scattering, sparse distribution. First found in the Marshall Islands, *C. bikinensis* is now known to reach the Tuamotu group. From the Carolines to the Philippines is about the range of *C. lessonii*. We must not discount the possibility of migration to new areas after a long period of limitation to an old range. For instance, *C. scapelliformis*, long known from the Red Sea to south Australia and Japan has of recent years turned up in Brazil and Guadeloupe, and by 1966 abundantly in Barbados and Antigua, areas where such a relatively large and distinctive alga could hardly have grown unrecorded through the previous decades. If one is reluctant to deny its earlier presence there one must remember the case of *Codium fragile* (Sur.) Hariot, much more closely documented in its migration from the Pacific to the eastern coast of the United States, eventually reaching northern New England. There it was never seen until recent years, in an area of intensive observation of the marine algae, but it is now abundant enough to constitute a nuisance to the shellfish industry.

List of specimens

Caulerpa ambigua Okam.

HAWAII

- LAYSAN I., from the s.w. side, Tsuda no. T-548, 6 xii 63.
 KAUAI I., Anahola, Doty no. 10224, 7 ii 52.
 OAHU I., Waikiki Beach, Choy, 16 iii 54, Doty no. 13063a, 4 xii 55, Ewa Beach, Littler no. 26500, 2 vi 70.

Caulerpa antoensis Yamada¹

MARSHALL ISLANDS

- ARNO ATOLL, Ine Village, Horwitz no. 9040, 10 vii 51.

CAROLINE ISLANDS

- PJNGELAP I., Meñez no. 21926, 1 vii 60.
 MOKIL IDS., Urak I., Meñez no. 21344, 29 vi 60.
 PULUWAT I., Meñez no. 23236, 7 viii 60.
 IFALUK IDS., Ifaluk I., Meñez no. 23055, 10 viii 60; Ella I., Meñez no. 23232, 10 viii 60; between Ifaluk I. and Falalap I., Meñez no. 23102, 10 viii 60.

A fragment of Yamada's original material (Yamada 1941, 1944a, b) from Ant Atoll near Ponape Island in the eastern Carolines, which he kindly sent me after my Bikini book appeared, showed very short axes

¹ *C. arenicola* Taylor 1950.

and irregularly disposed ramelli, but his 1941 figure, far better than that of 1944a which accompanied his formal description, shows them bilaterally disposed in large part. The ramelli on his plant are a little thicker than on the Bikini plants, reaching at least 200 μm . On some of the Caroline Island specimens they were only 135 μm diam, but in others reached 264 μm .

Caulerpa bikinensis Taylor

TUAMOTU ARCHIPELAGO

RAROIA I., Tomokgolou (? Tomogagie), Doty & Newhouse no. 11426, 29 vii 52.

Caulerpa brachypus Harv.

LINE ISLANDS

PALMYRA I., Long no. 2833, 27 xi 64.

MARSHALL ISLANDS

MAJURO ATOLL, Seiburth & Sorokin, no number, ii 70.

CAROLINE ISLANDS

PULUWAT I., Meñez nos. 23064, 23091, 7 viii 60; these included strongly dentate specimens.

YAP I., Meñez no. 21489, 19 viii 60.

PHILIPPINE ISLANDS

SAMAR I., Samar Prov., Guiuan, Santos no. 20466, 29 iv 48 (not dentate), Guiuan, Hinatunglan, Santos no. 26462, 17 vi 69 (very attenuate).

NEGROS I., Negros Oriental Prov., Siquijor I., Carrio Solong-on, Alcala no. 20522, n.d., Meñez nos T-1132, T-1137, 28 ix 67, Santos nos. 26042, 26047, 22 v 69, 26197, 26221, 26 v 69.

PALAWAN I., Palawan Prov., Cujo I., Meñez 16537, 30 iv 58.

MINDANAO I., Surigao del Norte Prov., Surigao, Meñez no. 18363, n. d.; Zamboanga City Prov., Little Santa Cruz I., Santos 26544, 26 viii 71.

SULU ARCHIPELAGO, Sulu Prov., Jolo Group, Pangasinan I., Doty & Hair no. 25418, vi 66; Siasi Group, Siasi I., Doty & Hair no. 25537; Tawitawi Group, Bilitan I., Doty & Hair no. 25499, 5 viii 66; Sibitu Group. Tumindao I., Sitangkai, Doty & Hair no. 25451, vii 66.

Caulerpa cupressoides (West) C. Ag.

LINE ISLANDS

FANNING I., Tenupa, Wainwright no. 20101, 2 vii 63

MARSHALL ISLANDS

ARNO ATOLL, Ine Village, Doty no. 9001, 26 v 51.

CAROLINE ISLANDS

KUSAI I., Lele Harbor, Meñez no. 15852, 16 vii 60, Tafsanak Village, Meñez no. 23407, 16 vii 70; Uta I., Meñez no. 23248, 17 vi 60.

PINGELAP I., Meñez nos. 21312, 21935, 7 viii 60.

TRUK IDS., Quoi I., Meñez no. 23191, 2 viii 60; Moen I., Meñez 15901, 31 vii 60; Fefan I., Meñez no. 23081, 8 viii 60; Falas I., Meñez no. 23513, 30 vii 60.

- ULUL I., Meñez no. 15883, 6 viii 60.
 PULUWAT I., Meñez nos. 23131, 23235, 7 viii 60.
 IFALUK I., Meñez no. 23126, 10 viii 60; between Ifaluk I. and
 Falalap I., Meñez no. 23063, 10 viii 60.
 SOROL I., Meñez nos. 23049, 23162, 13 viii 60.
 YAP I., north of harbor channel, Meñez nos. 21572, 23092, 18
 viii 60.
 HELEN I., reef, Meñez no. 15415 p.p., 28 viii 60.

PHILIPPINE ISLANDS

- LUZON I., Quezon Prov., Baler, Diksalarin, Velasquez no. 16469B,
 23 iv 66.
 CATANDUANES I., Catanduanes Prov., Benticayan s. of Vinticayan
 Point, Doty & Velasquez no. 16655, 21 v 58.
 SAMAR I., Samar Prov., Guiuan, Pagnamiton, Doty & Alvarez no.
 14324, 4 ii 65.
 MINDANAO I., Zamboanga City Prov., Sacol I., Doty & Hair no.
 25398, 22 vi 66.
 SULU ARCHIPELAGO, Jolo Group, Pangasinan I., Doty 25421, vi 66;
 Tapul Group, Siasi I., Doty & Hair no. 25525, 10 viii 66;
 Tawitawi Group, Tawitawi I., Balimbing Pt., Meñez no. 1101,
 23 ix 67; Bilitan I., Doty & Hair no. 25484, 5 viii 66.

Caulerpa elongata Weber-van Bosse

MARSHALL ISLANDS

- ARNO ATOLL, Horwitz no. 9046, 10 vii 51.

CAROLINE ISLANDS

- YAP I., Meñez no. 23780, 19 viii 60.

PHILIPPINE ISLANDS

- LUZON I., Sorsogon Prov., Bulusan, Kraft no. 349, 17 Mar. 68.

Caulerpa fastigiata Mont.

CAROLINE ISLANDS

- KUSAIE I., Tafansak, Meñez no. 21955, 16 vii 60; Utwa I., Meñez
 no. 23714, 17 vii 60.

PHILIPPINE ISLANDS

- SAMAR I., Samar Prov., Guiuan, Pagnamiton, Doty & Alvarez no.
 14332, 4 ii 65.
 NEGROS I., Negros Oriental Prov., Siquijor I., Carrio Solong-on,
 Santos nos. 26052, 26160, 22 v 69.

Caulerpa fergusonii Murray

PHILIPPINES

- LUZON I., Sorsogon Prov., Bulusan, Santos no. 26522, 9 viii 71.

Caulerpa lentillifera J. Agardh

CAROLINE ISLANDS

- TRUK IDS., Fefeian I., Meñez without number, 28 vii 60.

PHILIPPINE ISLANDS

- LUZON I., Batangas Prov., Matabungkay, Santos no. 20450 p.p.,
 3 iv 68. Pangasinan Prov., Hundred Islands, Virgin Cave I.,
 Doty & Meñez 16342, 15 ii 58.

- CATADUANES I., Cataduanes Prov., Virac Point, Doty & Velasquez no. 16746, 20 v 58.
- SAMAR I., Samar Prov., Guiuan, Hinatunglan, Santos 26461, 17 vi 69.
- CEBU I., Cebu Prov., Cebu City market, n. coll., no. 18318, 14 vii 58; Mactan I., Cordova, at *Caulerpa*-farm, Doty no. 16075, 17 i 58, Calawisan, Meñez no. T-1027, 8 ix 67.
- NEGROS I., Negros Oriental, Siquijor I., Solong-on, Alcala nos. 20520, 20523, Santos nos. 26198, 26 v 69.
- PALAWAN I., Palawan Prov., Pto. Princesa, Inagawan, Velasquez no. 3079, 20 vi 51; Cujo I., Cujo, Meñez 16535, 30 iv 58.
- MINDANAO I., Davao Prov., Davao, Sasa Wharf, Doty no. 18056, 26 vi 68; Zamboanga Prov., Little Santa Cruz I., Menez no. T-1057, 10 ix 67; Sacol I., dwarf, Meñez no. T-1096, 19 ix 67.
- SULU ARCHIPELAGO, Sulu Prov., Tapul Group, Siasi I., Doty & Hair no. 25530, 10 viii 66, Sibaud I., Santos nos. 26545, 26559, 14 ix 71; Manubal I., Doty & Hair no. 25529, 10 viii 6; Tapaan I., Doty & Hair no. 25574, Trono T4064, T4087, 29 xii 70. Tawitawi Group, Bilitan I., Doty & Hair nos. 25501, 25511, 5 viii 66; Tawitawi I., Balimbing Pt., Meñez no. T-1102, 23 ix 67.

The size of the ramelli on plants assignable to this species seems to vary greatly. In most specimens they are small, as we find in Cebu I. no. 18318, where the diameter is about 1.5 mm. In contrast, one places Bilitan I. no. 25511, where they are over 4 mm in the dry state. Similar coarse plants were found at Rongelap lagoon (Taylor 1950, p. 67) and it is possible that we are dealing with two species, rather than one very variable one.

Caulerpa lessonii Bory

CAROLINE ISLANDS

- TRUK IDS., Fefan I., Meñez no. 23029, 28 vii 60.
- YAP I., Yap Harbor, Meñez no. 23144, 18 viii 60.

PHILIPPINE ISLANDS

- LUZON I., Pangasinan Prov., Lingayan Gulf, Cabarruyan I., Anda, Santos no. 20406a, 22 ii 68. La Union Prov., San Fernando, Almazan no. 1300, 3 iii 68.

This group of *Caulerpas* from the islands gave me much concern because of a marked similarity to *C. cupressoides* var. *lycopodium* f. *elegans* (Crouan) Weber-van Bosse of the West Indies. They also resemble the figures and descriptions of *C. lessonii* Bory and *C. distichophylla* Sond. However, Prof. H.B.S. Womersley informs me that the ramelli of *C. distichophylla* are compressed, not terete as described by Mme Weber-van Bosse (1898, p. 341), and as are those of our plants, and as the type locality for the species *lessonii* is in the Caroline Islands the probability is strong that plants like these were what Bory had in hand, though I have not actually had the type to examine. The relation of the v. *lycopodium* f. *elegans* to *C. cupressoides* seems to me rather insecure, and these *lessonii* plants would have even less claim to relationship.

Caulerpa macrodisca Decne.

PHILIPPINE ISLANDS

CEBU I., Mandaue (Mandawi), north of Cebu City, Quijano no. 429,
6 vii 64.

Caulerpa mexicana (Sond.) J. Agardh

HAWAIIAN ISLANDS

KAUAI I., Haena Point, Randall no num., dwarf, 11 xi 51.

OAHU I., Hanauma Bay, Doty no. 3936, 13 xi 51; Lanikai,
Strasburg no num., 26 x 52; Maili, Rogers no num.,
11 v 56; Waimanalo Beach, C.F. Hastings no. 282, 15 ix 68.

LANAI I., Huawai Bay, Degener no. 28691, 9 i 64; Kapihaa Bay,
Doty & Lee no. 22071, 27 xi 60; Kaunapau, Doty & Lee no. 22111
28 ix 60.

MAUI I., Lahaina, Matsui no. 12862, ix 55.

PHILIPPINE ISLANDS

LUZON I., Sorsogon Prov., Bulusan, Santos no. 26253, 4 vi 69;
La Union Prov., San Fernando, Almazan no. 1306-2, 3 iii 65.

In western Atlantic waters *C. mexicana* and *C. taxifolia* are readily distinguished. Only in dwarfed plants about 1 cm tall are the characters so ill-developed as to lead to indecision. This is not so in the Pacific. Intermediates are not infrequent, and numbers 282, 12862, 22071, 22111, 26253 may be considered examples tending that way. It seems to me possible that the basic stock simply evolved two types clearly in one ocean but did not proceed so far in another. To blindly disregard that achieved potential shown in the Atlantic and reduce *C. mexicana* to synonymy seems to me quite the wrong attitude. Better to recognize that some plants have, in the Pacific, the full characters of *C. mexicana* and call them by that name, others of *C. taxifolia*, and that intermediates exist either by lack of complete evolutionary divergence or, as an alternative hypothesis, by hybridization.

To point out the characters of these two species in their distinct forms, I would suggest the following. For *C. taxifolia* I expect relatively narrow blades, usually long, with a narrow axis, and with ramelli of the order of 0.75-1.20 mm in width, about 5-12 times as long. There is little tapering toward the base, and tapering to the tip is gradual. They are strongly compressed, but are only about 3 times as broad as thick. Børgesen's illustrations (1913, figs. 104, 105) are good.

For *C. mexicana* I expect relatively broader blades, usually short, with broader axes and broader ramelli up to 1.0-2.5 mm wide, 2.5-5.0 times as long. They show substantial narrowing at the base, and at the tips they are more abruptly rounded-tapered as a rule. They are flat, and may be 10-30 times as broad as thick. They are often so close that they overlap distally, though in the var. *laxa* (Weber-van Bosse) Taylor they are widely spaced. Mme Weber-van Bosse's figure (1898) pl. XXIV no. 2 (as *C. pinnata* fa. *mexicana*),

although of a rather small individual, represents this species fairly well. Perhaps mine (1960, pl. 12, fig. 5) is a little better.

Caulerpa peltata Lamx.

HAWAIIAN ISLANDS

LAYSAN I., west side, Tsuda no. T-523, 6 xii 63.

NECKER I., Long no. T-943, 25 ix 64.

KAUAI I., Anahola Bay, Doty no. 10022, 2 ii 52.

OAHU I., Oli Bridge near Koko Head, Doty no. 8382; Kaneohe Bay, Moku-O-Loe (Coconut) Island, Littler no. 20538, 10 x 68.

LINE ISLANDS

FANNING I., Danger Point Pool, Wainwright no num., 9 vii 63.

MARSHALL ISLANDS

ARNO ATOLL, Ine Village, Horwitz no. 9080 with disks to 9 mm diam. dry, 26 v 51.

CAROLINE ISLANDS

PONAPE I., Epwelkapw, Meñez no. 15675, 20 vi 60.

TRUK IDS., Truk I., Meñez no. 21059, 31 vii 60; Moen I., Meñez no. 23693, 29 vii 60; between Moen and Falo Ids., Meñez no. 23383, 29 vii 60.

PALAU I., Iwayama Bay, Meñez no. 15102a, 22 viii 60.

PHILIPPINE ISLANDS

LUZON I., Quezon Prov., Baler, Digisit, Velasquez no. 16989, 24 iv 58; Sorsogon Prov., Bulusan, Santos no. 26513, 6 viii 71.

MINDORO I., Mindoro Oriental Prov., Puerto Galera, Sabang Cove, Velasquez no. 1632, 8 v 48.

NEGROS I., Negros Oriental Prov., Dumaguete City, Santos no. 26012, 20 v 69, Matio Beach, Santos no. 26080, 24 v 69, Uy-Pitching Beach, Santos no. 26149 (very good), 25 v 69, Mataio Beach, Santos no. 26024 (very good), Lo-Ok Beach, Santos no. 26244 (superb), 28 v 69.

MINDANAO I., Zamboanga Prov., Zamboanga City, Arena Blanco, Santos no. 26538, 24 viii 71.

SULU ARCHIPELAGO, Sulu Prov., Jolo Group, Pangasinan I., Doty & Hair no. 25245, 1966.

Caulerpa pickeringii Harv. & Bail.

TUAMOTU ARCHIPELAGO

RAROA ATOLL, outer reef, Doty & Newhouse no. 11162, 9 vii 52; Okarekare, Doty & Newhouse no. 11228, 1 viii 52.

Caulerpa racemosa (Forssk.) J. Agardh

HAWAIIAN ISLANDS

LAYSAN I., Tsuda no. T-541, T-594, 6 xii 63.

NECKER I., Long no. T-944, 25 ix 64.

KAUAI I., Anahola Bay, Doty nos. 9999, 10231, 2-7 ii 52.

OAHU I., Hanauma Bay, Doty no. 10672, 3 v 53, no. 10616, 5 iv 53; Manana (Rabbit) I., Doty no. 8833, 22 iv 51; Kaneohe Bay, Doty no. 8459, 24 xi 50; Ulupau Head, Kii Point, Strasburg no. 8596, 8 ii 51; Maili, Rogers no num., 11 v 46.

MAUI I., LaPerouse Bay, Doty no. 13187, 17 xii 55; McGregor Point, Matsui & Gilmartin no num., 24 vi 65.

- HAWAII I., Kona, Kealakekua, Randall no. 10041, 10 ii 52.
- GILBERT ISLANDS
- TARAWA ATOLL, Betia, Cooper no. 18823, vii 62 (with several varieties).
- MARSHALL ISLANDS
- ARNO ATOLL, Ine, Horwitz no. 9047, 10 viii 51.
- CAROLINE ISLANDS
- TRUK IDS., Dublon I., Meñez no. 273, Nb. 59, 31 vii 60; Fefan I., Meñez no num., 28 vii 60.
- YAP I., Yap harbor, Meñez nos. 21985, 23538, 19 viii 60.
- PALAU IDS., Iwayama Bay, Meñez no. 361, Nb. 59, 22 viii 60; Peleliu, Doty no. 20530, 23 ix 68.
- PHILIPPINE ISLANDS
- LUZON I., Albay Prov., Calayucay Bay, Doty & Velasquez no. 10891, 19 v 58; Sorsogon Prov., Bulusan, Santos nos. 20490, 15 v 58, 26771, 3 vi 69; Batangas Prov., Matabungkay, Santos nos. 1306, 20 iii 65, 20449, 3 iv 68; Pangasinan Prov., Lingayan Gulf, Hundred Islands, Doty & Menez no. 16267, 16 ii 58, Alaminos, Cangaluyan Reef, Meñez no. T-1015, 4 ix 67, Cabarruyan I., Anda, Santos no. 20401, 22 ii 68.
- CATANDUANES I., Catanduanes Prov., Benticayan Bay, Doty & Velasquez no. 16654, n. d.; Virac Point, Doty & Velasquez nos. 16743, 16744, 20 v 58.
- MINDORO I., Mindoro Oriental Prov., Puerto Galera, Doty no. 10909, 2-4 xii 53, Balête Cove, Velasquez no. 5306, 23 iv 62.
- SAMAR I., Samar Prov., Guiuan, Santos no. 20465, 26 iv 68, Hinatunglan, Santos nos. 26368, 26421, 15 vi 69.
- CEBU I., Cebu Prov., Danao, Pages no. 235, 3 xi 59; Liloan, Pages no. 78, 10 vi 60; Mactan I., Calawisan, Santos no. 26507, 21 vii 71, Beramis Dam, Santos no. 26507, 21 vii 71, Caulerpa-farm, Doty & Alvarez no. 14625, n. d.; Olango I., Sta. Rosa, Doty no. 16077, n. d.
- PALAWAN ARCHITELAGO, Palawan Prov., Inlulutoc Bay, no coll., no. 5750, 29 iv 64; Cuyo Ids., Cuyo, no. coll., 6000a, 12 v 64, Meñez no. 16536, 30 iv 58, Sandoval-Paras, no. 13066, vi 65.
- MINDANAO I., Surigao del Norte Prov., Hinatuan Mawes I., Meñez no. 18005, 7 vii 58; Zamboanga City Prov., Sacol I., Doty & Hair no. 25394, 22 vi 60, Pitogo, Doty & Hair no. 25353, 20 vi 66.
- SULU ARCHIPELAGO, Sulu Prov., Jolo Group, Pangasinan I., Doty & Hair no. 25419, 25424, 1966; Tapul Group, Siasi, Sibaud I., Santos nos. 26556, 26558, 14 ix 71, Manubal I., Doty & Hair nos. 25524, Tapaan I., Doty & Hair no. 25568, 10 viii 6; Tawitawi Group, Bilitan I., Doty & Hair nos. 25498, 25500, 25504, 5 viii 66; Sibutu Group, Tumindao I., Sitangkai, Doty & Hair nos. 25450, 25452, 1966.
- INDONESIA
- JAVA, Bay of Banten, Pulau Dua, Soegiarto no. 8, n.d.
- Since this species often grows tightly attached to the exceedingly rough, eroded intertidal rocks characteristic of tropical coral islands, it is commonly difficult to detach, spread out and display

the plants well. In such exposed places they form compact interlaced masses, and do not clearly develop distinctive varietal characters. In fact, plants which grow in relatively quiet water are those which show them. Pacific Caulerpas show features similar to those shown by western Atlantic individuals, although not always the same in range. For the purposes of this list it did not seem wise to attempt to list the varietal type of each collection, although the specimens as they were studied were annotated when appropriate. It may be of interest to point out a few distinctive forms. The last specimen listed, for instance, Soegiarto no. 8, appears to be the var. *corynephora* (Mont.) Weber-van Bosse. The commonest variety of most oceans, var. *clavifera* (Turn.) Weber-van Bosse, seems to be approximated by Bilitan I. no. 25504 and Bulusan no. 20490. Mactan I. no. 26507 may be associated with var. *lamourouxii* (Turn.) Weber-van Bosse. For var. *laetevirens* (Mont.) Weber-van Bosse we may pick Olango I. no. 16077 and Bilitan I. no. 25498 as reasonable examples. Under var. *occidentalis* (C. Agardh) Børg. may come Andanno. 20401 and Siasi I. no. 26556. Var. *turbinata* (J. Ag.) Eubank (which I have previously called var. *chemnitzia*) shows a wide range of size. Manubal I. no. 25524a and several others seem not too far from the ordinary concept of the variety. However, Guiuan no. 26421 is very much taller than usual, and Bulusan no. 26771 is an extremely lush variant which it would be hard to distinguish from *C. matsueana* Yamada (1944a p. 28), which may not be worthy of specific rank.

Caulerpa selago (Turn.) C. Agardh

PHILIPPINE ISLANDS

SULU ARCHIPELAGO, Sulu Prov., Sibutu Group, Tumindao I., Sitangkai, Doty & Hair no. 25449, 1966.

Caulerpa serrulata (Forssk J. Agardh, var. *serrulata*

HAWAIIAN ISLANDS

OAHU I., Hanouma Bay, Doty no. 10670, 3 v 53; Hanula Park, Doty no. 8661, 22 iv 51; Haleiwa, Fong no. num., 17 i 55.

MAUI I., Kihei, Matsui no. 12874, n. d.

LINE ISLANDS

PALMYRA I., Halstead no. 12190, 27 iv 53; Barren I., Doty no. 18586, 28 xii 59.

GILBERT ISLANDS

TARAWA ATOLL, Betio, Cooper no. 18809A, 18810, vii 62.

CAROLINE ISLANDS

PONAPE IDS., Mantapeitak I., Meñez no. 21543, 20 vi 60.

TRUK IDS., Quoi I., Meñez no. 21014, 2 viii 60.

PHILIPPINE ISLANDS

LUZON I., Sorsogon Prov., Gubut, Villaroya no num., iv 65; Albay Prov., Albay Gulf, Lubas Point, Doty & Velasquez 16846B, 18 v 58; Calayucay Bay, Doty & Velasquez no. 16892, 19 v 58; Quezon Prov., Baler, Digisit, Velasquez 16986, 24 iv 58; Batangas Prov., Matabungkay, Santos no. 1306, 20 iii 65; Pangasinan Prov., Caburruyan (Anda) I., Santos no. 20406b, 22 ii 58.

MINDORO I., Mindoro Oriental Prov., Puerto Galera, Medio Ids.,
Velasquez no. 3495, 12 v 53.

CEBU I., Cebu Prov., Danao, Sabang, Pages no. 99, 23 xi 60.

MINDANAO I., Zamboanga Prov., Sacol I., Doty & Hair no. 25392,
22 vi 66.

SULU ARCHIPELAGO, Sulu Prov., Tapul Group, Mandubal I., Doty &
Hair no num., 10 viii 66; Tawitawi Group, Bilitan I., Doty &
Hair no. 25502, 5 viii 66; Sibutu Group, Tumindao I.,
Sitangkai, Doty & Hair no. 25448, 1966.

Caulerpa serrulata var. *boryana* (J. Agardh) Weber-van Bosse

CAROLINE ISLANDS

PONAPE IDS., Nanmatol I., Meñez no. 23311, 23 vii 60

YAP IDS., Yap, Meñez no. 21853, 18 viii 60.

MARIANAS ISLANDS

SAIPAN I., Maniagassa I., Doty no. 20326, 24 xi 67.

PHILIPPINE ISLANDS

LUZON I., Pangasinan Prov., Hundred Ids., Cuenco I., Cuenco Cave,
Doty & Meñez no. 16204, 15 ii 58.

MINDANAO I., Davao Prov., Davao s. of Sasa Wharf, Doty no. 18055,
21 iv 58.

Caulerpa serrulata var. *spiralis* Weber-van Bosse

LINE ISLANDS

PALMYRA I., King no. 10835, 8 i 53; Barren I., Doty no. 18610,
Sand I., Doty no. 186211, 29 xii 59.

TUAMOTU ISLANDS

RAROA ATOLL, Doty & Newhouse no. 11010, 30 vi 52.

SOCIETY ISLANDS

MOPIHA'A I., Sachet no. 992, 8 vii 63.

GILBERT ISLANDS

TARAWA ATOLL, Betio, Cooper no. 18803, vii 62.

MARSHALL ISLANDS

ARNO ATOLL, Arno I., Doty no. 9225, 30 vii 51; reef off Motol-En
I., Horwitz no. 9494, 12 viii 51; Kabinlok I., Horwitz no. 9164,
n.d.

CAROLINE ISLANDS

PONAPE I., Mantapeitak I., Meñez no. 21678, 20 vi 60.

TRUK IDS., Moen I., Meñez nos. 15885, 29 vii 60, 15926, 1 viii 60.

PHILIPPINE ISLANDS

LUZON I., Sorsogon Prov., Gubat, Villaroya no. 13067, 6 v 65.

Batangas Prov., Matabungka, Santos no. 13065, 20 iii 65.

CATANDUANES I., Catanduanes Prov., Benticayan Bay, Doty &
Velasquez no. 16653, 21 v 68.

MINDORO I., Mindoro Oriental Prov., Puerto Galera, Uyenco no.
13068, n. d.

SULU ARCHIPELAGO, Sulu Prov., Jolo Group, Pangasinan I., Doty &
Hair no. 25417, vi 66.

When the *Caulerpa* materials were studied in Honolulu in 1966 and reviewed in 1967 the *serrulata* specimens were recorded as typical or not distinguishably different, or, as nearer one of two particular varieties. They were not studied again in 1973, and are here reported as annotated in 1966-67. Trono's attempt to separate off a non-

spiralled form (Trono 1973, p. 9, fig. 19) as *C. hummii* Diaz-Pifferer cannot be supported, for various degrees of twisting or flatness are to be found in *C. serrulata*. This is as true in the West Indies as in the Pacific. From the Diaz-Pifferer and Trono illustrations I would certainly place their plants in *C. serrulata*, and, if one wanted a varietal designation, near var. *pectinata* as understood by Mme Weber-van Bosse (1898), near her figures 4-6 on Pl. XXVI. Actually, the illustrations labeled *C. hummii* by these authors are very much closer to the type of *C. serrulata* (as *Fucus serrulatus* Forsskål), a photograph of which is before me, than are the elaborately spiralled forms, such as that illustrated by Trono (1973, fig. 2). The name *C. hummii* Diaz-Pifferer (1969, pp. 12-17) should be placed in the synonymy of *C. serrulata* (Forssk.) J. Ag.

It has been put to me that the difficulty of distinguishing between *C. cupressoides*, *C. serrulata* and *C. urvilliana* is very great in Pacific material. This may at times be so, and when only dwarfed or abnormally attenuate specimens are available will always be so.

To start with, *C. cupressoides* typically has terete erect axes, and the ramelli are terete, short in some forms, longer in others. When the ramelli are reduced to 3 rows the axis may be less clearly terete than when the ramelli are pluriseriate or irregularly placed. When they are biseriate the ramelli may be quite long, as in *C. cupressoides* var. *lycopodium* fa. *elegans*, or reduced nearly to teeth, as in var. *flabellata*, and then the axis is compressed.

In *C. urvilliana* the erect axes are terete in the stalk part, but become compressed upwardly, and in full development above triangular, where the teeth are triseriate. Ramelli are, then, represented by teeth, not by cylindrical structures. While often somewhat flexuous the axes do not become spiralled.

Also showing the lower axis at least briefly terete, *C. serrulata* axes are flattened above, sometimes broadly, and the margins are dentate. The type specimen is very small, with the flat branch axes not spiralled. The branch axes in this species do range from straight to elaborately spiralled, and in these the teeth may become somewhat dislocated and those on the inner border of the spiral may be reduced or suppressed. The illustrations purporting to be this species in my Bikini book (1950, pl. 30, figs. 1, 2) were incorrectly identified: they are forms of *C. urvilliana*. That on pl. 29, fig. 1 should be referred to *C. serrulata* var. *boryana*: the name used at that time would not satisfy the present rules of nomenclature.

Caulerpa sertularioides (Gmel.) Howe

HAWAIIAN ISLANDS

KAUAI I., Anahola Bay, Doty no. 9998, 2 ii 52; Aliomanu Beach, Doty no. 9923, 3 ii 52.

OAHU I., Mokuleia, Doty no. 12234, 9 xi 52; Kaneohe Bay, Moku-O-Loe I., Doty no. 8115, 3 x 50; Halona, Rogers no num., 3 v 46; Kuapa Pond, Engard no num., 21 iv 43; Mali near Lua-Lua-Lei, Doty no. 8734, 11 iii 51.

GILBERT ISLANDS

TARAWA ATOLL, Betio, Cooper no. 18802, vii 62.

CAROLINE ISLANDS

TRUK IDS., Moen I., Baker Docks, Stone no. 2181, vii 57.

PHILIPPINE ISLANDS

LUZON I., Quezon Prov., Baler, Diksalarin, Velasquez no. 16469, 23 iv 58, Digisit, no. 16985, 24 ix 58; Rizal Prov., Manila Bay, Velasquez no. 5577, 4 ii 64 (excellent), South Harbor, Doty & Menez no. 16297, n. d.; La Union Prov., San Fernando, Almazar no. 1306, 3 iii 65.

CATANDUANES I., Catanduanes Prov., Benticayan, Doty & Velasquez no. 16685b, Virac Point, Doty & Velasquez no. 16471, n. d.

CEBU I., Cebu Prov., Mactan I., Lapu Lapu, Calawisan *Caulerpa*-farm, Doty & Alvarez no. 14626, 4 iv 65.

PALAWAN ARCHIPELAGO, Palawan Prov., Cujo Ids., Cujo I., Menez no. 16539, n. d.

SULU ARCHIPELAGO, Sulu Prov., Jolo Group, Pangasinan I., n. coll., no. 25416, n. d.; Tapul Group, Tapaan I., Doty & Hair no. 25573, 10 viii 66, Tapaan Lagoon, Santos no. 26547, 10 ix 71, Sibaud I., Doty & Hair no. 25564, 10 viii 66.

Both fa. *brevipes* (J. Agardh) Sved. and fa. *longiseta* (Bory) Sved. are represented in this material, though perhaps less distinctively than in Caribbean material. To the former we may assign Kauai no. 9998 and Cujo no. 16539, to the latter Kaneohe Bay no. 8115 and Moen I. no. 2181. The plants from South Harbor no. 6297 showed exceptionally long and slender ramelli, which reach a length of 18 mm.

Caulerpa seuratii Weber-van Bosse

TUAMOTU ARCHIPELAGO

RAROIA ATOLL, Raroia, Doty & Newhouse 11639, 9 viii 52; Oneroa, Boty & Newhouse no. 11499, 29 vii 52 (excellent); Tomongoru (? Tomogagie), Doty & Newhouse no. 11427, 29 vii 52; Teuriamote, Doty & Newhouse no. 11476, 26 vii 52.

Caulerpa taxifolia (Vahl) C. Agardh

CAROLINE ISLANDS

TRUK IDS., Quoi I., Menez no. 23307, 2 viii 60.

YAP I., Menez no. 21897, 18 viii 60.

PHILIPPINE ISLANDS

NEGROS I., Negros Oriental, Siquijor I., Menez T-1138, 28 ix 67, Carrio Solong-on, Santos no. 26187, 26 v 69.

SULU ARCHIPELAGO, Sulu Prov., Mandubal I., Doty & Hair no. 25529a, 10 viii 66.

Dawson's figure 17 (1956, p. 36) I would unhesitatingly ascribe to *C. mexicana* (Sond.) J. Ag. The broad axes, with the ramelli clearly contracted toward the base, are characteristic.

Caulerpa urvilliana Mont., var. *urvilliana*

LINE ISLANDS

PALMYRA I., Sand I., Doty no. 186211, 29 xii 59.

FANNING I., North Pass, Wainwright no num., n. d.; Tempua,
Wainwright no. 20101, n. d., Greig Point, DeWreede no. 1222
p.p., 5 i 70.

TUAMOTU ARCHIPELAGO

RAROIA ATOLL, Kukina, Doty & Newhouse no. 11454, 3 vii 52;
between Temari and Kumekume, Doty & Newhouse no. 11021,
1 vii 52.

MARSHALL ISLANDS

ARNO ATOLL, Ine Village, Horwitz no. 9044, 10 vii 51.

CAROLINE ISLANDS

PINGELAP I., Meñez nos. 21454, 21925, 1 vii 60.

MOKIL IDS., Urak I., Meñez nos. 21227, 21285, 21360, 29 vi 60.

TRUK IDS., Quoi I., Meñez no. 21602, 2 viii 60.

IFALUK IDS., Ifaluk I., Meñez nos. 23111, 23126, 10 viii 60;
Ella I., Meñez no. 23230, 10 viii 60.

YAP I., south of the channel, Meñez nos. 21567, 15817 (very
good), 19 viii 60, north of the channel, no. 21896, 18 viii 60.

PALAU IDS., Peleliu I., Doty no. 20529, 23 xi 68.

HELEN I., west side, Meñez nos. 15480, 15519, 15537, 30 vii 60,
Helen Island Reef, Meñez no. 15390, 28-30 viii 60.

PHILIPPINE ISLANDS

LUZON I., Sorsogon Prov., Bulusan, Santos no. 20513 p.p.,
17 v 68..

NEGROS I., Negros Oriental Prov., Siquijor I., Carrio Solong-on,
Meñez no. 1135, 28 ix 67, Santos nos. 26208, 26055 (very good).
Tending toward v. *vitiensis*, Alcala no. 20518, 28 v - 29 vi 68,
Santos nos. 26041, 26182, 22 v 69.

PALAWAN ARCHIPELAGO, Palawan Prov., Cujo Ids., Cuyo, no coll.,
no. 16540, 30 iv 58.

SULU ARCHIPELAGO, Sulu Prov., Jolo Group, Pangasinan I., Doty
& Hair, no. 25447, vi 66; Tapul Group, s. of Siasi I., Doty
& Hair no. 25529b, 10 viii 66; Tapaan I., Trono no. T-4077,
29 xii 70; Tawitawi Group, Tawitawi I., Balimbing Point,
Meñez no. T-1101, 23 ix 67.

Caulerpa urvilliana var. *vitiensis* (Sond.) Weber-van Bosse

TUAMOTU ARCHIPELAGO

RAROIA ATOLL, Ohehoa, Doty & Newhouse no. 11503, 2 viii 57
(excellent).

PHILIPPINE ISLANDS

SULU ARCHIPELAGO, Sulu Prov., Jolo Group, Pangasinan I., Doty no.
25422, vi 66.

Caulerpa verticillata J. Agardh

HAWAIIAN ISLANDS

OAHU I., Kaneohe Bay, Moku-O-Loe (Coconut) Island, Doty no. 8117,
3 x 50 (excellent), Jones no. 10433, 7 i 52, Wainwright no num.,
17 vii 59, Buggeln & Tsuda no. 14186, 15 vi 64, Littler no.
20539, 10 x 68.

CAROLINE ISLANDS

PONAPE.,

MANTAPEITAK I., Meñez no. 23409, 20 vi 60.

KOLONIA I., mud flats toward Sokehs I., Meñez no. 21108, 25 vi 60

PHILIPPINE ISLANDS

CEBU I., Cebu Prov., Davao Bay, Boty & Alvarez no. 14350, 3 ii 65; Mactan I., Calawisan, Meñez no. T-1029, 6 ix 67.

NEGROS I., Negros Oriental Prov., Siquijor I., Carrio Solong-on, Santos no. 26161, 26 v 69.

Caulerpa webbiana Mont.

HAWAIIAN ISLANDS

LAYSAN I., Tsuda no num., 6 xii 63.

KAUAI I., Kuaehu Point, Abbott no num., 21 ii 46.

OAHU I., Mokuleia, Doty no. 12233, 9 xi 52; Laie, Doty no. 19287, 30 i 60; Waikiki, Doty no. 8260, 3 xi 50; Lua-Lua-Lei, Maili, Doty no. 8733.

EASTER ISLAND, Hotuiti, Matsui no. 20671, 3 iv 69.

MARSHALL ISLANDS

ARNO ATOLL, Enen Edrik I., Horwitz no. 9032, 7 vii 51.

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