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# The genus *Turbinaria* in eastern seas

BY WM. RANDOLPH TAYLOR, F.M.L.S.
*University of Michigan*

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The Algal genus *Turbinaria* (Phaeophyceae-Sargassaceae) has long been known as an important one in tropical and subtropical floras. These plants share space on intertidal and closely infratidal reefs with their justly more famous and difficult relatives in the genus *Sargassum*. Beside the complexities of that genus those of *Turbinaria* seemed to earlier botanists relatively unimportant. However, when the writer set about identifying Javanese and Philippine specimens he found a most confusing degree of variability among them. The type descriptions are in all cases too brief to be conclusive. On recourse to herbaria there seemed little agreement as to what names should be applied to given forms. The only relatively modern treatment of the genus (Barton 1891) proved so incomplete in data as to be of limited help.

Consequently the writer has been compelled to review the genus and to apply his interpretation of the various species not only to the Javanese-Philippine items originally before him but to all the specimens he was able to borrow originating from the eastern African coasts, the Red Sea, Indian Ocean, southeastern Asia, Australia and the islands of the Pacific Ocean. The two western Atlantic-Caribbean species he has already treated (Taylor 1960). With the synonymy as reported by Barton and modified by M. A. Howe (1920) and F. Børgesen (1933) he has in general been content. It is not presumed that the present account represents a definitive monograph of the genus. It is primarily concerned with delimitation of the several species, reporting their range of variation and their geographical distribution on the basis of specimens seen, and the writer feels that he has been able to correct long-established misconceptions of the ranges of some, like *T. decurrens*, based on incorrect identifications accepted in the literature. He has not, in fact, placed much confidence in old distribution records which he could not confirm (Martens 1866, Weber-van Bosse 1923). The reported ranges of the lesser-known species are, of course, subject to ultimate major revision. There are curious gaps in the reported ranges of some well-known ones, such as *T. ornata*, for which we lack records from much of the Indian Ocean and Persian Gulf. Studies are needed of the variability of such species as *T. filamentosa*, *T. compressa* and *T. gracilis*. He has seen only one specimen of the *Turbinaria* reputedly from South Africa [*T. trialata* (or *T. vulgaris*) var. *capensis*, Kützing 1860 p. 24, pl. 67, fg. II], which specimen came from the herbarium of the Riksmuseet, Stockholm, and so has not attempted to define it, but recognizes no essential relationship to *T. turbinata* (L.) Kuntze (Barton's *T. trialata*).

This study has been greatly facilitated by the use of the rich collections loaned from the University of California (Berkeley) through the kindness of Professor G. F. Papenfuss and Dr P. C. Silva, including new collections from the African continent by the former. In addition equally appreciated, if smaller, collections and authentic specimens have been loaned by the British Museum (Natural History) through the Keeper, J. E. Dandy, Esq.; from the Museum National d'Histoire Naturelle, Paris, by M. P. Bourrelly and M. M. Denizot; from the Rijksherbarium, Leiden, by Dr J. Th. Koster; from the University of Western Australia by Prof. G. G. Smith; from the State Herbarium, Perth, by Dr R. D. Royce; from the University of Adelaide by Dr H. B. S. Womersley; from India by Dr F. Thivy; from The Royal College, Nairobi, Kenya, by Prof. W. E. Isaac; from the Seaweed

Laboratory, Rondebosch, South Africa, by Mr R. H. Simons; by Prof. G. T. Velasquez from the University of the Philippines; from the University of Hawaii by Prof. M. S. Doty; from the Hopkins Marine Station by Dr D. P. Abbott; from the Farlow Herbarium, Harvard University, by Prof. I. M. Lamb; from the New York Botanical Garden by Dr C. T. Rogerson; and from the U.S. National Herbarium by Dr M. E. Hale. Part of this study was carried on under a grant by the Horace Rackham Graduate School from the Faculty Research Fund of the University of Michigan, which is gratefully acknowledged.

## *TURBINARIA* Lamouroux, 1828

Plants with wide-spreading fibrous bases which may have both hapteral and rhizomatous functions; erect axes borne singly on these, simple or branched, with age generally roughened below by stubs representing discarded leaves or branchlets, but the leaves generally crowded on the axes or branches above. Foliar organs showing a slender sub-

### KEY TO SPECIES*

1. Lateral longitudinal ridges normally dentate . . . . . 2
1. Lateral longitudinal ridges edentate, but sometimes ill-defined . . . . . 7
2. Leaves evesiculate . . . . . 3
2. Leaves normally vesiculate on mature plants . . . . . 4
3. Distal marginal blade obsolete . . . . . **T. murrayana** Barton
3. Distal marginal blade conspicuous (an Atlantic-Caribbean species) . **T. tricostata** Barton
4. Leaves small . . . . . 5
4. Leaves large, commonly over 10 mm. broad; lateral ridges acute to alate, with several teeth; intramarginal distal teeth absent . . . . . 6
5. Distal marginal blade narrow but evident; lateral faces somewhat compressed but their margins not acute, often sparingly dentate . . . . . **T. condensata** Sonder
5. Distal marginal blade obsolete, reduced to a slight ridge, which may be edentate or slightly toothed . . . . . **T. papenfussii** n. sp.
6. Leaves much longer than broad, the distal blade transverse . . . **T. decurrens** Bory
6. Leaves hardly longer than broad, the distal blade oblique . **T. triquetra** (J. Ag.) J. Ag.
7. Distal marginal blade deeply lobed, or discontinuous, or obsolete . . . . . 8
7. Distal marginal blade evident, essentially complete . . . . . 9
8. Leaves small, usually under 6 mm. broad, crowded on the branchlets, the blades commonly reduced to teeth, or obsolete . . . . . **T. luzonensis** n. sp.
8. Leaves larger, often exceeding 10 mm. in width, not notably crowded, the blades commonly deeply lobed . . . . . **T. gracilis** Sonder
9. Intramarginal crown teeth normally present . . . . **T. ornata** (Turn.) J. Ag.
   Leaves rather small, without vesicles or with rare small ones, with few or no coronal teeth **f. evesiculosa** (Bart.) n. comb.
   Leaves with very prominent vesicles distending the leaves more than in the typical form, generally without any coronal teeth . . . . . **f. ecoronata** n. f.
   Leaves with small vesicles, broad distal margins, irregularly placed marginal teeth and scattered distal intramarginal teeth not forming a regular crown **f. hainanensis** n. f.
9. Intramarginal crown teeth absent . . . . . 10
10. Receptacles chiefly basally branched, the long divisions often exceeding the leaves **T. filamentosa** Yamada
10. Receptacles progressively racemose on an evident axis . . . . . 11
11. Leaves larger, obpyramidal, the distal marginal teeth small, the vesicles relatively small (an Atlantic-Caribbean species) . . . . . **T. turbinata** (L.) J. Ag.
11. Leaves smaller, turbinate, the distal marginal teeth relatively large and the vesicles very prominent . . . . . **T. conoides** (J. Ag.) Kütz.
   Winged distal margins often broadly notched to the vesicle on one side, and with broad, obtuse teeth . . . . . **f. laticuspidata** n. f.
   Leaves often conspicuously reflexed, rather smaller than in the type **f. retroflexa** n. f.

* This key does not suffice to differentiate depauperate individuals, or account for otherwise typical forms of *T. ornata* and *T. condensata* with few or no distal or crown teeth, for those of *T. conoides* and *T. condensata* with reduced marginal blades, or for those individuals of almost any species which may in part be evesiculate, so that in all cases the detailed descriptions should be carefully considered.

terete articulation or a substantial lower stalk at the base, the outer portion constituting the effective part of the leaf triangularly obpyramidal or turbinate, truncate at the distal end where often bounded by a firm fleshy alate margin, or, the stalk chiefly subterete and the leaf peltate; lateral longitudinal ridges, like the distal margins, sometimes alate, sometimes obsolete. Vesicles generally present, immersed in the outer portion of the leaf, often absent in immature plants and even at maturity in some species. Cryptostomata generally present, small. Receptacles attached to the slender portions of the leaf-stalks, racemose, the lateral divisions simple or irregularly divided, sometimes appearing subcorymbose.

**Turbinaria papenfussii** n. sp. Plate 1, figs. 1–9

Plants to 20 cm. tall, the axes simple or branched. Leaves 12–18 mm. long, 5–10 mm. broad, rather abruptly expanded above the very short terete stalk with the sides commonly nearly parallel, the greatest width often not at the distal end. Terminal face small, rounded-triangular, flattened transversely or somewhat obliquely, the distal marginal blade reduced to a sparingly dentate ridge, or edentate, or even in part obsolete. Lateral faces concave, hardly expanded at all by the rather obscure vesicles, or these absent, the longitudinal ridges acute, relatively strongly dentate, the abaxial ridge not shorter than the lateral ones, occasionally even more prominent. Receptacles compact, at most as long as the leaves, at first racemose but the divisions ultimately forked and appearing subcorymbose.

Plantae simplices ramosaeve. Folia super stipitem quasi abrupte expansa, lateribus saepe subparallelis. Superficies terminalis parva, rotundo-triangularis, transverse aut paululum oblique complanata, lamina ad costam parce dentatam, aut edentatam, aut obsolescentem redacta. Superficies laterales concavae, per vesiculas vix expansae, costis longitudinalibus acutis, valdius dentatis, costa abaxiali non notabiliter brevi.

Plantae typicae in loco Sheik Said I. (Romia I.), Dahlac Archipelago, Ethiopia, dicto, a G. F. Papenfuss no. 20200, 22 iii 1962 lectae (Univ. Calif. no. M158092).

These specimens differ greatly from the other known Red Sea species. They are often simple, but when branched, compact, while those of *T. triquetra* may become very long and loosely branched. The leaves differ in their shape, which is of rather equal breadth while those of *T. triquetra* are clearly obpyramidal, in the marked reduction of the terminal blade, its more transverse position, and the almost complete absence of teeth around it. The longitudinal ridges may be only slightly toothed (in figures 1, 9) or more strongly in other individuals of the same sample, or quite notably as in the Suez specimen cited.

*Representative Specimens.* EGYPT: near Suez, coll. Mr. Lefevr, 1837 (PC). ETHIOPIA: Dahlac Archipelago, Sheik Said I. (Romia I.), G. F. Papenfuss 20200, 22 iii 62 (UC-M158092 type).

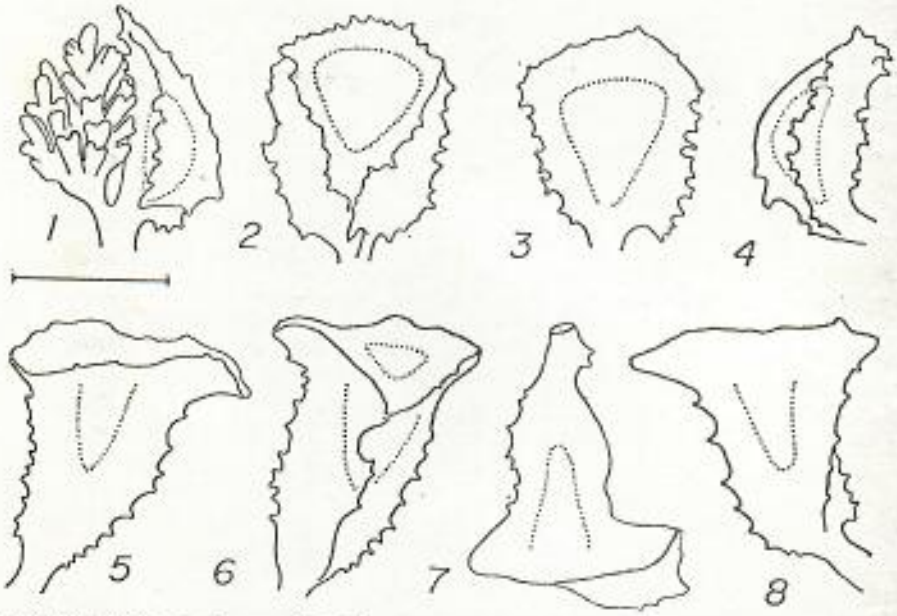
**Turbinaria decurrens** Bory 1827, p. 119. Plate 1, figs. 22–28

Plants to about 15 cm. tall, unbranched or with an occasional lateral branch, the axis below roughened by very conspicuous leaf bases, densely foliate above. Leaves somewhat fleshy, each obpyramidal on a very short terete stalk, to 15–25 mm. long, 12–16 mm. diam. Terminal aspect triangular, the margins with numerous small teeth, or nearly entire. Lateral leaf faces somewhat concave, except above where a little inflated by the rather small, deep vesicles, the marginal ridges extending to the angles of the terminal blades, acute to alate, finely to aculeate-toothed. Receptacular clusters compact, about half the length of the leaves, racemose, the primary divisions with 2–3 branchlets.

The type material of *T. decurrens* was examined (Text-figs. 5–8) critically and it showed clearly that the plants from the Red Sea area common in herbaria under this name had been misidentified. Western Pacific specimens agreed well with it. Leaves of *T. decurrens* are hardly to be distinguished from those of *T. murrayana*, except for the presence of the

vesicles in most leaves, and a tendency to be somewhat less fleshy, but there is not enough evidence at the present time on which to reduce *T. murrayana* to synonymy.

*Representative Specimens.* INDIA: Madras State, Gulf of Manaar, Pulli I., F. Thivy, 30 xii 59 (Thivy), Palk Bay, Pamban I., Akkalmadam, Thivy, 21 iii 59 (Thivy). PHILIPPINES: Luzon, Ilocos Sur, Sinait, H. H. Bartlett 14239, 2 vi 35 (MICH). Albay, Legaspi, M. S. Doty and G. T. Velasquez, 18 v 58 (Doty 16870), Libog, Doty and Velasquez, 19 v 58 (Doty 16943). Cebu I., Danao, P. D. Pages 220, 13 ii 62. Mindanao, Misamis Occidental, Baliangao, P. R. Manacop 5120, iii 36 (UC-633897), Surigao del Sur, Bislig, Agonoy I., E. G. Menez, 7 vii 58 (Doty 18328B), Mawes I., Menez, 7 vii 58 (Doty 18117), Davao, Daliao, E. B. Copeland 556, (UC-699277), Malalag, Copeland 619B, 24 iii 04 (UC-699279). Basilan




Text-figs. 1–8. Figs. 1–4, leaves of *Turbinaria triquetra* from Fontanier's Red Sea material. Figs. 5–8, leaves of *T. decurrens* from D'Urville's original material. Bar scale 1 cm. equiv. Magnification × 2.

I., Pangayan Ids., Balhani 633, i, ii 41 (MICH). SOLOMON ISLANDS: Malaita I., Uras Cove, C. T. Crocker, 27 v 33 (UC-513203). TYPE SPECIMEN: 'Flotante entre les Iles de la Société & la nouvelle Guinée. Durville 1825' (PC).

**Turbinaria murrayana** Barton 1891, p. 218, pl. 54, fig. 2

Plants with stout, simple erect axes to 8 cm. tall. Leaves rather firmly fleshy, evesiculate, to 20 mm. long, 17 mm. diam. at the somewhat concave distal end, obpyramidal with an inconspicuous terete stalk. Terminal aspect triangular, the distal marginal blade obsolescent, thick, minutely but sharply dentate, or sometimes subentire, distinct only between the lateral ridges which, however, reach to its angles. Lateral faces concave, the ridges acute, finely dentate or occasionally subentire. Receptacles attached near the leaf bases, at first racemose, later appearing subcorymbose, about half as long as the leaves.

In describing this species the writer has followed the original author in including only those plants which seem to lack vesicles entirely, but since to prove their absence would require soaking up and cutting into each leaf superficial evidence alone could be used. However, plants now recognized as *T. decurrens* are very similar, with differences presented in the discussion accompanying its description. The figures of the leaves of that species

could almost serve for *T. murrayana*, except for the presence of the vesicles and the less fleshy character of the whole structure. In a subsequent paper (1908) Mrs Gepp (née Barton) re-emphasizes the absence of vesicles in this species.

*Representative Specimens.* MALAYA: Singapore, H. N. Ridley, n.d. (BMNH). INDONESIA: Sumatra, Tagang (?Padang), H. Zollinger, 'Iter Javanicum secundum II no. 1086Z?' (L-937, 253–404). Java, Toppershoedje I., A. J. Kostermans 526, 15 x 38 (MICH); Oedjoeng Koelon, Kostermans 695, 18 x 38 (Mich). Bali, Sanoer, W. A. Setchell BS253, 15 vi 29 (UC-624797). Celebes, 'Palm ex herb. W. F. R. Suringar' (L-937, 253–365). Timor, Zippelius, x 1828 (L-906, 43–23). NEW GUINEA: fluid-preserved specimen coll. Capt. Sir E. Belcher, apparently an isotype (BMNH).

**Turbinaria triquetra** (J. Agardh) J. Agardh *apud* Kützing. Plate 1, figs. 10–21

Plants probably much exceeding 15 dm. in height, the main axes smooth, with lateral branches which reach a length of 0·5–1·5 dm., borne at intervals of 4–5 cm. on the lower portions of the plants, but closer above. Leaves congested on the lateral branches, about 8–18 mm. long, 5–18 mm. broad, the stalk portion very briefly subterete at the base, sharply expanded to the distal end, obpyramidal with concave sides, but the broad vesicles usually evident. Distal marginal blades often markedly oblique, commonly distended centrally by the vesicles, broadly triangular with convex margins which are often asymmetrical, seldom entire, generally strongly aculeate-dentate, the longitudinal ridges acute to alate, generally strongly aculeate-dentate or even ciliate. Receptacles attached to the leaf stalks near the base, rather shorter than the leaves, racemose, the branches little divided.

This is a Red Sea plant which is fairly frequent in herbaria under the name *T. decurrens*. *Turbinaria decurrens* was originally described on material from 'entre les îles de la Société et la Nouvelle-Guinée'. *Turbinaria triquetra* was described from Red Sea material collected by Fontanier and preserved in Paris. This has been examined and a few leaves are illustrated in Text-figures 1–4. While its eastward range limits are not known, no western Pacific plants resemble it at all closely. The Nicobar Islands specimens figured by Kützing (1860, pl. 68 fig. II) as this species seem to be *T. decurrens*, though hardly dentate. Specimens in herbaria generally consist of the lateral branches only, giving an altogether false idea of its magnitude, for it is surely the largest species of the genus. The dimension given above based on an herbarium specimen collected long ago, will undoubtedly be exceeded by the lengths of those collected by G. F. Papenfuss when they become available, for he in correspondence reports it at least as long as 4 meters. Occasionally the receptacles elongate greatly, 2–3 times exceeding the leaves, at least in part becoming sterile. The lateral divisions may become locally fusiform or even bear simplified vesiculate leaves.

It appears possible to dispose of the names *T. membranacea* and *T. tetraëdra* of Ruprecht (Oct. 1849). The former is based on Schimper's Un. Itin. no. 955, which he indicates came from Noweba, and the latter on no. 458 from El Tor. Examples of no. 458 have been seen, and found clearly referable to *T. triquetra* (J. Ag.) J. Ag. in Kützing (*ante* Aug. 1849). I am informed by Dr Paul C. Silva that the specimens from the Sbarbaro collection cited below were identified by Ruprecht and are presumably isotypes, although neither are ascribed to Schimper on the labels. Both seem to be *T. triquetra*, though no. 10, labelled *T. tetraëdra* (El Tor), has less extended, less dentate margins than is usual. Agardh's statement that his *T. vulgaris* var. *triquetra* has the 'lamina peltaeformi subnulla' is stressed by Ruprecht in his discussion, but as this statement does not conform with the actualities of Fontanier's specimen it may be discounted. As the Ruprecht names probably refer to the same species, and as they seem to be preceded by *T. triquetra*, it appears that they should be reduced to synonymy.

*Representative Specimens.* 'Red Sea'; coll. Dris Binder, n.d., (NY), Hohenacker, Meeresalgen 168, n.d. (UC-433722). EGYPT: El Tor, W. Schimper 458, 27 iii 1835 (NY, UC-409202),

herb. N. Sbarbaro 10, n.d. (UC-949473); Noweba (Nuweiba), herb. N. Sbarbaro 11, n.d. (UC-434097); Ghardaqua (Hurghada), C. Crossland RS22, ix, x 33 (UC-507875), Crescent Reef, Crossland RS51, RS64, 1 xi 33 (UC-513161, 513164); Kosseir (Quseir), Schimper 936, iv 1837 (NY, UC-436486). ETHIOPIA: Massawa, Dahlac Archipelago, Entedbir I., Goliat Bay, G. F. Papenfuss 20044, 14 iii 62 (UC-M158093), 20207, 3 iv 62 (UC-M158091). SOMALIA: Lasgori (?Las Koreh), J. M. Hildebrandt, iii 73 (UC-434097).

**Turbinaria gracilis** Sonder 1845, col. 52. Plate 3, figs. 13–21

Plants to 2 dm. tall, the erect axes sparingly branched. Leaves 10–22 mm. long, 6–18 mm. broad, the lower half stalk-like, subterete, the upper part rounded-turbinate, somewhat distended by the vesicle. Distal marginal blade deeply lobed or discontinuous, sometimes represented by large teeth, or in part by flat, ligulate, or even subfoliar projections which may be 2–5 mm. long, and sparingly dentate on the ends; lateral ridges obscure, entire. Receptacular clusters attached very near the stalk base, at first racemose, the lateral branchlets becoming irregularly forked, at maturity as long as the leaves.

The original description does not clearly define this species. However, a fragment of Preiss' material is available for comparison and it agrees well with Kützing's figures (1860, pl. 70) and with figures of this paper. Only the Western Australian specimens seem clearly within the typical form range of *T. gracilis*. Those from Queensland are suspiciously like forms of *T. conoides*, and specimens in herbaria called *T. gracilis* from Malaya, Indonesia and the Philippines all seem to be *T. conoides*.

*Representative Specimens.* AUSTRALIA: Western Australia, '*Turbinaria gracilis* Sond./ Preiss leg. 2534' (WRT-1187, probably an isotype); ?-Cape Cuvier, K. Sheard A353, viii 46 (UWA); Houtman-Abrolhos Ids., Pelsart I., G. G. Smith 196, viii 47 (UWA), H. B. S. Womersley A-5884d, h, 2 ix 47 (UC-754951, MICH); Rottnest I., A. B. Cribb 67:10, 9 viii 50 (UC-916896), R. D. Royce 859, 8 viii 50 (PERTH), Smith A355 (UWA); Cottesloe, Smith vii 44 (PERTH, UWA); Bunbury, Royce 378, 25 ix 49 (PERTH); Hamelin Bay, Royce 718, 21 vi 50 (PERTH); Cape Leeuwin, Smith A354, 8 viii 61 (UWA); Queensland, ?-Goode I., W. D. Powell, n.d. (FH), ?-near Daintree River, G. Tandy 228, 2 xii 28 (BM), Dunk I., E. J. Banfield, 1913–14 (as *T. decurrens* fa. *aurita* Lucas; SYDNEY).

**Turbinaria conoides** (J. Agardh) Kützing 1860, p. 24, **var. conoides.** Plate 2, figs. 1–8

Plants to 4·5 dm. tall, the stems generously branched, with branches to 2 dm. in length. Leaves spreading or erect, to 15 mm. long, 15 mm. broad at the distal end, the stalk portion subterete to slightly triangular for one-half to three-fourths of its length, sharply turbinate-inflated by the rather small vesicle when one is present; distal marginal blades evident, irregularly triangular in end view, the edges sharply dentate; sides of the inflated portion hardly compressed, the ridges obtuse and edentate. Receptacles attached near the base of the stalk, about three-fourths as long as the leaves.

This is a very variable species in the breadth of the distal marginal blades, in the size and number of the marginal teeth, and in the prominence of the vesicles, in the absence of which the leaves are peltate. It is not unusual for one edge of the blade to be relatively free of teeth and a little retuse. Kützing's (1860, 10:25, pl. 69 I) illustration of *T. heterophylla* appears to represent merely a proliferated plant of this species.

*Representative Specimens.* INDIA: Travancore, Trivandrum, E. W. Erlanson, n.d. (MICH); Andaman Ids., coll. unkn., n.d. (UC-99663), Dr Christ, n.d. (NY). MALAYA: Singapore, R. E. Holttum, x 28 (UC), St. John's I., F. J. H. Corner 22189, 31 xii 29 (UC-417174). PHILIPPINES: Luzon, Ilocos Sur, Sinait, H. H. Bartlett 14241, 2 vi 35, Pangasinan, Quezon I., J. V. Santos 1168, 9 v 38 (MICH), Alominos, E. Fenix, x 20 (UC), Polillo I., Polillo, A. Loher, v 08 (UC-240242), Tayabas, Mauban, H. M. Curran 9584, iii 08 (NY); Mindoro, Puerto Galera, G. Alcasid 3123, iv 34 (UC-699276); Cebu I., R. C. McGregor 1906

(UC-699284); Mindanao, Zamboanga, Caldera Bay, J. S. Domantay 5113, iv 39 (UC-633900), Basilan I., Boboh, Balhani 756, i–ii 41 (MICH); Sulu Archipelago, Tawitawi I., Tijitiji Reef, D. P. Abbott 49, 15 ii 57 (WRT-31035); Palawan Ids., Palawan I., Puerto Princesa, J. V. Santos 634, 21 iv 37 (MICH), Balabac I., L. Mangubat 522B, iii–iv 06 (NY, UC-699285 *p.p.*). AFRICA: Kenya, Mombasa, W. A. Setchell, 7 vi 27 (UC-311913 *p.p.*). INDONESIA: Java, Oedjoeng Koelon, A. J. Kostermans 696, 18 x 38 (MICH), Thousand Islands, Tjina I., Kostermans 366, 6 x 38 (MICH), Kaliage I., Kostermans 158a, 5 x 38 (MICH), Pajoeng I., Kostermans 479, 14 x 38 (MICH), Batavia, Amsterdam I., Kostermans 442, 11 x 38 (MICH); Celebes, Macassar, Setchell M482, 23 vi 29 (UC-735807); Flores Sea, Postillon Ids., Sarassa, Weber-van Bosse, n.d. (L-937, 253-410). PHOENIX ISLANDS: Canton I., M. S. Doty 10714, 9 iv 52 (NY). TONGA ISLANDS: U.S. South Pacific Exploring Exped. (Wilkes), 1838–42 (NY). SAMOA ISLANDS: Upolu, Apia, K. Rechinger 1509, n.d. (USNM, NY). NEW CALEDONIA: Kanala, herb. LeJolis, n.d. (L-937, 253-481). FIJI ISLANDS: A. Agassiz, 1898 (FH), South Pacific Exploring Exped. (Wilkes), 1838–42 (NY).

### Turbinaria conoides var. conoides f. laticuspidata n. f. Plate 2, figs. 9–12

Leaves 7–12 mm. long, 6–10 mm. diam.; subterete portion of the stalk prominent, somewhat thicker distally; vesicles absent and the leaves peltate, or causing a little enlargement below, the terminal blade forming a broad rim about the vesicle, irregular in shape and often broadly retuse on 1–2 sides, the margin subentire or more commonly with a few broad, low teeth.

Folia peltata aut vesiculata, haec laminas terminales latas, 1–2 incissuris latis saepe praeditis, atque margines subintegros, aut aliquot dentibus latis humilibus praeditos habentia. Plantae typicae in loco I. Cebu, Prov. Cebu, Repub. Philippinensis dicto, ab R. C. McGregor, 1906 lectae, in herb. Univ. Californensis (Berkeley) depositae.

These plants approach the typical form when the uppermost leaves are somewhat more sharply dentate (figs. 9, 10). A great majority of the leaves may be without vesicles, but it appears that in the upper parts of the best developed plants these eventually appear. Kützing's figure of *T. conoides* (1860, 10: 24, pl. 66 II) agrees better with the author's conception of this form than it does with the original description of the species by J. Agardh (1848).

*Representative Specimens.* INDIA: Tuticorin, W. Ferguson 4, n.d. (BMNH). MALAYA: Singapore, E. v. Martens, n.d. (UC-296395), Marchesetti, xii 80 (L-937, 253-412), R. E. Holttum, x 30 (UC-392359 *p.p.*). PHILIPPINES: Cebu I., R. C. McGregor, 1906 (UC Type); Mindanao, Surigao, Maribojoc, G. Menez, 12 xi 57 (DOTY-18364); Zamboanga, N. H. Whitford and W. I. Hutchinson 9284, i 08 (UC-699287); Palawan Ids., Palawan, Taytay, E. D. Merrill 9137, iv 13 (NY, UC-207322). INDONESIA: Java, Anjer, A. J. Kostermans 619a, 16 x 38 (MICH), Thousand Islands, Bokor I., Doty 12 xi 57 (DOTY-16599), Batavia, Kerkhof I., Kostermans 25, 25 ix 38 (MICH); Bali, O. Y. Seng B307, 1929–30 (UC-624794); Celebes, Macassar, W. A. Setchell M482, 23 vi 29 (UC-624793, 735805), Lei Lei, A. Weber-van Bosse n.d. (L-937, 253-421); New Guinea, Tak Tak, Weber-van Bosse n.d. (L-937, 253-403), Dobbo, Weber-van Bosse n.d. (L-937, 409–415). SOLOMON ISLANDS: Malaita I., Uras Cove, C. T. Crocker, 27 v 33 (UC-513204).

### Turbinaria conoides var. conoides f. retroflexa n. f.

Leaves on older parts of the stems generally strongly reflexed, often small, to about 8 mm. long, 5–6 mm. diam., the stalks slender, at the top very briefly expanded by the vesicle which may be 3 mm. diam.; distal marginal blade often appearing campanulate, irregular, narrow, sometimes with 2–3 major lobes, prominently acutely dentate.

Folia in stipitibus vetustioribus valde reflexa, saepe parva, satis campanulata, manifeste

acute serrata. Plantae typicae in loco I. Tandayong, Prov. Pangasinan, Repub. Philippinensis dicto, ab E. Y. Dawson et J. Domantay no. 11519, m. Apr. d. 5 lectae, in herb. Univ. Californiensis (Berkeley) no. M-098556 depositae.

*Representative Specimens.* MALAYA: Singapore, W. Birtwistle, v 28 (UC-341536). PHILIPPINES: Luzon, Pangasinan, Lingayan Gulf, Tandyong I., E. Y. Dawson and J. Domantay 11519, n.d., (UC-M098556); Negros I., Negros Occ., Murcielagos Bay, Baliangao, P. R. Manacop, iii 36 (UC-633899). INDONESIA: Java, Batavia, Kelapa I., A. J. Kostermans 292, 5 x 38 (MICH); Macassar Strait, A. Weber-van Bosse n.d., (L-937, 253-414).

### Turbinaria luzonensis n. sp. Plate 2, figs. 13–17

Plants to about 10 cm. tall, the axes simple or sparingly branched. Leaves 6–10 mm. long, 3–7 mm. diam., the lower half subterete and slender, sharply expanded by the vesicle and turbinate, laterally indistinctly 3-ridged, the ridges entire. Terminal aspect irregularly rounded triangular, somewhat flattened, with the distal marginal blade reduced to a relatively thick, narrow and somewhat undulate ridge, or sparingly and bluntly toothed, or represented by a very few teeth directly on the vesicle, or entirely suppressed. Receptacles shorter than the leaves, attached near the base, racemose, the lateral divisions seldom forked.

Folia turbinata, vix lateraliter compressa; laminae terminales marginales multum reductae, quae ad dentes directe in vesicula saepe redactae sunt, aut etiam omnino desunt. Plantae typicae in loco Mulanay, Prov. Quezon, I. Luzon, Rep. Philippinensis dicto, ab H. M. Curran no. 11125 lectae, n. Apr. 1908, in herb. Univ. Californiensis (Berkeley) no. 699281 depositae.

These plants resemble small *T. condensata* in leaf size, but the leaves do not have the distinct angled aspect of that species, and instead of a marginal blade and even supernumerary teeth on the distal face show obsolescence of rims and teeth. Their relationship is probably more close to *T. conoides* than to *T. condensata*.

*Representative Specimens.* PHILIPPINES: Luzon, Quezon Prov., Mulanay, muddy coral flats exposed at low tide, H. M. Curran 11125, iv 08 (UC-699281 Type, N.Y., isotype). Baler, on coral reef, J. V. Santos 329, 22 ix 35 (MICH).

### Turbinaria filamentosa Yamada 1925, p. 243, fig. 1

Plants slender, the axes simple, to 12 cm. tall. Leaves to 10–14 mm. long, 5–7 mm. broad, the stalk portion subterete and about half the length of the leaf, sharply inflated above and turbinate. Distal marginal blade narrow, the few teeth relatively coarse, or sometimes teeth absent; vesicles prominent in some leaves but in many obscure or absent, when the leaves appear peltate. Receptacular clusters attached near the leaf bases, reaching a length of 13 mm., sparingly branched below, the terminal divisions long, often extending far beyond the leaves.

Apart from the conspicuous receptacles there is little to distinguish these plants from small individuals of such a species as *T. condensata*, though intramarginal teeth were not noted on the available material. The branched receptacles in Sargassaceae often elongate considerably as they begin to degenerate. This is not particularly notable in *Turbinaria*, though seen prominently in material of *T. triquetra* (UC-M158094).

*Representative Specimens.* FORMOSA: Garaubi, Y. Yamada, iii 24 (NY, UC-M199682, probably isotypes).

### Turbinaria condensata Sonder *in* Kützing 1860, p. 25, pl. 69 II. Plate 2, figs. 18–28

Plants of moderate size, the axes with numerous lateral branchlets to 8 cm. or more in length. Leaves to 8–13 mm. long, 5–10 mm. diam., the lower portion stalk-like and terete for two-thirds the length, distended above by the prominent vesicle, more broadly turbinate than obpyramidal, but the sides a little compressed. Terminal aspect obscurely

an individual peculiarity than a widespread one. Turner's figures (1808), called *Fucus turbinatus*, represent *T. ornata* (Pl. 24, fig. c) in part only, as a variety, and instead of showing variation in that species include *T. decurrens* (fig. b) and, perhaps, *T. condensata* (since teeth are shown on the lateral ridges of a few distal leaves), or *T. conoides*. Certainly they do not represent *T. turbinatus* as we know it in the West Indies, which is better shown in Gmelin's (1768) engraving (Pl. 5, fig. 1).

Other more prevalent differences necessitate the designation of three lines of variation by form names. This seems to be the most widespread and common Indo-pacific species. Upwards of 250 herbarium sheets of this species and its variant forms have been examined for this study, and those cited selected as representative and covering the geographical range. Notably restricted have been the series from the Marshall Islands collected by the writer (Taylor 1950), and those from Indonesia, the Philippines and Hawaii.

*Representative Specimens.* CEYLON: W. H. Harvey 102. n.d. (NY, UC-262568). VIET NAM: Nhatrang, E. Y. Dawson *et al.* 11135, 29 i 53 (US, UC-M098823). CHINA: Kwantung Prov., Hainan I., Wenchang, C. K. Tseng, 29 iii 34 (UC-531730); Pratas I., Tseng 1164, viii–ix 33 (UC-531734). FORMOSA: Kyukyusho, Y. Yamada, iv 41 (UC-958473). RYUKYU ISLANDS: U.S. North Pacific Expl. Exped. (Ringgold-Rogers), 1853–56 (US); K. Okamura, n.d. (UC-418221). JAPAN: Amani Ids., Yoron I., T. Tanaka, 19 vii 55 (UC-M099283). PHILIPPINES: Batanes Prov., Batanes Ids., Basco, H. H. Bartlett 15402, 20 vii 35 (MICH); Babuyan Ids., Dalupiri I., Bartlett 14599, 17 vii 35 (MICH); Luzon I., Cagayan Prov., Sta. Ana, G. T. Velasquez 2378, 17 vi 35 (MICH), Ilocos Sur Prov., Sinait, Bartlett 14242, 2 vi 35 (MICH), Narvacan, Kelaw 12, 12 vi 35 (MICH), Tayabas Prov., Baler, J. V. Santos 430, 22 vi 35 (MICH), Mauban, H. M. Curran 9584, iii 08 (UC-699280); Mindoro I., Puerto Galero, Boaya Pt., Velasquez 1060, 29 iv 41 (MICH), San Isidro, Velasquez 975, 23 iv 41 (MICH), Bulalacao, C. B. Robinson 664, 14 iii 09 (NY, UC-699286); Calamian Ids., Culion I., Culion Harbor, Bartlett 15598, 27 vii 35 (MICH); Occ. Negros I., Murcielagos Bay, Baliangao, P. R. Manacop iii 36 (UC-633898); Cebu I., Lilioan Beach, Bartlett 16209, 20 ix 35 (MICH); Zamboanga I., Pta. Mariki, Balhani 373, i–ii 41 (MICH); Little Sta. Cruz I., Bartlett A402a, i–ii 41 (MICH); Tabtabon I., Balhani 570, i–ii 41 (MICH); Sulu Archipelago, Sibago I., Balhani 126, i–ii 41 (MICH); Basilan I., Punta Matangal, Sitkeang, Balhani 593, i–ii 41 (MICH); Tengolan I., Balhani 686, i–ii 41 (MICH); Jolo I., Bartlett 16044, 16 ix 35 (MICH); Cagayan Sulu I., D. P. Abbott 36, 28 ii 57 (WRT-31037); Palawan Islands, Balabac I., Mangubat 522c, iii–iv 06 (NY, UC), Gnat Reef, Abbott 17, 4 iii 57 (WRT-31037). MARIANAS ISLANDS: Saipan, Tanapag Harbor, A. R. Kruckeberg 3 vii 45 (MICH); Guam, Anigua, P. Nelson 514, n.d. (NY), J. B. Thompson *et al.* 429, v 12 (UC-207328). MARSHALL ISLANDS: Eniwetok Atoll, Eleugelab I., W. R. Taylor 46–354, 2 vi 46 (US, MICH, WRT-34500); Pokak (Taongi) Atoll, Kannen I., F. R. Fosberg 34436, 20 iii 52 (MICH), Sibylla I., Fosberg 34500, 21 vii 52 (MICH); Bikini Atoll, Bikini I., R. F. Palumbo 21, 25 vii 49 (UC-M142540); Kwajalein Atoll, Kwajalein I., Dawson 12654, 26 ix 53 (UC-M099667); Majuro Atoll, Rogeron I., E. T. Moul 8004 (WRT-27301); Jaluit Atoll, Kabenbock I., Dawson 13125, 3 x 54 (UC-M058901). LINE ISLANDS: Jarvis I., C. T. Crocker 30, 2 xi 36 (UC-633977); Christmas I., Fosberg 13278, 30 viii 36 (WRG-20745). HAWAII: French Frigate Shoal, Crocker 21, 18 xii 36 (UC-633968); Pearl and Hermes Reef, P. Galtsoff 41, 26 vii 30 (NY); Niihau I., A. & S. Robinson 13, 1908 (UC-622129); Molokai I., Pukoo, M. Reed 335, 3 viii 05 (UC-622664); Oahu I., Waialua, Mokuleia, O. Degener 27365, 4 v 61 (UC-M186936); Hawaii I., Hilo, W. A. Setchell 5234, 15 vii 00 (UC-622131). AFRICA: Somalia, Chisimaio (=Kismaju), A. Vatova, 26 x 30 (UC-789937); Tanganyika, Dar es Salaam, E. Jacobsen, ix 36 (UC-559924); Union of South Africa, Natal, Isipingo, W. E. Isaac B57, B1008, 11 vii 53 (CT). MADAGASCAR: Nossi Bé, J. M. Hildebrand 56, ix 79 (NY, UC-434096). MAURITIUS: Port Louis, N. Pike 152D, 1868 (NY). INDONESIA: Java I., Panganderan, Panti Teluk Prigi, H. M. Burkhill 2967, 22 ii 62 (MICH), Baai van Batavia, Eil. Amsterdam, Kostermans 443, 11 x 38 (MICH); Bali I., Sanoer, Setchell & Parks 253, 15 vi 29 (UC-735812); Timor I., Koepang, Martens xii 1862 (WRT-11756);

Amboina I., Robinson 2401, vii-ix 13 (NY); Banda Ids., Banda Neira, D. F. Visser, v 81 (L-941, 312-252). AUSTRALIA: Queensland, Cooktown, F. v. Müller, 1879 (UC-303898). TORRES STRAIT: Murray Ids., H. L. Clark, x 13 (FH). NEW GUINEA: Hatzfeldhafen, ?-Heydrich 31, 1892 (US, NY). GILBERT ISLANDS, Onotoa, P. Cloud & E. T. Moul 8821, 2 vii 51 (WRT-27300). SOLOMON ISLANDS: Bellona I., Crocker 676B, 20 vi 33 (UC-513205). FIJI ISLANDS: Viti Levu, Suva, Setchell & Parks 17766, 22–28 v 26 (UC-667510). TONGA ISLANDS: Tongatabu I., Hufagalupe, Setchell & Parks 17209, 25 vii 26 (UC-667538.) SAMOA ISLANDS: Niuafou I., H. C. Kellers, 29 ix 30 (NY); Savaii I., Mataatu Harbor, Crocker 4, 16 x 36 (UC-633958); Upolu I., Apia, E. Christopherson 501, 2 ix 29 (UC-791914); Tutuila I., Aua, Setchell 1104, 14 vi 20 (UC-233529), Anape Bay, Setchell 1206, 11 vii 20 (FH). COOK ISLANDS: Rarotonga I., Avarua, Parks 22431(619), 1929 (UC-634159). SOCIETY ISLANDS: Emio I., U.S. South Pacific Exploring Exped. (Wilkes) 1838–42 (US, NY); Tahiti I., Mara'a Pa'ea, C. Crossland 7040, xi 28 (UC-791848). AUSTRAL ISLANDS: Raivavae I., Crocker 9808(35), 3 xii 34 (UC-633814); Rimitara I., Crocker 9804(22), 25 xi 34 (UC-633740).

### Turbinaria ornata var. ornata f. ecoronata n. f. Plate 3, figs. 7–9

Erect axes simple or very sparingly branched, to 4·5 dm. tall. Leaves 10–15 mm. long, 8–10 mm. broad, the stalk slender and terete for 0·5–0·4 its length, abruptly distended by the prominent vesicle, without conspicuous lateral ridges or teeth; distal marginal blade irregularly triangular with greatly convex sides, the face distended by the vesicle, the margins narrowly but clearly winged and with prominent large teeth.

Folia satis magna, stipitibus infra teretibus, per vesiculam magnam abrupte distensa, laminae terminales irregulariter triangulares, lateribus convexis, marginibus latitudine variantibus, dentes magnos perspicuos praebentibus. Plantae typicae in loco I. Strawn, Palmyra Atoll dicto, ab E. Y. Dawson no. 19466, d. 18, m. Oct. 1958 lectae, in herb. Univ. Californiensis Berkeley no. M142118 depositae.

These plants differ from typical *T. ornata* in their looser growth habit, the even more conspicuously inflated vesicles which dominate the leaves, and the general absence of intramarginal crown teeth, although occasionally one or two of these were found to be present.

*Representative Specimens.* INDIA: Madras State, Palk Bay, Rameswaram I., Plakoda, F. Thivy, 29 i 53 (THIVY). MARSHALL ISLANDS: Jaluit Atoll, Jaluit I., E. Y. Dawson 13062, 29 ix 54 (UC-M058920). LINE ISLANDS: Palmyra Atoll, Strawn I., Dawson 19466, 18 x 58 (UC-M142118, Type), Sand Island, Dawson 142175, 18 x 58 (UC-M142175). PHOENIX ISLANDS: Canton I., G. F. Papenfuss, 31 i 49 (UC-910584), M. S. Doty 10714, 9 iv 52 (UC-M107942).

### Turbinaria ornata var. ornata f. evesiculosa (Barton) n. comb.

Plants to 12 cm. tall, simple or sparingly branched. Leaves coarse, but a little smaller than in the typical form, 7–12 mm. long, to 10 mm. diam. (dry), peltate or distally somewhat obpyramidal; vesicles absent or inconspicuous and not distending the leaves; distal marginal blade triangular with convex sides, marginally conspicuously coarsely toothed, the distal face without intramarginal teeth, or occasionally a very few present.

The plants Barton associated as a variety with *T. conoides* (1891 p. 217) are, rather, somewhat small variants of *T. ornata*. Careful examination of authentic material showed that vesicles were not always absent even from the plants available to Miss Barton. The leaves are generally larger than those of *T. conoides*, coarser, more coarsely toothed, and they show distinctive differences in habit and leaf form from it. Much as typical *T. ornata* (Pl. 3, figs. 1–6) seems to differ from f. *ecoronata* (Pl. 3, figs. 7–9) and f. *evesiculosa*, many plants are not sharply distinct in the critical features. The form names are needed so that

the variation in the species may be kept in orderly review without risking confusion with other plants through a single, too-generalized description.

*Representative Specimens.* PHILIPPINES: Cebu I., Liloan, P. D. Pages 224, 8 vi 60 (DOTY). INDONESIA: Java, Baai van Batavia, Edam Eil. and Enkhuizen Eil., A. Weber-van Bosse *ante* 1891 (BMNH, type or isotype material), A. Weber-van Bosse 734 (L-937, 253–426 and –429, designated *T. conoides* v. *evesiculosa* and probably equivalent to the British Museum material), Edam Eil., Kostermans 102, 20 ix 38 (MICH); Hoorn Eil., Kostermans 56, 27 ix 38 (MICH); Amsterdam Eil., Kostermans 443, 11 x 38 (MICH).

### Turbinaria ornata var. ornata f. hainanensis n. f. Plate 3, figs. 10–12

Plants stout, to 2-5 dm. tall, the main axes sparingly irregularly branched. Leaves with subterete stalks 0-5–0-66 the entire length, generally somewhat inflated distally by a small vesicle, or this lacking; lateral faces flattened but the margins not acute or dentate; distal marginal blade conspicuous, rounded-triangular, to 10–15 mm. broad (dry), probably often undulate rather than plane, most typically with long, acute teeth which are irregularly placed, some patent, others erect and so not all in the same plane; intramarginal teeth frequent, rather irregularly distributed, not forming a regular crown.

Folia satis magna, interdum peltata, interdum vesiculam parvam habentia, superficiebus lateralibus compressis; laminae terminales marginales manifestae, rotundo-triangulares, aliquantulum campanulatae aut tortae, dentibus marginalibus satis longis, positu maxime irregulares atque saepe dentibus distalibus irregulariter positis, praeditae. Plantae typicae in loco Wenchang, I. Hainan, Repub. Sinicae dicto, ab C. K. Tseng no. 954, m. Apr. d. 25—m. May d. 14, 1934 lectae, in herb. Univ. Californiensis, (Berkeley) no. 531733 depositae.

From the typical variety this form seems to differ in the irregular features of the leaves, particularly of the teeth.

*Representative Specimens.* CHINA: Kwantung, Hainan I., Wenchang, Eng-ko-hai, C. K. Tseng 954, 25 iv–14 v 34 (UC-531733, type), Eng-ko-hai, Tseng 432, 24 vi 33 (UC-531731), Ci-man, Tseng 717, 29 iii 34 (UC-531730). AFRICA: Kenya, north of Mombasa, W. E. Isaac 1962 (WRT), comes close to this form, although with relatively few intramarginal teeth.

#### REFERENCES


AGARDH, J. G., 1848. *Species, genera et ordines algarum. . . . I. Species, genera et ordines Fucoidearum. . . algas fucoideas complectens.* **1**: vii + 363 pp. Lund.

BARTON, E. S., 1891. A systematic and structural account of the genus *Turbinaria*, Lamx. *Trans. Linn. Soc. Lond., (Bot.)*, **3**: 215–26, pls. 54, 55.

BORGESEN, F., 1933. Some Indian Green and Brown algae, especially from the shores of the Presidency of Bombay, III. *Journ. Indian Bot. Soc.*, **12**(1): 1–16, 7 text-figs., pl. 1.

BORY DE ST. VINCENT, J. P., 1827. Botanique. Agamie. Hydrophites, pp. 62–177, pls. 1–24. In DUPERREY, L. I., *Voyage autour du monde sur 'La Coquille' pendant les années 1822, 1823, 1824 et 1825.* 1827–9. Paris.

GEPP, A. & GEPP, E. S., 1908. Marine Algae (Chlorophyceae and Phaeophyceae) and marine Phanerogams of the 'Sealark' expedition, collected by J. Stanley Gardiner. *Trans. Linn. Soc. Lond., (Bot.)*. **7**: 163–88, pls. 22–4.

GMELIN, S. G., 1768. *Historia Fucorum.* [10] + 1–6 + 1–239 pp., pls. IA, B, IIA, B, III–XXXIII. St. Petersburg.

HOWE, M. A., 1920. Algae, pp. 553–618. In BRITTON, N. L. & MILLSPAUGH, C. F., *The Bahama Flora*, vii + 695 pp. New York.

KÜTZING, F. T., 1849. *Species Algarum.* vi + 922 pp. Leipzig. [*ante* 17 Aug.: rev. in *Bot. Zeit.* **7**(33): cols. 596–600. 1849]

KÜTZING, F. T., 1860. *Tabulae Phycologicae*, **10**: iv + 39 pp. 100 pl. Nordhausen.

MARTENS, G. VON., 1866. Die Tange. In *Die Preussische Expedition nach Ost Asien*, Bot. Theil., 152 pp., 8 pl. Berlin.

RUPRECHT, F. J., 1849. Die Vegetation des Rothen Meeres und ihre Beziehung zu den allgemeinen Sätzen der Pflanzen-Geographie. *Mém. Acad. Imp. Sci. Saint Petersbourg, vi, Sci. Math., Phys. et Nat., 8 II Sci. Nat.*, **6**: 71–84. (Oct.).

SONDER, G., 1845. Nova Algarum genera et species quas in itinere ad oras occidentales Novae Hollandiae, collegit L. Preiss, Ph. Dr. *Bot. Zeit.*, 3(4): columns 49–57.

TAYLOR, WM. RANDOLPH, 1960. *Marine algae of the eastern tropical and subtropical coasts of the Americas*, ix + 870 pp., 14 photographs, 80 pl. Ann Arbor, Mich.

TURNER, D., 1808. *Fuci, sive Plantarum Fucorum generi a botanicis ascriptarum icones descriptiones et historia*, 1: 164 + 2 pp., 71 pl. London.

WEBER-VAN BOSSE, A., 1898. Liste des algues du Siboga. I. Myxophyceae, Chlorophyceae, Phaeophyceae [with Th. Reinbold], *Siboga Expeditie*. . ., 59a: 1–186, figs. 1–52, pls. 1–5, 1913; *Id.*, II. Rhodophyceae i, *ibid.*, 58b: ii + 187–310, figs. 53–109, pls. 6–8, 1921; *Id.*, ii, *ibid.*, 59c: 311–92, figs. 110–42, pls. 9–10, 1923. Leiden.

YAMADA, Y., 1925. Studien über die Meeresalgen von der Insel Formosa. *Bot. Mag. Tokyo*, 39(465): 239–54, 6 figs.

## EXPLANATION OF PLATES

PLATE 1. Leaves of *Turbinaria* species from various aspects

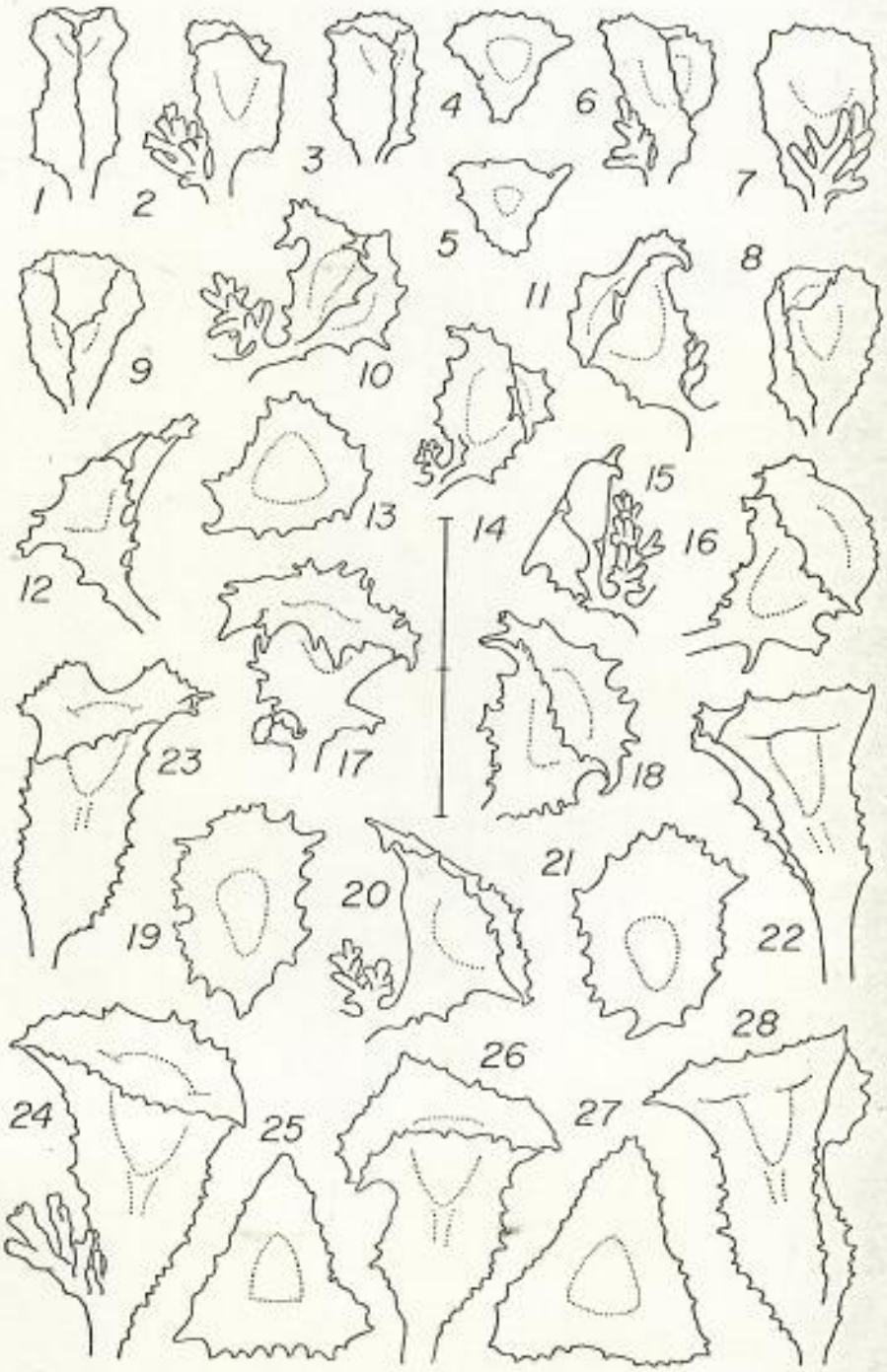
Figs. 1–9, *T. papenfussii*. Figs. 10–21, *T. triquetra*. Figs. 22–28, *T. decurrens*. Bar scale 2 cm. equiv. Magnification × 2.

PLATE 2. Leaves of *Turbinaria* species from various aspects

Figs. 1–8, *T. conoides*. Figs. 9–12, *T. conoides* fa. *laticuspidata*. Figs. 13–17, *T. luzonensis*. Figs. 18–28, *T. condensata*. Bar scale 1 cm. equiv. Magnification × 2.

PLATE 3. Leaves of *Turbinaria* species from various aspects

Figs. 1–6, *T. ornata*. Figs. 7–9, *T. ornata* fa. *coronata*. Figs. 10–12, *T. ornata* fa. *hainanensis*. Figs. 13–21, *T. gracilis*. Scale as for Plate 1. Magnification × 2.

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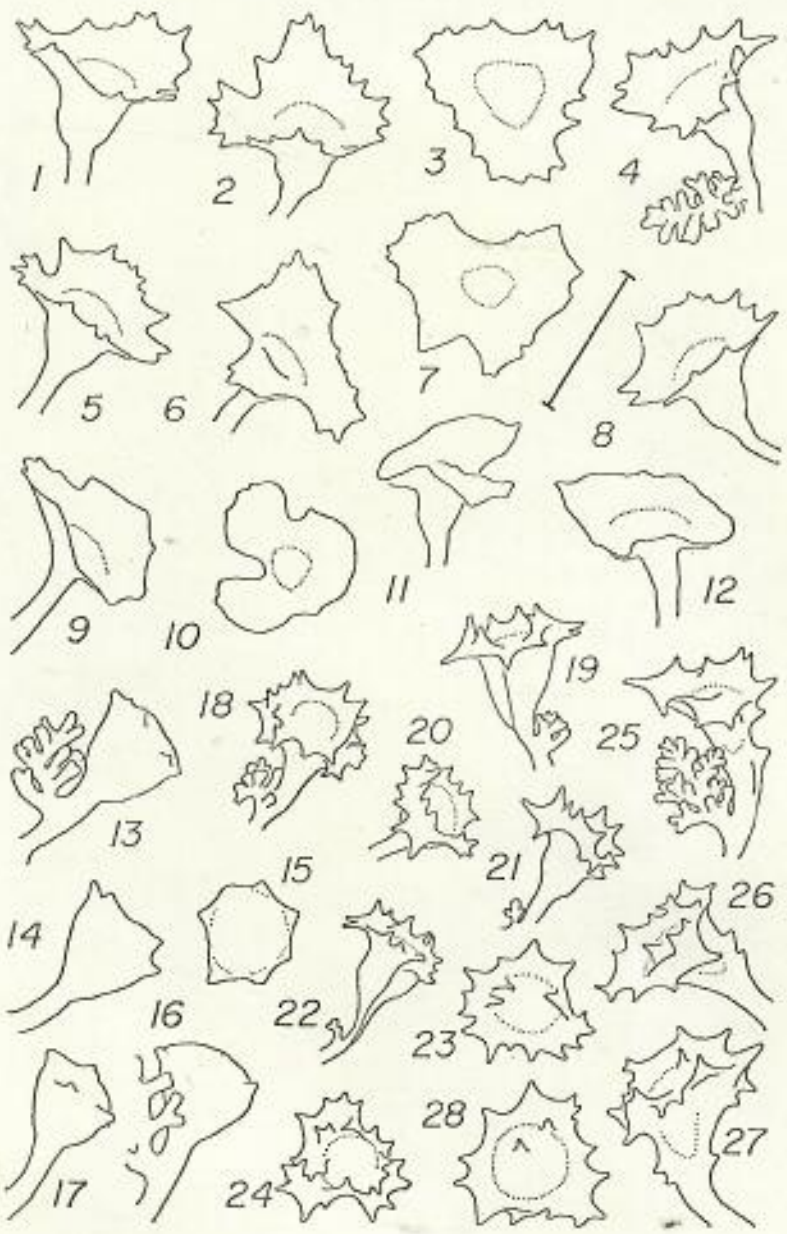
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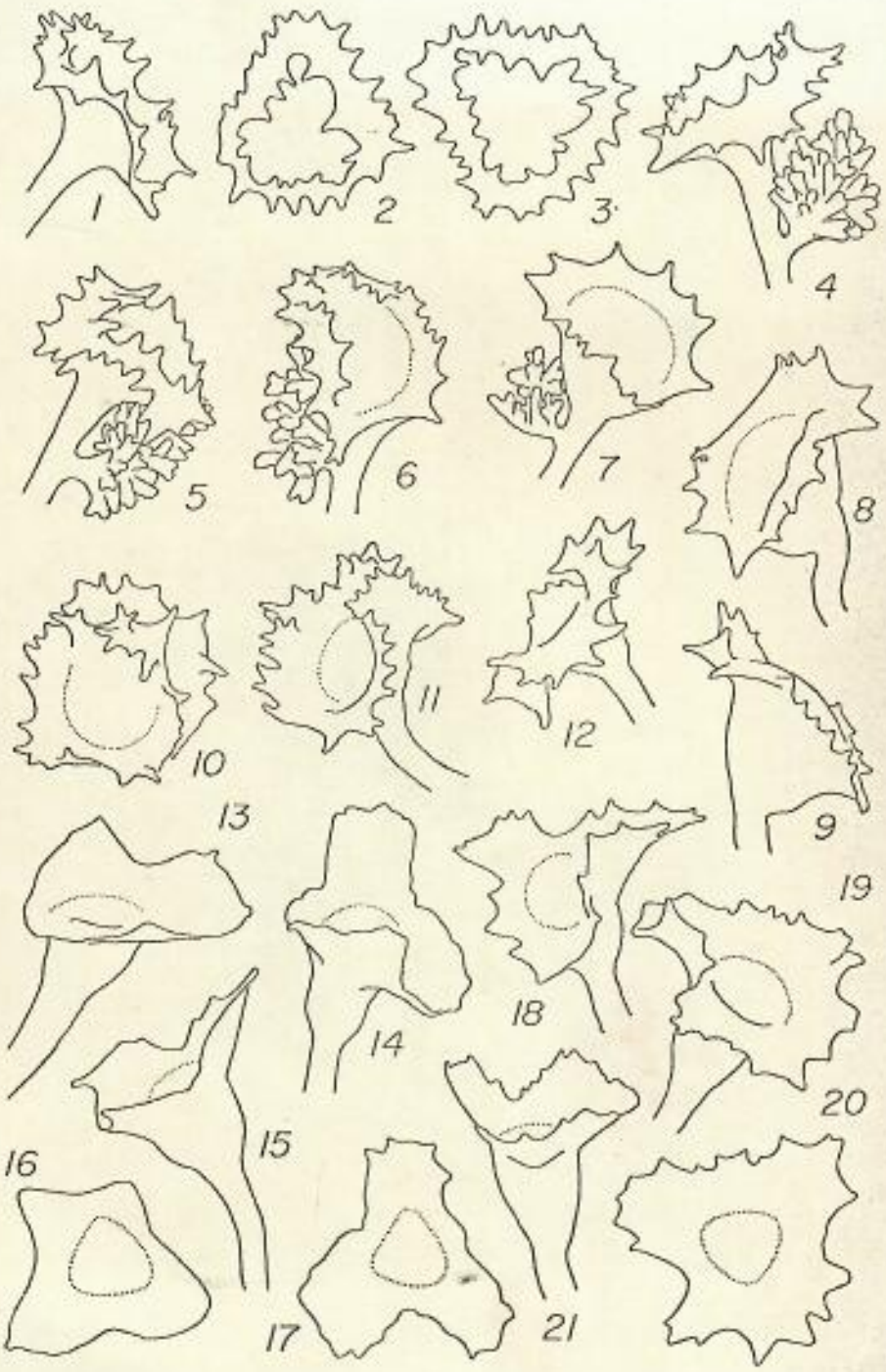


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