

COMMONWEALTH OF AUSTRALIA

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THE GENUS *CODIUM* (CHLOROPHYTA) IN SOUTHERN AUSTRALIA

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By P. C. SILVA* and H. B. S. WOMERSLEY†

[Manuscript received May 9, 1956]

Summary

Fifteen species of *Codium*, five of which were previously undescribed, occur along the southern coast of Australia. Detailed descriptions and illustrations of all species are given, together with their distribution and notes on the habitat of each.

INTRODUCTION

The representation of *Codium* in Australia, like that of marine algae in general, is rich both in individuals and in species. The present systematic account treats those species found in the region between south-west Western Australia and the Victorian–New South Wales border, including Tasmania.

Specimens were made available for study from: University of Adelaide (AD); Herb. Agardh, Botaniska Museet, Lund (LD); Allan Hancock Foundation, University of Southern California (AHFH); British Museum (Natural History) (BM); Jardin Botanique de l'Etat, Bruxelles (BR); Botanical Museum, Copenhagen (C); Division of Plant Industry, C.S.I.R.O., Canberra (CANB); Royal Botanic Garden, Edinburgh (E); Chicago Natural History Museum (F); Instituto Botanico, Firenze (FI); Staatsinstitut für allgemeine Botanik, Hamburg (HBG); University of Tasmania, Hobart (HO); Royal Botanic Gardens, Kew (K); Rijksherbarium, Leiden (L); Botanische Staatssammlung, München (M); National Herbarium of Victoria, Melbourne (MEL); University of Michigan (MICH); National Herbarium of New South Wales, Sydney (NSW); New York Botanical Garden (NY); Muséum National d'Histoire Naturelle, Laboratoire de Cryptogamie, Paris (PC); State Herbarium of Western Australia, Perth (PERTH); Naturhistoriska Riksmuseet, Stockholm (S); Trinity College, Dublin (TCD); University of California, Berkeley (UC); United States National Museum (US); Victoria University College, Wellington (VUC).

KEY TO SPECIES OF *CODIUM* IN SOUTHERN AUSTRALIA

1. Thallus appanate or subglobose 2
1. Thallus erect, simple or dichotomously branched 8
 2. Thallus appanate 3
 2. Thallus subglobose 7
3. Utricles mostly less than 100 μ dia. 4
3. Utricles mostly greater than 100 μ dia. 6
 4. Utricles devoid of hairs 1. *C. dimorphum*
 4. Older utricles with hairs (or hair scars) 5
5. Utricles 600–1300 μ long, regularly and conspicuously capitulate, apices symmetrical
..... 2. *C. capitulatum*

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5. Utricles 435-800 (-1150) μ long, irregularly constricted below apex, apices asymmetrical ... 3. *C. lucasii*
 6. Utricles in small clusters, apical wall thickened into galeate cap to 50 μ thick 4. *C. perrinae*
 6. Utricles in large clusters, apical wall thin or moderately thickened (-32 μ) 5. *C. spongiosum*
 7. Utricles mostly 450-1000 μ dia. at apex 6. *C. mamillosum*
 7. Utricles mostly 90-125 μ dia. at apex 7. *C. pomoides*
 8. Thallus simple or once-divided, broad and flat, felt-like 8. *C. laminarioides*
 8. Thallus dichotomously branched, branches terete or somewhat complanate 9
 9. Utricles not mucronate 10
 9. Utricles mucronate 14
 10. Utricles often longer than 1 mm 11
 10. Utricles never as long as 1 mm 12
 11. Utricles with galeate thickening at apex 9. *C. galeatum*
 11. Utricles with thin or slightly thickened apical wall, not galeate 10. *C. duthieae*
 12. Medullary filaments with plugs close to point of departure from utricle 11. *C. harveyi*
 12. Medullary filaments with plugs conspicuously distant from point of departure from utricle 13
 13. Utricles prominently introrsely umbonate 12. *C. muelleri*
 13. Utricles not introrsely umbonate 13. *C. australicum*
 14. Utricles mostly longer than 1 mm 14. *C. fragile*
 14. Utricles 475-680 μ long 15. *C. spinescens*

1. *Codium dimorphum* Svedelius, Svenska Exped. Magellansl nderna 3(8): 300, pl. 16, fig. 1; pl. 17, figs. 16-19 (1900).

Fig. 1

Codium adhaerens C. Agardh var. *incrassatum* Dellow, Trans. Roy. Soc. N.Z. 80: 124, figs. 8, 9 (1952).

Thallus applano-pulvinate, 2.5-10 mm thick, to 10 cm dia., tending to be crescent-shaped, lobed at margins, very firm, dark green. Utricles in large clusters, cylindrical (47-) 55-80 (-90) μ dia., 550-1000 μ from apex to point of origin from parent utricle; apices rounded to subtruncate; utricular wall 1.5 μ thick, at apex slightly thickened, apical thickening tending to make apex truncate or depressed. Utricles from free edge of thallus with marked apical thickening (-30 μ), expanded below apex (-125 μ dia.); incrassate apices lamellate, internally alveolate, and externally often foveolate. Hairs absent. Medullary filaments originating singly at base of each new utricle by broad outgrowth so that filament and utricle intergrade, gradually tapering to 20-35 μ dia. Gametangia narrowly ellipsoid to cylindrical, 44-75 μ dia., 240-380 μ long, borne singly on very short pedicel (about 3 μ long) 370-480 μ below apex of utricle.

Type.—Melinca, Guaitecas Is., Chile, *P. Dusen* (Herb. Svedelius; fragment in UC).

Known Range.—Tasmania. New Zealand. Chatham Is. Chile.

Representative Specimens Examined.—TASMANIA: Port Arthur, exposed positions in sublittoral fringe, 26.i.1951, *Cribb* 117.5 (UC). Cape Forestier, 21.vi.1954, *I. Bennett* (AD, A19,830). Tasman I., 28.vi.1954, *I. Bennett* (AD, A19,831). NEW ZEALAND: Stewart I.: Half Moon Bay,

25.ii.1935, *L. M. Jones*, Tilden's South Pacific Plants, ser. 2, no. 753 (F). Otago: St. Clair, Dunedin, 23.vi.1961, *M. Naylor* (VUC). Canterbury: Banks Peninsula, *S. Berggren* (LD). CHATHAM ISLANDS: *Travers* 40 (LD).

The distribution of this species undoubtedly is related to the Antarctic Circumpolar Current, which has its biological counterpart in an antarctic circumpolar marine algal province. It is apparently restricted to the sublittoral fringe or lower littoral zones in south-east Tasmania.

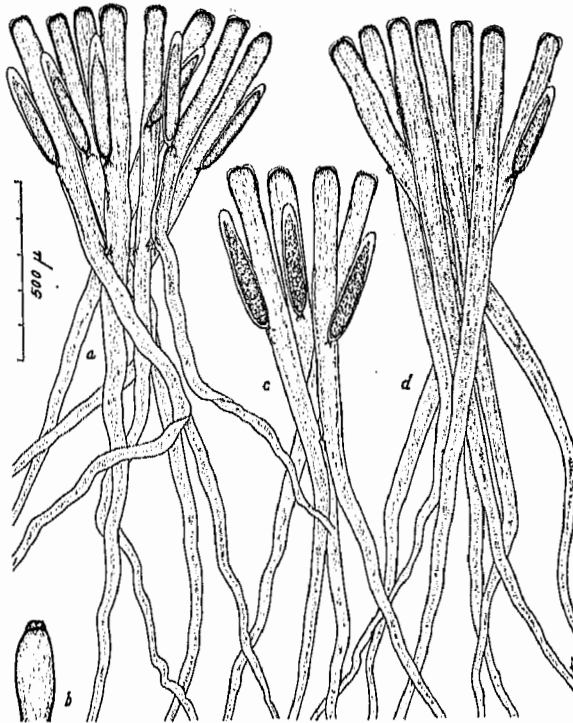


Fig. 1.—*C. dimorphum*. *a*, *b* (Molhuca, Chile, *Dusen* = type). *a*, mature group of utricles from centre of thallus; *b*, apex of utricle from edge of thallus, showing marked thickening; *c*, (St. Clair, Dunedin, New Zealand, *Naylor*) mature group of utricles from centre of thallus; *d*, (Port Arthur, Tas., *Cribb* 117·5) mature group of utricles from centre of thallus.

2. *Codium capitulatum* sp. nov.

Fig. 2; Plate 1, Fig. 1

Thallus applanatus, cum forma extenta et irregulare, adhaerens firmiter substrata, ad marginem cum lobosis, ad 1 cm crassus, firmus, fusco-viridis. Utriculi in magnis fasciculis, cylindrici; utriculi primi 600–1300 μ long., 70–140 μ dia. ad apicem, ad 230 μ dia. in partem mediam, constricti 50–80 μ infra apicem, cum multo pilorum cicatricibus in zona 95–270 μ infra apicem, interdum in verticalibus ordinibus; utriculi secundarii 600–1000 μ long., 40–85 μ dia. ad apicem, distincte

constricti 50–80 μ infra apicem, cum forma capitata, ad 115 μ dia. infra constrictionem, interdum cum multis pilorum cicatricibus, ordinatis similiter ad utriculos primos; apices rotundata symmetricaliter; membrana utricularis 1–1.5 μ crass., ad apicem paululum incrassata (2–4 μ in utriculis majoribus natu). Filamenta medullaria plerumque 16–45 μ dia. Gametangia fusiformia, 60–110 μ dia., 240–380 μ long., 1 gametangium per utriculum in brevi pedicelo positum (c. 7 μ long.), 320–415 μ infra apicem (ad aut ferme super partem mediam).

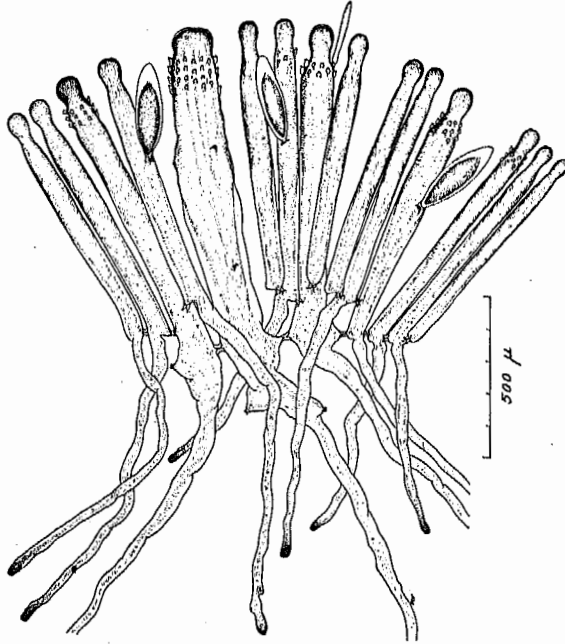


Fig. 2.—*C. capitulatum* (Elliston, S.A., Womersley (AD, A13,623)). Mature group of utricles from centre of thallus.

Thallus appanate, of extended and irregular shape, closely adherent to rock, with marginal lobes, to 1 cm thick, firm, dark green. Utricles in large clusters, cylindrical; primary utricles 600–1300 μ long, 70–140 μ dia. at apex, expanding to 230 μ dia. in middle, constricted 50–80 μ below apex, with numerous hair scars in band 95–270 μ below apex, at times arranged in vertical rows; secondary utricles 600–1000 μ long, 40–85 μ dia. at apex, prominently constricted 50–80 μ below apex, giving a capitate appearance, expanding to 115 μ dia. below constriction, often with numerous hair scars arranged as in primary utricles; apices symmetrically rounded; utricular wall thin (1–1.5 μ), very slightly thickened at apex (2–4 μ in older utricles). Medullary filaments mostly 16–45 μ dia. Gametangia fusiform, 60–110 μ dia., 240–380 μ long, borne 1 per utriculo on short pedicel (about 7 μ long), 320–415 μ below apex (at or just above middle).

Type.—Elliston, west coast of Eyre Peninsula, S.A. (lower littoral inside bay), 14.ii.1954, Womersley (AD, A19,384). Isotypes in BM, L, LD, MEL, UC.

Other Specimens Examined.—SOUTH AUSTRALIA: Point Sinclair, lower littoral, 26.i.1951, *Womersley*, (AD, A15,188). Point Sinclair, uppermost sublittoral in pools, 8.ii.1954, *Womersley* (AD, A19,558). Elliston, lower littoral in bay, 15.i.1951, *Womersley* (AD, A16,023). Point Westall, upper sublittoral pools, 19.i.1951, *Womersley* (AD, A13,807). Port Willunga, upper sublittoral, 23.ii.1955, *E. Wollaston* (AD, A20,400). VICTORIA: Point Lonsdale, *Tona Maclean* (UC). Walkerville, Waratah Bay, *I. Bennett*, Nov. 1949, lower littoral (AD, A15,230).

C. capitulatum is common just below and above low tide level on rock platforms on the west coast of Eyre Peninsula, especially where there is shade. Wave conditions vary from fairly calm to rough.

C. capitulatum is most closely related to *C. lucasii* on southern Australian coasts, from which it is easily distinguished, however, by its relatively long, regularly constricted utricles with symmetrically rounded apices. The utricles of *C. lucasii* by comparison are considerably shorter, not so regularly nor so conspicuously constricted, and with asymmetrical apices which may be rounded, truncate, or depressed. Moreover, unlike *C. capitulatum*, the apices of utricles of *C. lucasii* may be moderately to markedly incrassate with internal alveolation or eribrose pitting.

3. *Codium lucasii* Setchell in Lucas, Proc. Linn. Soc. N.S.W. 60: 200, text-fig. 3 (1935). Lucas, Seaweeds S. Aust. pt. 1: 50, fig 31 (1936). May, Proc. Linn. Soc. N.S.W. 63: 212 (1938). *Womersley*, Trans. Roy. Soc. S. Aust. 73: 145 (1950). *Silva*, Univ. Calif. Publ. Bot. 25: 87, 92-94, fig. 11 (1951). *Guiler*, Pap. Roy. Soc. Tasm. 86: 75 (1952).

Fig. 3

Thallus appanate or pulvinate, firm, slippery, dark green, 2.5-8 mm thick, at first orbicular, soon giving off broad or narrow lobes which form a close flat pattern rather tightly adherent to substratum but with free margins. Utricles in large clusters, cylindrical (45-) 50-100 (-130) μ dia. at apex, 435-800 (-1150) μ long, slightly to markedly constricted 40-70 μ below apex; apices truncate, depressed, or rounded, usually not perfectly symmetrical; utricular wall thin (1 μ), at apices slightly to moderately or even markedly thickened (-65 μ), internally often shallowly alveolate to deeply eribrosely pitted; hairs (or hair scars) common on older utricles, forming band of one or more irregular whorls extending from 70 to 145 μ below apex of utricle. Medullary filaments mostly 13-33 μ dia. Gametangia fusiform to oblong-ovoid, 60-125 μ dia., 215-360 μ long, borne 1 per utricle on short pedicel, 280-360 μ below apex.

Type.—Bondi, N.S.W., Aug. 1901, *A. H. S. Lucas* (UC 395199).

Known Range.—Cottesloe, W.A., around southern Australia to Redcliffe, Qld.

Representative Specimens Examined.—WESTERN AUSTRALIA: Cottesloe, 12.vi.1951, cast ashore, *Royce* 1039 (PERTH, UC). SOUTH AUSTRALIA: Head of Great Australian Bight, lower littoral, 4.ii.1954, *Womersley* (AD, A19,149). Elliston, lower littoral, 15.i.1951, *Womersley* (AD, A20,401) (UC). Pennington Bay, Kangaroo I., upper sublittoral reef pools, 28.i.1944, *Womersley* (AD, A2268). VICTORIA: Sorrento, upper sublittoral pools in shaded cave, 2.vi.1953, *Womersley* (AD, A18,830). NEW SOUTH WALES: Maroubra Bay, Oct. 1931, *A. H. S. Lucas* (UC). Balmoral, Sydney Harbour, 30.iv.1950, *Cribb* 50.9 (UC). Port Jackson, *W. H. Harvey*, *Algae Australicae Exsiccatae* 576, sub. *C. adhaerens* (TCD). Narrabeen Head, 20.iv.1951, *May* 2821 (NSW, UC). Newcastle, *W. H. Harvey*, *Algae Australicae Exsiccatae* 576, sub. *C. adhaerens*

(K). Fingal, 10.iv.1949, *Cribb* 12·5 (UC). QUEENSLAND: Redcliffe, 9.vii.1949, *Cribb* 20·16 (UC).

C. lucasii occurs just below or above low tide level, under moderate to rough wave action.

The applanate species of Australian *Codium* prior to the publication of *C. lucasii* were referred to *C. adhaerens* C. Agardh, which is strictly European in

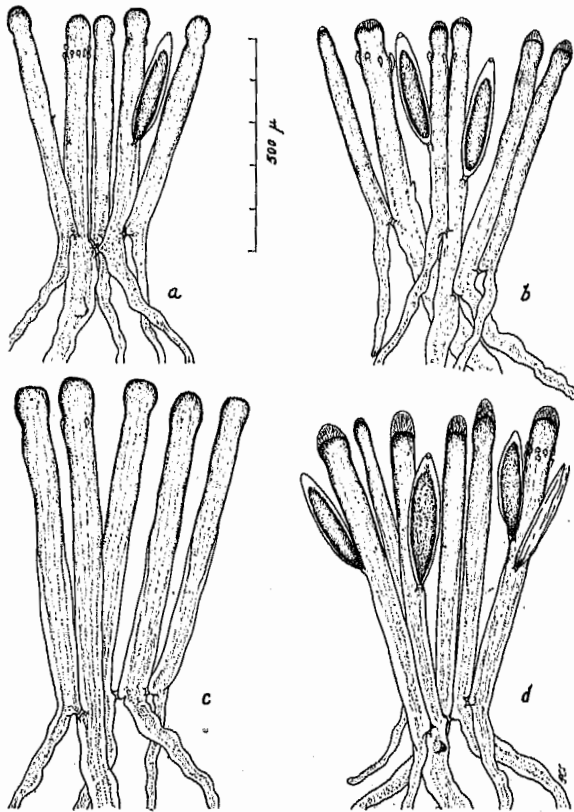


Fig. 3.—*C. lucasii*. Mature groups of utricles from centre of thallus. *a*, Redcliffe, Qld., *Cribb* 20·16; *b*, Balmoral, Sydney Harbour, N.S.W., *Cribb* 50·9; *c*, Elliston, S.A., *Womersley* (AD, A20,401); *d*, Cottesloe, W.A., *Royce* 1039.

distribution. Plants of *C. lucasii* from Port Jackson and Newcastle were distributed by Harvey as *Algae Australicae Exsiccatae* 576 and are the bases of the following erroneous records of *C. adhaerens*: Harvey 1863, p. lviii; Sonder 1880, p. 38; Lucas 1912, p. 171; May 1938, p. 212.

There is some doubt whether the Lord Howe Island record of Lucas (1935) should be referred to *C. lucasii*.

C. lucasii is closely related to, if not identical with, a widely distributed form in South Africa.

4. *Codium perrinae* Lucas, Proc. Linn. Soc. N.S.W. 60: 203, text-fig. 4 (1935).
Womersley, Trans. Roy. Soc. S. Aust. 73: 145 (1950). Guiler, Pap. Roy. Soc.
Tasm. 86: 75 (1952).

Fig. 4

Thallus pulvinate, orbicular when young, becoming crescentic or annular, to 12 cm across, glaucous green. Utricles in small clusters, ellipsoid-cylindrical to slightly clavate, 130–240 μ dia. at apex, to 375 μ dia. at distance of 230–350 μ below apex, 920–1700 μ long; apical wall moderately to markedly thickened into a lamellate galeate cap to 56 μ thick, occasionally slightly introrsely umbonate, externally foveolate. Medullary filaments mostly 26–60 μ dia. Hairs absent. Gametangia fusiform to subcylindrical, 65–100 μ dia., 370–450 μ long, borne 1 or 2 per utricle on a short pedicel 540–630 μ below apex of utricle.

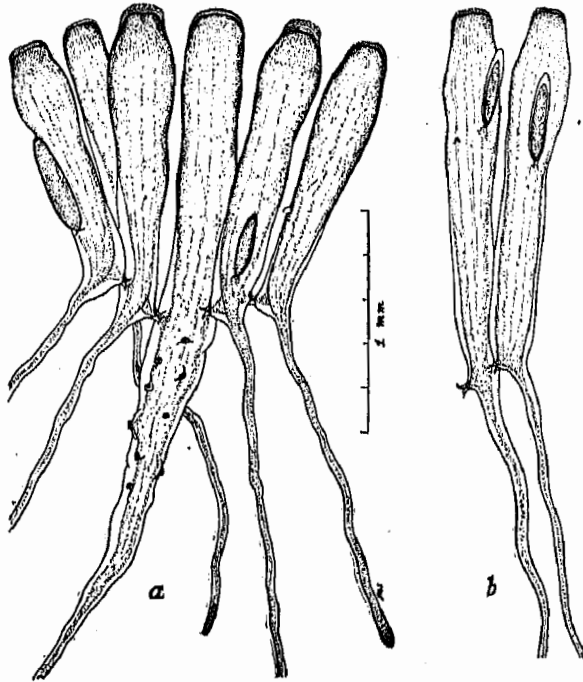


Fig. 4.—*C. perrinae*. *a*, (D'Estrees Bay, Kangaroo I., S.A., Womersley (AD, A12,781)); mature group of utricles with two juveniles arising as buds; *b*, (Nora Croina, S.A., Womersley (AD, A20,014)) group of utricles with gametangia.

Type.—Low Head, Bass Strait, Tas., Jan. 1930, *F. Perrin* & *A. H. S. Lucas* (CANB).

Known Range.—From Stenhouse Bay, Yorke Peninsula, to Low Head in Tasmania (see below).

Other Specimens Examined.—SOUTH AUSTRALIA: Stenhouse Bay, Yorke Peninsula, drift, 9.iv.1950, Womersley (AD, A13,168). D'Estrees Bay, Kangaroo I., upper sublittoral reef pools,

11.i.1950, *Womersley* (AD, A12,781) (BM, UC). Lefebre Peninsula, *F. von. Mueller* (HBG). Nora Creina, upper sublittoral pool, 14.xi.1955, *Womersley* (AD, A20,014). TASMANIA: Low Head, Jan. 1930, *Perrin & Lucas* (UC). Bellerive, June 1909, *Rothway* (HO).

Guiler (1952, p. 75) has reported several specimens from Tasmania under the name *Codium bursa* (L.) C. Agardh, a species restricted to warm Atlantic waters. That from Bellerive is *C. perrinae*; the others have not been checked, but may be *C. pomoides*.

C. perrinae is not a common species, but probably more general in occurrence than the known localities would indicate. It occurs in reef pools and the upper sublittoral zone under moderately rough conditions.

5. *Codium spongiosum* Harvey, Trans. R. Irish Acad. 22: 565 (1855); Harvey, Phyc. Austral. 1: pl. 55 (1858); 5: lvii (1863). Sonder, Fragm. Phytogr. Aust. 11 (suppl.): 38 (1880). J. Agardh, Acta Univ. Lund. 23: 38 (1887). De Toni, Syll. Alg. 1: 489 (1889). Wilson, Proc. Roy. Soc. Viet. 4: 188 (1892). J. Agardh, Acta Univ. Lund. 29: 99 (1894). Lucas, Proc. Linn. Soc. N.S.W. 37: 171 (1912). Schmidt, Bibl. Bot., Stuttgart 23 (Hft. 91): 32, figs. 14, 15? (1923). Lucas, Proc. Linn. Soc. N.S.W. 60: 202 (1935); Seaweeds S. Aust. 1: 51 (fig. 32) (1936). May, Proc. Linn. Soc. N.S.W. 63: 212 (1938). *Womersley*, Trans. Roy. Soc. S. Aust. 71: 247 (1947); *ibid.* 72: 161 (1948); *ibid.* 73: 146 (1950). May, Proc. Linn. Soc. N.S.W. 76: 92 (1951). Guiler, Pap. Roy. Soc. Tasm. 86: 75 (1952).

Fig. 5

Thallus pulvinate or appanate, with undulate to cerebriform lobes, spongy, to 15 cm thick, to 20 (-50) cm dia., loosely adherent to substratum. Utricles in large clusters, younger utricles cylindrical or clavate, 130-390 μ dia., 1.5-4 (-6) mm long, older utricles to 520 μ dia. at apex, gradually enlarging below up to 850 μ dia.; apices subtruncate to rounded; utricular wall 2-3 μ thick, at apices very slightly to moderately thickened (-32 μ), incrassate apices finally lamellate and slightly introrsely umbonate. Hairs (or hair scars) abundant, forming band about 120-200 μ wide and 130-430 μ below apex of utricle. Medullary filaments mostly 30-100 μ dia. Gametangia lance-ovoid or ampulliform, 50-175 μ dia., 215-360 μ long, usually several per utricle, each borne on short pedicel 360-660 μ below apex of utricle.

Lectotype.—King George's Sound, W.A., *W. H. Harvey*, *Algae Australicae Exsiccatae* 577 (TCD).

Known Range.—Point Cloates, W.A., around southern Australia to Green I. (near Cairns), Qld.; Tasmania. South Africa. Mauritius. Lord Howe I. New Caledonia. Hawaiian Is.

Representative Specimens Examined.—WESTERN AUSTRALIA: Point Cloates, comm. *May* 2822 (UC). Fremantle, 10.iv.1952, *Royce* 1158 (UC). Thompson Bay, Rottnest I., 19.x.1934, *C. M. Crosby*, Tilden's South Pacific Plants, ser. 2, no. 79 (F). King George's Sound, *W. H. Harvey*, *Algae Australicae Exsiccatae* 577 (K, TCD). SOUTH AUSTRALIA: Elliston, west coast of Eyre Peninsula, 15.i.1951, *Womersley* (AD, A16,625) (BM, K). Coffin Bay, upper sublittoral, 10.i.1951, *Womersley*, (AD, A13,751). Pig I., Pelican Lagoon, Kangaroo I., upper sublittoral,

12.iv.1947, *Womersley* (AD, A4489) (F, UC). Rocky Point Beach, Kangaroo I., drift, 4.vi.1947, *Womersley* (AD, A5706) (L). Port Vincent, drift, 8.iv.1950, *Womersley* (AD, A13,120). VICTORIA: Hayling's Reef, Apollo Bay, 17.i.1949, *Pope & Bennett* (AD, A15,276). NEW SOUTH WALES: Port Jackson, Feb.-Mar. 1881, dredged from 0.5 fm by H.M.S. *Alert*, *Coffinger* (BM). Middle Harbour, May 1906, *A. H. S. Lucas* (UC). Lake Macquarie, Jan. 1918, *A. H. S. Lucas* (NSW). QUEENSLAND: Moreton Bay, Jan. 1912, *C. P. White* (K). Point Lookout, Stradbroke I., Sept. 1949, *Cribb* 113 (UC). Bowen, *A. H. S. Lucas* (UC). Green I., near Cairns, June 1931, *Perrin & Lucas* (UC). TASMANIA: Stanley, *F. von Mueller* (K).

C. spongiosum is probably the most common prostrate *Codium* in southern Australia, being common under relatively calm conditions—such as the Gulf region of South Australia. It is a sublittoral species, extending to just below low tide level.

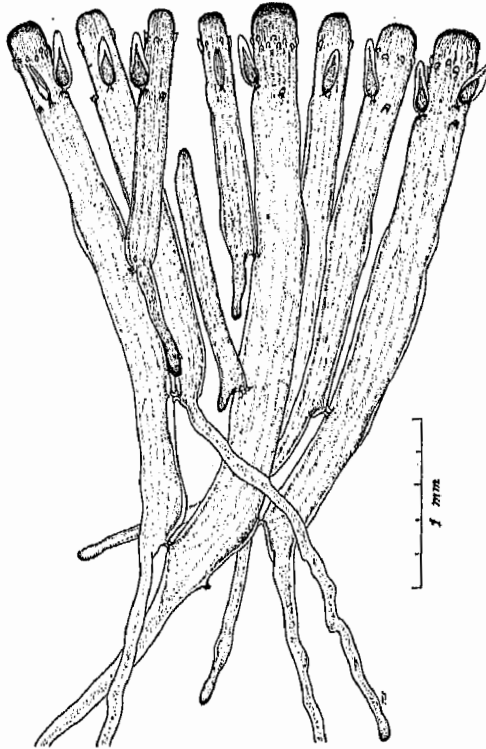


Fig. 5.—*C. spongiosum* (Point Lookout, Stradbroke I., Qld., *Cribb* 113). Mature group of utricles.

6. *Codium mamillosum* Harvey, Trans. R. Irish. Acad. 22: 565 (1855); Phyc. Austral. 1: pl. 41 (1858); Phyc. Austral. 5: lvii (1863). Sonder, Fragm. Phytogr. Aust. 11 (suppl.): 38 (1880). J. Agardh, Acta Univ. Lund. 23: 39 (1887). De Toni, Syll. Alg. 1: 491 (1889). Lucas, Proc. Linn. Soc. N.S.W. 37: 171 (1912); *ibid.* 52: 558 (1927); Trans. Roy. Soc. S. Aust. 53: 46 (1929b); Seaweeds S. Aust. 1: 53, fig. 34 (1936). *Womersley*, Trans. Roy. Soc. S. Aust. 71: 244 (1947); *ibid.* 72: 161 (1948); *ibid.* 73: 145 (1950); Rep. Aust. Geogr. Soc. No. 1 (3B): 36 (1953).

Fig. 6

Codium mamillosum var. *typicum* O. C. Schmidt, *Bibl. Bot., Stuttgart* 23 (Heft 91): 37, fig. 19 (1923).

Codium bursa var. *australis* Sonder, *Linnaea* 25(6): 660 (1853).

Thallus glaucous green, more or less globose, to 7 cm dia., attached to substratum by tuft of rhizoidal holdfasts. Utricles in small clusters, clavate, subtruncate

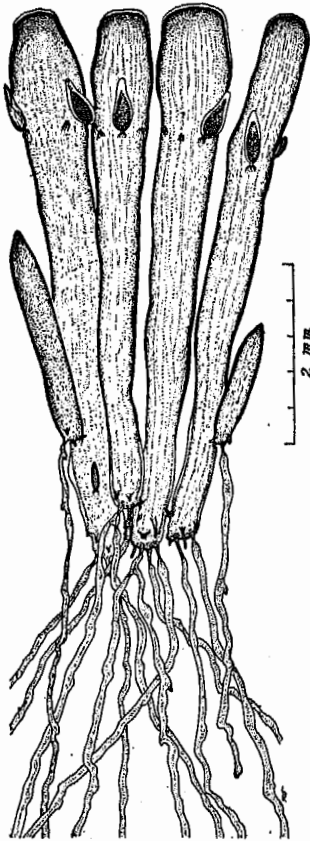


Fig. 6

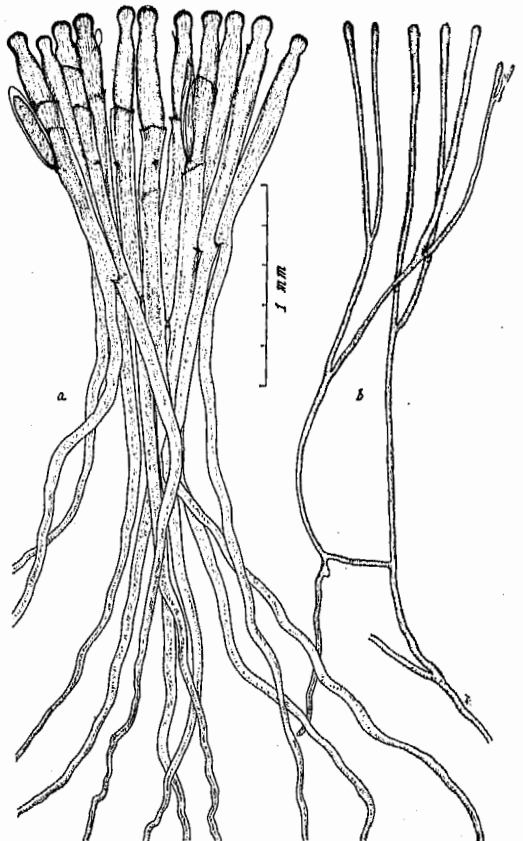


Fig. 7

Fig. 6.—*C. mamillosum* (City Beach, Perth, W.A., Royce 1200). Mature group of utricles.

Fig. 7.—*C. pomoides* (Mouth of Currie River, Tas., Cribb 75-16). *a*, mature group of utricles; *b*, juvenile utricle system.

or slightly rounded at apex, (400-) 450-1000 μ dia. at apex, often expanded below apex (-1500 μ dia.), tapering toward base (3-) 4-7 (-9) mm long, 5.5-13 \times long as broad; utricular wall 2.5-5 μ thick, slightly to moderately thickened at apex (-40 μ), inconnate apices finely lamellate. Hairs absent. Medullary filaments mostly 40-105 μ dia., several arising by slender outgrowths from base of each utricule, often branched or constricted near origin or both. Gametangia narrowly ellipsoid, ovoid, or ampulliform, 130-250 μ dia. (390-) 520-780 μ long, 1-3 per utricule, each borne on short pedicel (about 10 μ long) 1-2 mm below apex.

Lectotype.—Swan River, W.A., *W. H. Harvey*, *Algae Australicae Exsiccatae* 578 (TCD).

Known Range.—City Beach, Perth, to Warrnambool, Vic. Hawaiian Is.

Representative Specimens Examined.—WESTERN AUSTRALIA: City Beach, Perth, 7.v.1952, *Royce* 1200 (PERTH, UC). Cottesloe, Aug. 1928, *A. H. S. Lucas* (NSW). Rottneest I., 10.viii.1950, *Cribb* 67.1 (UC). Fremantle, *W. H. Harvey*, *Algae Australicae Exsiccatae* 578 (C, HBG, K, L, MEL, NSW, NY, PC, TCD, US). Esperance Beach, 2.ix.1947, *J. H. Willis* (MEL). Recherche Archipelago, 20.xi.1950, *J. H. Willis* (AD, A15,848). SOUTH AUSTRALIA: Elliston, low littoral in bay, shaded, 15.i.1951, *Womersley* (AD, A16,022) (K, UC). Holdfast Bay, July, 1943, *J. R. Harris* (AD, A1797) (UC). Lefebvre Peninsula, July 1852, *F. von Mueller* (MEL). Victor Harbour, 21.viii.1946, *May* 2265 (UC). West Beach, 12.ix.1948, *Womersley* (AD, A8700) (F, L, UC). Rocky Point Beach, Kangaroo I., 26.viii.1950, *Womersley* (AD, A13,361) (BM). Pennington Bay, Kangaroo I., drift, 23.i.1944, *Womersley* (AD, A2265). VICTORIA: Warrnambool, Jan. 1927, *A. H. S. Lucas* (UC).

C. mamillosum is a common species within its range, especially in calmer localities. It is a sublittoral species, only rarely reaching to low tide level in shaded habitats.

C. bursa var. *australis* Sonder is referable to *C. mamillosum*, judging from an examination of the type specimen (Lefebvre Peninsula, *F. von Mueller*, MEL). However, the plant distributed under this name by Harvey as *Algae Australicae Exsiccatae* 575 is *C. pomoides*. The following records of *C. bursa* are therefore based on both *C. mamillosum* and *C. pomoides*: Harvey 1863, pl. lviii; Sonder 1880, p. 38; Lucas 1912, p. 171.

Close relatives of *C. mamillosum*, namely, *C. globosum* Lucas and *C. cranwelliae* Setchell, are found in Queensland and New Zealand respectively.

7. *Codium pomoides* J. Agardh, *Acta Univ. Lund.* **29** (Afd. 2, Nr. 9): 100 (1894). Wilson, *Proc. Roy. Soc. Vict.* **4**: 188 (1892) (nomen nudum). Schmidt, *Bibl. Bot.*, Stuttgart **23** (Heft 91): 36 (1923). Svedelius, *Ark. Bot.* **19**(3): 56, fig. 13 (1924). Lucas, *Seaweeds S. Aust.* **1**: 53, fig. 33 (1936). Womersley, *Trans. Roy. Soc. S. Aust.* **71**: 244, 247 (1947); *ibid.* **72**: 159, 161 (1948); *ibid.* **73**: 146 (1950).

Fig. 7

Thallus globose or subglobose, to 12 cm dia., very firm, solid when young, becoming hollow by attenuation of plexus of medullary filaments, attached to substratum by small tuft of rhizoidal holdfasts. Utricles in large clusters, subcylindrical (69–) 90–125 (–175) μ dia. at apex, expanding to maximum dia. of 200 μ about 350–700 μ below apex, 1–3 mm from apex to point of origin from parent utricle; apices symmetrically rounded; utricular wall 2.5–5 μ thick, at apex usually slightly thickened, at times moderately thickened (–32 μ), lamellate, with a slight introrse umbo which is faintly alveolate. Utricles adjacent to base clavate or fusiform, not capitate, larger than those from other parts of thallus, 140–280 μ dia. Juvenile utricle systems abundant in all parts of thallus, intermixed with mature utricle clusters, especially abundant in basal region. Typical hairs absent, but scars from anomalous outgrowths common. Gametangia narrowly ellipsoid to cylindrical, 55–95 μ dia., 400–510 μ long, borne singly on pedicel about 10 μ long 625–700 μ below apex of utricle.

Type.—"Hab. ad oras australes Novae Hollandiae; legit J. Br. Wilson". The specimen should be in Herb. Agardh but it has not been located.

Known Range.—From 10 miles east of Eucla (W.A.-S.A. border) to Walkerville, Vic.; Tasmania.

Representative Specimens Examined.—SOUTH AUSTRALIA: 10 miles east of Eucla, drift, 3.ii.1954, *Womersley* (AD, A19,241). Elliston, upper sublittoral, 15.i.1951, *Womersley* (AD, A13,621) (BM, K). West Beach, 12.ix.1948, *Womersley* (AD, A8759) (F, L, UC). Rocky Point Beach, Kangaroo I., drift, 4.vi.1947, *Womersley* (AD, A5705). Pennington Bay, Kangaroo I., upper sublittoral, 28.i.1944, *Womersley* (AD, A2267). VICTORIA: Port Fairy, *W. H. Harvey*, *Algae Australicae Exsiccatae* 575, sub. *C. bursa?* var. *australis* (LD, BM, K, MEL, NSW, PC). Point Lonsdale, *Iona Maclellan* (UC). TASMANIA: Hunter I., N.W. Tas., upper sublittoral, 14.i.1954, *I. Bennett* (AD, A19,667). Low Head, Jan. 1930, *Perrin & Lucas* (UC). Mouth of Currie River, 17.ix.1950, drift, *Cribb* 75.16 (UC). Barnes Bay, Bruny I. 4-6 fm, 15.i.1949, *Womersley* (AD, A10,174).

C. pomoides is found mainly in the sublittoral fringe or upper sublittoral zone on rough coasts but also extends into deeper water. The thalli adhere very tightly to their substratum.

C. pomoides is one of the most interesting species of the genus anatomically and phylogenetically. Its only close relative is the highly restricted *C. johnstonei* Silva (1951) from deep waters of southern California and adjacent Baja California, Mexico.

Juvenile utricle systems are found abundantly throughout the thallus. An unmistakable ontogenetic series leading from a juvenile utricle system to a cluster of mature utricles has not yet been observed, but it seems probable that only certain of the juvenile utricles reach full size, the others shrivelling and falling off, thus accounting for the conspicuous scars to be seen on mature utricles.

Although typical hairs are not produced, in the region just below the constriction of the utricle (where hairs might be expected to develop) there are fairly numerous irregular outgrowths which shrivel and fall, leaving scars.

The following erroneous records of *C. bursa* are probably based at least in part on *C. pomoides*: Harvey 1863, p. lviii; Sonder 1880, p. 38; Wilson 1892, p. 187; Lucas 1912, p. 171; Lucas 1913, p. 59; Lucas 1929a, p. 10; Lucas 1929b, p. 46; Guiler 1952, p. 75.

8. *Codium laminarioides* Harvey, Trans. R. Irish Acad. 22: 565 (1855). Harvey, Phyc. Austral. 5: lvii (1863). Sonder, Frag. Phytogr. Aust. 11 (suppl.): 38 (1880). J. Agardh, Acta Univ. Lund. 23: 47 (1887). De Toni, Syll. Alg. 1: 497 (1889). Lucas, Proc. Linn. Soc. N.S.W. 37: 171 (1912). Schmidt, Bibl. Bot., Stuttgart 23 (Heft 91): 59 (1923) (excluding South African record and fig. 42).

Fig. 8

Thallus comprising a short terete stipe (to 12 mm long) and a felt-like, flat, greatly expanded frond, 1.5-2 mm thick, to 80 cm broad, simple or once dichotomous, the two segments unequally developed and irregularly lobed. Utricles narrowly ellipsoid to cylindrical, mostly 4-7 × long as broad, 65-185 (-290) μ max. dia. (usually well below apex), 475-790 μ long; apices rounded, utricular wall 1.5-2 μ

thick, at apex usually incrassate ($-30\ \mu$), conspicuously lamellate, occasionally faintly alveolate. Hairs (or hair scars) common, usually on all but youngest utricles, several (to 8) in irregular zone $70-150\ \mu$ below apex (where utricle is broadest). Medullary filaments mostly $20-55\ \mu$ dia. Gametangia cylindrical to lanciform, $40-86\ \mu$ dia., $175-245\ \mu$ long, 1-4 per utricle, each borne on short pedicel (about $5\ \mu$ long) on protuberance $310-420\ \mu$ below apex (near middle).

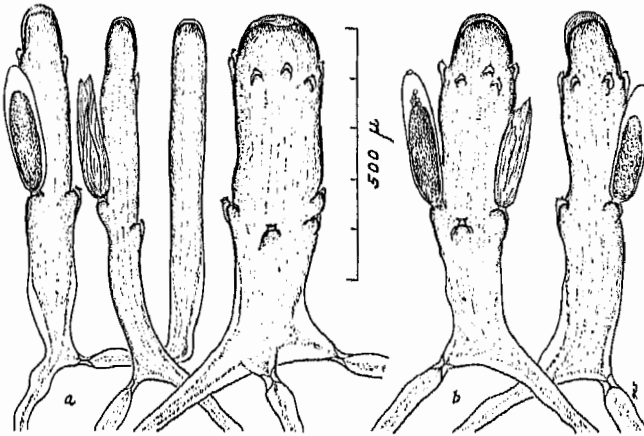


Fig. 8.—*C. laminarioides*. Individual utricles. *a*, Rottneest I., W.A., Cribb 61.42; *b*, Rottneest I., W.A., Harvey (NSW).

Lectotype.—Rottneest I., *W. H. Harvey*, *Algae Australicae Exsiccatae* 574 (TCD).

Known Range.—Cottesloe to King George's Sound, W.A.

Representative Specimens Examined.—WESTERN AUSTRALIA: Rottneest I., *W. H. Harvey*, *Algae Australicae Exsiccatae* 574 (TCD); 10.viii.1950, Cribb 61.42 (UC). Cottesloe, Aug. 1928, *A. H. S. Lucas* (UC); 12.vi.1951, *Royce* 1040 (AD, PERTH); 15.vi.1952, *Royce* 1271 (PERTH, UC). Fremantle, *W. H. Harvey*, *Algae Australicae Exsiccatae* 574 (K, MEL, NSW, PC, US); Sept. 1854, *George Clifton* (BM).

C. laminarioides is apparently a deep water species, found cast up after winter storms.

This remarkable species has twice been reported erroneously from South Africa: by Barton (1893, p. 82) on the basis of a specimen collected by Boodle at Cape Point (BM), referable to *C. stephensiae* Dickinson; and by Schmidt (1923, p. 59), whose figure 42 undoubtedly was based on a Becker specimen from the Kowie, referable to *C. platylobium* Areschoug. *C. laminarioides* is closely related to both *C. platylobium* and *C. latum* Suringar (from Japan), from which it differs in habit by the almost complete suppression (or lack of development) of dichotomous branching.

9. *Codium galeatum* J. Agardh, *Acta Univ. Lund.* 23 (Afd. 3, Nr. 2): 42, pl. 1, fig. 1 (1887). De Toni, *Syll. Alg.* 1: 494 (1889). Wilson, *Proc. Roy. Soc. Vict.* 4: 187 (1892). Lucas, *Proc. Linn. Soc. N.S.W.* 37: 171 (1912). Schmidt, *Bibl. Bot., Stuttgart* 23 (Heft 91): 45, fig. 27 (1923). Lucas, *Sea-*

weeds S. Aust. 1: 54, fig. 35a (1936). Womersley, Trans. Roy. Soc. S. Aust. 71: 244 (1947); *ibid.*, 72: 161 (1948); *ibid.* 73: 145 (1950) (pro parte). Guiler, Pap. Roy. Soc. Tasm. 86: 75 (1952).

Fig. 9

Codium tomentosum var. *australasiacum* Areschoug, Nova Acta Reg. Soc. Sc. Upsal. III, 1: 368 (1854).

Thallus erect, to 100 cm high, regularly dichotomously branched, 5–15 often distant dichotomies, branches uniformly terete, not tapering towards tips, firm,

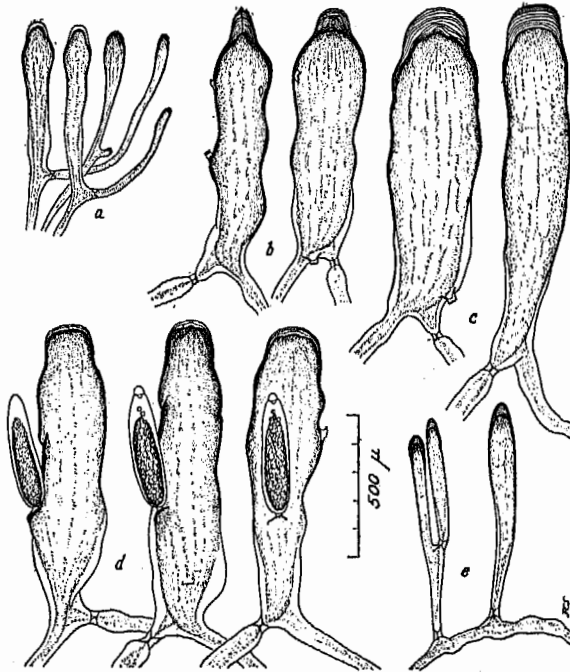


Fig. 9.—*C. galeatum*. *a, b, e*, Marino, Holdfast Bay, S.A., Womersley. (AD, A20,414) *a*, utricles from tip; *b*, utricles from middle of frond; *c*, (Port Phillip, Vic., *F. von Mueller* = lectotype) utricles from middle of frond; *d*, (City Beach, Perth, W.A., *Royce* 1196) utricles from middle of frond; *e*, utricles from base.

4–7 mm dia. Utricles stout, irregularly cylindrical to clavate (130–) 200–470 (–700) μ max. dia. (usually below apex), (650–) 750–1300 (–1500) μ long, usually 2–4 (–5) \times long as broad; utricular wall 3 μ thick at base, becoming thicker toward apex, usually forming a conspicuously striated cap to 125 μ thick, sometimes scalariform. Hairs (or hair scars) occasional, when present one to few per utricule, borne at broadest part of utricule, 260–440 μ below apex. Medullary filaments mostly 33–80 (–115) μ dia., markedly constricted by plug at origin. Gametangia cylindrical to lance-ovoid, 57–185 μ dia., 275–530 μ long, 1 (rarely 2) per utricule, each borne on distinct pedicel (about 13 μ long) on protuberance below middle of utricule.

Lectotype.—Port Phillip, Vic., *F. von Mueller* (LD, Herb. Agardh. 15588).

Known Range.—Champion Bay, W.A., around southern Australia to Ballina, N.S.W. (possibly to Rockingham Bay, Qld.).

Representative Specimens Examined.—WESTERN AUSTRALIA: Champion Bay, *Mrs. Gale* (MEL). City Beach, Perth, 7.v.1952, *Royce* 1196 (PERTH, UC). Rottnest I., 9.iv.1927, *W. A. Setchell* (UC); 9.viii.1950, *Cribb* 67.3 (UC). Geographie Bay, *F. von Mueller* (LD). Hamelin Bay, 21.vi.1950, *Royce* 713 (PERTH). King George's Sound, *W. H. Harvey*, *Algae Australicae Exsiccatae* 573, sub. *C. tomentosum*, (S, TCD); 1884, *F. von Mueller* (LD). Israelite Bay, 1888, *Miss Brooks* (MEL). Eucla, 1886, *T. D. Bath* (LD). SOUTH AUSTRALIA: Marino, Holdfast Bay, 21.v.1953, *Womersley* (UC). Elliston, upper sublittoral, 15.i.1951, *Womersley* (AD, A13,624). Vivonne Bay, Kangaroo I., shaded littoral pool, 4.i.1950, *Womersley* (AD, A12,752) (BM, K). Pennington Bay, Kangaroo I., drift, 14.i.1947, *Womersley* (AD, A4289) (MEL, UC). D'Estrees Bay, Kangaroo I., sublittoral fringe, 20.i.1947, *Womersley* (AD, A4151) (F). Port Elliot, drift, 17.x.1948, *Womersley* (AD, A9436) (S). Encounter Bay, Nov. 1929, *J. B. Cleland* (UC). Guichen Bay, 1.ix.1949, 5–8 fm, *Womersley* (AD, A10,936) (F). Rivoli Bay, Oct. 1848, *F. von Mueller* (MEL). VICTORIA: Bridgewater Bay, drift, 17.vii.1949, *C. Beauphohole* (AD, A12,034). Portland Bay, misit *Areschoug* (LD). Barwon Heads, Jan. 1903, *A. H. S. Lucas* (NSW). Port Phillip, *F. von Mueller* (LD, NY). Sorrento, 30.iv.1898, *H. T. Tisdall* (NSW). Walkerville, upper sublittoral, 19.v.1949, *Pope & Bennett* (AD, A12,203). NEW SOUTH WALES: Ballina, *Henderson* (MEL). QUEENSLAND: 1911, *Mrs. M. Doyle* (BM).

C. galeatum extends from the sublittoral fringe zone downwards on rough to moderate coasts. It is probably the commonest dichotomous species on rough coasts in South Australia and southern Western Australia.

C. tomentosum var. *australasiacum* *Areschoug* is referable to *C. galeatum*, judging from specimens in Herb. *Areschoug* (S), of which we consider as lectotype one labelled "*Codium tomentosum*. Victoria. *Aresch*".

10. *Codium duthieae* Silva, sp. nov.

Fig. 10; Plate 1, Fig. 2

Thallus erectus ad 60 cm alt., dichotome ramosus; rami omnino teretes, solum ad dichotomias aut fere omnino complanati; interdichotomiae 3–14 mm, dichotomiae ad 40 mm lat. Utricali cylindrici ad clavatos (130–) 175–500 (–720) μ dia. (450–) 670–1800 μ long.; apicibus late rotundatis, membrana utriculari 2–6 μ crass., ad apices (ad 42 μ) interdum incrassata. Pili (aut pilorum cicatrices) parci, interdum satis multi (ad 12 per utriculum), 185–430 μ infra apicem portati. Filamenta medullaria plerumque 43–72 μ dia. Gametangia lanceo-ovata, 70–160 μ dia. (235–) 270–430 μ long., aliquot (ad 8) per utriculum, omnia in pediculis c. 15 μ long. in protuberantia 345–675 μ infra apicem portata.

Thallus erect, to 60 cm high, dichotomously branched; branches wholly terete, flattened only at the dichotomies, or flattened almost throughout; interdichotomies 3–14 mm broad, dichotomies to 40 mm broad. Utricles cylindrical to clavate (130–) 175–500 (–720) μ dia., (450–) 670–1800 μ long; apices broadly rounded; utricular wall 2–6 μ thick, at apices occasionally thickened (to 42 μ). Hairs (or hair scars) occasional, at times fairly numerous (to 12 per utricle), borne 185–430 μ below apex. Medullary filaments mostly 43–72 μ dia. Gametangia lanceo-ovoid, 70–160 μ dia. (235–) 270–430 μ long, several (to 8) per utricle, each borne on pedicel about 15 μ long on protuberance 345–675 μ below apex.