

mate septal cycle. Columella fascicular, composed of one to several twisted laths.

REMARKS: Three subgenera are recognised in this genus: the nominate subgenus, *C. (Premocyathus)* and *C. (Acanthocyathus)*, the first two of which occur in New Zealand waters.

***Caryophyllia (Caryophyllia)* Lamarck, 1816**

Caryophyllia in which the calice is circular to elliptical (not highly compressed) and in which the corallum does not have edge spines or thecal crests.

TYPE SPECIES: *Madrepora cyathus* Ellis & Solander, 1786, by subsequent designation (Broderip 1828).

REMARKS: The approximately 56 recent species in this diverse subgenus were listed by Cairns (1991a) in such a way as to facilitate comparison among species. Characters found useful and relatively conservative in grouping species include: presence or absence of attachment; septal symmetry; and number of septal cycles. Other characters useful in discriminating species are: position of palar crown (before penultimate or antipenultimate septal cycle); relative width of highest-cycle septa relative to penultimate cycle; relative exsertness of septal cycles; degree of septal and palar sinuosity; development of columella; and pigment pattern.

Key to the 12 Species of *Caryophyllia* (*Caryophyllia*) known from the New Zealand Region

- 1 Corallum attached (ceratoid, trochoid, subcylindrical) 2
Corallum free (cornute) 11
- 2 Corallum with 12 or more pali 3
Corallum with 8–10 pali 9
- 3 Adult corallum large (GCD > 20 mm); 64–98+ septa 4
Adult corallum small to medium-sized (GCD usually < 20 mm); 48–60 septa 6
- 4 Pedicel narrow (PD: GCD < 0.2); last cycle of septa (third) wider than penultimate (second); 14–16–18 pali *C. atlantica*
Pedicel robust (PD: GCD > 0.2); last cycle of septa less wide than penultimate cycle; 12–26 pali 5

- 5 Twelve narrow pali present before S3 *C. ralphae*
Sixteen to 26 wide pali present before S4 *C. profunda*
- 6 S4 wider than S3; fossa deep *C. elongata*
S4 narrower than S3; fossa of moderate depth 7
- 7 Theca transversely ridged; septa pigmented black-brown *C. lamellifera*
Theca costate and/or granular; septa white 8
- 8 S1–2, 4 have straight inner edges; theca costate, columella consists of numerous (7–39) elements; common off North Island and Chatham Rise *C. japonica*
S1–2, 4 slightly sinuous; theca porcellanous; columella consists of 3–12 elements; common on Kermadec and Colville Ridges *C. diomedae*
- 9 Septa octamerally arranged (8 pali); theca transversely ridged; septa and pali highly sinuous *C. rugosa*
Septa pentamerally or hexamerally arranged (usually 10 pali); theca granular or porcellanous; septa and pali moderately sinuous 10
- 10 S1 wider and more exsert than S2; pentameral symmetry; S4 wider and more exsert than S3; corallum usually pigmented *C. hawaiiensis*
S1 equal to S2 in exsertness and width; decameral symmetry; S4 ≤ width of S3; corallum white *C. quadrageria*
- 11 Corallum with 24 pali *C. ambrosia*
Corallum with 12–16 pali *C. scobinosa*

***Caryophyllia (C.) rugosa* Moseley, 1881**
(Plates 6, h, 7, a-c)

Caryophyllia rugosa Moseley, 1881: 141–143, pl. 1, fig. 8; Cairns 1984: 11–13, pl. 2, figs A–B, pl. 4, fig. 1 (synonymy); Cairns & Keller 1993: 236, pl. 3, fig. 1; Cairns 1994: 47, pl. 20, fig. i, pl. 21, fig. a.

MATERIAL EXAMINED: New Records: NZOI Stn C527, 2, USNM 88387; Stn C530, 23, USNM 94005; Stn C531, 14, USNM 94003; Stn I91, 1, NZOI; Stn I741, 1, NZOI; Stn K803, 2, NZOI; Stn K825, 1, NZOI; Stn K826, 3, NZOI; Stn K839, 2, NZOI; Stn K842, 4, NZOI; Stn K843, 3, NZOI; Stn K844, 1, USNM 94004; Stn K867, 1, NZOI; Stn

Q70, 1, NZOI; BS307, 3, MoNZ CO87; BS309, 2, MoNZ CO251; BS310, 16, MoNZ CO82; BS313, 4, MoNZ CO94; BS438, 1, MoNZ CO255; BS441, 3, MoNZ CO233; BS 571, 3, MoNZ CO231; RV *Franklin* Stn 5/89/40, 3, AMS G15559.

DISTRIBUTION: New Zealand region: Lord Howe Seamount Chain; off Norfolk Island; Kermadec Islands (Map 16); 142–508 m. Elsewhere: Indo-West Pacific from southwest Indian Ocean to Japan and the Hawaiian Islands, including off the Chesterfield Islands (reported herein); 71–439 m.

DESCRIPTION: Corallum ceratoid to cylindrical and firmly attached through a thick pedicel and thin encrusting base, the latter covering a substratum up to twice the diameter of the calice. Largest New Zealand specimen (NZOI Stn C531) 6.4 x 5.8 mm in calicular diameter; coralla usually 8–10 mm in height. Theca porcellaneous in well-preserved coralla, covered with narrow (65–75 μ m wide), transverse, circumferential ridges, these ridges splitting and rejoining one another in their circuit around the corallum. Approximately 7–9 ridges occur per mm, each separated by a shallow groove of equal width. Costal ridges present on encrusting base as well as the apex of each exsert septum (Plates 6, h, 7, a). Most coralla are white; however, some coralla are light brown or have a light-brown thecal pigmentation encircling the calice. In several specimens thick, but short, longitudinal brown stripes are associated with the theca of the secondary septa.

In most (95%) of the specimens examined, septa are octamerally arranged in 3 complete cycles (8:8:16, 32 septa). Two specimens have nonameral symmetry (9:9:18, 36 septa), one has decameral symmetry (10:10:20, 40 septa), and one had septameral symmetry (7:7:14:4, 28 septa). Primary septa exsert (0.7–0.8 mm), extend about three-quarters distance to columella, and have extremely sinuous inner edges. Secondary septa less exsert, about four-fifths width of a primary, and also have extremely sinuous inner edges. Tertiary septa about three-quarters width of secondaries and have moderately sinuous inner edges. Septal faces bear short carinae. A tight crown of 7–8–10 slender (0.3–0.4 mm wide), extremely sinuous pali (P2) encircle a fascicular columella. Columella consists of 1–15 narrow (0.20–0.25 mm in diameter) elements. Based on 52 coralla, the average number of columellar elements/calice is 4.44 ($\sigma = 2.19$) and the mode was 4. When 4 columellar elements are present, they are usually arranged in a diamond pattern: 2 aligned with the 2 principal septa, and 2 aligned with the 2 mid-lateral primary septa. Fossa shallow.

TYPES: The syntypes of *C. rugosa* are deposited at the BM(NH).

TYPE LOCALITY: *Challenger* Stns 192 and 201, Banda and Sulu Seas; 187–230 m.

REMARKS: Four species of attached recent *Caryophyllia* are known to have octamerally arranged septa: *C. rugosa*; *C. octopali* Vaughan, 1907; *C. barbadensis* Cairns, 1979; and *C. marmorea* Cairns, 1984. *Caryophyllia rugosa* is easily distinguished from the others species by its transverse thecal ridges and extremely sinuous septa and pali. It appears to be an opportunistic species, often found attached to dead coralla of various species, bivalve shells, sponges, and rocks.

Caryophyllia (*C.*) *hawaiiensis* Vaughan, 1907

(Plate 7, d-f)

Caryophyllia hawaiiensis Vaughan, 1907: 76, pl. 5, figs 4a-b (not *Albatross* Stn 3885, = *Balanophyllia*); Cairns 1984: 11; 1991a: 12.

MATERIAL EXAMINED: New Records: NZOI Stn C530, 1, NZOI; Stn I76, 1, USNM 94010; Stn K803, 1, USNM 94011; Stn K838, 1, NZOI; Stn P5, 1, USNM 94012; Stn P48, 1, NZOI; Stn P115, 1, USNM 94013; BS310, 1, MoNZ CO85; BS571, 2, MoNZ CO229; BS807, 1, MoNZ CO87; *Albatross* Stn 3708, 2, USNM 22060; *Albatross* Stn 4894, 1, USNM 92684. Previous Records: Types of *C. hawaiiensis*.

DISTRIBUTION: New Zealand region: Kermadec and southern Three Kings Ridges; off Lord Howe Island (Map 18); 126–279 m. Elsewhere: off Hawaiian Islands; off Japan (Suruga Bay, and off Fukue Jima), reported herein; 128–174 m.

DESCRIPTION: Corallum ceratoid, straight, and firmly attached by a robust pedicel 0.34–0.49 GCD. Largest specimen known (NZOI Stn P115) 11.6 x 9.1 mm in calicular diameter and 27.7 mm in height, with a pedicel diameter of 5.3 mm. Costae absent or poorly defined, although in some specimens the 10 C1–2 are slightly ridged. Intercostal striae either faint or absent, the theca being porcellaneous and uniformly covered with very low, rounded granules, 2 or 3 occurring between each intercostal stria. Theca thin (about 0.2 mm), the upper half often speckled with a dark-brown colour. All septa except for the S3 are also bear dark-brown bands of pigmentation that parallel the inner septal edges. Degree of thecal and septal pigmentation quite variable.

Septa usually pentamerally arranged in 4 cycles (5:5:10:20), resulting in 40 septa and 10 pali, but see remarks for exceptions. S1 (5 primary septa) highly exsert (2.5–3.8 mm) and have straight, vertical inner edges that extend about three-quarters distance to columella. Because of the odd-numbered nature of symmetry, only one S1 is aligned with the greater calicular axis, the septum opposite this S1 being an S2. S2 about three-quarters as exsert (2.0–2.7 mm) and as wide as an S1 and have slightly sinuous inner edges. S3 only about one-third as exsert as an S2 but three-quarters their width, and have more sinuous inner edges than an S2. S4 variable in exsertness and width, depending on their position. S4 adjacent to S1 are almost as exsert and as wide as an S2 but considerably thinner, each pair of S4 flanking an S1 fused to it to form an exsert triangular lancet. On a slightly smaller scale, the S4 that flank each S2 also form smaller lancets, these S4 being slightly less exsert and wide as those that flank the S1. Pali relatively wide (0.7 mm) and sinuous, forming a distinct crown of 10 pali (P3) encircling a fascicular columella composed of 6–18 slender (0.6–0.9 mm in diameter) elements. Fossa deep.

TYPES: Four syntypes are deposited at the USNM (20749–50).

TYPE LOCALITY: *Albatross* Stn 3838, 21°04'05" N, 157°10'35" W (off Molokai, Hawaiian Islands), 168–388 m.

REMARKS: All but one of the New Zealand specimens has pentamerall symmetry and 10 pali, the specimen from NZOI Stn I76 having 48 hexamerally arranged septa and 12 pali. It should be noted that among the four Hawaiian syntypes, three have 10 pali, whereas one (USNM 20749) has 11 pali and 44 septa. And, of the three nontype specimens reported by Vaughan (1907) from *Albatross* Stn 4061 and 3838, two are typically pentamerall but one has 11 pali. Also, the three specimens reported herein from off Japan are all hexamerall, having 12 pali and 48 septa. Thus, although there is a tendency for this species to have pentamerall symmetry and 10 pali, specimens with hexamerall symmetry and 11 or 12 pali occur as well.

Caryophyllia (*C.*) *quadrageraria* Alcock, 1902
(Plate 7, g, h)

Caryophyllia quadrageraria Alcock, 1902a: 91–92; 1902c: 10, pl. 1, figs. 4, 4a; Keller, 1981a: 18; Cairns 1994: 46–47, pl. 20, figs c-h, pl. 41, figs c-d (synonymy).

Caryophyllia scobinosa decapali Yabe & Eguchi, 1942b: 120, 149, pl. 10, figs 6–7.

Caryophyllia profunda: Squires & Keyes 1967: 23 (in part: NZOI Stn C797, C810).

MATERIAL EXAMINED: New Records: NZOI Stn B489, 4, NZOI; Stn C776, 1, USNM 94007; Stn C777, 3, NZOI; Stn D74, 1, NZOI; BS899 (O645), 1, MoNZ CO298. Previous Records: Types of *C. quadrageraria* and *C. scobinosa decapali*; specimens reported as *C. profunda* by Squires and Keyes (1967) from NZOI Stn C797(2) and C810(1).

DISTRIBUTION: New Zealand region: coastal New Zealand from Three Kings Islands to Auckland Island (Map 7); 77–198 m. Elsewhere: off Japan; Korea Strait; Makassar Strait; Banda and Timor Seas; 54–296 m.

DESCRIPTION: Corallum ceratoid, straight, and attached by a pedicel 0.22–0.39 GCD. Coralla small, the largest New Zealand specimen (NZOI Stn C776) only 9.7 x 8.8 mm in calicular diameter and 13.4 mm in height, with a pedicel diameter of 3.0 mm. Theca granular, but costae well defined only near the calice where intercostal striae are deeply incised. Corallum white.

Septa decamerally arranged in 3 cycles (10:10:20, 40 septa). Primary septa about 1.5 mm exsert and have straight, vertical to slightly inclined inner edges that extend about three-quarters distance to columella. Secondary septa less exsert (about 1 mm), about five-eighths width of a secondary, and have sinuous inner edges. Tertiary septa equally exsert and usually equally as broad as the secondaries, and have straight inner edges. Ten broad (about 1.4 mm wide), highly sinuous pali (P2) form a crown before the secondary septa. Palar face ornamentation consists of tall, sparse granules, often fused into short carinae. Fossa of moderate depth; columella consists of 3–11 slender, twisted elements.

TYPES: Two syntypes of *C. quadrageraria* are deposited at the ZMA (Coel. 5534). The holotype and paratypes of *C. scobinosa decapali* are deposited at the TIUS.

TYPE LOCALITIES: *C. quadrageraria*: *Siboga* Stns 90, 251, 289; Makassar Strait, Banda and Timor Seas; 54–281 m. *C. scobinosa decapali*: *Soyo-Maru* Stn 210; 33°29' N, 135°28' E (Kii Strait, southeastern Honshu), 165 m.

REMARKS: Among the recent *Caryophyllia*, seven species are distinguished as having decamerall symmetry (Cairns 1991a), four of which occur in the Pacific: *C. quadrageraria*, *C. hawaiiensis*, *C. solida* Cairns, 1991a

(Galápagos, 37–488 m); and *C. perculata* Cairns, 1991a (Galápagos and off Panama, 54–64 m). *Caryophyllia quadragenaria* is most similar to *C. perculata*, but can be distinguished by lacking septal-face carinae and having short paler-face carinae. Vaughan (1907: 76) noted a similarity between *C. quadragenaria* and *C. hawaiiensis*, but the latter is relatively easily distinguished by having five extremely exsert S1 that are larger than the five S2, which more accurately classifies this species as pentamerous instead of decamerous. Furthermore, the S4 of *C. hawaiiensis* are wider than their S3 and the corallum is mottled with brown pigment.

Caryophyllia (C.) profunda Moseley, 1881
(Plates 7, i, 8, a-c)

Caryophyllia profunda Moseley, 1881: 138–139, pl. 1, figs 6, 6a (in part: not specimen from Cape Verde Islands); Marenzeller 1904a: 298; Gardiner 1913: 688–689; 1929: 126; 1939: 331; Powell 1947: 8, fig. 15; Ralph 1948: 108–109, top and middle figures; Squires 1958: 44, 91; 1960b: 196, 198–200, pl. 34, figs 5–7, pl. 35, figs 9–11; Ralph & Squires 1962: 6–7, pl. 1, figs 8–11; Squires 1964a: 11; Squires & Keyes 1967: 23, pl. 2, figs 1–4 (but not NZOI Stn A904, C608, C797, C810); Squires 1969: 17, pl. 6, map 1; Zibrowius 1974b: 751–755, pl. 1, figs 1–10 (discussion); Dawson 1979: 28; Cairns 1982: 17–19, pl. 5, figs 1–5 (in part: not *Eltanin* Stn 1403) (synonymy); Zibrowius & Gili 1990: 25–26, pl. 4, figs L–R; Cairns & Keller 1993: 235–236.

Caryophyllia maculata: Ralph 1948: 109, lower right figure.
Caryophyllia cf. *C. maculata*: Ralph & Squires 1962: 7, pl. 2, figs 1–2; Squires & Keyes 1967: 23, pl. 2, figs 5–6.

MATERIAL EXAMINED: New Records: NZOI Stn B152, 1, NZOI; Stn B473, 7, NZOI; Stn B476, 1, USNM 94018; Stn B487, 2, NZOI; Stn B489, 2, USNM 94014; Stn B554, 1, NZOI; Stn C399, 1, NZOI; Stn C642, 1, USNM 94015; Stn C690, 1, USNM 94016; Stn C703, 5, USNM 94017; Stn C814, 1, NZOI; Stn D6, 1, NZOI; Stn D228, 5, NZOI; Stn D876, 7, USNM 94019; Stn D888, 2, NZOI; Stn D899, 1, NZOI; Stn E291, 2, NZOI; Stn E636, 1, NZOI; Stn E720, 20, NZOI; Stn E751, 3, USNM 94020; Stn E755, 2, NZOI; Stn E792, 4, NZOI; Stn E796, 5, NZOI; Stn E804, 5, NZOI; Stn E846, 2, NZOI; Stn E849, 5, NZOI; Stn E908, 50, NZOI; Stn F10, 4, USNM 94021; Stn F797, 1, NZOI; Stn F933, 5, NZOI; Stn G303, 1, NZOI; Stn I375, 16, NZOI; Stn I745, 1, NZOI; Stn J55, 2, USNM 94037; Stn J59, 1, NZOI; Stn J676, 25, USNM 94038; Stn J679, 18, NZOI; Stn J971, 2, NZOI; Stn M782, 1, USNM 94039; Stn O841, 2, NZOI; Stn O852, 3, USNM 94040; Stn P13, 2, NZOI; Stn P14, 2, NZOI; Stn P842, 1, NZOI; Stn P846, 1, NZOI; Stn Q24, 3, NZOI; Stn Q25, 4, NZOI; Stn Q31, 1, NZOI; Stn Q38, 5, NZOI; Stn Q40, 10, NZOI; Stn Q743, 1, NZOI; Stn S6, 8, NZOI; Stn S8, 1, NZOI; Stn S122, 1, NZOI; Stn

S130, 20, NZOI; Stn S216, 5, NZOI; Stn S222, 10, NZOI; Stn S257, 4, NZOI; Stn S260, 1, NZOI; Stn T7, 1, NZOI; Stn U208, 4, NZOI; BS402, 1, MoNZ CO102; BS630, 6, MoNZ CO124; BS654 (R12), 1, MoNZ CO168; BS682 (R40), 1, MoNZ CO296; BS697 (R55), 1, MoNZ; BS718 (R76), 3, MoNZ; BS753 (R111), 4, MoNZ; BS770 (R128), 1, MoNZ CO308; BS842 (O588), 4, MoNZ; BS856 (O602), 1, MoNZ; BS888 (O634), 2, MoNZ; BS889 (O635), 20, MoNZ CO152; Doubtful Sound, Malaspina Beach, 20–30 m, USNM 76304. Previous Records: Syntypes of *C. profunda*; specimens reported by Gardiner (1939), Ralph and Squires (1962), Squires and Keyes (1967), and Zibrowius (1974b).

DISTRIBUTION: New Zealand region: widespread in New Zealand region from southern Norfolk Ridge to off Macquarie Island (Map 3); 20–1300 m, the shallow records limited to fiord locations. Elsewhere: cold-temperate southern hemisphere from Walvis Ridge (off Namibia) to New Zealand, including Tristan de Cunha, Gough Island, Agulhas Bank and Plateau, Madagascar Plateau, and St. Paul and Amsterdam Islands; 35–1116 m.

DESCRIPTION: Corallum ceratoid to subcylindrical, straight, and firmly attached through a robust pedicel up to 60% of GCD. Largest New Zealand specimen (NZOI Stn J55) 39.5 x 35.1 mm in calicular diameter and 81 mm in height, with a pedicel diameter of 13.3 mm. Calice usually a regular ellipse but occasionally elongate or polygonal. Costae well defined and approximately equal in width, each costa about 0.9 mm wide and separated by very thin (0.1 mm wide), shallow intercostal striae, which become wider and deeper only near the calicular edge. C1–3 sometimes slightly ridged. Theca glistening, each costa bearing numerous small rounded granules often arranged in horizontal rows of 4 or 5 granules, each short row resembling a transverse ridge. Corallum usually white, but often the theca is tinted a light brown.

Septa hexamerally arranged in 5 cycles, most large specimens having a full 96 septa and 24 pali; however, many specimens of medium size have fewer septa (64–92 septa, 16–23 pali, respectively), whereas one large specimen had 104 septa and 26 pali. A full fifth cycle can be present in coralla as small as 13 mm GCD. S1–2 moderately exsert (about 3 mm) and have straight, vertical inner edges that fuse to the columella only deep within fossa. S3 four-fifths to equivalent width of S1–2 and 2–3 mm exsert, the larger S3 characteristic of large specimens. S4 about three-quarters width of an S3 and have slightly sinuous inner edges, each of which is bordered by a broad, lamellar palus, the palus sometimes wider (2.2–4.8 mm wide) than its corresponding S4. Each

P4 is a thin (0.25 mm) lamella, rounded on top and with a vertical inner edge, separated from its corresponding S4 by a deep, U-shaped notch. Pali straight-edged (not sinuous), their faces virtually smooth, together forming a well-defined elliptical crown encircling the columella. S5 about three-quarters width of an S4 and have straight inner edges. Occasionally some pali of some specimens are divided into 2 or 3 lobes, each lobe separated by a deep thin slit. All septal and palar faces bear low, rounded granules. Fossa of moderate depth, containing the palar crown and fascicular columella, the latter composed of 5–30 slender, twisted elements, often fused among themselves.

TYPES: Approximately 20 syntypes of *C. profunda* are deposited at the BM(NH) (see Cairns 1982).

TYPE LOCALITY: *Challenger* Stn 135, 37°01'50 S, 12°19'10 W (Nightingale Island, Tristan de Cunha Islands), 183–274 m.

REMARKS: One of the commonest species in the New Zealand region, *C. profunda* is found in unusually shallow water in the fiords off the southwestern coast of South Island. This robust species is distinguished from other *Caryophyllia* by often having a broad pedicel, 16–24 pali (corresponding to 64–96 septa), and a characteristic costal granulation.

Caryophyllia (*C.*) *atlantica* (Duncan, 1873)
(Plate 8, d, e)

- Bathycyathus atlanticus* Duncan, 1873: 318, pl. 48, figs 1–2.
Caryophyllia laevicostata Moseley, 1881: 134, pl. 1, fig. 1.
?*Caryophyllia panda* Alcock, 1902a: 91; 1902c: 9, pl. 1, figs 3, 3a (new synonymy).
Caryophyllia alcocki Vaughan, 1907: 73–74, pl. 5, fig. 1; Not Yabe & Eguchi 1942b: 120.
Caryophyllia atlantica: Zibrowius 1980: 56–57, pl. 20, figs A–K (synonymy); Cairns 1982: 11.
Caryophyllia profunda: Squires & Keyes 1967: 23 (in part: NZOI Stn A904).
?*Caryophyllia pacifica* Keller, 1981a: 16–17, pl. 1, figs 2a–b; 1981b: 33, pl. 1, figs 1a–b (new synonymy).

MATERIAL EXAMINED: New Records: NZOI Stn A904, 1, USNM 94023; Stn I694, 4, NZOI; Stn S46, 2, NZOI; Stn U595, 1, USNM 94024; *Eltanin* Stn 1712, 11, USNM 94022. Previous Records: Types of *C. alcocki*; specimens reported by Zibrowius (1980) and Squires and Keyes (1967) as *C. profunda*.

DISTRIBUTION: Characteristic of seamounts, guyots,

and off small oceanic islands from east of East Cape to the Campbell Rise (Map 3); 1004–1474 m. Elsewhere: eastern Atlantic from Mediterranean to Ascension Island; Hawaiian Islands; ?Marcus-Necker Ridge (Keller 1981a); ?Ceram Sea (Alcock 1902c); 776–2165 m.

DESCRIPTION: Corallum ceratoid, often slightly curved near base, and attached through a slender pedicel rarely over 5 mm in diameter (PD:GCD = 0.18–0.20). Largest New Zealand specimen examined (NZOI Stn A904, originally reported by Squires & Keyes, 1967 as *C. profunda*) 30.3 x 27.6 mm in calicular diameter (broken at base); other intact coralla up to 50 mm in height. Calice elliptical, the edges quite lacerate. Costae well defined, 0.9–0.11 mm wide, and flat to slightly convex, the C1–3 sometimes slightly ridged. Intercostal striae quite narrow (about 50 µm) and shallow. Costae covered with small (0.10–0.15 mm diameter) rounded granules, 4 to 6 occurring across a costal width, but not aligned in rows. Corallum white.

Septa arranged in 3 size classes and 14–18 sectors, the most common complement being 16:16:32 (64 septa), which is displayed in 9 coralla; 2 coralla have 14 sectors (14:14:28, = 56 septa); 2 have 15 sectors (15:15:30, = 60 septa); and the large corallum from NZOI Stn A904 has 18 sectors (18:18:36 = 72 septa). Primary septa 4.0–4.5 mm exsert, extend about three-quarters distance to columella, and have straight, vertical inner edges. Secondary septa only about 1 mm exsert, about two-thirds width of a primary, and have slightly sinuous inner edges, each secondary bordered by a broad palus. Tertiary septa about 2 mm exsert, each pair fusing with its common primary to form a small triangular lancet. Tertiary septa wider than the secondaries by about 1 mm (about three-quarters width of a primary), their straight inner edges slightly overlapping the outer edges of the pali. Pali quite wide (up to 5 mm), slightly sinuous, and occasionally wider and thicker than their corresponding secondary septa. Septal faces bear tiny granules but those of the pali are quite coarse, 3–4 times the size of those on the septa. In only one specimen (NZOI Stn A904) were some pali divided into 2 or 3 smaller lobes. The palar crown of 14–18 lamellae is well defined and encircles an elongate columella composed of 2–8 broad fascicular elements that are usually linearly arranged.

TYPES: The lecto- and paralectotype of *B. atlanticus* are deposited at the BM(NH) (see Zibrowius 1980). The holotype of *C. laevicostata* is also deposited at

the BM(NH) (1880.11.25.22). Two syntypes of *C. alcocki* are deposited at the USNM (10744–45). The holotype of *C. panda* is deposited at the ZMA (Coel. 573). The type of *C. pacifica* is presumed to be deposited at the IOM.

TYPE LOCALITIES: *C. atlantica*: 39°39' N, 9°43' W (off Portugal), 1355–2000 m. *C. laevigata*: off Ascension Island, 776 m. *C. alcocki*: 23°05' N, 161°52' W (off Nihoa, Hawaiian Islands), 1602 m. *C. panda*: Siboga Stn 177, 2°24' S, 129°38' E (Ceram Sea), 163 m. *C. pacifica*: 23°32' N, 157°23' E (Marcus-Necker Ridge), 1420 m.

REMARKS: Although not apparent from Vaughan's (1907) description of *C. alcocki*, the two syntypes of this species contain 13 and 14 sectors of septa (52 and 56 septa, respectively), not four cycles of 48 hexamerally arranged septa as might be inferred. Zibrowius (1980) reported that eastern Atlantic specimens have 12–15 sectors (48–60 septa); the type of *C. pacifica* Keller, 1981a appears to have 13 sectors (54 septa). The New Zealand populations thus appear to differ from those reported previously by having a higher number of sectors (14–16–18), only its lower range consistent with Atlantic and Hawaiian populations. The New Zealand specimens also differ in having less exsert primary septa (4.0–4.5 mm), the primary septa of those from other regions reaching as high as 7 mm above the calicular edge.

Although Squires and Keyes (1967) included one specimen of *C. atlantica* in their account of *C. profunda*, *C. atlantica* is distinguished by having: tertiary septa wider than their secondary septa; on average, fewer septa and pali (*C. profunda* of equivalent size usually have 96 septa and 24 pali); a narrower pedicel; more exsert primary septa; thicker pali; and nonaligned costal granules. Comparisons to *C. diomedea* are made in that account.

The synonymies of *C. panda* and *C. pacifica* are considered as tentative only because I have not examined their type specimens.

Caryophyllia (*C.*) *ralphae* n. sp. (Plate 8, f-i)

MATERIAL EXAMINED: Types, q.v. Reference Specimens: two syntypes of *C. capensis* (BM(NH) 1950.1.11.63a).

DISTRIBUTION: Known only from northern Lord Howe Seamount Chain (Gifford Guyot) and south of the Chesterfield Islands (Map 18); 315–360 m.

DESCRIPTION: Corallum ceratoid, slightly flared distally, straight, and attached by a robust pedicel (PD: GCD = 0.31–0.40). Largest specimen (holotype) 32.5 x 24.8 mm in calicular diameter and 36.7 mm in height, with a pedicel diameter of 12.9 mm. Calice elliptical; edge serrate. Theca thick and smooth (but not porcellanous); costae well developed only from the calice to 4–6 mm below the calice, the rounded costae 0.6–0.9 mm wide and separated by deep intercostal furrows about 0.4 mm wide. Otherwise, costae on lower theca are flat, and intercostal striae are poorly defined (thin and shallow), covered with very low, rounded granules arranged 2 or 3 across a costa. Corallum white.

Septa hexamerally arranged in 4 cycles and an incomplete fifth cycle, 1 corallum having 1 pair of S5 in each of 9 half-systems (66 septa), another having a pair of S5 in every half-system and 2 pairs in 1 half-system (74 septa). S1–2 about 3.2 mm exsert, quite thick (about 1.5 mm at apex), and have straight, vertical inner edges that extend about two-thirds distance to columella. S3 only slightly less exsert, about three-quarters width of an S1–2, and have slightly sinuous inner edges. S4 only slightly less exsert and about three-quarters width of an S3, and have straight inner edges. S5 slightly less exsert and about two-thirds width of an S4. Before each S3 is a narrow (2.0–2.2 mm wide), rounded, thick, lamellar (not sinuous) palus (P3), together forming a crown of 12 elements deep in fossa. P4 are not formed even when pairs of S5 occur; instead, the position of the P3 seems to migrate to a location between the S3 and the accelerated S4. Columella consists of 3–6 granular rods, aligned along the axis of the GCD.

TYPES: Holotype: NZOI Stn I741, NZOI H-623. Paratypes: RV *Franklin* Stn 5/89/40, 3, AMSG15500, 1, USNM 94006.

TYPE LOCALITY: 22°43'00 S, 159°16'00 E (Gifford Guyot, northern Lord Howe Seamount Chain), 328 m.

ETYMOLOGY: This species is named in honor of Patricia M. Ralph for her contributions to our knowledge of New Zealand Scleractinia.

REMARKS: Among the approximately 58 recent species of *Caryophyllia* (see Cairns 1991a), a small subset of four species is characterised by having pali before its antipenultimate (vs penultimate) cycle of septa: *C. paucipalata* Moseley, 1881 (Lesser Antilles, 714–843 m); *C. capensis* Gardiner, 1904 (off South Africa, 59 m); *C. eltaninae* Cairns, 1982 (off South

Georgia, 101–261 m); and *C. ralphae*. *Caryophyllia paucipalata* is easily distinguished as having pentamerous symmetry: 40 septa and five pali; *C. eltaninae* differs from *C. ralphae* in having a much larger, fascicular columella; a shallower fossa; non-incised intercostal furrows; and a narrow pedicel. However, *C. ralphae* is remarkably similar to *C. capensis*, both species not only having a maximum of 12 pali regardless of S5, but also both species having a papillose columella. *Caryophyllia ralphae* differs in having much more highly exsert septa, a deeper fossa, and much larger and higher pali (those of *C. capensis* are almost indistinguishable from the columellar elements). Zibrowius and Gili (1990) do not consider *C. capensis* as a “true *Caryophyllia*”, perhaps because of its papillose columella and odd palal shape and placement, but they do not suggest an alternative genus. *Caryophyllia capensis* may well belong to a different genus, and, if so, *C. ralphae* should be placed with it.

Caryophyllia (*C.*) *diomedae* Marenzeller, 1904
(Plate 9, a-d)

Caryophyllia diomedae Marenzeller, 1904b: 79–80, pl. 1, fig. 2; Cairns 1991a: 11–13, pl. 4, figs c-e (synonymy).

Caryophyllia sarsiae Zibrowius 1974a: 779–782, pl. 3, figs a-f (new synonymy); 1980: 62–63, pl. 24, figs A-J (synonymy); Cairns 1991a: 12, pl. 4, fig. f; Cairns & Parker 1992: 19–20, pl. 5, figs b-f.

?*Caryophyllia* sp. Zibrowius 1974b: 755, 756, pl. 1, fig. 11, pl. 2, fig. 1.

Caryophyllia profunda: Cairns 1982: 17–19 (in part: *Eltanin* Stn 1403).

MATERIAL EXAMINED: New Records: NZOI Stn P946, 11, USNM 94057; Stn P947, 2, USNM 94058; Stn Q68, 1, USNM 94059; Stn R438, 1, NZOI; Stn S46, 1, NZOI; Stn T226, 7, USNM 94060; Stn T243, 1, NZOI; Stn T257, 1, NZOI; Stn U325, 7, USNM 94061; *Volcanolog* Stn B30-28, 3, AU11622, AUM; *Alexander Nesmeyanov* Stn N17–6, 5, AU12251, AUM; *Eltanin* Stn 1403, 1, USNM 47518. Previous Records: Types of *C. diomedae*; specimens reported by Zibrowius (1980) and Cairns (1982) as *C. profunda*.

DISTRIBUTION: New Zealand region: Lord Howe Seamount Chain; Colville and Kermadec Ridges; off Cape Palliser; Campbell Plateau (Map 3); 660–1200 m. Elsewhere: northeastern Atlantic from the Mediterranean to the Azores; Bermuda; off Pacific Panama; Cocos and Galápagos Islands; off Tasmania and Victoria; ?St. Paul Island; off Pukapuka Atoll, Cook Islands, 1585 m (reported herein, NZOI Stn U325); 245–2200 m.

DESCRIPTION: Corallum ceratoid, often flared distally, straight to slightly curved near base, and attached through a pedicel 0.26–0.36 GCD. Largest New Zealand specimen (*Eltanin* Stn 1403) 29.9 x 25.1 mm in calicular diameter and 35 mm in height, with a pedicel diameter of 10.2 mm; however, most specimens examined from this region 15–17 mm GCD. Calice elliptical; edges serrate. Theca thick and usually porcellanous (smooth) with little or no indication of costae. Intercostal striae and costal granules usually covered with stereome, producing a smooth, dense theca; costal granules usually visible only near calice. C1–2 sometimes slightly ridged. Corallum white, light yellowish-brown, or cream colour.

Septa of most coralla hexamerally arranged in 4 complete cycles (48 septa); however, of the 38 New Zealand specimens examined, 1 contains only 11 sectors (44 septa, 11 pali), another 13 sectors (52 septa, 13 pali), another 14 sectors (56 septa, 14 pali), and yet another 15 sectors (60 septa, 15 pali). Most Atlantic specimens reported by Zibrowius (1980) have 4 cycles of septa, but he also reported specimens with 10, 11, and 13 sectors. Six of the 10 specimens reported by Cairns and Parker (1992) have 14 sectors. S1–2 thick, about 3 mm exsert (up to 5.5 mm in large specimens), and have slightly sinuous inner edges that extend about three-quarters distance to columella. S3 about 2 mm exsert, two-thirds width of an S1–2, and have moderately sinuous inner edges. S4 1.5–2.0 mm exsert, two-thirds to four-fifths width of an S3, and have only slightly sinuous inner edges. A tight crown of 12–15 P3 encircles the columella, each palus about 2 mm wide and having sinuous edges, especially their outer edge. Columella consists of 3–12 slender, twisted elements.

TYPES: One syntype of *C. diomedae* is deposited at the USNM (22083). The holotype and paratype of *C. sarsiae* are deposited at the BM(NH) (1974.1.10.1–2).

TYPE LOCALITIES: *C. diomedae*: *Albatross* Stn 3358, 6°30' N, 81°44' W (off Coiba Island, Panama), 1043 m. *C. sarsiae*: 47°19' N, 6°36' W (Celtic Sea), 880–980 m.

REMARKS: I previously noted the resemblance of *C. sarsiae* to *C. diomedae*, concluding that *C. sarsiae* differed in having a more robust corallum and in lacking costal ridges (Cairns 1991a). The specimens from the New Zealand region bridge the morphological gap between these two nominal species, indicating that the type of *C. diomedae* is a relatively small specimen (GCD = 12.9 mm) having

48 septa, which is typical of most specimens, but that the species is capable of attaining a GCD of 30 mm and having up to 15 sectors (60 septa).

Four species of relatively large, attached species of *Caryophyllia* occur in the New Zealand region: *C. profunda*, *C. atlantica*, *C. diomedea*, and *C. ralphae*. *Caryophyllia profunda* is characterised by having in 16–24–26 sectors of septa (and thus 64–96–104 septa and 16–24–26 pali); wide, lamellar pali; a robust pedicel (PD: GCD up to 0.6); and horizontally aligned costal granules. *Caryophyllia diomedea* has fewer septa and pali (usually 48 septa and 12 pali, but as many as 60 septa and 15 pali); relatively narrow pali; a narrow pedicel (PD: GCD = 0.26–0.36); and a porcellanous theca. *Caryophyllia atlantica* is distinguished by having its tertiary septa wider than its secondary septa; 14–16–18 sectors of septa (56–64–72 septa and 14–16–18 pali); wide, slightly sinuous pali; a narrow pedicel (PD: GCD = 0.18–0.20); uniformly distributed costal granules; and highly exsert primary septa. *Caryophyllia ralphae* is distinguished by having pairs of S5 within a half-system without a corresponding P4. Within the New Zealand region the four species also have distinctive geographic and bathymetric ranges — *Caryophyllia ralphae* is known only from the northern Lord Howe Seamount Chain from relatively shallow water (315–360 m); *C. profunda*, contrary to its name, is the shallowest-occurring of the four species, found primarily off North and South Islands, including off Fiordland, at 20–1300 m; *Caryophyllia diomedea* is more characteristic of the Kermadec Ridge and Campbell Plateau, usually at greater depths (660–1200 m) than *C. profunda*; *C. atlantica* is known from isolated seamounts and off small islands at 776–2165 m.

Caryophyllia (C.) japonica Marenzeller, 1888
(Plate 9, e-h)

Caryophyllia japonica Marenzeller, 1888: 16; Cairns 1994: 45, pl. 4, fig. 1, pl. 19, figs c-i (synonymy).

Caryophyllia profunda: Squires & Keyes 1967: 23 (in part: NZOI Stn C608 and part (9 specimens) of C690).

MATERIAL EXAMINED: New Records: NZOI Stn B544, 1, USNM 94028; Stn D224, 1, NZOI; Stn E719, 5, USNM 94031; Stn E752, 1, NZOI; Stn F924, 9, NZOI; Stn G184, 4, USNM 94032; Stn G208, 1, NZOI; Stn G230, 1, USNM 94033; Stn G344, 2, USNM 94034; Stn G885, 2, NZOI; Stn H947, 4, NZOI; Stn I671, 6, USNM 94035; Stn J55, 3, NZOI; Stn Q2, 2, NZOI; Stn Q8, 1, NZOI; Stn Q174, 2, NZOI; Stn S67, 2, NZOI; Stn V372, 4, USNM 94036; Stn V373, 9, NZOI; BS480, 3, MoNZ CO137; Chatham Island

Expedition Stn 34, 2, MoNZ CO246; *Eltanin* Stn 1403, 6, USNM 94025. Previous Records: Two syntypes of *C. japonica*; specimens reported by Squires and Keyes (1967) as *C. profunda* (NZOI Stn C608, C690).

DISTRIBUTION: Bounty Plateau; Chatham Rise; Cook Strait; Challenger Plateau; off North and East Cape (Map 7); 106–946 m, but most records from 300–450 m. Elsewhere: Commander Islands, Bering Sea to Kyushu, Japan; 77–1680 m (Cairns 1994).

DESCRIPTION: Corallum ceratoid, straight, and firmly attached by a pedicel 0.21–0.39 GCD. Largest specimen examined (NZOI Stn C690) 18.4 x 16.1 mm in calicular diameter, but most coralla are much smaller, i.e., in the 10–12 mm GCD range. Adult coralla 10–16 mm in height. Costae variable in expression, usually slightly convex or even slightly ridged, but smooth (nongranular and glistening), with poorly defined intercostal striae. Near calice, intercostal striae absent, the theca being smooth. Corallum white.

In all coralla examined septa were hexamerally arranged in 4 complete cycles (48 septa) according to the formula: S1-2>S3≥S4, the S4 of larger coralla approximating the width of an S3. S1-2 1.0–1.7 mm exsert, with straight, vertical inner edges that meet the columella only deep within the fossa. S3 less exsert (0.5–0.7 mm), about half the width of an S1-2, and have slightly sinuous inner edges. S4 slightly more exsert than S3, each pair fusing with their adjacent common S1 or S2 to form a low calicular lancet. Inner edges of S4 straight and extend 0.8–1.0 width of an S3, depending on size of corallum. Twelve rather narrow (1.5–2.1 mm wide) pali form an elliptical crown, each palus having a highly sinuous outer edge but less sinuous inner edge. Tall granules and short carinae occur on summits of palar face undulations. Columella a discrete, sometimes hemispherical, structure, composed of numerous (7–39) slender, twisted elements.

TYPES: Two syntypes of *C. japonica* are deposited at the NMW (8168).

TYPE LOCALITY: Enoshima, Sagami Bay, Japan; depth unknown.

REMARKS: *Caryophyllia japonica* is part of a species (or subspecies) complex that extends from California to Japan (see Cairns 1994), including the taxa *C. arnoldi* Vaughan, 1900; *C. alaskensis* Vaughan, 1941; and *C. japonica* Marenzeller, 1888. The New Zealand specimens are indistinguishable from those

collected off Japan (Cairns 1994).

Caryophyllia japonica differs from *C. profunda* in having fewer septa and pali (only 48 and 12, respectively, vs 96 and 24), small specimens of *C. profunda* of equivalent size to large *C. japonica* having many more septa and pali. *Caryophyllia japonica* also differs in having sinuous S3 and P3; smaller and more numerous columellar elements; almost equivalent S3 and S4; and in lacking aligned costal granules.

Although similar, *C. japonica* differs from *C. diomedae* in having: a thinner theca; better defined costae; S1–2, 4 with straight (not sinuous) inner edges; and more columellar elements. Also, *C. japonica* is usually found at shallower depths than *C. diomedae* and, in general, in different parts of the New Zealand region (compare Maps 3 and 7).

One of the nine specimens from NZOI Stn C690 possesses a hypertrophied calice characterised by an enlarged, spongy, exsert columella, and an additional cycle of rudimentary P1–2 (Plate 9, f). This kind of structure is usually indicative of a gall of a parasitic ascothoracid barnacle (see Zibrowius & Grygier 1985), but a transverse section through the enlarged region showed it to be a solid structure, not hollow as would be a barnacle gall. The structure is also centralized and symmetrical in shape, which is not typical of ascothoracid galls.

Caryophyllia (C.) lamellifera Moseley, 1881
(Plates 9, i, 10, a-c)

Caryophyllia lamellifera: Moseley, 1881: 140–141, pl. 1, fig. 7a-b; Hutton 1904: 315; Not Squires 1958: 47, pl. 7, figs 21–22; Cairns 1991a: 12.

?*Caryophyllia cincticulatus* (sic): Van der Horst 1931: 4.

?*Caryophyllia lamellifera*: Cairns & Keller 1993: table 2.

MATERIAL EXAMINED: New Records: NZOI Stn I87, 2, NZOI; Stn I91, 1, USNM 94358; Stn P115, 3, USNM 94359; Stn Q46, 1, NZOI; BS307, 1, MoNZ CO87; *Soela* 1/82/59, 2, NMV F67791; RV *Franklin* 5/89/5, 5, AMS G15555. Previous Records: Syntypes of *C. lamellifera*.

DISTRIBUTION: New Zealand region: Kermadec Ridge between Raoul and Macauley Islands; southern Norfolk Ridge; off Lord Howe Island; Taupo Tablemount, Tasman Sea (Map 18); 89–1152 m. Elsewhere: ?southwest Indian Ocean (Van der Horst 1931); 128–274 m.

DESCRIPTION: Corallum ceratoid to trochoid, straight, and firmly attached by a robust pedicel 0.38–0.53 GCD. Largest specimen examined (NZOI Stn I91) 15.5 x 15.3 mm in calicular diameter and 21 mm in

thick (1.0–1.3 mm) and covered with closely spaced, transverse ridges, each horizontal ridge 0.18–0.20 mm wide and rounded on its edge. Ridges best developed on lower half of corallum. Costae and costal granules absent; theca glistening. Most coralla predominantly white, with brown vertical stripes corresponding to the C1–2 in upper corallum; upper edges of S1–2 and upper outer edges of S3–4 also brown.

Among the 15 specimens examined (new records), 8 have hexamerally arranged septa in 4 cycles (48 septa, 12 pali), whereas 7 coralla have septamerally arranged septa (56 septa, 14 pali). The larger of the two syntypes (GCD = 7.0 mm) has 46 septa and 11 pali, missing one pair of S4 and its corresponding P3; the smaller syntype (GCD = 2.2 mm) has only 24 septa and 6 pali. S1 highly exsert (up to 4.3 mm), with straight to slightly sinuous inner edges that extend about three-quarters distance to columella. S2 about three-quarters as exsert and as wide as an S1, with slightly sinuous inner edges. S3 least exsert septa (about 2.3 mm), extend two-thirds to three-quarters width of an S2, and have moderately sinuous inner edges. S4 adjacent to S1 almost as exsert as an S2, each pair of S4 flanking an S1 fusing with it to form a triangular lancet. S4 adjacent to S2 only slightly more exsert than an S3, each pair flanking an S3 also forming small lancets. S4 0.8–0.9 width of an S3 and have straight to slightly sinuous inner edges. Pali 1.05–2.20 mm wide and have sinuous inner edges, 12–14 pali forming a paler crown encircling the columella. Fossa of moderate depth; columella consists of 1–19 very slender (0.25–0.35 mm in diameter) twisted elements.

TYPES: The two syntypes of *C. lamellifera* are deposited at the BM(NH) (unregistered).

TYPE LOCALITY: *Challenger* Stn 170, 29°55' S, 178°14' W (north of Macauley Island, Kermadec Ridge), 1152 m.

REMARKS: *Caryophyllia lamellifera* was found at some of the same stations as *C. hawaiiensis* and both species share a similar pigmentation pattern and are about the same size. *Caryophyllia lamellifera* is distinguished by having: a transversely ridged theca (not granular); predominantly hexameral symmetry (12–14 pali) vs predominantly pentameral symmetry (10–12 pali); S4 less wide than S3; and a thicker theca and septa.

Two other recent species of *Caryophyllia* have a transversely ridged theca — *C. rugosa* (reported herein) and *C. corrugata* Cairns, 1979 (western Atlantic, 183–380 m). *Caryophyllia corrugata* differs in

height, but has a broken pedicel. Theca relatively having: ridged C1–2, a very small pedicel and flared calice, lamellar pali, and S4 that are much narrower than its S3; *C. rugosa* differs in having: a smaller corallum, octamerall symmetry, and extremely sinuous septa and pali.

The specimen reported by Squires (1958) as *C. sp.* cf. *C. lamellifera* from the lower Miocene of New Zealand has transverse thecal ridges but has 72 septa (18 pali) and is unlikely to be conspecific.

The larger syntype (from *Challenger* Stn 170, Plate 10, b, c) is a small, probably juvenile, specimen lacking a full fourth cycle and differs from most of the other New Zealand specimens reported herein in having sharper thecal ridges, a smaller corallum, and S4 that are wider than its S3. The first two differences may be attributed to ontogenetic changes, but the difference in relative widths of the third and fourth cycles is puzzling, since this is usually a conservative character throughout ontogeny.

Caryophyllia (C.) elongata Cairns, 1993
(Plate 10, d-f)

Caryophyllia elongata Cairns in Cairns & Keller, 1993: 236–237, pl. 4, figs A–B.

MATERIAL EXAMINED: New Records: NZOI Stn K804, 1, NZOI; NZOI Stn K830, 1, USNM 94056; Stn K858, 1, NZOI; Stn S571, 1, USNM 94055; Stn X221, 1, NZOI; BS310, 1, MoNZ CO85, 3, USNM 94054. Previous Records: Holotype.

DISTRIBUTION: New Zealand region: Kermadec Ridge from Raoul to Curtis Island; northern Three Kings Ridge (Map 14); 165–590 m. Elsewhere: Madagascar Plateau; 630–680 m.

DESCRIPTION: Corallum ceratoid to subcylindrical, having a thick pedicel (PD: GCD = 0.59–0.81) and a thin, expansive, encrusting base. Corallum relatively small, the largest New Zealand specimen (BS310) only 10.7 × 10.1 mm in calicular diameter (pedicel broken). Theca porcellanous (not costate), and uniformly covered with low, rounded granules. Corallum light yellow-brown.

Septa hexamerally arranged in 4 complete cycles (48 septa), even at a GCD of only 4.2 mm, according to the formula: S1 > S2 ≥ S4 ≥ S3. S1 about 1.5 mm exsert, with straight, vertical inner edges that reach the columella. S2 less exsert (about 1 mm), about 0.8 width of an S1, and also with straight inner edges. S3 and S4 about 0.6 mm exsert, the S3 about

0.8 width of an S2, with slightly sinuous inner edges. S4 unequal in width, those adjacent to S1 invariably wider (0.9–1.0 width of an S2) than those adjacent to S2 (0.8–0.9 width of an S2, which is equal to or slightly wider than an S3). P3 slender (about 1.1 mm wide), with very sinuous inner edges, forming a tight palmar crown of 12 elements deep in fossa. Columella composed of 3–9 slender, twisted elements, even more deeply set in fossa than the palmar crown.

TYPES: The holotype is deposited at the IOM.

TYPE LOCALITY: *Vityaz* Stn 2716, 33°17' S, 44°55' E (off Walter's Shoal, Madagascar Plateau), 630–680 m.

REMARKS: Of the 18 recent *Caryophyllia* species that can be characterised as attached species with four cycles of hexamerally arranged septa (see Cairns 1991a), in only five are the S4 equal to or greater than the width of their S3 — *C. calveri* Duncan, 1873 (northeastern Atlantic, 130–1050 m); *C. atlantica* (Duncan, 1873) (= ?*C. panda* Alcock, 1902a) (widespread, 776–2165 m); *C. polygona* Pourtalès, 1878 (Antilles, 700–1817 m); *C. alberti* Zibrowius, 1980 (Azores, 76–506 m); and *C. elongata* Cairns, 1993. *Caryophyllia elongata* differs from these other species in having S1 that are wider than their S2, a very deep fossa, and a yellow-brown corallum.

Caryophyllia (C.) scobinosa Alcock, 1902
(Plates 10, g-i, 11, a-c)

Caryophyllia cultrifera Alcock, 1902a: 89–90; 1902c: 7–8, pl. 1, figs 1, 1a (new synonymy).

Caryophyllia scobinosa Alcock, 1902a: 90; 1902c: 8, pl. 1, figs 2, 2a; Keller, 1981a: 17, fig. 2 (in part: *Vityaz* Stn 4680); Cairns & Keller 1993: 235 (synonymy); Cairns 1994: 45–46, pl. 20, figs a-b (synonymy).

Not *Caryophyllia* sp. cf. *C. scobinosa*: Cairns 1994: 45–46, pl. 19, figs j-l.

MATERIAL EXAMINED: New Records: NZOI Stn G817, 2, NZOI; Stn G818, 2, USNM 94045; Stn G819, 2, NZOI; Stn G821, 2, NZOI; Stn G822, 4, NZOI; Stn G824, 8, NZOI; Stn G825, 6, NZOI; Stn P943, 8, USNM 94046; Stn Q84, 73, USNM 94047; Stn U344, 1, NZOI; Stn U351, 3, NZOI; RV *Franklin* Stn 5/89/25, 4, AMS G15497, G15567, RV *Franklin* Stn 6/88/4, 10°34.28' S, 144°13.33' E, 815–825 m, 20 August 1988, 1, USNM 86559. Previous Records: Syntypes of *C. scobinosa*; holotype of *C. cultrifera*.

DISTRIBUTION: New Zealand region: known only from northern Lord Howe Rise (Map 16); 784–1051 m. Elsewhere: southwestern Indian Ocean from Tan-

zania to Madagascar Plateau; Sulu Sea; Celebes Sea; off Queensland (reported herein); off Tonga and Samoa (reported herein: NZOI Stn U344, 1, USNM 94048; Stn U351, 2, USNM 94049); 535–1270 m.

DESCRIPTION: Corallum cornute (usually curved between 45–90°) and free, the original unconsolidated pedicel only 0.9–1.1 mm in diameter. Largest New Zealand specimen examined (AMS G15497) 20 x 16 mm in calicular diameter and 24 mm in height. Calice elliptical: GCD: LCD = 1.15–1.25. Costae well defined, C1–2 0.5–0.6 mm wide and often ridged, especially near calice, where the ridges are sometimes sinuous. C3–4 0.6–0.9 mm wide and flat to slightly convex. Costae separated by thin, shallow striae and covered with low rounded granules 3 or 4 across a costa. Corallum white; however, theca from base to a parallel line 2–3 mm below calice usually worn and discoloured.

Coralla of most specimens hexamerally arranged in 4 cycles (48 septa) according to the formula S1–2>S3–4; however, larger coralla (e.g., GCD > 16 mm) have 56 or even 64 septa arranged in 14 or 16 sectors and have correspondingly 14 and 16 pali. S1–2 highly exsert (2.4–3.0 mm) and have slightly sinuous vertical inner edges that reach four-fifths distance to columella. The paliferous S3 are least exsert septa (about 0.7 mm) and have moderately sinuous inner edges. S4 about 2 mm exsert, a pair of S4 fusing with each S1+2 to form 12 rectangular lancets. Width of S4 often slightly less than S3 in young coralla, equal to width of S3 in most coralla, and sometimes slightly wider than S3 in larger coralla. A crown of 12–16 wide (1.8–1.9 mm), sinuous pali encircles a fascicular columella composed of 4–14 relatively broad, twisted elements.

TYPES: Six syntypes of *C. scobinosa* are deposited at the ZMA: Coel. 574, *Siboga* Stn 45, includes Alcock's illustrated specimen; Coel. 575, *Siboga* Stn 102, includes the largest syntype of 18.1 mm GCD. The holotype of *C. cultrifera* is also deposited at the ZMA (Coel. 1180).

TYPE LOCALITIES: *C. scobinosa*: Flores and Sulu Seas, 535–794 m. *C. cultrifera*: *Siboga* Stn 101, 6°15' N, 120°21' E (Sulu Sea), 1270 m.

REMARKS: Unattached, cornute species of *Caryophyllia* have been described from bathyal depths worldwide, including the following ten species: *C. cornuformis* Pourtalès, 1868; *C. seguenzae* Duncan, 1873; *C. scillaemorpha* Alcock, 1894; *C. scobinosa* Alcock, 1902a; *C. planilamellata* Dennant, 1906; *C. paucipaliata* Yabe

& Eguchi, 1942b; *C. grandis* Gardiner & Waugh, 1938; *C. mabahithi* Gardiner & Waugh, 1938; *C. balaenacea* Zibrowius & Gili, 1990; and *C. valdiviae* Zibrowius & Gili, 1990. Whereas some species are quite distinctive (e.g., *C. cornuformis*, *C. planilamellata*, *C. paucipaliata*, *C. grandis*, and *C. mabahithi*), the others are very similar, characterised by having highly exsert primary septa and associated calicular lancets, highest cycle septa that are wider than the pen-ultimate cycle, wide pali, and broad columellar elements. The number of septa and pali vary from 48/12 to 96/24, seemingly as a function of corallum size. It remains to be proven whether the remaining five taxa are separate sibling species, different subspecies, or simply growth forms of the same species. The specimens reported herein as *C. sco-binosa* represent specimens having small coralla and only 48 septa (12 pali), only several specimens having more septa. *Caryophyllia cultrifera* (holo-type with a GCD of 21.8 mm, having 48 septa) is suggested to be a synonym of *C. scobinosa*, its prominent C1–2 being part of the variation characteristic of *C. scobinosa*.

Caryophyllia (C.) ambrosia Alcock, 1898

(Plate 11, d, e)

Caryophyllia ambrosia Alcock, 1898: 12, pl. 1, fig. 1, 1a; Zibrowius 1980: 63–65, pl. 25, figs A–K (synonymy).

Caryophyllia ambrosia ambrosia: Cairns 1979: 59; Cairns & Keller, 1993: 234, pl. 13, fig. H; Cairns 1994: 48, pl. 21, figs d–h (synonymy).

MATERIAL EXAMINED: New Records: NZOI Stn D226, 3, NZOI; Stn D227, 4, NZOI; Stn D231, 3, NZOI; Stn E712, 1, NZOI; Stn E717, 1, NZOI; Stn E772, 1, USNM 94042; Stn E884, 7, USNM 94043; Stn F877, 4, USNM 94044; Stn F896, 1, NZOI; Stn F900, 3, NZOI; Stn P120, 6, NZOI; BS763 (R121), 1, MoNZ CO 244; BS 812 (O556), 3, MNZ; BS844 (O590), 24, MoNZ, 1, USNM 94041; J15/9/76, 1, MoNZ; *Alexander Nesmeyanov* Stn N17-15, 1, AU12248, AUM; east of Broken Bay, NSW, 827 m, 1, USNM 78612; RV *Franklin* 6/88/4, 10°34' S, 144°13' E, 815–825 m, 4, USNM 86558. Previous Records: Two syntypes of *C. ambrosia* (USNM); specimens reported by Zibrowius (1980).

DISTRIBUTION: New Zealand region: Lord Howe Rise; Challenger Plateau; Raukumara Plain; southern Colville Ridge (Map 7); 701–1180 m. Elsewhere: widespread: amphi-Atlantic; Indian Ocean; south-eastern Australia (reported herein): off Japan and Ryukyu Islands; 311–2670 m.

DESCRIPTION: Corallum straight to cornute (curved up to 90°), with a non-reinforced base 1.3–1.9 mm

diameter. Adult coralla massive and dense, with thick deposits of internal stereome. Largest corallum examined (BS844, MoNZ) 49 x 40 mm in calicular diameter and 42 mm in height. Calice elliptical: GCD: LCD = 1.2–1.3. C1–3 sometimes slightly ridged, but, in general, all costae equal in width, slightly convex, and separated by very thin intercostal striae. Costae uniformly covered with fine (about 0.2 mm in diameter) granules, 4 or 5 occurring across a costa. As in *C. scobinosa*, only a thin band of theca adjacent to the calice is well preserved (white), the remainder of the theca being worn and often discoloured.

Septa almost always hexamerally arranged in 5 complete cycles (96 septa), even at the small size of 19 mm GCD; however, a specimen of 15 mm GCD has only 12 pali and a partial fifth cycle. Two exceptions worth noting are a specimen of GCD 41 mm with 104 septa (26 pali) and the largest specimen of GCD 49 mm, which has only 92 septa (23 pali). S1–2 highly exsert (up to 7 mm) and have slightly sinuous inner edges that extend about three-quarters distance to columella. S3 only slightly less exsert, but otherwise similar to S1–2. S4 least exsert septa (about 2 mm) and have moderately sinuous inner edges extending two-thirds width of an S1–3. S5 3.0–4.5 mm exsert, a pair of S5 fusing with each S1–3 at the calicular edge to form lancets that alternate in height, the S1–2 lancets being slightly more exsert than those of the S3. Inner edges of S5 straight, the S5 equal to or slightly wider than the S4. A prominent crown of 24 wide (up to 5.5 mm) pali occurs before the S4. Palar edges only slightly sinuous, and bear granules 2–3 times the size of those on septal faces. Fossa of moderate depth, containing an elongate fascicular columella composed of 5–19 broad (up to 2.9 mm in diameter), twisted elements.

TYPES: Approximately 200 syntypes are presumed to be deposited at the Indian Museum, Calcutta. Two syntypes are deposited at the USNM (18157); two syntypes are at the MNHNP; two are at the ZMA (Coel. 1179); and one is at the MNW (8165).

TYPE LOCALITY: Laccadive Sea, Arabian Sea; 1829–1957 m.

REMARKS: At least four populations (?forms, subspecies, species) of *C. ambrosia* are recognised: (1) specimens from the eastern Atlantic and northern Indian Ocean (typical), characterised as having small to medium-sized coralla and 14–18 pali (56–72 septa); (2) specimens from the western Atlantic called *C.*

ambrosia caribbeana by Cairns (1979), characterised as having large coralla, but still only 14–18 pali; (3) specimens from off Japan (see Cairns 1994), characterised as having large coralla and usually 18–20 pali (72–80 septa), and (4) those specimens reported from off New Zealand and southeastern Australia, which have large coralla and a strong tendency to have 24 pali (96 septa). As mentioned in the discussion of *C. scobinosa*, these morphotypes may represent sibling species, subspecies, or just clinal or environmental variation.

Caryophyllia (Premocyathus) Yabe & Eguchi, 1942b

Caryophyllia having compressed coralla with carinate (but not spinose) convex thecal edge. Base invariably an open scar. Columella fascicular or papillose.

TYPE SPECIES: *Premocyathus compressus* Yabe & Eguchi, 1942b, by original designation.

REMARKS: Three species are recognised in this subgenus: ?*C. (P.) dentiformis* (Alcock, 1902b); *C. (P.) compressa* Yabe & Eguchi, 1942b; and *C. (P.) burchae* Cairns, 1984.

Caryophyllia (P.) compressa Yabe & Eguchi, 1942 (Plate 11, f-i)

Caryophyllia compressa Yabe & Eguchi, 1932b: 443 (*nom. nud.*).

Not *Caryophyllia compressa* Gardiner & Waugh, 1938: 180 (junior homonym); Cairns 1984: 14.

Premocyathus compressus Yabe & Eguchi, 1942b: 121, 151–152, pl. 10, figs 13–14.

Caryophyllia (P.) compressa: Mori 1987: 21–30, 9 figs; Not Wells 1956: F422, fig. 323, 3; Cairns 1994: 50–51, pl. 22, figs e-f (synonymy).

MATERIAL EXAMINED: New Records: NZOI Stn E840, 1, USNM 94062; BS441, 14, MoNZ CO240, 241; BS633 (P461), 3, MoNZ CO268. Previous Records: Specimens reported by Wells (1956), USNM.

DISTRIBUTION: New Zealand region: off Raoul Island, Kermadecs; off Three Kings Islands (Map 14); 402–757 m. Elsewhere: off Japan (Cairns 1994); 115–366 m; Pleistocene of Ryukyu Islands.

DESCRIPTION: Corallum compressed (GCD: LCD = 1.2–1.4) and invariably curved 30–45° in plane of GCD, the concave thecal edge rounded, the convex thecal edge usually crested or even keeled (up to

0.7 mm), although the expression of this costal ridge is quite variable. Costoseptum of primary septum aligned with convex edge often continuous with thecal edge ridge. Base of corallum invariably displays an open circular scar 1.0–1.5 mm in diameter. Costae equal in width (about 0.5 mm), flat to slightly convex, and covered with small, low, rounded granules arranged 4 or 5 across a costa. Intercostal striae quite thin and narrow. Corallum white.

Septal symmetry and number quite varied, the 16 specimens examined displaying 6 patterns. The 4 specimens from off Three Kings Islands show: 9:9:14, 7 (32 septa, 7 pali); 8:8:16, 8 (32 septa, 8 pali); 8:8:14, 7 (30 septa, 7 pali); and 7:7:14, 7 (28 septa, 7 pali). The 12 smaller specimens from Raoul Island have only 2 patterns: 6:6:12, 6 (24 septa, 6 pali), shared by 8 specimens, and 7:7:14, 7 (28 septa, 7 pali), shared by 4 specimens. Primary septa are little exsert (about 1.1 mm) and have quite sinuous edges that extend about three-quarters to columella. Secondary and tertiary septa equally exsert (about 0.8 mm), the secondaries about three-quarters width of a primary septum and have very sinuous inner edges, and the tertiaries less wide than the secondaries with only slightly sinuous inner edges. Narrow (about 0.7 mm wide) pali occur before the secondary septa, but only in those sectors in which paired tertiaries occur, which is sometimes irregular within a corallum. Pali have highly sinuous edges and bear larger granules than occur on septal faces. Fossa of moderate depth, containing a fascicular columella composed of 1–4 twisted elements.

Types: Four syntypes of *C. compressa* are deposited at the TIUS (60747).

TYPE LOCALITY: Pleistocene (Wan Formation) of Ryukyu limestone, Kikai-jima, Kagosima-ken.

REMARKS: Mori (1987) studied 1090 toptypic specimens of *C. compressa*, tabulating them into categories of type of septal symmetry and number of pali. His specimens fell into 57 septal arrangements permutations, ranging from 6:6:12, 6 (24 septa, 6 pali) to 14:14:12, 6 (40 septa, 6 pali), the commonest septal complement being 10:10:14, 7 (34 septa, 7 pali), possessed by 11.1 % of the population. The septal/pali arrangements of the New Zealand specimens represent some of the rarer permutations listed by Mori, e.g., the 9:9:14, 7 permutation was the 11th most common (2.4%) of his material, whereas the two patterns found in the Raoul specimens were found in only 0.5 and 0.9% of Mori's specimens. Nonetheless, these specimens are considered to be

conspecific with *C. compressa* and represent the first record of this species outside Japanese waters.

Coenocyathus Milne Edwards & Haime, 1848a

Like *Caryophyllia* (*Caryophyllia*), but forming colonies through extratentacular budding from a thick basal coenosteum and occasionally from theca of parent corallites. Pali before penultimate cycle of septa; columella fascicular.

TYPE SPECIES: *Coenocyathus cylindricus* Milne Edwards & Haime, 1848, by subsequent designation (Milne Edwards & Haime 1850: xii).

Remarks: Six recent species are known in the genus (see Cairns 1994), two of which are known from the Pacific: *C. brooki* and *C. sagamiensis* Eguchi, 1968.

Coenocyathus brooki n. sp. (Plate 12, a-d)

MATERIAL EXAMINED: Types, q.v.

DISTRIBUTION: Known only from the Kermadec Islands, including Raoul, Macauley, Curtis, and Cheeseman Islands, and Esperance Rock (Map 22); 7–95 m. Most specimens were collected by Fred Brook from the roofs of caves and from beneath overhangs.

DESCRIPTION: Coralla form small encrustations on rocks or calcareous substrata, the largest colony (the holotype) about 4 cm in diameter and containing 29 corallites. Primary mode of increase is by extratentacular budding from edge zone of the common coenosteum or between corallites. In some colonies (e.g., the holotype) calices elongate and then constricted medially, producing two equal-sized daughter corallites by intratentacular budding. No corallites were noted to bud from the theca of another corallite. Calices circular, elliptical, or irregular in shape, becoming quite elongate prior to intratentacular budding. Large corallites that are not in process of budding measure 12–13 mm in GCD. Costae 0.30–0.35 mm in width and are quite flat, separated by thin, shallow intercostal striae. Costae covered with low, rounded granules, usually aligned across a costa and fused into short transverse ridges. Corallum white.

Septal symmetry extremely irregular, ranging from 8–18 primary septa and pali, and 3 to 4 cycles of septa. The commonest symmetry is 6:6:12:24 (48 septa, 12 pali) or 6:8:14:28 (56 septa, 14 pali); in the latter case the original hexamerous symmetry is pre-

served even though an irregular number of higher-cycle septa are present. Although most half-systems contain 3 septa, some within the same corallite have 5 septa. Largest corallite examined has 18 pali and 84 septa. S1 highly exsert (up to 2.8 mm), extending about three-quarters distance to columella, with straight, vertical inner edges. S2 about half as exsert and three-quarters width of an S1, and also have straight inner edges. S3 least exsert septa, about three-quarters width of an S2, and have slightly sinuous inner edges. S4 equal to or more exsert than S3, four-fifths width of an S3, and have straight inner edges. Pali (P3) lamellar, 1.0–1.5 mm wide, and only slightly sinuous. Fossa deep, containing a fascicular columella consisting of 2–20 tightly twisted elements, each about 0.8 mm in diameter.

Types: Holotype: L4721, AIM AK72405. Paratypes: L892, 1 colony, AIM AK72410; L999, 3 colonies, AIM AK72409; L1050, 3 colonies, AIM AK72411; L1051, 2 colonies, AIM AK72408; L1413, 2 colonies, AIM AK72407, 2, USNM 94588; L1630, 1 colony, AIM 72406; L4722, 5 colonies, AIM AK72412; NZOI Stn K820, P-1011, 3 colonies, NZOI, 2 colonies, USNM 94130.

TYPE LOCALITY: L4721, west side of Cheeseman Island, Kermadec Ridge, 26 m.

ETYMOLOGY: This species is named for Fred Brook, who collected most of the type specimens and has made other collections of shallow-water azooxanthellate corals from the Kermadec, Norfolk, and Three Kings Islands.

REMARKS: *Coenocyathus brooki* is quite similar to *C. bowersi* Vaughan, 1906, known from the Gulf of Panama to southern California at 9–302 m (Cairns, 1994), particularly in its growth form and irregular septal symmetry. *Coenocyathus brooki*, however, differs in having transversely granulated costae, highly exsert S1, lamellar pali, more numerous columellar elements, and more septa in large corallites. Furthermore, although both species reproduce intratentacularly, *C. bowersi* does so by subdividing a corallite into numerous very small ones, whereas corallites of *C. brooki* elongate and then constrict, resulting in only two equal-sized daughter corallites.

Crispatotrochus Tenison-Woods, 1878a

Corallum solitary, ceratoid to turbinate, and usually attached. Septotheca costate or covered with

transverse ridges. Pali absent; columella fascicular, composed of discrete, twisted elements.

TYPE SPECIES: *Crispatotrochus inornatus* Tenison-Woods, 1878a, by monotypy.

REMARKS: Fourteen species are recognised in the genus, 12 listed by Cairns (1991a) and another two described herein. Four of the 14 species have decamerall symmetry; of the remaining ten species, six have only four cycles of septa, including the two species from the New Zealand region. Both species described herein have unique characters that distinguish them from others in the genus, one having a transversely ridged theca, the other an unattached, cornute corallum. Species of *Crispatotrochus* are widespread in the tropical to Subantarctic regions from 82–2505 m, but not yet known from the eastern Atlantic.

Crispatotrochus curvatus n. sp. (Plate 12, e-h)

Gardineria sp. Gardiner 1929: 125 (in part: *Terra Nova* Stn 96).

MATERIAL EXAMINED: Types, q.v.; 5 specimens identified as *Gardineria* sp. by Gardiner (1929), BM(NH) 1929.10.22.15–17.

DISTRIBUTION: Raukumara Plain and Bounty Trough; off North Cape (Map 7); ?128–1373–2505 m.

DESCRIPTION: Corallum trochoid and cornute, most coralla curved 45–90°. All specimens examined unattached, tapering to a slender (2.4–3.9 mm in diameter), circular, flat base. PD: GCD ranges from 0.16–0.29, the smaller ratio corresponding to large specimens, the larger to small specimens, a result of the pedicel diameter remaining constant as the calice increases in diameter. Largest specimen examined (holotype) 15.0 × 14.4 mm in calicular diameter and 26.0 mm in height, with a basal diameter of 2.4 mm. Calice circular to very slightly elliptical (GCD: LCD = 1.0–1.1) and serrate, the calicular theca associated with each S1–2 forming a small (about 0.9 mm in height) isosceles triangle and the 3 S3–4 between each S1–2 forming a lower (about 0.5 mm in height) equilateral triangle. Theca of lower half to three-quarters of corallum worn; upper theca costate, consisting of broad (0.8 mm), slightly convex, glistening costae separated by very thin (0.1 mm), shallow intercostal striae. Corallum white; theca and septa quite thin, both only about 0.1 mm thick.

Septa hexamerally arranged in 4 complete cycles (48 septa) in all but the smallest specimens of 11–12 mm GCD, these small specimens having very reduced S4, 3 or 4 pairs of which may be missing (resulting in 40–42 septa). S1–2 have vertical, broadly sinuous inner edges that fuse with columellar elements deep in fossa. S3 half to two-thirds width of an S1–2 and also have broadly sinuous inner edges. S4 one-quarter to half width of an S3, sometimes quite rudimentary, and have slightly sinuous inner edges. Septa thin and widely spaced, separated by 0.7–0.8 mm from one another. Septal faces of most specimens covered with sparse, low, pointed granules, but faces of those specimens from *Terra Noxa* Stn 96 also bear short, obliquely inclined carinae. Fossa of moderate depth with a fascicular columella consisting of 2–14 twisted elements.

Types: Holotype: NZOI Stn S154, NZOI H-624. Paratypes: NZOI Stn G703, 1, NZOI P-1012; Stn J658, 2, NZOI P-1013; Stn S152, 2, USNM 94122; Stn S154, 4, USNM 94123.

TYPE LOCALITY: 45°24.2' S, 173°59.8' E (Bounty Trough, northeast of Dunedin), 1373 m.

ETYMOLOGY: The species name *curvatus* (Latin *curvus*, bent) refers to the curved shape of the corallum.

REMARKS: Of the twelve previously described species of *Crispatotrochus* (see Cairns 1991a), only four have four cycles of hexamerally arranged septa: *C. inornatus* Tenison-Woods, 1878a; *C. cornu* (Moseley, 1881); *C. irregularis* Cairns, 1982; and *C. galapagensis* Cairns, 1991a, the other species having decamerall symmetry or five cycles of hexamerally arranged septa. *Crispatotrochus curvatus* is distinguished from all congeners by having a narrow, unattached pedicel, which is invariably associated with a cornute corallum. This species is also distinctive in having a serrate calicular edge, widely separated septa, and a deep bathymetric range (?128–1 373–2505 m), only *C. sp. A* (*sensu* Cairns 1982) having a similarly deep range (2305–2329 m).

Crispatotrochus rugosus n. sp. (Plate 13, a, b)

MATERIAL EXAMINED: Types, q.v.

DISTRIBUTION: Kermadec Ridge from south of Esperance Rock to north of Raoul Island; Lord Howe Seamount Chain (Map 16); 142–508 m.

DESCRIPTION: Corallum ceratoid, elongate, and often slightly flared distally. Corallum attached through

an elongate but thickened pedicel (PD: GCD = 0.35–0.41) and encrusting base. Holotype 14.3 × 13.0 mm in calicular diameter and 24.7 mm in height, with a pedicel diameter of 5.0 mm; largest specimen (NZOI Stn K840) 16.5 × 13.8 mm in calicular diameter and 31.4 mm in height. Calice slightly elliptical: GCD: LCD = 1.1–1.2. Theca uniformly covered with thin transverse ridges, 6–7 horizontal ridges per mm of theca. Thecal ridges sometimes better developed on lower half of corallum and encrusting base, but often present up to calicular edge. Corallum usually white, but two coralla (NZOI Stn C527) display a brown colouration on the upper edges of their S1–2 and associated C1–2.

Septa hexamerally arranged in 4 complete cycles (48 septa) according to the formula: S1>S2>S3>S4, only specimens below a GCD of 6.5 mm having an incomplete fourth cycle. S1 highly exsert (up to 3.2 mm) with sinuous (low amplitude, high period) inner edges that reach the columella. S2 less exsert (about 2.8 mm), about three-quarters width of an S1, and have the most sinuous inner edges of all 4 cycles (higher amplitude and shorter period than S1). S3 and S4 equally exsert (about 1.2 mm), each about three-quarters width of next lower cycle septa, and have only slightly sinuous inner edges. Fossa of moderate depth, containing a closely grouped, elliptical to elongate mass of discrete, slender (0.5–0.7 mm in diameter), twisted elements (a fascicular columella).

Types: Holotype: NZOI Stn Q70, NZOI H-625. Paratypes: NZOI Stn C527, 19, USNM 94125; Stn K826, 1, NZOI P-1014; Stn K840, 2, NZOI P-1015; Stn Q70, 1, USNM 94124.

TYPE LOCALITY: 26°59.7' S, 159°18.9' E (Lord Howe Seamount Chain), 376 m.

ETYMOLOGY: The species name *rugosus* (Latin *ruga*, wrinkled) refers to the fine transverse thecal ridges of this species.

REMARKS: *Crispatotrochus rugosus* is distinguished from its congeners that have four cycles of hexamerally arranged septa (see previous account) by having a distinctively transversely ridged theca and by having S2 that are less exsert and less wide than their S1. In all other species of *Crispatotrochus*, S1 and S2 are of equal size. *Labyrinthocyathus limatulus* is a similar species — having a transversely ridged theca, the same number of septa, and occurring at some of the same stations — but is distinguished by its maze-like columella and the equality of its S1 and S2.

Labyrinthocyathus Cairns, 1979

Corallum solitary, ceratoid to subcylindrical, and attached. Costae usually poorly defined or composed of transverse epithelial ridges. Pali absent; columella composed of an interconnected maze of lamellar plates.

TYPE SPECIES: *Labyrinthocyathus langae* Cairns, 1979, by original designation.

REMARKS: *Labyrinthocyathus* is quite similar to *Crispatotrochus*, differing primarily in its distinctive columellar structure, *Labyrinthocyathus* has a lamellar-maze columella, whereas *Crispatotrochus* has a fascicular columella. Eight species are recognised in the genus (see Cairns 1994), including three fossil species. A ninth, unnamed species is discussed below as *Labyrinthocyathus* sp. The genus is known from Eocene to recent and is widespread in tropical to temperate regions.

Labyrinthocyathus limatulus (Squires, 1964)
(Plate 13, c-f)

Ceratotrochus (*Ceratotrochus*) *limatulus* Squires, 1964b: 3–5, pl. 1, figs 5–9; Squires & Keyes 1967: 24, pl. 2, figs 9–10.

Labyrinthocyathus limatulus: Cairns 1979: 70.

MATERIAL EXAMINED: New Records: NZOI Stn C527, 4, NZOI; Stn I94, 2, USNM 94127; L1056, 1, AIM AK78393; L1057, 1, AIM AK76085; RV *Franklin* Stn 5/89/40, 3, AMS G15570, 1, USNM 94128; 7 km northeast of the Aldermen Islands (topotypic), 102 m, 2, MoNZ; 7.2 km northeast of the Aldermen Islands (topotypic), 102 m, 26, AUM. Previous Records: Type series of *C. limatulus*.

DISTRIBUTION: Lord Howe Seamount Chain; off Norfolk Island; off Three Kings Islands; southern Kermadec Ridge; off Alderman Islands (Map 17); 20–508 m.

DESCRIPTION: Corallum ceratoid to subcylindrical, attached through a robust pedicel (PD: GCD = 0.37–0.89) and stereome-reinforced base. Largest specimen examined (AMS G15570) 12.8 x 12.1 mm in calicular diameter and 18.9 mm in height, with a pedicel diameter of 5.5 mm. Calice circular to slightly elliptical (GCD: LCD = 1.0–1.1). Theca of basal third of large specimens distinctively transversely ridged; however, ridges on theca of middle third of corallum quite faint, and on upper third of large coralla the transverse sculpturing consists

merely of rows of horizontally aligned granules. Theca relatively thick; corallum white.

Septa hexamerally arranged in 4 cycles according to the formula: S1–2>S3>S4. Coralla 2–3 mm in GCD have only 3 cycles of septa, and those above 6 mm GCD usually have 4 cycles; however, pairs of S4 are sometimes missing resulting in 44 or 46 septa. S1–2 0.8–1.6 mm exsert and have highly sinuous inner edges that almost attain the columella. S3 0.5–0.8 mm exsert, about four-fifths width of an S1–2, and have moderately sinuous inner edges. S4 only 0.3–0.4 mm exsert, one-quarter to three-quarters width of an S3, and have only slightly sinuous inner edges. Fossa shallow to moderate in depth and contains a rather large columella that is elliptical in shape, composed of a maze of interconnected lamellae.

TYPES: The holotype and 12 paratypes of *C. limatulus* are deposited at the AIM. Ten paratypes are also deposited at the USNM (68260).

TYPE LOCALITY: 7.2 km northeast of the Aldermen Islands, off Coromandel Peninsula; 102 m.

REMARKS: *Labyrinthocyathus limatulus* is the only species in its genus to have a transversely ridged theca. The specimens reported herein are the first records of this rarely collected species subsequent to its description. One specimen (AMS G15570) bears an ascothoracid cavity in its theca, which caused the coral to wall off a section of the fossa (Plate 13, c, d).

Labyrinthocyathus sp. (Plate 13, g, h)

MATERIAL EXAMINED: NZOI Stn D159, 1, NZOI; Stn G941, 2, USNM 94129; Stn R439, 1, NZOI.

DISTRIBUTION: Hikurangi and Solander Troughs (Map 6); 665–1000 m.

DESCRIPTION: Corallum ceratoid, straight, and attached through a robust pedicel 0.35–0.45 GCD. Corallum small: 5.0–6.8 mm in circular calicular diameter and only 7.6–10.5 mm in height. Theca smooth or weakly costate and granular. Theca relatively thick; corallum white. Septa hexamerally arranged in 3 complete cycles (24 septa) according to the formula: S1>S2>S3. S1 only slightly exsert and have very sinuous inner edges that almost attain the columella. S2 less exsert, about three-quarters width of an S1, and have moderately sinuous inner edges. S3 about three-quarters width of an S2 and have only slightly

sinuous inner edges. Fossa of moderate depth, containing a rudimentary maze-like columella composed of lamellar to T-shaped columellar elements that are just beginning to fuse together.

REMARKS: *Labyrinthocyathus* sp. differs from *L. limatulus* in lacking a transversely ridged theca and in having fewer septa at a corresponding calicular diameter (neoteric). Specimens of *Labyrinthocyathus* sp. have only 24 septa even at a GCD of 6.8 mm, a size at which *L. limatulus* would have 44–48 septa. *Labyrinthocyathus* sp. also appears to have a slightly deeper bathymetric range and a more southerly distribution.

Polycyathus Duncan, 1876

Corallum colonial, cylindrical corallites basally united by a common coenosteum or by stolons. Septo-theca costate. Three to four cycles of septa; pali present before all but last cycle; columella papillose.

TYPE SPECIES: *Polycyathus atlanticus* Duncan, 1878, by monotypy.

REMARKS: There are approximately 16 species in *Polycyathus*, most listed and discussed by Wijsman-Best (1970) and Verheij and Best (1987). All species are characteristic of relatively shallow-water (less than 100 m) cave environments. Verheij and Best (1987) place the genus in the Rhizangiidae because of its similarity to *Astrangia*, but its septal and palmar morphology seem to be more consistent with the Caryophylliids, especially *Trochocyathus*.

Polycyathus norfolkensis n. sp. (Plate 16, g, h)

MATERIAL EXAMINED: Types, q.v.

DISTRIBUTION: Known only from caves and shaded overhangs off Norfolk Island; 10–20 m.

DESCRIPTION: Colonies consist of ceratoid to cylindrical corallites up to 12 mm in height, each corallite budding from a common basal coenosteum (not reptoid) or from the lower theca of a parent corallite. Holotypic colony consists of 9 corallites all united laterally or basally. Calices circular to slightly elliptical in shape, up to 4.2 mm in GCD. Costae about 0.5 mm wide, only slightly convex, and separated by very shallow, narrow (about 0.1 mm) intercostal striae. Costae covered with low, rounded granules,

2 or 3 occurring across the width of a costa. Costae usually well developed only on upper half to third of corallite, the lower portion usually encrusted with calcareous polychaetes, foraminiferans or bryozoans. Corallum white.

Septa hexamerally arranged in 3 complete cycles (S1>S2–3), a juvenile specimen 0.8 mm in diameter having only 12 septa, but all other specimens examined between a GCD range of 1.6–4.2 having 24 septa. S1 0.5–0.7 mm exsert, extend about half distance to columella, and have entire, slightly sinuous inner edges. Each S1 bears a small, cylindrical (0.15 mm in diameter) paliform lobe. S2–3 equal in size (about three-quarters width of an S1) and slightly less exsert than the S1. Inner edges of S2–3 of small corallites are usually dentate to lacinate; however, when the corallite matures (e.g., > 3.0 mm GCD) these septal edges become entire like the S1. Each S2 bears a lamellar palus that is about twice the thickness and width of a P1, slightly more recessed from the columella, and usually slightly taller than a P1. Outer edges (adjacent to S2) of P2 are thickened and highly granular. Together, the 12 P1–2 form a single irregular palmar crown. Fossa shallow, containing the palmar crown and a small papillose columella consisting of 1–5 cylindrical (0.1 mm in diameter) elements.

TYPES: Holotype: L4622, a colony of 9 corallites, AIM AK72401. Paratypes: L4620, 9 corallites composing 6 coralla, AIM AK72403; L4621, 11 corallites composing 3 coralla, AIM AK72404; L4622, 6 corallites composing 3 coralla, USNM 94592, L4623, 22 corallites composing 11 coralla, AIM AK72402.

TYPE LOCALITY: West side of Nepean Island, Norfolk Island (roof of cave at 15 m).

ETYMOLOGY: This species is named for its type locality.

REMARKS: According to Verheij and Best (1987), two previously described species of *Polycyathus* have only three cycles of septa: *P. hondaensis* (Durham & Barnard, 1952), known from Pacific Panama and the Galápagos; and *P. hodgsoni* Verheij & Best, 1987, known from the Philippines and Maldive Islands. *Polycyathus norfolkensis* differs from both species in having dimorphic pali (P2>P1) and a low number of columellar elements (1–5 vs 10–15 for the other two species). It is further distinguished from *P. hodgsoni* by larger corallites, and from *P. hondaensis* by having S2 and S3 of equivalent size and in lacking ornate septal granulation (see Cairns 1991a).

Trochocyathus Milne Edwards & Haime, 1848a

Corallum solitary, turbinate to ceratoid or bowl-shaped, fixed or free. Septotheca costate, sometimes covered with a thin epitheca. Discrete pali before all but last cycle of septa; columella papillose.

REMARKS: Three subgenera are recognized: the nominate subgenus, *T. (Aplocyathus)*, and *T. (Platycyathus)*. Species of the first two subgenera are represented in the New Zealand region.

Trochocyathus (Trochocyathus) Milne Edwards & Haime, 1848a

Trochocyathus lacking basal costal spines and with other than discoidal coralla (e.g., turbinate, ceratoid, or bowl-shaped). Most species attached, but several species are known to asexually divide transversely resulting in free anthocyathi. P1–2 usually form innermost and lowest palar crown; P3 form a second, higher crown; and P4, if present, form an even higher, more recessed crown. Columella papillose.

TYPE SPECIES: *Turbinolia mitrata* Goldfuss, 1827, by subsequent designation (Milne Edwards & Haime, 1850: xiv).

REMARKS: Species of *Trochocyathus* and *Paracyathus* have been interchanged by many authors. In this account I follow the distinction described by Cairns (1979), i.e., species of *Trochocyathus* bear discrete pali arranged in crowns, whereas species of *Paracyathus* bear multilobate paliform lobes that are usually indistinguishable from columellar elements. Nineteen recent species are attributed to this subgenus: *T. philippinensis* Semper, 1872; *T. rawsonii* Pourtales, 1874; *T. cinctulatus* (Alcock, 1898); *T. caryophylloides* Alcock, 1902a; *T. rhombocolumna* Alcock, 1902a; *T. rawsonii sensu* Gardiner (1904); *T. cooperi* (Gardiner, 1905); *T. mauiensis* (Vaughan, 1907); *T. oahensis* Vaughan, 1907; *T. gardineri* (Vaughan, 1907); *T. japonicus* Eguchi, 1968; *T. fossulus* Cairns, 1979; *T. fasciatus* Cairns, 1979; *T. aithoseptatum* Cairns, 1984; *T. sp. A sensu* Cairns & Keller (1993); *T. decamera* Cairns, 1994; *T. maculatus* n. sp.; *T. gordonii* n. sp.; and *T. cepulla*, n. sp.

Trochocyathus (T.) rhombocolumna Alcock, 1902
(Plates 13, i, 14, a, b)

Trochocyathus (Thecocyathus) rhombocolumna Alcock, 1902a:

98; 1902c: 16, pl. 2, fig. 12.

Paracyathus tenuicalyx Vaughan, 1907: 69–70, pl. 6, figs 1a–b (new synonym).

Paracyathus gardineri: Gardiner & Waugh, 1938: 183–184 (in part: *John Murray* Stn 157, pl. 3, fig. 5).

Trochocyathus rhombocolumna: Cairns & Keller, 1993: 240.

MATERIAL EXAMINED: New Records: NZOI Stn N897, 3, NZOI; Stn S572, 7, USNM 94100; RV *Franklin* Stn 47, 1, AMS G15493 (Britannia Seamount). Previous Records: holotypes of *P. tenuicalyx* and *T. rhombocolumna*.

DISTRIBUTION: New Zealand region: Lord Howe Seamount Chain (Britannia Seamount); Three Kings Ridge; southern Kermadec Ridge (Map 19); 419–530 m. Elsewhere: off southwestern Mozambique; Maldives Islands; Sulu Sea; and Hawaiian Islands; 110–522 m.

DESCRIPTION: Corallum ceratoid, straight, and attached through a robust pedicel 0.34–0.56 GCD. Largest New Zealand specimen (NZOI Stn S572) 14.4 × 12.1 mm in calicular diameter and 19.6 mm in height, with a pedicel diameter of 4.8 mm. Entire theca, from base to calice, covered with small, transverse ridges, each ridge 0.18–0.20 mm wide. Corallum white.

Septa hexamerally arranged in 4 complete cycles according to the formula: S1>S2>S4>S3. S1 moderately exsert (about 2.1 mm) and quite thick (up to 0.8 mm), with straight inner edges that extend about four-fifths distance to columella. S2 slightly less exsert (about 1.9 mm), less wide (four-fifths of an S1), and also with straight inner edges. S3 about 1.6 mm exsert, three-quarters width of an S2, with slightly sinuous inner edges. S4 least exsert septa (about 1.3 mm) but slightly wider than the S3, each S4 adjacent to an S1 being wider than those adjacent to an S2. A crown of 6 small (about 0.5 mm wide) pali occur before the S1 low in the fossa. Six wider pali (about 0.9 mm wide) occur before the S2, their upper edges rising higher than those of the P1. A third crown of 12 large pali occur before the S3, each P3 1.4–1.5 mm wide and rising higher in the fossa than the P2. Inner edges of all pali straight, those of the P1–2 being directly adjacent to columella, those of the P3 slightly recessed from the columella. Fossa of moderate depth. Columella variable, composed of 4 or 5 coarse papillae or several solid, irregularly shaped elements moulded into a medial line or a rhomboidal shape.

TYPES: The holotype of *T. rhombocolumna* is deposited at the ZMA (Coel. 1327). The holotype of *P. tenuicalyx* is deposited at the USNM (20755).

TYPE LOCALITIES: *T. rhombocolumna*: Siboga Stn 95, 5°43.5' N, 119°40' E (Sulu Sea), 522 m. *P. tenuicalyx*: Albatross Stn 3895, 20°59'45 N, 157°19'20 W (off Molokai, Hawaiian Islands), 460–784 m.

REMARKS: The New Zealand specimens of *T. rhombocolumna* differ from those previously reported by having larger coralla and better developed thecal striations. In the non-New Zealand specimens, the transverse thecal ridges occur only on the basal half to third of the corallum, the upper theca bearing convex granular costae separated by thin, deep intercostal striae. It is believed that with increase in size, the granular costae and intercostal striae are gradually covered with an epitheca that bears transverse ridging, until no evidence of costae is present in large specimens. The holotype of *P. tenuicalyx* is an example of such a juvenile specimen (GCD = 8.5 mm) in which only the lower half of the theca bears transverse ridges.

Among the recent species of *Trochocyathus*, only two have transverse thecal ridges: *T. cinctulatus* (Alcock, 1898) and *T. rhombocolumna*. Specimens of *T. cinctulatus* have not been examined but that species was described as having a 9–10 part symmetry, its illustration looking suspiciously like *Caryophyllia rugosa*.

***Trochocyathus (T.) maculatus* n. sp.** (Plate 14, c, d)

MATERIAL EXAMINED: Types, q.v.

DISTRIBUTION: Kermadec Islands (off Raoul and Curtis); off Lord Howe Island; Taupo Seamount and Dam-pier Ridge west of Lord Howe Island (Map 19); 100–183 m.

DESCRIPTION: Corallum ceratoid and straight, attached by a broad pedicel 0.60–0.75 GCD. In cross section the pedicel appears to be polycyclic, but the thecal rings are instead produced by the formation of thin exothecal dissepiments over raised basal costae. Largest specimen (NZOI Stn K851) 13.8 x 11.7 mm in calicular diameter and 14.1 mm in height, with a pedicel diameter of 9.6 mm. Calice elliptical (GCD: LCD = 1.17–1.25) and lacerate, caused by the projection of 6 highly exsert septal lancets. Costae well defined only on upper half of corallum, where they are slightly convex and granular, separated by deep intercostal furrows only near the calice. Costal definition fades on lower half of corallum to a fine uniform granulation. Theca thin (about 0.2 mm), which results in a light corallum. Corallum white,

but theca and all septa (but not pali) mottled with dark-brown pigment.

Septa hexamerally arranged in 4 cycles and sometimes part of a fifth. Specimens 7.7–12.2 mm in GCD usually have 48 septa; one of 11.8 mm GCD has 58 septa; and the largest specimen of 13.8 mm GCD has 64 septa (8 pairs of S5). S1 highly exsert (2.5–2.7 mm) and have straight, vertical inner edges that extend almost to columella, each having a small (0.5 mm wide) palus deep in fossa. S2 less exsert (about 2.2 mm) and about three-quarters width of an S1, each S2 having a slightly sinuous inner edge that bears a narrow palus equal in width to the P1 but rising higher in the fossa. S3 least exsert septa (about 1.9 mm), about three-quarters width of an S2, and have slightly sinuous inner edges. P3 over twice as wide as P1–2 and project higher in the fossa. S4 that are adjacent to S1 are slightly more exsert and equal to or slightly wider than an S3, each pair of S4 flanking an S1 fusing with that septum in a triangular lancet. S4 that are adjacent to S2 are less exsert and less wide than an S3. If pairs of S5 are present, they are usually wider than the S4 they flank, and the corresponding P4 is equal in width to a P3 but rises even higher in the fossa and is more recessed from the columella. P4 occasionally dissected into 2–4 smaller lobes. Inner edges of P3–4 coarsely dentate, the dentition merging imperceptibly with the columellar elements. Fossa of moderate depth, containing an elliptical field of 20–30 fine (about 0.3 mm in diameter) papillae.

TYPES: Holotype: NZOI Stn P115, NZOI H-626. Paratypes: NZOI Stn K826, 1, NZOI P-1016; Stn K851, 2; USNM 94101; Stn Q46, 1, USNM 94102; Stn T233, 1, NZOI P-1017; RV *Franklin* Stn 5/89/5, 1 AMS G15504.

TYPE LOCALITY: 31°25.9' S, 159°02.2' E (off Lord Howe Island), 183 m.

ETYMOLOGY: The species name *maculatus* (Latin *maculatus*, spotted) refers to the mottled black pigmentation of the corallum.

REMARKS: Although two other species of *Trochocyathus* have pigmented coralla (*T. virgatus* and *T. aitho-septatum*), *T. maculatus* is distinguished by its discontinuous, "spotty" pigmentation. It also appears to be unique within the genus by increasing in basal diameter by producing exotheca over raised costae, which produces partitioned concentric basal rings as in *Rhizosmilia*.

Trochocyathus (T.) gordonii n. sp. (Plate 14, e-g)

MATERIAL EXAMINED: Types, q.v.; NZOI Stn T256, 1 poorly preserved specimen, NZOI.

DISTRIBUTION: Known only off the Kermadec Islands from north of Raoul to Curtis Island (Map 20); 398–710 m.

DESCRIPTION: Corallum ceratoid, straight to slightly cornute (curvature usually $< 45^\circ$), and attached by a slender pedicel only 1.5–3.0 mm in diameter, or 0.14–0.33 GCD. Largest corallum (holotype) 12.8 x 11.2 mm in calicular diameter and 17.2 mm in height, with a pedicel diameter of 2.5 mm. Calice elliptical: GCD: LCD = 1.10–1.25. Costae well defined only near calicular edge, where they are 0.6–0.8 mm wide, rounded, and separated by deep intercostal furrows about 0.2 mm wide. Lower two-thirds to three-quarters of theca granular, the costal definition gradually fading toward base. Costal granules small and rounded, 4 or 5 occurring across a costae near the calice. Corallum white or yellowish-brown.

Coralla above a GCD of 4 mm consistently have 3 cycles of decamerally arranged septa (10:10:20 = 40 septa); the symmetry of smaller specimens is hexamerall, often 6:6:12 = 24 septa. Primary septa moderately exsert (about 2.5 mm) and have slightly sinuous inner edges that extend three-quarters distance to columella. A crown of 10 rather slender (0.7–0.9 mm wide) pali adjoin the primary septa. These pali have slightly sinuous inner edges and oblique carinae on their faces. Both secondary and tertiary septa equally exsert (about 1.7 mm) and are about three-quarters width of a primary septum. A crown of 10 pali occur before the secondary septa, these pali about twice the width of the P1 and rise about 1 mm higher in the fossa than those before the primary septa; they also bear prominent, oblique, carinate paler faces. Thus, 2 crowns of pali are present, the inner edges of both crowns extending an equal distance to the columella, but the P2 being wider and higher in the fossa. Each pair of tertiaries flanking a primary septum form low lancets with their common primary septum. Fossa of moderate depth containing an elliptical papillose columella composed of 10–15 highly granular elements that are closely fused to one another.

TYPES: Holotype: NZOI K828A, NZOI H-627. Paratypes: NZOI Stn K828A, 91, NZOI P-1018, 20, USNM 94104; Stn K840, 3, NZOI P-1019; Stn K859, 18, NZOI P-1020.

TYPE LOCALITY: 28°35.4' S, 177°50.7' W (north of Raoul Island), 440–510 m.

ETYMOLOGY: This species is named in honour of Dennis P. Gordon of NZOI, who encouraged and facilitated my study of the New Zealand Scleractinia.

REMARKS: Among the 19 recent species of *Trochocyathus* listed in the generic remarks, only two have decamerally arranged septa: *T. decamera* Cairns, 1994 (Japan, 70–88 m) and *T. gordonii*. *Trochocyathus gordonii* differs from *T. decamera* in attaining a much larger size, having a much smaller PD: GCD, lacking the thin epitheca characteristic of *T. decamera*, and in having tertiary septa of equal (not greater) width than the secondaries. Aside from septal symmetry, *T. gordonii* differs from most other species of *Trochocyathus* in having only two size classes of pali; most hexamerally symmetrical species have three size classes (P1, P2, and P3), the P2 and two P3 in each system forming a chevron-shaped pattern.

Trochocyathus (T.) cepulla n. sp. (Plate 15, a, b)

Trochocyathus sp. Sieg & Zibrowius, 1989: 192, fig. 1k-m.

MATERIAL EXAMINED: Types, q.v.

DISTRIBUTION: New Zealand region: Kermadec Islands (Macauley Island) and southern Norfolk Ridge (Wanganella Bank) (Map 11); 398–449 m. Elsewhere: off New Caledonia; 570–610 m.

DESCRIPTION: Anthocyathus unattached and irregular in shape, including hemispherical to cylindrical, the corallum sometimes horizontally constricted prior to transverse division. Base of anthocyathus flat to slightly convex, showing no overt scar of detachment. Largest anthocyathus examined (holotype) 10.5 x 9.4 mm in calicular diameter and 12.0 mm in height, with a basal diameter of 8.5 mm and slight thecal constriction 3.6 mm above base. Calice slightly elliptical (GCD: LCD = 1.11–1.13) and usually slightly smaller than the maximum calicular diameter (i.e., the corallum at calice level curves inward resulting in a lesser diameter). Costae well defined only at calicular edge where they are separated by shallow furrows; otherwise costae are broad (0.7–0.8 mm wide), flat, finely granular (5 or 6 granules across a costa), and bordered by very thin, shallow intercostal striae. Only one anthocaulus is known, measuring 6.1 x 5.5 mm in calicular di-

ameter and 5.4 mm in height, and being cylindrical in shape. Theca quite thick, about 1 mm wide, and of a uniformly light brown colour.

Septal symmetry quite irregular in the 4 specimens examined, but the basic pattern seems to be that of 4 cycles of hexamerally arranged septa: S1>S2>S3>S4. The small anthocaulus has only 42 septa, whereas the 3 anthocyathi have 44, 48, and 49 septa. Septal systems within each corallum show uneven levels of development; a corallum may have a system with 1, 2, or no pairs of S4, or even 2 pairs of S4 and a pair of S5. S1 about 2 mm exsert with slightly sinuous inner edges that extend about three-quarters distance to columella and are internally bordered by a small palus 0.7–0.8 mm wide. S2 only slightly less exsert and slightly less wide (0.8–0.9 width of an S1) and also have slightly sinuous inner edges, each of which is bordered by a wider (1.1–1.4 mm) and slightly taller palus. S3 about 0.9 width of an S2 and have sinuous inner edges, each bordered by a P3 of equal width to a P2 but slightly recessed from the columella and rising higher in the fossa. S4 about 0.9 width of an S3 and have thin straight inner edges. Fossa very shallow, the paralar (P3) and columellar elements rising to the calicular edge. Columella composed of an elliptical field of 14–25 tuberculate papillae, each 0.3–0.6 mm in diameter.

TYPES: Holotype: NZOI Stn P13, NZOI H-628. Paratypes: NZOI Stn K840, 1 P-1021, USNM 94094; Stn P13, 2 P-1022, USNM 94095.

TYPE LOCALITY: 32°10.5' S, 167°21.2' E (Wanganella Bank, southern Norfolk Ridge), 449 m.

ETYMOLOGY: The species name *cepulla* (Latin *cepa* diminutive *cepulla*, small onion) refers to the onion-like shape of some of the coralla of this species.

REMARKS: Among the 19 recent species in this subgenus (see subgeneric remarks), three are known to reproduce asexually by transverse division: *T. cooperi* (Gardiner, 1905), *T. gardineri* (Vaughan, 1907), and *T. cepulla*. *Trochocyathus cooperi* is easily distinguished by its compressed calice and downward projecting thecal edge spines, but *T. cepulla* and *T. gardineri* (Hawaiian Islands, 274–470 m) are quite similar and may be sister species. In general, the two species are similar in shape and septal complement, but *T. cepulla* differs in having a much thicker theca and incurved calicular edge. Furthermore, *T. cepulla* has a very irregular septal symmetry (the hexameral symmetry of *T. gardineri* is easily distin-

guished), a smaller corallum size, a shallower fossa, and S4 that are smaller than their S3 (in *T. gardineri* the S4 adjacent to S1 are wider than the adjacent S3).

Trochocyathus (Aplocyathus) d'Orbigny, 1849

Coralla bowl-shaped and unattached. Coralla bear one or more basal costal spines on 5 or 6 of its C1. Pali occur before all but last cycle of septa. Columella papillose.

TYPE SPECIES: *Turbinolia armata* Michelotti, 1838, by monotypy.

REMARKS: Most of the approximately eight species in this subgenus occur in the Eocene to Miocene of Italy (see Chevalier 1961), Caribbean, and California; only one described recent species is known: *T. (A.) hastatus*. Wells (1984) placed this species in the subgenus *Stephanocyathus (Acinocyathus)*, and Bourne (1903) considered *S. stella* and *S. sexradii* (= *S. (Acinocyathus) spiniger*) to be congeneric with *T. hastatus*. There is little doubt that *Trochocyathus (Aplocyathus)* and *Stephanocyathus (Acinocyathus)* are quite similar and may even be identical; the only difference I can discern is that *Acinocyathus* has broad paliform lobes, whereas *Aplocyathus* has narrower pali.

Trochocyathus (A.) hastatus Bourne, 1903 (Plate 15, c-h)

Trochocyathus hastatus Bourne, 1903: 29–32 (in part: pl. 5, figs 2–5, not pl. 6, figs 8–11, = *Bourneotrochus stellulatus*). *Stephanocyathus (Acinocyathus) hastatus*: Wells 1984: 213.

MATERIAL EXAMINED: New Records: NZOI Stn K828, 4, USNM 94111; Stn K859, 1, NZOI; Stn K860, fragment, USNM 94112; Stn T225, 1, USNM 94113; Stn T256, 3, NZOI. Previous Records: 2 syntypes at AMS.

DISTRIBUTION: New Zealand region: Kermadec Islands from north of Raoul to off Curtis Island (Map 21); 460–710 m. Elsewhere: off Tutanga, Funafuti, Tuvalu; 366 m.

DESCRIPTION: Corallum bowl-shaped, the base flat to evenly rounded, sometimes with a scar of former substrate attachment visible at centre of base. Largest specimen known (specimen "A" of Bourne 1903) 18 × 16 mm in calicular diameter; largest New Zealand specimen (NZOI Stn T225) 16.7 × 13.6 mm

in calicular diameter and 11.4 mm in height. Calice elliptical: GCD: LCD = 1.07–1.27. Costae well-defined in upper corallum, 0.5–0.6 mm wide, rounded, and separated by relatively deep intercostal furrows about 0.3 mm wide. On lower half of corallum intercostal furrows become shallow striae, and on corallum base costae are replaced by a smooth, porcellanous theca. Costae near calice covered with very small (30–40 μ m) pointed granules, 6 or 7 occurring across a costa. In all specimens examined, 5 elongate (up to 15 mm), slender, tapered (2.2 mm to 0.4 mm) costal spines project almost horizontally from the perimeter of the base. A spine corresponds to 5 of the 6 C1, 1 missing from one of the 2 principal C1 aligned with the greater calicular axis. Lower half of corallum, pali, and columella white; however, upper outer regions of all septa and adjacent theca of upper corallum dark brown.

Septa hexamerally arranged in 4 complete cycles (48 septa), even at a GCD of only 12 mm. S1 highly exsert (up to 4.5 mm), quite thick (about 1.2 mm), and have straight, vertical inner edges, except for the principal S1 associated with the missing costal spine, which is slightly less exsert and less wide than an S2. S2 about three-quarters as exsert and half as wide as an S1, and have finely sinuous inner edges. S3 about two-thirds as exsert and three-quarters as wide as an S2, and also have finely sinuous inner edges. S4 adjacent to S1 slightly more exsert and wider than S3, whereas S4 adjacent to S2 are slightly less exsert and less wide than an S3. Inner edges of S4 straight. A crown of 6P1, 6P2, and 12P3 encircle the columella, the inner edges of all pali reaching the same distance toward the columella but each cycle having a different width: P1 0.6–0.8 mm wide, P2 about 1.2 mm wide, and P3 about 2.2 mm wide, each paler cycle projecting slightly higher in the fossa as well. Fossa of moderate depth; columella consists of 7–13 small (0.4–0.5 mm in diameter) papillae that are laterally fused to one another.

TYPES: Bourne (1903) mentioned eight specimens in his original account of the species, five referred to as specimens A–E and three additional specimens received after the paper had gone to press, all of which must be considered as syntypes. Two syntypes (specimens B and D) are deposited at the AMS (G14462–3); three are deposited at the BM(NH) (1903.12.1.2–4); and the deposition of the remaining specimens is unknown. The three added specimens are a different species, named *Bourneotrochus veroni* by Wells (1984).

TYPE LOCALITY: Off Tutanga, Funafuti, Tuvalu, 366 m.

REMARKS: Of the 14 complete specimens known of this species, 13 have five costal spines and only one (Bourne 1903: pl. 5, fig. 5) has six costal spines. This apparent discrepancy between hexamerally arranged septa and pentamerally arranged costal spines is diagnostic for the species and may be unique among the Scleractinia. *Trochocyathus* (*A.*) *armatus* (Michelotti, 1838) also has only five costal spines, but its septa are also pentamerally arranged, resulting in 40 septa. The records reported herein are believed to be the first report of this species since its description.

Tethocyathus Kühn, 1933

Corallum solitary, ceratoid to subcylindrical, fixed or free; if attached, base polycyclic. Septotheca covered by a thick epitheca. Discrete paliform lobes present before all but last cycle of septa: an inner crown (P1–2) and an outer, upper crown (P3). Columella papillose.

TYPE SPECIES: *Thecocyathus microphyllus* Reuss, 1871, by original designation.

REMARKS: The difference between *Trochocyathus* and *Tethocyathus* is quite small, *Tethocyathus* being distinguished by having a thick epitheca (Chevalier 1961; Cairns 1979; Zibrowius 1980). According to Zibrowius (1980) this character has little taxonomic weight and according to Cairns (1979) it is an unreliable generic level character. The genus is nonetheless provisionally maintained pending a revision of the larger *Trochocyathus-Paracyathus-Tethocyathus* species complex. The five species provisionally assigned to *Tethocyathus* are: *T. cylindraceus* (Pourtalès, 1868), *T. microphyllus* Reuss, 1871 (type species); *T. recurvatus* (Pourtalès, 1878); *T. virgatus* (Alcock, 1902a); and *T. variabilis* Cairns, 1979.

Tethocyathus cylindraceus (Pourtalès, 1868)

(Plates 15, i-k, 16, a, b)

Thecocyathus cylindraceus Pourtalès, 1868: 134.

Trochocyathus (*Thecocyathus*) sp. Gardiner 1929: 126; Ralph & Squires 1962: 17; Squires & Keyes 1967: 29.

Not *Paracyathus conceptus* Gardiner & Waugh, 1938: 184–185, pl. 4, figs. 8–9; Wells 1964: 113, pl. 1, figs. 11–12.

Paracyathus conceptus: Ralph & Squires 1962: 7–8, pl. 2, figs. 3–4; Squires & Keyes 1967: 23 (in part: Not NZOI

Stn C627, C648, or pl. 2, figs 7–8); Dawson 1979: 30 (in part: NZOI Stn A904, C814).

Tethocyathus cylindraceus: Cairns 1979: 83–84, pl. 13, figs 8–11 (synonymy).

MATERIAL EXAMINED: New Records: NZOI Stn A804, 2, USNM 94090; Stn C777, 5, NZOI; Stn C814, 7, USNM 94087; Stn F933, 2, NZOI; Stn I375, 1, USNM 94089; BS402, 1, MoNZ CO105; BS682 (R40), 2, MoNZ CO296; BS770 (R128), 11, MoNZ CO308; BS843 (O589), 1, MoNZ CO216; BS856 (O.602), 1, MoNZ CO277; BS898 (O644), 2, MoNZ CO288; BS899 (O645), 5, MoNZ CO298; north side of Poor Knights Island, 10 m, 5, NZGS; L3071, 64, AIM AK78395. Previous Records: Specimens reported by Gardiner (1929), Ralph and Squires (1962), and Squires and Keyes (1967); syntypes of *T. cylindraceus*.

REFERENCE MATERIAL: 12 syntypes of *Paracyathus conceptus*, BM(NH) 1950.1.9.839–850, 859–867.

DISTRIBUTION: New Zealand region: off northeastern New Zealand from Three Kings Islands to Hawke Bay (Map 9); usually found in cave environments in shallow water, e.g., Rikoriko Cave on Aorangi Island, Poor Knights Islands, 5–327 m. Elsewhere: Straits of Florida; off Jamaica; Barbados; 155–649 m (Cairns 1979).

DESCRIPTION: Corallum ceratoid to subcylindrical, usually straight, and attached through a robust pedicel (PD: GCD = 0.45–0.85) and polycyclic base. Largest specimen examined 11.5 mm in calicular diameter and 15.4 mm in height, with a pedicel diameter of 7.5 mm. Calice circular to slightly elliptical. Most coralla bear a thick, transversely striate epitheca that completely obscures the underlying costae; however, in some larger specimens the epi-theca is confined to the upper half of the corallum and in some small coralla this epitheca is poorly developed or not yet developed. But in most coralla the epitheca is so well developed that it forms a small rim or lip encircling the calice, resulting in a shallow circular groove between the upper, outer septal edges and the epitheca. When costae are visible, they are rounded and finely granular, the intercostal striae also bearing a row of fine granules. Theca relatively thick. Corallum white; polyps pale green (F. Brook, pers. comm.).

In all specimens examined septa are hexamerally arranged in 4 cycles according to the formula S1>S2>S3>S4, but pairs of S4 are sometimes missing in coralla less than 7 mm in GCD. Septa little exsert: S1–3 1.0–1.7 mm exsert, the S4 only about 0.8 as exsert. S1 thick with slightly sinuous inner edges, extending about three-quarters dis-

tance to columella. S2 equally as thick and only slightly less wide than an S1, also with slightly sinuous inner edges. S3 slightly less thick and about 0.8–0.9 as wide as an S2, with slightly more sinuous edges than the S1–2. S4 relatively thin (0.7–0.8 width of an S3) with straight to slightly sinuous inner edges. An inner crown of 12 P1–2 occurs low in the fossa, both cycles of pali 0.7–0.8 mm wide, but P2 thicker than P1. A second crown of 12 P3 occurs slightly higher in the fossa and recessed from the columella, each P3 about 0.3 mm wide, thick, sometimes with a bifurcate outer edge. In each system, a triad of 2 P3 and 1 P2 form in a chevron-shaped configuration, characteristic of most species of *Trochocyathus* and *Tethocyathus*. Fossa of moderate depth, containing a papillose columella consisting of 12–20 slender (about 0.5 mm in diameter), smooth rods.

TYPES: Thirteen syntypes of *T. cylindraceus* are deposited at the MCZ (2763, 5611).

TYPE LOCALITY: "Off Florida Reefs" (= Straits of Florida), 183–366 m.

REMARKS: Although the New Zealand specimens of *T. cylindraceus* are far removed from any previously reported, no differences were found among them and the syntypes and other specimens reported from the western Atlantic (Cairns 1979). *Paracyathus conceptus* Gardiner & Waugh, 1938 is known from off the Maldive Islands and the Red Sea from 229–805 m, and differs in having an elongate, elliptical calice; pairs of S5 in larger coralla (up to 58 septa); a much less well-developed epitheca; and "paracyathid" paliform lobes, i.e., sometimes doubled and often flattened perpendicular to the septal plane and not arranged in chevrons within a system. It would appear to be a true *Paracyathus*.

Tethocyathus virgatus (Alcock, 1902) n. comb.
(Plate 16, c-f)

Trochocyathus (*Thecocyathus*) *virgatus* Alcock, 1902a: 98–99; 1902c: 16–17, pl. 2, fig. 13.

Not *Trochocyathus virgatus*: Marenzeller, 1907: 21–23, pl. 2, fig. 4; Wells, 1964: 112–113, pl. 1, figs 8–10.

MATERIAL EXAMINED: New Records: NZOI Stn K826, 1, USNM 94091; Stn N897, 3, NZOI; Stn S572, 4, USNM 94093; Stn U591, 8, NZOI. Previous Records: Two syntypes.

DISTRIBUTION: New Zealand region: Three Kings, Colville, and Kermadec Ridges (Map 11); 142–530 m.

Elsewhere: Sulu Archipelago; 275 m, the depth of 15 m from *Siboga* Stn 96 is assumed to an error.

DESCRIPTION: Corallum ceratoid to subcylindrical, attached by a robust pedicel (PD: GCD = 0.54–0.84) and polycyclic base. Largest specimen examined (NZOI Stn U591) 16.3 × 15.9 mm in calicular diameter and 26 mm in height. Calice circular to only slightly elliptical: GCD: LCD = 1.0–1.1. Epitheca variable in development, in some specimens (e.g., NZOI Stn N897) quite thick, obscuring underlying costae, but in other specimens less thick, revealing flat, granular costae about 0.8 mm wide. Theca of most specimens highly encrusted and also bored by acrothoracid barnacles. Theca thick. Corallum predominantly white, but the 6 S1 and associated C1 are pigmented a dark to purplish brown, conveniently marking the hexameral symmetry of the corallum. In one syntype (*Siboga* Stn 105) and to a lesser degree specimens from NZOI Stn S572, the S2 are also darkly pigmented.

Septa hexamerally arranged in 4 complete cycles (48 septa), the arrangement and position of septa and pali sometimes made irregular by the coral's reaction to acrothoracid commensals (Plate 16, d, e). S1 1.7–2.8 mm exsert and quite thick, appearing swollen (0.7–1.3 mm thick). S2 equally as exsert and thick as S1 but only about 0.9 as wide as an S1. S3 and S4 equally exsert (about 0.6 that of S1–2) and considerably less thick than the S1–2. S3 about 0.9 width of an S2. S4 adjacent to S1 equal to or slightly wider than an S3, whereas those S4 adjacent to S2 are usually less wide than an S3. All septa have straight inner edges. A crown of 6 P1 1.2–1.6 mm wide lies deep in the fossa. Another 6 P2, each 1.4–1.5 mm wide, occur slightly higher in the fossa but at the same proximity to the columella as the P1. A third crown of 12 P3, each 1.4–1.6 mm wide, occurs slightly recessed from the columella but each P3 rising higher in the fossa than the P2. All pali quite thick (thicker than the septa), their faces being highly granular and ridged. Fossa relatively deep. Columella consists of 3–40 slender, tuberculate papillae.

TYPES: Two syntypes are deposited at the ZMA: *Siboga* Stn 105 (Coel. 1328) and *Siboga* Stn 96 (1323).

TYPE LOCALITY: *Siboga* Stn 96 and 105: Sulu Archipelago; ?15–275 m.

REMARKS: *Tethocyathus virgatus* is distinguished from other recent species in the genus by its larger size, larger pali, and distinctively pigmented CS1.

Although not common, acrothoracid barnacles are known in a variety of scleractinian hosts (Zibrowius 1976), including *T. virgatus* and western Atlantic populations of *Tethocyathus cylindraceus*.

Stephanocyathus Seguenza, 1864

Corallum solitary, bowl-shaped, free. Septotheca costate, in some species the C1 bearing long spines or the C1–2 bearing tubercles. Paliform lobes usually present before all but last cycle. Columella papillose or a solid fusion of inner septal edges.

REMARKS: The genus is divided into three subgenera, all of which are represented in the New Zealand region: *S. (Stephanocyathus)*, *S. (Acinocyathus)* and *S. (Odontocyathus)*.

Stephanocyathus (Stephanocyathus) Seguenza, 1864

Stephanocyathus in which the base does not bear elongate costal spines or tubercles.

TYPE SPECIES: *Stephanocyathus elegans* Seguenza, 1864, by subsequent designation (Wells 1936).

REMARKS: Approximately seven recent and an equal number of fossil species are known in this subgenus, only two recent species known from the Indo-West Pacific region: *S. platypus* (Moseley, 1876) and *Stephanocyathus* sp. (*sensu* Cairns & Parker 1992), from off Tasmania.

Stephanocyathus (S.) platypus (Moseley, 1876) (Plate 17, a-c)

Ceratotrochus platypus Moseley, 1876: 554.

Stephanotrochus platypus: Moseley 1881: 154, pl. 3, figs 4a–b, 5a–c.

Stephanocyathus sp. Squires & Ralph 1965: 262–263, figs 3–4; Squires & Keyes 1967: 24, pl. 2, figs 11–12.

Stephanocyathus platypus: Cairns 1982: 24–25, pl. 7, figs 3–6 (synonymy); Cairns & Parker 1992: 24–25, pl. 7, figs a–c, map 7.

MATERIAL EXAMINED: New Records: NZOI Stn E773, 1, NZOI; Stn E774, 1, NZOI; Stn E783, 1, NZOI; Stn E801, 1, NZOI; Stn E880, 1, NZOI; Stn G817, 1, NZOI; Stn G819, 3, NZOI; Stn G820, 3, NZOI; Stn G821, 2, USNM 94161; Stn G823, 4, NZOI; Stn G824, 2, USNM 94162; Stn G825, 3, NZOI; Stn E829, 1, NZOI; Stn G888, 1, NZOI; Stn I686, 1, USNM 94163; Stn I698, 1, USNM 94164; Stn P120, 1,

USNM 94165; Stn P942, 1, NZOI; Stn Q83, 7, NZOI; Stn Q84, 8, NZOI; BS707 (R65), 1, MoNZ CO284; BS761 (R119), 1, MoNZ CO144; BS762 (R120), 1, MoNZ CO145; K1/24/81, 1, MoNZ; K1/25/81, 1, MoNZ; *Poong San* 1, 1, MoNZ; KTN/26/82, 1, MoNZ; 37°28.7' S, 167°26.1' E, 700–892 m, 1, MoNZ; 48°22.5' S, 179°56' E, 547–561 m, 2, MoNZ CO9; 37°36' S, 176°50' E, 457–585 m, 1, AIM AK3106; *Trinity* II, 2, AIM AK8474. Previous Records: Specimens reported by Squires and Ralph (1965) and Squires and Keyes (1967); 2 syntypes.

DISTRIBUTION: New Zealand region: widespread in region bounded by Lord Howe Rise, eastern Chatham Rise, and Bounty Plateau (Map 2); 561–1168 m, but most common between 700–900 m. Elsewhere: Southern Australia to New South Wales, including Tasmania; and seamounts east of Chatham Island; 560–1219 m.

TYPES: Two syntypes of *C. platypus* are deposited at the BM(NH) (1880.11.25.57).

TYPE LOCALITY: *Challenger* Stn 164, 34°13' S, 151°38' E (off Sydney, Australia), 750 m.

REMARKS: *Stephanocyathus platypus* has been adequately described and figured by Cairns (1982) and Cairns and Parker (1992) and will not be fully redescribed here. To summarise, the corallum of this species is bowl-shaped, with a flat, unattached base and upturned edges. It may attain the quite large calicular diameter of 95 mm (uncatalogued MoNZ specimen) and a height of 47 mm, but small specimens of less than 25–30 mm GCD are low and discoidal, lacking upward peripheral thecal growth. Septa are hexamerally arranged in five cycles, pairs of S6 present in larger coralla. S1 are extremely exsert and wider than the S2, which are wider than the S3. However, those S4 adjacent to S2 are wider than S3 and often loosely fused to its adjacent S2 near the columella. Conversely, those S4 adjacent to S1 are less wide than an S3 and sometimes loosely fuse to their adjacent S3. S5 are uniformly short. The columella is flat, composed of greatly thickened inner edges of S1–2.

Although rarely reported before 1992, *S. platypus* is a common element of the temperate southwest Pacific region at 700–900 m, and aside from unusually large specimens of *D. dianthus*, *S. platypus* is one of the largest solitary corals in this region.

Stephanocyathus (Acinocyathus) Wells, 1984

Stephanocyathus in which the base bears 6 elongate costal spines corresponding to the C1.

TYPE SPECIES: *Stephanotrochus spiniger* Marenzeller, 1888, by original designation.

REMARKS: Among the approximately 10 names applied to species in this subgenus, only three appear to be valid: the type species *S. (O.) spiniger* (Marenzeller, 1888); *S. (O.) explanans* (Marenzeller, 1904a); and the fossil species *S. (O.) mantelli* (Milne Edwards and Haime, 1857). Wells (1984) and Cairns and Parker (1992) listed most of the nominal species. Wells (1984) created the combination *S. (A.) hastatus* (Bourne, 1903), but this species is considered to be in the subgenus *Trochocyathus (Aplocyathus)* herein.

Stephanocyathus (A.) spiniger (Marenzeller, 1888) (Plates 17, d-f, 18, c)

Stephanotrochus spiniger Marenzeller, 1888: 20–21.

Stephanotrochus tatei Dennant, 1899: 117–119, pl. 3, figs 1a-c; Cairns & Parker 1992: pl. 7, fig. h.

Odontocyathus sexradii Alcock, 1902a: 100–101; 1902c: 23, pl. 3, figs 20a-b.

Odontocyathus stella Alcock, 1902b: 119–120; 1902c: 24, pl. 3, figs 21a-b.

Odontocyathus japonicus Yabe and Eguchi, 1932c: 149–152, pl. 14, text-figs 1–3.

Stephanocyathus (Acinocyathus) spiniger: Wells 1984: 209, pl. 2, figs 10–13; Cairns & Parker 1992: 26–27, pl. 7, figs. g-i (synonymy); Cairns & Keller 1993: 243; Cairns 1994: 57, pl. 25, figs a-c (synonymy).

MATERIAL EXAMINED: New Records: NZOI Stn F10, 2, NZOI; Stn F898, 1, USNM 94153; Stn F915, 1, NZOI; Stn F916, 2, NZOI, 1, USNM 94154; Stn I64, 3, NZOI; Stn I91, 3, USNM 94155; Stn I94, 7, USNM 94156; Stn I345, 1, NZOI; Stn I356, 3, USNM 94157; Stn I363, 1, NZOI; Stn I745, 6, NZOI; Stn J699, 1, NZOI; Stn J710, 1, NZOI; Stn K804, 1, NZOI; Stn P14, 39, USNM 49231 and 94158, NZOI; Stn P16, 2, USNM 94159; Stn P85, 1, USNM 94160; Stn T256, 1, NZOI; BS748 (R106), 1, MoNZ; BS756 (R114), 3, MoNZ; BS757 (R115), 1, MoNZ; BS849 (O595), 1, MoNZ; BS878 (O624), 5, MoNZ CO225; BS881 (O627), 7, MoNZ CO279; outside Poor Knights Island, depth unknown, 2, AUM; out from Doubtless Bay, depth unknown, 1, AUM.

DISTRIBUTION: New Zealand region: off Lord Howe Island; southern Norfolk Ridge; Kermadec Islands; northern North Island from Bay of Plenty to off Cape Egmont (Map 17); 174–590 m, with one outlying record at 1300 m (NZOI Stn I745). Elsewhere: widespread throughout Indo-West Pacific from southwest Indian Ocean to Japan, including South Australia; 120–695 m. Also Upper Oligocene, Victoria, Australia (as *S. tatei*) and Neogene of Kyushu (as *S. japonicus*).

TYPES: The holotype of *S. spiniger* is deposited at the NMW. The holotype and paratype of *S. tatei* are deposited at the NMV (P27072-3). The holotypes of *O. sexradii* and *O. stella* are deposited at the ZMA (Coel. 1304, 1305, respectively). The holotype of *O. japonicus* is deposited at the TIUS (40876).

TYPE LOCALITIES: *S. spiniger*: Enosima (Sagami Bay), Honshu, Japan; depth unknown. *S. tatei*: Upper Oligocene at Spring Creek, 13 miles (21 km) south of Geelong, Victoria. *O. sexradii*: Siboga Stn 156, 0°29.2' S, 130°05.3' E, 46 m. *O. stella*: Siboga Stn 159, 0°59.1' S, 129°48.8' E, 41 m. *O. japonicus*: Neogene of Segoe, southwest Kyushu, Japan.

REMARKS: This widespread Indo-West Pacific species has been adequately described and figured elsewhere (Cairns & Parker 1992; Cairns 1994) and need not be redescribed here. It is quite distinctive among the New Zealand species in having six elongate slender costal spines (C1) that either elevate the corallum above the substratum or anchor it into a soft substratum. Only one other species in the New Zealand region has elongate costal spines, *Trochocyathus hastatus*, that species being distinguished by having hexamerally symmetrical septa but only five costal spines and only four cycles of septa.

The largest specimen reported from the New Zealand region (NZOI Stn P85) is 33 mm in calicular diameter. Small specimens less than 20 mm in calicular diameter are flat, hexagonal in outline, and have only four cycles of septa. These small specimens (Plate 18, c) have yet to form a vertical thecal wall but do bear six prominent costal spines. This distinctive juvenile stage was named *Odontocyathus stella* by Alcock (1902b). In these small specimens it is often possible to see the incorporated substratum on which the corallum originally settled, which include foraminiferans, echinoid spines, pebbles, and bryozoans.

Stephanocyathus (Odontocyathus) Moseley, 1881

Stephanocyathus with 12-18 short basal spines or tubercles (C1-2, sometimes C3), sometimes fusing into a basal rim.

TYPE SPECIES: *Platytrachus coronatus* Pourtalès, 1867, by monotypy.

REMARKS: Five species are known in this subgenus: *S. (O.) coronatus* (Portalès, 1867); *S. (O.) nobilis*

(Moseley, 1873); *S. (O.) weberianus* (Alcock, 1902a); *S. (O.) campaniformis* (Marenzeller, 1904a); and *S. (O.) ixine* Squires, 1958. The subgenus occurs in tropical to temperate waters of the Atlantic and Indo-West Pacific and is commonest from at 800-1500 m.

Stephanocyathus (O.) weberianus (Alcock, 1902)
(Plate 17, g-i)

Stephanotrochus weberianus Alcock, 1902a: 101-102; 1902c: 25, pl. 3, figs 22, 22a.

Stephanotrochus sibogae Alcock, 1902a: 102-103; 1902c: 25-26, pl. 3, figs 23, 23a.

Stephanocyathus (O.) weberianus: Cairns 1994: 57-58, pl. 25, figs d-f (synonymy).

MATERIAL EXAMINED: New Records: NZOI Stn I745, 2, NZOI; Stn Q68, 3, USNM 94149.

PREVIOUS RECORDS: Holotype of *S. weberianus*.

DISTRIBUTION: New Zealand region: Lord Howe Seamount Chain (Map 19); 1045 m. Elsewhere: off Japan, South China Sea, Sulu Sea, Makassar Strait, Banda and Timor Seas, Chesterfield Islands (reported herein); 206-1302 m.

TYPES: The holotype of *S. weberianus* is deposited at the ZMA (Coel. 1322). The deposition of the holotype of *S. sibogae* is unknown.

TYPE LOCALITIES: *S. weberianus*: Siboga Stn 284, 8°43.1' S, 127°16.7' E (Timor Sea), 828 m. *S. sibogae*: Siboga Stn 88, 0°34.6' N, 119°08.5' E (Makassar Strait), 1301 m.

REMARKS: Based on the five specimens reported herein, nothing can be added to the description of this species given by Cairns (1994). *Stephanocyathus weberianus* is characterised by having a flat, eroded base that is often encircled by a swollen basal rim; relatively small costal tubercles; and a tendency to have numerous pairs of S5 even at a relatively small calicular diameter. The specimens reported herein are all rather small and worn, the largest specimen (NZOI Stn 745) only 23.8 mm in calicular diameter and having 60 septa. These specimens are marginal to the New Zealand region and probably represent the southern limit of the range of this tropical/subtropical species.

Stephanocyathus (O.) coronatus (Pourtales, 1867)
(Plates 17, j-1, 18, a, b)

Platycyathus coronatus Pourtales, 1867: 114.

Odontocyathus coronatus: Moseley 1881: 148-151, pl. 2, figs 4a-b, 5a-b.

Stephanocyathus (O.) coronatus: Cairns 1979: 109-111, pl. 20, figs 5-6, 8-9 (synonymy).

MATERIAL EXAMINED: New Records: NZOI Stn P943, 6, USNM 94146; Stn P945, 1, USNM 94147; Stn P947, 7, NZOI; Stn Q874, 1, NZOI; Stn U198, 1, USNM 94148; Stn U592, 2, NZOI; Stn Z2097, 1, NZOI; *Alexander Nesmeyanov* Stn 17-15, 2, AUM; RV *Franklin* Stn 5/89/25, 10, AMS 15560, G15568; *Franklin* Stn 5/89/32, 2, AMS G15495. Previous Records: specimens reported by Moseley (1881); holotype of *P. coronatus*.

DISTRIBUTION: New Zealand region: Lord Howe Rise; Three Kings Ridge; Kermadec Ridge (Map 11); 646-1276 m. Elsewhere: Caribbean, Bahamas, Gulf of Mexico; 543-1250 m.

DESCRIPTION: As the name implies, the corallum is crown-shaped, with a flat to slightly convex base and straight thecal edges that diverge from a hypothetical basal angle of 40-50°. Calice circular and highly lacerate, all septa being highly exsert. Medium to large-sized coralla quite tall, the ratio of corallum height to basal diameter being 1.0-1.7. Largest specimen known (NZOI Stn P945) 36.1 mm in calicular diameter and 32.3 mm in height, with a basal diameter of 18.9 mm. Base costate, the C1-2 slightly ridged and the centre of the base often slightly produced and often still attached to a fragment of the settlement substratum. At the edge of the base, each of the 12 C1-2 bears a prominent, often complexly ornamented tubercle, in one case (NZOI Stn P943, Plate 18, a, b) the blunt tubercles extending outward 9 mm and having a diameter of 2.5 mm. Tubercles project horizontally to slightly downward and provide increased stability for the corallum. Costae on vertical theca well developed, 1.0-1.4 mm wide, slightly convex, separated by intercostal striae, and covered with fine granules. C1-2 slightly wider and prominent than other costae. Corallum white.

Septa hexamerally arranged in 4 cycles and an incomplete fifth cycle, the largest specimen having only 58 septa, but a smaller corallum from AMS G15560 having 60 septa. S1 highly exsert (up to 10.5 mm), thick (up to 1.6 mm), with straight, vertical inner edges, each bordered by a broad (about 3 mm wide) notch and a thick, horizontal paliform lobe 1.5-2.0 mm wide that extends to the columella.

S2 equal to or slightly less exsert (up to 8.5 mm) than the S1, but otherwise identical in structure. S3 less exsert (about 4 mm), about three-quarters width of an S1-2, and have straight inner edges, each bordered by a narrow notch (about 1.5 mm wide) and a tall (up to 5 mm) paliform lobe about 2 mm wide. If pairs of S5 are present in a half-system, the enclosed S4 is accelerated to almost the size of an S3 and bears a P4 of equal size to the P3. Pairs of S5 and S4 that are adjacent to S1-2 form short, rectangular lancets at the calicular edge. Fossa of moderate depth and quite spacious, due to the relative thinness of all septa. Columella composed of a variable number (4-20) of tuberculate papillae.

TYPES: The holotype of *P. coronatus* is deposited at the MCZ (2769).

TYPE LOCALITY: 30°41' N, 77°03' W (Blake Plateau off Florida), 841 m.

REMARKS: Although this species was previously known only from the western Atlantic, I have no reservation in identifying the New Zealand specimens as *S. coronatus* based on comparison with numerous typical specimens from the western Atlantic.

Stephanocyathus coronatus slightly overlaps the geographic and bathymetric range of *S. weberianus*, but is distinguished from that species by (1) having less septa at a corresponding calicular diameter, (2) having more exsert S1-2, (3) having a taller corallum (height:basal diameter of *S. coronatus* = 1.0-1.7 vs 0.64-0.72 for *S. weberianus*), (4) having a costate (not worn or smooth), slightly convex base, and (5) having well-developed, complexly ornamented costal tubercles.

Vaughanella Gravier, 1915

Corallum solitary, patellate to trochoid, and usually firmly attached by a robust pedicel. Septotheca costate. Paliform lobes present on all but last cycle of septa. Columella papillose.

TYPE SPECIES: *Caryophyllia margaritata* Jourdan, 1895, by monotypy (see Zibrowius 1980: 103).

REMARKS: *Vaughanella* is extremely similar to *Stephanocyathus (Odontocyathus)*, differing from that subgenus only in having an attached corallum and in lacking costal spines. Four species are known in this genus: the type species *V. margaritata* (Jourdan,

1895), known only from off Newfoundland; *V. concinna* Gravier, 1915; *V. oreophila* Keller, 1981b; and *V. multivalifera*, n. sp.

Vaughanella oreophila Keller, 1981 (Plate 18, d, e)

Vaughanella oreophila Keller, 1981b: 32–33, pl. 2, fig. 1a–b.

MATERIAL EXAMINED: NEW RECORDS: NZOI Stn P8, 1, USNM 94166; Stn P946, 5, NZOI, 5, USNM 94167; Stn P947, 2, USNM 94168.

DISTRIBUTION: New Zealand region: southern Norfolk Ridge; northern Colville Ridge (Map 12); 646–757 m. Elsewhere: Marcus Necker Ridge, North Pacific; 1420 m.

DESCRIPTION: Corallum trochoid (basal angle 37–53°), straight, and firmly attached through a stereome-reinforced pedicel 0.28–0.38 diameter of calice. Calice circular to very slightly elliptical (GCD :LCD = 1.0–1.05). Largest New Zealand specimen (NZOI Stn P8) 22.4 x 22.0 mm in calicular diameter and 24.3 mm in height, with a pedicel diameter of 6.3 mm. Most of theca smooth and porcellanous, but near calice costae are faintly distinguishable and inconspicuously granular. Corallum white, but theca of lower half of corallum often black in colour.

Septa hexamerally arranged in 4 complete cycles (S1–2>S3>S4), the largest specimen having 5 pairs of S5, for a total of 58 septa. S1–2 3.1–3.3 mm exsert, thick (about 1.2 mm), and have vertical, straight inner edges. Each S1–2 internally bordered by a broad (1.7–2.0 mm wide) notch and a small, lamellar or papillose, pointed paliform lobe 0.4–0.9 mm in diameter, which is sometimes indistinguishable from the columellar elements. P1–2 have vertical inner edges but obliquely oriented outer edges. S3 1.5–1.8 mm exsert, about two-thirds width of an S1–2, and also have straight inner edges. Each S3 bordered by a deep notch about 1.0 mm wide and a tall (about 3 mm) rounded, lamellar paliform lobe 1.7–2.6 mm wide, the 12 P3 forming a distinct crown within the fossa. P3 thick, their inner and outer edges vertical and straight. The P3 crown rises much higher in the fossa than the P1–2 and is more recessed from the columella. S4 equally exsert but only about two-thirds as wide as an S3, and do not bear paliform lobes unless flanked by a pair of S5, in which case the enclosed S4 is about the same size as an S3 and bears a P4. S5 equal in size to an unaccelerated S4. Fossa of moderate depth. Columella papillose, consisting of 2–10 slender (0.4–0.5 mm in diameter) rods.

Types: The holotype is deposited at the IOM.

TYPE LOCALITY: Vityaz Stn 6367, 23°32' N, 157°23' E (Marcus Necker Ridge), 1420 m.

REMARKS: This is the first report of this species subsequent to its original description, which was based on only two specimens.

Vaughanella multivalifera n. sp. (Plate 18, g, h)

MATERIAL EXAMINED: TYPES, Q.V.

DISTRIBUTION: Known only off Macauley Island, Kermadec Ridge and Raukumara Plain off Cape Runaway (Map 12); 1357–1450 m.

DESCRIPTION: Corallum patellate (basal angle 58–100°) and firmly attached by a broad pedicel (PD: GCD = 0.36–0.70). Calice elliptical: GCD: LCD = 1.02–1.24. Largest of the 3 coralla examined (the holotype) 33.6 x 29.6 mm in calicular diameter and 22.3 mm in height, with a pedicel diameter of 12.2 mm. Costae consist of thin, finely granular ridges, but only well developed in upper corallum. Theca of holotype also have costae of equal width corresponding to each interseptal space, resulting in 192 costae for a corallum with only 96 septa. Corallum white; however, lower three-quarters of holotype discoloured to a shade of brown.

Septa hexamerally arranged in 5 complete cycles (96 septa) according to the formula S1≥S2>S3>S4>>S5, but the smaller paratype of GCD 18.5 mm lacks 7 pairs of S5, resulting in a total of only 82 septa. S1–2 highly exsert (5.0–5.7 mm) and relatively thin, their inner edges extending to the columella. Lower third of inner edges of S1–2 bear 3 or 4 small paliform lobes, the lobes ranging from 0.5–1.6 mm in width, the innermost lobes indistinguishable from the columellar elements. S3 much less exsert (2.5–3.0 mm) and thinner than the S1–2, but also extend to the columella where the inner edges of each pair of S3 within a system are loosely fused to their common S2. As with the S1–2, the lower third to half of the inner edges of the S3 bear several narrow paliform lobes. S4 less exsert (about 2 mm) than the S3 and extend about four-fifths distance to columella, the inner edges of each pair of S4 within a half-system loosely fused to their common S3. As with the other septa, the lower inner edges of the S4 bear several thin paliform lobes. S5 equally as exsert as S4, but otherwise rudimentary. Thus, only the S1 and S5 are independent septa, the inner

edges of the S2-4 bending toward and fusing with one another within each system. Inner edges of all septa very slightly sinuous, and, because the septa are relatively thin and follow the contour of the theca, a wide, open fossa results. Columella a low, central, circular papillose structure.

TYPES: Holotype: NZOI Stn T244, NZOI H-629. Paratypes: NZOI Stn F874, 2 P-1023, USNM 94152.

TYPE LOCALITY: 30°05.2' S, 178°10.2' W (off Macauley Island, Kermadec Ridge), 1450 m.

ETYMOLOGY: The species name *multipalifera* (Latin *multae*, much + *palus*, stake + *fera*, suffix meaning "bearing") refers to the multiple paliform lobes on the lower, inner edges of the S1-4.

REMARKS: *Vaughanella multipalifera* is distinguished from the other species in the genus by having multiple paliform lobes on their S1-4. This character is so distinctive that a placement in this genus is considered tentative; however, there are no other caryophylliid genera that are consistent with this morphology.

Bourneotrochus Wells, 1984

Corallum solitary and discoidal, often reproducing by transverse division resulting in a free anthocyathus with a large basal scar. Costal spines associated with C1. Septotheca porcellanous basally and costate laterally. Pali present before all but last cycle of septa; columella papillose.

TYPE SPECIES: *Bourneotrochus veroni* Wells, 1984 (= *Deltocyathus stellulatus* Cairns, 1984), by original designation.

REMARKS: Although I originally placed *B. stellulatus* in the genus *Deltocyathus* (Cairns 1984) and Wells (1984) independently referred to specimens of his new genus as "deltocyathids", its palar arrangement and thus taxonomic affinities seem to be closer to *Trochocyathus* than *Deltocyathus*. Its pali stand independently in successive crowns, not fused to one another in chevrons as in *Deltocyathus*.

Only one species is known in the genus: *B. stellulatus* (Cairns, 1984).

Bourneotrochus stellulatus (Cairns, 1984)
(Plates 18, f, i, 19, a-c)

Trochocyathus hastatus Bourne, 1903: in part, 32-37, pl. 6, figs 9-11.

Deltocyathus stellulatus Cairns, 1984 (April): 15-16, pl. 3, figs C-D.

Bourneotrochus veroni Wells, 1984 (December): 213-214, pl. 3, figs 7-18.

Bourneotrochus stellulatus: Cairns 1991b: 13, 49, 52.

MATERIAL EXAMINED: New Records: NZOI Stn F319, 3, USNM 94150; Stn G3, 2, USNM 94151; Stn K858, 1, NZOI; Tui AUZ40, 1, MoNZ CO247; RV *Franklin* Stn 5/89/40, 13, AMS G15557. Previous Records: Type series of *D. stellulatus* and *B. veroni*.

DISTRIBUTION: New Zealand region: off Curtis Island, Kermadecs; Norfolk Ridge; Lord Howe Seamount Chain (Gifford Guyot) (Map 18); 326-710 m. Elsewhere: off Queensland; Chesterfield Islands (reported herein); Funafuti, Tuvalu; Austral Seamounts off Cook Islands, 847 m (reported herein, NZOI Stn F319); Hawaiian Islands; 274-476 m. Pleistocene of Vanuatu.

DESCRIPTION: Corallum (anthocyathus) discoidal and cylindrical, usually tapering to a smaller calicular diameter than basal diameter. For instance, the largest specimen examined (NZOI Stn F319) is 5.5 mm in basal diameter, 4.4 mm in calicular diameter, and 3.1 mm in height. Base flat to concave, the concavity due to a circular scar of detachment measuring 1.8-2.2 mm in diameter, sometimes exceeding the calice in diameter. Theca thick. Base of corallum porcellanous, but thecal wall costate. Costae equal in width (0.15-0.18 mm) and separated by rather broad (0.09-0.10 mm), shallow intercostal furrows. Costae and costal spines covered with irregularly shaped, coarse granules 50-60 µm in diameter, whereas the granules in the intercostal furrows are smaller (7-10 µm) and angular in shape. Six costal spines (C1) present, one projecting horizontally from the outer edge of each CS1. Costal spines blunt and up to 0.9 mm in length; however, Bourne (1903) reported C1 spines up to 2.0 mm in length. In tall specimens, 2 spines may correspond to each C1, the original set of 6 and another upper set of 6 corresponding to a developing anthocyathus that will eventually detach. In some coralla an additional set of 6 much smaller (0.4 mm long) costal spines also occur on the CS2. Anthocaulus unknown. Corallum white.

Septa hexamerally arranged in 3 to 4 cycles, the fourth always incomplete. Most coralla examined have 36 septa, which includes a pair of S4 in each system, but the largest specimen of 4.4 mm calicular diameter has only 24 septa (as do all specimens

from NZOI Stn F319) and the holotype of *B. veroni* (GCD = 2.9 mm) has 30 septa. Thus, there appears to be no correlation between calicular diameter and number of septa. S1 little exsert and have slightly sinuous inner edges that extend about three-quarters distance to columella where each is bordered by a small (0.25–0.30 mm wide), lamellar to rod-shaped palus. S2 equally exsert, about three-quarters width of an S1, and also have sinuous inner edges. A larger (about 0.4 mm wide) and taller palus (P2) occurs before each S2. S3 equally exsert and as wide as an S2, but usually slightly thicker, and do not bear pali unless flanked by a pair of S4, in which case the P3 is similar in size to a P2 but slightly more recessed from the columella. When present, S4 are similar in size to a S3. All septal faces are covered with rather large (50–60 μ m tall), blunt granules. P1–3 highly sinuous and bear quite tall (up to 0.1 mm), obliquely oriented, serrate carinae. Fossa shallow; columella papillose, composed of 7–18 small (0.06–0.08 mm), interconnected papillae.

TYPES: The holotype of *D. stellulatus* is deposited at the USNM (60516); paratypes are also deposited at the USNM and Bishop Museum. The holotype (*Kimbla* Stn 1) of *B. veroni* is also deposited at the USNM (71852). Three paratypes are also deposited at the USNM: #1, *Kimbla* Stn 1, USNM 71853; #2, *Kimbla* Stn 24, USNM 73966; and #3, *Kimbla* Stn 2, USNM 71854.

TYPE LOCALITIES: *D. stellulatus*: 19°48' N, 154°58' W (off Hawaii), 337 m. *B. veroni*: east of Lady Elliot Island, 43 miles (69 km) north of Fraser Island, Queensland; 476–531 m.

Deltocyathus Milne Edwards & Haime, 1848a

Corallum solitary, discoidal to patellate, and free in adult state. Septotheca costate. Pali before all but last cycle; within each system the inner edges of each pair of S3 fuse to the P2 near the columella (and P4 to P3, if S5 present), forming the characteristic chevrons (deltas). Paliform lobes sometimes present before last septal cycle. Columella papillose.

TYPE SPECIES: *Turbinolia italica* Michelotti, 1838, by monotypy.

REMARKS: Among the approximately 17 recent species in the genus *Deltocyathus*, the two described from the New Zealand region are easily distin-

guished by having either a spinose corallum or five cycles of septa, characteristics shared with only one and two, respectively, other species in the genus. Two other *Deltocyathus* species have been reported from the northern edges of the New Zealand region by Keller (1982): *D. vaughani* from off Lord Howe Island at 1640 m and *D. murrayi* from the northern Kermadec Ridge at 1950 m, neither of which I have examined. Species of *Deltocyathus* are common worldwide, except for the eastern Pacific, at lower shelf and slope depths.

Deltocyathus ornatus Gardiner, 1899

(Plate 19, d, e)

Deltocyathus ornatus Gardiner, 1899: 163–164, pl. 20, figs 25a–b.

?*Deltocyathus heteroclitus* Wells, 1984: 210, pl. 3, figs 1–6.

MATERIAL EXAMINED: New Records: NZOI Stn I86, 4, NZOI; Stn P16, 1, NZOI; Stn P27, 6, USNM 94169; Stn P34, 5, USNM 94170; RV *Franklin* Stn 5/89/40, 17, AMSG15501. Previous Records: Types of *D. heteroclitus*, USNM.

DISTRIBUTION: New Zealand region: Norfolk Ridge (Map 19); 280–390 m. Elsewhere: Sandal Bay, Lifu, Loyalty Islands; off southern Great Barrier Reef (Wells 1984); 73 m. ?Pleistocene of Vanuatu.

DESCRIPTION: Corallum circular but with highly serrate calicular edges, a small (about 1.3 mm) rectangular lancet corresponding to each C3 and adjacent pair of C4, made even more obvious by the 12 elongate costal spines (C3) that project from the lancets. Corallum base flat to undulatory, each C3 and adjacent pair of C4 forming a broad (about 1.3 mm wide) ridge, each C3 extending up to 3.0 mm beyond the calicular edge as a slender, tapered costal spine. Costal spines horizontal in orientation and taper from a diameter of about 0.9 mm to a pointed tip of 0.3 mm and are covered with tiny spines. C1–2 are slender ridges (0.2–0.3 mm wide) that fall between the valleys formed by the much larger C3–4, each C1–2 bearing a row of small spines. Often in the center of the base is a circular scar 0.9–1.1 mm in diameter. Largest specimen examined (NZOI Stn P34) 12.0 mm in calicular diameter and 4.5 mm in height. Corallum white.

Septa hexamerally arranged in 4 complete cycles (48 septa). S1 only independent septa, each extending only 0.5–0.6 distance to columella and bearing a large, lamellar palus up to 1.8 mm wide, which extends to the columella. The pali associated with the 2 principal septa (those 2 S1 aligned with the

greater calicular axis of the calicular ellipse) are smaller than the other 4, i.e., about 0.5–1.0 mm wide. S2 equal to or only slightly less wide than S1 and also bear pali (P2) of equal size to those of the S1, but the P2 crown is slightly recessed from the columella. S3 smallest of septa, reaching only about one-third distance to columella but also extending beyond calice for a short distance along proximal part of costal spines. Each S3 internally bordered by a large (up to 2.0 mm wide), tall palus (P3), the inner edges of which fuse to its adjacent P2 by a porous lamella. S4 slightly wider than S3 but do not bear pali, the inner edges of each pair of S4 fused to the lower outer edge of their common P3 through a porous lamella. Thus, 3 crowns of pali are present: the innermost 6P1, which are dimorphic in size; a second similarly sized crown of P2 slightly recessed from the columella; and a third crown of 12 P3, which are the largest, tallest, and most recessed from the columella. Fossa shallow, there being no vertical theca at the calicular edge. Columella papillose, consisting of an elliptical field of short, small (0.4–0.5 mm in diameter) tuberculate papillae that are fused to one another.

TYPES: The holotype *Deltocyathus ornatus* is deposited at the BM(NH). The types of *D. heteroclitus* are deposited at the USNM (71849–51).

TYPE LOCALITY: *D. ornatus*: Sandal Bay, Lifu, Loyalty Islands; 73 m. *D. heteroclitus*: USGS Stn 24918, Navaka River, Vanuatu, Pleistocene.

REMARKS: A series of small specimens (GCD range: 4.0–8.9 mm) from RV *Franklin* Stn 5/89/40 suggest that the equally small Pleistocene specimens from Vanuatu described by Wells (1984) as *D. heteroclitus* may be the juvenile stages of *D. ornatus*, the former being characterised by having ≤ 36 septa and only 6 costal spines. Costal spines (C3) are present only in those half-systems having a pair of S4, and thus a corallum of 36 septa would have only 6 pairs of S4 and 6 costal spines. Specimens with a range of septa and spines (36–48 septa and 6–12 spines) were found among the specimens from RV *Franklin* Stn 5/89/40. The records presented herein are thought to represent the first report of this species since its description.

Only one other species of *Deltocyathus* bears elongate costal spines, the western Atlantic *D. calcar* Pourtalès, 1874, which is easily distinguished by having only six spines associated with the S1.

Deltocyathus formosus n. sp. (Plate 19, f, g)

MATERIAL EXAMINED: Types, q.v.

DISTRIBUTION: Southern Norfolk Ridge; Kermadec Islands (Map 15); 142–565 m.

DESCRIPTION: Corallum shaped as a very shallow bowl, with a slightly convex base and only slightly upturned peripheral edge. Calice circular and highly serrate, each costoseptum projecting individually 1.0–1.5 mm beyond calicular perimeter. Holotype 18.1 mm in calicular diameter and 4.7 mm in height; paratypes up to 18.4 mm in calicular diameter. A small (1.8–2.0 mm in diameter) central basal scar usually present. Costae low, convex ridges that are equal in width and separated by shallow, but well-defined intercostal furrows. Costae bear rounded granules usually arranged in a single row, grading into finer, pointed spines at calicular edge and septal faces. Corallum white to light brown, the holotype bearing 3 concentric bands of light-brown pigment on its base, as well as having light-brown lower, outer septal edges.

Septa hexamerally arranged in 5 cycles; however, fifth cycle usually incomplete, 1 or more pairs of S5 often missing from various systems, resulting in coralla with 86–96 septa. The holotype contains 94 septa and only 1 specimen is known to have a complete fifth cycle of 96 septa. It is not unusual for 1 half-system to have all 4 S5 whereas the adjacent half-system has no S5. S1 only independent septa, extending about half distance to columella, and bordered by a large (1.5–1.9 mm wide) lamellar palus, which extends to the columella. S2 slightly less wide and also bear P2, which are equally as wide as P1 but slightly recessed from the columella. S3 slightly less wide than S2, each bearing a P3 equally as wide as the P1–2, the inner edges of each pair of P3 loosely fused to the inner edge of their common P2 near the columella. S4 less wide than S3 and bear tall pali, the inner edges of which are loosely fused to their adjacent P3. S5 rudimentary: finely dentate at calicular edge, quite slender (a row of spines) for most of their length, but near the columella joined to their adjacent S4 by a series of 4–6 slender trabeculae. Thus, 4 crowns of pali occur in each corallum (P1–4), each successive crown recessed slightly more from the columella and standing slightly higher in the fossa. Fossa shallow, containing an elliptical field of closely inter-connected short granular papillae 0.2–0.3 mm in diameter.

Types: Holotype: BS581, MoNZ CO266. Paratypes: NZOI Stn I96, 3, P-1024, USNM 94171; Stn K826, 1, P-1025, NZOI; Stn K828, 2, P-1026, NZOI; Stn K870, 1, P-1027, NZOI; Stn P13, 1, P-1028, USNM 94172; Stn T214, 6, P-1029, USNM 94173; BS888 (O634), 1, MoNZ CO228.

TYPE LOCALITY: 29°13.96' S, 177°52.84' W (1800 m northwest of Napier Island, Kermadec Ridge), 530–567 m.

ETYMOLOGY: The species name *formosus* (Latin *formosus*, beautifully formed) is given to this handsome species.

REMARKS: Only two other species of *Deltocyathus* have five cycles of septa: *D. magnificus* Moseley, 1876 and *D. rotulus* (Alcock, 1898), both of which differ in having much larger coralla and serrate, ridged costae. *Deltocyathus magnificus* is further distinguished by having a flat to concave base and well-developed S5; *D. rotulus* differs in having a basal scar, a lanceted calicular edge, a columellar platform, and very reduced P3.

Conotrochus Seguenza, 1864

Corallum solitary, ceratoid to trochoid, and free or attached by a small pedicel that is often augmented by a lateral thecal attachment. Theca thick and covered with an epitheca such that costae are usually masked. Septa exsert, but upper, outer septal edges join theca below upper thecal edge, forming a circular thecal rim as exsert as septa. Paliform lobes may be present before S2; columella composed of twisted lamellae often fused to one another in pairs.

TYPE SPECIES: *Conotrochus typus* Seguenza, 1864, by original designation.

REMARKS: Two recent and two fossil species are known in this genus, the recent species being *C. funiculumna* (Alcock, 1902a) (see Cairns 1994) and *C. brunneus* (Moseley, 1881).

Conotrochus brunneus (Moseley, 1881) (Plate 20, a, b)

Pleurocyathus brunneus Moseley, 1881: 159–160, pl. 2, figs 1a–c.

Phloeocyathus hospes Alcock, 1902b: 116–117.

Conotrochus brunneus: ?Gardiner & Waugh, 1938: 175–176, pl. 5, figs 11–12; Cairns & Parker, 1992: 22; Cairns & Keller, 1993: 246, pl. 4, figs F–G (synonymy).

MATERIAL EXAMINED: New Records: NZOI Stn K870, 3, NZOI; Stn U591, 1, USNM 94116; Stn U599, 1, USNM 94117; BS442, 3, MoNZ CO262; RV *Franklin* Stn 5/89/25, 1, AMS G15498. Previous Records: Types of *P. brunneus* and *P. hospes*.

DISTRIBUTION: New Zealand region: ridges north of New Zealand, including Lord Howe Rise, Three Kings Ridge, and the Kermadec Islands (off Raoul and Esperance) (Map 16); 486–1051 m. Elsewhere: off Madagascar; Indonesia; ?Maldives; southern West Australia; ?110–366–1089 m.

DESCRIPTION: Corallum ceratoid and relatively small, originally attached by a small (0.8–0.9 mm in diameter) pedicel, but invariably secondarily attached by lateral thecal adhesions near the pedicel, which tend to coalesce with the pedicel to produce an attachment up to 3 mm in diameter. Illustrated specimen (Plate 20, a, b) 7.8 mm in calicular diameter and 16.4 mm in height; largest New Zealand specimen (AMS G15498) 9.1 mm in calicular diameter. Epitheca covered with horizontal serrate ridges, which appear to have been the previous upper calicular edges of periodic incremental growth. Theca glistening and coarsely granular; vertical costae are faint or completely masked. Upper calicular edge forms a smooth circular rim about 0.4 mm thick that is as exsert as uppermost septa. Slightly lower in fossa the theca is reinforced with a thick layer of internal stereome, thickening the thecal wall up to 1.0 mm. Well-preserved coralla light brown in colour or bear longitudinal brown to black costal stripes.

Septa hexamerally arranged in 4 cycles, the fourth usually incomplete. Number of septa roughly a function of calicular diameter, the most common complement being 36 septa (e.g., specimens 6–8 mm in GCD have 1 pair of S4 in each system); however, smaller coralla (GCD = 5–6 mm) have only 24–28 septa, and the largest specimen (GCD = 9.1 mm) has only 38 septa. S1 most exsert (to level of upper theca) and have vertical, straight to slightly sinuous inner edges that extend to the columella. S2 equally exsert and about three-quarters width of S1. S3 that are unflanked by S4 about three-quarters width of an S2; S3 flanked by a pair of S4 are almost as wide as an S2. S4 equal in width to an unaccelerated S3. Inner edges of S2 often bear a small (0.5 mm wide) lamellar paliform lobe, virtually indistinguish-

able from the columellar elements except for its position. Inner edges of all septa thin (about 0.15 mm), but thecal edges quite thick (about 0.5 mm), forming a robust fusion with the thickened theca. Fossa relatively deep. Columella composed of several lamellar papillae.

TYPES: The holotype of *P. brunneus* is deposited at the BM(NH). The holotype of *P. hospes* is deposited at the ZMA (Coel. 1308).

TYPE LOCALITIES: *P. brunneus*: Challenger Stn 194, 4°34' S, 129°57'30 E (off Banda Island). Moseley listed 60 fm (110 m) as the depth for this station, but the narrative for the cruise (Tizard *et al.*, 1885) lists 200 fm (366 m), which is more consistent with the known range for this species. *P. hospes*: Siboga Stn 150, 0°06' N, 129°07.2' E (Halmahera Sea), 1089 m.

REMARKS: *Conotrochus brunneus* differs from *C. funicolumna* in having a smaller corallum (≤ 9 mm GCD), fewer septa (usually 36, rarely as many as 48), internal stereome, and a brown theca. *Conotrochus brunneus* also appears to be found in slightly deeper water (366–1089 m) than *C. funicolumna* (165–600 m).

Squires (1958) reported the fossil species *Conotrochus typus* var. *australiensis* from the early Miocene of Mossburn, Southland, New Zealand.

Aulocyathus Marenzeller, 1904a

Corallum solitary, ceratoid, and free; most coralla showing evidence of budding from a longitudinally fragmented parent corallum. Costae poorly defined. Upper, outer septal edges join theca below upper thecal edge, usually forming a circular thecal rim. Slender paliform lobes occasionally present on S1–3; columella trabecular.

TYPE SPECIES: *Aulocyathus juvenescens* Marenzeller, 1904a, by monotypy.

REMARKS: Four species are known in this genus: *Aulocyathus matricidus* (Kent, 1871); *A. juvenescens* Marenzeller, 1904a; *A. recidivus* (Dennant, 1906); and *A. atlanticus* Zibrowius, 1980. The genus was partially reviewed by Cairns (1994).

Aulocyathus recidivus (Dennant, 1906)
(Plate 20, c-f)

Ceratotrochus recidivus Dennant, 1906: 159, 160, pl. 6, figs 1–2.

Paracyathus conceptus: Squires & Keyes 1967: 23 (in part: NZOI Stn C648, pl. 2, figs 7–8).

Aulocyathus recidivus: Cairns 1982: 25–26, pl. 7, figs 7–9, pl. 8, fig. 1 (synonymy); Cairns & Parker 1992: 22–24, pl. 6, figs d-e, g-h, map 6 (synonymy); Cairns & Keller 1993: 247, pl. 5, fig. C; Cairns, 1994: 59–60, pl. 26, figs a-b.

MATERIAL EXAMINED: New Records: NZOI Stn D159, 1, NZOI; Stn E749, 1, NZOI; Stn E793, 1, USNM 94118; Stn E797, 1, NZOI; Stn E852, 1, NZOI; Stn J659, 2, NZOI; Stn J660, 8, USNM 94119; Stn P120, 8, USNM 94120; Stn T243, 1, NZOI; Stn U584, 4, NZOI; BS819 (O564), 1, MoNZ. Previous Records: Specimens reported by Squires and Keyes (1967).

DISTRIBUTION: New Zealand region: widespread, from the Kermadecs to off Macquarie Island (Map 3); 245–1137 m (shallowest records occur in fiord area). Elsewhere: off Madagascar, South Australia, Victoria, Tasmania, and Japan; 128–1000 m.

TYPES: Five syntypes of *C. recidivus* are deposited at the NMV (F41516, F59348) (Stranks 1993).

TYPE LOCALITY: Off Cape Jaffa and Neptune Island, South Australia, 165–190 m.

REMARKS: Recent descriptions and figures of *A. recidivus* can be found in Cairns (1982, 1994) and Cairns and Parker (1992) and thus it need not be redescribed here. *Aulocyathus recidivus* is characterised by having: an elongate, ceratoid corallum that is invariably budded from a fragment of a parent corallum; glistening, hollow costal granules; a serrate calicular edge; a very irregular septal symmetry and complement, resulting in 32–66 septa; slender paliform lobes (P3); and a deep fossa with a trabecular columella. Specimens from several lots (NZOI Stns D159, E852, J659, J660, and U584) were at first thought to represent a distinct, more robust species; however, they are more likely to be simply large specimens of *A. recidivus* that attain a GCD of up to 15 mm, a height of up to 41 mm, and have a thicker (and thus denser) theca and corallum. Their calicular margins are smooth, not serrate, and their columellar elements are fused into fewer, more robust elements.

Dasmosmilia Pourtalès, 1880

Corallum solitary, ceratoid to turbinate, and usually free — most coralla asexually budded from a frag-

ment of parent corallum. Theca and septa quite thin. Paliform lobes present before penultimate cycle of septa and occasionally also before lower cycle septa. Columella trabecular. Endotheca sparse or absent.

TYPE SPECIES: *Parasmilia lymani* Pourtalès, 1871, by subsequent designation (Wells 1936).

REMARKS: *Dasmosmilia* is very similar to *Aulocyathus*, differing in having better-defined costae and in lacking the calicular thecal rim. Only three species are known: *D. lymani* (Portalès, 1871), *D. variegata* (Portalès, 1871), and *D. valida* Marenzeller, 1907.

Dasmosmilia lymani (Portalès, 1871)
(Plates 20, g-i, 21, a)

Parasmilia lymani Portalès, 1871: 20, pl. 6, figs 8–10.
Goniocyathus pacificus Yabe & Eguchi, 1932a: 389, text-fig. 2.
Dasmosmilia lymani: Cairns 1979: 132–134, pl. 25, figs 1–3, 8–9 (synonymy); Zibrowius 1980: 70–71, pl. 28, figs A–L, pl. 29, figs A–L (synonymy).
Dasmosmilia pacifica: Cairns 1994: 63, pl. 27, figs f-i, pl. 41, figs f-g.

MATERIAL EXAMINED: New Records: NZOI Stn E879, 9, USNM 94138; Stn E883, 2, NZOI; Stn F877, 2, NZOI; Stn F896, 6, USNM 94139; Stn F909, 20, USNM 94137; Stn I21, 1, NZOI; BS707 (R65), 1, MoNZ CO284; BS763 (R121), 8, MoNZ CO244; BS831 (O576), 3, MoNZ CO278. Previous Records: Syntypes of *P. lymani* and *G. pacificus*.

DISTRIBUTION: New Zealand region: off northern New Zealand from off Gisborne to northwest of Kaipara Harbour (Map 8); 633–1002 m. Elsewhere: western Atlantic from Brazil to Massachusetts; eastern Atlantic between Portugal, the Azores and Spanish Sahara (48–366 m); off Japan (168–355 m). Pleistocene of Ryukyu Islands (Cairns 1994).

TYPES: The syntypes of *P. lymani* are deposited at the MCZ (Cairns 1979). The syntypes of *G. pacificus* are deposited at the TIUS (see Cairns 1994).

TYPE LOCALITIES: *P. lymani*: off Florida Keys, 128–269 m. *G. pacificus*: 34°17'45 N, 137°04'45 E (off Honshu, Japan), 168 m.

REMARKS: *Dasmosmilia lymani* is well described and illustrated by Cairns (1979, 1994) and Zibrowius (1980) and will only be diagnosed below. The species is characterised by having a very brittle, cera-

toid to trochoid corallum, the theca being so thin that it easily fractures longitudinally into fragments from which complete new coralla asexually develop. Only 4 (8%) of the New Zealand specimens (Plate 20, h) have a pedicellate attachment to a substratum other than a parent corallum, which is assumed to be evidence of sexual reproduction. The pedicels of these specimens are quite narrow: 1.5–1.6 mm in diameter (PD: GCD = 0.10). Septa are somewhat irregularly arranged as 12–24 primaries, 12–24 secondaries, and 24–48 tertiaries, resulting in 48–96 septa. Coralla having 96 septa are rare, most coralla having 48–72 septa arranged in groups of four (1 primary, 1 secondary, and 2 tertiary septa). Broad paliform lobes occur before the secondary septa and the columella is fascicular. There is no endotheca.

In my revision of the North Pacific Scleractinia (Cairns 1994), I distinguished *D. pacifica* from *D. lymani* by its having a more serrate calicular edge, each primary septum and adjacent pair of tertiary septa forming a small lancet; the septa of *D. lymani* were reported not having lancets. The larger number of specimens available from the New Zealand region show that this character is variable, most of the New Zealand specimens having lanceted calicular margins but some not. Furthermore, some typical Atlantic *D. lymani* are known to have calicular lancets (see Zibrowius 1980: pl. 28, fig. L), although this condition is much less common in Atlantic populations. The New Zealand populations also differ in having a deeper bathymetric range than previously collected specimens: 633–1002 m vs 48–366 m for Atlantic and Japanese specimens. This is consistent with Keller's hypothesis (Keller 1978, 1989; Cairns & Keller 1993) that deeper-living specimens in nutrient-poor waters have more highly serrate calicular edges.

Desmophyllum Ehrenberg, 1834

Corallum solitary, cylindrical to trochoid, and fixed. Septotheca costate. Pali absent. Columella usually absent or expressed only in small coralla as rudimentarily fascicular. Endothecal dissepiments present in elongate coralla.

TYPE SPECIES: *Madrepora dianthus* Esper, 1794, by subsequent designation (Cairns 1994).

REMARKS: Although at least 11 species have been described in the genus *Desmophyllum*, most are junior synonyms of the cosmopolitan *D. dianthus*; several

other nominal species, such as *D. solidum* and *D. gracile*, belong to other genera. A second valid recent species is *D. striatum* Cairns, 1979, known from the western Atlantic at 130–823 m.

Desmophyllum dianthus (Esper, 1794)

(Plate 21, d-f)

Madrepora dianthus Esper, 1794: pl. 69, figs 1-3.

Desmophyllum cristagalli Milne Edwards & Haime, 1848a: 253, pl. 7, figs 10, 10a; Gardiner 1929: 125–126; Ralph 1948: 109, fig. 2 (bottom left); Ralph & Squires 1962: 9–10, pl. 3, figs 1–10; Squires 1965: 785–787; Squires & Keyes 1967: 25, pl. 3, figs 12–14; Squires 1969: 17, pl. 6, map 1; Dawson 1979: 28; Cairns 1979: 117–119, pl. 21, figs 7–8, pl. 22, fig. 8 (synonymy); Zibrowius 1980: 11–121, pl. 61, fig. A–O, pl. 62, figs A–M (synonymy); Cairns 1982: 29–30, pl. 8, figs 9–12, pl. 9, figs 1–3 (synonymy).

Desmophyllum dianthus: Cairns 1994: 26–27, pl. 9, fig. a-b (synonymy).

MATERIAL EXAMINED: New Records: NZOI Stn A910, 1, NZOI; Stn D5, 5, NZOI; Stn D6, 2, NZOI; Stn D39, 2, NZOI; Stn D899, 1, NZOI; Stn E313, 1, NZOI; Stn E756, 1, NZOI; Stn E792, 2, NZOI; Stn E803, 40, NZOI; Stn E821, 5, NZOI; Stn E830, 3, NZOI; Stn E852, 1, NZOI; Stn E860, 2, NZOI; Stn F81, 1, NZOI; Stn F143, 1, NZOI; Stn F146, 5, NZOI; Stn F868, 10, NZOI; Stn G3, 1, NZOI; Stn G172, fragment, NZOI; Stn G197, 1, NZOI; Stn G200, many, NZOI, 3, USNM 94064; Stn G941, 2, USNM 94065; Stn H923, 3, USNM 94066; Stn I676, 1, NZOI; Stn I685, many, NZOI; Stn I694, 1, NZOI; Stn I721, 10, NZOI; Stn J59, 1, NZOI; Stn J485, 23, USNM 94067; Stn J711, 2, NZOI; Stn K795, 1, NZOI; Stn K800, 8, NZOI; Stn K804, 1, NZOI; Stn K858, 5, NZOI; Stn M773, 1, USNM 94068; Stn M779, 1, USNM 94072; Stn P57, 1, NZOI; Stn Q102, 2, NZOI; Stn Q340, many, NZOI; Stn Q341, many, NZOI; Stn Q343, 20, NZOI; Stn Q741, 2, NZOI; Stn R437, 1, NZOI; Stn R438, 1, NZOI; Stn S22, 1, NZOI; Stn S25, 30, NZOI; Stn S27, 2, NZOI; Stn S28, 30, NZOI; Stn S29, 1, NZOI; Stn S30, 37, NZOI; Stn S53, 1, NZOI; Stn S99, 10, NZOI; Stn S125, 4, NZOI; Stn S126, 50, NZOI; Stn S127, 1, NZOI; Stn S248, 3, NZOI; Stn S260, 3, NZOI; Stn S565, 2, NZOI; Stn S573, 5, NZOI; Stn T8, 2, NZOI; Stn T214, 1, NZOI; Stn T256, 15, USNM 94069; Stn U573, 2, NZOI; Stn U582, 1, USNM 94070; Stn U599, 7, USNM 94071; Stn U602, 1, NZOI; Stn V365, 50, NZOI; Stn X152, 2, NZOI; Stn Z3943, 1, NZOI; Stn Z3948, 1, NZOI; BS300, 2, MoNZ CO224; BS310, 5, MoNZ CO80, 85; BS342, 2, MoNZ CO91; BS559, 10, MoNZ CO118; BS560, 7, MoNZ CO127; BS742 (R100), 1, MoNZ; Goal I., Doubtful Sound, 91 m, 4, MoNZ CO86; Hotto Bay, Snares I., MoNZ CO125; off Farewell Spit, 640 m, 1, MoNZ CO67; Cook Strait, 6, MoNZ CO63; FV *San Manukau*, 1, AIM 8314; off Castlepoint, 220 m, 1, NZGS; *Volcanolog* 64, 6, AUM; *Volcanolog* B30-28, 11,

AUM; Rumble II/*Tui*, 1, AUM; ENE of Otago Heads, 503 m, 2, Portobello Lab.; Papanui Canyon, 320–400 m, 1, Portobello Lab.; Taiaroa Canyon, 400–500 m, Otago University. Previous Records: Neotype of *D. dianthus*; holotype of *D. cristagalli*; specimens reported by Ralph and Squires (1962), Squires (1965), and Squires and Keyes (1967).

DISTRIBUTION: New Zealand: throughout entire region; 25–1750 m, the shallowest records from the fiords (Map 4). Elsewhere: cosmopolitan, except for off continental Antarctica and northern boreal Pacific; 35–2460 m.

TYPES: The neotype of *D. dianthus* is deposited at the USNM (92475). The holotype of *D. cristagalli* is deposited at the MNHNP.

TYPE LOCALITIES: *D. dianthus*: Sagami Bay, Honshu, Japan; depth unknown. *D. cristagalli*: Gulf of Gasconne; depth unknown.

REMARKS: Complete descriptions and illustrations of this common species are found in Ralph and Squires (1962), Cairns (1979, 1982, 1994), and Zibrowius (1980). Coralla are often found in deep-water bank environments (see remarks of *Goniocorella dumosa*), often attached to *G. dumosa*, *Madrepora oculata*, stylasterids, and isidid gorgonians; dead specimens often provide a substratum for *Stenocyathus vermiformis*.

The coral is quite variable in shape, ranging from serpentine to ceratoid and trochoid, depending on its environment. Individual coralla are sometimes clumped into quasicolonies. The largest corallum from the New Zealand region is 55 mm in calicular diameter, which, although quite large, is not the maximum diameter for the species, but some of the New Zealand specimens (e.g., NZOI Stn G197, G200, Q343, and V365) are extremely long (up to 190 mm), which is a record length for *D. dianthus*.

Its C1–3 are ridged and the theca finely granular. Septa are hexamerally arranged in five or six cycles according to the formula: S1–2>S3>S4>S5>S6, the S1–2 usually highly exsert. The fossa is deep and bears a rudimentary fascicular columella composed of 1–9 small elements, which is usually visible only in small specimens. Elongate specimens bear endothecal dissepiments, which significantly reduce the density of large specimens. The shallowest records in the New Zealand region (NZOI Stn Q741, S248, S260, M773, M779) occur in the Southland fiords, these specimens having broader pedicels than the deeper-water populations.

Thalamophyllia Duchassaing, 1870

Colonial corallum formed by extratentacular budding of ceratoid corallites from a thin common basal coenosteum resulting in reptoid to phaceloid coralla. Pali and columella absent; fossa deep. Endotheca absent.

TYPE SPECIES: *Desmophyllum riisei* Duchassaing & Michelotti, 1864 by monotypy.

REMARKS: *Thalamophyllia* differs from *Desmophyllum* in having a loosely integrated colonial corallum that is intermediate between reptoid and phaceloid. It is similar to *Hoplangia*, but differs primarily in the degree of corallite integration, the corallum of *Hoplangia* being intermediate between phaceloid and plocoid. The level of corallite integration of *Thalamophyllia* places it between *Desmophyllum* (solitary) and *Hoplangia* (phaceloid), the more advanced stage being *Lophelia* (sympodial). A similar progression is found among the dendrophylliid genera — *Balanophyllia* (solitary), *Rhizopsammia* (reptoid), *Cladopsammia* (phaceloid), and *Dendrophyllia* (sympodial). Four species are recognised in *Thalamophyllia* — *T. riisei* (Duchassaing & Michelotti, 1864), *T. tenuescens* (Gardiner, 1899), *T. gasti* (Döderlein, 1913), and *T. gombergi* Cairns, 1979.

Thalamophyllia tenuescens (Gardiner, 1899) n. comb.

(Plate 21, g-i)

Desmophyllum tenuescens Gardiner, 1899: 161–162, pl. 19, figs 1a-b.

MATERIAL EXAMINED: New Records: NZOI Stn K838, 5, USNM 94141; BS571, 1, MoNZ CO230; RV *Franklin* Stn 5/89/40, 1, AMS G15556; off Cebu, Mactan I., 22 m, 6, USNM 94142. Previous Records: 4 syntypes of *D. tenuescens*.

DISTRIBUTION: New Zealand region: Lord Howe Seamount Chain; Kermadec Islands (Map 19); 200–315 m. Elsewhere: Loyalty Islands; Philippines (reported herein); 22–73 m.

DESCRIPTION: Largest colony (USNM 94142) a cluster of 6 corallites united basally by thin coenosteum. Largest corallite from New Zealand region (NZOI Stn K838) 4.5 × 2.4 mm in calicular diameter and 20.8 mm in height, with a pedicel diameter of 2.4 mm. Corallites elongate-ceratoid and often broken from the basal coenosteum in collection, thus

resembling a solitary corallum (e.g., *Desmophyllum*). C1 highly ridged; C2 slightly less ridged; C3 absent, even when S3 are present. Calice hexagonal in outline, each CS1 forming a corner of the polygon. Theca white, covered with low, rounded granules.

Septa hexamerally arranged in 3 cycles according to the formula: S1>S2>>S3; however, in elongate, well-preserved coralla, the S3 are absent in the upper 2–4 mm of the corallum, sometimes giving the impression of a corallum with only 12 septa. S1 exsert (0.6–0.7 mm), with straight inner edges and relatively narrow, but their lower, inner edges converge deep in fossa. S2 less exsert, about half width of an S1, also with straight inner edges that converge deep in fossa. S3 rudimentary, absent from upper corallum. Fossa quite deep.

TYPES: Four of the 7 syntypes of *D. tenuescens* are deposited at the BM(NH) (1950.1.10.113–116); two more are deposited at the University Museum of Zoology, Cambridge (H. Zibrowius, pers. comm.).

TYPE LOCALITY: Sandal Bay, Lifu, Loyalty Islands, 73 m.

REMARKS: Although similar to *T. riisei* and *T. gasti*, *T. tenuescens* appears to be distinguished by its rudimentary to absent S3, this cycle as well as some S4 being well developed in the other two species. This appears to be the first report of this species subsequent to its description in 1899.

Rhizosmilia Cairns, 1978

Phaceloid coralla formed by extratentacular budding from a thin common basal coenosteum. Corallite bases increase in diameter by adding exothecal dissepiments over raised costae producing concentric rings of partitioned chambers that resemble polycyclic development in cross section. Vescicular endothecal dissepiments present. Paliform lobes present before penultimate septal cycle (usually P3). Columella variable, including papillose, lamellar, and fascicular.

TYPE SPECIES *Rhizosmilia gerdae* Cairns, 1978 by original designation.

REMARKS: Five species are recognised in this genus: *R. maculata* (Pourtalès, 1874); *R. gigas* (Van der Horst, 1931); *R. sagamiensis* (Eguchi, 1968); *R. gerdae* Cairns, 1978; and *R. robusta* Cairns, 1993.

Rhizosmilia maculata (Pourtalès, 1874)
(Plate 21, b, c)

Bathycyathus maculatus Pourtalès, 1874: 34-35, pl. 6, figs 5-6.

Caryophyllia maculata: Moseley 1881: 139-140 (in part: *Challenger* Stn 170, pl. 4, fig. 9, 9a); Hutton 1904: 315; Zibrowius 1974b: 755; Cairns, 1977a: 9-10, pl. 1, figs 1-3.

Not *Caryophyllia maculata*: Ralph 1948: 109, lower right figure (*C. profunda*).

Not *Caryophyllia* cf. *C. maculata*: Ralph & Squires 1962: 7, pl. 2, figs 1-2; Squires & Keyes 1967: 23, pl. 2, figs 5-6 (= *C. profunda*).

Rhizosmilia maculata: Cairns 1978: 216 (synonymy).

MATERIAL EXAMINED: New Records: None.

PREVIOUS RECORDS: Specimen reported by Moseley (1881) from *Challenger* Stn 170, BM(NH) (un-registered); holotype.

DISTRIBUTION: New Zealand region: one dubious record between Raoul and Macauley Islands, Kermadec Ridge; ?1152 m. Elsewhere: Western Atlantic from Florida to Brazil; 3-161 m (Cairns 1977).

TYPES: The holotype is deposited at the MCZ.

TYPE LOCALITY: Off Abrolhos, Brazil, 55 m.

REMARKS: The specimen reported as *Caryophyllia maculata* by Moseley (1881) from the Kermadec Islands is conspecific with typical western Atlantic specimens, but it is highly unlikely that a relatively shallow-water western Atlantic species would be present in the South Pacific, especially at the depth of 1152 m. It is also unlikely that the other specimen Moseley reported from off Brazil occurred as deep as 732 m. Furthermore, the record of *C. lamellifera*, also from *Challenger* Stn 170, is much deeper than all other records of this species from the Kermadecs (89-342 m). All this suggests a labelling error pertaining to the two lots of *C. maculata* and/or specimens from *Challenger* Stn 170. Some errors in *Challenger* station data have been noted before (Zibrowius 1980). I therefore do not consider *Rhizosmilia maculata* to occur in the New Zealand region.

Hoplangia Gosse, 1860

Colonial corallum formed by extratentacular budding of short cylindrical corallites from a common basal coenosteum or from lower theca

corallites. Colonies phaceloid to plocoid. Pali and columella absent. Endotheca absent.

TYPE SPECIES: *Hoplangia durotrix* Gosse, 1860, by monotypy.

REMARKS: Only one species is known — *Hoplangia durotrix* Gosse, 1860.

Hoplangia durotrix Gosse, 1860 (Plate 22, a-d)

Hoplangia durotrix Gosse, 1860: 338, pl. 10, fig. 9; Zibrowius 1980: 123-125, pl. 64, figs A-L, pl. 65, figs A-L (synonymy).

MATERIAL EXAMINED: New Records: off Mokohinau Island, 15 m, 5 colonies, AU6097 (AUM); off White Island, Bay of Plenty, 110 m, 3 colonies, MoNZ CO243; L1056, 10 corallites, AIM AK76084; L2633, 10 colonies, AIM AK78002; L2641, 4 colonies, AIM AK78002; L2680, 5 colonies, AIM AK78100; L2712, 6 colonies, AIM AK78093; L2715, 3 corallites, AIM AK78096; L2925, 5 colonies, AIM AK78232; L2926, 2 colonies, AIM AK78233; L2929, 2 colonies, AIM AK78226; L3069, 11 colonies, AIM AK78394, 3 colonies, USNM 94586. Previous Records: Specimens reported by Zibrowius (1980).

DISTRIBUTION: New Zealand region: northeastern New Zealand from off Three Kings Islands to East Cape, including: Poor Knights Island, Mokohinau Island, Great Barrier Island, Mercury Island, and White Island (Map 8); 7-110 m, most records hand-collected by Fred Brook from cave environments. Elsewhere: Mediterranean and northeastern Atlantic between England and Canary Islands; 3-150 m (Zibrowius 1980).

DESCRIPTION: The New Zealand specimens are represented only by relatively small plocoid colonies, the largest (AIM AK78232) about 50 mm in diameter and containing about 50 corallites. Corallites cylindrical, up to 4.1 mm in diameter, and primarily attached to a common basal coenosteum, but also budded from the walls of other corallites. Calices circular to slightly elliptical (GCD: LCD = 1.0-1.25). Costae poorly defined; theca and coenosteum uniformly covered with coarse granules. Corallum white.

Septa hexamerally arranged in 4 cycles, the fourth never complete, 32-36 septa being the commonest complement. All septa equally and only slightly exsert (about 0.3 mm) with moderately sinuous, smooth inner edges. S1 widest of septa, extending about three-quarters distance to centre of fossa in

upper corallum. The four lateral S1 are slightly wider than the two principal S1, their inner edges almost meeting in centre of fossa. S2 three-quarters to four-fifths width of S1; S3 about three-quarters width of S2; and S4 about three-quarters width of S3. Fossa deep, lacking a columella.

YPES: The holotype is deposited at the BM(NH) (1934.12.5.6).

TYPE LOCALITY: Weymouth Bay, English Channel; depth unknown.

REMARKS: The discovery of a shallow-water Mediterranean to northeast Atlantic cave-dwelling species off northeastern New Zealand with no apparent intermediate records is perplexing. It is possible that the species was transported on ship hulls during or just after World War II, and thus represents an introduced species. One of the lots of New Zealand specimens (MoNZ CO243) was attached to an antipatharian axis at 110 m, but most of the other colonies were collected from the roofs of caves or under overhangs at shallower depths of 7–53 m.

Goniocorella Yabe & Eguchi, 1932a

Corallum colonial and bushy, formed by extratentacular budding. Branch anastomosis common, the branches also united by slender, tubular coenosteal bridges. Pali and columella absent. Tabular endothecal dissepiments common and widely spaced.

TYPE SPECIES: *Pourtalesmilia dumosa* Alcock, 1902c, by original designation.

REMARKS: The virtually right-angled, extratentacular budding, the unique coenosteal bridges, and the widely spaced tabular dissepiments easily distinguish *Goniocorella* from all other coral genera. In the New Zealand region it might be confused with *Anomocora*, another elongate parasmiliid, but *Anomocora* bears paliform lobes, a columella, and lacks coenosteal bridges. *Goniocorella* might also be confused with *Solenosmilia*, but that genus has equal, dichotomous intratentacular budding.

The genus is monotypic.

Goniocorella dumosa (Alcock, 1902)
(Plate 22, e-h)

Pourtalesmilia dumosa Alcock, 1902c: 36–37, pl. 5, fig. 33.

Goniocorella dumosa: Squires 1960b: 197–198, pl. 33, figs 1–4; Ralph & Squires 1962: 11, pl. 4, fig. 1; Squires 1965: 785–788; Squires & Keyes 1967: 25, pl. 3, figs 15–16; Squires 1969: 17, pl. 6, map 2; Dawson 1979: 29; Cairns 1982: 31–34, pl. 9, figs 7–9, pl. 10, figs 1–2 (synonymy); Beu & Climo, 1974: 307; Beu, 1978: 395, figs 102; Wells 1986: 139–143; Cairns & Keller 1993: 250, pl. 6, fig. E; Cairns 1994: 63–64, pl. 27, fig. j (synonymy).

MATERIAL EXAMINED: New Records: NZOI Stn A502, NZOI; Stn D871, NZOI; Stn D899, NZOI; Stn E79, NZOI; Stn E400, NZOI; Stn E731, NZOI; Stn E756, NZOI; Stn E870, NZOI; Stn E908, NZOI; Stn F10, NZOI; Stn F81, NZOI; Stn F762, NZOI; Stn F868, NZOI; Stn G32, NZOI; Stn G172, NZOI; Stn G184, NZOI; Stn G200, NZOI; Stn G208, NZOI; Stn H636, NZOI; Stn H914, NZOI; Stn H923, USNM 94074; Stn I19, NZOI; Stn I721, NZOI; Stn J55, NZOI; Stn J58, NZOI; Stn J59, NZOI; Stn J485, NZOI; Stn J657, NZOI; Stn J676, NZOI; Stn J678, NZOI; Stn J679, NZOI; Stn J680, NZOI; Stn J683, USNM 94075; Stn J711, USNM 94076; Stn P68, USNM 94077; Stn Q4, NZOI; Stn Q11, NZOI; Stn Q13, NZOI; Stn Q20, NZOI; Stn Q25, NZOI; Stn Q31, NZOI; Stn Q38, NZOI; Stn Q40, NZOI; Stn Q340, NZOI; Stn Q341, NZOI; Stn Q343, NZOI; Stn R437, NZOI; Stn S22, NZOI; Stn S25, NZOI; Stn S29, NZOI; Stn S30, NZOI; Stn S53, NZOI; Stn S122, NZOI; Stn S181, NZOI; Stn S565, NZOI; Stn T109, NZOI; Stn V365, NZOI; Stn X121, NZOI; Stn X122, NZOI; Stn Z3907, NZOI; Stn Z3924, NZOI; Stn Z3925, NZOI; Stn Z3928, NZOI; Stn Z3934, NZOI; Stn Z3936, NZOI; Stn Z3939, NZOI; Stn 3941, NZOI; Stn Z3941, NZOI; Stn Z3946, NZOI; Stn Z3947, NZOI; Stn Z3950, NZOI; BS842 (O588), MoNZ; BS668 (R26), MoNZ; BS672 (R30), MoNZ; BS697 (R55), MoNZ; BS709 (R67), MoNZ; BS742 (R100), MoNZ; *Volcanolog* Stn 64, AUM, AU12299; *Tui* (Rumble II), AUM; Papanui Canyon, 420 m, Portobello Lab.; Taiaroa Canyon, 540–620 m, Portobello Lab. Previous Records: specimens reported by Squires (1960b, 1965) and Squires and Keyes (1967).

DISTRIBUTION: New Zealand: widespread in region from Norfolk Island to Campbell Rise, especially the Chatham Rise (Map 1); 88–1488 m, but most records between 300–400 m. Elsewhere: off South Africa, Indonesia, and Japan; 100–760 m.

YPES: Several syntypes are deposited at the ZMA (Coel. 1097).

TYPE LOCALITY: Siboga Stns 156, 259, Banda Sea, Indonesia, 469–487 m.

REMARKS: *Goniocorella dumosa* was adequately described and figured by Squires (1960b) and Cairns (1982, 1994). It is characterised by having large, bushy colonies, each branch bearing a terminal

corallite 3–4 mm in diameter. Most of its branches are reinforced by slender (1.0–1.5 mm diameter), hollow, tubular coenosteal bridges. C1–3 usually present. Three hexamerally arranged cycles of septa are present (S1>S2>S3), the S3 being quite rudimentary. All septa are nonexsert and relatively narrow. The fossa is deep and invariably sealed off by a thin, horizontal tabular dissepiment.

Large and numerous colonies of *G. dumosa* form the framework of deep-water (300–400 m) structures called "coppices" by Squires (1965). He reported three such structures on the Chatham Rise (NZOI Stns A910, D90) and Campbell Plateau (NZOI Stn D175); many more probably occur in the region. *Desmophyllum dianthus* is also abundant in these coppices, adding to their structural integrity. Because colonies of *G. dumosa* form a bushy interlocking network of branches, the hollow spaces formed within the colony provide numerous niches for a diverse assemblage of attached organisms, including the corals *Stenocyathus vermiformis* and *Flabellum knoxi*. Non-scleractinian members of this assemblage include various species of stolonifera, sponges, stylasterids, bryozoans, polychaetes, ophiuroids, asteroids, gastropods, bivalves, anemones, and foraminifera. Wells (1986) described a fossil coral thicket composed of *Goniocorella* from the late Mio-cene of Mount Bruce, northern Wairarapa, North Island. The distribution and characteristics of deep-water coral banks were reviewed by Cairns and Stanley (1982).

Anomocora Studer, 1878

Corallum subcylindrical and usually curved to serpentine in shape, often asexually budded from a parent corallum. Corallum considered to be colonial, although third-generation buds are rare. Paliform lobes usually present on S1–3; columella trabecular. Theca thin and tabular endothelial dissepiments present, both characters resulting in a light corallum.

TYPE SPECIES: *Coelosmilia fecunda* Pourtales, 1871, by monotypy.

REMARKS: At least two species are known in this genus — *A. fecunda* (Pourtales, 1871) and *A. carinata* Cairns, 1991. Specimens reported as *A. fecunda* by Marenzeller (1904a), Gardiner and Waugh (1939), and Eguchi (1968) require re-examination. The New Zealand specimens are remarkably similar to *A. fecunda*, which is known only from the North Atlantic.

Anomocora cf. *fecunda* (Pourtales, 1871)

(Plate 23, a-c)

?*Coelosmilia fecunda* Pourtales, 1871: 21–22.

Anomocora sp. Cairns 1984: 18–19, pl. 3, fig. G.

Not *Anomocora fecunda*: Eguchi 1968: C42, pl. C10, figs 1–5, pl. C20, figs 10–11, pl. C23, fig. 3.

MATERIAL EXAMINED: New Records: NZOI Stn J683, 1, NZOI; Stn K825, many, NZOI; Stn K838, many, USNM 94140; Stn K842, 3, NZOI; Stn P16, 3, NZOI; BS571, 1, MoNZ CO230. Previous Records: Syntypes of *C. fecunda*.

DISTRIBUTION: New Zealand region: Norfolk and Kermadec Ridges; Bay of Plenty (Map 14); 145–388 m. Elsewhere: Hawaiian Islands (244–322 m); ?North Atlantic at 73–563 m, as *A. fecunda* (see Cairns 1979, Zibrowius 1980).

DESCRIPTION: Corallum recumbent, curved to serpentine in shape, and invariably having a broken base resulting from budding from a parent corallum. Except for the three specimens from NZOI Stn P13, which are larger (GCD = 8.1 mm, length to 56 mm), all other New Zealand specimens reported herein have smaller calicular diameters (e.g., 3.1–4.9 mm), although they may attain a length of 61 mm. Their corallum size and shape is convergent with that of *Eguchiphyllia gaditana*, and both species co-occur at some stations. Each colony is represented by a primary axial corallite from which numerous (up to 20) corallites bud in an irregular fashion, often perpendicular to the axial corallite. Buds apparently begin development near the calicular edge, grow to a length of 8–13 mm simultaneously with an equal growth of the axial corallite, and ultimately detach, leaving a small scar on the parent corallum. Thus, an elongated (old) axial corallite may bear buds of progressively increasing length from the calice to 8–15 mm below the calice, below which the theca is studded with scars. Third-generation buds do not form. C1–2 represented by small ridges, the C3 being slightly broader and flat. Calicular margin serrate, a small triangular apex corresponding to the C1–2. Corallum white; theca quite thin, only about 0.1 mm.

Septa essentially hexamerally arranged in 4 cycles, the last cycle never complete. Small corallites (GCD about 3 mm) usually have only 3 cycles of septa (S1>S2>S3); but larger corallites (GCD = 4–5 mm) have a very irregular development of S4, some specimens having 1, 2, or no pairs of S4 in each system within the same corallite. Even in the largest axial corallites, 36 seems to be the maximum number of septa, achieved by having 1 pair of S4 in

each system. In well-preserved coralla, S1 are slightly exsert (about 1 mm), have slightly sinuous inner edges, and are rather thin, extending only about half distance to centre of calice. S2 are half as exsert and three-quarters as wide as an S1, each S2 bearing a thin paliform lobe about 0.5 wide. S3 rudimentary, unless flanked by a pair of S4, in which case the S3 is almost as wide as an S2 and bears a similarly shaped paliform lobe. S4 rudimentary. Widely spaced tabular dissepiments occur in elongate coralla, but are rarely seen in intact specimens, becoming obscured by paliform lobes and the trabecular columella.

Types: The syntypes of *C. fecunda* are deposited at the MCZ (CAIRNS 1979).

Type Locality: Southern Straits of Florida, 124–576 m.

Remarks: The New Zealand specimens of *Anomocora* are extremely similar to typical populations from the North Atlantic, although colonies are clearly at the small end of the size variation spectrum; the larger specimens from NZOI Stn P16 are more consistent with typical *A. fecunda*. The only possibly significant difference in the New Zealand specimens is their relatively well-developed paliform lobes before the S2 and accelerated S3, often forming a distinct crown. In western Atlantic specimens these lobes are extremely irregular in shape, often present only as twisted, contorted ribbons, and never found in a regular crown.

Solenosmilia Duncan, 1873

Corallum colonial, dendroid to subphaceloid in shape, achieved by equal dichotomous intratentacular branching. Lacinate P4 sometimes present; columella trabecular or absent. Tabular endothecal dissepiments present.

Type Species: *Solenosmilia variabilis* Duncan, 1873, BY monotypy.

Remarks: *Solenosmilia* is distinguished from other azooxanthellate colonial caryophylliids by its equal, intratentacular branching, each corallite continuing to increase in length and branch again. *Lophelia*, a similar genus, differs in having unequal intratentacular budding, which leads to a sympodial corallum. *Solenosmilia* is a monotypic genus.

Solenosmilia variabilis Duncan, 1873

(Plate 23, d, e)

Solenosmilia variabilis Duncan, 1873: 328, pl. 42, figs 11–18; Squires 1969: 18, pl. 6, map 2; Zibrowius 1980: 143–145, pl. 75, figs A–N (synonymy); Cairns 1982: 31, pl. 9, figs 4–5 (synonymy); Cairns & Parker 1992: 29–30, pl. 8, figs d–e; Cairns & Keller, 1993: 250, pl. 6, fig. D (SYNONYMY).

Material Examined: New Records: NZOI Stn E719, USNM 94143; Stn E800, NZOI; Stn E852, USNM 94144; Stn F319, NZOI; Stn I674, NZOI; Stn I676, NZOI; Stn R439, NZOI; Stn S46, USNM 94145; Stn S571, NZOI; Stn S573, NZOI; Stn T243, NZOI; Stn U568, NZOI; Stn U573, NZOI; Stn U574, NZOI; Stn Z3948, NZOI; Volcanolog Stn B30-28, AU11622, AUM; Volcanolog Stn B30-20/1, AU11621, AUM; Tui (Rumble II), AUM. Previous Records: *Syntypes* of *S. variabilis*.

Distribution: New Zealand: throughout the region from Kermadec and Three Kings Ridge to Macquarie Ridge, but not common (Map 2); 509–1260 m. Elsewhere: worldwide, except for off continental Antarctic and the North and East Pacific but including the Austral Seamounts off Cook Islands, 847 m (reported herein, NZOI Stn F319); 220–2165 m (Cairns 1982).

Types: *Syntypes* of *S. variabilis* are deposited at the BM(NH): 1883.12.10.73, 74–76 (ZIBROWIUS 1980).

Type Locality: Off southwestern Spain, 1190–2003 m.

Remarks: *Solenosmilia variabilis* is fully described and illustrated by Zibrowius (1980) and Cairns (1979, 1982) and will not be redescribed here. It is distinguished from other colonial corals in the New Zealand region by its distinctive intratentacular budding, which produces equal, three-dimensional dichotomous branching. According to Squires (1969), *S. variabilis* is the most southerly distributed colonial scleractinian: i.e., Eltanin Stn 1422 (56°19' S, 158°29' E, Hjort Seamount).

Family TURBINOLIIDAE Milne Edwards & Haime, 1848a

Conocyathus d'Orbigny, 1849

Corallum solitary, conical, and free. Transverse division not present. Theca perforate, the perforations being regular, elliptical pores. Costae well developed, in some species double the number of septa. Prominent P2 present; columella a solid central fusion.

TYPE SPECIES: *Conocyathus sulcatus* d'Orbigny, 1849, by monotypy.

REMARKS: *Conocyathus* is distinguished from other perforate tubinoliids by having large P2 and smooth costae. The history and characteristics of this genus are fully discussed by Filkorn (in press) who lists six valid species in the genus, five of which are exclusively fossil (Oligocene to Miocene) and the sixth, *C. zelandiae*, known from Oligocene to recent.

Conocyathus zelandiae Duncan, 1876

(Plate 23, f-i)

Conocyathus zelandiae Duncan, 1876: 431, pl. 38, figs 1-3; Tenison Woods 1878a: 294, 295, 302; Hutton 1904: 315; Squires 1958: 59, pl. 9, figs 15-18; Wells 1959: 286; Ralph & Squires 1962: 17; Squires & Keyes 1967: 29; Filkorn in press.

Conocyathus scrobiculatus Dennant 1902: 260-261, pl. 6, figs 1a-b.

Trematotrochus zelandiae: Harrison 1911: 1029-1030, pl. 57, fig. 14, pl. 58, figs 15-17; Folkson 1919: 14.

Turbinolia australiensis Gardiner, 1939: 332-333, pl. 21, figs 1-2.

MATERIAL EXAMINED: New Records (all from Australia): *Alpha Helix* Stn 79-M14, 7, USNM 80852; *Alpha Helix* Stn 79-M15, 4, USNM 80851; Watson's Bay, Port Jackson, NSW, depth unknown, 5, USNM 83011; "Western Australia", Verco Collection, depth unknown, 2, USNM 85713; Torquay, near Geelong, Victoria, Miocene, 2, USNM 67965 and 67979. Previous Records: Syntypes; fossil specimens reported by Squires (1958).

DISTRIBUTION: New Zealand region: Cook Strait; depth unknown (Duncan 1876); Oligocene of New Zealand (Squires 1958). Elsewhere: Persian Gulf; western Australia (Folkson 1919); off New South Wales; Arafura Sea (reported herein); Eocene to Miocene of South Australia (Dennant 1902). No previous record of this species had reported a depth of capture. The two lots from the *Alpha Helix* were collected at 22-24 m.

DESCRIPTION (based on Australian specimens): Corallum conical, free, and quite small: the largest specimen examined (USNM 83011) only 3.4 mm in calicular diameter and 6.1 mm in height. Basal angle acute, 25-28°; calice perfectly circular. C1-2 equal in size and length, extending from calice to about 0.2 mm beyond the base, where they all meet at the epicentre.

C1-2 0.12-0.15 wide for most of their length, but just below the origin of the C3 (i.e., lower 0.6-1.5 mm of corallum) they expand to almost twice that width. C3 originate 0.6-1.5 mm above the base and maintain a constant width (0.14-0.18 mm) to the calice. C4 originate 1.9-2.7 mm above base and also maintain a constant width of 0.10-0.12 mm to the calice; C4 do not correspond to septa. Costae covered with very low, rounded granules about 15 µm in diameter, producing a smooth costal texture. Intercostal furrows deep (about 60 µm) and equally wide (55-65 µm). Within each intercostal furrow are regularly spaced, circular (55-65 µm in diameter) pores. Corallum white.

Septa hexamerally arranged in 3 complete cycles (S1>S2>S3) with no traces of a fourth cycle even when C4 are well developed. S1 highly exsert (about 0.7 mm) and have straight, vertical inner edges that fuse with the columella low in fossa. S2 less exsert (about 0.5 mm) and about half the width of an S1, each bearing an enormous lamellar palus (P2) that is twice the width (about 0.6 mm) of its corresponding S2 and equally as exsert as an S1. S3 about 0.4 mm exsert and half the width of an S2, the inner edges of each pair of S3 firmly fused to its common S2 by 3 or 4 solid trabecular processes. Septal and palar faces covered with coarse granules 30-40 µm in height and 70-90 µm in diameter. Fossa shallow to absent. Columella a circular (0.6-0.8 mm in diameter), smooth, flat, encircled by and fused to the tall P2 palar crown and the lower, inner edges of the S1.

TYPES: The two syntypes of *C. zelandiae* are deposited at the BM(NH) (1890.2.27.2-3). The larger syntype measures 3.75 mm in calicular diameter and 7.8 mm in height. The holotype of *T. australiensis* is also presumed to be at the BM(NH). The holotype of *C. scrobiculatus* is deposited at the NMV (P27097).

TYPE LOCALITIES: *C. zelandiae*: Cook Strait, depth unknown. *T. australiensis*: Port Jackson, NSW, depth unknown. *C. scrobiculatus*: Eocene of Spring Creek, near Geelong, Victoria, Australia.

REMARKS: Although the type locality of *C. zelandiae* was given as "Cook Strait" by Duncan (1876), it has never again been reported in the recent fauna in the New Zealand region, which led Ralph and Squires (1962) and Squires and Keyes (1967) to doubt the authenticity of the type local

ity. It is true that Duncan described species from many different localities in his 1876 paper and that *C. zelandiae* is better known from off Australia and even the Persian Gulf; however, it should be noted that *C. zelandiae* has a very small corallum and could easily be overlooked. The description and illustrations provided above are based on Australian specimens, in the hope that additional specimens may be collected in the New Zealand region from 20–25 m.

Alatotrochus Cairns, 1994

Corallum solitary and cuneiform, with a rounded (unattached) base and prominent, costate thecal edge crests. Transverse division absent. Theca imperforate. Costae serrate, extending from calice to base, one costa corresponding to every septum and another to every interseptal space, resulting in twice as many costae as septa. Four cycles of highly exsert septa. Pali absent; columella linear-papillose.

TYPE SPECIES: *Platytrochus rubescens* Moseley, 1876, by original designation.

REMARKS: *Alatotrochus* differs from most other imperforate tubinoliid genera in having twice as many costae as septa, although some species of *Cryptotrochus* and *Conocyathus* also share this characteristic. Other distinguishing characters of the genus are its highly exsert and widely spaced septa and large, costate thecal edge crests. Only one species is known in the genus.

Alatotrochus rubescens (Moseley, 1876) (Plate 24, a, b)

Platytrochus rubescens Moseley, 1876: 552.

Sphenotrochus rubescens: Moseley 1881: 157–159, pl. 6, figs 8, 8a; Fowler, 1888: 11–14, figs 9–12; Fadlallah, 1983: 132.

Alatotrochus rubescens: Cairns 1994: 68–69, pl. 29, figs g–l.

MATERIAL EXAMINED: New Records: NZOI Stn E868, 1, NZOI; Stn P13, 1, USNM 94175. Previous Records: One syntype.

DISTRIBUTION: New Zealand region: known only from southern Norfolk Ridge midway between Norfolk Island and Three Kings Islands (Map

14); 449–751 m (based on dead coralla). Elsewhere: off Kyushu, Japan; Banda Sea; 193–236 m.

TYPES: Four syntypes are deposited at the BM(NH), one numbered 1880.11.25.163.

TYPE LOCALITY: *Challenger* Stn 192, 5°49'15 S, 132°14'15 E (Kai Islands, Banda Sea), 136 m.

REMARKS: This species was recently described and illustrated by Cairns (1994). The two New Zealand specimens were both dead when collected, the specimen from NZOI Stn E868 only a worn shell of a corallum. The better-preserved specimen (NZOI Stn P13) is 12.1 x 8.7 mm in calicular diameter and 12.9 mm in height and is typical of the species. The New Zealand records probably represent the southern limit of this species.

Sphenotrochus Milne Edwards & Haime, 1848a

Corallum solitary and cuneiform, with a rounded, unattached base. Transverse division lacking. Theca imperforate. Costae granular or smooth, one costa corresponding to each setum. Costae sometimes degenerate into discontinuous fragments. Pali absent; columella lamellar or composed of aligned papillae.

TYPE SPECIES: *Turbinolia crispa* Lamarck, 1816, by subsequent designation (Milne Edwards & Haime 1850: xvi).

REMARKS: This genus and its similarity to *Platytrochus* were discussed by Cairns (1989a). Approximately 35 species are recognized in the genus, which ranges from Eocene to recent, only 10 of which are known from the present day, at depths of 9–403 m. Two recent species are known in the New Zealand region.

Sphenotrochus (*Sphenotrochus*) Milne Edwards & Haime, 1848a

Sphenotrochus in which the costae are continuous from point of origin to calice.

REMARKS: Most of the species in the genus belong in the nominate subgenus, including eight of the ten recent species.