

Sphenotrochus (S.) ralphae Squires, 1964
(Plates 24, c-e, 25, a-c)

Sphenotrochus n. sp. B: Ralph & Squires 1962: 9, pl. 2, figs 7-8.

Sphenotrochus raphae (sic) Squires, 1964b: 5-6, pl. 1, figs 1-4.

Sphenotrochus ralphae: Squires & Keyes 1967: 24-25, pl. 3, figs 8-9; Dawson 1979: 30; ?Hayward *et al.* 1982: 160; Not Brook 1982: 169, fig. 4a; ?Hayward *et al.* 1984: 159; 1985: 101.

MATERIAL EXAMINED: New Records: NZOI Stn B808, 1, NZOI; Stn C344, 1, NZOI; Stn E319, 1, NZOI; Stn E340, 6, NZOI; Stn E391, 1, USNM 94183; BS329, 1, MoNZ CO326; BS346, 2, MoNZ CO327; BS415, 1, MoNZ CO333; BS732 (R90), 2, MoNZ CO340; BS744 (R102), 13, MoNZ CO341; BS747 (R105), 5, MoNZ CO342; off Mayor Island, stomach of *Nemadactylus macropterus*, 64-165 m, 50, AIM AK76312, 22, USNM 94587; off Mayor Island, stomach of *N. macropterus*, 64-146 m, 68, AIM AK76313, 10, USNM 94593, southwest end of Slipper Island, 7 m, 1, AUM. Previous Records: Holotype and paratypes of *S. ralphae* (USNM and AIM); specimens reported by Ralph and Squires (1962) as *Sphenotrochus* n. sp. B.

DISTRIBUTION: Endemic to New Zealand: off North Island from Cape Egmont to Bay of Plenty, including off Three Kings Islands (Map 9); 7-104 m.

DESCRIPTION: Corallum small and triangular, with flat faces and rounded edges. Angle of thecal edges 20-25°; inclination of thecal faces, 14-16°. Largest specimen examined (AIM AK76312) 5.5 x 3.6 mm in calicular diameter; coralla never more than 9 mm in height. Calice elliptical: GCD: LCD = 1.50-1.63. Costae sharply ridged near base, but rounded and coarsely granular for upper two-thirds of corallum. One to 2 rows of large rounded granules up to 0.1 mm in diameter occur on the upper edges of the costae, whereas much smaller, pointed granules about 30 µm tall and 20 µm in diameter project from the lateral faces of the costae into the intercostal spaces. Near calice costae are 0.27-0.31 mm wide and separated by deep (0.35 mm at edge) intercostal furrows 0.11-0.12 mm wide. C1-2 continuous from base to calice; C3 originate within 1 mm of base; the C4 within 2.5 mm of base. Costae vertical in center of thecal face, but tend to be obliquely parallel to thecal edges toward the corallum edge. Corallum white and sometimes porcellanous.

Septa hexamerally arranged in 4 cycles, the last incomplete, according to the formula: S1-2>S3>S4. Almost all coralla examined between a GCD of 2.6 and 5.4 mm contain 32 septa, having 1 pair of S4 in each of the 4 end half-systems (6:6:12:8). Two coralla (GCD = 4.1 mm and 5.4 mm) have 34 septa, having an additional pair of S4 in one of the end half-systems, and another corallum (AIM AK76313) has 36 septa, having 2 additional pairs of S4. S1-2 highly exsert (about 0.7 mm) and have vertical to slightly concave lower inner edges, which fuse with the columellar elements deep in fossa. S3 less exsert (about 0.5 mm), one-third to half width of an S1-2, have finely dentate inner edges, and are rudimentary lower in fossa. S4 about 0.4 mm exsert and about half width of an S3. Fossa relatively shallow, containing an elongate, papillose columella composed of 5-8 finely granular, aligned elements. Alignment of columellar elements sometimes slightly irregular directly in centre of fossa, where 2 elements may be paired adjacent to the medial S2. Columellar elements interconnected basally and usually 0.2-0.3 mm in diameter. In some coralla the terminal columellar elements (those adjacent to the principal S1) are short lamellae.

TYPES: The holotype and 6 paratypes are deposited at the AIM. Seven paratypes are also deposited at the USNM (68262).

TYPE LOCALITY: Between Tryphena Harbour and Cape Barrier, Great Barrier Island; 44 m.

REMARKS: See the discussion of *S. squiresi* for comparisons to that closely related species. Because these two species are so similar, some of the previous reports are listed with a query in the synonymy, pending re-evaluation of those specimens.

In two (AIM AK76313) of the approximately 200 coralla examined, the calice was in the process of intratentacular division.

Sphenotrochus (S.) squiresi n. sp.
(Plates 24, f, g, 25, d-f)

Sphenotrochus intermedius: Gardiner 1939: 333 (in part: *Discovery* Stn 934).

?*Sphenotrochus (S.) ralphae*: Brook 1982: 169, fig. 4a.

MATERIAL EXAMINED: Types, q.v. Specimen reported

as *S. intermedius* by Gardiner (1939), *Discovery* Stn 934, BM(NH) 1939.7.20.473.

DISTRIBUTION: Known only from a very small region between Three Kings Islands and North Cape (Map 9); 66–318 m, but most records over 100 m.

DESCRIPTION: Viewed from the side, the lower 3–4 mm of a corallum is either U-shaped or triangular, the angle of the thecal edges ranging from 70–90°. However, above a corallum height of about 4 mm the thecal edges as well as the faces are parallel. Holotype 6.6 x 3.7 mm in calicular diameter and 10.0 mm in height; largest specimen (BS905) 7.1 x 3.9 mm in calicular diameter and 11.4 mm in height. Calice elliptical, but elongate: GCD: LCD = 1.70–1.96. Costae rounded from calice to base and coarsely granular, some worn costae appearing to be moniliform. Costal granules triangular, up to 70 µm tall and 80 µm in basal diameter, projecting from both the upper and lateral edges of each costa. Costae orientated perfectly vertical, even those near thecal edge. Costae 0.20–0.25 mm wide and separated by deep (0.2 mm) intercostal furrows 0.07–0.20 mm wide. C5 do not originate from C4 trifurcations but independently from the edge costae about 3.5 mm above base. Corallum white.

Septa hexamerally arranged in 5 cycles, the fourth and fifth incomplete, according to the formula: S1–2>S3>S4>S5. Almost all coralla examined of GCD 3.6 to 6.6 mm contained 40 septa, having 1 pair of S4 and 1 pair of S5 in each end half-system (6:6:12:8:8). Very small coralla (GCD < 2.7 mm) have only 32 septa, whereas several coralla 5.2–7.1 mm in GCD (BS642, BS905) have 46 septa, including 3 additional pairs of S5 in the end systems. S1–2 highly exsert (about 0.8 mm) and have very sinuous, vertical inner edges that fuse with the columellar elements. S3 less exsert (about 0.6 mm), have dentate inner edges, and are about half the width of an S1–2, except for the 4 S3 in the end half-systems, which are almost as wide as the S1–2. S4, which are only present in the end half-systems, about half width of an accelerated S3; S5 about two-thirds width of an S4. Fossa shallow, containing an elongate, papillose columella. In the holotype, 5 columellar elements are present: 2 terminal lamellar elements and 3 central aligned papillae, which are pillar-shaped. Other coralla bear a medial row of coarse (0.18–0.20 mm in diameter), granular pillars, interconnected at their bases.

TYPES: Holotype: NZOI Stn C764, NZOI H-630. Paratypes: NZOI Stn C766, 2, P-1030, USNM 94184; Stn E274, 2, P-1031, NZOI; Stn E278, 1, P-1032, NZOI; Stn E302, 1, P-1033, NZOI; Stn E340, 1, P-1034, NZOI; Stn E387, 1, P-1035, NZOI; Stn E390, 1, P-1036, USNM 94185; BS392, 10, MoNZ CO329; BS394, 7, MoNZ CO331; BS395, 13, MoNZ CO332; BS631 (P441), 6, MoNZ CO334; BS632 (P449), 3, MoNZ CO335; BS635 (P475), 4, MoNZ CO336; BS637 (P485), 2, MoNZ CO330, 1, USNM 94187; BS638 (P487), 2, MoNZ CO354; BS641 (P571), 3, MoNZ CO338; BS642 (P574), 24, MoNZ CO274; BS893 (O639), 24, MoNZ CO343; BS895 (O641), 33, MoNZ CO307, 19, USNM 94186; BS898 (O644), 2, MoNZ CO289; BS899 (O645), 2, MoNZ CO301; BS902 (O648), 1, MoNZ CO346; BS904 (O650), 2, MoNZ CO344, 1, USNM 94188; BS905 (O651), 53, MoNZ CO345, 9, USNM 94189; BS911 (O657), 43, MoNZ CO347; BS912 (O658), 5, USNM 94190; BS913 (O659), 2, MoNZ CO349.

TYPE LOCALITY: 34°08.5' S, 172°08.5' E (off Three Kings Islands), 66 m.

ETYMOLOGY: This species is named in honour of Donald F. Squires, who has advanced our knowledge of New Zealand Scleractinia more than anyone.

REMARKS: *Sphenotrochus squiresi* differs from *S. ralphae*, the other recent *Sphenotrochus* from New Zealand, in two basic ways: corallum shape and number of septa. *Sphenotrochus squiresi* has parallel thecal edges and thus vertically oriented costae, whereas those of *S. ralphae* diverge at a constant angle and thus have obliquely orientated costae. Secondly, *S. squiresi* usually has 40 septa, *S. ralphae*, 32 septa. *Sphenotrochus squiresi* also differs in having a more compressed calice (GCD: LCD = 1.70–1.96 vs 1.50–1.63 for *S. ralphae*); sinuous inner septal edges of S1–2; and coarser columellar elements. Bathymetrically, *S. squiresi* is usually found deeper than 100 m, whereas the range of *S. ralphae* is 7–104 m.

Three fossil *Sphenotrochus* are known from New Zealand: *S. aschistus* Squires, 1958 (early Pliocene); *S. laculatus* Squires, 1962a (Tertiary); and *S. sp. A* of Squires (1962a) (Tertiary), all of which are easily distinguished from *S. squiresi* by their greater number of septa and different costal morphology. Among the ten other recent species in the genus (see Cairns 1989a; Cairns & Keller 1993), *S. squiresi* is most similar to *S. gardineri* Squires, 1961, known only from the subantarctic Magel-

lanic region at 9–403 m (Cairns 1982). Both species have vertically aligned costae, and small specimens of *S. gardineri* have the same configuration and number of septa as *S. squiresi*, but larger specimens have 48 septa. Furthermore, *S. gardineri* has a triangular shape (constantly divergent thecal edges); and thin, ridge-like, finely granular costae, not thick and coarsely granular as in *S. squiresi*.

Kionotrochus Dennant, 1906

Corallum solitary, often reproducing asexually by transverse division. Anthocaulus cylindrical; anthocyathus conical with a rounded base. Theca imperforate; costae finely granular, one costa corresponding to each septum. Septa 24–26. Poorly defined styliform paliform lobes (P2) present, often indistinguishable from the styliform columella.

TYPE SPECIES: *Kionotrochus suteri* Dennant, 1906, by monotypy.

REMARKS: *Kionotrochus* is compared to *Cryptotrochus* in the discussion of that genus, and the history of the genus *Kionotrochus* is discussed by Cairns (1989a). Only one species is recognised: *K. suteri*.

Kionotrochus suteri Dennant, 1906

(Plates 25, g, h, 26, a-f)

Kionotrochus suteri Dennant, 1906: 155–156, pl. 5, fig. 5a-b; Wells 1937: 239, pl. 1, figs 17–18; Cairns 1988: 710, figs 13–14; 1989a: 29.

Kionotrochus (K.) suteri: Squires 1960a: 283–287, figs 1–11; Ralph & Squires 1962: 8–9, pl. 2, figs 5–6; Squires 1964b: 6–7, pl. 2, figs 10–14; Squires & Keyes 1967: 25, pl. 3, fig. 10–11; Dawson 1979: 29; Brook 1982: 169–171, fig. 4b-e; Hayward, *et al.* 1985: 101.

MATERIAL EXAMINED: New Records: NZOI Stn C748, 1, NZOI; Stn C752, 10, NZOI; Stn C769, 27, NZOI; Stn C771, 10, NZOI; Stn C774, 7, NZOI; Stn C776, 10, NZOI; Stn C778, 1, NZOI; Stn C780, 20, NZOI; Stn C781, 22, USNM 94193; Stn C782, 3, NZOI; Stn C792, 20, USNM 94194; Stn C793, 100, USNM 94195; Stn E255, 2, NZOI; Stn E256, 6, NZOI; Stn E258, 3, NZOI; Stn E261, 13, NZOI; Stn E274, 2, NZOI; Stn E278, 1, NZOI; Stn E348, 1, NZOI; Stn E349, 3, NZOI; Stn E351, 3, NZOI; Stn E356, 1, NZOI; Stn E358, 4, NZOI;

Stn E359, 5, NZOI; Stn E364, 7, NZOI; Stn E370, 1, NZOI; Stn E374, 1, NZOI; Stn E378, 1, NZOI; Stn E389, 3, NZOI; Stn E391, 1, NZOI; Stn F75, 14, USNM 94199; Stn F915, 1, USNM 94200; BS335, 2, MoNZ; BS362, 30, MoNZ; BS363, 30, MoNZ; BS369, 30, MoNZ; BS370, 10, MoNZ; BS372, 30, MoNZ; BS380, 10, MNZ; BS391, 8, MoNZ CO253; BS394, 1, MoNZ; BS395, 13, MoNZ CO350; BS631 (P441), 10, MoNZ CO351; BS632 (P449), 14, MoNZ CO352; BS633 (P461), 2, MoNZ CO269; BS634 (P465), 4, MoNZ CO271; BS635 (P475), 17, MoNZ CO353; BS636 (P476), 8, MoNZ; BS637 (P485), 20, MoNZ; BS638 (P487), 3, MoNZ CO354; BS639 (P515), 13, MoNZ CO355; BS641 (P541), 9, MoNZ; BS724 (R82), 10, MoNZ; BS733 (R91), 25, MoNZ; BS734 (R92), 15, MoNZ; BS747 (R105), 19, MoNZ CO356; BS756 (R114), 10, MoNZ; BS768 (R126), 8, MoNZ; BS833 (O578), 80, MoNZ CO286, 20, USNM 94201; BS881 (O627), 50, MoNZ CO280; BS893 (O639), 194, MoNZ CO357; BS895 (O641), 50, MoNZ CO306; BS898 (O644), 8, MoNZ CO291; BS905 (O651), 3, MoNZ CO358; BS910 (O656), 1, MoNZ CO293; BS911 (O657), 43, MoNZ CO360; BS912 (O658), 26, MoNZ CO359. Previous Records: 23 syntypes (USNM 94202); specimens reported by Wells (1937), Ralph and Squires (1962), Squires (1964), and Squires and Keyes (1967).

DISTRIBUTION: Endemic to New Zealand, from off East Cape to just north of Kaipara Harbour, including Three Kings Islands (Map 8); 44–622 m, but most records between 100–200 m.

DESCRIPTION: Fixed anthocaulus cylindrical, up to 2 mm in height and 2.0–2.7 mm in diameter, often attached to a bivalve shell. Anthocaulus polycyclic, the first thecal ring forming at a diameter of about 1.1 mm, the second at 2.0 mm, and the third, if present, at about 2.7 mm. The anthocaulus invariably contains 3 cycles of 24 (total) septa, a central columellar tubercle, and often 6 P2. Young anthocyathi (Plate 26, a, b) are tympanoid, matching the calicular diameter of the parent anthocaulus (i.e., 2.0–2.7 mm), have 24 septa and 6 P2, and usually show some evidence of a basal detachment scar. Anthocyathi soon cover over their detachment scar as they transform from a tympanoid to a conical corallum with a rounded base. Largest corallum examined (BS833) 6.8 mm in calicular diameter and 6.5 mm in height, the H:W of mature specimens often approximating 1.0. Costae 0.38–0.42 mm wide, rounded, and covered with fine, blunt granules 40–50 µm in height and width. Intercostal furrows deep and wide (0.15 mm), extending from base to calicular edge. Corallum white.

Septa hexamerally arranged in 3 or 4 cycles, the fourth cycle never complete, according to the formula: S1>S2>S3>S4. Coralla of 3.8–5.1 GCD may have only 24 septa, whereas the apparent maximum of 36 septa (1 pair of S4 in each system) occurs in specimens of 4.0–6.1 mm GCD; the largest calice of GCD 6.8 mm has only 34 septa. S1 about 0.8 mm exsert and quite wide, having vertical, slightly sinuous inner edges that reach far into the fossa. S2 equally exsert but only about four-fifths width of an S1. S3 less exsert than and about half width of an S2. S4, if present, about half width of an S3. Styliiform paliform lobes usually present before S2, sometimes forming a crown of 6 pillars surrounding the columella; however, the expression of P2 is variable, the lobes sometimes indistinguishable from the central columella. Columella styliiform, usually consisting of 1, but up to 3, pillars. Paliform lobes and columellar elements all about 0.5 mm in diameter and finely granular. Fossa shallow.

TYPES: Seventy syntypes of *K. suteri* were mentioned by Dennant (1906): the holotype and 39 paratypes are deposited at the NMV (F41513, F59350, respectively); 23 syntypes, including 8 anthocauli, are also deposited at the USNM (94202).

TYPE LOCALITY: 15 miles (24 km) off Great Barrier Island, New Zealand, 201 m.

REMARKS: *Kionotrochus suteri* is a commonly collected, relatively shallow-water coral in the New Zealand region and, as such, has been studied and redescribed several times — Squires (1960a, 1964b), Ralph and Squires (1962), and Brook (1982).

As Dennant (1906) observed in his original description, *K. suteri* asexually buds free (unattached) anthocyathi from a fixed (attached) anthocaulus, the latter also called the trophozoid in previous literature. Although the evidence for this mode of reproduction was circumstantial, it was generally accepted (Squires 1964b; Ralph & Squires 1962), the first and only example of an anthocaulus still attached to its anthocyathus being that figured by Brook (1982: fig. 4d). Anthocauli are not as common as anthocauli in the study material, constituting about 5% of the specimens examined.

Cryptotrochus Cairns, 1988

Corallum solitary, conical, and free, with a pointed base. Transverse division and asexual fragmentation lacking. Theca imperforate. Costae well developed, sometimes double the number of septa, i.e., 1 corresponding to each septum and each interseptal space. Four cycles of highly exsert septa. Prominent P2 present; columella papillose.

TYPE SPECIES: *Cryptotrochus carolinensis* Cairns, 1988, by original designation.

REMARKS: *Cryptotrochus* is most similar to *Kionotrochus*, but the latter differs in reproducing by transverse division, which results in a flat or bowl-shaped base, and in having much less developed (obscure) P2. Three species are recognised in the genus — *C. carolinensis* Cairns, 1988 (type species, from western Atlantic, 320–338 m); *C. javanus* Cairns, 1988 (Java Sea, 585 m); and *C. venustus* (Alcock, 1902a).

Cryptotrochus venustus (Alcock, 1902) n. comb.
(Plates 26, g-i, 27, a, b)

Ceratotrochus venustus Alcock, 1902a: 92; 1902c: 10, pl. 1, figs 5, 5a.

MATERIAL EXAMINED: New Record: NZOI Stn U584, 16, NZOI, 5, USNM 94178. Previous Record: Holotype of *C. venustus*.

DISTRIBUTION: New Zealand region: known only from one record on Three Kings Ridge (Map 15); 1137 m. Elsewhere: Kepulauan Kai, eastern Banda Sea, Indonesia; 397 m.

DESCRIPTION: Corallum conical, having a pointed base the edges of which diverge at an angle of 50–60° but in the upper corallum becoming almost parallel. Largest specimen examined (NZOI Stn U584) 13.3 x 13.2 mm in calicular diameter and 14.9 mm in height, which is larger than the holotype of 9.6 mm GCD. Calice circular to only very slightly elliptical: GCD: LCD = 1.01–1.14. Costae ridged, 0.15–0.25 mm in width, and finely spinose, the spines only about 23 μm in diameter. Twice as many costal ridges exist as septa (usually 96), one corresponding to each septum and a slightly narrower one corresponding to each interseptal space. Costae straight to slightly

crooked and discontinuous in lower third of corallum, each costa fragmenting into segments and thus not displaying distinct costal trifurcations characteristic of most other turbinoliids. Inter-costal furrows relatively shallow and of equal width to costae. Corallum white.

Septa hexamerally arranged in 4 complete cycles according to the formula: S1>S2>S3>S4, only 1 corallum having an additional pair of S5 (50 septa). S1 highly exsert (about 3 mm) with straight, vertical inner edges that fuse to the columella. In one specimen each S1 appears to have a small paliform lobe directly adjacent to the columella. S2 also highly exsert (up to 2.5 mm), about four-fifths width of an S1, also with straight, entire edges, each of which is separated from its corresponding P2 by a deep, wide notch. P2 quite prominent (up to 4 mm tall) and variable in thickness, in some coralla (Plate 26, h) being quite slender (0.6 mm wide), tall, and pointed (lanceolate), but in other specimens being much wider (up to 1.5 mm) and thicker, with a blunt upper edge (lamellar). In all cases, the 6 P2 form a very distinct crown of pali that rises well above the columellar elements and reaches as high as the upper edges of the S3. S3 about 1.8 mm exsert, three-quarters width of an S2, and have straight to slightly concave inner edges. In many coralla a small P3 is also present on the inner edges of some or all S3 in a corallum, these P3 often fusing to the base of the adjacent P2. Presence of P3 variable, some coralla having none. S3 about 1.1 mm exsert, and about one-third width of an S3. Septal faces smooth and planar; whereas palar faces are coarsely granular. Fossa shallow, the paliform lobes extending above the calicular edge; columella composed of 2-7 granular papillae fused among themselves and to inner edges of S1 and P2.

TYPES: The holotype is deposited at the ZMA (Coel. 1184).

TYPE LOCALITY: *Siboga* Stn 256, 5°26.6' S, 132°32.5' E (eastern Banda Sea), 397 m.

REMARKS: Alcock's (1902a, c) characterisation of the holotype as having five cycles of septa was incorrect. The specimen does have five cycles of costae (actually only 88), but only four cycles of septa.

Cryptotrochus venustus is quite similar to *C. javanus* in corallum shape and size, and calicular characteristics (number and shape of septa and

P2 crown). They are also found in the same geographic and bathymetric ranges, but *C. venustus* differs primarily in the number and morphology of its costae. It has twice as many costae as *C. javanus* (88-96 vs 48); the costae of *C. venustus* are narrower and less well defined, especially in the lower corallum; and *C. venustus* lacks costal trifurcations. Furthermore, the costal granulation of *C. venustus* is much finer and the intercostal furrows shallower.

Peponocyathus Gravier, 1915

Corallum solitary, globose to cylindrical. Transverse division present. Theca imperforate; costae serrate, one corresponding to each septum. Pali present before all but last cycle of septa; columella papillose.

TYPE SPECIES: *Peponocyathus variabilis* Gravier, 1915 (= *P. folliculus* (Pourtales, 1868)) by original designation.

REMARKS: Re-examination of specimens from the Atlantic, off Japan, the Philippines, and those from New Zealand convince me that Zibrowius (1980, 1984: 84) was correct in assuming that *P. folliculus* could be distinguished from *P. stimpsonii* (= *P. australiensis*) by reproducing through transverse division. I had previously (Cairns, 1989a: 29) considered specimens of *P. folliculus* in the process of transverse division and those with flat bases to be the exclusive result of parricidal budding and rejuvenescence, as did Stolarski (1992). It is often difficult, if not impossible, to distinguish between the two processes in many specimens, but, in general, parricidal budding results in multiple coralla that remain attached to one another, and daughter coralla that have fewer septa than the parent. Furthermore, rejuvenescent coralla do not have costae continuous between parent and daughter. Transverse division results in anthocyathi that become free of the parent anthocaulus; coralla with horizontal basal scars with poorly formed costae; and daughter coralla with the same number of septa as the parent. In the rare cases in which an anthocyathus is still partially attached to its parent, it can be seen that costae are continuous from parent to daughter. Because anthocyathi can quickly regenerate the basal region and thus cover the detachment scar with well-developed costae, this character is best seen in small, young specimens or those just detached.

Stolarski (1992), I think correctly, decided that peponocyathid species that reproduce by transverse division should be generically distinct from those that do not undergo fission, proposing the name *Truncatocyathus* (type species *Discotrochus duncani* Reuss, 1871, Miocene of Poland) for those species. But, if *P. folliculus* is considered to be a transversely dividing species, *Truncatocyathus* becomes a junior synonym of *Peponocyathus*, since *P. variabilis* (= *P. folliculus*) is the type species of *Peponocyathus*. Another junior synonym of *Peponocyathus* is *Cylindrophyllia* Yabe & Eguchi, 1937. What is actually needed is a name for the peponocyathan species that do not undergo transverse division, for which two names are available — *Deltocyathoides* Yabe & Eguchi, 1932a, and *Paradeltoocyathus* Yabe & Eguchi, 1937, both of which have been applied to the other recent peponocyathan species, *P. australiensis* (Duncan, 1870) (see Cairns 1989a). Species included in *Peponocyathus*, as emended, are: *P. variabilis* Gravier, 1915 (= *P. folliculus* (Pourtalès, 1868)); *P. duncani* (Reuss, 1871) (= ?*P. pseudo-duncani* [Vašiček], 1946); *P. lecomptei* (Wells, 1937); *P. minimus* (Yabe & Eguchi, 1937); and *P. dawsoni*, n. sp.

Peponocyathus dawsoni n. sp.

(Plate 27, d-f, h-j)

?*Deltocyathus lens*: Gardiner 1939: 333.

Notocyathus (*Paradeltoocyathus*) *orientalis*: Squires & Keyes 1967: 24, pl. 3, figs 2–7; Dawson 1979: 30.

MATERIAL EXAMINED: Types, q.v.

DISTRIBUTION: New Zealand: throughout the region from Three Kings Ridge to off Auckland Island, but not common (Map 6); 87–988 m.

DESCRIPTION: Corallum variable in shape, often tympanoid, cylindrical, or onion-shaped, the calice often being smaller in diameter than mid-corallum. Base (of anthocyathus) usually flat and poorly constructed, characteristic of separation from a basal anthocaulus; a distinct basal scar usually present. All specimens examined unattached, except for the holotype, which consists of two anthocyathi still attached, the parent corallum itself unattached. Largest specimen examined (NZOI Stn C510) 8.0 mm in calicular diameter, 5.5 mm in height, and 5.4 mm in basal scar diameter. Holotype 6.5 mm in diameter and

3.5 mm in height. Costae equal (0.10–0.12 mm) in width and finely granular, separated by deep intercostal furrows. Corallum white.

Septa arranged in 3 to 4 cycles, coralla as small as 3.4 mm having a complete fourth cycle. S1 exsert and quite broad, their inner edges extending well into fossa. S2 about four-fifths width of an S1; S3 about two-thirds width of an S2; S4 slightly wider than S3. A small paliform lobe occurs before each S1, a much larger palus before each S2, and a small palus before each S3. Each pair of S4 merge before its common P3, and each pair of P3 merge with its common P2 closer to the columella. Fossa quite shallow; columella papillose.

TYPES: Holotype: Chatham Island Expedition Stn 4, MoNZ CO245. Paratypes: NZOI Stn A910, 8 P-1037, USNM 81802; NZOI Stn C510, 1, P-1038; Stn D149, 4, P-1039; NZOI; Stn D173, 8 P-1040, NZOI; Stn E274, 1 P-1041, USNM 94182; Stn U582, 6, P-1042; USNM 94180; BS634 (P462), 5, MoNZ CO271; Chatham Island Expedition Stn 4, 7, MoNZ, 6, USNM 94181; MU76-139, 2, Portobello Marine Laboratory.

TYPE LOCALITY: 43°14' S, 176°11' E (north of Chatham Island), 366 m.

ETYMOLOGY: This species is named in honour of Elliot W. Dawson in recognition of his work on New Zealand natural history.

REMARKS: *Peponocyathus dawsoni* differs from other species in the genus by attaining a much larger size, having a squat shape (diameter usually larger than height), and in having four cycles of septa at a relatively small size.

Tropidocyathus Milne Edwards & Haime, 1848a

Corallum solitary and cuneiform to campanulate in shape, with a rounded (unattached) base and occasionally with alate lateral crests. Transverse division lacking but asexual fragmentation common in one species. Theca imperforate; costae serrate to granular and correspond to septa. Pali present in 3 crowns (P1–3) before all but last cycle. Columella papillose to lamellar.

TYPE SPECIES: *Flabellum lessoni* Michelin, 1842, by monotypy.

REMARKS: *Tropidocyathus* was discussed and its five species listed by Cairns (1989a). It is distinguished from other turbinoliid genera by its 3 well-developed paler crowns and its relatively large size.

Tropidocyathus pileus (Alcock, 1902)
(Plate 28, a-c)

Trochocyathus pileus Alcock, 1902a: 96–97; 1902c: 15–16, pl. 2, fig. 11, 11a.

Tropidocyathus pileus: Cairns 1989a: 34–35, pl. 17, figs a-h (synonymy); 1994: 68, pl. 29, figs d-e (synonymy).

MATERIAL EXAMINED: New Record: NZOI Stn P14, 1, USNM 94176. Previous Records: Syntypes of *T. pileus*.

DISTRIBUTION: New Zealand region: known only from one specimen collected on the southern Norfolk Ridge halfway between Norfolk Island and Three Kings Islands (Map 11); 319 m. Elsewhere: widespread in Indo-West Pacific from off Tanzania to off Japan (see Cairns 1994); 123–522 m.

TYPES: Four syntypes are deposited at the ZMA (Coel. 7352, 1326).

TYPE LOCALITY: *Siboga* Stn 95, 5°43' N, 119°40' E (Sulu Archipelago), 522 m.

REMARKS: The single specimen reported herein is 15.9 x 11.7 mm in calicular diameter and 16.3 mm in height; contains 56 septa (1 pair of S5 in each end half-system); and was dead and slightly damaged on collection. It is typical in size and morphology to previously described and illustrated specimens from off Japan and the Philippines (Cairns 1989a, 1994) and need not be redescribed here. This specimen represents the southernmost record of the species, which was previously 26°32' S off Queensland (Cairns 1989a).

Notocyathus Tenison-Woods, 1880

Corallum solitary and conical, with a free, pointed base. Transverse division lacking. Theca imperforate; costae serrate, corresponding to septa. Septa slightly exsert. Pali present before all but last cycle, the P1–2 often suppressed in adult stage; pairs of P3 unite in V-shaped structures. Fossa shallow; columella papillose.

TYPE SPECIES: *Caryophyllia viola* Duncan, 1865, by subsequent designation (Felix 1927).

REMARKS: This genus and its similarity to *Peponocyathus* are discussed by Cairns (1989a). Five nominal species are known, including three from the Oligocene to Miocene of Australia and New Zealand, and two recent species — *N. conicus* and *N. venustus* (Alcock, 1902b).

Notocyathus conicus (Alcock, 1902)
(Plate 27, c, g)

Citharocyathus conicus Alcock, 1902b: 118–119; 1902c: 22, pl. 3, fig. 18, 18a; Yabe & Eguchi, 1941b: 212, figs 5a-b.

Sphenotrochus viola: Gerth 1921: 393.

Not *Notocyathus conicus*: Squires 1958: 54–55, pl. 9, figs 12–14 (= *N. euconicus* and *Peponocyathus* sp.); 1962a: 147 (= *Peponocyathus* sp.).

Notocyathus conicus: Cairns 1989a: 28, pl. 13, figs a-i (synonymy); 1994: 64–65, pl. 28, figs a-b.

MATERIAL EXAMINED: New Records: NZOI Stn G3, 2, NZOI; BS441, 5, MoNZ CO259, 3, USNM 94177. Previous Records: 2 syntypes.

DISTRIBUTION: New Zealand region: northern Norfolk Ridge; Kermadec Ridge off Raoul Island (Map 10); 402–710 m. Elsewhere: off Japan; Philip-pines; Indonesia; 34–923 m. Pleistocene of Ryukyu Islands (Yabe & Eguchi 1941b). Miocene of Java (Gerth 1921).

TYPES: Two syntypes of *C. conicus* are deposited at the ZMA (Coel. 1185).

TYPE LOCALITY: *Siboga* Stn 95, 5°43.5' N, 119°40' E (Sulu Sea), 522 m.

REMARKS: *Notocyathus conicus* was fully described and illustrated by Cairns (1989a, 1994) based on specimens from off the Philippines and Japan, respectively. The New Zealand specimens, particularly those from Stn BS441, are very similar to the syntypes from the Sulu Sea, the largest New Zealand specimen measuring 7.7 mm in calicular diameter and 8.1 mm in height. *Notocyathus conicus* is similar to *N. venustus*, based on a detailed comparison made by Cairns (1989a). An exclusively fossil species also occurs in New Zealand, *N. euconicus* Squires, 1962a (late Oligocene to middle Miocene), which is also similar to *N. conicus*, but appears to differ in having a narrower corallum with constantly

increasing calicular diameter, not constricted as in the case of larger *N. conicus*. Other fossil species of *Notocyathus* reported by Squires (1958) — *N. orientalis*, *N. cuspidatus*, and *N. pedicellatus* Tenison-Woods, 1880, are probably peponocyathans.

Thrypticotrochus Cairns, 1989a

Corallum solitary, small, and conical; transverse division absent, but regeneration from asexual fragmentation quite common. Theca imperforate; costae serrate, one corresponding to each septum. One to three narrow paliform lobes on inner edges of every S1–3. Columella papillose.

TYPE SPECIES: *Thrypticotrochus multilobatus* Cairns, 1989a, by original designation.

REMARKS: *Thrypticotrochus* is distinguished from other turbinoliid genera by having multiple (1–3) paliform lobes on every S1–2. Two species are known — the type species *T. multilobatus* Cairns, 1989a and *T. petterdi* (Dennant, 1906), from off New South Wales.

Thrypticotrochus multilobatus Cairns, 1989
(Plate 28, d-h)

Thrypticotrochus multilobatus Cairns, 1989a: 37, pl. 19, figs b-g; Cairns & Keller 1993: 254, pl. 7, figs F, I.

MATERIAL EXAMINED: New Records: NZOI Stn G1, 1, NZOI; Stn K818, 1, NZOI; BS438, 9, USNM 94179; BS570, 4, MNZ CO267; BS633 (P461), 2, MoNZ CO268; BS833 (O578), 4, MoNZ CO285; BS895 (O641), 2, MoNZ CO307; BS893 (O639), 1, MoNZ. Previous Records: Types.

DISTRIBUTION: New Zealand region: southern Norfolk Ridge; off Three Kings Islands; Kermadec Ridge (off Raoul Island); off East Cape (Map 11); 95–440 m. Elsewhere: southwest Indian Ocean (off Mozambique and Tanzania); South China Sea; off Philippines; off Queensland; 130–925 m.

TYPES: The holotype and 4 paratypes are deposited at the USNM (holotype, 81901). One syntype is also deposited at the MNHNP and another at the AMS (G15259).

TYPE LOCALITY: *Albatross* Stn 5576, 5°25'56 N, 120°03'39 E (Sulu Sea), 507 m.

REMARKS: This species was recently described and illustrated in the original account and need not be redescribed here. The New Zealand specimens represent the largest coralla known for this species, a specimen from Stn BS833 measuring 6.1 mm in calicular diameter and 6.9 mm in height (Plate 28, e, g). Coralla greater than about 4.5 mm in calicular diameter contain septa of the fifth cycle, up to about 72 septa. Of the 23 specimens reported herein, 21 had generated from a fragment of a parent corallum.

Superfamily Flabelloidea Bourne, 1905
Family GUYNIIDAE Hickson, 1910

Pedicellocyathus n. gen.

Corallum solitary, ceratoid, and firmly attached. Transverse division absent. Base reinforced with 12 *symmetrically* arranged, hollow rootlets. A row of mural spots, pores, or internal depressions occurs in every interseptal space. Pali absent; columella a rudimentary fusion of lower, inner edges of S1–2.

TYPE SPECIES: *Pedicellocyathus keyesi*, here designated.

ETYMOLOGY: The generic name *Pedicellocyathus* (Latin *pedicellus*, a small, slender stalk, dim. of *pes*, foot + *cyathus*, cup) is an allusion to the basal pedestal formed by the rootlets. Gender masculine.

REMARKS: AMONG THE 10 guyniid genera (eight listed by Cairns 1989a: table 3), *Pedicellocyathus* is most similar to *Onchotrochus* Duncan, 1870, which is known only from the Upper Cretaceous of England. Only these two genera lack both pali and columella, and do not reproduce by transverse division. *Pedicellocyathus* is distinguished by having symmetrically arranged rootlets, a ceratoid (not cylindrical) corallum, and up to four (not two) cycles of septa.

Pedicellocyathus keyesi n. sp. (Plate 29, a-f)

Stenocyathus decamera Ralph & Squires, 1962: 11–12 (in part: specimen from off Mayor Island, pl. 4, fig. 6 and probably 2 specimens from Poor Knights Islands); Squires & Keyes 1967: 28 (in part: specimens from Victoria University #8 and Miscellaneous Stn 20).

MATERIAL EXAMINED: Types, q.v.

Distribution: Endemic to the northeastern coast, Three Kings Islands to East Cape (Map 9), 70–194 m.

DESCRIPTION: Corallum relatively small, straight, and ceratoid, the largest specimen examined (BS833) 9.2 × 8.1 mm in calicular diameter and 16.6 mm in height. Holotype 7.0 × 6.3 mm in calicular diameter and 16.1 mm in height, with a pedicel diameter of 3.5 mm. Corallum re-juvenescence common (see Ralph & Squires 1962: pl. 4, fig. 6). Calice slightly elliptical: GCD: LCD = 1.1–1.2. Basal 2–3 mm of corallum reinforced with 12 symmetrically arranged, hollow, contiguous rootlets (Plate 29, a, b, f), each rootlet 0.6–0.7 mm in width. The ring of rootlets forms a thick pedestal, which firmly anchors corallum to substratum. Epitheca above rootlets smooth and porcellanous, but studded with rows of circular pores or spots 0.06–0.07 mm in diameter, a row corresponding to each interseptal space. If not visible exteriorly, these regions of variable calcification are expressed within the calice as thecal depressions (Plate 29, c). Corallum white.

Septa hexamerally arranged in 4 cycles, coralla 5–6 mm in GCD having only 34–36 septa, the complete fourth cycle (48 septa) present only in the largest specimen of 9.2 mm GCD. Pairs of S4 usually first inserted in the 4 end systems, and subsequently in the 2 lateral systems. Septal formula: S1>S2>S3>S4. S1 have straight to very slightly sinuous inner edges and are quite wide, especially the 4 lateral S1, the inner edges of which almost meet in centre of fossa. S2 about four-fifths width of an S1, their lower, inner edges fusing with the columella. S3 only one-third to half width of an S3 and sometimes (especially in small coralla) have sinuous inner edges. S4 rudimentary. Septal faces covered with tall (about 0.1 mm), pointed granules. Fossa deep; columella a central, elliptical fusion of lower, inner edges of S1–2.

TYPES: Holotype: BS833 (O578), MoNZ CO285. Paratypes: NZOI Stn C804, 1, P-1043; Stn C814, 2, P-1044; USNM 94270; NZOI Stn E283, 1, P-1045; NZOI Stn E393, 1, P-1046; USNM 94269; BS833 (O578), 7, MoNZ CO285, 2, USNM 94268; BS881 (O627), 1, MoNZ CO282; BS911 (O657), 3, MoNZ CO294; off Mayor Island, 146–220 m, 1, *S. decamera* of Ralph & Squires (1962), MoNZ CO184.

Type Locality: 37°38.5' S, 178°56.4' E (off East Cape, New Zealand), 143–153 m.

ETYMOLOGY: This species is named in honour of Ian W. Keyes, of the Institute of Geological and Nuclear Sciences, Lower Hutt.

REMARKS: Ralph and Squires (1962) included at least one specimen (off Mayor Island) of *P. keyesi* in their nontype material of *Stenocyathus decamera*. It is interesting to note that a label with that specimen reads "*Stenocyathus* (?)", but the author and date of this note are unknown. Although not examined, it is probable that their specimens from off the Poor Knights Islands are also *P. keyesi*. *Pedicellocyathus* resembles *Stenocyathus* in size, shape, and the possession of mural spots/pores, but there the resemblance stops. *Pedicellocyathus* differs in lacking pali and columella, having hollow basal rootlets, having a fourth cycle of septa, and in having internal thecal depressions.

Truncatoguynia Cairns, 1989a

Corallum solitary, compressed-cylindrical, and elongate (often curved). Asexual reproduction by transverse division predominates. Anthocaulus unknown. Calicular margin smooth. Rows of thecal spots occur in every interseptal space, but appear to flank tertiary septa. Columella a fusion of the primary septa; pali absent.

TYPE SPECIES: *Truncatoguynia irregularis* Cairns, 1989a, by original designation.

REMARKS: Only one of the other nine guyniid genera has a truncate base resulting from transverse division, i.e., *Temnotrochus*, distinguished by having a papillose columella, P1-2, and three size classes of septa. *Truncatoguynia* is monotypic.

Truncatoguynia irregularis Cairns, 1989 (Plates 29,g,h,30,a,b)

Truncatoguynia irregularis Cairns, 1989a: 43, pl. 22, figs f-g, pl. 23, figs a-c, f; 1994: 70, pl. 30, figs e-f.
Truncatoguynia sp. Cairns 1989a: 43, pl. 23, figs d-e.

MATERIAL EXAMINED: New Records: NZOI Stn C531, 10, USNM 81893; Stn K825, 1 NZOI; Stn P17, 1,

94272; BS438, 3, MoNZ CO256; BS891 (O637), 1, MoNZ CO292. Previous Records: Types.

DISTRIBUTION: New Zealand region: southern Norfolk Ridge; Kermadec Ridge (off Raoul Island) (Map 12): 133–248 m. Elsewhere: northern Ryu-kyu Islands; north of Pratas Islands, South China Sea; 80–161 m.

DESCRIPTION: Corallum an elongate, compressed (GCD: LCD = 1.4–1.5) cylinder up to 39 mm in length (BS434), longer coralla gently curved in plane of GCD. Multiple regenerations common in elongate specimens, the longest having a H: GCD = 7.7. Specimen with largest calice (BS434) 5.8 x 4.2 mm in diameter and 32.9 mm long. Coralla in the 3.2 mm GCD size range are also common. Rounded thecal edges and faces are virtually parallel, resulting in a calice equal in size to its truncate base. Rows of white thecal spots (about 0.1 mm in diameter) occur in every interseptal space, but appear to be paired across each tertiary septum. Theca light brown but lined with rows of white spots and longitudinally divided by very thin, shallow striae corresponding to each S1–2 or primary septa. Fine (25–50 μ m wide), closely spaced transverse epithecal ridges cover the theca (Plate 30, a).

Septa irregularly arranged, but the most common formula is S1–2>S3 (24 septa), which is characteristic of most small coralla. Based on 50 well-preserved specimens, 21 have 24 septa (12:12), 2 have 26 septa (13:13), 13 have 28 septa (14:14); 10 have 30 septa (15:15); and 4 have 32 septa (16:16). The odd number of primary septa (i.e., 13 and 15) is caused by an asymmetry in the calicular ellipse, in which one side of the corallum is slightly larger than the other and thus accommodates an additional sector of septa. Primary septa (S1–2 of coralla having 24 septa) thick (about 0.1 mm) and sinuous, with highly spinose septal faces, the blunt spines up to 0.13 mm in height. Secondary septa (S3 of coralla having 24 septa) much smaller (0.05 mm in thickness), and rudimentary in width, with irregular, straight, dentate inner edges. Fossa of moderate depth, containing an elongate, rudimentary columella to which the lower, inner edges of the S1–2 are fused.

TYPES: The holotype (81890) and 10 paratypes are deposited at the USNM. One paratype is also deposited at the AMS.

TYPE LOCALITY: *Albatross* Stn 5311, 21°33' N, 116°15' E (north of Pratas Island, S. China Sea), 161 m.

REMARKS: When I first described this species and genus, I referred to a second undescribed species from the Kermadec Islands (NZOI Stn C531) that had hexamerall symmetry, a smaller calice, and a longer corallum. Having now examined over 100 specimens from six stations in the New Zealand region, I now consider the specimens from NZOI C531 to represent a population of *T. irregularis* that has small calices and thus only 24 septa. The 84 specimens from BS434 show that this species ranges from 3.2–5.8 mm in GCD and 24–32 septa/calice, the septal number depending on the size and shape of the calice. The corallum length seems to be simply a function of age and/or recency of transverse division.

Stenocyathus Pourtalès, 1871

Corallum solitary, cylindrical to ceratoid, and usually attached. Transverse division absent. Base and pedicel reinforced with a solid granular coenosteum. Calicular margin smooth. Rows of thecal spots, pores, or depressions occur in every interseptal space. Three cycles of septa; pali before S2; columella one twisted lath.

TYPE SPECIES: *Coenocyathus vermiformis* Pourtalès, 1868, by monotypy.

REMARKS: Only one widespread recent species is known in this genus: *S. vermiformis*; however, two fossil species are reported from the Paleocene and Eocene of Alabama and Tonga, respectively (Cairns 1979). *Stenocyathus* is distinguished from other guyniid genera by having a fascicular columella and P2.

Stenocyathus vermiformis (Portalès, 1868) (Plate 30, c-g)

Coenocyathus vermiformis Portalès, 1868: 133–134.
Stenocyathus vermiformis: Cairns 1979: 168–170, pl. 32, figs 8–10, pl. 33, figs 1–2 (synonymy); 1982: 52, pl. 16, figs 8–11 (synonymy); Cairns & Parker 1992: 42, pl. 14, figs b-c; Cairns & Keller 1993: 273, pl. 12, figs E-F.
Stenocyathus decamera Ralph & Squires, 1962: 11–12 (in part: pl. 4, figs 2–5; not specimen from Mayor Island); Squires & Keyes 1967: 28, pl. 6, figs 3–5; Squires 1969: 17, pl. 6, map 2; Dawson 1979: 30.

MATERIAL EXAMINED: New Records: NZOI Stn A910, 1, USNM 94264; Stn C510, 1, NZOI; Stn D149, 1, NZOI; Stn D166, 1, USNM 94265; Stn E291, 1, NZOI; Stn E855, 1, NZOI; Stn G941, 1, NZOI; Stn J659, 3, USNM 94266; Stn J711, 1, NZOI; Stn J716, 3, NZOI; Stn K527, 1, NZOI; Stn K795, 1, NZOI; Stn K800, 1, NZOI; Stn K830, 2, NZOI; Stn K840, 1, NZOI; Stn K858, 1, NZOI; Stn S572, 1, USNM 94368; Stn T256, 1, NZOI; Stn U599, 1, NZOI; *Matai*, 2, MoNZ CO89; *Tui* Stn AU2/53, 9, MoNZ CO249 and 250; BS441, 1, MoNZ CO258; Malaspina Beach, Doubtful Sound, 20–30 m, 1, USNM 94267. Previous Records: Types of *C. vermiformis* and *S. decamera*; specimens reported by Ralph and Squires (1962) and Squires and Keyes (1967).

DISTRIBUTION: New Zealand: widespread in the region, from Kermadec Islands to Macquarie Ridge (Map 2); 30–805 m, the shallowest record of 30 m from off Fiordland. Elsewhere: quite widespread in all oceans, except for eastern Pacific; 80–1229 m.

DESCRIPTION: Corallum cylindrical and elongate, straight or irregularly bent, the largest New Zealand specimen (NZOI Stn D175) 13 mm long and 5 mm in calicular diameter. Smaller coralla 2.5–3.5 mm in calicular diameter also common. Corallum usually firmly attached to a rock or dead coral skeleton, the latter including coralla of *Madrepora*, *Balanophyllia*, *Gardineria*, *Goniocorella*, and *Desmophyllum*. Base and lower 1–3 mm of pedicel often reinforced with solid, coarsely granular (granules about 0.1 mm in diameter) stereome that envelopes all or part of the base and continues to spread over the substratum up to 8 mm in diameter. Upper edges of the granular stereome often divided into narrow fingers about 0.3–0.4 mm wide (Plate 30, c). Theca distal to granular pedicel smooth and porcellanous, usually bearing 24 longitudinal rows of circular white spots 0.30–0.35 mm in diameter. Thecal spots eventually become external depressions and ultimately thecal pores as the coral gets older and dies.

Septa hexamerally arranged in 3 complete cycles (however, see Remarks) according to the formula: S1>S2>S3. S1 nonexsert, quite thick (0.13–0.16 mm), and have very sinuous inner edges. S2 about three-quarters width of an S1 and also have quite sinuous inner edges. S3 usually slightly wider than S2 but thinner and less sinuous. A crown of 6 massive, sinuous pali occurs before the S2, surrounding a single, tightly twisted fascicular columellar element.

TYPES: Thirty-eight syntypes of *C. vermiformis* are deposited at the MCZ (see Cairns 1979). The holotype of *S. decamera* and two specimens labelled as paratypes are deposited at the NZGS (CO1380 and 1381–2, respectively). Ralph and Squires (1962) mentioned at least 3 more nontype specimens from two other localities in their original account.

TYPE LOCALITIES: *C. vermiformis*: off Florida Keys, 110–1229 m. *S. decamera*: off Shelter Island, Doubtful Sound, Westland, New Zealand, 134 m.

REMARKS: The holotype and large paratype of *S. decamera*, as well as another specimen more recently collected from Doubtful Sound (USNM 94267) all have decamerall symmetry: 10:10:20 (40 septa, 10 pali), although the calice of the holotype is now too damaged to determine its palar structure. The smaller paratype has hexamerall symmetry and the nontype specimen from off Mayor Island is *Pedicellocyathus keyesi*. With only these three exceptions, all subsequently collected specimens of *Stenocyathus* from off New Zealand (approximately 67 specimens from 30 stations) are hexamerally symmetrical: 6:6:12 (24 septa, 6 pali). The three specimens from Doubtful Sound are therefore believed to represent a variation of the typical species, differing in having decamerall symmetry and an unusually shallow depth range (30–134 m).

Temnotrochus n. gen.

Corallum solitary, compressed-cylindrical, and elongate. Asexual reproduction by transverse division predominates; anthocaulus unknown. Calicular margin smooth, expressed as a thin rim that extends beyond upper outer septal edges. Rows of thecal spots occur in every interseptal space. Columella papillose; paliform lobes before S1–2.

TYPE SPECIES: *Temnotrochus kermadecensis*, here designated.

ETYMOLOGY: The genus name *Temnotrochus* (Greek, *temno*, sever, cut + *trochos*, common suffix for coral generic names, literally meaning anything round) refers to the transverse division method of asexual reproduction. Gender masculine.

REMARKS: The generic placement of *Temnotrochus*

in Guyniidae is tentative, as only two of the eight specimens examined show evidence of thecal spots that are characteristic of that family. Within the Guyniidae, *Temnotrochus* is most similar to *Cyathosmilia* Tenison-Woods, 1878c, known only from the Eocene to Oligocene of South Australia. Of the ten known guyniid genera (Cairns 1989a: Table 3), these are the only two that have paliform lobes before the first two septal cycles. *Temnotrochus* is distinguished from the fossil genus by having transverse division, a papillose columella, and in lacking costae. Its possession of P1–2 also distinguishes it from flabellid genera only one flabellid genus (*Falcatoflabellum*) is known to have P2.

Temnotrochus kermadecensis n. sp.
(Plate 31, a-d)

MATERIAL EXAMINED: Types, q.v.

DISTRIBUTION: Known only from off Raoul Island, Kermadecs; 366–402 m.

Description: Corallum quite small, with a straight corallum, and an elliptical calice (GCD: LCD = 1.32–1.40). Holotype only 1.78 x 1.35 mm in calicular diameter and 3.06 mm in length; largest specimen 4.22 mm long. Corallum rejuvenescence or incomplete transverse division not observed. Basal scar convex to V-shaped in profile, and equal in size to distal calice. Calice smooth (not serrate), rising about 0.3 mm above the upper outer septal edges, producing a delicate calicular rim. Epitheca porcellanous and relatively smooth, but bearing numerous very fine (10–20 µm wide), closely spaced growth ridges. Theca white and translucent near calicular edge. In two specimens small (20–30 µm in diameter), white thecal spots, slightly more opaque than surrounding theca, occur in rows in every interseptal space, seemingly paired across each S3. Spots also evidenced inside calice as small depressions of the same size (Plate 31, c).

Septa hexamerally arranged in 3 complete cycles (S1>S2–3, 24 septa) in all specimens examined. Although the upper, outer edges of the S1 do not reach the top of the calicular margin, their upper margins form exsert lobes that rise as much as 0.4 mm above the calicular rim. Inner edges of S1 quite sinuous. S2 about three-quarters width of an S1 and also have sinuous inner edges. S2 equal to width of an S2, but, because they are

less sinuous, appear to be much thinner. Inner edges of all 6 S2 and the 4 lateral S1 (excluding the principal S1) bear tall, slender, highly sinuous paliform lobes in one elliptical crown of 10 elements. In only 1 specimen does a rudimentary P1 occur before a principal S1. P2 0.20–0.25 mm wide, whereas P1 only about 0.11 mm wide and not quite as tall. Within the palar crown lies a papillose columella composed of 1–3 linearly arranged pillars similar in size and shape to the P1. Fossa shallow.

Types: Holotype: BS441, MoNZ. Paratypes: BS441, 3, MoNZ, 4, USNM 94287.

TYPE LOCALITY: 3.7 km off Nugent Island, Raoul Island, Kermadec Ridge; 366–402 m.

REMARKS: *Temnotrochus kermadecensis* is similar to *Idiotrochus kikutii* (Yabe & Eguchi, 1941a), a western Pacific species known from 143–645 m (Cairns 1989a). Both species have very similar calices, containing 24 septa of the same relative sizes, and 10 pali (2 usually absent from the principal S1). Furthermore, both species reproduce by transverse division and the theca of *I. kikutii* is often porcellanous, like that of a flabellid. But *I. kikutii* differs fundamentally in having faint costae, which alternate in position with its septa, and does not have thecal spots or pores.

Family FLABELLIDAE Bourne, 1905

Flabellum Lesson, 1831

Corallum solitary, fixed or free. Corallum ceratoid, campanulate, or highly compressed; base not reinforced with stereome. Wall epithecate, usually lacking costae but invariably bearing fine, chevron-shaped growth ridges that peak at major septa. Transverse division absent. Pali, dissepiments, and synapticulae absent. Columella rudimentary, consisting of a fusion of lower, inner edges of lower cycle septa.

Key to the Eight Species of *Flabellum* known from the New Zealand Region

- 1 Calice elliptical to strongly compressed (GCD:LCD > 1.4) 2
- Calice slightly elliptical to circular (GCD: LCD < 1.3) *F. impensum*

- 2 Thecal faces meet in a sharp edge that bears a crest 3
Thecal edges rounded and lack crests 6
- 3 Corallum highly compressed (GCD: LCD usually > 1.7); edge angle usually > 130°; thecal faces slightly concave (corallum constricted) 4
Corallum less compressed (GCD: LCD 1.4–1.7); edge angle usually < 130°; thecal faces slightly convex 5
- 4 Theca reddish-brown; edge angle 130–180°; tropical in distribution
..... *F. messum*
Theca white; edge angle usually > 180°; temperate in distribution *F. lowekeyesi*
- 5 Septa octamerally arranged in four size classes (e.g., large coralla have 16:16:32:64, = 128 septa); 16 primary costae ridged *F. hoffmeisteri*
Septa hexamerally arranged in five complete cycles (96 septa); thecal faces smooth and porcellanous (not costate) *F. aotearoa*
- 6 Corallum campanulate, GCD: LCD = 1.4–1.7; C1 and often C2 ridged; septa widely spaced; calicular margin lacerate *F. apertum*
Corallum highly compressed, GCD: LCD > 2; thecal faces flat; septa more closely spaced; intact calicular margin smooth 7
- 7 Pedicel diameter 1.1–1.3 mm; corallum robust; columella rudimentary
..... *F. angiosomum*
Pedicel diameter 2.6–3.3 mm; corallum quite fragile; columella often well developed *F. knoxi*

***Flabellum (Flabellum)* Lesson, 1831**

Flabellum having a smooth and continuous (not jagged or lacerate) calicular edge.

TYPE SPECIES: *Flabellum pavoninum* Lesson, 1831, by monotypy.

REMARKS: Approximately 28 recent species are known in the nominate subgenus, half of which occur in the Indo-West Pacific (see Cairns 1989a), including three in the New Zealand region.

Whereas one of these species, *F. knoxi*, is quite common and in fact characteristic of the southern New Zealand region, the other two species are rarely collected. *Flabellum impensum* is more characteristic of the Antarctic region and *F. angiosomum* is reported for the first time since its original description from off northwest Australia.

***Flabellum (F.) knoxi* Ralph & Squires, 1962**
(Plates 31, e-g, 32, a)

Flabellum knoxi Ralph & Squires, 1962: 14–15, pl. 7, figs 1–2; Squires 1964a: 11–12, 19–20, pl. 1, figs 4–6, pl. 2, fig. 7, pl. 3, figs 3–5, pl. 4, figs 1–4; 1969: 18, pl. 6, map 4; Squires & Keyes 1967: 26–27, pl. 5, figs 1–2; Cairns 1982: 42–44, pl. 13, figs 4–7; 1989a: 46; Seilacher 1991: fig. 6.

MATERIAL EXAMINED: New Records: NZOI Stn D87, 4, NZOI; Stn D904, 2, NZOI; Stn E74, 27, NZOI; Stn E75, 3, NZOI; Stn E79, 2, NZOI; Stn E121, 4, NZOI; Stn E123, 2, NZOI; Stn E148, 1, NZOI; Stn E405, 2, NZOI; Stn E410, 1, NZOI; Stn E413, 1, NZOI; Stn E421, 5, NZOI; Stn E422, 4, NZOI; Stn E423, 5, NZOI; Stn E424, 60, NZOI; Stn E428, 3, NZOI; Stn E434, 1, NZOI; Stn E436, 1, NZOI; Stn E713, 5, NZOI; Stn E717, 1, NZOI; Stn E719, 11, NZOI; Stn F90, 1, NZOI; Stn F110, 3, NZOI; Stn F136, 1, NZOI; Stn F144, 1, NZOI; Stn F147, 10, NZOI; Stn F750, 1, NZOI; Stn F753, 1, NZOI; Stn G33, 5, NZOI; Stn G38, 1, NZOI; Stn G177, 1, NZOI; Stn G184, 3, NZOI; Stn G198, 1, NZOI; Stn G223, 1, NZOI; Stn G233, 1, NZOI; Stn G240, 1, NZOI; Stn G244, 1, NZOI; Stn G245, 1, NZOI; Stn G254, 2, NZOI; Stn G255, 1, NZOI; Stn G258, 1, NZOI; Stn G259, 2, NZOI; Stn G262, 1, NZOI; Stn G273, 1, NZOI; Stn G276, 1, NZOI; Stn G278, 1, NZOI; Stn G279, 10, NZOI; Stn G291, 2, NZOI; Stn G292, 19, NZOI; Stn G293, 1, USNM 94331; Stn G329, 1, NZOI; Stn G371, 2, NZOI; Stn G398, 1, NZOI; Stn G651, 6, NZOI; Stn G667, 1, NZOI; Stn G688, 1, NZOI; Stn G697, 4, USNM 94332; Stn G937, 9, USNM 94333, Stn G938, 2, NZOI; Stn H939, 2, NZOI; Stn H942, 1, NZOI; Stn H945, 2, NZOI; Stn H955, 1, NZOI; Stn I669, 2, NZOI; Stn I689, 10, NZOI; Stn I698, 1, NZOI; Stn I703, NZOI; Stn I707, 1, NZOI; Stn I716, 1, USNM 94334; Stn J485, 2, NZOI; Stn Q1, 1, NZOI; Stn Q6, 2, NZOI; Stn Q7, 2, NZOI; Stn Q8, 4, NZOI; Stn Q16, 1, NZOI; Stn Q19, 2, NZOI; Stn Q338, 4, NZOI; Stn Q341, 1, NZOI; Stn S22, 1, NZOI; Stn S27, 5, NZOI; Stn S29, 1, NZOI; Stn S42, 3, NZOI; Stn S48, 2, NZOI; Stn S52, 8, NZOI; Stn S142, 1, NZOI; Stn S148, 1, USNM 94335; Stn S157, 2, NZOI; Stn S159, 5, NZOI; Stn S160, 7, NZOI; Stn S168, 50, NZOI; Stn S173, 10, NZOI; Stn S174, 1, NZOI; Stn T38, 3, NZOI; Stn T48, 5, NZOI; Stn T88, 10, NZOI; Stn V386, 3, NZOI; Stn V387, 15, NZOI; Stn V388, 15, NZOI; Stn Z3909, 1,

NZOI; BS654 (R12), 1, MoNZ CO167; BS665 (R23), 1, MoNZ CO148; J9/15/77, 2, MoNZ; J17/2/84, 1, MoNZ CO177; JC10/57/71, 2, MoNZ; JC11/2/71, 2, MoNZ; *Azuchi Maru* Stn 96, 1, MoNZ; MU74/94, 3, Portobello Marine Lab.

PREVIOUS RECORDS: 2 paratypes of *F. knoxi*, MoNZ; specimen reported by Squires (1964a), and Squires and Keyes (1967).

DISTRIBUTION: Endemic to New Zealand region, but commonest on the Chatham Rise and Bounty and Campbell Plateaus (Map 5); 160–1167 m, but most commonly collected between 400–700 m.

DESCRIPTION: Corallum compressed (GCD: LCD = 2.0–4.5), never constricted, and light weight; theca and septa thin and quite fragile. Corallum wider than tall: GCD: H = 1.1–1.5. Angle of thecal edges bimodal, the lower edges (younger coralla) diverging at 60–70°, but increasing to 135–180° in larger coralla. Some coralla that appear to have been living in the prone position have lateral edges that virtually meet, forming an incomplete heart-shaped cavity below the pedicel (Plate 31, e). Although thecal edges are usually rounded, in some larger coralla the edges are slightly ridged, but never carinate. Inclination of lateral faces variable, ranging from 29° to 48°. Largest specimen examined (NZOI Stn D904) 128 × 54 mm in calicular diameter and 66 mm in height. Pedicel circular, 2.6–3.3 mm in diameter, the basal plate containing the 12 protosepta. Septa at calicular margin invariably broken, caused by dredging of such fragile coralla; however, in the rare case of an intact corallum, the calicular edge is perfectly smooth. Thecal faces virtually flat and somewhat coarse, a very narrow stria corresponding to each septum. Theca between lines covered with very fine transverse rugae (up to 12/mm) in a chevron-shaped arrangement, the apex of each row of chevrons peaking at the C1–5. Theca uniformly reddish-brown, entirely white, or white with narrow reddish-brown stripes corresponding to each septum.

Septa hexamerally arranged in 6 to 7 cycles. Four cycles (48 septa) attained at a GCD of about 14 mm; fifth cycle (96 septa) attained at about 21 mm; sixth cycle (192 septa) at about 37 mm; and as many as 400 septa (S7+) may be present in larger specimens. S1–4 (S1–5 of larger coralla) quite wide, sometimes fusing with the corresponding septa from the opposite face in centre of calice or even intercalating with those of the

opposite face. S1–4 and S5 have quite slender, concave upper edges (SCI about 13). Inner edges of S1–4 vertical, the lower edges being extremely sinuous (SSI = 3.7–9.2) and contributing to a well-developed columella. S5 half to three-quarters width of an S1–4 (S5 same width as S1–4 in larger coralla) and also with sinuous inner edges. S6 rudimentary, only about one-fifth width of an S5, with straight inner edges. Septal faces somewhat corrugated and bear low, sparse granules. Fossa quite narrow and elongate, containing a well-developed trabecular columella about 2 mm wide consisting of a fusion of the sinuous lower inner edges of the S1–5. Columella so robust that it often remains intact after the remaining corallum has deteriorated (Plate 32, a).

TYPES: Ten specimens from three stations were reported in the original description, one designated as the holotype, the other nine herein considered to be paratypes. The holotype and most paratypes are presumed to be deposited at the Canterbury Museum; however, two paratypes from Stn 52 are deposited at MoNZ.

TYPE LOCALITY: Ralph and Squires (1962) did not specify which of the three Chatham Island stations yielded the holotype. Chatham Rise, 402–512 m.

REMARKS: Within the subgenus, *F. knoxi* is most similar to *F. magnificum* Marenzeller, 1904a, a western Pacific species known from 291–700 m (see Cairns 1989a). Both species have large coralla, often seven complete cycles of septa, a striped theca, and similarly shaped septa. *Flabellum knoxi* differs in having rounded lateral edges (not crested as in *F. magnificum*), a slightly larger pedicel, a less open corallum (face angle 29–48° vs 44–58° for *F. magnificum*), and a better-developed columella. *Flabellum knoxi* differs from another similarly-shaped species, *F. lamellulosum* Alcock, 1902a (western Pacific, 198–402 m), by lacking thecal edge crests, having a larger pedicel, and having a greater SSI.

Among the New Zealand fossil corals, *F. knoxi* is most similar to *F. laticostatum* Tenison-Woods, 1880, from the late Oligocene of Canterbury, this species reported as *F. pavoninum distinctum* by Squires (1958); *F. knoxi* appears to differ in having a larger face angle and in having rounded thecal edges.

Squires (1964a) should be consulted for an ecological analysis of the growth position of this species and an explanation for why certain coralla have recurved and/or reflexed coralla.

Flabellum (F.) angiostrum Folkesson, 1919
(Plate 32, d, f)

Flabellum angiostrum Folkesson, 1919: 5, pl. 1, figs 1-3; Cairns 1989a: 46.

MATERIAL EXAMINED: New Records: NZOI Stn 192, 9, USNM 94322; Stn 197, 15, NZOI, 20, USNM 94323; Stn U599, 1, NZOI.

DISTRIBUTION: New Zealand region: southern Norfolk Ridge; Three Kings Ridge (Map 13); 540-640 m. Elsewhere: off Cape Jaubert, near Dampierland, Western Australia; ?22 m.

DESCRIPTION: Corallum highly compressed (GCD: LCD = 2.1-3.1), never constricted, and robust. Corallum significantly wider than tall: GCD: H = 1.25-1.45. Thecal edges always rounded, never ridged or crested, with a bimodal angle of divergence — edges of lower 7-9 mm of corallum diverging at a relatively low angle (i.e., 60-80°), but gradually increasing to 125-180° in larger coralla. Inclination of lateral faces 26-39°. Largest specimen examined (NZOI Stn 197) 49.8 x 20.5 mm in calicular diameter and 33.8 mm in height. Pedicel small and circular, intact bases only 1.1-1.3 mm in diameter with 6 protosepta. Thecal faces flat and smooth, with no evidence of costae other than very fine striae that correspond to each septum. Theca usually reddish-brown with slightly darker pigmented stripes corresponding to C1-4.

Septa primarily hexamerally arranged in 6 complete cycles (192 septa), this stage attained by coralla as small as 25 mm GCD. Larger coralla, especially those with a high edge angle and thus longer calice, have as many as 268 septa (e.g., the holotype). Additional septa above the sixth cycle stage (193-268 septa) are not added as a smaller size class of septa. Instead, an S5 is enlarged to the width of an S1-4, an adjacent S6 is enlarged to the width of an S5, and a pair of S7 form flanking the accelerated S6, each about the size of a normal S6. In this way three size classes of septa are maintained. Septal formula: S1-4>S5>S6>S7. S1-4 concave and finely dentate near calicular edge (SCI about 5) with broad, quite sinuous (SSI = 5-7) inner edges that reach the columella. S5 about three-quarters width of an S1-4; S6 only half width of an S5 and extend only half way down theca. Fossa deep, elongate, and quite narrow, containing a rudimentary (about 1 mm wide) trabecular columella

consisting of the lower inner edges of the S1-4 and accelerated S5.

YPES: HOLOTYPE: Swedish Natural History Museum, Stockholm.

TYPE LOCALITY: 72 km WSW off Cape Jaubert (Western Australia), 22 m.

REMARKS: Among the Indo-West Pacific species of *Flabellum* (*Flabellum*), *F. angiostrum* is quite similar to *F. knoxi* (especially when compared to young specimens of *F. knoxi*), including corallum shape, septal number, and pigmentation. But *F. angiostrum* differs in having a much more robust corallum (thicker theca and septa), a much smaller pedicel diameter with fewer protosepta, a less well-developed columella, a slightly more compressed corallum (lower edge angle), and more septa at a smaller corresponding GCD. Also, *F. knoxi* is not known to occur north of 38°S, whereas *F. angiostrum* is not known to occur south of 33°S.

Flabellum angiostrum also bears resemblance to the southeast Australian *F. australe* Moseley, 1881, the latter appearing to differ in having straight, crested thecal edges and rough, corrugated thecal faces.

Flabellum (Flabellum) impensum Squires, 1962
(Plate 32, b, c)

Flabellum impensum Squires, 1962b: 14, 17-19, pl. 2, figs 4-7; ?1969: 18, pl. 6, map 3; Cairns 1982: 38-41, pl. 10, figs 8-9, pl. 11, fig. 10, pl. 12, figs 1-8 (synonymy).

?*Flabellum* sp. A Cairns 1994: 28-29, pl. 10, figs a-b.

MATERIAL EXAMINED: New Record: NZOI Stn I666, 1, NZOI. Previous Records: Holotype; specimens reported by Cairns (1982, 1994).

DISTRIBUTION: New Zealand region: Bounty Plateau east of Bounty Island and southwest of the Antipodes Islands; ?Hjort Seamount (Squires 1969); 1165-2100 m. Elsewhere: circumpolar off continental Antarctica; ?off Aleutian Islands (Cairns 1994); 46-2260 m.

DIAGNOSIS OF SPECIMENS FROM *ELTANIN* STN 2143 (ANTIPODES ISLANDS): Corallum ceratoid; calice elliptical, GCD: LCD = 1.15-1.30. Largest corallum 27.7 x 24.0 mm in calicular diameter and 43.5 mm in height. Pedicel large, 2.1-3.7 mm in diameter.

Theca smooth and worn, each costa bordered by a very thin (about 20 μm) shallow, longitudinal stria, which delimit broad, flat costae. Corallum white. Septa hexamerally arranged in 5 cycles: S1-3>S4>S5. Septa not exsert, upper edges of septa quite narrow (about 0.5 mm) and finely dentate for upper 5 mm adjacent to calice, which results in a high SCI of 11-13. Lower in fossa the inner edges of each S1-2 gracefully arch into a broad septum having thickened, but not sinuous, vertical inner edges that fuse into a columella deep within the fossa. S3 half to three-quarters width of an S1-2; S4 one-third to half width of an S3; S5 rudimentary. Fossa deep, containing a rudimentary columella.

Types: The holotype is deposited at the NZOI (H3), but has been fractured subsequent to its original description.

TYPE LOCALITY: NZOI Stn A464, 73°20' S, 174°00' E (Ross Sea), 369-384 m.

REMARKS: The specimens from the Bounty Plateau represent one of the morphological extremes of the species, i.e., a form having a ceratoid corallum with a very low GCD: LCD. They also represent the northernmost range of a species otherwise known only from off continental Antarctica. Squires (1969) plotted a distributional record of *F. impensum* in the vicinity of Hjort Seamount, but this record was undocumented and no such specimen can be found in the collections of the NZOI or USNM. Squires' records of *F. impensum* from off South America are a mixture of *F. curvatum* and *F. impensum* (see Cairns 1982). I (Cairns 1994) reported several specimens very similar to ceratoid *F. impensum* from off the Aleutian Islands, which, if conspecific, would result in a bipolar distribution.

Flabellum (Ulocyathus) M. Sars, 1851

Flabellum having a jagged or lacerate calicular edge.

TYPE SPECIES: *Ulocyathus arcticus* M. Sars, 1851 (= *Flabellum macandrewi* Gray, 1849), by monotypy.

REMARKS: Jagged or serrate calicular edges result from the growth of small triangular thecal apices corresponding to the lower cycle septa (i.e., S1-3, 4). Lacerate calicular edges result from more

prominent, apically pointed rectangular or triangular thecal projections that correspond to each lower cycle septum and the pair of higher cycle that flank them. These tall projections are herein termed "lancets".

Approximately 17 recent species are known in this subgenus (Cairns 1989a), 13 of which occur in the Indo-West Pacific, including five in the New Zealand region. Cairns (1989a) divided the subgenus into three groups of species based on their corallum shape: constricted, compressed, and campanulate. Two New Zealand species have constricted coralla (*F. lowekeyesi* and *F. messum*), two have laterally compressed coralla (*F. aotearoa* and *F. hoffmeisteri*), and one has a campanulate corallum (*F. apertum*). *Flabellum lowekeyesi*, *F. aotearoa*, and *F. apertum* are all common in the New Zealand region, the first two known only from this region, whereas *F. messum* and *F. hoffmeisteri* are rarely collected in the New Zealand region and known only from the northern ridges.

Flabellum (U.) lowekeyesi Squires & Ralph, 1965 (Plate 32, g-i)

Flabellum lowekeyesi Squires & Ralph, 1965: 259-261, figs 1-2; Squires & Keyes 1967: 27, pl. 6, figs 1-2; Cairns 1989a: 54; Cairns & Keller 1993: 262, pl. 10, figs D-E.

MATERIAL EXAMINED: New Records: NZOI Stn D136, 1, NZOI; Stn D224, 5, NZOI; Stn D225, 3, NZOI; Stn D226, 3, NZOI; Stn D227, 4, USNM 94314; Stn D228, 1, NZOI; Stn D230, 1, NZOI; Stn D231, 4, NZOI; Stn D235, 1, NZOI; Stn D244, 1, NZOI; Stn E121, 1, USNM 94315; Stn E772, 2, NZOI; Stn E825, 1, NZOI; Stn E826, 1, NZOI; Stn E873, 1, NZOI; Stn E879, 4, NZOI; Stn E880, 4, NZOI; Stn E884, 7, NZOI; Stn E889, 1, NZOI; Stn E890, 1, NZOI; Stn E894, 3, NZOI; Stn E899, 3, NZOI; Stn E902, 1, NZOI; Stn F100, 2, NZOI; Stn F135, 1, NZOI; Stn F144, 2, NZOI; Stn F872, 1, NZOI; Stn F877, 1, NZOI; Stn F909, 4, NZOI; Stn F913, 2, NZOI; Stn G817, 1, NZOI; Stn G818, 2, NZOI; Stn G819, 1, NZOI; Stn G820, 2, USNM 94317; Stn G822, 1, NZOI; Stn G825, 1, NZOI; Stn G893, 2, NZOI; Stn I25, 1, NZOI; Stn I34, 1, NZOI; Stn I352, 10, NZOI; Stn I353, 1, NZOI; Stn I366, 3, NZOI; Stn I664, 9, NZOI; Stn I667, 2, NZOI; Stn I686, 5, USNM 94318; Stn I699, 3, NZOI; Stn I702, 4, USNM 94319; Stn I704, 2, NZOI; Stn I715, 50, NZOI, 24, USNM 94320; Stn P120, 1, NZOI; Stn P942, 1, NZOI; Stn Q84, 8, NZOI; Stn S43, 1, NZOI; Stn S72, 1, NZOI; Stn T32, 30, NZOI; Stn Z3911, 1, NZOI; BS302, 1, MoNZ CO 90; BS707 (R65), 2, MoNZ; BS762 (R120), 5, MoNZ CO147;

BS806 (O550), 1, MoNZ; BS830 (O575), 2, MoNZ; BS844 (O590), 1, MoNZ CO218; BS846 (O592), 1, MoNZ; JC19/9/84, 1, MoNZ; JC19/19/84, 2, MoNZ; FV *Cordilla*, 1, MoNZ; *Eltanin* Stn 1850, 14, USNM 82929; *Eltanin* Stn 1983, 6, USNM 94321; FV *Belinda*, 1, SAM H12598. Previous Records: Types and nontypes of Ralph and Squires (1965).

DISTRIBUTION: New Zealand region: widespread in region from Lord Howe Rise to the Endeavour Rise (Map 1); 381–1064 m, but most records between 600 to 900 m. Elsewhere: southwest Indian Ocean; off Tasmania (reported herein); 835–1050 m.

DESCRIPTION: Corallum compressed (GCD: LCD = 1.2–1.7–2.8), the lateral thecal faces being slightly concave medially resulting in an elongate but constricted or “pinched” calicular outline. Coralla extremely fragile, it being very unusual to obtain a specimen even with a partially intact calicular edge by conventional dredging techniques. Calicular edge deeply lacerate, each S1–2 producing a prominent triangular lancet, which includes itself and 2 or 3 septa to either side, each lancet separated by deep calicular notches. The most deeply incised notches separate the 2 principal S1 from the adjacent lateral face septa, this notch being as deep as 12 mm, effectively isolating the 2 principal septa and their adjacent 2 or 3 septa from the next half-system. Angle of straight thecal edges 180–240°; inclination of lateral faces (at point of constriction) 27–37°. Corallum approximately as tall as wide (GCD: H = 0.95–1.10–1.30). Lateral edges bear a prominent crest for entire length, their distal edges wrapping around the calice and continuous with the principal S1. Crests up to 4.7 mm high (gradually increasing toward calice), 0.15–0.20 mm wide, and often quite sinuous. Lateral edges quite short, the LEL: H ratio only 0.26–0.45. Largest specimen examined (NZOI Stn I34) 76 x 45 mm in calicular diameter and 59.5 mm in height. Pedicel elliptical, 2.2–2.5 x 1.7–1.9 mm in diameter; all coralla examined were unattached. Thecal faces bear the characteristic fine chevron-shaped growth ridges between intercostal striae, the theca also bearing a very fine granulation. All coralla examined white, some specimens having a light reddish-brown colour to the columella and lower, inner edges of the S1–3 adjacent to the columella.

Septa hexamerally arranged in 6 complete cycles (192 septa) according to the formula:

S1–3>S4>S5>S6. Fourth cycle (48 septa) attained at a GCD of about 14 mm; fifth cycle at about 39 mm GCD; and only larger coralla of over 45 mm GCD having a full sixth cycle. S1–3 have straight, thickened inner edges that fuse with the columella low in fossa. S4 about three-quarters width of an S1–3, with straight but not thickened inner edges that reach the columella only quite low in fossa. Lower inner edges of S4 often fuse to those of S1–3. S5 about one-third width of an S4 and extend only about half distance down the theca. S6 rudimentary, extending only 10–15 mm down the theca, and have irregular inner edges. Septal faces covered by very fine granules. Fossa deep, containing a crescent-shaped trabecular columella about 2 mm wide, its curved shape following the underlying curvature of the corallum.

Polyps quite fleshy and cream-coloured with light-yellow tentacles (Squires & Keyes 1967).

TYPES: The holotype is deposited at the MoNZ (CO185). A paratype is also deposited at the USNM (45601).

TYPE LOCALITY: Marine Department prawn trawl 29, 42 km off Cape Brett, New Zealand, 732 m.

REMARKS: Among the 22 species known in the subgenus *Flabellum* (*Ulocyathus*) (see Cairns 1989a), four have constricted coralla: *F. alabastrum* Moseley, 1876; *F. messum* Alcock, 1902c; *F. lowekeyesi* Squires & Ralph, 1965; and *F. marcus* Keller, 1974. *Flabellum lowekeyesi* is compared to the very similar *F. messum* in the following account of that species. It differs from *F. alabastrum* (known only from the Atlantic Ocean) in having a much taller corallum (GCD: H = 0.95–1.3 vs about 1.5 for *F. alabastrum*) and in having much shorter, crested lateral edges (LEL: H = 0.26–0.45 vs about 0.9 for *F. alabastrum*, which also lacks crests). *Flabellum lowekeyesi* differs from *F. marcus* (central Pacific) in having six (not four) cycles of septa and in having a white (not brown) corallum.

Flabellum (*U.*) *messum* Alcock, 1902

(Plate 33, a-c)

Flabellum laciniatum var. *messum* Alcock, 1902c: 31.

Flabellum (*U.*) *messum*: Cairns 1989a: 58–59, pl. 30, figs. f–i, k (synonymy); Cairns & Keller 1993: 263, pl. 10, figs G–H.

MATERIAL EXAMINED: New Records: NZOI Stn T226, 8, USNM 94325; Stn T243, 1, NZOI. Previous Record: 1 syntype of *F. laciniatum messum*.

DISTRIBUTION: New Zealand region: Kermadec Ridge from off Macauley Island to north of Raoul Island (Map 22); 800–1035 m. Elsewhere: Indonesia, Philippines, Mascarene Plateau; 368–949 m.

DIAGNOSIS: Corallum compressed and constricted medially. Angle of straight, crested thecal edges 130–180°; inclination of concave lateral faces 36–44°. Largest New Zealand specimen (NZOI Stn T226) 45.1 × 22.7 mm in calicular diameter and 39 mm in height. Calice deeply lacerate. Pedicel elliptical in cross section: 2.4 × 2.8 mm. Thecal faces bear fine chevron-shaped growth ridges, but also a coarse granulation, which gives the theca a rough texture. C1–3 usually slightly ridged. Entire corallum reddish-brown, except for theca corresponding to C1–3 and edge crests, which are white. Septa hexamerally arranged in 5 cycles according to the formula: S1–3>S4>S5, S5 being quite rare and only occasionally found in the largest coralla. Fossa deep and narrow, containing a crescent-shaped columella composed of the fusion of the lower inner edges of the S1–3.

TYPES: Five syntypes of *F. laciniatum* var. *messum* are deposited at the ZMA (1214) (Van Soest 1979).

TYPE LOCALITY: *Siboga* Stns 45, 284, 314, Indonesia, 694–828 m.

REMARKS: *Flabellum messum* is extremely similar to *F. lowekeyesi*, the two taxa being perhaps sister species or subspecies of one species. When closely compared, *F. messum* differs in having: reddish-brown, rough-textured theca; a smaller maximum corallum size and correspondingly fewer septa (i.e., few, if any, S6); a smaller edge angle (i.e., usually < 180°); and a slightly more robust corallum. Although found at the same depths, *F. messum* is known only from tropical regions, *F. lowekeyesi* from more southerly temperate regions.

Flabellum messum is more fully described by Cairns (1989a) and therefore is only diagnosed above.

Flabellum (U.) aotearoa Squires, 1964
(Plate 33, d-f, i)

Flabellum aotearoa Squires, 1964b: 7–9, pl. 2, figs 15–18; Squires & Keyes 1967: 26, pl. 4, figs. 2–3; Dawson 1979: 28–29; Cairns 1989a: 54, 58.

Flabellum sp. cf. *F. deludens*: Wells 1984:2 15, pl. 4, figs 8–10.

MATERIAL EXAMINED: New Records: NZOI Stn I76, 1, NZOI; Stn I735, 1, NZOI; Stn I745, 2, NZOI; Stn J699, 4, NZOI; Stn J699, 4, USNM 94337; Stn J976, 1, NZOI; Stn P14, 33, USNM 49233 and 94336; Stn P27, 1, NZOI; Stn T214, 1, NZOI; BS441, 5, MoNZ CO316; BS723 (R81), 1, MoNZ; BS833 (O578), 1, MoNZ CO287; BS866 (O612), 1, MoNZ; BS878 (O624), 6, MoNZ CO225; BS881 (O627), MoNZ CO281. Previous Records: Types and nontypes of Squires (1964b); specimens reported by Wells (1984) as *F.* sp. cf. *F. deludens*, USNM 71859.

DISTRIBUTION: New Zealand region: Lord Howe Seamount Chain; Norfolk Ridge; Kermadec Ridge; off northeastern North Island from North Cape to East Cape (Map 16); 130–565 m. Elsewhere: off Chesterfield Islands; 1300 m (reported herein); Late Pleistocene of Vanuatu (Wells 1984).

DESCRIPTION: Corallum compressed (GCD: LCD = 1.40–1.75), having sharp, carinate thecal edges. Angle of thecal edges (exclusive of crests) 80–140°; inclination of thecal faces 38–43°, the higher range characteristic of larger specimens. Largest specimen examined (NZOI Stn P14) 31.7 × 22.7 mm in calicular diameter and 28.7 mm in height. Thecal edges bear thin (about 0.25 mm) crests up to 2.5 mm in height that are usually continuous from just above the pedicel to the calice, but are occasionally disrupted; crests straight and slightly sinuous. Pedicel small and elliptical: 1.8–2.1 × 0.9–1.3 mm in diameter, the longer axis always aligned with the GCD. Calicular margin moderately scalloped, the S1–2 and adjacent S5 forming a relatively low, triangular lancet 1.1–1.5 mm in height; smaller lancets about 0.7 mm in height correspond to the S3. Thecal faces only slightly convex. Theca quite smooth, covered by numerous very fine granules, producing a glistening and slippery texture. Well-preserved specimens display reddish-brown thecal stripes adjacent to every septum, the theca overlaying the septa being a translucent white. Poorly-preserved specimens have a uniformly opaque white colour.

Septa hexamerally arranged in 5 cycles according to the formula: S1-2>S3>S4>S5, specimens as small as 15 mm GCD having a full fifth cycle of 96 septa. Only one specimen is known to have more than 96 septa, the holotype, which has 5 pairs of S6 in its end half-systems, resulting in 104 septa. S1-2 slightly exsert, with highly sinuous inner edges that solidly fuse with the columella. S3 less exsert, about 0.8 as wide as an S1-2, and also have quite sinuous inner edges that reach the columella. S4 about half width of an S3 and have only moderately sinuous inner edges. S5 rudimentary, only one-fifth to one-quarter width of an S4, and have straight inner edges. Septal faces bear small granules that are aligned with trabeculae that radiate outward from the thecal wall. Fossa deep and narrow, containing an elongate, rudimentary columella composed of the lower, inner edges of the S1-3.

TYPES: The holotype from *Ikatere* Stn B26 is deposited at AIM. A paratype from *Ikatere* Stn B26 is also deposited at the USNM (68261), but the deposition of the paratype from *Ikatere* Stn B27 is unknown.

TYPE LOCALITY: 35°04' S, 174°23.2' E (northeast entrance to Bay of Islands, near Cape Brett), 184 m (corrected depth in Squires & Keyes 1967).

REMARKS: In his original description of *F. aotearoa*, Squires remarked that it was closely related to an undescribed species from the Philippines, which was probably *F. marenzelleri* Cairns, 1989a, the type series of which were available to him at that time. *Flabellum marenzelleri* is quite similar, but differs in having octamerally arranged septa; much higher, rectangular calicular lancets; a uniform thecal colouration; and a coarser thecal granulation. *Flabellum planus* Squires, 1962a, described from the Altonian (early Miocene) of the North Island, is also remarkably similar to *F. aotearoa*. Examination of the type specimens of *F. planus* (USNM and NZGS) and 20 topotypic specimens collected by the author (USNM) indicates that the only difference between the two species is that *F. planus* has few septa: having S5 adjacent to each S3 but invariably lacking S5 adjacent to the S2, which results in 62 septa.

Flabellum (U.) hoffmeisteri Cairns & Parker, 1992
(Plate 33, g, h)

Flabellum japonicum: Hoffmeister 1933: 7, pl. 1, figs 1-2; Cairns 1989a: 56, 57, pl. 29, figs j-k.

Flabellum (U.) hoffmeisteri Cairns & Parker, 1992: 47-48, pl. 16, figs d-f, map 18.

MATERIAL EXAMINED: New Records: NZOI Stn K804, 11, NZOI; Stn K828, 1, NZOI; Stn K829, 16, USNM 94324; Stn K830, 1, NZOI; Stn P947, 1, NZOI. Previous Records: Types.

DISTRIBUTION: New Zealand region: Kermadec Ridge off Raoul Island; northern Colville Ridge (Map 22); 440-646 m. Elsewhere: off Victoria and Tasmania; 110-660 m.

DESCRIPTION: Corallum robust and laterally compressed (GCD: LCD = 1.35-1.75), with evenly convex thecal faces. Angle of thecal edges 63-105°, the edges bearing a thin crest up to 3.0 mm in height and extending from the pedicel to several mm below calicular edge. Inclination of lateral faces 50-60°. Largest New Zealand specimen examined (NZOI Stn K829) 47.6 x 35.4 mm in calicular diameter and 37.4 mm in height, with a pedicel diameter of 2.5 mm. Calicular edge only moderately lacerate, a small triangular apex about 1.5 mm tall corresponding to each of the 16 primary septa and much smaller apices corresponding to the secondary and tertiary septa. Only the 2 principal costae are crested, the 14 lateral primary costae expressed as low, rounded ridges that radiate upward from the pedicel to the calicular edge apices associated with each primary septum. Theca constituting primary costae brownish-black.

Septa octamerally arranged in 4 size classes (16:16:32:32-64 = 96-128 septa), only the largest specimen (NZOI Stn K829) having a complete fourth size class, as well as 4 pairs of septa of a fifth size class, resulting in 136 septa. Most specimens, however, have a variable and incomplete fourth size class of septa, the quaternaries often occurring in pairs flanking the secondary septa (but not the primary septa), resulting in a calice with 96 septa. Sixteen primary septa quite broad, with thickened, sinuous inner edges. Secondary septa about three-quarters width of primaries and also quite sinuous, but do not reach the columella. Tertiaries about half width of secondaries and also with sinuous inner edges. Quaternaries rudimentary and usually quite short. Fossa deep and elongate, containing a rudimentary trabecular columella composed of the lower, inner edges of the primary septa.

Types: The holotype is deposited at the SAM (H642); paratypes are deposited at the USNM, NMV, and SAM.

TYPE LOCALITY: Soela Stn 27, 37°59' S, 150°05' E (off Victoria), 452 m.

REMARKS: Among the five species of *Flabellum* (*Ullocyathus*) that have laterally compressed coralla (see Cairns 1989a), only two have octamerall septal symmetry: *F. marenzelleri* Cairns, 1989a and *F. hoffmeisteri* Cairns & Parker, 1992. *Flabellum marenzelleri* is distinguished from *F. hoffmeisteri* by having a much more compressed corallum (face angle only 39–47°) and in having a deeply lacerate calicular margin, each primary septum projecting up to 4 mm as a prominent rectangular lancet. *Flabellum marenzelleri* is known only from the Philippines at 247–315 m.

Flabellum hoffmeisteri is also similar to *F. tuthilli* Hoffmeister, 1933, an octamerally symmetrical campanulate species known from South Australia at 400–800 m. A detailed description of that species is given by Cairns and Parker (1992).

Flabellum (*U.*) *apertum apertum* Moseley, 1876
(Plate 35, a-c)

Flabellum apertum Moseley, 1876: 556 (in part: *Challenger* Stn 145); 1881: 167–168 (in part: *Challenger* Stn 145), pl. 6, figs 7a-c; Squires & Keyes 1967: 26, pl. 4, figs 4–5; Squires 1969: 16, 18, pl. 6, map 4; Keller 1974: 205–208 (in part: Subantarctic records); Dawson 1979: 19; Cairns 1982: 44–46, pl. 13, figs 8–11, pl. 14, figs 1–4 (synonymy).

Not *Flabellum apertum apertum*: Squires 1958: 68, pl. 13, fig. 13.

Flabellum patagonichum Moseley, 1881: 166–167, pl. 15, figs 1–7.

Flabellum deludens: Ralph & Squires 1962: 12, pl. 4, figs 7–8 (= holotype of *F. raukawaensis*).

Flabellum raukawaensis Squires & Keyes, 1967: 27, pl. 4, figs 8–9; Cairns 1989a: 54.

Not *Flabellum* cf. *apertum*: Yabe & Eguchi 1942b: 136, pl. 12, figs 3a-c.

Flabellum apertum apertum: Cairns 1994: 74.

MATERIAL EXAMINED: New Records: NZOI Stn D836, 9, USNM 94288; Stn E399, 1, USNM 94289; Stn E707, 1, NZOI; Stn E713, 3, NZOI; Stn E714, 29, NZOI; Stn E715, 1, NZOI; Stn E718, 1, NZOI; Stn E719, 6, NZOI; Stn E725, 11, USNM 94290; Stn E753, 1, NZOI; Stn E757, 3, USNM 94 291; Stn E782, 2, NZOI; Stn F110, 2, USNM 94292; Stn F112, 1, NZOI; Stn F123, 1, NZOI;

Stn F128, 1, USNM 94293; Stn F764, 5, NZOI; Stn F767, 1, NZOI; Stn F873, 8, NZOI; Stn F874, 8, NZOI; Stn F878, 3, NZOI; Stn G665, 1, USNM 94294; Stn G666, 2, NZOI; Stn G701, 5, USNM 94295; Stn G703, 2, USNM 94297; Stn G947, 1, NZOI; Stn G955, 1, NZOI; Stn I694, 1, NZOI; Stn K873, 5, NZOI; Stn S46, 1, NZOI; Stn S154, 1, USNM 94298; Stn S166, 1, NZOI; Stn U573, 2, NZOI; BS353, 1, MoNZ; BS649 (R7), 3, MoNZ; BS762 (R120), 1, MoNZ CO146; BS771 (R129), 3, MoNZ; *Eltanin* Stn 1403, 1, USNM 82011. Previous Records: Types of *F. apertum*, *F. patagonichum*, and *F. raukawaensis*; specimens reported by Squires and Keyes (1967) and Squires (1958).

DISTRIBUTION: New Zealand region: widely distributed from Three Kings Islands to Hjort Seamount (Map 4); 322–1575 m. Elsewhere: circum-Subantarctic; 220–1500 m (Cairns 1982).

DESCRIPTION: Corallum campanulate and compressed (not constricted), with a GCD: LCD of 1.3–1.7. Angle of thecal edges bimodal: for lower 10–12 mm of corallum, edges diverge at a 130–170° angle above which they are inflected upward at a much narrower angle. Lateral faces similarly inflected, resulting in a full, campanulate corallum. Largest specimen examined (NZOI Stn G947) 70 x 41 mm in calicular diameter and 40 mm in height. Pedicel 2.0–3.5 mm in diameter and often eroded. Calice deeply lacerate, a tall triangular lancet up to 6 mm in height corresponding to each S1–2 and their adjacent pair of S4, and a smaller lancet up to 1.6 mm in height corresponding to each S3. Principal costae ridged and often crested from pedicel to calice; 4 lateral C1 also ridged or crested at point of thecal inflection. Often the 6 C2 are also ridged or crested (up to 2 mm) beginning slightly above the lateral C1 ridges. Corallum usually white and porcellanous, but some coralla a uniform light reddish-brown.

Septa hexamerally arranged in 4 cycles at a GCD as small as 24 mm according to the formula: S1–2>S3>>S4. Large specimens (GCD 55–60 mm) often have some rudimentary S5, the largest specimens (GCD > 65 mm) having a full fifth cycle. When the fifth cycle is incomplete, S5 are first inserted as pairs flanking the S1–2 (between S1–2 and adjacent S4) and only later in the interseptal position between the S3 and S4. S1–2 with straight, thickened inner edges that come close to fusing with inner edges of septa from opposite face. S3 half to three-quarters width of an S1–2, becoming wider in larger coralla until their inner edges reach the columella. S4 about

one-third width of an S3. S5, if present, rudimentary. All septa thin (0.20–0.35 mm) and well separated from one another by a distance of 3.0–3.5 mm. Fossa deep and open, containing a rudimentary elongate columella composed of a fusion of the lower, inner edges of the S1–3.

Types: The lectotype (designated by Cairns 1982) and 7 paralectotypes of *F. apertum* are deposited at the BM(NH), as are the syntypes of *F. patagonichum*. The holotype of *F. raukawaensis* is deposited at the MoNZ (CO186).

TYPE LOCALITIES: *Flabellum apertum*: Challenger Stn 145, 46°40' S, 37°50' E (off Prince Edward Island), 567 m. *Flabellum patagonichum*: Challenger Stn 305, 47°48.3' S, 74°47' W (off Penguin Island, Patagonia, Chile), 220 m. *Flabellum raukawaensis*: 41°33' S, 174°55' E (off Palliser Bay, New Zealand), 695 m.

REMARKS: Keller (1974) synonymised *F. japonicum* Moseley, 1881, *F. deludens* Marenzeller, 1904a, and *F. raukawaensis* Squires & Keyes, 1967 with *F. apertum*. Although I believe the first two species to be distinct (Cairns 1989a), I agree that *F. raukawaensis* is a junior synonym of *F. apertum*. The holotype of *F. raukawaensis* differs from most specimens in having an almost complete fifth cycle of septa at the relatively small GCD of 45 mm. Another virtually topotypic specimen from *Eltanin* Stn 1403 has the same characteristics, but both specimens are believed to represent precocious septal development.

The New Zealand Tertiary specimen reported as *F. apertum apertum* by Squires (1958) differs from *F. apertum* in having a fifth cycle of septa at the very small size of 20 mm GCD, having a laterally compressed (not campanulate) corallum, and having equally developed C1–2.

Flabellum apertum is distinguished from other species in the subgenus by its costal morphology; having a full, campanulate corallum; and its widely spaced septa. Subspecies *F. apertum borealis* was described by Cairns (1994) from off Japan at 307–1141 m. The typical subspecies was more fully described and figured by Cairns (1982).

Monomyces Ehrenberg, 1834

Corallum turbinate, ceratoid, or laterally compressed. Transverse division lacking. Pedicel

usually reinforced with asymmetrically arranged, contiguous rootlets. Four to six cycles of septa, the lower cycle septa often having concave upper edges. Calicular edge smooth. Fossa deep; pali absent; columella rudimentary.

TYPE SPECIES: *Monomyces anthophyllum* Ehrenberg, 1834, by subsequent designation (Wells 1936).

REMARKS: Three species are known in *Monomyces*: the type species *M. pygmaea* (Risso, 1826), Mediterranean; *M. rubrum* (Quoy & Gaimard, 1833); and the Italian Miocene *M. deperditus* (Michelotti, 1871).

Monomyces rubrum (Quoy & Gaimard, 1833) (Plate 34, a-i)

Turbinolia rubra Quoy & Gaimard, 1833: 188–189, pl. 14, figs 5–9.

Flabellum nobile Holdsworth, 1862: 198–199, pl. 28, figs 4–5.

Flabellum latum Studer, 1878: 630, pl. 1, figs 3a–b.

Desmophyllum gracile Studer, 1878: 629–630, pl. 1, figs 2a–b; 1889: 180.

Cylicia vacua Tenison-Woods, 1879: 134, pl. 12, figs 4a–b.

Flabellum rugulosum Tenison-Woods, 1880: 12–13, figs 8a–b; Ralph 1948: 108, fig. 1.

Not *Flabellum rubrum*: Gardiner 1902: 463; 1904: 125; Folkson 1919: 4; Faustino 1927: 50; Gardiner & Waugh 1938: 174; Yabe & Eguchi 1942a: 96; 1942b: 132 (see Cairns 1989a).

Flabellum harmeri Gardiner 1929: 122–123, pl. 1, figs 19–20.

Flabellum rubrum: Powell 1947: 8, fig. 16 (= typical form); Ralph 1948: 108; Ralph & Squires 1962: 13–14, pl. 5, figs 1–18, pl. 6, figs 1–9; Squires 1963: 11–41, pls 1–2 (synonymy!); Squires & Keyes 1967: 27–28, pl. 5, figs 3–8 (= *latum* form); Squires 1964b: 7; Morton & Miller 1968: 160, pl. 7, fig. 5; Squires 1969: 18, pl. 6, map 3; Dawson 1979: 29; Grace & Grace 1976: 99; Brook 1982: 171–172.

Flabellum rubrum rubrum: Squires 1958: 65–66 (in part: pl. 12, figs 1–2, 4–5).

Flabellum rubrum campanulatum: Squires 1958: 67, pl. 14, figs 1–8.

Flabellum gracile: Wells 1958: 269; Ralph & Squires 1962: 12–13, pl. 4, figs 9–10; Squires & Keyes 1967: 26, pl. 4, figs 6–7 (not NZOI Stn C810).

Flabellum campanulatum: Squires 1960c: 1–2.

Monomyces rubrum: Cairns 1989a: 79.

MATERIAL EXAMINED: New Records/Typical form: NZOI Stn B482, 2, NZOI; Stn B653, 10, USNM 80140; Stn B808, 2, NZOI; Stn C821, 1, USNM 79793; Stn I14,

NZOI; Stn I15, 1, NZOI; Stn I47, 15, NZOI; Stn I52, 5, NZOI; Stn I53, 6, USNM 94348; Stn I56, 1, USNM 94349; Stn I343, 2, NZOI; Stn J362, 3, NZOI; Stn J672, 5, USNM 94350; Stn 674, 4, USNM 94351; Stn J951, 18, USNM 94352; Stn M774, 1, USNM 94353; Stn M775, 3, USNM 94354; Stn M776, 2, NZOI; Stn M782, 2, NZOI; Stn M793, 1, USNM 94355; Stn O.849, 2, NZOI; Stn Q105, 2, NZOI; Stn Q174, 2, NZOI; Stn Q738, 5, NZOI; BS770 (R128), 15, MNZ; Doubtful Sound, 4-7 m, USNM 76303; Taranaki Bight, 2, USNM 80133. *Forma nobile*: NZOI Stn C758, 1, NZOI; Stn C777, 6, NZOI; Stn E291, 6, NZOI; Stn E848, 30, USNM 94341; Stn E849, 1, NZOI; Stn E876, 2, USNM 94342; Stn F923, 1, NZOI; Stn F924, 1, USNM 94343; Stn F933, 2, USNM 94344; Stn J953, 1, USNM 94345; Stn J954, 7, NZOI; Stn J959, 11, NZOI; Stn J966, 3, USNM 94346; Stn J969, 1, NZOI; Stn J970, 2, USNM 94347; BS895 (O641), 19, MoNZ CO307; BS896 (O642), 14, MoNZ CO232; BS897 (O643), 1, MoNZ CO223; BS898 (O644), 3, MoNZ CO289; BS899 (O645), 4, MoNZ CO298; BS906 (O652), 5, MoNZ CO297; BS910 (O656), 5, MoNZ CO227. *Forma latum*: NZOI Stn B205, 10, USNM 80139; Stn E254, 1, NZOI; Stn E261, 1, NZOI; Stn E368, 2, NZOI; Stn F933, 1, NZOI; Stn I50, 3, NZOI; Stn I67, 4, NZOI; Stn I370, 1, NZOI; Stn I371, 22, USNM 94338; Stn J966, 1, NZOI; Stn N369, 3, NZOI; Stn P64, 3, NZOI; BS401, 1, MoNZ; BS833 (O578), 8, MoNZ CO287; BS881 (O627), 1, MoNZ CO281; BS909 (O655), 1, MoNZ CO238; *Eltanin* Stn 370, 2, USNM 80131. Previous Records: Type of *D. gracile*; specimens reported by Squires and Keyes (1967), Ralph and Squires (1962).

DISTRIBUTION: The typical form of *M. rubrum* has the widest distribution, extending from Three Kings Islands to Stewart Island (Squires & Keyes 1967: fig. 1), although, as Squires and Keyes noted, it is absent from four coastal regions: East Cape to Castlepoint, between North Cape and Raglan, from Karamea Bight to Jackson's Head, and Timaru to Stewart Island. Otherwise, this form is quite common off New Zealand at depths of 0-201 m, most particularly at depths of 10-50 m. This relatively shallow range is consistent with Squires' (1963) thesis that the typical form, which has a robust polycyclic base, is adapted to areas of unstable substrate and/or turbulent water. Squires (1960c, 1963) should be consulted for the fossil record of this species.

Despite 21 records, *forma nobile* is known from the very restricted geographic region of Three Kings Islands to Cape Brett (Map 6) at depths of 70-410 m; however, most specimens were collected at 150-300 m making it the "deep-water" form of the species. Squires (1963: 31) suggested that its unique form of basal reinforcement was

an adaptation to attach to objects lying above the seafloor, such as antipatharian axes and other corals "where increasing weight of the corallum may result in bending or breaking of the substrate". In fact, many of the specimens of this form are attached to dead coralla of the same species.

Forma latum also has a circumscribed distribution, known only off the North Island from North Cape to East Cape, Cook Strait, and one isolated record on the extreme western Chatham Rise (Map 6). The depth range of specimens examined is 59-163 m; however, dead specimens are known from much deeper (e.g., 549 m, Gardiner 1929). This flabellate form, which has a large, but non-reinforced pedicel, was considered by Squires (1963) to be the "deep-water" form, the implication being that in calmer, deeper water basal reinforcement would not be required. In general, this is true, but Brook (1982) has reported this form from as shallow as 1 m in sheltered habitats.

DESCRIPTION: Typical form: Corallum compressed (GCD: LCD = 1.3-2.5), with straight, rounded thecal edges, and flat thecal faces. Angle of thecal edges 52-75°; inclination of lateral faces 20-27°. Specimens relatively small, rarely larger than 28 mm in GCD or height (i.e., GCD: H ≤ 1), the lectotype of *Turbinolia rubra* being one of the larger representatives of this form. Pedicel circular: 2.0-2.7 mm in diameter. Asymmetrical polycyclic development present, but invariably confined to only one edge (about one-quarter of base) of corallum. Up to 4 layers of polycyclic chambers may be present at basal edge, increasing area of corallum attachment up to 20-fold. Theca usually heavily encrusted with bryozoans, foraminiferans, calcareous worm tubes, and/or coralline algae. Unencrusted theca relatively smooth, covered with very fine longitudinal costal striae and closely spaced chevron-shaped growth striae. Corallum white.

Septa arranged in 4 size classes, the total number of septa roughly correlated with GCD, as graphed by Squires (1963: fig. 4). A corallum of 12 mm GCD has about 12 primary, 12 secondary, 24 tertiary, and a variable number of quaternary septa; a corallum of 15-19 mm GCD has about 16 primary septa; 20-22 mm GCD, about 18 primary septa; and larger coralla of 20-28 mm GCD, 20-22 primary septa, but a total that rarely exceeds 124. Primary septa with slightly convex upper edges and straight, thickened lower edges

that attain the columella. Secondary septa half to four-fifths width of a primary, but do not fuse with the columella. Tertiaries much smaller than secondaries, and quaternaries are rudimentary. Fossa deep, containing an elongate trabecular columella about 1 mm wide.

Forma *nobile*, described by Holdsworth (1862) as a separate species and again by Studer (1878) as *Desmophyllum gracile*, differs from the other two forms in having a tall, almost ceratoid corallum, usually 2–3 times the GCD in height. (The other two forms have a GCD: H of 1.0–1.5). Also characteristic of this form is its method of basal reinforcement, referred to as the “second type” or by “talons” by Squires (1963). At a height of 21–25 mm the corallum produces a tubular epi-thechal chamber (a “talon”) 3–4 mm in diameter near the calicular margin. This tube grows downward and gradually spreads around the circumference of the pedicel, such that at the corallum base it has encompassed the pedicel and usually forms a V-shaped junction on the opposite side of the corallum where its leading edges meet. This tube, or rootlet, is one layer thick (not poly-cyclic as in the typical form) and contiguous with the pedicel, increasing the pedicel diameter of 2.5–3.5 mm to about 7 mm. The GCD: LCD of this form is similar to that of the typical form (1.3–2.2), but less than that of forma *latum*. Large specimens typically have 22 primary septa, 22 secondary septa, 44 tertiary septa, and up to 88 quaternary septa, the largest specimen examined being 32 x 20 mm in calicular diameter and 68 mm in height, with a pedicel diameter of 6.3 mm. Small specimens of this form are often bent in growth form, have hexamerous symmetry and sinuous inner septal edges, but may not have yet formed the accessory rootlets. Such a specimen formed the basis for Studer’s (1878) description of *D. gracile*.

The third form, forma *latum*, is characterised by lacking any kind of basal rootlet reinforcement. Originally described by Studer (1878) as *Flabellum latum*, this form was also described as *Cylicia vacua* Tenison Woods, 1879, *F. rugulosum* Tenison Woods, 1880, and *F. harmeri* Gardiner, 1929. Aside from lacking basal reinforcement, specimens of forma *latum* tend to have larger, flabellate coralla up to 135 mm in GCD (BS401); have a GCD: LCD up to 4.8; and an edge angle of 50–80°, but as great as 120° in the extreme case. Consistent with their large size, there are often more septa, larger specimens having up to 48 primary septa and the corresponding num-

ber of secondary to quaternary septa, although quaternary septa are quite irregularly developed. This form may also have a larger pedicel, up to 4.0 mm in diameter. Not all specimens lacking basal reinforcement have large, highly flabellate coralla; many are similar to the typical form in shape but simply lack rootlets. Also, some perfectly typical flabellate *latum* forms have basal rootlets. Given this wide variation and inter-gradation of characteristics, I agree with Squires (1963: 17–18, 31) in assuming that the presence or absence of rootlets is variable within a population and probably correlates to the local environmental conditions and the substratum to which the coral is attached.

YPES: The lectotype and paralectotype (designated by Squires 1963) of *Turbinolia rubra* are deposited at the MNHN. The deposition of the two syntypes of *F. nobile* is unknown. The holotype of *D. gracile* and presumably that of *F. latum* are deposited at the ZMB (*D. gracile*, #1880). The deposition of the two syntypes of *C. vacua* is unknown. The lectotype (designated by Ralph 1948) and two paralectotypes of *F. rugulosum* are deposited at NZGS (CO555–557). Four syntypes of *F. harmeri* are deposited at the BM(NH).

TYPE LOCALITIES: *Turbinolia rubra*: Cook Strait, 46 m. *Flabellum nobile*: “New Zealand”. *Desmophyllum gracile*: According to the label with the holotype and a later publication by Studer (1889), the holotype was obtained from *Gazelle Stn 24*, 20°07' S, 57°26.5' E (off Port Louis, Mauritius), 75–411 m; however, the type locality given by Studer (1878) was 34°09.9' S, 172°35.8' E (off Three Kings Islands), 165 m. *Flabellum latum*: 34°16' S, 172°59.6' E (off North Cape), 82 m. *Cylicia vacua*: off Wellington. *Flabellum rugulosum*: Ngaruroro River, Hawke’s Bay, Nukumaruan (early Pleisto-cene). *Flabellum harmeri*: *Terra Nova Stn 91*, off Great King Island, 549 m (dead).

REMARKS: Squires (1963) provided an exhaustive account of the synonymy, morphology, ontogeny, phylogeny, ecology, and distribution of *Flabellum* (= *Monomyces*) *rubrum*. I am in general agreement with the taxonomic conclusions of Squires, i.e., *M. rubrum* is a variable species endemic to New Zealand that has great variation in corallum shape and pedicel morphology that is probably dependent on the environment. I have separated the morphological variation into three forms, having some but remarkably little

overlap in shape and distribution.

Monomyces rubrum is the most commonly collected scleractinian in New Zealand waters, being quite conspicuous (reddish-orange polyp, yellow tentacles) and one of the few intertidal species. Although the synonymy presented above is long it is not complete, but does include all junior synonyms and significant references; Squires (1963) should be consulted for a more complete synonymy.

The typical and *nobile* forms of *M. rubrum* are easily distinguished from all other New Zealand Scleractinia by their characteristic method of basal reinforcement, but specimens of forma *latum* are quite similar in size and shape to *F. knoxi*. Forma *latum* differs in having: a robust, dense corallum (that of *F. knoxi* is light and fragile); a smaller edge angle (usually 50–80° vs 135–180° for *F. knoxi*); a rudimentary columella; and thickened, straight inner edges of the primary septa (S1–4 of *F. knoxi* are highly sinuous). Furthermore, although there is a slight overlap in the geographic and depth ranges, forma *latum* occurs off the North Island and Cook Strait at depths of 59–163 m, whereas *F. knoxi* occurs predominantly on the Chatham Rise and Bounty and Campbell Plateaus at depths of 160–1167 m (mostly at 400–700 m).

Polymyces Cairns, 1979

Corallum solitary; ceratoid to trochoid; and attached to substratum by a pedicel reinforced with symmetrically (6 pairs around circumference) or asymmetrically (2 pairs on corallum edge) developed, contiguous exothecal rootlets. Four to five cycles of septa; calicular margins lacerate to serrate. Pali absent; columella rudimentary.

TYPE SPECIES: *Rhizotrochus fragilis* Pourtalès, 1871, by original designation.

REMARKS: *Polymyces* is quite similar to *Monomyces*, differing primarily in the character implicit in their names, i.e., specimens of *Polymyces* have 4–12 contiguous rootlets, whereas specimens of *Monomyces* have only one massive rootlet or asymmetrical polycyclic development. *Polymyces* also differs in having serrate to lacerate calicular margins, *Monomyces* has smooth upper edges. Only three species are known in the genus: the type species *P. fragilis* (Portalès, 1868),

from the western Atlantic at 75–796 m (Cairns 1979); *P. montereyensis* (Durham, 1947) (= *P. tannerensis* (Durham & Barnard, 1952)), known from off southern California and Peru at 69–212 m (Cairns 1994); and *P. wellsii*.

Polymyces wellsii Cairns, 1991 (Plate 35, d-f)

Polymyces wellsii Cairns, 1991a: 22, pl. 8, figs f, i, pl. 9, figs a-b.

MATERIAL EXAMINED: New Records: NZOI Stn E731, 3, USNM 94304; Stn G941, 1, NZOI; Stn K806, 3, NZOI; Stn X138, 2, USNM 94305; BS342, 2, MoNZ CO91. Previous Records: Type series of *P. wellsii*.

DISTRIBUTION: New Zealand region: off northeastern New Zealand (Bay of Plenty and off Hawke Bay), Kermadec Islands (north of Raoul Island) (Map 10); 355–1165 m. Elsewhere: Galápagos Islands; 391–813 m.

DESCRIPTION: Corallum ceratoid, with a slightly flared calice; theca and septa thin and brittle; calice quite fragile. Largest specimen (NZOI Stn X138) 50 mm in GCD and 40 mm in height. Calicular edge highly lacerate. GCD: LCD = 1.2–1.5. Pedicel strongly reinforced by asymmetrically developed rootlets, which increase the pedicel diameter up to 5.5–6.0 mm. About 7–10 mm above the base, 4 narrow (about 0.7 mm in width), flattened exothecal rootlets develop, two corresponding to each half-system adjacent to one of the principal septa. These 4 rootlets grow downward, ultimately encircle the base and fuse, the edges of the combined chamber meeting itself on the opposite edge of the corallum in a U- or V-shaped junction near the base. These rootlets continue to encrust the surrounding substratum, thus not only increasing the pedicel diameter but also increasing the substratum attachment, giving greater stability to the corallum. Theca smooth, glistening, and reddish-brown in colour, the C1–2 sometimes slightly raised and pigmented a darker shade. Rootlets and coenosteum covering substratum white.

Septa hexamerally arranged in 4 to 5 cycles, the fourth cycle attained at the relatively small GCD of about 10 mm and persisting to at least a GCD of about 30 mm (e. g., the holotype). Larger coralla, however, show a development of a fifth cycle, a specimen 40 mm in GCD (NZOI Stn

E731) having 6 pairs of S5 (60 septa) and the largest specimen of 50 mm GCD (NZOI Stn X138) having a full fifth cycle of 96 septa. Septal formula: S1-2>S3>S4>S5. S1-2 highly exsert, forming slender triangular lancets up to 5 mm tall at calicular edge, with straight, thickened inner edges that extend so far into fossa that they almost meet their counterparts from the opposite face. S3 also form smaller (1.0-1.5 mm in height), exsert lancets; are three-quarters width of an S1-2; and have thin, finely sinuous inner edges. S4 not exsert, about one-third width of an S3, and have finely sinuous inner edges. If pairs of S5 are present, they take the dimensions of an S4, the S4 are increased in width to a typical S3, and the S3 are accelerated to about four-fifths the width of an S1-2. Fossa deep and narrow, containing a rudimentary columella formed by the fusion of the thickened lower, inner edges of the S1-2.

TYPES: The holotype and 10 of 11 paratypes are deposited at the USNM. One paratype is also deposited at the Harbor Branch Oceanographic Museum, Fort Pierce, Florida.

TYPE LOCALITY: *Johnson-Sea-Link* Stn 1916, 1°18.7' S, 89°48.8' W (northwest of Española, Galápagos), 545-562 m.

REMARKS: *Polymyces wellsi* is easily distinguished from the two other species in the genus by its asymmetrical rootlet development, the other species both having six pairs of symmetrically placed rootlets. In addition, *P. wellsi* differs from *P. fragilis* in having up to five cycles of septa and straight (not sinuous) inner septal edges of the S1-2; and from *P. montereyensis* in having a much more lacerate calicular margin and a pigmented corallum.

The method of basal reinforcement and resultant effect on *P. wellsi* is similar to that of *Monomyces rubrum* forma *nobile*, differing only in that the rootlet of *M. rubrum* originates as a single, massive root, whereas in *P. wellsi* four smaller rootlets seem to appear simultaneously. *Polymyces wellsi* is further distinguished from *M. rubrum* forma *nobile* by its lacerate calicular edge, hexamerall symmetry, smaller GCD: LCD, and pigmented corallum, as well as occurring in much deeper water.

Rhizotrochus Milne Edwards & Haime,
1848a

Corallum solitary; ceratoid, trochoid, or compressed; and attached. Pedicel small and not reinforced, but corallum attachment to substratum augmented with 2 to over 20 discrete (free standing, noncontiguous) rootlets that anchor theca to substratum. Three to 6 or even 7 cycles of nonexsert septa; calicular margin smooth. Pali absent; columella rudimentary.

TYPE SPECIES: *Rhizotrochus typus* Milne Edwards & Haime, 1848, by monotypy.

REMARKS: *Rhizotrochus* is most similar to *Polymyces*, both genera reinforcing their attachment to the substratum by rootlets, but in different ways. *Rhizotrochus* produces 2 to over 20 discrete (free standing), slender rootlets, each of which independently fuses to the substratum, whereas in *Polymyces* the rootlets are contiguous with the pedicel. In addition, the calicular edge of *Rhizotrochus* is smooth, that of *Polymyces* is serrate to lacerate.

Four species are known in *Rhizotrochus*: the type species *R. typus* Milne Edwards & Haime, 1848a (Indo-West Pacific, 20-1048 m) (see Cairns 1994), *R. levidensis* Gardiner, 1899 (Loyalty Islands, 192 m); *R. tuberculatus* (Terison-Woods, 1879) (off South Australia and Tasmania, see Cairns & Parker 1992); and *R. flabelliformis*. The genus is further discussed by Cairns (1989a) and Cairns and Parker (1992).

Rhizotrochus flabelliformis Cairns, 1989
(Plates 35, g-i, 36, a, b)

Flabellum latum: Alcock 1902c: 31.

Rhizotrochus flabelliformis Cairns, 1989a: 81, pl. 41, figs k-l, pl. 42, figs b, d.

MATERIAL EXAMINED: Previously known only from one specimen, the holotype, *R. flabelliformis* is herein reported from 37 additional specimens from 12 localities: NZOI Stn I374, 1, USNM 94299; Stn I375, 5, NZOI; Stn J679, 8, USNM 94300; Stn J709, 1, USNM 94301; Stn K795, 6, USNM 94302; Stn K844, 1, NZOI; Stn P10, 6, USNM 94303; BS715 (R73), 2, MoNZ CO221; BS720 (R78), 4, MoNZ CO162; BS843 (O589), 1, MoNZ CO215; RV *Franklin* Stn 5/89/47, 1, AMS G15561; *Volcanolog* Stn 64, 1, AUM 12299. Previous Records: Holotype.

DISTRIBUTION: New Zealand region: Lord Howe Seamount Chain (Britannia Seamount); southern Norfolk Ridge; off northeastern New Zealand; Kermadec Ridge (Map 17); 228–419 m. Elsewhere: Sulu Archipelago, Philippines; 275 m.

DESCRIPTION: Corallum robust and highly laterally compressed (GCD: LCD = 2.4–3.4), with flat (not constricted) thecal faces and rounded thecal edges. Angle of thecal edges variable, ranging from 30–115°; inclination of lateral faces, 25–35°. Largest specimen known (NZOI Stn P10) 67 x 28 mm in calicular diameter and 63 mm in height. Pedicel circular and quite small: 1.2–1.5 mm in diameter. Early in ontogeny (e.g., height 3–4 mm, GCD 13–14 mm, septal complement 96) the theca associated with the two narrow calicular edges curves downward (Plate 36, a, b), eventually contacting and fusing with the substratum on either side of the pedicel. Gradually these two thecal extensions form tubes (rootlets) usually 4–5 mm in diameter (in some cases up to 9 mm in diameter) and the thecal edges resume their normal upward growth. Each tube contains the rudiments of the principal septum (S1) and the 3–5 adjacent septa to either side. The two rootlets confer much greater stability to the massive corallum than the relatively small original pedicel. Theca smooth but invariably heavily encrusted with foraminiferans, serpulids, and/or bryozoans. Corallum a light reddish-brown, young coralla having more intense C1–2 pigmentation.

Septa hexamerally arranged in 6 to 7 cycles, the fifth cycle complete at a GCD as small as 14 mm (S1–4>S5), the full sixth cycle attained at a GCD of about 45 mm (S1–4>S5>S6), and only part of the seventh cycle (246–284 septa) attained even in the largest coralla. S1–4 have concave (SCI up to 8), sometimes sinuous, upper edges and moderately to very sinuous lower, inner edges, which almost meet their counterparts from the opposite face in the upper fossa. S5 about three-quarters width of an S1–4, also quite thin near the calicular edge, but with straight inner edges. S6 small, only about one-third width of an S5, and extend only partially toward base of corallum. Fossa deep and narrow, not affording a view of the rudimentary columella in an intact specimen.

TYPE: The holotype is deposited at the ZMA (Coel. 1216).

TYPE LOCALITY: *Siboga* Stn 105, 6°08' N, 121°19' E (Sulu Archipelago, Philippines), 275 m.

REMARKS: *Rhizotrochus flabelliformis* is easily distinguished from its three congeners by having a flabellate corallum and only two massive rootlets that are aligned with the GCD. All other species have elliptical coralla and a variable number of smaller rootlets associated with the C1–2. In the New Zealand region, *R. flabelliformis* might be confused with the *latum* form of *M. rubrum*, but is distinguished by its smaller pedicel diameter and its large, discrete rootlets. The latter character would also serve to distinguish it from the forms of *M. rubrum* that possess contiguous rootlets or polycyclic development. The distribution of *R. flabelliformis* overlaps the northern range of *M. rubrum*, but it is much more widespread in the tropical western Pacific.

Gardineria Vaughan, 1907

Corallum solitary, trochoid to turbinate, attached by a polycyclic base and short, contiguous basal rootlets. Epitheca transversely wrinkled. Upper, outer septal edges separated from calicular edge by a deep notch. Fossa shallow; paliform lobes usually present before S2; columella papillose or absent.

TYPE SPECIES: *Gardineria hawaiiensis* Vaughan, 1907, by original designation.

REMARKS: Five species are recognised in this genus: *G. hawaiiensis* Vaughan, 1907; *G. paradoxa* (Pourtales, 1874); *G. simplex* (Pourtales, 1878); *G. minor* Wells, 1973; and *G. philippinensis* Cairns, 1989a.

Gardineria hawaiiensis Vaughan, 1907

(Plate 36, c-f, i)

Gardineria hawaiiensis Vaughan, 1907: 65–66, pl. 4, fig. 1; Cairns 1984: 23.

Gardineria musorstomica Cairns, 1989a: 82–83, pl. 42, figs c, e-g.

MATERIAL EXAMINED: New Records: NZOI Stn E731, 1, USNM 94306; Stn E859, 4, NZOI; Stn E861, 1, NZOI; Stn I97, 2, USNM 94307; Stn K826, 3, NZOI; Stn K830, 3, USNM 94308; Stn K840, 2, NZOI; Stn K858, 1, NZOI; Stn P14, 1, USNM 94310; Stn T256, 1,

NZOI; Stn U591, 1, NZOI. Previous Records: types of *G. hawaiiensis* and *G. musorstomica*.

DISTRIBUTION: New Zealand region: southern Norfolk Ridge; Kermadec Islands; Bay of Plenty (Map 13); 142–602 m. Elsewhere: Hawaiian Islands; Philippines; 192–541 m.

DESCRIPTION: Corallum trochoid to turbate, having a basal angle ranging from 32–85°: the wider angle characteristic of the large holotype of *G. hawaiiensis* and an equally large specimen from NZOI Stn I97; the narrower basal angle characteristic of the small holotype of *G. musorstomica*. Largest specimen examined (holotype of *G. hawaiiensis*) 32.6 mm in calicular diameter and 20.3 mm in height, having regenerated from a smaller calice of the parent corallum. Pedicel robust (PD: GCD = 0.3–0.4), formed by polycyclic development, the outermost thecal ring often generating short, contiguous, accessory rootlets at base of corallum. Epitheca bears fine, transverse striae and usually rises well above the upper, outer septal edges as a thin circular lip. Corallum white.

Septa hexamerally arranged in 4 cycles, but fourth cycle never complete. Specimens up to 15 mm GCD have only 3 cycles (24 septa), whereas the largest specimens of GCD = 30–32 mm have up to 36–44 septa, and a specimen of 20 mm GCD (NZOI Stn P14) has the intermediate complement of 30 septa. S1 thick with straight inner edges that fuse deep in fossa. S2 about three-quarters width of an S1, each bearing a broad, lamellar paliform lobe on its lower, inner edge. S3 about three-quarters width of an S2, unless flanked by a pair of S4, in which case they are equal in width to an S2 and also bear an equal-sized paliform lobe. S4 equal in width to an unflanked S3. Thus, there are only 3 size classes of septa: S1; S2 and flanked S3; and S4 and unflanked S3. All septa are well separated from one another by a distance of about 1.5 mm at calicular edge. Fossa shallow. Columella may consist of 1–3 papillae or be absent.

TYPES: The holotype of *G. hawaiiensis* is deposited at the USNM (20731). The holotype of *G. musorstomica* is deposited at the MNHNP.

TYPE LOCALITIES: *G. hawaiiensis*: Albatross Stn 3991, 22°15'25 N, 159°23'15 W (Kauai, Hawaiian Islands), 497–541 m. *G. musorstomica*: MUSORSTOM Stn 2–32, 13°40.5' N, 120°53.9' E (Philippines), 192–220 m.

REMARKS: One of the dangers in describing a species based on only one specimen is that it may be a juvenile or aberrant specimen. This seems to have been the case for both Vaughan (1907) and myself (Cairns 1989a). Vaughan's unique specimen of *G. hawaiiensis* is unusually large, has a very open calice, and was a product of rejuvenescence, thus not affording a characterisation of its pedicel and attachment. The holotype of *G. musorstomica* of 13.5 mm GCD is a juvenile specimen, having only 3 cycles of septa, and is somewhat worn. Given the intermediate variation represented by the New Zealand specimens, *G. hawaiiensis* and *G. musorstomica* would appear to be the same species.

Gardineria sp.

(Plate 36, g, h)

MATERIAL EXAMINED: NZOI Stn I96, 1, NZOI; Stn I735, 1, USNM 94311; Stn I743, 2, USNM 94312; Stn P10, 1, NZOI.

DISTRIBUTION: South of Chesterfield Islands; Lord Howe Seamount Chain; southern Norfolk Ridge (Map 17); 291–378 m.

REMARKS: The five specimens listed above are extremely similar to *G. hawaiiensis*, but differ in having more septa at a corresponding GCD (neotenic). Specimens of 17–21 mm GCD already have 48 septa and a specimen from NZOI Stn I96 of 19 mm GCD has 58 septa. Furthermore, the septa are arranged in four size classes (S1>S2>S3>S4) and are much more closely spaced (only 0.3–0.5 mm apart vs 1.3–1.5 mm for *G. hawaiiensis*). Finally, the P2 of *Gardineria* sp. A are narrower and slightly pointed, not broad and rounded as in *G. hawaiiensis*.

The specimens reported as *Gardineria* sp. by Gardiner (1929) from off North Cape (*Terra Nova* Stn 96) belong to the genus *Crispatotrochus* and are discussed further in the account of that genus.

Javania Duncan, 1876

Corallum solitary, subcylindrical to turbate, and attached by a pedicel that is strongly reinforced with numerous layers of dense stereome. Three to five cycles of highly exsert septa present, resulting in a lacerate calicular edge. Pali absent; columella rudimentary or absent.

TYPE SPECIES: *Javania insignis* Duncan, 1876, by monotypy.

REMARKS: *Javania* is similar to *Rhizotrochus* and *Polymyces* in having a basal reinforcement, but differs in that its pedicel is modified by concentric layers of dense coenosteum (stereome), not by hollow rootlets. Eleven species are known in the genus: eight are listed by Cairns (1989a) in his review of the genus; *J. borealis* and *J. californica* were described recently by Cairns (1994); and *J. pachythea* is described herein. Of the eight recent species, four have five cycles of septa, three have four cycles of septa, and one species has only three cycles of septa.

Javania lamprotichum (Moseley, 1880)
(Plate 37, b, c)

Desmophyllum lamprotichum Moseley, 1880: 41-42, figs 1-2.

Javania lamprotichum Cairns 1984: 21, pl. 4, figs D-E.

MATERIAL EXAMINED: Previously known only from 5 specimens from 2 localities, herein are reported an additional 13 specimens from 3 localities: NZOI Stn K846, 4, NZOI, Stn K858, 2, USNM 94283; Stn T256, 7, USNM 94282. Previous Records: Holotype; specimen from off Hawaii (Cairns 1984).

DISTRIBUTION: New Zealand region: Kermadec Ridge off Macauley and Curtis Islands (Map 20); 465-710 m. Elsewhere: off Molokai, Hawaiian Islands and Johnston Atoll; 244-322 m (Cairns 1984).

DESCRIPTION: Corallum robust and ceratoid, with a slightly flared, serrate calicular margin and a GCD: LCD of 1.25-1.35. Largest specimens known (SANGO Stn 13-13 (Cairns 1984) and NZOI Stn T256) 42 x 32 mm in calicular diameter and 39 mm in height. Pedicel robust and elliptical in cross section, composed of numerous thin concentric layers of translucent to opaque white, dense stereome, which attains a diameter of 3.5-10 mm, depending on age of corallum. Pedicel stereome spreads over substratum, further strengthening the attachment. Theca smooth and porcellanous, the theca and septa being a uniform shade of reddish-brown; however, basal stereome white. Well-preserved coralla often display a more intense pigmentation (longitudinal stripes) associated with the C1-2; however, most specimens were dead when collected and covered

with a thin black coating.

Septa hexamerally arranged in 5 cycles, the complete fifth cycle attained as early as 9-10 mm GCD and not exceeded even in the largest coralla. S1-2 about 3 mm exsert and quite wide, having thick, vertical, sinuous inner edges that extend almost to their counterparts on the opposite face. Septal sinuosity less evident in large specimens, being replaced with a uniform inner septal thickness. S3 about 2.5 mm exsert, three-quarters width of an S1-2, and also have sinuous inner edges. S4 only about 1 mm exsert, about half the width of an S3, and have sinuous inner edges. S5 rudimentary, only one-third to half width of an S4. Fossa deep and elongate, containing a rudimentary columella composed of the fused lower edges of the S1-2.

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

TYPE LOCALITY: Unknown (specimen bought from a dealer).

REMARKS: Aside from *J. lamprotichum*, three of the eleven species in this genus are characterised by having five cycles (96) of septa in the adult stage: *J. insignis* Duncan, 1876 (Indo-West Pacific, 46-825 m, see Cairns 1994); *J. antarctica* (Gravier, 1914) (off continental Antarctica, 53-1280 m, see Cairns 1982); and *J. borealis* Cairns, 1994 (Aleutian Islands, 247-348 m). *Javania lamprotichum* is most similar to the North Pacific *J. borealis*, but is distinguished by having a slightly flared calice, a reddish-brown corallum, sinuous inner septal edges, and, in general, a more robust corallum with thicker theca and septa resulting in less space between adjacent septa.

In the New Zealand region, *J. lamprotichum* could be confused with *Polymyces wellsii* based on size, shape, and colour. *Javania lamprotichum* is distinguished by having a solid, stereome-reinforced pedicel (not rootlets), sinuous S1-2 edges, a less highly lacerate calicular edge, and the acquisition of S5 at a much smaller size.

Javania pachythea n. sp.
(Plates 36, j-l, 37, a)

Javania sp. Cairns 1989a: 76 (in part: USNM 82014).

MATERIAL EXAMINED: Types, q.v.

DISTRIBUTION: New Zealand region: Lord Howe

Seamount Chain; Norfolk Basin; Kermadec Ridge; off northern North Island (Map 17); 360–1045 m. Elsewhere: off Chesterfield Islands (NZOI Stn T182); 672 m.

DESCRIPTION: Corallum tall and slender (ceratoid to subcylindrical), having a slightly elliptical calice, GCD: LCD = 1.1–1.2. Largest specimen (holotype) 11.7 × 9.7 mm in calicular diameter, 29.1 mm in height, and 5.8 mm in pedicel diameter. Calicular margin serrate, produced by the exsert S1–3. Pedicel thickened with concentric layers of dense stereome, producing a strong shaft and base of support. Thecal walls also quite robust, up to 2.3 mm thick in some specimens. Exterior of theca glistening and finely granular, the individual granules 30–40 μm in diameter. C1–2 sometimes expressed as low ridges. Corallum usually white but may be light brown in some specimens.

Septa hexamerally arranged in 4 complete cycles according to the formula: S1–2>S3>>S4. S1–2 relatively highly exsert (2.0–2.3 mm) and have straight to slightly sinuous inner edges that extend well into fossa. S3 also exsert (1.1–1.4 mm), about three-quarters width of an S1–2, and have slightly sinuous inner edges. S4 not exsert and often not even present at calicular edge, but deep within the calice S4 are one-third to half the width of an S3 and have slightly sinuous inner edges. Fossa deep and narrow; columella not detected.

TYPES: Holotype: NZOI Stn K846, H-631. Paratypes: NZOI Stn C527 P-1047, 10, USNM 82014; NZOI Stn J716, 1 P-1048; NZOI Stn P57 P-1049, 1; NZOI Stn Q68 P-1050, 1; NZOI Stn S562 P-1051, 1, USNM 94284; NZOI Stn T182, 1 P-1052, USNM 94285; NZOI Stn T226, 1 P-1053, USNM 94286; RV *Franklin* Stn 5/89/40, 1, AMS G15502.

TYPE LOCALITY: 30°13.1' S, 178°32.0' W (off Macaulay Island, Kermadecs), 610 m.

ETYMOLOGY: The species name *pachythea* (Greek *pachys*, thick + *theke*, case or box) refers to the thick theca of this species.

REMARKS: Among the 11 species of *Javania*, only three have four cycles of septa: *J. cailleti* (Duchassaing & Michelotti, 1864); *J. pseudoalabastra* Zibrowius, 1974d; and *J. pachythea*. The latter is most similar to the widespread and variable *J. cailleti* (see Cairns 1984) and may

represent only a subspecies or form of that species, but differs from *J. cailleti* by having a smaller, subcylindrical corallum and a very thick theca. In shape, *J. pachythea* resembles *J. duncani* Wells, 1977 (Eocene of Tonga), but that fossil species appears to differ in having only three cycles of septa. However, the preservation of the holotype of *J. duncani* is not sufficient to distinguish S4 even if they were present.

Truncatoflabellum Cairns, 1989a

Corallum solitary and usually highly compressed. Asexual reproduction by transverse division quite common, resulting in a distal anthocyathus budded from a basal anthocaulus. Calicular margin smooth to slightly serrate. Most species bear one or more pairs of thecal edge spines or edge crests on the anthocyathus and one or more pairs of edge spines on the anthocaulus. Pali absent; columella rudimentary.

TYPE SPECIES: *Euphyllia spheniscus* Dana, 1846, by original designation.

REMARKS: Species of *Truncatoflabellum* differ from the subgenus *Flabellum* (*Flabellum*) in their propensity to asexually propagate by transverse division and in having thecal edge spines. Cairns (1989a, c) explained the philosophical rationale for distinguishing these genera. Approximately 33 species are known in the genus, 27 of which are listed by Cairns (1989a: 61). More recently described or previously overlooked species include: *T. dens* (Alcock, 1902a); *T. truncum* (Cairns, 1982); *T. gardineri* Cairns in Cairns & Keller, 1993; *T. multispinosum* Cairns in Cairns & Keller, 1993; *T. phoenix* n. sp.; and *T. arcuatum*, n. sp.

Truncatoflabellum paripavoninum (Alcock, 1894) (Plate 37, d, e)

Flabellum paripavoninum Alcock, 1894: 187; 1898: 21, pl. 2, figs 3a, b.

Truncatoflabellum paripavoninum: Cairns 1989a: 72–73, pl. 37, figs j–l, pl. 38, fig. a (synonymy).

MATERIAL EXAMINED: New Records: NZOI Stn K805, 1, NZOI; Stn T241, 1, NZOI; Stn T243, 1, USNM 94278; Stn T244, 1, NZOI; Stn T259, 2, USNM 94279.

Distribution: New Zealand region: Kermadec

Ridge between Raoul and Macauley Islands (Map 21); 1035–1450 m. Elsewhere: Laccadive Sea, Philippines, Indonesia; 476–1163 m (see Cairns 1989a).

DIAGNOSIS OF ANTHOCYATHUS: Angle of thecal edges quite variable, ranging from 57–135°; inclination of thecal faces 32–62°. Largest New Zealand specimen (NZOI Stn T243) only 23.3 x 13.0 mm in calicular diameter and 22.0 mm in height, with a basal scar of 8.1 x 4.3 mm, but specimens exist up to 49 mm in GCD (Cairns 1989a). Thecal faces meet in acutely angled edges, but thecal edges not carinate or spinose. Basal scar quite variable in size: 6.8–14.5 x 4.1–6.8 mm. C1–2 sometimes slightly raised as rounded ridges. Corallum white to light brown. Septa hexamerally arranged in 6 cycles, but sixth cycle does not begin to appear until a GCD of about 26 mm and thus is absent from all New Zealand specimens examined. Septal formula of small specimens: S1–2>S3>S4>S5, but as the corallum increases in size, S3 become as wide as the S1–2 and ultimately S6 are added. Fossa deep; columella well developed, consisting of a relatively wide (2.0–2.2 mm) trabecular mass fused to the lower, inner edges of the S1–3.

TYPES: The holotype is presumed to be deposited at the Indian Museum, Calcutta.

TYPE LOCALITY: *Investigator* Stn 177, 13°47'4 N, 73°07' E (off Pedro Bank, Laccadive Sea), 1163 m.

REMARKS: There exist three closely related Pacific species of *Truncatoflabellum* characterised by having non-spinose thecal edges, costate thecal faces (C1–2), well-developed columellas, and that occur in relatively deep water (> 1000 m): *T. trapezoideum* (Keller, 1981b) (Marcus-Necker Ridge, central Pacific, 1630 m); *T. truncum* (Cairns, 1982) (eastern Pacific from Peru to Chile and Falkland Plateau, 595–1896 m); and *T. paripavoninum*. *Truncatoflabellum paripavoninum* differs from the other two in having thecal faces that meet in a sharp edge, the other two species having rounded thecal edges. However, *T. trapezoideum* is known from only one specimen and *T. paripavoninum* is a variable species, which might allow for the eventual synonymy of these two species. The Kermadec Ridge specimens reported herein are intermediate in corallum shape between *T. trapezoideum* and *T. paripavoninum*, having a relatively low edge angle char-

acteristic of the former and the sharp thecal edges characteristic of the latter. *Truncatoflabellum paripavoninum* is more fully described and discussed by Cairns (1989a).

Truncatoflabellum dens (Alcock, 1902), n. comb.
(Plate 37, f-h)

Flabellum dens Alcock, 1902a: 106–107; 1902c: 32, pl. 4, figs 30, 30a; Cairns 1989a: 54, pl. 28, figs g-k (synonymy).

MATERIAL EXAMINED: New Records: NZOI Stn K800, 1, USNM 94275; Stn K858, 1, USNM 94274; Stn P16, 1, NZOI; BS441, 57, MoNZ CO 261, 11, USNM 94276. Previous Records: Types of *F. dens*.

DISTRIBUTION: New Zealand region: Kermadec Ridge off Raoul and Curtis Islands; Norfolk Ridge south of Norfolk Island (Map 12); 320–555 m. Elsewhere: Sulu Archipelago, 522 m (Alcock, 1902c).

DESCRIPTION: Corallum small and highly compressed (GCD: LCD = 1.7–2.3), the inclination of lateral faces only 14–18°. Angle of thecal edges usually bimodal, at a height of 5–6 mm changing from 58–80° to a narrower 21–35°. Largest New Zealand specimen (NZOI Stn K858) 12.7 x 7.8 mm in calicular diameter and 14.8 mm in height, not much smaller than the largest syntype of 13.8 mm GCD. Sixty-two of the 68 New Zealand specimens from Stn BS441 originate in a small pedicel 1.3–1.4 mm in diameter containing 12 protosepta. Their lower thecal edges are sharp to carinate, their upper edges rounded and non-spinose. The remaining six specimens are anthocyathi that resulted from transverse division and thus have a trapezoid shape (Plate 37, f). Separated anthocyathi are similar in shape to pedicellate coralla as viewed from above the thecal edge inflection, and usually have 2 or 3 pairs of edge spines and a basal scar diameter of 3.3–3.7 x 2.2–2.6 mm. All septa nonexsert, producing a smooth calicular margin. Well-preserved coralla have a smooth, porcellanous theca bearing reddish-brown stripes corresponding to every interseptal space.

Septa hexamerally arranged in 3 to 5 cycles, the last cycle never complete. Small coralla of 6–7 mm GCD often have only 4 pairs of S4, one pair in each end half-system, resulting in 32 septa. As corallum increases in size (e.g., 7–9 mm

GCD), additional pairs of S4 form in the 2 lateral half-systems until a full fourth cycle is achieved (48 septa). In larger coralla of 8–10 mm GCD, pairs of S5 occasionally occur in end half-systems before the fourth cycle is complete. Largest coralla (GCD 10–13 mm) have a full fourth cycle and 4 pairs of S5, for a total of 56 septa. S1–2 have extremely sinuous inner edges, the sinuosity extending from calicular edge to columella. S3 about half width of an S1–2 and have less sinuous inner edges. S4 about half width of an S3 and have straight inner edges. Upper edges of all septa quite narrow and broadly concave near calicular edge (SCI about 10). Fossa deep and elongate, containing a trabecular columella 0.7–0.8 mm wide composed of the inner edges of the S1–2.

TYPES: Nine syntypes of *F. dens* are deposited at the ZMA (Coel. 1209).

TYPE LOCALITY: *F. dens*: Siboga Stn 95, 5°43.5' N, 119°40' E (Sulu Archipelago), 522 m.

REMARKS: Previously known from only nine worn syntypes, 71 additional specimens of *T. dens* are herein reported from four localities, many of these specimens alive when collected. The population of 68 specimens from BS441 show that the species may asexually reproduce by transverse division, but that most specimens remain intact and do not divide. The syntype series of nine specimens are all in the latter category and thus I had placed the species in *Flabellum* (*Flabellum*) (Cairns 1989a), but because the species occasionally reproduces by transverse division, it is perhaps better placed in *Truncatoflabellum*, as Zibrowius (1974d) earlier implied.

Among the approximately 33 species in the genus, *T. dens* is distinguished by its unique tooth-like shape; its relatively small corallum; and its low number of adult-stage septa (48–56). It is quite similar to but differs from *T. pusillum* Cairns, 1989a (Philippines, 143–146 m) in having a more elongate calice (GCD: LCD = 1.7–2.3 vs 1.4–1.7 for *T. pusillum*), a larger corallum, and a lesser tendency to divide transversely. It is also similar to *T. zuluense* Cairns (in Cairns & Keller, 1993), which is known from the southwest Indian Ocean at 62–84 m, both species having a tendency to remain intact and to lack edge spines; however, *T. dens* differs in having a more highly compressed (lower face angle), a more elongate calice (higher GCD: LCD), a bi-

modal edge angle, and a smaller pedicel diameter.

Truncatoflabellum phoenix n. sp.

(Plates 37, i, 38, a-f)

Truncatoflabellum sp. B: Cairns 1994: 79, pl. 33, figs i, l.

MATERIAL EXAMINED: Types, q.v.

DISTRIBUTION: New Zealand region: Kermadec Ridge between Raoul and Macauley Islands (Map 21); 145–179 m. Elsewhere: northern Ryukyu Islands; 80–88 m (as *Truncatoflabellum* sp. B Cairns, 1994).

DESCRIPTION: Corallum an elongate, compressed (GCD: LCD = 1.3–2.3) tube, having parallel thecal edges and faces, resulting in a basal scar equal in size to calice. Holotype 4.3 x 2.7 mm in calicular diameter and 7.4 mm long; however, another specimen from the same lot and same GCD is 17.5 mm long (H: GCD = 4.1). Long coralla characterised by multiple regeneration events, the daughter corallum usually smaller in diameter than the parent, at least initially. Calicular edges rounded, with 1–6 pairs of slender, cylindrical, downward-curved edge spines, the number proportional to length of corallum. Calicular edge smooth. Theca smooth and por-cellanous, pigmented periodically with transverse brown bands about 2.5 mm thick.

Septa hexamerally arranged in only 3 cycles: S1–2>>S3. Several specimens from the Ryukyu Islands have pairs of S4 in their end half-systems for a total of 32 septa. S1–2 not exsert, with quite sinuous inner edges and spinose faces. S3 only one-third to half width of an S1–2, much thinner, and rudimentary lower in fossa. Fossa of moderate depth, containing a relatively well-developed columella about 0.6 mm in width composed of a fusion of the lower, inner edges of the S1–2.

TYPES: Holotype: NZOI Stn C531, H-632, USNM 94616. Paratypes: NZOI Stn C531, 6, P-1054, USNM 82010; NZOI Stn K825, 1, P-1055, USNM 94277; TM (KT9202, YT1), 1, USNM 92811.

TYPE LOCALITY: 29°14'40 S, 178°02 W (south of Raoul Island), 179 m.

ETYMOLOGY: The species name *phoenix* (Latin *phoenix*, having regenerative powers) refers to the elongate coralla of this species characterised by multiple events of regeneration.

REMARKS: *Truncatoflabellum phoenix* is most similar to *T. dens*, but differs from it and all other species in the genus by having parallel thecal edges and faces and a slender, elongate corallum characterised by multiple regeneration events. It also has the least number of septa of all species.

Truncatoflabellum arcuatum n. sp.
(Plate 38, g-i)

MATERIAL EXAMINED: Types, q.v.

DISTRIBUTION: Known only in the New Zealand region, from southern Norfolk and Kermadec Ridges and off Cape Egmont (Map 12); 350–364 m.

DESCRIPTION OF ANTHOCYATHUS: Corallum shaped like a tall isosceles triangle with a truncate tip. Angle of thecal edges 14–15°; inclination of thecal faces 8–11°. Corallum straight or, in large specimens, slightly curved in axis of LCD, the height of the corallum up to 3.5 times the GCD. Calicular edges straight and acute, the holotype having several very low (0.3 mm) edge crests, but no edge spines. Calicular edge smooth and slightly arched in side view and quite laterally compressed (GCD: LCD = 1.8–2.6). Holotype 12.0 x 6.1 mm in calicular diameter and 24.3 mm in height, with a scar diameter of 5.9 x 2.7 mm; however, largest specimen (NZOI Stn C640, dead) 12.2 x 5.9 mm in calicular diameter and 40.1 mm in height. Basal scar 3.3–5.9 x 2.1–2.7 mm. Theca smooth, porcellanous, and always white. Corallum dense. Anthocaulus unknown.

Septa hexamerally arranged in 4 cycles, larger specimens having some pairs of S5 in end half-systems (e.g., the holotype has 6 pairs of S5 for a total of 60 septa). Septal formula: S1-2>S3>>S4. S1-2 not exsert and have very sinuous inner edges. S3 one-third to half width of an S12 and have slightly sinuous inner edges that sometimes reach the columella deep in fossa. S4 rudimentary, expressed only in upper half of corallum. Fossa of moderate depth, containing a well-developed trabecular columella that fuses to the inner edges of the 12 S1-2 and various accelerated S3 in those half-systems having S5.

TYPES: Holotype: NZOI Stn I96, NZOI H-633. Paratypes: NZOI Stn C640, 3, P-1056, USNM 94280; NZOI Stn K795, 3, P-1057, USNM 94281.

TYPE LOCALITY: 32°10.8' S, 167°21.2' E (southern Norfolk Ridge between Norfolk Island and Three Kings Islands), 356 m.

ETYMOLOGY: The species name *arcuatum* (Latin *arcuatus*, bent like a bow) refers to the slight curvature of the corallum of larger specimens.

REMARKS: Among the approximately 33 species in this genus, *T. arcuatum* is distinguished by its highly compressed (face angle 8–11°), elongate (H: GCD up to 3.5) corallum, and its lack of thecal edge spines. It is perhaps most similar to *T. dens*, but can be distinguished by its larger size; acute, crested thecal edges; and larger basal scar.

Placotrochides Alcock, 1902b

Corallum solitary and compressed. Asexual reproduction by transverse division predominates, resulting in a distal anthocyathus and basal anthocaulus. Anthocaulus base reinforced with stereome. Calicular margin smooth. Thecal edge spines and crests absent. Pali absent; columella well developed.

TYPE SPECIES: *Placotrochides scaphula* Alcock, 1902b, by subsequent designation (Wells 1936).

REMARKS: *Placotrochides* differs from *Truncatoflabellum* by having a stereome-reinforced anthocaulus base. It differs from most species of *Truncatoflabellum* by lacking thecal edge spines and crests, having a relatively small edge angle, and in having widely spaced septa. Only two species are attributed to this genus: *P. frusta* Cairns, 1979 (Atlantic, 497–1300 m) and *P. scaphula*.

Placotrochides scaphula Alcock, 1902
(Plates 38, j, 39, a)

Placotrochides scaphula Alcock, 1902b: 121–122; 1902c: 34, pl. 4, figs 32, 32a; Cairns 1989a: 78–79, pl. 40, fig. 1, pl. 41, figs a-e (synonymy); Cairns & Parker 1992: 48–49, fig. 15h, i; Cairns & Keller 1993: 272–273, pl. 12, figs D, G; Cairns 1994: 79–80, pl. 34, figs f-h.

MATERIAL EXAMINED: New Record: NZOI Stn G941, 2, NZOI, 2, USNM 94273. Previous Records: Holotype; specimens reported by Cairns (1989a, 1994) and Cairns and Keller (1993).

DISTRIBUTION: New Zealand region: only known from one station off Hawkes Bay (Map 9); 665 m. Elsewhere: off Japan; Philippines; Flores Sea; southwest Indian Ocean, Victoria, Australia; 80–1628 m.

DIAGNOSIS OF SPECIMENS FROM NZOI STN G941: Corallum shaped like that of *T. arcuatum*, but not quite as compressed (GCD: LCD = 1.4–1.6). Angle of thecal edges 10–11°; inclination of lateral faces 9–10°. Corallum elongate: H: GCD up to 2.3. Calicular edges straight, the faces meeting at an acute angle but not crested or spinose. Calicular edges smooth and slightly arched. Largest specimen examined 11.8 x 8.1 mm in calicular diameter and 26.6 mm in height, with a scar diameter of 7.5 x 4.5 mm. Theca smooth, but appearing worn (not porcellanous), marked by very thin longitudinal striae 0.05–0.10 mm thick that correspond to each C1–3 and delimit flat costae about 0.1 mm wide. Septa hexamerally arranged in 4 complete cycles (48 septa) according to the formula: S1–2>S3>>S4. S1–2 not exsert, with moderately sinuous inner edges. S3 only half width of S1–2 in upper corallum but their lower, inner edges reach the columella. Septa rudimentary, extant only in upper corallum. Fossa of moderate to great depth, containing a well-developed trabecular columella about 1.5 mm in width.

TYPES: The holotype is deposited at the ZMA (Coel. 1094).

TYPE LOCALITY: *Siboga* Stn 212, 5°54.5' S, 120°19.2' E (Flores Sea), 462 m.

REMARKS: The holotype is a small specimen only 6.9 mm in GCD having scarcely over three cycles of septa (28). Much larger specimens have been reported from off the Philippines (Cairns 1989a, i.e., 13 mm GCD) and of Japan (Cairns 1994, i.e., 10 mm GCD). Although the New Zealand specimens are not the largest known in calicular diameter (11.8 mm), they are by far the longest known specimens (up to 26.6 mm long), having a H: GCD up to 2.3 compared with a H: GCD of ≤ 1 for most previously reported specimens. The New Zealand specimens also have a full com-

plement of 48 septa, not achieved by even the larger Philippine coralla. *Placotrochides scaphula* is thus assumed to reach a maximum GCD of about 12–13 mm and a septal complement of 48 septa after which it increases in size by adding to its length.

In the New Zealand region, *P. scaphula* could easily be confused with *Truncatoflabellum arcuatum*, both species having convergent corallum shape and size. *Placotrochides scaphula* is distinguished by having a fuller corallum (i.e., a lower GCD: LCD), a better developed columella, a nonporcellanous theca; and less sinuous and more widely spaced septa.

Falcatoflabellum n. gen.

Corallum solitary, elongate, and cylindrical; corallum slightly curved and compressed. Asexual reproduction by transverse division predominates; anthocaulus unknown. Calicular margin slightly serrate. Thecal edge spines and crests absent. Columella fascicular; paliform lobes occasionally present before S2.

TYPE SPECIES: *Falcatoflabellum raoulensis*, here designated.

ETYMOLOGY: The genus name *Falcatoflabellum* (Latin *falcatus*, curved like a sickle + *flabellum*, fan) refers to the gently curved nature of the corallum of the type species. Gender: neuter.

REMARKS: Among the twelve genera recognised within the Flabellidae (Cairns 1989a: table 4), *Falcatoflabellum* most closely resembles *Conosmilia* Duncan, 1865, both genera having relatively small coralla with only three size classes of septa and a fascicular columella. [Most flabellid genera have a rudimentary fused columella, two have lamellar columellas, and one has a papillose columella.] *Falcatoflabellum* differs from *Conosmilia* in reproducing by transverse division; it also has a cylindrical corallum, whereas that of *Conosmilia* is ceratoid. Also, *Falcatoflabellum* has predominantly hexamerall symmetry (24 septa), whereas *Conosmilia* has predominantly octamerall symmetry (32 septa). *Conosmilia* is known only from the upper Eocene to Miocene of South Australia (Duncan 1865, 1870).

Among the four flabellid genera that have transverse division (Cairns 1989a: table 4) *Falcatoflabellum*

flabellum is most similar to *Placotrochides*, both genera having cylindrical, slightly compressed coralla with basal scars, but *Falcatoflabellum* differs in having a fascicular columella and paliform lobes.

Falcatoflabellum raoulensis n. sp.
(Plate 39, b-g)

MATERIAL EXAMINED: Types, q.v.

DISTRIBUTION: Known only from off Raoul Island, Kermadec Islands; 366-402 m.

DESCRIPTION: Corallum cylindrical and only slightly compressed (GCD: LCD = 1.1-1.2), elongate specimens gently curved up to 45° in plane of GCD. Holotype 2.62 x 2.17 mm in calicular diameter and 9.8 mm in height (H: GCD = 3.7). Elongate specimens often display evidence of regeneration or rejuvenescence, a smaller-diameter corallum issuing from the calice of a slightly larger parent corallum. Some elongate coralla also evidence incomplete divisions, represented by a transverse weakness of the corallum that ultimately breaks after death or upon collection, resulting in "middle" fragments that have no distinct calice. Basal scar planar and usually of equal size to calice. Calice not arched, but flat and slightly serrate, the S1-2 rising to small triangular apices. Epitheca porcellanous and smooth, but on higher magnification (Plate 39, b) one observes broad (0.25-0.30 mm), flat costae separated by very thin (about 30 µm) longitudinal rows of irregularly shaped, shallow pores, which constitute the intercostal striae. Corallum white to translucent. Anthocaulus stage unknown.

Septa of most specimens hexamerally arranged in 3 complete cycles (S1>S2>S3); however, 6 specimens (7.1% of specimens examined) have heptamerally arranged septa (i.e., 7:7:14 = 28 septa) and one specimen has pentamerally arranged septa (i.e., 5:5:10 = 20 septa). S1 about 0.3 mm exsert, with extremely sinuous inner edges. S2 slightly less exsert, about three-quarters width of an S2, also with sinuous inner edges. S3 not exsert, about half width of an S2, and much thinner than other septa. Faces of S1-2 bear tall (up to 80 µm), pointed granules. Fossa shallow, containing a well-developed columella composed of 2-4 broad (0.25-0.40 mm), loosely twisted fascicular elements. Often 4 colu-

mellar elements are arranged in a diamond shape, 2 aligned with the principal septa and the other 2 aligned with the opposing S2 in the lateral systems. Occasionally several lobes are present before the S2; however, they may be entirely absent from a corallum, and, when present, never occur before all 6 or 7 S2. Paliform lobes lamellar or fascicular in shape, but invariably smaller than columellar elements.

TYPES: Holotype: BS441, MoNZ CO258. Paratypes: BS441, 63, MoNZ CO258, 20, USNM 94313.

TYPE LOCALITY: 3.7 km off Nugent Island, Raoul Island, Kermadec Ridge, 366-402 m.

ETYMOLOGY: This species is named for its type locality, Raoul Island.

REMARKS: See remarks on genus.

Suborder DENDROPHYLLIINA
Family DENDROPHYLLIIDAE Gray, 1847

Balanophyllia S. Wood, 1844

Corallum solitary, ceratoid to trochoid, fixed or free. Synapticulotheca often costate and/or covered with epitheca. Septa arranged in a Pourtalès Plan. Pali/paliform lobes may or may not be present; columella papillose to spongy.

TYPE SPECIES: *Balanophyllia calyculus* S. Wood, 1844, by monotypy.

REMARKS: Approximately 53 recent species of *Balanophyllia* are known, at least 31 of which are recorded from the Indo-West Pacific realm. Whereas the Atlantic and eastern Pacific species are relatively well known (Cairns 1977b, 1994, Zibrowius 1980), the Indo-West Pacific species are in need of revision, several species known only from their type specimens and many reported only a few times. Three species are reported from the New Zealand region; however, over a dozen lots remain unidentified either because of poor preservation or because they are unique specimens not referable to any known species.

Balanophyllia chnous Squires, 1962
(Plate 40, a-e)

"*Thecopsammia*, sp.? *Balanophyllia*, sp.?" Gardiner 1929: 126–127.

Balanophyllia chnous Squires, 1962b: 13, 21–22, pl. 1, fig. 17, pl. 2, figs 1–3; 1969: 17–18, pl. 6, map 2; Cairns 1982: 54–57, pl. 16, figs 1–3.

MATERIAL EXAMINED: New Records: NZOI Stn E278, 7, USNM 94222; Stn E841, 6, NZOI; Stn E848, 8, USNM 94223; Stn F924, 2, USNM 94221; Stn F928, 1, NZOI; Stn F933, 1, NZOI; Stn J953, 2, USNM 94224; Stn J959, 4, NZOI; BS396, 1, MoNZ CO106; BS642 (P574), 1, MoNZ CO289; BS881 (O627), 9, MoNZ CO282; BS895 (O641), 20, MoNZ CO307 and 313; BS896 (O642), 6, MoNZ, 3, USNM 94225; BS897 (O643), 16, MoNZ CO223, 2, USNM 94226; BS898 (O644), 4, MoNZ CO289; J01/56/71, 1, MoNZ CO242. Previous Records: Holotype of *B. chnous*.

DISTRIBUTION: Known only from a small region between Three Kings Islands and North Cape (Map 8); 140–549 m, although most records are shallower than 300 m.

DESCRIPTION: Corallum ceratoid and elongate; straight to irregularly bent; and attached by a robust pedicel (PD: GCD = 0.43–0.51). Largest specimen examined (MoNZ CO242) 17.4 × 13.3 mm in calicular diameter and 48 mm in height. Coralla often attached to dead coralla of *Monomyces rubrum* forma *nobile*, as well as to bivalve shells, echinoid tests, and rocks. Pedicel and base appear to be polycyclic, and occasionally a specimen appears to have a contiguous rootlet. Most coralla have a thick epitheca that reaches to within 5–8 mm of calicular edge. Epitheca usually heavily encrusted with foraminiferans, serpulid tubes, bryozoans, sponges, and juveniles of *B. chnous*. Corallum above epitheca composed of a very porous, non-costate synapticulotheca. Corallum white.

Septa hexamerally arranged in 4 cycles at a GCD of 6–9 mm, additional pairs of S5 present in larger coralla, up to a maximum complement of 72 septa in the largest coralla examined. S1 only slightly exsert and have straight, vertical, entire inner edges that reach the columella. S2 slightly less exsert, about four-fifths width of an S1, and have entire inner edges that reach the columella only if the columella is quite large. S3 small (about one-quarter width of an S2) and porous, with lacinate inner edges. Pairs of S4 fuse before their common S3 and continue to columella as a single septum, sometimes loosely merging with inner edges of the other S4 within the system. S4 also porous, with lacinate inner

edges. Fossa shallow to moderate in depth, containing a discrete, convex, elongate columella composed of numerous fine papillae. In some coralla the width of the columella is as much as one-third the LCD, but it is usually somewhat smaller.

TYPES: The holotype (1929.10.22.25) and five paratypes (1929.10.22.22–24, 26–27) are deposited at the BM(NH). They are the same specimens reported by Gardiner (1929) as: "*Thecopsammia*, sp.? *Balanophyllia*, sp.?"

TYPE LOCALITY (corrected): *Terra Nova* Stn 91, "from Summit, Great King, Three Kings Islands, S. 10°W, 25 miles", 549 m (see Remarks).

REMARKS: I earlier suggested that there may have been a labelling error concerning the type locality of *B. chnous* (Cairns 1982). *Terra Nova* Stn 191 (Bay of Whales, Ross Sea) is given as the collection locality for this species by Gardiner (1929) at the beginning of his species account, in the general introduction, and on the label of the holotype. However, *Terra Nova* Stn 91 (off Three Kings Islands) is given as the locality at the end of Gardiner's species account, four other species also reported by Gardiner from this same *Terra Nova* station. No additional specimens of *B. chnous* have been collected in the Antarctic, despite extensive collections made in the Ross Sea (Cairns 1982). Nonetheless, the matter was left unresolved by Cairns in 1982. In this paper many additional specimens of *B. chnous*, some virtually identical to the holotype, are reported from 16 stations all in the vicinity of Three Kings Islands (i.e., near *Terra Nova* Stn 91). There is little doubt that the type series of *B. chnous* originated from the Three Kings Islands region (*Terra Nova* Stn 91, not 191) and that a mislabelling occurred after collection.

Balanophyllia chnous is distinguished from the other two New Zealand *Balanophyllia* by having a relatively small, ceratoid corallum with a heavily encrusted basal epitheca and a relatively well-developed columella. It is also known from a very restricted geographic range.

Balanophyllia gigas Moseley, 1881

(Plate 40, f-h)

Balanophyllia gigas Moseley, 1881: 193; Cairns 1994:

83, pl. 35, figs j-l (synonymy).

Balanophyllia alta: Ralph & Squires 1962: 15 (in part: pl. 8, figs 2-3, specimen from Cook Strait).

Dendrophyllia japonica: Ralph & Squires 1962: 15-16, pl. 8, figs 4-5; Squires & Keyes 1967: 28 (in part: miscellaneous stations 44, 56, C627).

Balanophyllia hawaiiensis Vaughan, 1907: 148-149, pl. 44, figs 4-5 (new synonymy).

Material Examined: New Records: NZOI Stn J686, 6, USNM 94219; Stn J705, 7, NZOI; Stn J971, 2, NZOI; Stn J976, 1, USNM 94220; BS630, 4, MoNZ CO123; *Tui* (Rumble IV Seamount), 1, AU11141, AUM. Previous Records: Holotype of *B. gigas* and syntypes of *B. hawaiiensis*; specimens reported as *B. alta* and *D. japonica* by Ralph and Squires (1962); specimens reported as *D. japonica* by Squires and Ralph (1967).

DISTRIBUTION: New Zealand region: off coastal New Zealand (Map 7); 148-640 m, although most records shallower than 300 m, the shallowest off Fiordland. Elsewhere: off Japan; Kai Islands, Banda Sea; off Hawaii; 90-348 m.

DESCRIPTION: Corallum ceratoid and elongate; usually straight but some coralla slightly curved; and attached by a robust pedicel (PD: GCD = 0.42-0.57). Largest specimen examined (*D. japonica* of Ralph & Squires, 1962: AIM AK33937) 33.3 x 27.5 mm in calicular diameter and 79 mm in height, with a pedicel diameter of 16.5 mm. Clumping of solitary coralla may superficially resemble a rudimentary colonial structure. Synchronicula of homogeneous, non-epithecate porosity, with poorly defined costae only on lower pedicel of some coralla and/or expressed as slight elevations of the C1-3 in upper corallum. Corallum white.

Septa hexamerally arranged in 5 cycles, the fourth cycle complete at a GCD of about 12 mm, the fifth at a GCD of about 21 mm, and the largest circular corallum of 33 mm GCD has half of the sixth cycle, resulting in 144 septa. S1-2 slightly exsert (about 1 mm) and quite wide, their inner edges almost meeting their counterparts from the opposite face. Inner edges of S1-2 vertical, straight, entire, and often slightly thickened, their size and characteristics making them easily distinguished. S3 also slightly exsert and about four-fifths width of an S1-2, equal to S1-2 in width if S6 are present in a half system. S4 small, each flanked by a pair of lacinate S5, which fuse before each S4 and extends to columella. In large coralla a broad paliform lobe occurs on inner edge of each S5 that lies

adjacent to an S1 or S2, a pair of P5 occurring near the inner edge of each S3. Septal faces minutely spinose, appearing smooth. Fossa deep and narrow, containing a rudimentary trabecular columella.

TYPES: The holotype of *B. gigas* is deposited at the BM(NH) (1880.10.11.23). Four syntypes of *B. hawaiiensis* are deposited at the USNM (20823).

TYPE LOCALITIES: *B. gigas*: "Japan", depth unknown. *B. hawaiiensis*: Albatross Stn 4059, 19°48' N, 154°48' W (off Hawaii), 348-532 m.

REMARKS: Ralph and Squires (1962) identified *B. gigas* as both the Miocene *B. alta* and recent *Dendrophyllia japonica*. Although similar in size and robustness to *D. japonica*, *B. gigas* is distinguished by having a solitary, attached corallum; lacking discrete costae; having prominent S1-2 and a full fifth cycle at a GCD of only 21 mm; and in having a narrower fossa and corresponding smaller columella.

The New Zealand specimens of *B. gigas* differ slightly from Japanese specimens in lacking an epitheca and in having less well-defined costae. *Balanophyllia gigas* is the largest of all species in the genus, the New Zealand specimens being the largest known specimens of the species.

*Balanophyllia crassithec*a n. sp.

(Plates 40, i, 41, a, b)

MATERIAL EXAMINED: Types, q.v.

DISTRIBUTION: Known only from the New Zealand region off Lord Howe and Norfolk Islands; the Kermadec Ridge; and off northeastern North Island (Map 18); 190-508 m.

DESCRIPTION: Corallum ceratoid to trochoid; usually straight; and firmly attached by a thick pedicel (PD: GCD = 0.30-0.56). Largest specimen examined (NZOI Stn J686) 17.8 x 14.4 mm in calicular diameter and 46 mm in length, with a pedicel diameter of 9.2 mm; holotype 19.0 x 15.1 mm in calicular diameter, but only 29 mm in height, the pedicel being broken. Coralla usually attached to rocks or dead coralla of same species. Lower half to two-thirds of corallum epithecate and covered with encrusting organisms. Synchronicula near calice quite porous and only weakly costate, bearing poorly-defined, shallow

intercostal striae. Theca extremely thick, in some coralla up to 4.2 mm in width. Corallum white.

Septa hexamerally arranged in 4 complete (48 septa) cycles, occasionally with an incomplete fifth cycle, the largest calice having 72 closely spaced septa. S1–2 equal in size; only very slightly exsert (about 1 mm); with straight, entire inner edges that change to coarsely dentate in vicinity of columella. In half systems lacking S5, S3 are about half width of S1–2 and flanked by a pair of S4 that have very coarsely dentate inner edges, each pair merging before its common S3 and continuing to the columella as a single septum. In half systems with one pair of S5, the S4 adjacent to the S2 and the S5 adjacent to the S1 are of equal width, with coarsely dentate inner edges (rectangular teeth), their inner edges often fusing near the columella. In some half systems 2 pairs of S5 are present. Fossa of moderate depth, containing a small, elongate, non-discrete (flat to slightly concave, merging with inner edges of S1–2,4,5) columella composed of very fine papillae.

TYPES: Holotype: BS715 (R73), MoNZ CO222. Paratypes: NZOI Stn C527, 1, P-1058, USNM 94227; NZOI Stn J686, 12, P-1059, USNM 94228; NZOI Stn J705, 4, P-1060, USNM 94229; NZOI Stn J971, 1, P-1061, NZOI; Stn K844, 1, P-1062, NZOI; Stn P35, 1, P-1063, NZOI; Stn P85, 1, P-1064; MoNZ BS571, 1; MoNZ BS715 (R73), 1, MoNZ CO222, 2, USNM 94230; BS843 (O589), 3, MoNZ CO216 and 276.

TYPE LOCALITY: 37°17.0'S, 176°51.0'E (Rangatira Knoll, northwest of White Island, Bay of Plenty), 251–308 m.

ETYMOLOGY: The species name *crassitheca* (Latin *crassus*, thick + *theca*, container) refers to the thick theca of this species.

REMARKS: Given the confused state of the taxonomy of the Indo-Pacific *Balanophyllia*, it may seem foolhardy to describe yet another species, but *B. crassitheca* appears to differ from all other species in having a very thick theca, crowded septa, and coarsely dentate inner septal edges. It was directly compared to over half of the Indo-Pacific species based on voucher specimens deposited in the USNM, and to the other species through the literature.

Endopachys Lonsdale, 1845

Corallum solitary, cuneiform, and free, with alate edge crests on lower corallum. Asexual reproduction by budding from thecal edges common. Synapticulotheca weakly costate and highly porous. Septa arranged in a Pourtalès Plan. Paliform lobes (usually P4) present; columella rudimentary to spongy.

TYPE SPECIES: *Turbinolia maclurii* Lea, 1833, by subsequent designation (Milne Edwards & Haime 1850: lii).

REMARKS: *Endopachys* is quite similar to *Balanophyllia*, but differs in the cuneiform shape of its corallum and its propensity to bud from its thecal edges, although *B. stimpsonii* and *B. carinata* also bud coralla from their theca. The latter species is intermediate in corallum shape between the two genera. One recent and five fossil species are recognised (Wells 1975).

Endopachys grayi Milne Edwards & Haime, 1848 (Plate 41, c-h)

Endopachys grayi Milne Edwards & Haime, 1848b: 82–83, pl. 1, figs 2, 2a; Cairns 1984: 27, pl. 5, fig. E (synonymy); Cairns & Keller 1993: 276; Cairns 1994: 84–85, pl. 36, figs e, h, pl. 37, fig i (synonymy). *Endopachys oahense* Vaughan, 1907: 147–148, pl. 44, fig. 3.

MATERIAL EXAMINED: New Records: NZOI Stn E864, 85, USNM 94208; Stn I743, 3, NZOI; Stn K818, 1, NZOI; Stn K819, 1, NZOI; Stn P1, 17, USNM 94209; Stn P2, 9, USNM 94210; Stn P5, 1, NZOI; BS434, 10, MoNZ; BS833 (O578), 37, MoNZ CO287; BS882 (O628), 13, MoNZ CO283; BS883 (O629), > 100, MoNZ. Previous Records: Holotype of *E. oahense*.

DISTRIBUTION: New Zealand region: southern Norfolk Ridge; south of Three Kings Islands; Kermadec Ridge off Raoul Island; off East Cape (Map 13); 95–143 m. Elsewhere: widespread in tropical and warm temperate Indo-Pacific from off South Africa to Japan and Gulf of California, including south of Chesterfield Islands (New Caledonia) (reported herein); 37–386 m.

DESCRIPTION: Corallum triangular, with a highly compressed, rounded base. Edge angle a relatively constant 25–30°, but face angle only 15–25° for basal 9–10 mm, above which the faces di

verge at a much higher angle (i.e., 42–57°) resulting in an almost circular to diamond-shaped calice having a GCD: LCD of only 1.1–1.2. One of the largest New Zealand specimens (NZOI Stn E864) is 19.9 × 17.7 mm in calicular diameter and 27.8 mm in height. Thecal edges of basal thick and bulbous, up to 3 mm thick. Thecal faces above this swollen crest meet in an acute angle and invariably support several buds or scars of bud detachment. Asexually generated buds rarely maintain a connection beyond a corallum height of 4–5 mm; however, in some specimens the connection is never severed (Plate 41, e, g, h). A bud occasionally forms at the base of a corallum, resulting in 2 connected coralla growing in opposite directions. No coralla were observed to be attached to a substratum other than its parent corallum. Coralla begin bud formation at the relatively early stage of 8–10 mm GCD. Synapticulotheca quite porous, each septum corresponding to a flat costa about 0.5 mm wide that is bordered by intercostal furrows about 0.2 mm wide. Corallum white.

Septa hexamerally arranged in 5 cycles, the fifth incomplete, a corallum 8–10 mm in GCD with 48 septa and one of the largest of GCD 19 mm with 90 septa. S1–2 slightly exsert, thick, porous, and have straight, finely dentate lower inner edges. S3 about half width of S1–2, with finely dentate inner edges that do not reach the columella. S4 usually slightly wider than the S3 they flank, each bearing a wide paliform lobe that is paired with another in each half-system. In larger coralla, upper calicular edges of S4 bifurcate, thus becoming paired S5, and another cycle of rudimentary, dentate S4 develop between each split S4. The paliform lobes thus eventually realign with these septa. Fossa deep. Columella often absent, but if present, expressed as an elongate fusion of lower inner edges of S1–2 and P4.

TYPES: The deposition of the holotype of *E. grayi* is unknown. The holotype of *E. oahense* is deposited at the USNM (20822).

TYPE LOCALITIES: *E. grayi*: unknown. *E. oahense*: Albatross Stn 3810, south of Oahu, Hawaiian Islands, 386–463 m.

REMARKS: Only one recent widely distributed and morphologically variable species of *Endopachys* is considered to exist, many of the nominal species synonymised by Umbgrove (1950). The New

Zealand specimens differ slightly from most Indo-Pacific populations by having a taller and narrower corallum, characterised by a smaller edge angle of 25–30° (vs 50–55° for most populations). The New Zealand specimens also often have a thicker, bulbous basal crest region, which is more characteristic of the holotype of *E. oahense*.

Eguchipsammia Cairns, 1994

Basally unattached, recumbent coralla formed through sparse, irregular, extratentacular budding from an axial corallite. Lateral attachment to substrata by epitheca not uncommon. Synapticulothecate: costate and/or epithecate. Septa arranged in a Pourtalès Plan. Paliform lobes may be present; columella spongy to swirled.

TYPE SPECIES: *Dendrophyllia cornucopia* Pourtalès, 1871, by monotypy.

REMARKS: *Eguchipsammia* is distinguished from *Dendrophyllia* by having unattached, recumbent coralla with very sparse, irregular branching. Six species are currently recognised in the genus: *E. gaditana* (Duncan, 1873); *E. cornucopia* (Portalès, 1871); *E. japonica* (Rehberg, 1892); *E. fistula* (Alcock, 1902a); *E. serpentina* (Vaughan, 1907); and *E. wellsii* (Eguchi, 1968), three of which occur in the New Zealand region.

Eguchipsammia gaditana (Duncan, 1873) (Plate 42, a-c)

Balanophyllia gaditana Duncan, 1873: 333.

Dendrophyllia gaditana: Zibrowius 1980: 176–178, pl. 89, figs A–N (synonymy); Cairns 1984: 25, pl. 4, fig. I (synonymy); Cairns & Keller 1993: 279–280.
Eguchipsammia gaditana: Cairns 1994: 85–86.

MATERIAL EXAMINED: New Records: NZOI Stn C530, 4; NZOI Stn C531, 11, USNM 94241; NZOI Stn E865, 2, USNM 94242; NZOI Stn I71, 2, USNM 94243; NZOI Stn K803, 7; NZOI Stn K825, 1, USNM 94244; NZOI Stn K838, 4, USNM 94245; NZOI Stn K839, 1; NZOI Stn K842, 7; NZOI Stn K857, 2, USNM 94246; NZOI Stn T217, 1, USNM 94247; NZOI Stn U582, 1; BS310, 20, MoNZ CO83; BS313, 4, MoNZ CO93; BS437, 9, MoNZ CO265; BS896 (O642), 1, MoNZ CO232. Previous Records: Specimens reported by Zibrowius (1980).

DISTRIBUTION: New Zealand region: ridges north

of North Island, including Norfolk, Three Kings, and Kermadec Ridges (Map 15); 57–988 m, but most records between 100 and 200 m. Elsewhere: worldwide, including amphi-Atlantic, southwest Indian Ocean, off Hawaiian Islands, Australia, and Japan; 73–505 m.

DESCRIPTION: Corallum consists of an elongate, cylindrical, axial corallite from which numerous smaller corallites bud at right angles to the axial. Although secondary corallites bud within the edge zone region (0.5 mm from calice), they often remain attached long after the edge zone has progressed. Synapticulotheca beneath edge zone costate, each costa slightly convex, finely granular, and separated by thin porous intercostal furrows. In some coralla the C1–2 are slightly ridged. Proximal to edge zone, which may be as close as 1 mm to calice, costae are usually covered with a very thin epitheca. Largest New Zealand specimen examined (BS310) 90 mm long, bears 20 buds or scars of bud attachment, and has an axial GCD of 5.0 mm, although GCDs of 13 mm are common, especially for budding corallites. Corallum not basally attached to substratum, but occasionally sides of axial or secondary corallites adhere to hard substrata. Corallum white.

Septa hexamerally arranged in 3 to 4 cycles, depending on calicular diameter. Small corallites (e.g., GCD = 1–3 mm) usually have only 3 cycles of septa, cycles 2 and 3 being arranged in a Pourtalès Plan. Large calices with a variable number of S4, the largest corallites with a full 48 septa. S1 only slightly exsert, with smooth, vertical inner edges that fuse with the columella. S2 about half width of S1, each S2 enclosed by a pair of S3 that fuse directly before it high in the fossa and continues toward columella as a finely dentate septum. In larger corallites, pairs of S4 merge before their common S3 and ultimately before their common S2 within its system in a typical Pourtalès Plan. Columella a small, non-discrete, concave spongy mass in center of fossa.

TYPES: The holotype of *B. gaditana* is deposited at the BM(NH) (1883.12.10.97).

TYPE LOCALITY: Porcupine Stn 29, 36°20' N, 6°47' W (Iberian-Morocco Gulf), 417 m.

REMARKS: *Eguchipsammia gaditana* and *E. wellsi* are characterised as having very slender corallites

and delicate coralla, but *E. gaditana* is distinguished by its nondiscrete, spongy columella; its fusion of S3–4 high in the fossa; and epithecate lower corallum (see Cairns 1994).

Eguchipsammia fistula (Alcock, 1902)

(Plate 42, d-h)

Balanophyllia (*Thecopsammia*) *fistula* Alcock, 1902a: 109; 1902c: 42, pl. 5, figs 36, 36a.

Dendrophyllia oahensis Vaughan, 1907: 154–155, pl. 46, fig. 1 (new synonymy); Cairns 1984: 25.

Dendrophyllia fistula: Cairns & Keller, 1993: 281 (synonymy).

Not *Balanophyllia fistula*: Yabe & Eguchi 1942b: 141.

Eguchipsammia fistula: Cairns 1994: 86, pl. 36, figs f-g.

MATERIAL EXAMINED: New Record: NZOI Stn K842, 31 branch fragments, NZOI, 12, USNM 94240. Previous Records: Syntypes of *B. fistula* and holotype of *D. oahensis*.

DISTRIBUTION: Known from only one site in New Zealand region off Macauley Island, Kermadecs (Map 22); 325 m. Elsewhere: western Indian Ocean; off Maldives; Sulu Archipelago; Hawaiian Islands; 210–900 m.

DESCRIPTION: Corallum consists of an elongate, cylindrical, axial corallite, from which several corallites of about equal diameter bud at right angles. Epitheca thick, usually extending to within 1 mm of the calice and masking the underlying costae and synapticulotheca. Epitheca smooth, but composed of fine (25–65 µm wide) transverse corrugations. Largest Kermadec specimen 6.4 x 5.7 mm in calicular diameter and 57 mm in length, sporting only 3 buds and one scar of bud detachment. Coralla rarely, if ever, basally attached; however, scattered epithelial attachment to small objects is not uncommon. Corallum white.

Septa hexamerally arranged in 4 complete cycles (48 septa): S1–2 independent, S3–4 arranged in a Pourtalès Plan. S1 slightly exsert, with straight, vertical inner edges that border the columella. S2 equally exsert and only slightly less wide than the S1. S3 quite small, a pair of S4 meeting before its common S3 often in a small paliform lobe (P3). Inner edges of S1–4 and paliform lobes smooth (not dentate). Fossa relatively shallow, containing a discrete, convex columella composed of closely swirled fascicular elements.

TYPES: Three syntypes of *B. fistula* are deposited at the ZMA (Coel. 563, 564). The holotype of *D. oahensis* is deposited at the USNM (20827).

TYPE LOCALITIES: *B. fistula*: Siboga Stn 105 and 107, Sulu Archipelago, Philippines; 270–275 m. *D. oahensis*: Albatross Stn 4114, 21°40'10 N, 158°08'45 W (Waimea Bay, Oahu, Hawaiian Islands), 282–357 m.

REMARKS: Comparison of the syntypes of *B. fistula* to the holotype and other Hawaiian specimens of *D. oahensis* show no differences. Among the three species of *Eguchipsammia* known from the New Zealand region, *E. fistula* is intermediate in size, and characterised by having a very well-developed epiteca and a shallow fossa.

Eguchipsammia japonica (Rehberg, 1892) n. comb.

(Plate 43, a-c)

Dendrophyllia japonica Rehberg, 1892: 28–29, pl. 4, fig. 4; Van der Horst 1926: 44–45, pl. 3, figs 4–5; Gardiner 1929: 127, pl. 1, figs 1–2; Squires & Keyes 1967: 28, pl. 6, figs 6–8; Dawson 1979: 28; Cairns 1994: 90 (synonymy).

Not *Dendrophyllia japonica* Van der Horst, 1922: 51 (junior primary homonym).

Not *Dendrophyllia japonica*: Ralph & Squires 1962: 15–16, pl. 8, figs 4–5 (= *Balanophyllia gigas*).

Balanophyllia alta: Ralph & Squires 1962: 15 (in part: pl. 8, fig. 1).

MATERIAL EXAMINED: New Records: NZOI Stn D242, 12, USNM 94212; Stn D424, 12, NZOI; Stn F933, 9, USNM 94213; Stn I375, 4, NZOI; Stn J683, 5, NZOI; Stn J711, 8, NZOI, 2, USNM 94214; Stn J716, 7, USNM 94216; Stn K795, 1, NZOI; Stn K826, 12, NZOI; Stn P13, 5, NZOI; Stn Z2098, 8, NZOI; BS314, 5, NZOI; BS313, 1, MoNZ CO126; BS630, 3, MoNZ CO123; *Eltanin* Stn 1718, > 20, USNM 79500. Previous Records: Specimens reported by Squires and Keyes (1967) and Ralph and Squires (1962) as *D. japonica*.

DISTRIBUTION: Widespread in New Zealand region from the northern ridges to off Fiordland and Chatham Rise (Map 5); 142–785 m. Elsewhere: off Japan; Banda Sea; 115–245 m.

DESCRIPTION: Corallum robust, subcylindrical, and elongate, often vermiform. Largest New Zealand specimen (*Eltanin* Stn 1718) 150 mm long and 20.5 mm in GCD, although some populations (e.g., NZOI Stn J711) have consistently

smaller calicular diameters that rarely exceed 8–10 mm. Irregular, asexual budding from edge zone quite common, some coralla having 10–20 buds or scars of bud detachment, the latter more common on lower theca. Third generation buds never observed. Base of all coralla either organically connected to parent corallum or broken, the latter condition a result of detachment from parent; coralla not observed attached to a substratum. Costae well defined, consisting of very finely spinose, flat to slightly convex strips 0.3–0.5 mm wide that are usually present from base to calice. Intercostal striae narrow (about 0.1 mm) and porous. Corallum white, the coenosarc (edge zone) extending only 20–40 mm from calice, below which the synapticulotheca appears worn.

Septa hexamerally arranged in 5 cycles, the fifth cycle always incomplete. Coralla 4 mm in GCD have only 3 cycles; those 5–9 mm in GCD have a complete fourth cycle; and larger coralla (up to 20 mm GCD) contain pairs of S5, but in no specimen was a complete fifth cycle present. S1 not exert, their straight inner edges usually extending well into fossa. S2 four-fifths width of an S1, but also merge with columella low in fossa. S3 also independent and about two-thirds width of an S2. In half-systems lacking S5, the 2 S4 merge before the S3 and have dentate inner edges in this region. One or 2 pairs of S5 occur in half-systems of larger coralla, developed in a Pourtalès Plan. Fossa deep and elongate. Columella quite variable, some small coralla with fascicular columella, whereas most larger coralla have an elongate, papillose columella of variable size. Endothecal dissepiments present.

TYPES: Two syntypes of *D. japonica* are deposited at the ZMB (Van der Horst 1926).

TYPE LOCALITY: "Japan."

REMARKS: Previously (Cairns 1994), I placed Rehberg's *D. japonica* in *Dendrophyllia* because I interpreted its large-diameter basal fractures as evidence that it was an attached, sparsely branched dendrophylliid. After having examined more specimens from the New Zealand region, I now see that buds may attain a large basal diameter prior to detachment, and that the New Zealand taxon previously identified as *D. japonica* has a recumbent corallum with randomly arranged, detachable buds — characteristic of

the genus *Eguchipsammia*. In fact, it is remarkably similar to, if not conspecific with, the type species *E. cornucopia* (Pourtalès, 1871), known only from the Atlantic at 132–960 m (Cairns 1979).

Detached buds, before they have generated buds themselves, could easily be mistaken for a *Balanophyllia* with a broken pedicel.

Cladopsammia Lacaze-Duthiers, 1897

Small, phaceloid colonies formed by extratentacular budding from a common basal coenosteum and from edge zone of larger corallites. Poralis well developed. Pali absent; columella spongy.

TYPE SPECIES: *Cladopsammia rolandi* Lacaze-Duthiers, 1897, by monotypy.

Remarks: As previously noted (Cairns 1994), *Cladopsammia* has a colony form intermediate between that of *Rhizopsammia* (reptoid) and *Dendrophyllia* (branching), characterised by budding from a common coenosteum. Four species are recognised: *C. rolandi* Lacaze-Duthiers, 1897; *C. gracilis* (Milne Edwards & Haime, 1848b); *C. eguchii* (Wells, 1982); and *C. echinata* Cairns, 1984.

Cladopsammia eguchii Wells, 1982 (Plate 43, d)

Balanophyllia eguchii Wells, 1982: 211, 213, pl. 1, figs 4–6; 1983: 239–240; Cairns 1991a: 23, pl. 9,
Cladopsammia eguchii: Cairns 1994: 88, pl. 38, figs a–b.

MATERIAL EXAMINED: New Record: L1630, 6 colonies, AIM AK76949, 1, USNM 94591; Gulf of California off La Paz, USNM 93919. Previous Records: holotype and non-type specimens of Wells (1982).

DISTRIBUTION: New Zealand region: known only from one collection from the roof of a cave on west side of N. Meyer Island, Raoul Island, Kermadec Ridge (Map 22), 7 m. Elsewhere: off Queensland; Japan; Hawaiian Islands; Gulf of Panama; Galápagos Islands; Gulf of California (reported herein); 1–85 m.

TYPES: The holotype is deposited at the USNM (46966).

TYPE LOCALITY: Marchena Island, Galápagos, 6 m.

REMARKS: *Cladopsammia eguchii* was relatively recently described (Wells 1982) and redescribed by Cairns (1991a, 1994) and need not be re-described again. It is the only colonial dendrophylliid in the New Zealand region known to have a phaceloid growth form. The largest colony from Stn L1630 is 40 mm in width and contains about 20 corallites. The largest corallite of this corallum is 11.2 x 8.8 mm in calicular diameter and 32 mm in height, containing a full fifth cycle of septa.

Dendrophyllia de Blainville, 1830

Corallum colonial, extratentacular budding forming colonies of three shapes: 1) arborescent, with axial corallites, 2) small, bushy coralla with sparse branching, and 3) dendroid colonies with sympodial branching. All forms originate from a single basal stem. Synapticulotheca usually clearly costate. Septa arranged in a Poralis Plan. Pali may be present; columella spongy or papillose. Tabular endothelial dissepiments may be present.

TYPE SPECIES: *Madrepora ramea* Linnaeus, 1758, by subsequent designation (Milne Edwards & Haime 1850: liii).

REMARKS: In my emendation of the generic diagnosis of *Dendrophyllia* (Cairns 1994), I divided the 25–30 recent species in that genus into three growth forms (see above diagnosis), all growth forms having in common a colony supported by a single basal stem, as opposed to an encrusting, stoloniferous, phaceloid, or unattached growth mode. In the New Zealand region two species of *Dendrophyllia* are known: *D. arbuscula* Van der Horst, 1922 (a member of growth-form 2 above) and *D. alcocki* (Wells, 1954) (a member of growth-form 3 as diagnosed).

Dendrophyllia arbuscula Van der Horst, 1922 (Plate 43, e, f)

Dendrophyllia arbuscula Van der Horst, 1922: 53, pl. 8, fig. 6; Cairns 1994: 90–91, pl. 38, figs i–l (synonymy).

MATERIAL EXAMINED: New Records: NZOI Stn I72, 1, USNM 94237; NZOI Stn I76, 2I; NZOI Stn K823, 1; NZOI Stn K843, 1, USNM 94238; BS571, 1, MoNZ CO231, 1, USNM 94239.

DISTRIBUTION: New Zealand region: off Norfolk and Kermadec Islands (Raoul and Macauley Islands) (Map 15); 202–259 m. Elsewhere: off Japan; East China Sea off Korea; Banda Sea; Strait of Malacca; 40–240 m.

DESCRIPTION: Colonies small and sparsely branched at irregular intervals, the largest New Zealand specimen (BS571) 70 mm tall and having only 6 corallites. Primary corallites cylindrical (GCD up to 10 mm) and firmly attached to substratum; secondary- to quaternary-generation corallites ceratoid to cylindrical. Costae inconspicuous, being flat, highly porous, and poorly delineated by intercostal striae. The solitary coral *Caryophyllia rugosa* is often attached to dead basal sections of corallum. Corallum white.

Septa hexamerally arranged in 4 cycles (48 septa). S1 slightly exsert and thick near calicular edge, with straight, vertical inner edges that extend to the columella. S2 less exsert, about three-quarters width of an S1, reaching the columella only deep in fossa. S3 small, only one-fifth to one-quarter width of an S2, each flanked by a pair of S4, which fuse before their common S3 and continue to the columella. Paliform lobes absent. Inner edges of S4 dentate to lacinate for entire length. Fossa of moderate depth, containing a well-formed, discrete, spongy columella, which is often constricted into 3 contiguous sections by the penetration of inner edges of 4 lateral S1. Endothecal dissepiments present.

TYPES: Three syntypes of *D. arbuscula* are deposited at the ZMA (Coel. 1254, 5477).

TYPE LOCALITY: *Siboga* Stns 260 and 277, Banda Sea, 45–90 m.

REMARKS: *Dendrophyllia arbuscula* belongs to the "second growth form" as defined by Cairns (1994), i.e., those species having small, bushy coralla originating from a primary (axial) corallite and bearing relatively few additional corallites, in this case not more than four generations. Other species having this growth form include: *D. cornigera* (Lamarck, 1816); *D. cladonia* Van der Horst, 1927; and *D. horsti* (Gardiner & Waugh, 1939), the first species known from the eastern Atlantic, the latter two species from the Indian Ocean. *Dendrophyllia arbuscula* thus far appears to be limited to the western Pacific.

Dendrophyllia alcocki (Wells, 1954)

(Plates 43, g-i, 44, a, b)

Sclerhelia alcocki Wells, 1954: 465–466, pl. 177, figs 1–2.
Dendrophyllia palita Squires & Keyes, 1967: 28–29, pl. 6, figs 9–10; Dawson 1979: 28.

Dendrophyllia minuscula: Gardiner & Waugh 1939: 237 (in part: *John Murray* Stn 157).

Dendrophyllia alcocki: Zibrowius 1974c: 570–573, figs 10–14; Manning, 1991: 518.

Enallopsammia sp. Zibrowius & Grygier, 1985: 134.

MATERIAL EXAMINED: New Records: NZOI Stn C527, 10, USNM 88386; NZOI Stn C530, 2; NZOI Stn D159, 2 dead fragments, USNM 79492; NZOI Stn D424, 10 dead fragments, USNM 94259; NZOI Stn E859, 6, USNM 94260; NZOI Stn I91, 5, USNM 94261; NZOI Stn I92, 3, USNM 94262; NZOI Stn J683, 2; NZOI Stn J705, 11; NZOI Stn K795, 1; NZOI Stn K826, 3; NZOI Stn K838, 21; NZOI Stn K842, 41; NZOI Stn K872, 3; NZOI Stn N897, 6; NZOI Stn P85, 1; NZOI Stn P925, 1; NZOI Stn Q70, 1; NZOI Stn S572, 7; NZOI Stn T217, 21; NZOI Stn U594, 2. Previous Records: Type and nontypes of *D. palita* reported by Squires & Keyes (1967); holotype of *S. alcocki*.

DISTRIBUTION: New Zealand region: Norfolk, Three Kings, and Kermadec Ridges; Bay of Plenty; off Cape Egmont; off Fiordland; Solander and Hikurangi Troughs (Map 3); 118–570 m, the shallowest occurrence off Fiordland. Elsewhere: off Maldives; Bikini Atoll; Solomon Islands (Zibrowius & Grygier 1985); New Caledonia (Manning 1991); Tasman Sea west of Lord Howe Seamount Chain (NZOI Stn P925); 177–420 m.

DESCRIPTION: Uniplanar to arborescent colonies formed by extratentacular sympodial budding, a calice generated approximately every 3–5 mm on opposite sides of a branch; branch anastomosis absent. Largest New Zealand specimen (NZOI Stn B490) 110 mm in height and 8 mm in basal diameter, but most branches examined only 3–5 mm in diameter. Only several colonies were collected with their base intact, most specimens represented by broken distal branches. Calices 3–4 mm in diameter. Coenosteum dense and relatively solid, noticeably porous only near calicular edge and occasionally on surface of distal branches as irregularly spaced circular pores 0.05–0.13 mm in diameter; theca also uniformly covered with tiny (10–19 mm diameter) pits. Costae inconspicuous, the coenosteum covered with numerous small (0.13–0.15 mm tall,